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RE^4 Project

REuse and REcycling of CDW materials and structures in energy efficient pREfabricated elements for building REfurbishment and construction

D1.1 Data collection on CDW	
Author(s)[1]:	CETMA, ACCIONA, CBI, FENIX, QUB, ROS, NTUST, ACR+
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Work package:	WP1 - Mapping and analysis of CDW reuse and recycling in prefabricated elements
Distribution[2]	PU
Status[3]:	Final
Abstract:	This report outlines the current CDW management situation, not only in the participating countries but in all European countries, against the background of national (and/or regional, where appropriate) waste management plans and prevention programmes. The analysis has been extended also to extra EU countries, such as Taiwan Singapore and Honk-Kong, with the aim to compared the situation at extra-continental level.
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[1] *Just mention the partner(s) responsible for the Deliverable*
[2] *PU: Public, RE: restricted to a group specified by the consortium, CO: Confidential, only for members of the consortium; Commission services always included.*
[3] *Draft, Revised, Final*

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ACRONYMS & ABBREVIATIONS

CDW	Construction and Demolition Waste
WMP	Waste management plans
EoW	End of Waste
WMA	Waste Management Act
WPP	Waste Prevention Plan
FWMP	Federal Waste Management Plan
RMA	Resource Management Agency
OWD	Walloon Waste Office
EPR	Enterprises and extended producer responsibility
C&D	Construction and Demolition
BCR	Brussels Capital Region
EQAR	European Quality Association for Recycling
OAK	Cyprus Recycling Organisation
ECDW	Excavation, Construction and Demolition Waste
CYSTAT	Statistical Service of Cyprus
MoE	Ministry of Environment
EPR	Extended Producer Responsibility
NOTRe	New Territorial Organisation of the French Republic
PREDEC	CDW prevention and management plan for the Paris Region
ADEME	French Environment and Energy Management Agency
FFB	French Building Federation
SOeS	Observation and Statistics department
SNED	National Syndicate of Demolition Companies
ANR	National Research Agency
TGAP	General Tax on Polluting Activities
EGF.BTP	National Syndicate for General Contractors in Building and Public Works
AbfRRL	European Waste Management Directive(Directive 2008/98/EC
KrWG	Circular Economy Act
AbfG	National Waste Disposal Act
AVV	Waste Register Ordinance
ZSA	Central Body for Waste Supervision
LfU	State Office for Environment
UMK	Conference for Ministers for Environment
NWMP	National Waste Management Plan
DSS	Decision Support System
MIPL	Mixed-integer linear programming
NWPP	National Waste Prevention Program
NEP	National Environmental Program

KEHOP	Environment Efficiency and Energy Operational Programme
GINOP	Economic Development and Innovation Operational Programme
TOP	Regional and Local Development Operational Programme
DECLG	Department of Environment, Community and Local Government
EPA	Environmental Protection Agency
FAS	Training and Employment Authority
CIF	Construction Industry Federation
WFD	Waste Framework Directive
POPs	Persistent Organic Pollutants
NHWMP	National Hazardous Waste Management Plan
NCDWC	National Construction and Demolition Waste Council
GPP	Green Public Procurement
EWC	European Waste Catalogue
NRA	National Roads Authority
BREEAM	Building Research Establishment Environmental Assessment Method
LEED	Leadership in Energy and Environmental Design
USGBC	United States Green Building Council
USEPA	United States Environmental Protection Agency
WRAP	Waste Resources Action Programme
PRTR	Pollutant Release and Transfer Register
CSO	Central Statistics Office
STRIVE	Science, Technology, Research and Innovation for the Environment Programme
HDP	High-Density Polyethylene
PVC	Polyvinyl Chloride
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale
ANPAR	National Association of Manufacturers Recycled Aggregates
SNPA	Sistema Nazionale della Protezione dell'Ambiente
MUD	Modello Unico di Dichiarazione Ambientale
IFEU	Institute (Institut für Energie- und Umweltforschung Heidelberg
SEE	Southeast Europe
SARMa	Sustainable Aggregates Resource Management
MPS	Secondary Raw Materials
MOU	Memorandum of Understanding
LMW	Law on Management of Waste
NSO	National Statistics Office – Malta
BSSA	Decree on landfills and bans waste
LAP	National Waste Management Plan

C2C	Cradle-to-Cradle
VANG	**Waste To Raw material**
REBus	Resource Efficient Business Models
UCA'	Urban Conservation Areas
EC	European Commission
EEA	European Environment Agency
PERSU	National Waste Management Plans
MSW	Municipal waste management
RERU	Outstanding Regime for Urban Rehabilitation
MIRR	Integrated Map for Waste Registration
SIRAPA	Integrated Registration System developed by the Portuguese Environment Agency
INE	Instituto Nacional de Estatística
APA	Agência Portuguesa do Ambiente
APOGER	Portuguese Association of Waste Management Operators and Recycler
AICCOPN	Industrial Association of Construction and Public Works
ANMP	National Association of Portuguese Municipalities
GEOTA	Grupo de Estudos de Ordenamento do Território e Ambiente
PAHs	Polycyclic Aromatic Hydrocarbons
HCl	Hydrochloric acid
HF	Hydrofluoric acid
SOx	Sulphuric acid
CO	Carbon monoxide
NOx	Nitrogen oxides
VOC's	Volatile Organic Compounds
PAH's	Polycyclic aromatic hydrocarbons
H_2S	Hydrogen sulphide
ANPM	National Environmental Agency
SEPA	Swedish Environmental Protection Agency
ADS	Waste Data system
BAU	Business as usual
WEEE	Waste electrical and electronic equipment
PNIR	National Integrated Waste Plan
PEMAR	State Framework Plan on Waste Management
FERCD	Spanish Federation of Construction and Demolition Waste
HQE	Haute Qualité Environnementale
WAC	Waste Acceptance Criteria
VVEA	Ordinance for Avoidance and Disposal of Waste
TVA	Technical Ordinance for Waste
BAFU	Federal Agency for Environment
ARV	Association for Building Material Recycling and Waste

	Information Switzerland
PCBs	Polychlorinated biphenyls
PAH	Polycyclic aromatic hydrocarbons
TEEP	Technically, environmentally and economically practicable (
EAE	Environment Agency (England)
NRW	Natural Resources Wales
SEPA	Scottish Environment Protection Agency
NIEA	Northern Ireland Environment Agency
BRE	Building Research Establishment
HQM	Home Quality Mark
RICS	Royal Institution of Chartered Surveyors
ICE	Institution of Civil Engineers
ENCORD	European Network of Construction Companies for Research and Development
CDEW	Construction, Demolition and Excavation Waste
NFDC	National Federation of Demolition Contractors
TM	Technical Memorandum
CIBSE	Chartered Institute of Building Services Engineers
SEDA	Scottish Ecological Design Association
CCS	Considerate Constructors Scheme
NIEA	Northern Ireland Environment Agency
WRA	Wood Recyclers' Association
RFD	Refuse Derived Fuel
EWC-STAT	European Waste Classification for Statistics
EUROSTA	Statistical Office of the European Union
DRIDS	Demolition and Refurbishment Information Datasheets
UKCG	UK Contractors Group
RCA	Recycled Concrete Aggregate
RMA	Recycled Masonry Aggregate
MPA	Minerals Production Association

1. INTRODUCTION

1.1 Summary

The aim of this first report is to analyse the current CDW management situation in the participating countries against the background of national (and/or regional, where appropriate) waste management plans and prevention programmes. So each partner has provided information about the belonging country, establishing direct contacts with the relevant Ministry of Environment or the proper Agency for Environmental Protection and Research (e.g. ISPRA in Italy) for the quantitative data on CDW. For a more complete study, each involved partner has also provided information also for neighbouring countries, while CETMA has provided information for all the remaining European countries, using EUROSTAT (or other relevant database) only for obtaining data about the other EU countries not involved in RE4 project.

Since NTUST in not located in an European Country, it has been decided that it should provide information about the belonging country, Taiwan, so that a comparison between European situation and another continent should be done.

The Table 1 the partition of countries among involved partners.

Table 1. Countries distribution among involved partners.

Country	Partner in charge
Austria	ROS
Belgium	ACR+
Bulgaria	CETMA
Croatia	CETMA
Cyprus	QUB
Czech Republic	FENIX
Denmark	CBI
Estonia	CETMA
Finland	CBI
France	ACR+
Germany	ROS
Greece	CETMA
Hungary	CETMA
Ireland	QUB
Italy	CETMA

Latvia	CETMA
Lithuania	CETMA
Luxembourg	CETMA
Malta	ACR+
Netherlands	CETMA
Poland	FENIX
Portugal	ACCIONA
Romania	CETMA
Slovakia	FENIX
Slovenia	CETMA
Spain	ACCIONA
Sweden	CBI
Switzerland	ROS
United Kingdom	QUB
Taiwan	NTUST

At the beginning of the project (i.e. September 2016), the Task leader CETMA sent to the other partners a list of information to be completed for each country, as following:

1. Legal Framework – Waste Management Plans and Strategies
   - 1.1. National Legislation concerning CDW
   - 1.2. Waste management plans (WMP) and Strategies
   - 1.3. Legal framework for sustainable management of CDW
   - 1.4. Targets
   - 1.5. End of Waste (EoW) status
2. Non legislative instruments (best practices, guidelines, recommendations…)
3. CDW management performance – CDW data
   - 3.1. CDW generation data
   - 3.2. CDW treatment data
   - 3.3. CDW exports/imports data
   - 3.4. CDW treatment facilities data
   - 3.5. Future projections of CDW generation and treatment

3.6. Methodology for CDW statistics

4. C&D waste management in practice

 4.1. CDW management initiatives
 4.2. Drivers / barriers to increase CDW recycling

5. CDW sector characterization

 5.1. CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)
  5.1.1. *Product description and applications*
  5.1.2. Quantitative analysis
  5.1.3. Recovery techniques
  5.1.4. Environmental and economic impacts of CDW waste management
  5.1.5. Drivers / barriers to increase recycling
 5.2. Recycled materials from CDW
 5.3. Market conditions / costs and benefits.

All the contributions are reported in the paragraph below.
Much of the information contained in this deliverable have been taken from reports, drafted by DELOITTE in 2015 within a project commissioned by European Commission and published on the website of the European Community[4]. These data have been updated, where possible, through national or EUROSTAT database, or with recent regulation and statistics.

[4] Reference to each documenti s reported in the text of the deliverable.

2. AUSTRIA

2.1 Legal Framework – Waste Management Plans and Strategies

2.1.1 National Legislation concerning CDW

Austria has recently replaced its multitude of regulations concerning handling and treatment of CDW recently with the Recycled Construction Materials Regulation, which came into force on 1st January 2016 and was last changed on 28th October 2016 [1].

The main aim of this regulation is to guarantee environmentally compatible Reinforced Concrete building materials and legal certainty for their users and producers.

Specific requirements for recycling-oriented demolition and separation as well as manufacture and construction with recycled construction materials are determined. These ensure that the European Waste Framework Directives obligations are met. Furthermore, a link to a new Austrian standard on the use of recycled aggregates (ÖNORM B 3140) is established. This standard covers a wider range of end uses than EN 12620.

ÖNORM B 3151 establishes a standard method for the dismantling of buildings. It clearly states that removed building components have to be used elsewhere if possible. Furthermore, it provides templates for a material building survey and reporting prior to dismantling.

2.1.2 Waste management plans (WMP) and Strategies

The Federal Minister of Agriculture, Forestry, Environment and Water Management is required to release a Federal Waste Management Plan at least once every six years. The fifth and latest Federal Waste Management Plan was released in 2011. The next one is being published in 2017.

This plan serves to accomplish the requirements and principles set by the Waste Management Act of 2002 (AWG 2002) and it is available in English language [3].

The European Waste Framework Directive of 2008 was implemented in the Austrian Waste Management Act in 2010. Therefore, it implements a similar 5-step European Waste Hierarchy as seen in German standards [4].

The Federal Waste Management plan features a comprehensive guide covering waste streams, treatment facilities, material requirements, waste prevention, treatment principles, shipment guidelines and remediation of contaminated sites.

2.1.3 Legal framework for sustainable management of CDW

The legal framework for sustainable management of waste is reported Table 2.

Table 2. Legal framework for sustainable management of CDW.

Legal framework	
National or regional obligation for selective demolition	Dismantling is covered in the recently established Recycled Construction Materials Regulation, which points to ÖNORM B3151 (recovery oriented dismantling).
National or regional sorting (on-site or in sorting facility)	Sorting should take place on-site if the CDW exceeds a certain tonnage. Mixing the CDW on-site and sorting it later in a facility is only allowed when sorting on-site causes unreasonable financial strain
National or regional separately collect different materials (iron, steel, plastic, glass, hazardous waste etc.)	
Green public procurement requirements	Recovery is part of the set requirements in building demolition. Specific guidelines and standards must be followed. Dismantling must take place according to the state of technology

2.1.4 Targets

Concerning the targets of re-use, recycling and recovery of CDW, Austria refers to the European Waste Framework Directive target.

2.1.5 End of Waste (EoW) status

The end of waste status is defined under the Waste Management Act in Section §5 and Recycled Construction Materials Regulation in Section §14 and it complies with the criteria set by the European Waste Framework Directive:

– the object is normally used for this specific purpose,
– there is a market for it
– there are quality criteria that take into account waste-specific pollutants into account, especially in the form of technical or legal standards or recognised quality guidelines, and
– the object does not cause any greater environmental pollution or risk than a comparable primary raw material or a comparable product from a primary resource [2].

Harmful substances, materials and threshold values for pollutants and that must be avoided are stated in section 3 § 7 and annex 2 of the Recycled Construction Materials Regulation.

2.2 Non legislative instruments (best practices, guidelines, recommendations…)

– **Federal Waste Management Plan** (**FWMP**): The FWMP already mentioned in paragraph 1.2 serves to support achievement of the objectives and principles of the Waste Management Act of 2002.
– The Austrian Construction Materials Recycling Association [5] provides several guidelines, leaflets and best practice checklists covering various aspects of treating construction residue and using recycled construction materials.

– The **Resource Management Agency** (RMA) [6] has published a primer aims at improving overall sustainability in construction.

2.3 CDW management performance – CDW data

2.3.1 CDW generation data

In 2014, Austria's mineral building waste amounted to approximately 9,5 million tonnes (Figure 1) [7].

This amount fluctuates every year, since it heavily depends heavily on the level of construction and demolition activities.

Section §17 of the Austrian Waste Management Act states that owners (i.e. producers, collectors and processers) of waste have to keep continuous records on type, quantity, origin and whereabouts of their waste.

Treatment plants of hazardous waste must also report origin, quantity and whereabouts of their hazardous and non-hazardous waste.

<u>Hazardous waste</u>

Regular producers of hazardous waste in Austria have to register themselves electronically and to report hazardous waste production.

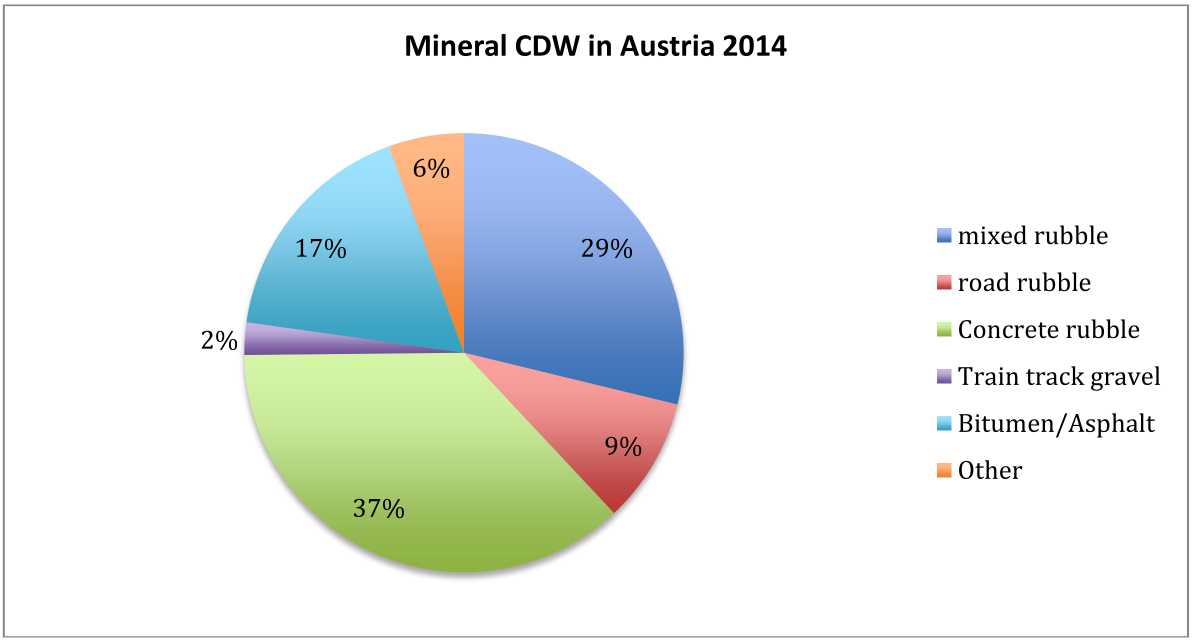

Figure 1. Groups of waste in Austria 2014, source: Federal Ministry of Agriculture, Forestry, Environment and Water Management.

2.3.2 CDW treatment data

8,7 of 9,5 million tonnes were processed in treatment facilities [7]. The amount of processed CDW has risen constantly over the last two decades.

Only 570.000 tonnes were sent to landfill, mostly due to inhomogeneity of waste streams. This amount has remained somewhat constant over the last decade [7].

2.3.3 CDW exports/imports data

Austria imported 46.000 tonnes and exported 17.000 tonnes of CDW in 2014 [7].

2.3.4 CDW treatment facilities data

Austria has 411 CDW stationary and mobile treatment facilities as of 2014. Their combined capacity is estimated to exceed treatment of 10 million tonnes per year [7].

These facilities are capable of separating iron scrap, wood and plastic from mineral fractions. Then, the mineral fractions are used to produce construction aggregates with specific granularity.

2.3.5 Future projections of CDW generation and treatment

No future projections were found for Austria.

2.3.6 Methodology for CDW statistics

Waste figures follow Eurostat guidelines.
It should be noted that the rise in numbers after 2009 might be a result of increased reporting compliance, rather than increased waste production. For the time being, no changes in methodology for CDW statistics are planned.

2.4 C&D waste management in practice

2.4.1 CDW management initiatives

Austria has one national and several regional CDW management initiatives.
The national platform [8] consists of a market platform for supply and demand of recycled CDW.
The Resource Management Agency (RMA) hosts several initiatives related to legal incentives for urban mining waste [9], a concept for the sustainable use of CDW [10] and a framework for the development of a regional network for the reuse of building components [11].

2.4.2 Drivers / barriers to increase CDW recycling

A list of Drivers / barriers to increase CDW recycling ais reported in Table 3.

Table 3. Drivers / barriers to increase CDW recycling.

Factor	Drivers	Barriers
Quality of RC-material	The recently implemented Recycled Construction Materials Regulation [1] greatly increases transparency and common properties of recycled	

Factor	Drivers	Barriers
	CDW materials	
Price		Primary raw materials are still available at low prices. Therefore, secondary building materials lack attractiveness
Legal	Austria has a standardised, national legal framework for the use of recycled CDW materials	Trade and use of RC-materials must be within the waste legislation framework. Accounting and licensing costs are therefore to be considered by the manufacturers.
Public procurement		No fixed quota for recycled materials or similar requirements
Reputation		RC-materials have a negative image and are not trusted y the constructers
Guideline	A nation-wide guideline that complies with EU standards	

2.5 CDW sector characterization

Austria's CDW sector is characterized by many small businesses with 10 and 50 employees. Smaller companies tend to declare themselves as building company, not as recycler. That leads to the conclusion that there could be even more small businesses that do not show up in the statistics.

Most of these businesses (roughly 80%) are organized in the Austrian Association for Recycling of Building Materials. This association works closely together with federal ministries.

2.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

No data about specific CDW material groups has been found.

Quantitative analysis

No data about specific CDW material groups has been found.

Recovery techniques

No data about specific CDW material groups has been found.

Environmental and economic impacts of CDW waste management

No data about specific CDW material groups has been found.

Drivers / barriers to increase recycling

No data about specific CDW material groups has been found.

2.5.2 Recycled materials from CDW

Austria's CDW plants are constantly increasing the number of quality labelled recycling materials they produce (Figure 2). The labels are provided by a third party.

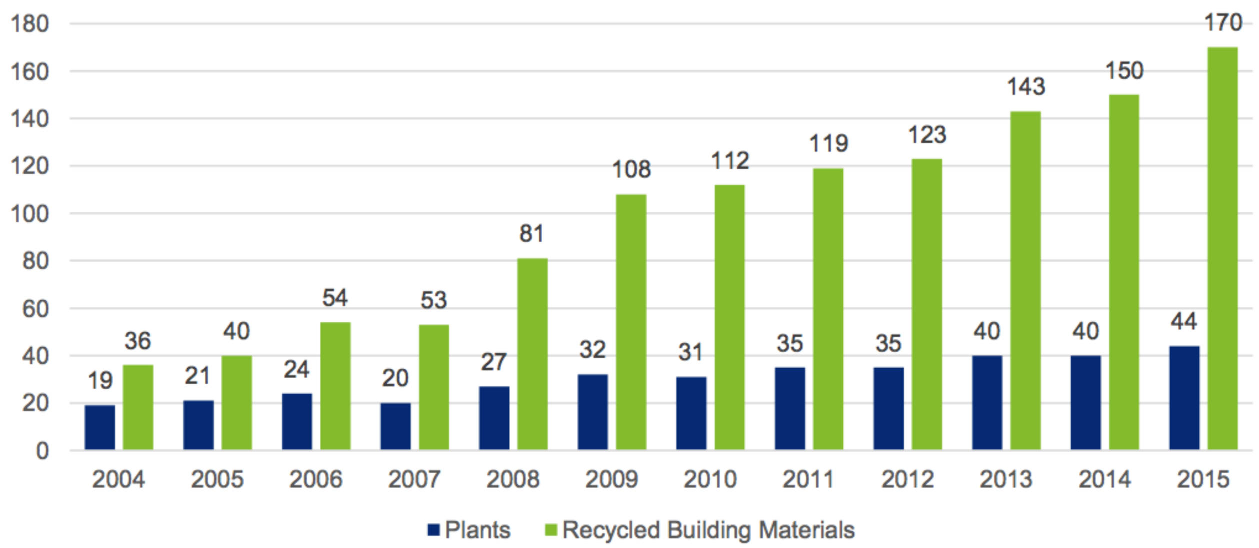

Figure 2. Quantity of labelled recycling materials in Austria

2.5.3 Market conditions / costs and benefits

As mentioned above, primary raw material prices are still too low to give secondary building materials a significant market share.

The main incentive is given by the law for Remediation of Contaminated Sites (ALSAG), which charges EUR 9,20 per ton of mineral building waste that is not recovered in a proper way [12].

3. BELGIUM

3.1 Legal Framework – Waste Management Plans and Strategies

3.1.1 National Legislation concerning CDW

Flanders (Deloitte, 2015)

There are two legislative documents that concern the management of CDW in Flanders:

– The Decree of 2012 on the management of material cycles and waste ("Materialendecreet" or Materials Decree);
– VLAREMA, which is the implementation order of the Decree of 2012, providing provisions on transport and trade of waste, reporting of waste and resources, use of resource, selective collection by enterprises and extended producer responsibility (EPR) (Deloitte, Screening Template for Construction and Demolition Waste management in: Belgium V2 - September 2015, 2015) [13].

There are two additional documents which refer specifically to recycled granulates:

– Demolition management system – aims to guarantee the quality and traceability of recycled aggregates. It focuses on the processing of granulates, transport of recycled aggregates and the effective use.

The management system resulted in a regulation for ensuring the quality of recycled granulates, entitled the 'eenheidsreglement' that formed the basis for the certification of recycled aggregates.

Brussels Capital Region (BCR)

The CDW management's legislative framework is defined in the following process:

– Before construction, an Environmental Permit (EP) (Ordonnance du 5 juin 1997 relative aux premise d'environnement) must be obtained.
– There is a mandatory recycling process of the stone and sand fraction of CDW [14]
– The fraction should be processed for use as secondary raw material on different projects.

BRUDALEX [15] (entered into force 23 January 2017) is a new legislative framework that aims at assisting the transition to a circular economy in Brussels. The following aspects refers to CDW:

– It is mandatory for holders of CDW to sort and to have their CDW sorted in a sorting facility.

Wallon Region

The basis of the legislation is the waste decree of 27 June 1996. The environment permit in the Walloon region describes conditions for waste management on building sites [16]. The submission of all data gets sent to the Walloon Waste Office (OWD).

3.1.2 Waste management plans (WMP) and Strategies

Flanders

There is no new MINA plan (MINA 5) in development at the moment. MINA plan 4 (effective from 2011-2015) is still being used to provide guidelines for environmental policy, including waste and material strategies/policy [17]. The other two action programs "Resource conscious construction in cycles" (2014-2020) [18] and "Resource conscious construction 2014-2016"[19] are also still in effect.

Flanders is working on a new Executive Plan on Waste and new indicators in a broader sense. It is still unclear when this report will be released.

Brussels Capital Region

The Brussels government is currently evaluating the 4th Waste Plan (**Plan de prévention et de gestion des déchets**, May 2010) of the BCR. A new plan has not yet been released as of yet.

Wallonia

Wallonia published a new "**Waste-Resource Management Plan**" (Plan wallon des déchets-ressources) in 2015. It is divided in six chapters:

1. Framework: sets the overall strategic framework, includes structural actions related to data and the fight against environmental crime
2. Prevention: waste prevention and reuse plan for both industrial and household waste
3. Household waste management: waste management plan for household waste
4. Industrial waste management: waste management plan for industrial waste
5. Management of street cleanliness: plan for public cleanliness and against littering and illegal dumping of waste
6. Financial means which will need to be put in place and spending plan.

The plan has no end date, although it sets objectives for the next ten years, up to 2025.

Wallonia's new plan aims to bring Wallonia in the direction of circular economy following the European Commission's circular economy package from 2 December 2015

Wallonia will develop and/or will increase various policies and corresponding tools in order to increase the quality and relative quantity of waste which can be used as a secondary resource. Amongst these are:

– Compulsory source separation of certain waste streams
– Promotion of building deconstruction instead of demolition.

Wallonia will study the option of backfilling taxation, at least to ensure a form of monitoring, as it is not considered recycling.

Controls of specific waste streams will be reinforced. Amongst those more relevant to the construction sector are:

– Wood waste
– CDW and excavated soil: the following actions will be implemented with the aim of professionalizing the market:
    - ✓ on-site controls of operations
    - ✓ the application of fines
    - ✓ the adaptation of legal texts, if necessary
    - ✓ the definition of task distribution between local and regional authorities, particularly by setting a construction site size threshold setting which level of administration is concerned
    - ✓ Vade-mecum drafting for control services
    - ✓ Development of an excavated soil monitoring operation system

The prevention plan identifies CDW among the priority waste streams in which to develop targets and develop actions (detailed on p. 94 in the Plan). Additionally, construction materials are included in the priority streams for which measures to increase re-use should be developed.

3.1.3 Legal framework for sustainable management of CDW

<u>Flanders</u>

There is a national/regional sorting obligation for Flanders (on-site and for different materials) for certain CDW from enterprises and households [20]. There is a voluntary green public procurement requirement currently in Belgium. The separate collection of hazardous waste, such as waste containing asbestos, is mandatory.

<u>Brussels Capital Region</u>

Currently, there is a national/regional sorting obligation on the reuse of inert waste that has to occur either on-site or by sending it to a sorting centre [21]. Contracting authorities may include environmental clauses in the special specifications for their procurement; however this is not a requirement [22].

<u>Wallonia</u>

There are national/regional sorting obligations for different materials, including metal [23]; paper, metal plastic and glass [24] and for the collection and management of hazardous waste from C&D operations. By 2020, non-hazardous construction and demolition waste (excluding 17054) are subjected to either a preparation for their reuse (recycling, backfilling operations, etc.), all at a competitive minimum of 70% of weight [24]. There are requirements for sustainable purchasing [25].

3.1.4 Targets

The targets should still be the same as though reported in the EC report **Errore. L'origine riferimento non è stata trovata.**. This would be a 70% recovery rate.

3.1.5 End of Waste (EoW) status

Flanders
The EoW criteria established in the Materials Decree of 2012 are still effective. These criteria fall under the national legislative.

Brussels Region
The EoW criteria established in Article 9 of the 'Ordonnance relative aux déchets du 14 juin 2012' are still in effect.

Wallonia
New legislation is under development but has not yet been released yet. "When the legislation will be in place, Federations will try to create an EoW for recycled aggregates and for excavated soil **Errore. L'origine riferimento non è stata trovata.**.

3.2 Non legislative instruments (best practices, guidelines, recommendations…)

Flanders
Government projects undertaken with the objective to look at CDW will be initiated under the Materials Programme, which will continue until 2019.

Wallonia
Wallonia has several projects dedicated to CDW, largely focused on Wallonia but incorporates information from Flanders where available. These projects are **WALOSCRAP** and **BATILOOP**, managed by GreenWin and supported by the Walloon Construction Confederation. The focus is to improve the flows generated from construction waste and interaction [27].

3.3 CDW management performance – CDW data

3.3.1 CDW generation data

Eurostat has published the following data (Table 4) for construction waste. The table depicts the waste split into different categories.

Table 4. Eurostat - data for construction waste.

Generation of waste by waste category – Construction [tons]	2014	2012	2010	2008
Total Waste	**26.383.330**	**24.570.406**	**18.164.766**	**15.441.861**
Chemical and medical wastes (subtotal)	30.224	105.635	90,663	8.990

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Generation of waste by waste category – Construction [tons]	2014	2012	2010	2008
Recyclable wastes (subtotal, W06+W07 except W077)	984,756	865,620	1,025,225	1.134.699
Equipment (subtotal, W077+W08A+W081+W0841)	11.240	2.987	2.209	2.847
Animal and vegetal wastes (subtotal, W091+W092+W093)	256.196	211.341	69.368	107.293
Mixed ordinary wastes (subtotal, W101+W102+W103)	862,516	1,136,853	1,725,627	566.214
Common sludges	455	20.063	11.323	626
Mineral and solidified	24.237.943	22.227.907	15.240.351	13.621.193

As can be seen from the table, a large part of the construction waste is composed of recyclable wastes. Additionally, the mixed ordinary waste could possibly be reused/recycled depending on what exactly the composition is of the mixed waste.

3.3.2 CDW treatment data

<u>Brussels Capital Region</u>

Construction and demolition waste (CDW) produced in the BCR: estimates of recycling and/or sorting expressed in ton and as percentage, on the basis of four different studies

Sources: studies commissioned by Environment Brussels: see (1), (2), (3) and (4)

	2011 (1)	May 2012 (2)	May 2012 (3)	Dec. 2013 (4)
Quantity of CDW generated per year	~650000 T (waste stream)	**~650000 T**	600000 T (collected)	~700000 T (waste stream)
recyled	*552500 T*		*500000 T*	
not recycled	*~100000 T*			
neither recycled nor reused			*100000 T*	
% recycled	~85%			
% sorted		**77%**		75%
% not recycled	~15%			
Sorted quantity per year:		**~500000 T**		525000 T
sorted on the construction site		*~400000 T*		
Quantity of unsorted CDW per year:		**~150000 T**		150000 T
mixed CDW that is sorted at sorting centres		**~75000 T**		

(1) Environment Brussels, 2011. *Technisch verslag - Voorbeeldgebouwen : Het beheer van bouwafval : Fiche 4.3, Info-fiche voor professionelen*, page 4

(2) CERAA-ROTOR, May 2012 *Etude sur l'analyse du gisement, des flux et des pratiques de prévention et de gestion des déchets de construction et de démolition en RBC*, page 158

(3) PWC, May 2012 *Analyse des emplois existants et potentiels dans le secteur des déchets en Région de Bruxelles-Capitale*, diagram on page 55

(4) Environment Brussels, *Nieuwsbrief voor ondernemingen*, no. 23, Dec. 2013, page 3

Figure 3. Construction and demolition waste (CDW) produced in the BCR

The CDW generation has been relatively consistent over the last few years, including the percentage that is increased (Figure 3). Unfortunately, there is no further information available after 2013.

Flanders

There was a document [28] released by Flanders that reported treatment data. The data collection was valid up till 2012. There was no backfilling in Flanders, so there were zero values reported for this section. Furthermore, internal recycling was not included in the reported data.

Wallon Region

The region had a valorisation rate of 85% in 2008 [29]. There are been not reportable data available since this.

3.3.3 CDW exports/imports data

For the majority of Belgium, there are no data available on CDW exports/imports. The only data is from 2011, concerns the import/export between the different legislative regions (Flanders, Brussels, Walloon Region). There is, however, a limited amount of exports to the Netherlands for tar asphalt for thermal cleaning.

3.3.4 CDW treatment facilities data

Flanders

In 2014, there were 197 fixed locations that dealt with the sorting of mixed CDW, crushing of rubble and the mixing of lean concrete. There were also 50 mobile installations working under the COPRO-certification in Flanders. There are four landfills for inert waste (category 3) located in Flanders (2013 data).

Brussels Capital Region

In 2016, there were only three sorting facilities in Brussels. CDW ware exported to other regions and this still seems to be the case in 2017.

Wallon Region

In 2016, there were 5 landfills for inert waste in Wallonia. 99% of the waste has being landfilled is soil (OWD data) [13]. There are 242 centres authorized to perform the sorting/recycling of construction and demolition inert waste. Out of these, 150 are building contractors.

3.3.5 Future projections of CDW generation and treatment

This information is not currently available for any of the regions.

3.3.6 Methodology for CDW statistics

Please check the Deloitte report on notes on the methodology [13].

3.4 C&D waste management in practice

3.4.1 CDW management initiatives

<u>Flanders</u>
A report [29] of the European Environment Agency (2016) stated that the Materials Programme of Flanders is looking for a profitable system to collect windowpanes (flat glass) in order to produce new glass material. Furthermore, a 'materials methodology for building components is being developed as a measurement tool' to help stakeholders make conscious material choices [31]. The materials methodology is being 'tested in a series of innovative construction projects' in addition to 'pilot projects on flexible construction in social housing' [31].

<u>Wallonia</u>
There is a concentration on the construction sector, especially concerning flat glass. This can be seen by some of the projects that were initiated by GreenWin.

Other projects include the Reverse Metallurgy project. The Reverse Metallurgy project brings together different industrial and academic Walloon partners in order to allow the development of techniques for better recycling metals and to develop measures focusing on smart steels or new surfaces. The ambition of the Reverse Metallurgy project is to recycle metals so that they can be used as raw materials again [32].

3.4.2 Drivers / barriers to increase CDW recycling

As mentioned in the EC report, one of the main barriers to the increase for CDW recycling is the difference in legislation amongst the Belgian regions and the lack of cooperation between the regions. Facilitating this would significantly increase the possibilities for CDW recycling.

At the moment, 'collaboration agreements' are created between the relevant political entities. The Coordination Committee for International Environment Policy (CCIM/CCPIE), created through such an agreement, created a subgroup on material resource efficiency policy through which CDW would be discussed.

3.5 CDW sector characterization

There is very little information available on this aspect, especially as everything is so different in the three different regions. We will have to tackle this in Task 1.3 so at that point we can hopefully offer more information.

3.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

No data found.

Quantitative analysis

No data found.

Recovery techniques

CDW treatment in case study countries – Belgium selection

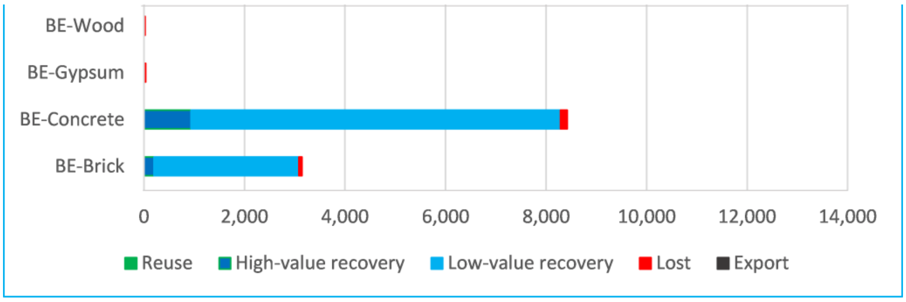

Figure 4. CDW treatment in case study countries – Belgium selection[33]

Figure 4 shows some statistics taken by the HISER project for Belgium (other case study countries included Netherlands, Spain and Finland). As shown, only concrete and brick have a high-value recovery level in Belgium. Wood and gypsum, instead, are largely lost in CDW, whereas a large level of low-value recovery level occurs for concrete and brick.

Furthermore, 'Brick-to-brick' occurs in Belgium, as an abundant of CDW brick is available and the streams area largely well monitored. The gypsum waste management system also seems to be quite sophisticated in Belgium.

There also was a report [34] released by the Vlaams BBT-kenniscentrum focusing on best available techniques for CDW in Flanders.

Environmental and economic impacts of CDW waste management

Currently, there is very little information about the impact of CDW waste on the environment and economic situation in Belgium. This may chance when there is review on the WMP.

Drivers / barriers to increase recycling

<u>Flanders</u>
There are several drivers for the increase in CDW recycling, including the:

– Adoption of several sectorial implementation plans
– Taxes on landfilling
– Stony-fraction recycling rate was increased to 95% with the stimulation of both practical and technical solutions and economic benefits (landfill taxes).

In contrast, the barriers are:
– The difference legislations in the Belgium region remains an issue for smoother recycling.
– Modern construction material is more complex and this provides a hindrance to the recycling of waste, resulting in a larger landfill amount
– Logistical aspects can also prove to be a challenge.

Brussels Capital Region

There are several drivers for the increase in CDW recycling, including the:

- The cost of treatment of mixed waste can be 3-10 times higher than the cost of treatment for sorted waste.
- There is legal text that requires government to provide subsidies to non-profit or social organizations that are active in the area of reuse and preparation for reuse.

In contrast, the barriers are:

- Certain legal aspects can be time consuming, such as waiting for the approval to sort containers on public roads.
- The soil ordinance does not encourage the recovery in soils.

It seems to be fairly expensive to try to fulfil different sorting, storage and recycling suggestions [13].

Walloon Region

There are several drivers for the increase in CDW recycling, including the:

- Similarly to Brussels, the treatment costs for sorted waste is less expensive than for mixed waste.
- Legislation is strict and obliges to a high recycling rate for CDW.

In contrast, the barriers are very similar to the barriers of the Brussels region, including the too strict legislations for certain fractions. Additionally, there are no EoW criteria for recycling aggregates.

3.5.2 Recycled materials from CDW

An estimated 90% of the recycled aggregates are used as sub base and base layers in road construction. 10% are used in road-like applications on construction sites. Less than 1% of the recycled aggregate is used in high-grade application. Of particular note, in Flanders there need to be a certification on the environmental qualities for the recycled aggregates [35].

3.5.3 Market conditions / costs and benefits

No data found.

4. BULGARIA

4.1 Legal Framework – Waste Management Plans and Strategies

4.1.1 National Legislation concerning CDW

First legal framework and definition of CDW were given in the national act "Law limiting the harmful effects of waste on the environment" (1997). The Waste Management Act of 2003 brought precisions to waste management laws and it was reformulated and completed by the Waste Framework Directive (WFD) 2008/98/EC, in 2012. The updated Waste Management Act was enforced on July 13th 2012. Some specifications about CDW are given in several articles.

An Ordinance on construction and demolition waste management and use of recycled construction materials was put into place the same year, on November 13th 2012. The Ordinance defines more specific regulations regarding collection and re-use of CDW and the obligations of relevant parties.

Some additional Ordinances in the field of waste management, are the following:

- -Ordinance n°1 from June 4th 2014 on the procedures and forms for providing information about the waste treatment activities and the procedures for keeping public registers;
- -Ordinance n°2 from July 27th 2014 on waste classification;
- -Ordinance n°4 on conditions and requirements for the construction and operation of incineration and co-incineration plants;
- -Ordinance n°6 from 27 August 2013 on the conditions and requirements for construction and operation of landfills and other facilities and installations for recovery and disposal of waste.

4.1.2 Waste management plans (WMP) and Strategies

Waste in Bulgaria is governed by the Ministry of Environment and Water, whose National Strategic Plan sets out the overall aims in this area. The waste management strategy for the period 2014-2020 is addressed in the national Development Plan, the Environment Health National Action Plan and the two National Waste Management Programmes. One of these programmes addresses CDW specifically: "Programme to achieve the targets for recycling and recovery of construction and demolition waste". The action plans have different outcomes such as update of legal texts, use of recycled materials in specific type of constructions and creation of standards and requirements for certifications in the building sector.

Additionally, there is a specific National Strategic Plan for CDW Management for 2011-2020, which presents more details than the National Waste Management plan, such as:

- recommendations and accordingly the legal requirements in Bulgaria
- the current situation and waste management practices and processes
- a forecast of activity and waste to be produced
- a presentation of different plans to reach the objectives

– a choice of plan with concrete actions and indicators to measure the results.

From admistrative point of view:
– introduction of "green public procurement (GPP) criteria";
– including recovery and recycling activities as a part of the National certificate construction system ;
– identifying the main obligations and responsibility to the CDW generators: site waste management plan, achievement of the recycling targets, special requirements for construction design, requirements for selective demolition of buildings.

From economic and technical point of view:
– increasing of landfill tax;
– implementation of quality assurance system for the products, produced from recycled CDW
– Establishing a network of facilities for CDW treatment, producing recycled material with guaranteed quality.

Following those national plans, most municipalities created their own municipal waste management programs, starting from the 2015, with specific sections focusing on CDW management. These programs include a set of "soft" measures mainly related mainly to:

– Preparation of guidelines and sample standard requirements in the tender documents for procurement of construction (by contracting authorities at central, regional and local level) for: preparation for re-use, recycling and other recovery of construction waste; preparation and implementation of management plans for construction waste as part of the project construction documentation and implementation of these plans as a condition for adjustment of investment projects; for use of recycled building materials in the construction works; training for contracting authorities;
– Support for projects of branch organizations of the construction industry and the production of building materials for the development of methodological and training materials/information portals in application of the relevant national legislation and policies relating to construction waste;
– Continued implementation of economic instruments through incentives and sanctions to result in the achievement of objectives/deductions for disposal of household waste and control;
– Integrated activities of recycling and recovery of waste from construction and demolition of buildings in the national certification system for sustainable development in Bulgaria;
– Development and maintenance of a web-based platform for supply and demand of recycled building materials and second-hand building materials and promotion of a platform, etc.

The management plan for construction waste include:

– general data for the investment project;
– description of the subject of removal;

– forecast of construction waste generated and the level of material recovery;
– forecast the type and quantity of products utilized for construction waste, which are used in construction;
– measures to be taken in the management of construction waste generated in accordance with the requirements of regulations and laws.

In the negotiation process for the award of construction works and / or removal of construction contracting authority or authorized officer:

– determined responsible for the implementation of the management plan for construction waste for the building;

When carrying out construction works and removal of buildings, construction waste must be separated by type and transmitted for further material recovery.

An important requirement of the Bulgarian legislator is that construction waste has to be collected, stored, transported and prepared for use separately.

This training is done on specially equipped sites — these are sites for recovery and recycling of construction waste.

Generally, sites are of three types. Each site must meet specific requirements. Requirements must meet construction waste:

– construction waste must comply with the requirements laid down in the investment project construction;
– person making the material recovery through the use of construction waste backfilling must have a document according to the requirements of the waste management for activities waste treatment code R10.

4.1.3 Legal framework for sustainable management of CDW

Waste from construction and demolition operation are highly recyclable and reusable. Thus, from environmental problem it can be transformed into a useful resource. This is a basic approach to sustainable waste management imposed by the active EU policy in this sector.

Bulgarian legislation requires before starting construction works and/or removal of construction contracting to prepare a management plan for construction waste.

With specific text, the legislature prohibits illegal dumping, incineration, and any other form of unauthorized treatment of construction waste, including disposal in containers for collection of household waste and packaging waste.

The main national instrument for sustainable management of CDW is the Ordinance on CDW management, which has the aim to:

– Develop of CDW waste management model, to ensure implementation of legal framework, technical infrastructure for CDW treatment;
– To ensure that by 2020, the preparing for re-use, recycling and other material recovery, of non-hazardous construction and demolition waste shell be increased to a minimum of 70% by weight;

– To reduce the environmental impacts caused by generated CDW;
– To improve the efficiency of use of resources;
– To increase the investments in CDW management sector;
– To increase the responsibilities of pollutants.

Main requirements contained in the Ordinance are:

– selective deconstruction of buildings with separation of the main components
– separation of waste materials during the execution of construction and repair works;
– recycling of concrete , ceramics , asphalt and mineral components (Implementation of Targets 70% until 2020
– implementation of CDW recycling products in infrastructure projects:
  - ✓ for construction of buildings - 2 % from total amount of construction products;
  - ✓ road construction - 10 %;
  - ✓ renovation works – 3%
– <u>CDW MANAGEMENT PLAN</u>
  - ✓ general information about the investment project -Annex № 2;
  - ✓ description of the demolition object -Annex № 3 ;
  - ✓ forecast CDW generation and the level of material recovery - Annex № 4;
  - ✓ estimates of the type and quantity of CDW recycling products implemented during the project - Annex № 5;
  - ✓ measures to be taken relative to the CDW management
– <u>TRANSPORT BOOK</u>
  - ✓ Information for those who carry out the transportation of CO and – Annex 6
  - ✓ persons who are transferred to CO process works and removal.
– Specific waste stream recovery targets for every projects
  - ✓ 17 01 01 concrete - 85%;
  - ✓ 17 01 02 bricks- 70%;
  - ✓ 17 01 03 tiles - 70 %;
  - ✓ 17 02 01 wood - 80%;
  - ✓ 17 02 02 glass- 80%;
  - ✓ 17 02 03 plastics- 80%;
  - ✓ 17 03 02 asphalt- 80 %;
  - ✓ 17 04 01 metals- 90 %;
– Specific CDW recovery targets for road and rail road construction sector - 80%.

Requirements do not apply to:

  - ✓ demolition of buildings with a gross floor area less than 100 square meters

- ✓ reconstruction and renovation of buildings with an area less than 500 square meters
- ✓ renovation of use of buildings with an area less than 500 square meters
- ✓ Building with an area less than 300 square meters;
- ✓ remove unusable or unsafe buildings, as ordered by the emergency authority.

In the National Construction and Demolition Waste Management Strategic Plan 2011-2020 there is a description of CDW management scenario:

– selective demolition of buildings,
– separate collection,
– high quality recycling of main streams – concrete, asphalt, ceramics, wood, plastic, metals and glass.

Main priority is for construction of entire needed infrastructure for CDW recycling and quality assurance of the final products, including achievement of high CDW recycling level.

4.1.4 Targets

According to Waste Framework Directive (WFD) by 2020, the preparing for re-use, recycling and other material recovery of non-hazardous CDW should be increased to at least 70% of their total weight, excluding contaminated soil, earth and rock masses from excavations in natural state. These ambitious targets are envisaged in the national legislation by defining in a stepwise manner by year the targets for recycling and other recovery, to achieve the ultimate goal in 2020:

– by 1 January 2016 – at least 35% of the total weight of waste
– by 1 January 2018 – at least 55% of the total weight of waste
– by 1 January 2020 - at least 70% of the total weight of waste.

An important prerequisite for achieving these objectives are the adoption and respect of proper actions, as described in the previous paragraph.

Recycled waste excludes backfilling purpose materials and energy recovery.

Targets for recovery of materials from non-hazardous construction and demolition waste from 2014 to 2020 are given following the classification of the WFD (Table 5). The last two lines are referred to road works and rail works:

Table 5. Targets for recovery of materials from non-hazardous construction and demolition waste [tons].

	2016	2017	2018	2019	2020
17 01 01 Concrete	85%	85%	85%	85%	85%
17 01 02 Bricks	43%	50%	57%	63%	70%
17 01 03 Tiles and Ceramics	43%	50%	57%	63%	70%
17 02 01 Wood - untreated	67%	70%	73%	77%	80%
17 02 02 Glass - uncontaminated	44%	53%	62%	71%	80%

	2016	2017	2018	2019	2020
17 02 03 Plastic - excludes packaging waste	58%	63%	69%	74%	80%
17 04 05 Iron and steel	90%	90%	90%	90%	90%
17 04 01 Copper, bronze and brass	90%	90%	90%	90%	90%
17 04 02 Aluminum	90%	90%	90%	90%	90%
17 04 03 Lead	90%	90%	90%	90%	90%
17 04 04	90%	90%	90%	90%	90%
17 04 06 Tin	90%	90%	90%	90%	90%
17 04 11 Other cables e 17 04 10 Cables containing oil, coal tar and other hazardous substances	90%	90%	90%	90%	90%
17 03 02 Other bituminous mixtures	62%	67%	71%	76%	80%

Also, targets for use of recycled products are as follows (Table 6) [38]:

Table 6. Targets for use of recycled products.

	2016	2017	2018	2019	2020
Construction of building financed by public funds	1%	1.5%	1.5%	1.5%	2%
Construction of roads with public funds	8%	8%	8%	10%	10%
Rehabilitation, renovation or reconstruction of roads financed by public funds	2%	2%	3%	3%	3%
Construction, reconstruction and renovation of other buildings with technical infrastructure financed by public funds	5%	5%	6%	7%	8%
Recycling of construction waste for backfilling	10%	11%	11%	11%	12%

4.1.5 End of Waste (EoW) status

In chapter 4 of the Ordinance on construction and demolition waste management and use of recycled building materials, specific criteria are established when construction and demolition waste becomes a recycled building material.

4.2 Non legislative instruments (best practices, guidelines, recommendations…)

Bulgaria is associated to European Quality Association for Recycling e.V. (EQAR), founded in 2005. The activities of this association are:
- Promoting international cooperation and experience sharing between national quality protection organizations and their members,
- Transfer of know-how on CDW recycling
- Supporting the dissemination of thinking on quality protection and quality assurance for recycled building materials at European level.

Non-legislative instruments are:

- Economic instrument such as landfill tax which is increased between 2011 to 2014 years, from 0.25 €/t to 17.5 €/t, for construction and demolition waste
- Voluntary agreement between government, business and construction industry
- Sustainability standards, such as BREAAM, LEED, HQE, DGNB. Out of these four standards, DGNB is the most applied in Bulgaria, but still certification of sustainable buildings is limited (about 10 project under all systems in Bulgaria). It is not compulsory for any project type, and there is no big public awareness either.

4.3 CDW management performance – CDW data

4.3.1 CDW generation data

EUROSTAT database reports the following data (Table 7) for CDW generated between years 2010 and 2014.

Table 7. EUROSTAT database for CDW generated between years 2010 and 2014 [tons].

	2010	2012	2014
Mineral waste from construction	27.109	624.332	491.341
Metal wastes, ferrous	1.244	10.225	11.893
Metal wastes, non-ferrous	19	7.233	315
Glass wastes	24	56	3
Plastic wastes	43	77	110
Wood wastes	409	15.356	1.721
Total	**78.880**	**1.032.651**	**1.340.467**

4.3.2 CDW treatment data

Main treatment options for CDW in Bulgaria are:

- Landfill
- Recycling into aggregates for read construction or backfilling
- Re-use

– Energy recovery.

The Ordinance N.1 of 4 June 2014 states that quantitative and qualitative CDW data shall be collected annually by the companies for collecting, transporting, treating and using recycled CDW, but no public data was found yet. Data published by EUROSTAT deal with different waste categories becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as reported in the Table 8.

Table 8. EUROSTAT database for "Mineral waste from construction" [tons]

Mineral waste from construction	2010	2012	2014
Landfill / disposal (D1-D7, D12)	18.814	417.774	29.503
Deposit onto or into land	18.797	417.774	29.503
Land treatment and release into water bodies	17	0	0
Incineration / disposal (D10)	23	8.656	2
Incineration / energy recovery (R1)	0	0	0
Recovery other than energy recovery	30.040	60.606	652.508
Recovery other than energy recovery - backfilling	0	0	0
Recovery other than energy recovery - except backfilling	30.040	60.606	652.508
Total waste treatment	**48.877**	**487.036**	**682.013**

4.3.3 CDW exports/imports data

Very low and variable quantities of imports/exports of CDW are reported by National Statistics Institute, as write in the Deloitte factsheet (Table 9).

Table 9. Quantities of imports/exports of CDW reported by National Statistics Institute

	2008	2009	2010	2011	2012	2013
Quantities of CDW exported (Ktons)	-	3	-	-	5.743	-

Experts believe that imports and exports of CDW is not developed at all in Bulgaria to this date due to a lack of:

– Information of the concerned players;
– Incentive to recycle;
– Maturity of treatment facilities and capacities in neighbouring countries offering a cross-border service with a substantial financial benefit for the Bulgarian companies.

4.3.4 CDW treatment facilities data

The last known data about CDW treatment facilities traces at year 2013, as reported in the DELOITTE factsheet. Data as of September 2013 shows that the country counts 12 municipal landfills for construction waste, 113 municipal landfills and 32 regional landfills. Among these landfills, only the regional ones are compliant with the EU legislation. The other landfills accept all kind of CDW, such as bricks, tiles and ceramics, mixed materials, soil, stones.

The 2014-2020 plan from the Ministry of Environment and Water states that, according to the actual distribution of facilities, 28 regions are targeted for the construction of mobile and fixed treatment facilities:

- 14 fixed platforms with total capacity 1 040 000 tons per year;

- 14 mobile platforms with total capacity 790 000 tons per year.

In 2014, there are several fixed and mobile facilities for recycling construction waste operating in major cities such as Sofia, Rousse and Burgas.

Construction projects of facilities are ongoing, led by regional administrations.

4.3.5 Future projections of CDW generation and treatment

No data found about this topic.

4.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

4.4 C&D waste management in practice

4.4.1 CDW management initiatives

No data found

4.4.2 Drivers / barriers to increase CDW recycling

– <u>Economic barriers: High availability and low cost of raw materials</u>

- ✓ The main corresponding policy option to overcome this is making landfilling of waste unattractive, by introducing a ban or high levies on landfilling

– <u>Cultural barriers: Misconception of the quality of recycled products</u>

- ✓ Turning waste into a valuable raw material: this can be achieved through quality certification of secondary raw material from CDW
- ✓ Communicating on the benefits of secondary raw material
- ✓ Development of end-of-waste criteria
- ✓ Green Public Procurement (GPP)

– <u>Technical barriers: ineffective sorting and contamination of the waste flows</u>

- ✓ Encourage the sorting of CDW "at source"
- ✓ Selective demolition / controlled deconstruction.

4.5 CDW sector characterization

4.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Concrete appears in two forms in the waste. Structural elements of building have reinforced concrete, while foundations have mass non-reinforced concrete. Concrete constitute more than 40% of waste generated. Main applications in the construction sector are: buildings, roads and infrastructure.

Bricks and masonry are generally mixed with cement, mortar or lime. Masonry can be recycled with or without mortar separation. Main applications in the construction sector are masonry construction especially for building.

Ceramic construction products are used mainly for buildings. After a building is demolished, ceramic construction products can be crushed and then used as secondary raw materials for different applications. Recycled tiles are almost identical to bricks. Tile is, often, mixed with brick in final recycled product. Main application in the construction sector are: covering of roofs, floors and walls.

Even though gypsum comprises a small share of the stony CDW material, it is 100% and eternally recyclable thanks to its chemical composition.

Asphalt waste application in the construction sector is pavement for road construction and maintenance.

Wood recovered in good condition from beams, window frames, doors, partitions and other fittings is reused. Wooden material can, next to or after being re-used, recycled for roof structure, building framework, floors, doors, etc.

Quantitative analysis

No data found

Recovery techniques

Recovery techniques for several building materials are reported in Table 10

Table 10. Recovery techniques

CDW material	Recovery techniques
Concrete	- Landfill - recycling into aggregates for road construction or backfilling

CDW material	Recovery techniques
	- recycling into aggregates for concrete production re-use of precast elements (concrete blocks)
Bricks	- landfill - recycling (replaces sand, gravel, stones, rocks e.g. to fill roads, to produce tennis sand, to serve as aggregate in concrete re-use
Ceramics and tiles	- landfill - recycling (replaces sand, gravel, stones, rocks e.g. to fill roads, to produce tennis sand, to serve as aggregate in concrete re-use
Gypsum	- landfill recycling into new plasterboards (In substitution of natural gypsum or In substitution of synthetic gypsum)
Asphalt	- landfill, - recycling in a stationary plan, in-situ, recycling, material recovery
Wood	- landfill - recycling into derived timber products, energy recovery
Concrete	- Landfill - recycling into aggregates for road construction or backfilling - recycling into aggregates for concrete production re-use of precast elements (concrete blocks)

Environmental and economic impacts of CDW waste management

– Saving the natural resources
– Low material consumption
– Low transport costs
– Low emissions
– Low cost for landfilling
– Preserve the environment and human health.

Drivers / barriers to increase recycling

Please refer to Section 4.4.2

4.5.2 Recycled materials from CDW

The construction market going down also affects the recycled products market. So far only three of the most common and significant materials are recycled from the 22 existing platforms: concrete, reinforced concrete and ceramics.

In practice, even if recyclers have recycling authorizations for a wider range of codes of products, in reality it appears that CDW can be refused to the transporter coming to dispose of the waste as it is considered to have too poor recoverable output, as it is been observed with ceramics for example.

4.5.3 Market conditions / costs and benefits

The construction industry in 2015 was characterized by favorable dynamics and a change in the growing negative trend established over the years.

Statistical data for some indicators bear a positive sign and indicate the expected pace of recovery and rebuilding growth of the construction sector.

The ranking by economic indicators in comparative aspect registers optimism and positive outlook for the industry. The illustrated growth is mainly based on completed EU projects in the area of road and water supply and sewage infrastructure.

The construction industry in 2015, according to preliminary data, formed 4.7% of the total gross value added for the economy.

In the future, the main priorities of the industry should be searching for and finding mechanisms for better absorption of EU funds as a major factor of growth rates in the construction industry at this stage.

The estimates of the Construction Chamber in Bulgaria for 2016 bring more optimism. After record low levels of construction volumes, the construction sector is set for a slow return to a positive rate in 2016.

There are still obstacles, which need to be eliminated:

– Still there are no factors for sufficiently secure environment enabling companies and related suppliers to show growth and positive development trends.
– Lack of activity and good conditions for stimulating the investments.
– There is indebtedness of the business to the banks as well as intercompany indebtedness. There are initiated projects where the banks had stopped the financing at some stage due to non-repayments on loans.
– Intercompany deficit persists; there is no free cash. Indicative is the fact of a significant drop of nearly 62.0% on an annual basis in tangible fixed assets in 2015.
– The banking crisis in 2014 in Bulgaria left significant impact and the signs could be seen in 2015. Many of the construction companies are still trapped in the banking crisis. The business remained on the market, but a serious economic revaluation of the business programs had to be made.
– What should be the priorities for the construction sector development the in the future:
    - ✓ Investment in „green economy“.
    - ✓ More funds in the state budget for public investment – public procurement.
    - ✓ Development of small and medium businesses.
    - ✓ Creating conditions by the government for attracting foreign investment.

- ✓ Progress in absorption of funds under EU-funded programs.

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5. CROATIA

5.1 Legal Framework – Waste Management Plans and Strategies

5.1.1 National Legislation concerning CDW

The main legislation for Waste Management in Croatia is the Law on Sustainable Waste Management (OG 94/13), which has been in force since 23.07.2013.

The relevant legislation governing various aspects of CDW management is in line with the European WFD which was officially transposed into the Croatian law. Related regulations include:

- Act on Sustainable Waste Management (OG No. 94/13)
- Waste Management Strategy of the Republic of Croatia (OG No. 130/05)
- Ordinance on waste management (OG No. 23/14, 51/14, 121/15, 132/15)
- Ordinance on by-products and end-of-waste status (OG No. 117/14)
- Waste Management Plan of the Republic of Croatia for 2007-2015 (OG No. 85/07,126/10, 31/11, 46/15)
- Ordinance on the waste catalogue (Official Gazette 90/15)
- Ordinance on the methods and conditions for the landfill of waste, categories and operational requirements for waste landfills (Official Gazette 114/15)
- Ordinance on construction waste and waste containing asbestos (Official Gazette 69/16)
- Ordinance on thermal treatment of waste (Official Gazette 75/16)
- Decision on the adoption of the Waste Management Plan of the Republic of Croatia for the period 2017 – 2022 (Official Gazette 3/17)

5.1.2 Waste management plans (WMP) and Strategies

On the national level, two relevant waste management development frameworks are in force: the Croatian Waste Management Strategy for the period 2005–2025 and the related Waste Management Plan for the period 2007–2015. A draft National Waste Management Plan 2015-2021 was published on September 21 2015 for public consultation.

The Croatian Waste Management Strategy includes the assessment of the current situation, main waste-management objectives and measures, hazardous-waste management measures and guidelines for the recovery and disposal of waste.

The Strategy also tackles the area of CDW in two separate sections (2.3.2. and 4.2.2) and provides an overview of the current state of CDW in Croatia as well as guidelines for the CDW management system improvement, such as:

- educate and inform all participants in the construction waste management process,
- prevent uncontrolled disposal of construction waste in municipal landfills and elsewhere,
- establish full control over construction waste streams, from the place of waste generation to the place of final use/disposal, including improvement of the information system,
- introduce recovery systems for all types of construction waste and for up to 80 percent of total quantities,

– encourage use of construction materials that are environment-friendly,
– regulate construction waste management through implementation regulations and namely:
  - ✓ specify the obligation to plan construction waste management in the period following removal of a built facility, and
  - ✓ specify the obligation to also plan such management for other construction waste situated on the same lot,
– inspect, at the county level, all landfills in which construction waste is disposed of; based on the analysis of data about all landfills, use appropriate landfills for the disposal of inert waste, while other landfills must be improved and closed down,
– make sure that maximum quantities of construction waste are submitted to recovery and/or recycling so as to obtain new construction materials which are, by their quality, equal to other construction materials,
– inert landfill sites will be opened in individual counties and in the City of Zagreb - either as separate sites or next to municipal waste landfills; as a rule, they will be organized in the scope of waste management centres and will have mobile or stationary treatment facilities; in the transition period, portions of municipal landfills may be used for sorted and recovered construction waste as needed for some parts of landfills (subject to approval by the competent authority),
– advance and improve the system for the separate collection and recycling of individual types of construction waste, and establish centres for the recovery and disposal of construction waste.

The recently published NWMP (National Waste Management Plan) includes the following measures aimed at increasing waste prevention activities, about CDW:

1. Encourage the reuse of materials from demolition but establishing an incentive fee for these materials.

2. Promotion of sustainable construction by developing a guide to sustainable construction.

3. Encouraging the exchange and re-use of products through development of a framework and guidelines for undertaking reuse activities in Croatia.

Although some detail is provided on some of these measures, the current version of the plan does not include a timetable of when these measures will be implemented.

5.1.3 Legal framework for sustainable management of CDW

Measures for a sustainable management of CDW in Croatia are contained in the mentioned National Legislation. Particularly, the Act of Sustainable Waste Management, at Art.35, defines the obligation of separate collection for different materials.

5.1.4 Targets

The only national target concerning CDW is consistent with WFD target and is defined in Article 55 of the Act on Sustainable Waste Management; it states that 70 % of the CDW mass have to be recovered and recycled, according to the Directive 2008/98/EC of the European Parliament and of the Council. By 1 January 2020 the Republic of Croatia shall take measures to ensure the preparation for re-use, recycling and other material recovery of nonhazardous construction waste, including the backfilling and spreading of waste, when such waste are used in place of other materials, excluding the material from nature specified under waste code 17 05 04 – soil and stones.

5.1.5 End of Waste (EoW) status

In chapter 4 of the Ordinance on construction and demolition waste management and use of recycled building materials, specific criteria are established when construction and demolition waste becomes a recycled building material.

More details are contained in the "Ordinance on by-products and end-of-waste status (OG No. 117/14)", in which special EoW status requirements have been established for seven CDW types by reference to recovery activities for the manufacture of building products:

– Concrete, bricks, tiles and ceramics
– Wood, glass and plastic
– Bituminous mixtures
– Coal tar and tarred products
– Soil (including excavated soil form contaminated sites), stones and dredging spoil
– Insulating materials and asbestos-containing construction materials, gypsum-based construction material
– Other construction and demolition wastes.

Draft rules establishing the EoW status criteria, in line with the European ones, for aggregates derived from CDW and waste from public works for the use in road applications are being prepared.

5.2 Non legislative instruments (best practices, guidelines, recommendations…)

Among non-legislative instruments there is the publication "Construction and demolition waste management plan", developed within the project LIFE05 TCY/CRO/00014 CONWAS "Development of sustainable construction and demolition waste management system for Croatia". This document represents the implementation document of the Waste Management Strategy with the basic objective of establishing a complete and sustainable system of waste management. The study presents measures for realization of the objectives of the Construction and Demolition Waste Management Plan that refer to the legislation and regulations, to activities of counties, the City of Zagreb, towns and municipalities; measures of collecting, separating, recovery and recycling of construction and demolition waste, measures of disposal of construction and demolition waste and management of special-category construction and demolition waste as well as informative-and-educational measures.

In Croatia, since 2010 there is the Croatia Green Building Council, with the aim to educate, and to spread the information and knowledge about planning and building of construction projects and their use with the goal of sustainability, taking in consideration the interests of those who use the facilities, environmental protection, social responsibility and economic viability.

In the last years, in Croatia, more and more investors turn to green building. Therefore the need for national certification consultants, according to international standards of green building, is increasing and one of the most known certification systems is LEED.

5.3 CDW management performance – CDW data

5.3.1 CDW generation data

EUROSTAT database reports the following data for CDW generated between years 2010 and 2014 (Table 11).

Table 11. EUROSTAT database for CDW generated between years 2010 and 2014 [tons].

	2010	2012	2014
Mineral waste for construction	1.064	169.361	164.440
Metal wastes, ferrous	2.038	82.721	128.446
Metal wastes, non-ferrous	7	10.162	11.623
Glass wastes	77	920	1.679
Plastic wastes	15	225	367
Wood wastes	23	289	3.274
Total	**7.656**	**682.058**	**621.307**

5.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories coming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 12.

Table 12. EUROSTAT database for "Mineral waste from construction" [tons]

Mineral waste from construction	2010	2012	2014
Landfill / disposal (D1-D7, D12)	40.333	121.345	86.801
Deposit onto or into land	40.333	121.345	86.801
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	1.500	0	0
Incineration / energy recovery (R1)	1.522	30	3.160
Recovery other than energy recovery	997	128.818	197.478

Mineral waste from construction	2010	2012	2014
Recovery other than energy recovery - backfilling	0	0	5.701
Recovery other than energy recovery - except backfilling	997	128.818	191.777
Total waste treatment	**44.352**	**250.193**	**287.439**

The practice of CDW pre-treatment activities (mechanical sorting, biological treatment, physic-chemical treatments) is not followed in Croatia. According to the provided information, waste originating from construction or demolition operation are disposed on the site (heaped together) or they are immediately covered. In addition, CDW are not treated/recycled on the site and no such data exist.

5.3.3 CDW exports/imports data

No data found.

5.3.4 CDW treatment facilities data

No data found.

5.3.5 Future projections of CDW generation and treatment

No data found.

5.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

5.4 C&D waste management in practice

5.4.1 CDW management initiatives

Voluntary agreement between government, business and construction industry are examples of initiatives in CDW management but not public information are found.

5.4.2 Drivers / barriers to increase CDW recycling

Main obstacles and drivers to sustainable CDW management are:

a) Legislation and regulation
- Clear CDW recycling policies or rules are yet to be defined and implemented, including legal provisions regarding the enforcement of the CDW legislation. The current human and financial resources seem insufficient.
- EoW status and criteria have been defined by law.

- Croatian Government is working on strategic documents and regulation and it will soon introduce new CDW rules proving a more detailed and clearer definition and explanation of the regulation.

b) Treatment facilities and their territorial network:
   - There is a need for more (organized) CDW collection sites, there are still insufficient selective separation facilities in place and most CDW is disposed in regular solid-waste landfills (around 50 % according to the data from the Croatian Waste Management Strategy).
   - There is a high transportation and disposal costs.
   - National strategic programs and EU funding priorities promote the establishment of treatment facilities.

c) Monitoring system:
   - There are still a number of wild landfills, as indicated by large unreported quantities of waste.
   - There are a relatively low rate of data collection about treated waste and related facilities.
   - There is a strong engagement of the Croatian Environmental Agency in improving the system based on the announced changes to the data management system.

d) Public awareness:
   - There is a lack of interest in not only CDW waste management, but the waste management in general, with relatively scarce CDW-specific information, brochures and education. A higher engagement by all stakeholders is needed.

e) Public procurement:
   - There are no specific initiatives around public procurement to support the use of recycled materials from CDW or environmentally sound materials.

f) Market conditions
   - Market prices and operating costs of CDW sorting, recovery and recycling are still considered too high according to the stakeholder interviews.

5.5 CDW sector characterization

5.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

The types of materials that can appear in construction and demolition waste depending on the type of construction work are shown in Table 13.

Table 13. Types of materials that can appear in construction and demolition waste

Excavation	Structural Engineering	Building Construction	Mixed construction and demolition waste
Earth (peat) Sand, gravel Clay, loam Stone	Bitumen (asphalt) or concrete-bound material Sand, gravel, crushed stone	Concrete Brick Limestone Mortar	Wood Plastics Paper, cardboard Metal

Excavation	Structural Engineering	Building Construction	Mixed construction and demolition waste
		Plaster Expanded clay Gaseous concrete Clinker Natural stone	Cables Paint, lacquer Rubble

According to CONWAS publication, CDW are sorted into two basic groups immediately at waste origin:

1. **Homogeneous construction and demolition waste** whose recovery or recycling is easier in technical-technological sense, and recycled materials are technically applicable without any special restrictions, is divided into following types:

• **Asphalt scrap** (waste from destruction of asphalt curtains) and **mixed asphalt and concrete scrap** – from the Waste Catalogue: 17 03 – Bitumen mixtures, coal tar and products containing tar

• **Concrete scrap** (waste from demolition of concrete structures) – from the Waste Catalogue: 17 01 01 – Concrete

• **Stone waste** (construction and demolition waste containing stone materials only) – from the Waste Catalogue: 17 05 – Soil, stones and excavator yield

• **Separated brick and roofing-tile scrap in building demolition ("ceramic" scrap)** – from the Waste Catalogue: 17 01 02 bricks and 17 01 03 – roofingtiles/tiles and ceramic ware

• **Glass, paper, plastics** from the Waste Catalogue 17 02 01, 17 02 02, 17 02 03

2. **Mixed construction waste** whose recovery is complicated in technical-technological sense, and the recycled materials are technically applicable as building materials with predetermined restrictions and are divided into following types:

• **Mineral (inert) construction waste, rubble** (mixed inert construction waste of mineral composition from demolition of recent construction without considerable brick content) – from the Waste Catalogue: 17 01 06* – Mixtures or separate fractions of concrete, bricks, roofing-tiles/tiles and ceramic ware containing hazardous substances, and 17 01 07 – Mixtures or separate fractions of concrete, bricks, roofing-tiles/tiles and ceramic ware which are not listed under 17 01 06

• **Mineral (inert) construction waste with brick and roofing-tile scrap** (mixed construction waste from demolition of older construction with a considerable content brick and roofing-tile content) – from the Waste Catalogue: 17 01 06* – Mixtures or separate fractions of concrete, bricks, roofing-tiles/tiles and ceramic ware which contain hazardous substances, and 17 01 07 – Mixtures or separate fractions of concrete, bricks, roofing-tiles/tiles and ceramic ware which are not listed under 17 01 06 and 17 08 Plaster-based construction materials

• **Uncategorised construction waste** (mixed construction or demolition waste of various composition with a possible partial content of non-mineral elements) – from the Waste Catalogue: 17 09 Other demolition waste.

Raw materials obtained from recycling of construction and demolition waste can be also used as:

– • material for structural layers of roads, pathways, car parks
– • admixture for new asphalt-concrete mixtures
– • admixture to various types of concrete
– • material for production of concrete elements and constructions

Some possibilities of re-use waste materials from building construction and structural engineering after recycling processes are:

Table 14. Possibilities of re-use of waste materials from building construction and structural engineering

Type of material	**Origin**	**Application**
Pure brick scrap	Brick production	Admixture for production of wall elements, concrete, light concrete, stabilization, drainage layers, filling, levelling
Mixed demolition scarp in building construction with brick scrap (rubble mixed with brick)	Housing construction, Building construction	Admixture for production of wall elements, concrete, light concrete, stabilization, drainage layers, filling, levelling, final floor layers.
Mixed demolition scrap in building construction	Industry, building construction	Levelling stabilization, construction of sports grounds.
Mineral waste	Industry, building construction	Levelling, construction of sports grounds – drainage
Recycled sand	Industry, building construction	Basis for laying infrastructural pipes (gas, water etc.)
Asphalt scrap	Road construction	Unbound upper supporting layers, unbound lower supporting layers, bound supporting layers, construction of farm roads, admixtures for asphalt

Type of material	Origin	Application
		production
Concrete scrap	Road construction, bridge construction, industrial construction	Unbound upper supporting layers, unbound lower supporting layers, cement-bound supporting layers, construction of farm roads, admixtures for concrete production, drainage layers
Mixed asphalt/concrete scrap	Road construction, car parks, bridge construction	Unbound upper supporting layers, unbound lower supporting layers, bound supporting layers, construction of farm roads
Pure brick scrap	Brick production	Admixture for production of wall elements, concrete, light concrete, stabilization, drainage layers, filling, levelling

After recycling process there is also some "useless material" left which could be used for filling up areas planned to be levelled and designed, or used as road base, especially farm roads and construction of noise buffers near some roads. Such "useless materials" are environmentally non-hazardous materials when permanently disposed or materials whose further processing does not yield raw material for products of value.

Quantitative analysis

No data found

Recovery techniques

Recovery techniques in Croatia are:

– Disposal, recovery and storage: this technique is regulated by the Minister responsible for environment protection by way of the Ordinance on Construction and demolition waste management. Disposal of CDW is proposed following the classification given in paragraph 5.1.1.
– Separation, collection, recycling and recovery. This technique is possible if conducted by means of separate collection at waste origin and afterwards packaging waste is handled in the way defined by regulations for such waste type. Only if such separation is ecologically and economically unjustified the waste does not have to be separated and it is collected in joint containers and sorted at waste sorting facilities.

Environmental and economic impacts of CDW waste management

– Saving the natural resources
– Low material consumption
– Low transport costs
– Low emissions
– Low cost for landfilling
– Preserve the environment and human health.

5.5.2 Recycled materials from CDW

Even if there are different possibilities to recycling CDW, as reported in paragraph 5.1.1, active recycling activities are not yet developed. As a result, there are no CDW products or their consumption. End-of-waste criteria for aggregates are not established. So far, the criteria have been adopted for iron, aluminum, copper and glass.

5.5.3 Market conditions / costs and benefits

There are no financial incentives for recycling CDW and there are no penalties either.

6. CYPRUS

6.1 Legal Framework – Waste Management Plans and Strategies

6.1.1 National Legislation concerning CDW

Cyprus has transposed the revised EU Waste Framework Directive 2008/98/EC on Waste (WFD 2008/98/EC) [45] into national law (Waste Law of 2011 N. 185(I)/2011[46] and subsequent amendments [47]).

In addition, The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments [49] impose conditions and measures for the proper management of Excavation, Construction and Demolition Waste (ECDW) in accordance with the Waste Law of 2011 N. 185(I)/2011 [46] and subsequent amendments[49].

6.1.2 Waste management plans (WMP) and Strategies

The Waste Management Plan of Cyprus [50] was published in 2004 by the Department of Environment and contains a section for the management of CDW. However, its CDW generation data for the period (1996-1999) and the management options are considered outdated and do not reflect the current situation in Cyprus [51]. No other document specifically related to CDW has been published by the Department of Environment.

6.1.3 Legal framework for sustainable management of CDW

According to the Construction and Demolition Waste Management in Cyprus Report [51] existing pieces of legislation which promote the sustainable management of CDW are listed as follows:

National/Regional Obligation for Selective Demolition

No specific National/Regional Obligation for Selective Demolition exists.

National/Regional Sorting Obligation (on-site or in sorting facility)

No specific National/Regional Sorting Obligation exists.

National/Regional Separate Collection Obligation for Different Materials (such as iron, steel, plastic and glass)

No specific National/Regional Separate Collection Obligation for Different Materials exists.

Obligation for Separate Collection and Management of Hazardous CDW

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments [49].

Related Green Public Procurement Requirements

No

Obligation for Participation to, or Establishment of CDW Management Systems, by the Construction/Demolition Project Contractors

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation to Submit Detailed CDW Management Plan for the Amount of CDW Generated from the Construction/Demolition Activities by the Project Contractors

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation of Contractors to follow the Principles of the Waste Hierarchy Throughout the Duration of the Construction Project

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation of Contractors to Maintain Detailed Register of CDW Quantities Generated, by Waste Type and its Treatment Options

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation of Contractors to Increase the Use of Recycled Materials and Receive Recycled Materials from the Official CDW Management Systems for Use in the Construction Projects

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation of Collection of CDW Only by the Certified Systems of Alternative CDW Management

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

Obligation for the Re-use or Return Back to the Supplier of Any Recycled Construction Materials Not Used in the Construction Project

Yes-The Solid and Hazardous Waste (Management of Excavation, Construction and Demolition Waste) Regulations of 2011 (P.I. 159/2011) [48] and subsequent amendments[49].

6.1.4 Targets

The only target applicable to Cyprus related to CDW is the 70% target for re-use, recycling and recovery by 2020 in accordance with WFD 2008/98/EC [45]. No targets for the re-use, recycling or recovery of specific CDW materials used in construction have been set.

6.1.5 End of Waste (EoW) status

At present, no End of Waste (EoW) criteria exist in Cyprus.

6.2 Non legislative instruments (best practices, guidelines, recommendations…)

There is very limited use of non-legislative instruments (i.e. best practices, guidelines, recommendations etc.) in Cyprus, which deal with the re-use, recycling and recovery of CDW.

A notable exception is the non-profit Cyprus Recycling Organisation (OAK) which was the first Excavation, Construction and Demolition Waste (ECDW) Management System to be authorized in 2014. During its first year of operation, 120 out of 2200 registered construction contractors in Cyprus became its members. In its Annual Report for 2014 [52], OAK estimated that its members, which only represent 7% of the total number of contractors in the country, generated 220000 tonnes of ECDW (approximately 49% of the total amount of ECDW generated in 2014). The above amount of ECDW was managed in accordance with national and European legislation leading to the recovery of 200000 tonnes (recovery rate of 90%). However, the report raised strong concerns regarding the fate of 230000 tonnes of ECDW (including hazardous ECDW) which were generated by the vast majority of contractors which are not members of OAK.

In 2015, a second ECDW Management System known as Cypriot Organisation for the Treatment of Waste (KODA) was licensed by the Cypriot Ministry of the Interior.

6.3 CDW management performance – CDW data

6.3.1 CDW generation data

In Cyprus, CDW generation data is obtained by the Statistical Service of Cyprus (CYSTAT) through surveys in accordance with Regulation EC No. 2150/2002 On Waste Statistics [53]. The above data is supplemented with estimations provided by the Statistical Office of the European Union (EUROSTAT). Statistical estimations are necessary in order to fill in gaps and improve the low-accuracy of existing data. However, large quantities of generated CDW are not properly reported. Consequently, official data on CDW generation based on surveys and estimations might not be representative of the real situation in the country [51].

EUROSTAT data for mineral CDW generation (NACE R2 Code: F, Waste Code: W121) for years 2010, 2012 and 2014[54] are shown in Table 15 below.

Table 15. Mineral CDW generation data in Cyprus for years 2010, 2012 and 2014 (Data published by EUROSTAT)

Year	**CDW Generation**		
	Hazardous [tons]	**Non-hazardous [tons]**	**Total [tons]**
2010	11404	145369	156773
2012	0	130369	130369
2014	0	148384	148384

The reliability of the above data is questionable since no hazardous CDW was reported in 2012 and 2014 compared to 11404 tons generated in 2010.

6.3.2 CDW treatment data

In Cyprus, CDW treatment data is obtained by the Statistical Service of Cyprus (CYSTAT) through surveys in accordance with Regulation EC No. 2150/2002 On Waste Statistics [53]. The above data is supplemented with estimations provided by the Statistical Office of the European Union (EUROSTAT). Statistical estimations are necessary in order to fill in gaps and improve the low-accuracy of existing data. However, large quantities of generated CDW are not properly reported. Consequently, official data on CDW generation based on surveys and estimations might not be representative of the real situation in the country [51].

EUROSTAT data for mineral CDW treatment (Waste Code: 121) for years 2010, 2012 and 2014[54] is shown in Table 16.

Table 16. Mineral CDW treatment data in Cyprus for years 2010, 2012 and 2014 (Data published by EUROSTAT

<table>
<tr><th rowspan="2">Year</th><th colspan="2">Deposit onto or into land</th><th colspan="2">Recovery other than energy</th><th rowspan="2">Total CDW Treated (Hazardous +Non-hazardous) (tonnes)</th></tr>
<tr><th>Hazardous (tonnes)</th><th>Non-hazardous (tonnes)</th><th>Backfilling Non-hazardous (tonnes)</th><th>Except Backfilling Non-hazardous (tonnes)</th></tr>
<tr><td>2010</td><td>11410</td><td>148360</td><td colspan="2">481</td><td>0</td></tr>
<tr><td>2012</td><td>0</td><td>54801</td><td colspan="2">21291</td><td>62129</td></tr>
<tr><td>2014</td><td>0</td><td>68949</td><td colspan="2">0</td><td>42283</td></tr>
</table>

Comparison of Table 15 and Table 16 reveals an ongoing discrepancy between the reported quantities of mineral CDW generated and managed. However, as more ECDW Management Systems become operational the above discrepancy will be significantly limited, leading to more accurate data [55].

6.3.3 CDW exports/imports data

At present, no data is available related to exports/imports of CDW.

6.3.4 CDW treatment facilities data

Currently in Cyprus, there are three licensed facilities for treatment of CDW. These are M. S. (Skyra) Vassas Ltd [56], Skyra Lima Ltd [57] and CH Mylonas Quarries Ltd [58]. The facilities are licensed to perform D1 (Landfill), D13 (Blending or mixing prior to submission to any of the operations numbered D1 to D12) and D15 (Storage pending any of the operations numbered D1 to D14) disposal operations in accordance with the classification in Annex I of the WFD 2008/98/EC [45]. They are also licensed to perform R4 (Recycling/reclamation of metals and metal compounds), R5 (Recycling/reclamation of other inorganic materials) and R13 (Accumulation of material intended for any operation numbered R1 to R12) recovery operations in accordance with the classification in Annex II of the WFD 2008/98/EC [45]. There is no available data regarding the capacity of the above facilities for recovery or disposal operations.

6.3.5 Future projections of CDW generation and treatment

Currently, there are no official future projections of CDW generation and treatment. However, CDW generation data is directly related to the performance of the construction industry and CDW Management Systems such as OAK use the data provided by CYSTAT to estimate future CDW generation [51].

6.3.6 Methodology for CDW statistics

In Cyprus, the methodology used for collecting data on CDW generation and treatment complies with EUROSTAT guidelines [51] .

6.4 C&D waste management in practice

6.4.1 CDW management initiatives

No CDW management initiatives outside the existing legal framework are known to exist in Cyprus. However, efforts are being made by OAK to raise awareness of its members (construction contractors), their clients, regional/national administrative authorities and the public regarding the benefits of proper treatment of CDW. This is mainly done by organising frequent seminars all over the country and publishing relevant information online [59] - [65][36].

6.4.2 Drivers / barriers to increase CDW recycling

Factors which act both as drivers and barriers for increasing CDW recycling include legislation and regulation, number of regional treatment facilities, number of CDW management systems, data reporting and construction work contracts. More specifically:

- Creation of a legal framework for CDW management by transposing WFD 2008/98/EC [45] has acted as a driver for increasing CDW recycling. However, there is a clear lack of implementation of the above legislation due to low organisational capacity of the public administration. In addition, the mentality of most construction contractors in Cyprus is that CDW is not an important issue. It can be disposed more or less anywhere and left there as it is mostly inert material which is not hazardous for humans or the environment [51].

– The recent construction of a third licensed facility for CDW treatment (CH Mylonas Quarries Ltd) has significantly increased the CDW treatment capacity of the country. However, there is still not sufficient capacity. In addition, existing facilities are not able to satisfactory cover the entire country. As a result, CDW generated in many areas of the country has to be transported over long distances for treatment. This significantly increases the treatment costs leading to uncontrolled disposal in illegal landfills [51].
– The existence of two collective (ΟΑΚ and ΚΟΔΑ) and three single-member (established by a single construction contractor/producer of CDW) CDW Management Systems [66] has acted as a driver for increasing CDW recycling. However, there is a significant lack of knowledge and experience when it comes to design and implementation of CDW management activities. In addition, the mentality of most construction contractors in Cyprus regarding proper management of CDW acts as a barrier.
– The obligation of the licensed CDW Management Systems to report data obtained by their members on CDW treatment has acted as a driver for increasing CDW recycling. In addition, their estimates on future CDW generation and treatment point towards the right direction. However, CDW management systems are only obliged to report CDW treated quantities. Estimates on CDW generated quantities might not be very accurate [51].
– The obligation of construction contractors to prepare waste management plans as part of the project permitting process has acted acts as a driver for increasing CDW recycling. However, mandatory requirements for sustainable management of CDW are usually absent when it comes to the tendering of public works [51].

The main factors which act as barriers for increasing CDW recycling are the market conditions and the lack of standards, guidelines, recommendations or best practices.

– The financial crisis of 2012 has led to a significant contraction of the construction activity in Cyprus. Consequently, much smaller quantities of CDW were generated from 2012 onwards. This subjected CDW management systems to a lot of pressure since the quantities of CDW requiring treatment were also significantly reduced. In addition, lack of environmental taxes (such as the landfill tax or the aggregates levy in the UK) means that natural raw construction materials are cheaper and easier to access compared to recycled ones [51].
– There are no guidelines, recommendations or best practices for selective demolition or design standards for use of recycled materials in new construction. In addition, there are no EoW criteria for inert CDW. Finally, there is no official policy for either the promotion or use of recycled materials from CDW [51].

6.5 CDW sector characterization

6.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

There are no recycled materials from CDW in Cyprus. There are no financial incentives such as the introduction of environmental taxes or the establishment of EoW criteria for creating a market. Natural raw construction materials are cheaper and easier to access compared to recycled ones. Finally, no design standards for the use of recycled materials in new construction have been developed [51].

Quantitative analysis

Please refer to Section "Product description and applications"

Recovery techniques

Please refer to Section "Product description and applications"

Environmental and economic impacts of CDW waste management

Please refer to Section "Product description and applications"

Drivers / barriers to increase recycling

Please refer to Section 6.4.2

6.5.2 Recycled materials from CDW

Please refer to Section "Product description and applications".

6.5.3 Market conditions / costs and benefits

There is no developed market for CDW recycled materials in Cyprus. In addition, recycling of CDW is considered by most construction contractors, which are struggling to keep their businesses afloat (due to a severe reduction of 80% of the construction production index during the period 2008-2014 [67] as an extra cost they have to avoid paying.

7. CZECH REPUBBLIC

7.1 Legal Framework – Waste Management Plans and Strategies

7.1.1 National Legislation concerning CDW

In Czech legislation, the official definition of CDW is, currently, non-existing. However, a regulation regulating the conditions of storing waste in landfills and their use on the ground surface (Decree 294/2005) defined in its §2, section v) recycled material from CDW as "material output from a device used for recovery and reuse of non-hazardous CDW other categories of waste and waste similar to CDW, consisting of crushing and separation to different fractions in facilities for that purpose" [68]. In the Czech Republic, packaging waste, municipal waste and electrical waste are not considered CDW.

In 2008, the Ministry of Environment (MoE) introduced the methodological guidance [69] on the CDW management. This guideline considers CDW as waste generated during construction, maintenance, refurbishment and demolition of buildings. The most frequently produced waste materials in the Czech Republic are soil, stones and construction products.

The key legislation piece developed by the EU is the WFD. The Directive's requirements are translated to the Waste Act no.185/2011. This law concerns and regulates three areas of actions [70]. First, it sets rules for waste prevention and waste management. Second, it regulates rights and obligation of actors involved in waste management. Third, the law coordinates the involvement of public administration bodies in the field of waste management. In addition to the Waste Management law, the Czech Republic developed WMP, which sets objectives concerning waste management – current one is in effect from 2015 and will be until 2024. Local and Regional authorities develop their WMPs, which are in compliance with national WMP.

The utilization of the treated waste is allowed in case it is within the framework of the Decree no. 383/2001[71] on details of waste management. It further sets requirements for facilities, which collect, eliminate, store and purchase waste. Landfilling and waste utilization on ground surface is regulated by the Decree no. 294/2005. In case a waste, including CDW, fulfils requirements set by the Regulation 163/2002 and Act no. 22/1997 on technical and safety requirements, it can be regarded as a product. Once a waste becomes a product, it is no longer covered by the Waste legislation.

City planning and building code law 183/2006 obliges regional and local authorities to authorize demolitions only their permissions, which includes undertaking pre-demolition audit and CDW management plan. To prevent waste, actions to promote prevention are in place – several measures can be found in the Czech WMP, Act no. 477/2001, on Packaging as well as in the Waste Act no. 185/2001. In addition to this legislation, WPP has been in place since 2014. The WPP offers guidelines for the CDW management, these are:

– Awareness raising campaigns
– Support the use of recycled or recovered CDW
– Enter voluntary agreements with construction materials producers

– Create a tool for registration of safe building materials generated from CDW.

Landfilling

Starting from 2024, it will be prohibited to landfill recyclable waste. Currently, Regulation 352/2014 prohibits landfilling of several waste materials. Waste, which is banned from landfilling is as follows:

– Material or a product, which has an obligation to be returned to the supplier after its lifespan
– Liquid waste or waste that generates liquid elements (metallic mercury as an exception)
– Dangerous waste (explosives, high oxidation properties, waste producing toxic gases)
– Waste which reacts aggressively in contact with water
– Waste generated during a research with not clearly identified properties
– Waste with strong odour
– Waste containers and equipment containing gas being held at a different pressure to the atmosphere.

7.1.2 Waste management plans (WMP) and Strategies

The Czech Republic has produced several plans on waste management – among those are WMP, and Waste Prevention Plan (WPP).

The WMP of Czech Republic for 2015-2024 sets both the quantitative and qualitative objectives concerning the waste management. The MoE publishes annual reviews of the WMPs implementation on their website. There are three types of WMP in the Czech Republic – national, regional and municipality level ones. These WMPs follow hierarchical structure – the regional and municipal ones are expected to adopt national WMP targets. Regional and municipal WMPs are being tailored specifically to their territory. Within the scope of the national WMP, the section 3.3.1.4 concerns with the CDW. The principles mentioned there revolve around the CDW generation and treatment while taking into account protection of environment and human health as well as maximization the recovery and reuse of CDW [72].

The first WPP was passed and adopted in 2014 and states that the CDW recovery targets have been met. The WPP offers guidelines for the CDW management, these are [73]:

– Awareness raising campaigns
– Support the use of recycled or recovered CDW
– Developing guidelines aimed at prevention of CDW
– Enter voluntary agreements with construction materials producers
– Create a tool for registration of safe building materials generated from CDW.

7.1.3 Legal framework for sustainable management of CDW

There are five main topics in regards to CDW. Five of them are dealt with through legislation. The first is the national and regional obligation for selective demolition - the law is Waste Act No.185/2011. In that law, paragraph 12 deals with prohibition of mixing hazardous waste.

The same Act also deals with the second topic: national and regional sorting obligation. In the Act, paragraph 16 establishes the obligation to the waste producer to collect waste sorted by types and categories. Though it is not mentioned whether the obligation applies to on-site soring or a sorting facility, it binds both cases and can be applied to the CDW. The third topic of separation, collection a management of hazardous waste from construction and demolition operations can also fall under paragraph 12 of the same Act related to the prohibition of mixing hazardous waste. Topic 4 is the national and regional separate collection obligation for different material such as iron, steel, plastic, glass, etc. There are two acts of legislation dealing with this topic, the first was the government regulation No. 312/352/2014 about the WMP for Czech Republic 2015-2024. This regulation from 2014 does not support landfilling or energy recovery of recyclable waste and bans recyclable waste from landfilling from 2024. The second act is the amendment of the Waste Act 229/2014. This amendment though put together in 2014, applied from January 2015. It says that municipalities in the Czech Republic will have to ensure separate collection of metal and biodegradable waste as well as hazardous waste, paper, plastic and glass. The fifth topic dealt with is a topic of conditions of landfill and use of the ground surface. The topic is dealt with by Decree No.294/2005 of the MoE. It amends Decree No.383/2001. The new Decree sets conditions for landfilling/management/use on the ground surface of hazardous and non-hazardous waste [74].

7.1.4 Targets

The previous targets set for the Czech Republic revolved around the rate of recycling. The first target was set to recover/recycle 50% of CWD produced by December 31, 2005. The next target raised the percentage to 75% for waste produced by December 31, 2012. Both targets were met. The Table 17 shows the production of CDW waste, percentage of CDW from the total waste production and the percentage of waste utilization in given years. It is important to note that these statistics differ from data submitted to the EUROSTAT.

Table 17. Waste production and utilization in CZ in years 2002-2012, MoE [75]

Year	CWD Production (thousand tons)	Percentage of CDW from total waste production (%)	Percentage of waste utilization (%)
2002	8.802.5	23.2	55.9
2003	9.748.5	26.9	76.9
2004	14.489.8	37.4	77.9
2005	11.893.1	39.9	85.1
2006	11.983.1	42.7	100
2007	14.441.4	47.5	93.8
2008	15.421.3	50.1	100
2009	15.279.7	47.4	93.8
2010	15.643.1	49.2	84.8

2011	13.701.5	44.7	92.3
2012	13.888	46.3	95.1

Currently, the WFD regulates that the Member States must adopt all necessary measures to achieve the recovering/recycling minimum target of 70% by the end of 2020. In the Czech Republic, this Directive was adopted and translated to the regulation 352/2014. Nevertheless, as this number was a standards years ago, many argue that 70% is insufficient. To conclude, the Czech Republic implements European directive more than satisfactory. On the other hand, the amount of recovered CDW used as construction material is only approximately 23% [76].

7.1.5 End of Waste (EoW) status

The concept defines when certain waste ceases to be waste and obtains a status of a product or of a secondary raw material. The WFD states that certain waste shall cease to be waste when it has undergone a recovery operation and is in compliance with EoW criteria. These criteria have been translated to the Waste Act 185/2001 [77]. The criteria are as follows:

– The substance or object is commonly used for specific purposes
– There is an existing market or demand for the substance or object
– The use is legal – meets technical and legal requirements
– The use of it will have no negative environmental or human health impact
– The waste meets requirements defined by EU legislation.

At the moment, the Czech Republic did not specify the criteria used particularly for CDW. A final decision whether or not a material is waste can be made by local or regional authority on request of the material producer.

7.2 Non legislative instruments (best practices, guidelines, recommendations…)

The non-legislative instruments that are dealt with in the Czech Republic can be divided into four main topics that together include all the various instruments. The first main topic relates to the two key sustainability initiatives. Those initiatives serve as an instrument by putting together certain standards that must be met in order to earn the initiatives certification. They are BREEAM and LEED. Both are widely used in the Czech Republic and both create incentives to attract international customers with the use of certified buildings.

The second topic is a set of non-legislative instruments of the extended procedure responsibility schemes. The scheme of "take back" (the idea that companies which make/sell the product containing bulky or toxic elements are responsible for taking the product back after consumers are done with it) derives from Decree No. 325/2008 and is mandatory in the Czech Republic. There is also a "take-back" requirement for End of Life vehicles, electric and electronic equipment and accumulators. Act 477/2001 sets packaging requirements. It says that packaging must be minimal in volume and mass and must be in compliance with Czech technical requirements.

The methodological guidance on CDW management recommends performing an inspection of the buildings and its surroundings before demolitions. The aim of this inspection is to identify parts of the buildings that may contain hazardous materials and such part should be removed separately to avoid mixing of hazardous and non-hazardous materials. Nevertheless, is it not a legislation and thus is not mandatory. When it comes to recycling, the same rules apply to CDW as to primary products.

In the Czech Republic, there are two existing CDW initiatives – raw material policy and value added tax for certain types of recycled materials. The Raw Material Policy describes the progress in waste material utilisation as compared to raw materials. Such policy will result in the development of the Action plan which aims to promote the reuse of waste – including CDW. The government lowered VAT for certain types of recycled materials, for certain services, and for green public procurement to promote recycling [78].

7.3 CDW management performance – CDW data

7.3.1 CDW generation data

This chapter aims to present the data on CDW in the Czech Republic collected by the ISOH – the database of the MoE. The Table 18 summarizes the production of CDW in the Czech Republic in years 2009-2014. The table does not include neither dangerous waste nor waste with insignificant production amounts. It is possible to note that the waste production is gradually increasing in all CDW areas with the exception of waste 17 05 06. The data is adopted from the Association for recycling of building materials in the Czech Republic [79].

Table 18. Production of particular CDW in the Czech Republic, 2009-2014

Code	Waste	2009 (kt)	2010 (kt)	2011 (kt)	2012(kt)	2013 (kt)	2014 (kt)
1701	**Concrete, bricks, tiles and ceramics**	**2998**	**3167**	**3033**	**3445**	**3249**	**3688**
17 01 01	Concrete	1132	1163	1127	1385	1292	1422
17 01 02	Bricks	919	834	776	735	757	745
17 01 03	Tiles and ceramics	15	18	11	14	12	16
17 01 07	Mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	886	1130	1092	1250	1172	1473
17 03	**Bituminous mixtures, coal tar and tarred products**	**516**	**466**	**443**	**531**	**510**	**573**
17 03 02	Bituminous mixtures containing other than those mentioned in 17 03 01	513	456	439	526	508	568
17 05	**Soil (including excavated soil from contaminated sites),**	**10708**	**10845**	**9053**	**8908**	**9966**	**11128**

	stones and dredging spoil						
17 05 04	Soil and stones other than those mentioned in 17 05 03	9116	8825	8420	7832	9442	10619
17 05 06	Dredging spoil other than those mentioned in 17 05 05	1003	1687	306	622	130	102
17 05 08	Track ballast other than those mentioned in 17 05 07	54	47	60	64	80	112
17 06	**Insulation materials and asbestos-containing construction materials**	**74**	**111**	**71**	**59**	**61**	**66**
17 08	**Gypsum-based construction material**	**7**	**7**	**8**	**7**	**9**	**11**
17 09	**Other construction demolition waste**	**580**	**614**	**630**	**496**	**609**	**451**
17 09 04	Mixed construction demolition wastes other than those mentioned in 17 09 01, 17 09 02, and 17 09 03	485	555	585	473	590	441
	Total	**14883**	**15210**	**13239**	**13447**	**14404**	**15916**

Looking at the Table 18 from the perspective of prospect recycling or recovering, the most suitable CDW materials are those, which can be further used as recycled gravel, namely, concrete, tar, brickwork and its mixtures. Their production is monitored in Table 20.

Such materials have to be used further within the framework of circular economy. It is possible to note that these materials represent approximately 30% of CDW in the Czech Republic.

Table 19. The most suitable CDW for recovery in the Czech Republic, 2009-2014 [79]

Code	2009 (kt)	2010 (kt)	2011 (kt)	2012 (kt)	2013 (kt)	2014 (kt)
1701	2.998	3.167	3.033	3.445	3.249	3.688
17 03 02	513	456	439	526	508	568
17 09 04	485	555	585	473	590	441
Total	3.996	4.178	4.057	4.444	4.347	4.697
% from total CDW	26,8%	27,3%	30,6%	33%	30,2%	29,5%

7.3.2 CDW treatment data

CDW treatments data have been released by the Czech Statistical Office since 2013. The Table 20 summarizes CDW treatment in the Czech Republic in 2013 [78].

Table 20. CDW treatment in Czech Republic in 2013

	EWC 17 01 (tonnes)	EWC 17 03 (tonnes)	EWC 17 05 (tonnes)	EWC 17 09 (tonnes)	Total (tonnes)
Recycling/reclamation of other inorganic materials	1.470.154	360.966	1.035.937	93.996	2.961.053
Deposit into or onto land	193.402	21.832	306.504	129.296	651.034
Use of wastes for landscaping	458.556	5.252	1.913.950	26.767	2.404.525
Use of waste for the deposit reclamation	31.956	N/A	393.635	4.893	430.484
Deposit of wastes as technological material to make landfills safe	205.038	8.889	204.807	106.154	542.888
Total	**2.993.080**	**615.839**	**6.934.469**	**500.953**	**11.044.341**

7.3.3 CDW exports/imports data

The shipment of waste requirements are defined in the Waste Act 185/2001 and Decree 381/2001. It ensures that the amount of international hazardous waste is kept to a minimum. The Table 21 illustrates import and export data in Czech Republic in period 2009-2013.

Table 21. Import and Export of CDW in CZ in period 2009-2013 [78]

			Imports			Exports		
Waste Category	year	unit	HAZ	NHAZ	TOTAL	HAZ	NHAZ	TOTAL
TOTAL CDW	2013	T	9.614	658672	658682	3653	1161974	1165628
TOTAL CDW	2012	T	1.4	594215	594216	2743	1418613	1421356
TOTAL CDW	2011	T	99.45	635498	635597	3224	1472715	1475940
TOTAL CDW	2010	T	39	510801	510840	549	1242924	1243474
TOTAL CDW	2009	T	7.	413305	413312	227	724152	724380

7.3.4 CDW treatment facilities data

In the Czech Republic, there are close to 300 functional landfills and over 7.000 permissions for treatment facilities dealing with CDW. Treatment facilities are responsible for collection, sorting, recycling, waste recovery, storage, landfill, composting, use of waste for reclamation and waste utilization for landscaping. Landfills are operated by both public and private entities and are divided into three types: landfill for hazardous waste, landfill for inert waste and landfill for other waste. According to the MoE, landfills capacity is sufficient.

7.3.5 Future projections of CDW generation and treatment

According to contemporary estimations, experts believe that in a near future we will be able to see a growing number in CDW generation. By the year 2020, the estimations point towards increase of 10%. There are plans in motion for the creation of measures to reduce mentioned waste – those plans are in effect since 2014 and are expected to be completed by 2019. The period during which the CDW reduction is expected to be visible is 2020 to 2025 [75]. The two main activities from the prevention approach are the reduction of the production of construction waste and the reduction of the levels of non-environment friendly substances.

7.3.6 Methodology for CDW statistics

Economic entities must report on their impact of their economic activities on the environment. The national methodology of data collection on CDW treatment is in line with EUROSTAT instructions.

7.4 C&D waste management in practice

7.4.1 CDW management initiatives

Environmental product declaration which quantifies the environmental impact of a building materials and products is a part of the waste prevention program. The Czech Republic is a member of the European Quality Association for Recycling which promotes international cooperation and shares best practices concerning recycling. The association for recycling of construction materials deals with issues related to the recycling of CDW. They hold conferences linked to CDW management practices. Similarly, Green Building Council organizes seminars to spread knowledge on the latest legislation regarding the CDW management. The environmental technology verification offers an option to certify innovative processes such as reprocessing of bricks. Moreover, there are several opportunities for waste exchange. The Czech Republic was involved (in 2011) in a project ACT CLEAN which enabled SMEs to participate in training and to access technology to undertake eco-efficient production. Last but not least, there are many researches examining the improvement in waste management and in the use of waste [78].

7.4.2 Drivers / barriers to increase CDW recycling

The Czech Republic has been showing above-standard results concerning the utilization of waste. One of the reasons might be an increasing interest in the field of circular economy. The EU has been pushing for the circular economy in Member States and consequently both governmental bodies and non-governmental ones are promoting the principles of circular economy. For instance, the Institute of Circular Economy aims to spread the ideas of circular economy to the public – the institute organizes educational programs, coordinates project and provides expertise in this field. The re-use of CDW is slowly becoming an acceptable option. The educational programs do not take into consideration only circular economy per se, but also CDW management in general. ARSM organizes annual conferences on CDW, including addressing the necessity to raise an awareness to the waste recycling. Furthermore, the MoE will in a near future present a new waste management legislation, which will, in the framework of "end of waste", re-consider the classification of waste and what is now referred to as waste, might become secondary raw material [75]. Nevertheless, the most significant driver behind the motivation to re-use the CDW are financial incentives. The Czech governmental bodies are aware of it and try to discourage landfilling. At the moment, the landfill fee ranges from 4 euro per ton of concrete to 46 euro per ton of plastics; the fees are expected to be continuously increasing [80].

Even though the previous chapter suggested that the potential for CDW management is rather large in the Czech Republic, there are still several obstacles to the CDW management. First, the recently developed WPP is focused on the theoretical application; practical guidelines are lacking. Though the circular economy seems to be progressing in the Czech Republic, industries tent to have hesitant stances towards it. It is linked to the second barrier – in many cases, to landfill CDW is cheaper in comparison to recovering/recycling it. Due to limited amount of CDW treatment facilities, the distance from the site to the facility might be long and consequently costly and time-consuming. Third, since the CDW recycling is rather recent phenomenon, the awareness and information about the recyclability of CDW and its benefits are lacking. Next, the opinion that the Waste regulations are an administrative burned without any benefit, prevails. Lastly, to re-classify some CDW as secondary raw materials might be challenging as they are often viewed as having pollutant potential [78].

7.5 CDW sector characterization

7.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most used concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements. It is used for construction of buildings, roads and infrastructure.

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes.

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass, generally used for covering roofs, floors, walls, showers, or other objects such as table tops. Tiles are often used to form wall and floor coverings, and can range from simple square tiles to complex mosaics. Tiles are most often made of ceramic, typically glazed for internal uses and unglazed for roofing.

Asphalt is a sticky, black and highly viscous liquid or semi-solid form of petroleum. It may be found in natural deposits or may be a refined product; it is a substance classed as a pitch. The primary use (70%) of asphalt/bitumen is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete.

Wood is a porous and fibrous structural tissue found in the stems and roots of trees, and other woody plants. It is an organic material, a natural composite of cellulose fibres which are strong in tension embedded in a matrix of lignin which resists compression. Wood has been used for thousands of years for fuel, as a construction material, for making tools and weapons, furniture and paper, and as a feedstock for the production of purified cellulose and its derivatives, such as cellophane and cellulose acetate.

Gypsum is a soft sulphate mineral composed of calcium sulphate dehydrate. It is widely mined and is used as a fertilizer, and as the main constituent in many forms of plaster, blackboard chalk and wallboard. Among other uses, gypsum is used in buildings construction.

Quantitative analysis

The quantitative data concerning the production in Czech Republic are available only for concrete, gypsum, and asphalt [81]. The tables Table 22, Table 23 and Table 24 illustrate this production.

Table 22. Concrete production in the Czech Republic

	Concrete production (million m^3)		Growth rate 2006/2008	Population (million inhabitants)		Production per capita		Cement consumption (million tonnes)		Growth rate 2006/2008
	2006	2008		2006	2008	2006	2008	2006	2008	
CZ	8.0	9.6	20%	10.2	10.38	0.78	0.92	4.8	5.1	6.25%

Table 23. Gypsum production in the Czech Republic

	2005 (tonnes)	2008 (tonnes)	Population in 2008	Production per capita	Share to the EU production	Growth rate 2005/2008

CZ	24.000	35.000	10.381.130	0.0034	0.1%	45.8%

Table 24. Asphalt production in the Czech Republic

	2005 (million tonnes)	2008 (million tonnes)	Population in 2008	Production per capita	Share to the EU production	Growth rate 2005/2008
CZ	5.6	7.3	10.381.130	0.7	2.5%	30.4%

Recovery techniques

- **Concrete**: Landfill, recycling into aggregates for read construction or backfilling, recycling into aggregates for concrete production, re-use of precast elements
- **Brick**: Landfill, recycling, re-use
- **Tile**: Landfill, recycling, re-use
- **Asphalt**: Landfill, recycling in a stationary plant, in-site recycling, material recovery
- **Wood**: Landfill, recycling into derived timber products, energy recovery
- **Gypsum**: Landfill, recycling into new plasterboards (in substitution of natural or synthetic gypsum)

Environmental and economic impacts of CDW waste management

Despite the fact that landfilled concrete does not significantly increase groundwater pollution, it still proves problematic on the account of space that is filled and not used otherwise. The treatment of concrete before its re-use is problematic as the dust might cause serious health problems for workers. The benefit of re-use is that there is no need for virgin aggregates to be extracted from quarries and be processed. The most negative environmental impacts of concrete production derive from cement production. The direct re-use of concrete blocks avoids the production of concrete, and therefore the associated impacts of cement production.

Similar to concrete, landfilling of bricks and tiles does not cause serious environmental issues. The recycling would prevent extraction of raw materials; however, the use of raw material is not the issue as it is largely available locally in Europe and the extraction of clay for construction products represents only 5% of the total mineral extraction. Recycled coarse and fine aggregates are supposed to save the cost of transportation; however, as clay brick and tile plants are frequently located near clay deposits and sand quarries, the cost of transportation is minimal. On the other hand, the re-use of recovered bricks and tiles avoids the manufacturing processes which are associated with high energy consumption and emissions. The low cost of bricks and tiles produced from virgin materials does not make recycling feasible option.

Concerning the landfill of asphalt, one must be cautious whether the asphalt consists of tar. In case it does, it is classified as hazardous waste and must be handled accordingly. If asphalt does not contain tar, then there are no major environmental impacts of landfilling it. The carbon footprint for recycled asphalt is lower than for asphalt made of raw materials. The production costs of both asphalt made of reclaimed aggregates and asphalt made of virgin materials are assumed to be identical and thus do not encourage recycling.

Landfilling of construction and demolition wood waste is associated with release of methane emission. As the surface of wood used in construction is often treated with chemicals, there is a possibility of ground water pollution. To ensure good quality wood products made from secondary wood, the requirements limits for toxic particles in recycled wood are the same as for raw materials. The most noticeable benefit is that re-use of wood saves natural resources that are becoming scarce. Due to limited supplies of natural resources, the price of recycled wood is gradually increasing.

Landfilling of gypsum poses a threat to environment due to the fact that it releases dangerous hydrogen sulphide gas if in contact with organic waste or exposed to rain. The production of plasterboards from both recycled gypsum and one from virgin materials has similar environmental impacts. On the other hand, the gypsum is estimated to be scarce in future and thus the recycling might become more popular. Also, due to a limited amount of raw gypsum, the price of raw gypsum increased more than 50% in the last 3 years [81].

Drivers / barriers to increase recycling

Provided in section 7.4.2

7.5.2 Recycled materials from CDW

Under the Act 22/1997, it is possible to use specific CDW as aggregates for railway construction, as backfilling material for disposal of mines, construction fill, rehabilitation of mine dumps and as railway ballast and service roads for mining operations.

It is allowed to use recycled materials in construction under the condition that the material meets the requirements of primary materials. In the Czech Republic, recycled materials include recycled bricks and recycled concrete aggregates. Recycled construction materials are further divided into six categories – recycled concrete, recycled road material, recycled masonry, mixed recycled CDW, recycled asphalt and R-material which is to be used in the hot asphalt mixtures.

7.5.3 Market conditions / costs and benefits

Construction materials must meet the technical requirements set for the Czech Republic in the Act 22/1997. Building products which are to enter the market must have CE label.

The prices for landfill range between 6 € and 225€. This fee is then used as a compensation to the municipality in which territory the landfill is located. The charge is being increased annually to encourage environmentally friendly methods of waste disposal by financially disadvantage the waste landfilling. Nevertheless, in rural areas, CDW treatment facilities are often lacking and the cost of transportation often exceeds the price of landfill. To provide more treatment facilities of CDW might be a driver for improving the recycling situation in the Czech Republic.

8. ESTONIA

8.1 Legal Framework – Waste Management Plans and Strategies

8.1.1 National Legislation concerning CDW

The main national legislation concerning waste in Estonia is the "Waste Act" which has several amendments since 2004, but is also transposing the EU Mining Waste Directive 2006/21/EC (2010) and new Waste Directive 2008/98/EC. Waste Act provides the organization of waste management, requirements for preventing waste generation and the health and environmental hazards arising from waste, including measures for improving the efficiency of the use of natural resources and reducing the adverse impacts of such use, and liability for violation of the established requirements.

Even if the Waste Act does not include specific rules for CDW management, it lays down the general rules that should apply for the management of waste according to the waste hierarchy, as presented in the WFD (2008/98/EC). This means that each professional activity related to CDW management falls under appropriate permitting regulations, as described in Chapter 6 of the law.

About environmental impact of waste, paragraph 6 of Waste Act reports that the processes or methods used in waste handling shall not endanger health, property or the environment. The waste handling shall implement all the necessary measures to avoid or reduce as much as possible the environmental nuisances caused by waste, depending on the waste typology.

There is no specific legislation in place for the management of CDW, but the management of CDW is well articulated in the local waste management rules which are issued at municipality level. CDW therefore, is regulated at municipality level with the obligatory rules laid down in the local government waste management rules (Waste Act, Art.71). The local waste management rules are governed by the provisions of the National Waste Management Plan as well as the Regional Waste Management Plans.

8.1.2 Waste management plans (WMP) and Strategies

Estonia has a brand new National Waste Management Plan for the period 2014-2020. A chapter of the new WMP is dedicated to the development of the national Waste Prevention Plan (WPP), according to provisions stated in the WFD (2008/98/EC). As reported in the DELOITTE study, the WMP places specific focus on the promotion and intensification of support for investments and financing to companies engaged in waste recycling in order to enhance their performance and treatment capacity with the aim of contributing to the achievement of both recovery/recycling targets of the WFD, for municipal solid waste and construction and demolition waste. The goal of Estonia, as described in the WMP, is to reduce landfilling as much as possible and recover the highest possible share of CDW.

CDW is considered as a priority waste stream in the WPP section within the WMP of Estonia. Several measures for waste prevention, in line with Annex IV of the WFD, are presented in the WPP and they are also applicable to CDW.

Also within the **Estonian Environmental Strategy 2030**, coordinated and prepared by the Ministry of the Environment, there is a chapter dedicated to waste. This chapter deals with main trends in the sphere of the environment which can be observed both in Estonia and Europe. More and more environmentally sustainable and easily recoverable materials are being used. Disposal of building and demolition waste in landfills is decreasing, as with a view to economic savings other applications have been found for inert waste. More environmentally sustainable and easily recoverable materials are being used in products. The principles of producer liability and "polluter pays" are being enforced and implemented on a growing basis. The environmental impact of landfills is decreasing, as old landfills that fail to conform to environmental requirements are being closed down and environmentally sustainable technologies are being employed for establishing new landfills.

8.1.3 Legal framework for sustainable management of CDW

No data found

8.1.4 Targets

Estonia is one of the very few Member States in EU-28 that have included a more ambitious target in their National Waste Management Plan than that of the Waste Framework Directive (2008/98/EC). The new Waste Management Plan of Estonia (for the period 2014-2020) is setting a target of 75% recovery of CDW by 2020. Taking into consideration that Estonia has already reached the target of the Waste Framework Directive (2008/98/EC), as in 2011 the recovery rate of CDW was at the level of 72%, it is most likely that this target will be fulfilled by 2020.

Therefore, in the Estonian Environmental Strategy 2030, it is set that by 2030 waste disposed to landfills will have decreased by 30% and the harmfulness of waste generated will have been reduced significantly. Among the initiative to do it, it is important to increase the sorting and recovery, including recycling, of waste to minimise the waste amounts to be disposed. Also, the harmfulness of waste and the content of hazardous substances in waste must be reduced, as this would preclude the increase of discharges into air, water and soil in the course of waste handling.

Some indicators produced for the time being, are:

- Generation of hazardous waste ↓. Base level: 7,029,000 tons per year;
- The relative share of recovered waste among all the generated waste, for the following materials: glass, plastics, paper ↑. Base level: 53%, 36%, 45%;
- The ratio of products of concern brought to market to the collected and recovered waste arising from products of concern ↓;
- The relative share of local governments with a waste management system that conforms to requirements ↑↔.

8.1.5 End of Waste (EoW) status

Currently, there are no End of Waste criteria established in Estonia concerning materials from the CDW stream. The principles for establishing End of Waste criteria are clearly articulated in the Waste Act. There is no information available on the status or future planning for development of such criteria.

8.2 Non legislative instruments (best practices, guidelines, recommendations…)

Despite having high recovery rates and the fact that Estonia already surpassed the 70% recovery target of the Waste Framework Directive (2008/98/EC) concerning CDW as early as 2011 (72%), Estonia still faces a problem with acquiring high quality recycling and the production of recycled CDW that can be effectively used back into construction activities. In order to address the current situation and in an effort to overcome the apparent barriers in improving (a) the quality of recycling and (b) the market of CDW recycled products (e.g. recycled aggregates), the waste management sector in Estonia through its **Waste Management Association** initiated the creation of a **Waste Recycling Cluster** (eventually becoming the Recycling Competence Centre).

The activities of the Recycling Competence Centre are mainly focused on the development of different waste recycling projects (incl. international projects), trainings for all stakeholders in waste management/recycling and sharing internationally the experiences of Estonian companies in waste recycling. Further areas of focus include the development of standards and a certification scheme for recycled aggregates.

The Recycling Competence Centre has been successful in establishing partnerships with other cluster networks and recycling associations in the EU (e.g. the Austrian Association for the Recycling of Building Materials - BRV) as well as an extensive network of partners in the Nordic countries, especially Norway, Finland and Sweden. The wide partner network has facilitated knowledge sharing and dissemination, among the international and national partners and the Recycling Competence Centre, and has led to increased uptake of the latest developments and technologies in the sector.

The academic partners in the Recycling Competence Centre, namely the 3 Universities taking part in the initiative, are mainly responsible for the dissemination of research results and demonstration of innovative practices in CDW management and especially the utilization of recycled aggregates in different construction projects (e.g. the construction of a test road with recycled materials).

8.3 CDW management performance – CDW data

8.3.1 CDW generation data

EUROSTAT database reports the following data (Table 25) for CDW generated between years 2010 and 2014.

Table 25. EUROSTAT database for CDW generated between years 2010 and 2014 [tons].

	2010	2012	2014
Mineral waste for construction	203.822	307.980	318.108
Metal wastes, ferrous	33.765	8.943	15.095
Metal wastes, non-ferrous	2.058	263	296
Glass wastes	36	170	287

Plastic wastes	208	166	188
Wood wastes	3.398	9.541	8.036
Total	**436.289**	**657.089**	**671.347**

8.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 26.

Table 26. EUROSTAT database for "Mineral waste from construction" [tons]

Mineral waste from construction	2010	2012	2014
Landfill / disposal (D1-D7, D12)	21.522	19.779	18.052
Deposit onto or into land	21.522	19.779	18.052
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	0	0
Incineration / energy recovery (R1)	4.091	3.078	1.092
Recovery other than energy recovery	582.814	520.223	705.065
Recovery other than energy recovery - backfilling	56.776	113.814	123.459
Recovery other than energy recovery - except backfilling	526.038	406.409	581.606
Total waste treatment	**608.427**	**543.081**	**724.210**

As reported in Deloitte documents, the majority of CDW recovered in Estonia is used for backfilling purposes, which consists a low form of recovery operation according to the waste treatment hierarchy.

8.3.3 CDW exports/imports data

No data has been found, apart what reported in DELOITTE document and shown in the Table 27.

Table 27. Quantities of imports/exports of CDW reported in DELOITTE document

	2011	2012	2013
Imports (Total)	**551 558**	**271 089**	**149 760**
Non-hazardous	551 558	271 089	149 760
Hazardous	0	0	0
Exports (Total)	**227 095**	**200 948**	**239 474**
Non-hazardous	227 095	198 879	237 249
Hazardous	0	2 069	2 225

8.3.4 CDW treatment facilities data

According to DELOITTE document the number of landfills operating in Estonia is declining in the last years.

There are no specific figures for the total available treatment capacity in Estonia, but estimations from the Estonian Waste Recycling Competence Centre indicate that the current installed capacity is more than enough to cover the treatment of CDW generated in Estonia. Actually, there might be a slight overcapacity and many Estonian waste management companies are thinking of importing CDW for recovery.

There is no specific data on mobile vs. fixed treatment units. The waste management companies in Estonia employ a great variety of methods for the collection and treatment of CDW. Most commonly, waste management companies prefer to collect all CDW mixed in large containers and sort it afterwards in their facilities.

8.3.5 Future projections of CDW generation and treatment

No study containing future projections of CDW generation and treatment in Estonia was identified. No such projections were also identified in the new WMP of Estonia for 2014-2020.

However, thanks to the activity of the Recycling Competence Centre, in Estonia there has been a positive trend in recycling of CDW (especially the mineral fraction, which was mostly backfilled in the past) and in the production of recycled aggregates.

Currently, the management of the Recycling Competence Centre is in the process of application for new financing opportunities, as a continuation project to the previous two (namely the Waste Recycling Cluster and the Recycling Competence Centre which just ended its project period at 31 August 2015), looking for EU funding but also for private funding through the companies of EWMA.

8.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

8.4 C&D waste management in practice

8.4.1 CDW management initiatives

In order to address the current issues of CDW management in Estonia and in an effort to overcome the apparent barriers in improving (a) the quality of recycling and (b) the market of CDW recycled products (as described above), the waste management sector in Estonia through its waste management association initiated the creation of a Waste Recycling Cluster (eventually becoming the Recycling Competence Centre). As the waste management sector in Estonia is widely deregulated, private waste management companies play a major role in the management of CDW. Therefore, the creation of the Recycling Competence Centre came as a result of the need within the sector to improve and create the appropriate conditions that will increase recycling of CDW and the production of quality recycled products with high added value. The Recycling Competence Centre is an entirely private sector initiative which attracted funding through the EU regional development fund, but did not have any Estonian public financial support.

One of the most important initiative of the Estonian Recycling Centre is the application for official accreditation by the Estonian authorities for establishing a certification scheme for recycled materials (e.g. recycled aggregates). On June 30th, 2015 the Estonian Certification Centre of Recycled Materials was established as the result of waste management/recycling companies and research and educational institutions co-operation project Estonian Waste Recycling Cluster.

The main task of the Estonian Certification Centre of Recycled Materials is certification of waste products.

The first certification scheme was developed for compost and on Feb.17th, 2016 the Estonian Accreditation Centre issued accreditation certificate confirming that the Certification Centre of Recycled Materials conforms the requirements as certification body.

In 2017 it is envisaged that other recycled materials as such as digestate, crushed concrete etc will be included as well.

The Recycling Competence Centre will develop its own certification scheme for recycled aggregates which will set the necessary quality requirements for recycled CDW according to international standards. The development of one single certification scheme, within the CDW recycling sector for recycled products, will enable a uniform approach to secondary materials and harmonize the market environment for accepting such materials for use, on par with natural materials for construction purposes.

8.4.2 Drivers / barriers to increase CDW recycling

Even if in Estonia CDW management legislation exists at national and local level, there is a general satisfactory implementation of rules on CDW management.

Target in the Waste Management Plan of Estonia is set a higher level than that defined in the rest of the Europe, but limited recovery options for CDW are present. Currently, only aggregates are recycled and, at the moment, there are several barriers which hinder the development of higher quality recycling and the uptake of recycled aggregates as raw materials for new construction projects. Most importantly, the mentality in the construction sector which treats recycled materials as inferior to natural raw materials. There is a considerable lack of trust in recycled materials, which are perceived as of lower quality by builders and developers, and proof is needed that recycled materials have equal technical standards to virgin materials. As a result to this mistrust, there is very little or no demand for recycled CDW. Therefore, the market for recycled aggregates is not developed and there is little uptake of this material within the construction sector.

8.5 CDW sector characterization

8.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

The main targeted materials for recovery is mineral waste for the production of high quality aggregates. Metals from CDW are separately collected and directed to the market of metals waste for recycling (mainly abroad). Wood CDW is considered very problematic as a material for recovery as there are not many technological available options at the moment for the efficient recovery and use of wood CDW. As a result, the amounts of wood CDW generated are mostly used on site for energy recovery (heating). So far no treatment of the gypsum based materials and sheet glass exist in Estonia. Plastics, rubber and tar materials are mainly burned in permitted waste incineration and co-incineration (cement work) facilities. Most part of mineral CDW is used for backfilling operations. Recycled aggregates are used only for secondary roads (low traffic), bicycle paths, parking lots, etc.

Quantitative analysis

Despite the significant achievement of establishing the national waste register, there are some quantitates of CDW not reported.

Recovery techniques

The majority of CDW recovered in Estonia is used for backfilling purposes, which consists a low form of recovery operation according to the waste treatment hierarchy. Through the activity of the Recycling Competence Centre there are increasing quantitative of CDW that are recycled and can be used as recycled aggregates. At the moment, there are no other recycling options available in Estonia, for recycling other CDW materials.

Demolition works are usually done at a good technical level. Most widely used treatment options (crushing, sieving, etc) for concrete and bricks are available.

Environmental and economic impacts of CDW waste management

No data found.

Drivers / barriers to increase recycling

Provided in section 8.4.2.

8.5.2 Recycled materials from CDW

The market for recycled CDW materials in Estonia is not very developed yet. So far, the major part of mineral CDW is used for backfilling operations (reclamation of old quarries, use on construction works, etc.) and is not recycled to new products.

To this day, the only materials derived from CDW are the recycled aggregates.

8.5.3 Market conditions / costs and benefits

No market and no demand for recycled CDW are attended in Estonia; natural materials are always preferred over recycled materials in the construction works.

There are strong financial incentives in place in Estonia for encouraging recycling and recovery of CDW over landfilling. As landfilling is considered to be rather an expensive option, waste recovery services and infrastructure have developed considerably over the last years.

Currently the resource tax on natural materials is considered to be at very low level and do not represent the actual situation of prospective resource scarcity of natural materials for construction (e.g. aggregates), because discourages the use of recycled materials, as natural materials are still cheaper than their respective recycled materials.

9. FRANCE

9.1 Legal Framework – Waste Management Plans and Strategies

France has a powerful legal and regulatory framework with pre-audits on demolition sites, national and regional waste management plans including CDW, amongst others, benefiting CDW management. However, according to the stakeholders contacted by BIO by Deloitte for their study more significant financial and human resources need to be allocated to CDW legislation enforcement. Furthermore, the study highlighted insufficient regulation of backfilling and ground raisings.

9.1.1 National Legislation concerning CDW

Law 2009-967 of 3 August 2009, known as "*Grenelle I*" law, and **Law 2010-788** of 12 July 2010, known as "*Grenelle II*" law, make **pre-audits compulsory on demolition sites** (Articles 46 and 190, respectively). This measure is made compulsory for certain categories of buildings by **Decree n°2011-610** of 31 May 2011, which created articles R. 111-43 to R. 111-48 of the French Construction and Housing Code, and is supplemented by the Ministerial Order of 19 December 2011. The pre-audits, named "diagnosis on waste arising from demolition works", aim to characterise the materials present on site and plan the CDW management.

Order n°2010-1579 of 17 December 2010 amends the Environment Code to transpose the legislative part of the Waste Framework Directive 2008/98/EC (abbreviated WFD) into French law. It specifies the definition of waste, introduces the hierarchy in treatment operations, enforces waste prevention and sets the obligation to have a national waste prevention plan. **Decree n°2011-828** of 11 July 2011 then finalised the transposition of the WFD (regulatory part). It reformed waste territorial planning, set a limit on incineration and landfill, and imposed separate collection for recovery on large bio-waste producers. The **Environment Code** also impacts CDW by specifying the responsibility of waste producers and through its definition of waste prevention. Additionally, **waste traceability** is compulsory in France following **Decree n°2011-828** of 11 July 2011 and a couple of accompanying Ministerial Orders from 2012.

Since the 2010 Order, all companies are supposed to implement **source separation and collection** of waste. **Five waste streams** are targeted: paper, metal, plastic, glass, and wood. However this particular measure was not applied until the **Decree n°2016-288** of 10 March 2016, which sets the regulatory grounds for implementing source separation and collection of these five waste streams by companies in Article 3, hence its nickname: the 5-stream Decree ("*Décret 5 flux*" in French). Large producers of waste must do so for all five waste streams whereas small companies will gradually have to sort only paper. This piece of legislation specifies that several producers situated on a common site with the same waste management operator count as one larger producer. Furthermore, Article 5 of this Decree sets the legal framework for measures relative to the **recovery of construction material, product and equipment waste**. Indeed, distributors whose distribution unit is at least 400 m² and whose annual turnover is at least 1 M€ must organise the recovery of waste from the same type of construction materials, products and equipment as they distribute, within a radius of ten kilometres. Waste professionals hope this Article, which entered into force on 1 January 2017, will help reduce illegal dumping (Barrault, 2016). This Article 5 of the 5-stream Decree is a direct implementation of Article 93 of the **Law 2015-992** of 17 August 2015, related to energy transition for a green growth. The energy transition law (abbreviated "*LTECV*") also includes various other measures regarding CDW:

- Article 70 sets numerical targets for CDW prevention and recovery
- Article 78 prohibits inert waste disposal on agricultural lands
- Article 94 states that if waste destined for development, rehabilitation, or construction works is received by someone on a land they own, this person cannot receive financial compensation for using said waste
- Article 96 was the precursor to Article 3 of the 5-stream Decree, and further forbids and sanctions discriminations against recycled or reused materials offering the same performance level.

Decree n°2014-1501 of 12 December 2014 modified the classification of facilities for environmental protection (ICPE in French, facilities classified for environmental protection). Following this Decree, inert waste landfills, known as ISDI, short for inert waste storage facilities in French, were submitted to ICPE legislation from 1 January 2015 with the objective of improving consistency in the status of landfills and facilitating penalisation of illegal landfills.

Transport of CDW is also regulated as **non-inert waste transport** must be registered with local authorities, the "*Préfecture*", if quantities exceed 100 kg of hazardous waste or 500 kg of non-hazardous waste. **CDW regulation infringement** such as illegal dumbing or incineration on site is punishable by law, with sanctions of up to 2 years imprisonment and a fine of 76 000 €.

Although not specific to CDW, France has 18 extended producer responsibility (EPR) schemes, some of which impact a small fraction of the waste which can arise on a construction, renovation, or demolition site: waste electric and electronic equipment, tyres, furniture, gas bottles, batteries and accumulators, and light bulbs.

9.1.2 Waste management plans (WMP) and Strategies

National level

The first national waste prevention plan was adopted in February 2004, followed by the 2009-2012 Waste action plan in September 2009, which covered both prevention and management. In 2012, to meet the requirements of the Waste Framework Directive, waste prevention and management were separated to have distinct plans addressing each.

The **2014-2020 National waste prevention programme** was drawn up in 2012 and approved by Ministerial order in August 2014. Waste streams were classified into 3 levels of priority, with CDW identified as a priority 1 stream due to the huge amounts generated. Therefore one of the key objectives of the national waste prevention programme is to at least stabilise CDW generation by 2020 (260 Mt). The following actions are foreseen to meet this objective:

- Implement specific awareness-raising for building owners / construction developers, and other stakeholders from the buildings and public works sector.
- Develop voluntary commitment charters for the building and public works sector to encourage waste prevention
- Identify and use incentive levers to develop construction material re-use
- Review the regulation relative to demolition audits and improve it if necessary.

The **waste reduction and recovery plan 2016-2025** was published in January 2017 in a document acting jointly as the basis for the "national strategy of transition towards a circular economy". It summarises work carried out so far and objectives linked to the energy transition law. The energy transition law set objectives to increase material recovery to 55% in weight of non-hazardous, non-inert waste by 2020 (65% by 2025) and 70% recovery of CDW by 2020. By 2025 the amount of waste sent to disposal (landfill of incineration without energy recovery) must be reduced by half.

Furthermore, this same law aims to reinforce public procurement for a circular economy via its Article 79. Indeed, regarding CDW, public authorities must ensure that their tenders for construction or road works include a requirement to give priority to reuse or recycled materials. They must ensure that 50% of materials used for road works come from reuse or recycling of CDW in 2017, increasing to 60% in 2020. Additionally, amongst these materials, from 2017 onwards at least 10% of materials used in surface layers and at least 20% of those used in foundation layers must come from reuse or recycling. From 2020 onwards this must reach 20% for surface layers and 30% for foundation layers.

The waste plan also highlights the need to bring framework regulation up to date regarding waste status (end-of-waste, by-product status, for example). Indeed, the government will continue ongoing work on the clarification of regulation and will prepare modifications if necessary to facilitate waste recovery whilst maintaining the same insurances regarding environmentally-sound waste treatment.

<u>Local level</u>
France is divided in Regions, which are, in turn, subdivided into Departments. The France factsheet for the study "Resource-Efficient Use of Mixed Waste" describes plans and strategies at national (p. 11), then at local level (p. 13). Indeed, the Ministerial Circular of 15 February 2000 established the Departmental CDW prevention and management plans. The Grenelle II law then made these plans mandatory and under the responsibility of the Departmental Councils (Regional Council in the Île-de-France Region).

However, Article 8 of Law n.2015-991 **of 7 August 2015 on the New Territorial Organisation of the French Republic**, known as the "NOTRe" law, has transferred this responsibility to the Regions of France (which have also been redefined). Furthermore, the regional waste prevention and management plan will act as a unique framework for all types of waste, whereas until now departments had to develop plans for three separate streams: hazardous, non-hazardous, and CDW.

The modalities of this new regional plan are specified in Decree n.2016-811 **of 17 June 2016**. The regional plan must include:

- A state of play of waste prevention and management
- A six- and twelve-year forecast of the trends of waste quantities produced in the territory
- Waste prevention, recycling and recovery targets setting out the national targets adapted to regional specificities, and relevant indicators
- A six- and twelve-year waste prevention planning and waste management planning
- A regional action plan for circular economy

Certain waste streams will be covered by specific planning within the regional plan, amongst which is construction and demolition waste, for which the plan must include:

- A summary of actions related to the deployment of waste recovery
- A qualitative and quantitative identification of secondary mineral resource available at a regional scale.

The regional plan will be revised every six years at least.

The official deadline for the regional plans was February 2017 according to the NOTRe law, which set a limit of 18 months to write these plans. However this deadline was near impossible to meet with the Decree implementing the law was only published mid-June 2016 and the numerous changes faced by the Regions. Indeed, their borders were modified, departments were fused, and waste management was also severely changed by the NOTRe law.

The regional CDW prevention and management plan for the Paris Region (*Région Île-de-France* in French), known as PREDEC, was adopted in June 2015 (Conseil régional d'Île-de-France, 2015). A new single regional waste management plan will be published in the coming months. In other regions, current departmental waste prevention and management plans will apply until the publication of a new regional plan.

9.1.3 Legal framework for sustainable management of CDW

Table 28, adapted from BIO by Deloitte [88] identifies specific national or regional legislation which can create good conditions for a sustainable management of CDW.

Table 28 – Legal framework for sustainable management of CDW

Description	Occurrence (Yes/No), Key scope or exemptions	Policy reference & year
Obligation for selective demolition	No – mandatory pre-demolition audit for certain categories of buildings before demolition work, but no obligation for selective demolition	Law 2009-967 (Grenelle I) of 3 August 2009 – Article 46 Law 2010-788 (Grenelle 2) of 12 July 2010 – Article 190 Obligation from March 2012 for specific types of buildings
Sorting obligation (on-site or in sorting facility)	No – though it is prohibited to mix hazardous waste with other waste	Environment Code Article L. 541-7-2
Separate collection obligation for different materials	Yes – source separation & collection for paper, metal, plastic, glass, and wood is compulsory for companies, not specific to C&D operations	Decree n°2016-288 of 10 March 2016 – Article 3 Smaller companies will gradually have to sort paper only
Obligation for separate collection and management of hazardous waste from C&D operations	No	
Related Green public procurement requirements	No – though in 2017, 50% of materials used for road works should come from CDW reuse or recycling, 60% in 2020	Law 2015-992 (LTECV) of 17 August 2015 – Article 79

9.1.4 Targets

As mentioned in previous sections, several targets have been defined in existing policy and regulation:

- **Stabilise the generation of CDW by 2020** at the level reached in 2010 (260 Mt), an objective set by the 2014-2020 Waste prevention plan
- **70% CDW recovery and recycling by 2020**, an objective set by the WFD present in Article 19 of the bill on energy transition for a green growth and reiterated in the Waste reduction and recovery plan 2016-2025. However, this has not yet been transposed into French law, and the wording excludes neither hazardous CDW nor naturally occurring material, contrary to the WFD target.
- **30% reduction in the amount of non-hazardous, non-inert waste sent to disposal** (landfill or incineration without energy recovery) by 2020 compared to 2010, and 50% reduction by 2025, an objective set by the same Article 19 of the energy transition bill.
- Public authorities will have to ensure that **50% of materials used in road works** originate **from reuse or recycling of CDW in 2017**; 60% in 2020, according to Article 79 of the bill on energy transition for a green growth and reiterated in the Waste reduction and recovery plan 2016-2025.

9.1.5 End of Waste (EoW) status

The Environment Code describes the principles of end of waste status in Article L.541-4-3, created by Order 2010-1579. This was supplemented by Decree 2012-602 of 30 April 2012, which specified the terms according to which the EoW criteria are adopted and the related procedure.

Only two types of materials are currently covered by EoW criteria. European regulation adopted in 2011 covers recycled metal. In France, Order of 29 July 2014 states that shredded wood packaging waste shall no longer to be considered waste when it is used as a biofuel in boilers. EoW criteria for steel industry slag for use in road and public works are currently under discussion.

Decree 2016-1890 of 27 December 2016 brings various adaptation and simplification measures in the field of waste prevention and management. Article 6 specifies the composition and operation of the advisory board on EoW.

Finally, French jurisprudence recognised that it is possible to end the waste status in an implicit way, without requiring specific regulatory criteria. This is only possible for production processes which use waste instead of raw materials, in part or completely. The resulting product is not considered waste, though it must be similar to the products which would have resulted from the process had only raw materials been used. The "implicit" end of waste status in production processes is explained in a notice published in the Official Journal of 13 January 2016[5].

9.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non-legislative instruments include best practices, guidelines, recommendations, and the like. They are an essential part of CDW management and they can create conditions for a sustainable management of this type of waste. See section 9.4.1, as many initiatives received national funding and/or issued recommendations.

The key instruments in France are:

- **Landfill tax** ("*TGAP*" in French for general tax on polluting activities): this tax from 2009 raises the cost of polluting activities so as to divert economic actors away from them
- **Incentives and budget lines dedicated to waste prevention and management**: various funding possibilities are available in France, for stakeholders ranging from companies to local communities. One of the better known funding bodies is the French Environment and Energy Management Agency, ADEME, though others include European funds, Caisse des Dépôts et Consignations, etc.

[5] The notice in the Official Journal of 13 January 2016 is available at the following link : https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031825201

- **Environment Agency**: founded in 1991, the French Environment and Energy Management Agency, **ADEME** provides full support to individuals, companies, and local communities regarding waste prevention and management, in the form of information, technical assistance, or funding.
- **Sustainable Construction Methodological Guidebook**: Edited by the Saine-Saint-Denis General Council in 2009
- **Building certification standards covering CDW**: HQE (2005), BREEAM (1990) and LEED (1998) exist in France
- **Industry sustainability standard covering CDW**: the Quarries Environment Charter (2004) is a global environment voluntary commitment, and the Clean Building Approach (2005) aims to improve working methods and quality of life on building sites.
- **Public sector sustainability standard covering CDW**: the Green Site and Clean Site charters were initiate by ADEME and consist in an approach that covers all environmental aspects of a site
- **Environment Assurance Plan**: this contractual obligation is an operational document drafted by the environment coordinator or the client. Each company which will work on the construction site must fill it in before starting the work, indicating which provisions they will take to limit and monitor the nuisances and impacts of their operation on the environment.

Furthermore, various guidance and tools have been developed to improve CDW management regionally and nationally in France. These include guidebooks written by ADEME or the French Building Federation (FFB), smartphone applications, and a website called OPTIGEDE which acts as an online information sharing platform. A comprehensive table of such guidance and tools is available in BIO by Deloitte (2015). New instruments arise regularly, such as the guide on the environmental acceptability of recycled aggregates from CDW in road works published by CEREMA in January 2016, for example, which aims to encourage the use of recycled aggregates [89].

9.3 CDW management performance – CDW data

The latest official national data on CDW dates back to a survey from 2008 (SOeS, 2010). The French Ministry of the Environment, Energy, and the Sea launched a new survey on CDW produced in 2014, conducted by Observation and Statistics department (SOeS). The description of the survey was published on 27/1/15[6] and the data and final report, though initially due end 2016, should be available in spring 2017[7]. The 2008 survey has served as a benchmark for biennial estimates sent to Eurostat and for national publications by ADEME.

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[6] SOeS "Survey on waste and excavated materials produced by the construction and public works sector in 2014" description, from 27/01/2015: http://www.statistiques.developpement-durable.gouv.fr/sources-methodes/enquete-nomenclature/1542/0/enquete-dechets-deblais-produits-lactivite-btp-2014-edd.html

[7] SOeS thematic surveys on construction and building works: http://www.statistiques.developpement-durable.gouv.fr/logement-construction/s/entreprises-btp-enquetes-thematiques.html

As all this data relies on a survey on 2008 statistics, which is therefore almost a decade old, a certain amount of caution should be applied when interpreting the data.

Raw materials consumed in France in 2013 add up to 784 Mt (either from France or imported), of which half (**391 Mt**) were construction materials. This amount is obtained by adding raw materials extracted from the territory or imported and subtracting material exports. Construction material apparent consumption in France in 1990 was 12% higher than that in 2013 [90].

9.3.1 CDW generation data

Eurostat data was updated in February 2017 with 2014 data (Eurostat, 2017), whilst the ADEME published data relevant to 2012 in its summary of key waste statistics in December 2016. Total **waste production** in France was 328 Mt in 2014 (345 Mt in 2012), of which **232 Mt** were from the construction sector (247 Mt in 2012). The breakdown of total waste generation and that of CDW is shown in Table 29 [90] [93].

From 2006 to 2010, waste generation grew, but in 2012 the trends was reversed with a 2.8% reduction. This is mostly due to a slowing construction sector, for which waste generation dropped by 5% [90].

Table 29 – Waste generation in France, total (left) and from the construction sector (right) (Eurostat, 2017)

Type of waste	**2012 (Mt)**	**2014 (Mt)**		**Type of CDW**	**2012 (Mt)**	**2014 (Mt)**
Non-hazardous	333.43	317.52		Non-hazardous	244.33	229.16
Hazardous	11.30	10.41		Hazardous	2.38	2.58
Total waste generated	**344.73**	**327.93**		**Total waste generated**	**246.70**	**231.74**

Construction waste in 2014 was made up of **229.16 Mt** of **non-hazardous** waste, covering 216.49 Mt inert waste and 12.67 Mt non-inert waste, and **2.58 Mt** of **hazardous** waste, adding up to a total of 231.74 Mt [93].

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723583

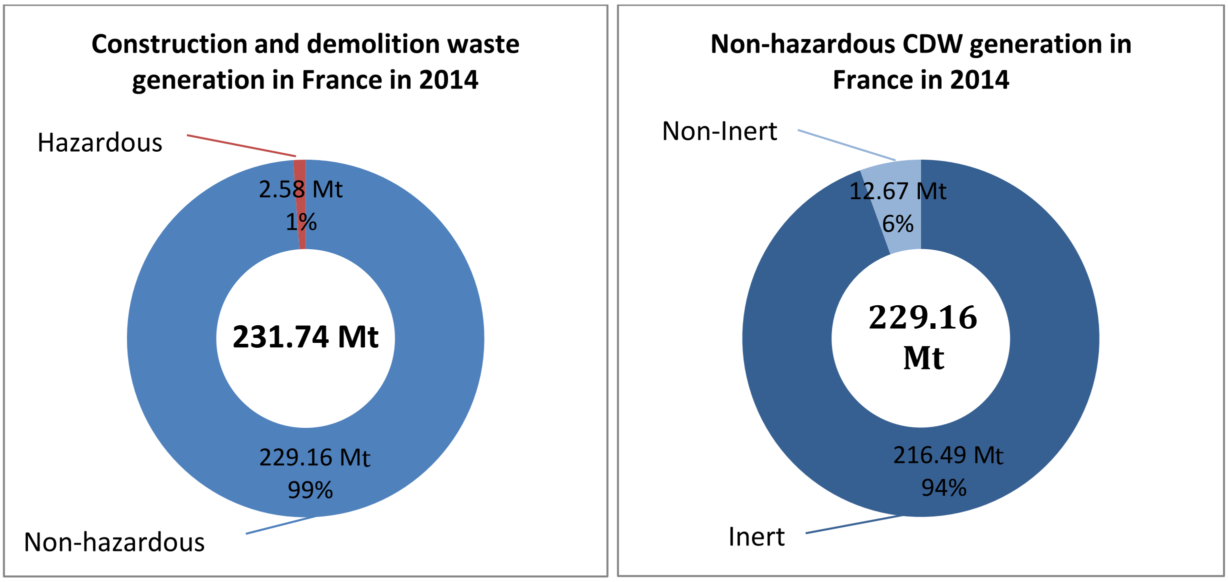

Figure 5 – CDW generation in France in 2014, total (left) and breakdown of non-hazardous waste generation (right) [93]

In France, CDW is divided into two sectors: building and public works. The 2008 SOeS survey gives the breakdown of waste generated per sector, with building works further divided into structural and finishing works, as shown in Table 30:

Table 30 – Waste generation per construction sector in 2008 [100]

Sector	Amount generated (Mt)	% inert waste	% non-haz., non-inert waste	% hazardous waste
Building works	38.2	72.4	26.1	1.5
Structural works	*28.1*	*80.8*	*18.0*	*1.2*
Finishing works	*10.1*	*49.0*	*48.6*	*2.4*
Public works	216.3	97.6	1.5	0.9
Total	**254.5**	**93.8**	**5.2**	**1.0**

In a Q&A document on construction and demolition waste for construction professionals, the FFB also mentions waste generation per type of building works: 90% of the 38.2 Mt generated originate from renovation or demolition sites. 65% comes from demolition, 28% from renovation, and 7% from new construction [94].

9.3.2 CDW treatment data

The 2008 survey does not mention the final destination of CDW sent to collection, grouping, or sorting facilities. Despite this barrier to reliable recovery and disposal data, it does give a certain insight into the type of treatment used per type of waste, as detailed in Table 31.

Table 31 – CDW destination per type of waste in 2008, in million tonnes [100]

Type of CDW	Collection, sorting centre	Reuse, recycling	Quarry filling	Incineration, cement plant	Landfill	Other, incl. take-back	Total
Inert	73.58	77.16	41.57	-	36.55	10.03	**238.89**
Non-haz., non-inert	9.66	1.24	-	0.17	0.70	1.41	**13.18**
Hazardous	0.50	0.86	-	0.03	1.00	0.12	**2.51**
Total	**83.74**	**79.26**	**41.57**	**0.20**	**38.25**	**11.56**	**254.58**

Although it is chemically inert and therefore does not require specific treatment, inert waste poses a definite challenge, both regarding transport and storage, due to its sheer amount. It can be used for quarry filling, or crushed into aggregates for road works, landscaping, or to make concrete. The remaining waste which is not recycled is then sent to specialised landfills.

Of the 241 Mt of inert waste produced in 2012 (231.3 Mt of it being CDW), almost half (49%) was recycled and 17% was used in road works or backfilling. The remaining 34% were landfilled [90]. It is worth noting that landfills are called storage facilities in France, hence many documents talk of storage rather than landfill. Furthermore, backfilling performed in the framework of an inert waste landfill is recorded as landfilling, but this is not the case if it is performed at a non-inert waste landfill, which introduces a certain bias in statistics.

The SNED indicates that the average recovery of deconstruction waste is around 90% for inert waste and 45% for non-hazardous waste [98].

9.3.3 CDW exports/imports data

In 2013, reported imports of waste reached 2.5 Mt, among which 1.6 Mt of uncontaminated soil and stones were imported from Switzerland and Luxemburg to be recycled.

In 2013, reported exports of waste reached 1.6 Mt.

Data taken from the service de l'Observation et des Statistiques (SOeS) publication "Rapport 2013 sur les mouvements transfrontaliers de déchets dans le cadre de la Convention de Bâle et du règlement (CE) n° 1013/2006 du Parlement européen et du Conseil", published in August 2016, accessed from [99].

9.3.4 CDW treatment facilities data

CDW landfill data is relatively simple to obtain in France. However, it is much more difficult to obtain precise information on CDW recycling facilities.

ADEME reported a total of 228 non-hazardous landfills in France, 16 for hazardous waste, and 657 for inert waste by end 2014 [90]. However, this only includes landfills with a prefectural authorisation. Indeed, BIO by Deloitte cites data from 2013 that is double that amount for inert waste landfills, as there were some awaiting regularisation, and close to 500 illegal ones [88].

9.3.5 Future projections of CDW generation and treatment

The only indication on future CDW generation is the objective set by the 2014-2020 Waste prevention plan to stabilise the generation of CDW by 2020 at the level reached in 2010 (260 Mt).

9.3.6 Methodology for CDW statistics

The 2008 survey was conducted by the French Environment Ministry (at the time, its name was Ministry for Ecology, Energy, Sustainable Development and the Sea, though this changes regularly after elections). 7 000 establishments were surveyed by post between November 2009 and March 2010. The survey reports waste amounts based on the latest destination known by the producer, not the final one, as they are not always aware of the final destination of their waste. Asbestos removal companies are not classified as construction companies in French nomenclature but they were surveyed nonetheless to include this data into the survey.

The description of the methodology for the new survey, on 2014 data and due to be published in spring 2017, is available from the SOeS website: http://www.statistiques.developpement-durable.gouv.fr/sources-methodes/enquete-nomenclature/1542/0/enquete-dechets-deblais-produits-lactivite-btp-2014-edd.html.

9.4 Construction and demolition waste management in practice

9.4.1 CDW management initiatives

Various initiatives currently exist in France. Four interesting cases are highlighted in the following pages:

- **Paprec/Raboni partnership**, allowing construction SMEs to deposit their construction waste and pick up new materials on the same site
- **RECYBETON project**, a national R&D programme, which aims to find solutions to recycle each cubic metre of deconstructed concrete as a component of new concrete.
- **DEMODULOR project**, which approached construction waste prevention from the disassembly angle
- **DEMOCLES project**, on recycling of waste from **finishing works** on demolition/rehabilitation sites.

Of course, many other initiatives exist. For example, the National Syndicate of Demolition Companies (SNED) and the French Building Federation (FFB) launched a joint initiative in

May 2016: **Imaterio**, a free **construction waste and material database** (www.imaterio.fr). It connects owners of inert waste and reuse materials with potential users. Although intended for professionals, Imaterio can also be used by individuals who might wish to respond to an advertisement. In March 2015 the SNED and FFB launched a **waste traceability software** called **Investigo** (www.investigo.fr), free for use by members of the SNED [98].

Name	**Paprec/Raboni partnership**
Description	The Paprec Group is a company specialised in recycling and recovery whereas Raboni is a distributor of construction/renovation materials. Faced with the observation that building industry tradesmen struggle to find solutions for their **building site waste**, and therefore end up sending it to landfills instead of recycling, Paprec and Raboni decided to set up a partnership to counter this issue. Construction SMEs can **deposit their waste and pick up new construction materials on the same site**. The waste is then directed to Paprec recovery/recycling facilities.
Scope	Raboni has 12 recycling centres, with one full-time Paprec employee per site. 4 sites have fluvial access: collection is therefore done by a barge with a capacity of 360 tonnes of waste per rotation (equivalent to 60 waste collection vehicles). Paprec has 2 recycling centres dedicated exclusively to CDW in the region.
Year established	2004, renewed in 2014 for 5 years
Geographical coverage	Paris Region (Île-de-France)
Leadership	Industry-led
Tonnes recycled	Approximately 70 000 m^3 collected per year, with a recycling rate close to 80%

A new pilot operation initiated by the Syndicate for **PVC pipes and fittings**, STR-PVC was launched in October 2016 to increase collection and recycling of plastic pipes and fittings in France. PUM Plastiques, a distributor, and Paprec Plastiques, the plastics recycling branch of the Paprec Group, partnered up to capture this stream from tradesmen and to offer new services for their clients, to anticipate landfill bans, and to encourage sustainable practices. At the launch of the pilot, Paprec containers were placed in PUM Plastiques agencies in two cities initially, Rennes and Limay, with more locations planned in coming months. Customers can bring their waste pipes and fittings for recycling.

Name	RECYBETON
Description	RECYBETON (complete recycling of concrete) is a national R&D programme which aims to **increase reuse** of materials from **deconstructed concrete** as constituents of new concrete or hydraulic binders, including fine particles.
Scope	Collaborative research project on deconstructed concrete, involving 47 partners for 5 years with a budget of 5 M€
Year established	2012
Geographical coverage	National
Leadership	Public-private partnership

Part of the scientific programme of RECYBETON is covered by the ECOREB project, funded by the National Research Agency (ANR) for 4 years, from end 2012. As part of the RECYBETON project, ECOREB addresses scientific issues associated with the use of crushed concrete aggregate as a constituent of new concrete.

Name	DEMODULOR
Description	DEMODULOR demonstrated the technical, environmental, and economic feasibility of **disassembly** in renovation or deconstruction for simplified recovery and recycling of materials and products. The project was led by the Materials and Equipment for a Sustainable Construction (MECD) alliance, gathering the network of technical and industrial centres in the construction sector. Its aim was to develop constructive waste prevention solutions using a systemic approach of disassembly (dismountable structures).
Scope	The project focused on bearing elements (walls and floors) as well as the building envelope (roof and walls).
Year established	2012-2015
Geographical coverage	National
Leadership	Industry-led, supported by ADEME

Name	DEMOCLES
Description	The DEMOCLES project aimed to increase recycling of elements from **finishing works** on demolition/rehabilitation sites. DEMOCLES followed a collaborative and operational approach, integrating actors from all across the value chain – over 40 partners were involved. Thanks to 6 pilot sites and technical working groups, the project successfully: • Identified operational and economic challenges linked to sorting waste on-site and downstream treatment

	• Defined a common and reliable framework for on-site sorting to ensure an adapted recycling stream, at limited costs • Formulated concrete and operational recommendations on waste management for both the client and the contractor • Developed recommendations on the competence-building needs for on-site sorting.
Scope	Waste from finishing works, which represents about 10 million tonnes, or 30% of all waste produced by the construction sector
Year established	2014-2016
Geographical coverage	National, with six test building sites in Île-de-France and Rhône-Alpes
Leadership	Public-private partnership

9.4.2 Drivers / barriers to increase CDW recycling

Drivers and barriers to increase CDW recycling were presented in a clear and concise fashion in the factsheet of the Resource Efficient Use of Mixed Wastes study [88]. Most of these are listed in the following table.

A more recent study analysed drivers and barriers to reuse of construction products and materials [96].

Category	Drivers	Barriers
Legislation & regulation	• CDW management plan implementation (national and departmental, though soon regional) • Compulsory pre-demolition audits • Objective of stabilising CDW production by 2020 at 2010 level • EoW status and criteria defined by law	• Delay in entry into force of departmental CDW management plans • Insufficient support through public procurement of the use of recycled materials from CDW • Requirement for contractors to demonstrate technical feasibility of use of construction materials from recycling • Insufficient regulation of backfilling and ground raisings in the Town planning Code
Allocation of resources	• ADEME has a large intervention budget on waste & circular economy – 191 M€ in 2017	• Insufficient resource allocation (financial, human) to the enforcement of CDW legislation • Sanctions are too low and rarely applied
Reuse		• Uncertainty in EU Construction Products Regulation as to the obligations of EC marking for reclamation products
Sorting & recycling	• Large number of innovative companies and R&D programmes • Guidance from the road works sector could benefit building works	• Very limited number of mechanised sorting lines in France • Demolished buildings not designed for easy deconstruction and recycling • Lack of space on building sites
Treatment facilities		• Insufficient number of treatment installations, therefore too distant from sites, which encourages illegal dumping • Apparent reluctance of local authorities to authorise new facilities
Market conditions	• Landfill tax (TGAP) as a tool to improve recycling	• The landfill tax is low compared to other EU Member States • Operating costs of CDW sorting, recovery, and recycling are declared as being too high by most construction companies
Definitions & statistical data	• Separate targets for inert waste and non-inert non-hazardous waste	• Difficulty to assess CDW sources and streams precisely • Inconsistencies with backfilling reporting and definition
Contracts for building & public works		• Waste management is often neglected in contracts • Lack of traceability and control of the recycling rate to check commitment in tenders

9.5 CDW sector characterization

9.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

No updates

Quantitative analysis

The 2008 survey gives more detailed information on waste generation in the French construction sector. As reported in Table 32, inert waste is by far the predominant type of waste generated, with 94% of CDW. Unpolluted soil and stones make up most of it, as they account for 73% of inert waste, or 71% of CDW [100]. However, they should not be included in the calculation of recycling performances towards the 70% objective of the Waste Framework Directive. Table 33, instead, instead, reports the amount of non-hazardous waste generated in 2008.

Table 32 – Inert waste generation in 2008 [100]

Type of inert waste	Amount generated (Mt)
Concrete	17.84
Bricks, tiles, ceramic, and slate	2.87
Glass	0.10
Tar-free bituminous mixtures	9.30
Unpolluted soil and stones	175.11
Other materials from road demolition	11.82
Non-polluted track ballast	0.97
Non-polluted dredging spoil	2.60
Other inert waste	1.18
Mixed inert waste	17.09
Total inert waste	238.89

Table 33 – Non-hazardous, non-inert waste generation in 2008 [100]

Type of non-hazardous, non-inert waste	Amount generated (kt)
Wood untreated or treated with non-hazardous substances (palettes…)	1 835
Plastic materials (incl. flexible floor coverings)	435
Ferrous or non-ferrous metals	1 201
Insulation materials: fibreglass, stone wool	118
Plaster	1 844
Plant material	651
Waste tyres (m^3 not shredded)	18
Other types of non-hazardous, non-inert waste	542
Mixed non-hazardous, non-inert waste	1 119
Mixed inert waste and non-hazardous, non-inert waste (Ordinary Industrial Waste[8])	5 421
Total non-hazardous waste	13 183

Updated information, on the year 2014, will be included in the survey which will be published in spring 2017.

Recovery techniques

No updates

Environmental and economic impacts of CDW waste management

No updates

Drivers / barriers to increase recycling

No updates

9.5.2 Recycled materials from CDW

Inert materials such as concrete and rubble are widely used in road works. Recycled aggregates are thus the main construction and demolition waste product. Plaster and wood are two other waste streams for which recycling is already operational. The DEMODULOR project gathered data indicating the destination of certain materials [97]:

- Steel: 98% recycling/reuse, 2% landfill
- Concrete: 67% recycling/reuse, 33% landfill
- Wood: 57.2% recycling/reuse, 17.3% landfill, 25.5% energy recovery
- Terracotta: 39% recycling/reuse, 6% landfill, 55% material recovery

[8] Ordinary industrial waste is known as DIB in France, for "*déchets industriels banals*"

In France, 35 million m³ of ready-to-use concrete were produced in 2015, by 516 companies, and consumption per capita is 0.54 m³ per year. This ranks France as the second producer and fifth consumer of concrete in Europe [102]. Yet despite this, concrete recycling into concrete is still rare in building works. The National Research Agency funded the ECOREB project aiming to change this tendency by removing scientific barriers associated with the used of crushed concrete aggregates as a constituent of new concrete.

There are two main barriers two the use of recycled materials from CDW in public procurement. The first is the requirement for contractors to demonstrate that it is technically possible to use construction materials from recycling. The second is linked to the price of recycled materials. They may be more expensive than raw materials, particularly if they are located further away and therefore lead to increased transport costs. As price is unfortunately the main criteria in public procurement, this can make recycled materials less competitive and therefore limits their increased use.

9.5.3 Market conditions / costs and benefits

Costs linked to legal management of building works CDW represent 2-4% of the total revenues in the building sector, or 1.2-2.4 billion Euro, depending on if waste is sorted or not, according to data from 1998 [94]; these information are summarised in Table 34.

Table 34 – General Tax on Polluting Activities (TGAP) rates for waste in 2016 [95]

<table>
<tr><th colspan="3">Type of waste treatment facility</th><th>Tax rate in €/tonne</th></tr>
<tr><td rowspan="6">Non-hazardous waste landfill</td><td colspan="2">Unauthorised landfill</td><td>150</td></tr>
<tr><td rowspan="5">Authorised landfill</td><td>A. EMAS registered or ISO 14001 certified</td><td>32</td></tr>
<tr><td>B. With biogas recovery >75%</td><td>23</td></tr>
<tr><td>C. Bioreactor landfill (biogas capture and leachate reinjection, biogas recovery)</td><td>32</td></tr>
<tr><td>D. Meeting both previous criteria</td><td>15</td></tr>
<tr><td>E. Other</td><td>40</td></tr>
<tr><td rowspan="8">Non-hazardous waste incineration plant</td><td colspan="2">A. EMAS registered or ISO 14001 certified</td><td>12</td></tr>
<tr><td colspan="2">B. With high energy performance</td><td>12</td></tr>
<tr><td colspan="2">C. With NO_x emissions <80 mg/Nm³</td><td>12</td></tr>
<tr><td colspan="2">D. Meeting both A and B</td><td>9</td></tr>
<tr><td colspan="2">E. Meeting both A and C</td><td>6</td></tr>
<tr><td colspan="2">F. Meeting both B and C</td><td>5</td></tr>
<tr><td colspan="2">G. Meeting A, B, and C</td><td>3</td></tr>
<tr><td colspan="2">H. Other</td><td>15</td></tr>
<tr><td rowspan="2">Hazardous waste</td><td colspan="2">Landfill</td><td>25.57</td></tr>
<tr><td colspan="2">Incineration plant or other treatment</td><td>12.78</td></tr>
</table>

There is a General Tax on Polluting Activities (TGAP) in France, which must be paid by companies whose activities or products are considered polluting: waste, pollutant emission, oils, detergents, extracted materials, etc. The amount of the tax depends on the category of activity or product and is modified every year. It is based on the weight in tonnes of waste received in an installation to which it applies. The rate is also slightly higher in continental France and Corsica than it is in Guadeloupe, Martinique, and Reunion Island. The 2017 rates for continental France are listed in Table 34 [95]. These rates apply from 1 January 2017 to 31 December 2017.

The French Building Federation (FFB) gathered information on the costs of waste management which entrepreneurs should consider. These include:

- Labour for sorting or dismantling prior to the removal of waste from the building site
- Specific installations required on-site (storage area, skips, etc.)
- Scale effect linked directly to the amount of waste to remove
- Waste transport (linked to distance from treatment facilities)
- Waste treatment (grouping or sorting centre, treatment centre, recycling, incineration, landfill).

The estimated the costs per destination of the waste (excluding transport and skip costs), listed in Table 35. If waste is mixed, the highest cost applies.

Table 35 - Estimate CDW management costs per destination of the waste [94]

Destination	**Estimated cost (excluding transport and skip rental)**
Inert waste recycling plant	a few euro per tonne
Non-hazardous recycling plant	variable, can be zero (metal by-back)
Inert waste landfill	1-8 €/tonne
Non-hazardous waste landfill	80-120 €/tonne
Hazardous waste landfill	200-500 €/tonne
Incineration plant	60-110 €/tonne
Hazardous waste specific treatment	200-1200 €/tonne

Waste management adds up to 10-25% of deconstruction costs [98].

Finally, the National Syndicate for General Contractors in Building and Public Works, EGF.BTP, estimated the cost of waste removal per type of material and treatment for 2009, shown in Table 36.

Table 36 – Estimate CDW management cost per material and type of treatment [92]

Waste	**Treatment**	**Cost excl. taxes, incl. transport**
Inert	Recycling	10-19 €/tonne
	Landfill	10-31 €/tonne

Wood	Recycling	0-91 €/tonne
	Incineration, energy recovery	19-183 €/tonne
Plaster	Recycling	58 €/tonne
	Landfill	106 €/tonne
Mixed waste	Incineration	122 €/tonne
	Landfill	122-290 €/tonne
Hazardous waste	Treatment then landfill	230 €/tonne and over
	Directly to hazardous waste landfill	230-350 €/tonne

All these sources therefore highlight the importance of sorting CDW – if not from an environmental perspective, then at least to reduce costs.

10. GERMANY

10.1 Legal Framework – Waste Management Plans and Strategies

10.1.1 National Legislation concerning CDW

The European Waste Management Directive (Directive 2008/98 / EC, AbfRRL) has been implemented into German law, modernizing the existing German waste legislation through the new Circular Economy Act (KrWG), which is currently Germany's main waste disposal statute. This Act replaces the first uniform National Waste Disposal Act (AbfG), adopted in 1972. The objective of the new Act is to achieve a sustainable improvement in environmental and climate protection as well as resource efficiency in waste management by strengthening waste prevention and recycling of waste. At the same time, the adoption of EU legal concepts and definitions as well as the clarification of central regulations are intended to facilitate the practical and legal application of the law [103].

As Germany consists of 16 federal states, certain aspects of the CDW disposal, which are not regulated centrally are governed by the states themselves, such as the determination of entities, which are subject to waste disposal obligations, authorizing bodies for waste disposal matters and municipal waste disposal ordinances.

Prior to dismantling a building, it is important to determine the age of construction and the buildings use to identify typical pollutants or polluted building materials of that time or contamination in relation to the operation of the building. In case of relevant findings, a technical investigation with sampling has to be carried out.

Although not mandatory, a dismantling and disposal concept is recommended. Building materials containing pollutants must be removed prior to dismantling or demolition. In case that fraction of the CDW are classified as hazardous waste, the Waste Register Ordinance (AVV) in connection with instructions set out by the Federal Ministry for Environment must be taken into account.

For the recycling or dismantling of commercial CDW the Ordinance on the Management of Municipal Waste (Gewerbeabfallverordnung) applies. In case of hazardous waste, evidence (proof of disposal and accompanying documents) according to the Proof Ordinance (Nachweisverordnung) must be provided to the Central Body for Waste Supervision (Zentrale Stelle Abfallüberwachung (ZSA)) at the State Office for Environment (LfU). In case of transport of commercial waste, the notification and permit regulation (AbfAEV) must be applied. The respective county administration authority (County Council or Environment Agency) is responsible for granting the transport license.

Other regulations (Abfallverzeichnisverordnung, AVV) regulate the types of wastes, classified into hazardous and non-hazardous wastes [103].

10.1.2 Waste management plans (WMP) and Strategies

There is no national waste management plan or strategy in place. The Circular Economy Act sets out a clear hierarchy how to deal with CDW listed below:

- prevention
- preparation for recycling
- recycling
- other types of recovery, particularly use for energy recovery
- disposal

The Circular Economy Act (Section 30 (1)) stipulates that the Federal States are responsible for the development of WMP's, which should cover the following aspects:

1. aim of waste prevention and recovery, and in particular preparation for re-use and recycling, as well as waste disposal,
2. existing situation in waste management,
3. necessary activities to improve the recovery of waste and waste disposal, including an evaluation of their aptitude to achieve the objectives
4. waste treatment installations to ensure waste disposal, as well as the recovery of mixed waste from private households including which is collected in other areas of origin within the national borders.

The waste management plans shall list the following:
1. authorised waste treatment installations
2. areas suitable for landfilling, for other waste disposal installations, as well as for waste treatment installations

The waste management plans can also determine which bodies responsible for waste management are to be chosen and which waste treatment installations the parties obliged to carry out waste treatment must use.

10.1.3 Legal framework for sustainable management of CDW

The legal framework for sustainable management of CDW is rather complex in Germany as countrywide legislations are not in place yet. The Table 37 sets out regulations and frameworks in place.

Table 37. Legal framework for sustainable management of CDW.

National or regional obligation towards	Germany
National or regional obligation for selective demolition	No obligation exists on a national level; several states have put a recommendation for selective demolition in their respective waste management plans. Furthermore, the Ordinance on the Management of Municipal Wastes, which is currently under revision, is likely to contain national obligations for selective demolition in its new version
National or regional sorting (on-site or in sorting facility)	Defined at national level (Section 8, Management of Municipal Wastes Ordinance). Separation and

National or regional separately collect different materials (iron, steel, plastic, glass, hazardous waste etc.,)	requirements for the pre-treatment of CDW.
Green public procurement requirements	Guidance for sustainable construction (Leitfaden Nachhaltiges Bauen, 2013) provides recommendations with regards to strategies for dismantling for the next generation of buildings, dismantling is not fully covered yet, in addition the document is not legally binding

10.1.4 Targets

The targets with regards to waste recycling are defined under § 14 Promotion of recycling and other material recycling of the Circular Economy Act (KrWG).

From the 1 January 2015 paper, metal, plastic and glass waste shall be collected separately in order to achieve a safe and high quality recycling. Technical and economical considerations shall be applied.

For the reuse and recycling of CDW the Federal Government aims to implement ambitious goals set out by the EC under Directive 2008/98/EC [104]. 70% (by weight) of non-hazardous building and demolition waste shall be reused or recycled, with the exceptions of materials occurring in nature from the 1 January 2020. This figure includes the filling up in which waste substitutes other materials. The Federal Government will review this target in light of the development of the construction industry and the general conditions for the recycling of CDW by 31 December 2016 [105].

10.1.5 End of Waste (EoW) status

The end of waste status is defined under the Circular Economy Act in Secrion §5. A substance or an object is no longer considered as waste, if it has passed a recycling or recovery process and it is characterised by all of the following criteria:

- it is usually used for certain purposes,
- there is a market or a demand for it,
- it meets all technical requirements applicable to its particular purpose, as well as all legislation and applicable standards for products, and
- its use as a whole does not lead to harmful effects on human beings nor the environment.

In order to fulfil the last aspect listed above, the Federal Government is authorized to determine threshold values for pollutants and harmful substances. The end of waste status is also valid for CDW and ends with the successful recovery or recycling technique, while fulfilling the requirements of the waste regulations [105].

10.2 Non legislative instruments (best practices, guidelines, recommendations…)

The Federal Government developed a Guideline for Sustainable Construction that provides in its latest edition guidance with regards to the demolition of buildings. However, these recommendations relate to the design and construction of new buildings in order to minimise CDW for future generations. The Guidelines are binding in case of governmental projects and only informatory character for all other projects.

In add,ition several Federal States have developed guidelines for the dismantling of buildings (e.g. Brandenburg, Bavaria) but also the Federal Institute for Occupational health and safety and medicine.

The LAGA (Bund/Länder Arbeitsgemeinschaft Abfall) is a working committee of the Conference for Ministers for Environment (UMK). Founded in 1963 the LAGA aims to ensure the implementation of waste legislation in the Federal Republic of Germany as far as possible within the Federal States through information and fact sheets as well as guidelines [106].

10.3 CDW management performance – CDW data

10.3.1 CDW generation data

Construction and demolition waste in Germany consist of building rubble, road construction, soil and stones, as well as building site waste. Construction gypsum plasters are collected separately.

Construction and demolition waste, including road construction waste accounted in 2014 with 209.5 million tonnes (52.3%) for the largest share of waste. The largest fraction of CDW was excavated soil, of which 85% was utilised for landfill in construction or at the pithead excavations. The remaining mineral construction waste was also used to a considerable extent [107].

In 2012, CDW accounted for 192.0 million tonnes of waste, with 109.8 million tonnes through excavation, which was utilized to a total of 88 %, for the same purposes as identified in 2014. The remaining 82.2 million tonnes of CDW consisted of building rubble, road construction, construction site waste as well as construction waste based on plaster. These waste streams were recycled up to 95.5%.

Figure 6 shows mineral waste figures from 2012, broken down into different streams.

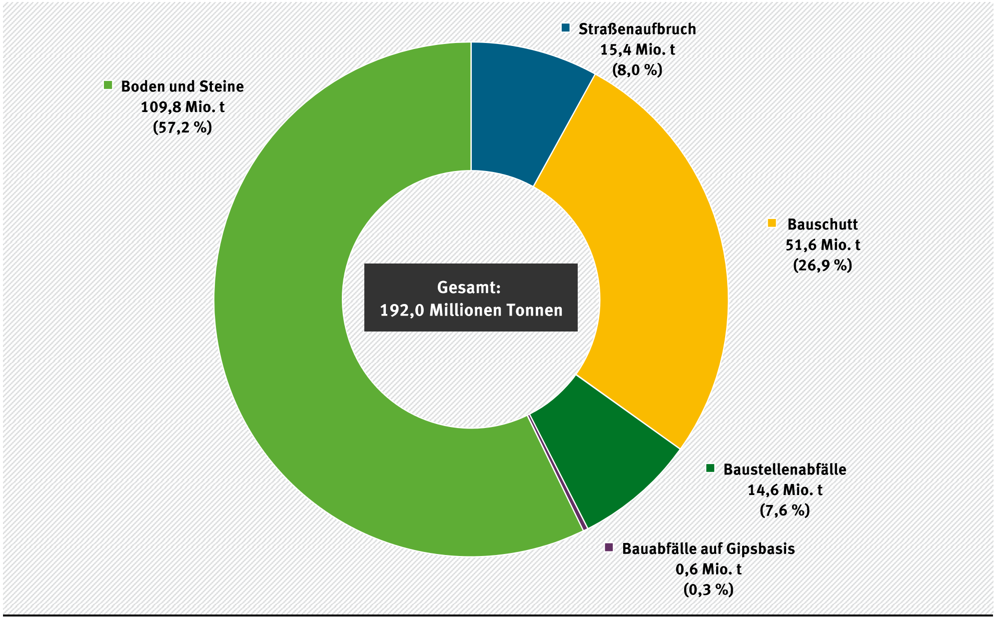

Figure 6. Groups of waste in Germany (2012 broken down into different streams), source Federal Ministry for Environment.

Hazardous waste

From 1999 onwards, hazardous waste is merely reported as a sum in the waste balance. Approximately 6% of the hazardous waste in 2014 was generated by the industrial and construction sectors. 67% of this waste could be utilized [107].

10.3.2 CDW treatment data

Reliable figures for CDW generation and treatment were taken from a report that the Federal Statistic Office published in 2014, with figures dating back to 2006. The overall amount of CDW totals to 197 million tonnes, whereof 89% of waste has been exploited and 88% has been recycled [108].

10.3.3 CDW exports/imports data

The Federal Ministry for Environment provides figures with regards to for the trans-national transport of waste for Germany (Figure 7, Figure 8 and Figure 9). The published data show that the shipment is mainly carried out between neighbouring countries, in particular from the border areas. The average transport distance between the place where the waste were generated and the disposal is less than 500 km (average) [109].

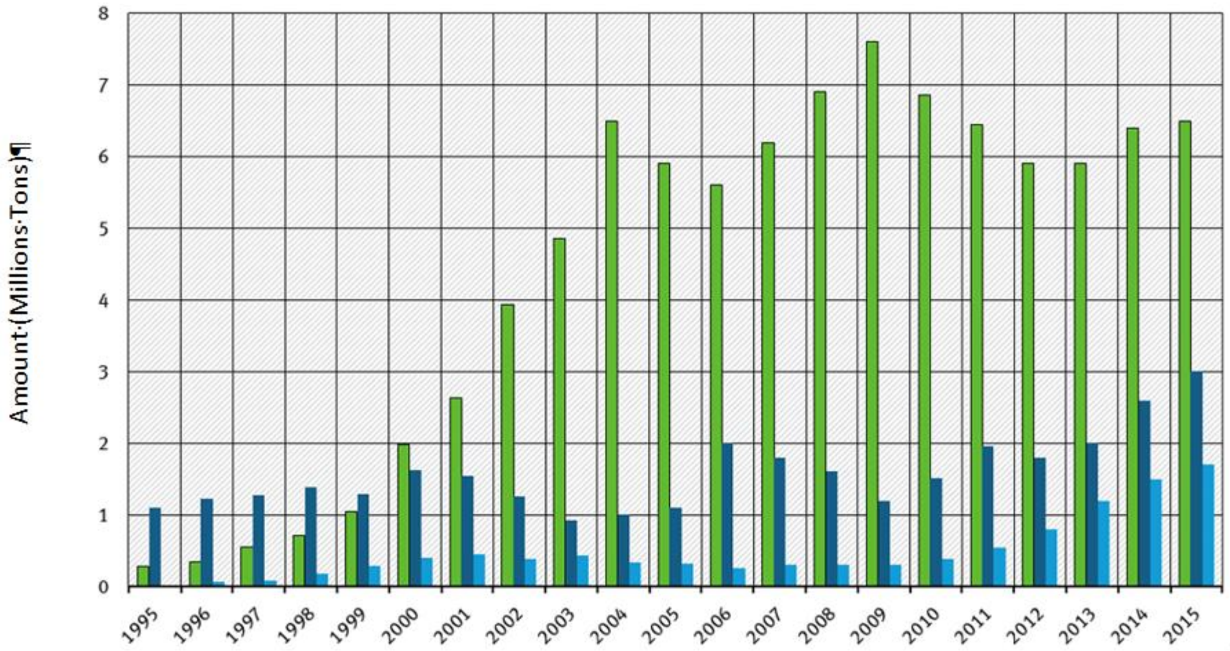

Figure 7. Amount of waste Import – Export in Germany in MIO Tons, source UBA [109]

Grenzüberschreitende Verbringung von zustimmungspflichtigen Abfällen
Zeitreihe Import nach Staaten - Mengen in 1000 t

Staatengruppe	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU-Staaten	6227	5689	5307	5889	6431	7157	6379	5806	5099	5127	5 671	5807
EFTA-Staaten	245	257	303	323	394	446	447	598	737	715	709	668
Andere OECD-Staaten	10	6	4	9	15	16	23	29	29	32	29	19
Nicht-OECD-Staaten	10	13	14	19	14	8	11	20	15	12	17	25
Summe	**6492**	**5965**	**5628**	**6240**	**6854**	**7627**	**6861**	**6452**	**5881**	**5886**	**6426**	**6519**

Staatengruppe	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU-Staaten	64	61	52	194	247	428	567	916	1808	2427	3692	4587
EFTA-Staaten	12	28	46	82	91	115	129	120	165	193	229	250
Andere OECD-Staaten	0	0	1	3	5	3	3	3	3	4	4	8
Nicht-OECD-Staaten	0	0	0	1	4	2	2	5	8	7	10	9
Summe	76	89	100	281	347	548	701	1044	1985	2630	3934	4854

Quelle: Umweltbundesamt

Daten für 1994 ab Inkrafttreten der EG-Abfallverbringungsverordnung im Mai 1994
Zuordnung der Staaten gemäß Status von 2015

Figure 8. Amount of waste Import – Export in Germany in MIO Tons, source UBA [109] – Update

Grenzüberschreitende Verbringung von zustimmungspflichtigen Abfällen
Zeitreihe Export nach Staaten - Mengen in 1000 t

Staatengruppe	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU-Staaten	929	836	1476	1423	1192	869	1145	1526	1428	1734	2346	2716
EFTA-Staaten	63	198	384	284	256	199	189	242	249	238	251	295
Andere OECD-Staaten	5	2	2	1	3	3	3	3	7	2	3	2
Nicht-OECD-Staaten	0	0	3	0	0	0	0	3	4	2	1	3
Abfälle nach Artkel 37 und 63 VVA	39	68	101	118	111	131	177	177	120	14	11	10
Summe	1036	1103	1966	1827	1561	1201	1514	1950	1809	1990	2613	3027

Staatengruppe	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
EU-Staaten	797	1050	936	821	936	974	1114	1088	1371	1399	1150	823
EFTA-Staaten	0	35	9	42	39	57	63	70	53	64	67	54
Andere OECD-Staaten	0	0	0	24	35	17	4	3	1	1	2	2
Nicht-OECD-Staaten	0	0	0	3	1	0	0	0	0	0	0	0
Abfälle nach Artkel 37 und 63 VVA	0	0	0	208	210	230	204	126	203	76	45	28
Summe	798	1085	945	1099	1220	1278	1385	1288	1628	1540	1263	907

Quelle: Umweltbundesamt

Figure 9. Amount of waste Import – Export in Germany in MIO Tons, source UBA [109] - Update

10.3.4 CDW treatment facilities data

No data found.

10.3.5 Future projections of CDW generation and treatment

No data found.

10.3.6 Methodology for CDW statistics

Waste figures are based on the Environmental Statistics Act [110]. The figures are reported by the treatment plants directly to the individual statistical offices of the Federal States, which then provide the data to the Federal Statistical Office. In addition, the initiative Circular Economy Construction is monitoring the utilisation of CDW and provides waste figures in their annual reports [111].

10.4 C&D waste management in practice

10.4.1 CDW management initiatives

The German government is encouraging the construction industry to establish and follow the principals of the circular economy. The aim is understand existing buildings as urban mining and minimise the extraction of raw materials. The total amount of anthropogenic stock in Germany, including rocks, metals, wood and plastics, can be estimated with 51.7 billion tons of material. This corresponds roughly to the sum of all raw materials obtained worldwide in 2000. The Federal Environment Agency has initiated projects to generate reliable data on the available secondary raw materials in order to develop an urban mining

strategy. In this way, not only valuable natural resources can be protected in the future, but also the import dependency for numerous raw materials can be mitigated. [112].
In addition, in 2012 the non-profit organisation Cradle to Cradle was founded in Germany with the aim to establish a different handling of resources and to establish continuous material cycles, which are healthy for humans and the environment. The concept is not limited to construction, but covers all resources and substances.

10.4.2 Drivers / barriers to increase CDW recycling

Recycling of CDW is an important step towards a reduction of resource extraction and the associated environmental impacts. Especially in Germany, where access to raw materials is limited, CDW offers a huge potential of high quality raw materials, which can be efficiently recovered and processed to feature a similar quality of other high quality starting materials.

The increased use of plastic-based building materials, such as windows, doors or insulation materials as well as the increasing importance of composites and the generally increasing variety of materials used in the construction sector will lead to ever higher demands with regards to appropriate processing and recycling procedures.

In many cases, economic considerations are the main barriers to CDW reuse and recycling as waste disposal as well as access to raw materials is much cheaper than an appropriate reuse or recycling of CDW. However, increasing prices for raw materials could lead to a turn around.

10.5 CDW sector characterization

10.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

The potential applications of several building materials are reported in Table 38.

Table 38. CDW materials and applications.

CDW material	Application
CONCRETE	Concrete waste in Germany is mainly used as filling material for roadworks. In addition, the first architectural projects are finalised using RE concrete (Neubau von Forschungs- und Laborgebäude Lebenswissenschaften Humboldt-Universität). Due to limited access to sand and other aggregates necessary for concrete the use of RE concrete in Switzerland is very common.
BRICKS	Bricks are reused in smaller applications, where full bricks could be dismantled from the building.
WOOD	Due to a surplus of wood in Germany, recycled materials are mainly used for energy generation. In addition, in buildings constructed after world war II, wooden elements were often treated, which implies that material cannot be reused inside buildings.
GYPSUM	In Germany plasterboards offer a high potential for recycling, whereas gypsum plaster boards are rarely generated from CDW.

Quantitative analysis

No data found.

Recovery techniques

No data found.

Environmental and economic impacts of CDW waste management

No data found.

Drivers / barriers to increase recycling

Provided in section 10.4.2

10.5.2 Recycled materials from CDW

No data found.

10.5.3 Market conditions / costs and benefits

No data found.

11. GREECE

11.1 Legal Framework – Waste Management Plans and Strategies

11.1.1 National Legislation concerning CDW

Up to date legislation in Greece includes the following: **European Directive 98-EE-2008, Law 2939/2001, Law 3854/2010** (modification of previous law), **JMD36259/1757/E103/2010** (CDW, Solid Marble Wastes, concrete), **JMD 50910/03**, **Law 4030/2011** (paragraph 4), **Law 4042/2012-part B**, **Law4067/2012** (New Construction Code). However, the program for the management of CDW was put in place with the Joint Ministerial Decision 36259/1757/E103 (Gov. Gazzete, second issue, 1312/24.8.2010) in 2010.

Law 4042/2012 on waste management, which transposed the Waste Framework Directive 2008/98/EC into national law, provided for the obligation of the Ministry of Environment, Energy and Climate Change to compile a (new) National Waste Management Plan (NWMP) in compliance with Law 4042/2012 which would set out the policy, strategy, principles and targets for the management of waste in Greece and which would suggest the appropriate measures and actions to be taken for the achievement of these targets and principles.

11.1.2 Waste management plans (WMP) and Strategies

On the basis of the provisions of the (new) NWMP, (new) regional waste management plans should be prepared for the management of all waste produced at regional level.

The new National Waste Management Plan ("New NWMP"), described the new plan as "the reversal of government policy which has been pursued for the last ten years. The aim of the new plan is to direct us to a zero-waste economy and society, which converts waste into resources."

The key priority targets of the New NWMP centre around the re-allocation of waste management to a municipal level, placing the responsibility for separation at source and recycling on the municipalities through small-scale units, the encouragement of community participation, the targeting of advanced waste management techniques and, as an overarching principle, maintaining the public nature of waste management. The consequences are, according to the plan, reduced costs, local communities reaping the profits from waste management through appropriate financial incentives and up to 16,000 new jobs, presumably most of those in the public sector. Alternative waste management, currently almost entirely privately-run, will also be brought under public control.

11.1.3 Legal framework for sustainable management of CDW

No data found.

11.1.4 Targets

The program for the management of CDW was put in place with the Joint Ministerial Decision 36259/1757/E103 (Gov. Gazzete, second issue, 1312/24.8.2010) in 2010. Present

Gazzatte has specific quantitative targets, concerning the recycling and reuse of CDW. Those targets are summarized below:

1) By 2012, the preparing for reuse, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 30 % by weight.

2) By 2015, the preparing for reuse, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 50 % by weight.

3) By 2020, the preparing for reuse, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.

In particular, energy recovery is excluded from this scope, while category 17 05 04 (excavated material) is not included in the calculation of the target.

11.1.5 End of Waste (EoW) status

There are no End of Waste criteria established in Greece.

11.2 Non legislative instruments (best practices, guidelines, recommendations…)

CDW management cannot be only a subject of technical and scientific process but also political, social and educational ones. In order to implement recycling targets, Greece created the term Alternative Waste Management and founded the National Organization for the Alternative Management of Packaging and Other Products, which later was renamed at "Greek Recycling Organization".

The alternative management of Construction and Demolition Wastes in Greece began in 2011 with the establishment and licensing of the first Collective Alternative Management System which is located in Thessaloniki. From 2012 until 2014, collection systems adopted came up to 9, covering 18 geographical regions. According to statistics maintained by the Greek Recycling Organization, the amount of CDW managed by the existing in 2012 was more than 12.000 tons[9], for 2013 around 50.000 tons, while for 2014 more than 20.000 tons [10]. The amount collected from the Alternative Management Systems is a very low percentage compared to the quantity of CDW believed to have been produced and which comes up to around 2.000.000 tons.

Other non-legislative instruments that contribute to create conditions for a sustainable management of CDW are BREEAM and LEED.

[9] data only from treatment plant "Anakyklwsis Adranwn Makedonias SA"
[10] data only from treatment plant "Anakyklwsis Adranwn Makedonias SA"

11.3 CDW management performance – CDW data

11.3.1 CDW generation data

EUROSTAT database reports data shown in Table 39 for CDW generated between years 2010 and 2014.

Table 39. EUROSTAT database for CDW generated between years 2010 and 2014.

	2010	2012	2014
Mineral waste for construction	1.545.533	601.476	355.171
Metal wastes, ferrous	173.361	67.540	39.898
Metal wastes, non-ferrous	0	0	0
Glass wastes	36.640	14.275	8.698
Plastic wastes	128.495	50.061	29.575
Wood wastes	202.051	78.718	46.504
Total	**2.086.080**	**812.519**	**479.999**

11.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in Table 40.

Table 40. EUROSTAT database for "Mineral waste from construction"

Mineral waste from construction [tons]	**2010**	**2012**	**2014**
Landfill / disposal (D1-D7, D12)	1.544.505	601.668	139.486
Deposit onto or into land	1.544.505	601.668	139.486
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	0	0
Incineration / energy recovery (R1)	0	0	0
Recovery other than energy recovery	249	2.701	626
Recovery other than energy recovery - backfilling	249	133	31
Recovery other than energy recovery - except backfilling	0	2.568	595
Total waste treatment	**1.544.754**	**604.369**	**140.112**

11.3.3 CDW exports/imports data

There is no data available concerning the exports and imports of CDW in Greece.

11.3.4 CDW treatment facilities data

Landfills for inert CDW do not exist in Greece. There are mostly general purpose landfills, receiving all kinds of waste except hazardous waste.

According to national waste planning, it is suggested that at least one landfill for inert waste should be constructed in each of the Greek administrative regions, with specific preference in the island regions to integrate separate modules for inert waste in existing landfill sites instead of designating a new site.

The existing CDW treatment facilities in Greece treat mainly the mineral fraction of CDW, while materials such as metals, plastics and glass are sent to recycling facilities that handle each specific material fraction. Wood wastes sometimes are treated in the CDW treatment facilities or alternatively disposed. There are 54 CDW treatment facilities in Greece, all affiliated with the certified CDW management systems pursuant to JMD 36259/1757/E103/2010.

11.3.5 Future projections of CDW generation and treatment

The new WMP includes the projection of future CDW generation until 2020. The projection of CDW generation was based on the production of the building construction sector since no concrete data exist on CDW from road works, infrastructure projects and excavations. As a result, naturally occurring materials from big infrastructure projects and other excavation activities are not taken into account in the projections. Moreover, naturally occurring materials are also excluded from the calculation of the CDW recovery target in the WFD.

Within the **DEWAM** project (Information System for Demolition Waste Management), a Decision Support System (DSS) has been developed, namely **DeconRCM**, and in it, estimation of the generated CDW quantities are realized with the use of an algorithmically model in Excel file format, based on building practices in Greece. The output of CDW quantities estimation model is stored in databases, also developed with MySQL. Optimization of the integrated CDW management is solved with the use of a mixed-integer linear programming (MIPL) model. Cost parameters that are included are; (i) the fixed deconstruction process cost, (ii) the fixed cost of demolishing the entire building, (iii) the fixed demolition process cost, (iv) the variable cost of deconstructing the building (€/t), (v) the variable cost of separating CDW, plus loading cost in container for each material, (vi) the fixed cost of using/renting a container and (vii) the variable cost of a container to a disposal site (€/container). Revenues from secondary materials' sales are also considered.

11.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

11.4 C&D waste management in practice

11.4.1 CDW management initiatives

In order to assist construction companies, public bodies, engineers and individuals towards environmental sound management of CDW, a web-based Decision Support System (DSS) has been developed, namely DeconRCM, within the framework of of the DEWAM project (Information System for Demolition Waste Management). A beta version of DeconRCM can be visited at: http://pandora.meng.auth.gr/deconrcm. Currently, the application is built for the case of the Region of Central Macedonia, Greece, but can be easily expanded to other areas with the necessary adjustments. In this paper, functional specifications of DeconRCM are provided, together with a brief description of its technical aspects. The DSS tool's capabilities are illustrated through a case study of a major construction project at the campus of Aristotle University Thessaloniki, Greece.

11.4.2 Drivers / barriers to increase CDW recycling

As reported in DELOITTE study, main drivers/barriers to increase CDW recycling are listed below.

Main obstacles to sustainable CDW management:

1. <u>Lack of political will</u>

• There is low, if non-existent, political will to tackle the issue of illegal CDW disposal and the enforcement of the law concerning CDW management. Major delays in the application of the laws and complementary regulations for CDW.

• Low financial and human resources support to environmental inspections renders the inspection and enforcement of the CDW management regulations totally ineffective.

• Recent amendments in CDW management regulations resulted in ambiguity which stalls the effort for increased CDW recovery.

• Delays in administration of fines or non-conviction of CDW management rules violators

2. <u>Mentality in the construction sector</u>

• General mentality in the construction sector (and of the general public in Greece) is that CDW is not considered to be a waste stream that requires immediate attention and treatment. It can be disposed somewhere and left there, since its inert nature makes it harmless for human health and the environment.

• Contractors prefer to avoid the cost of CDW management.

• No market/no demand for recycled CDW, natural materials are always preferred over recycled materials in the construction works.

3. Lack of treatment facilities and low territorial network

• The current network of CDW treatment facilities is not sufficient to cover the total amount of generated CDW or even the national territory of Greece

• There is no register of appropriate sites (e.g. abandoned quarries, etc.) for the establishment of new CDW treatment facilities.

4. Lack of incentives for recycling

• The landfill tax is not considered enough for diverting CDW from landfilling to recovery, accentuated by the ineffective control of illegal activities concerning dumping of CDW.

• Cost of recovery activities is higher than the prices of the recycled end-product. No pull effect from market conditions.

Main drivers to sustainable CDW management

1. Existence of a well-articulated legal framework for CDW management including provisions for the sustainable management of CDW.

2. Existence of a separate authority (EOAN – Greek Recycling Organization) for the supervision of the alternative management of CDW (recovery, recycling).

3. Organization of CDW Management Systems by the actors in the construction sector (obliged by legislation) for the sustainable management of CDW

4. Strong community awareness for the creation of preconditions for sustainable CDW.

11.5 CDW sector characterization

11.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

CDW refer to a wide range of materials, which, according to their origin can be divided into the following categories:

- Demolition materials such as concrete, aggregates, wood, bricks and other building materials.
- Road materials such as bituminous mixtures as well as aggregates of various particle sizes.
- Excavation materials, such as excavated soil, sand, gravel, rocks etc, which arise almost in every construction activity, especially during the underground constructions and geotechnical engineering works.

- Construction and Demolition Wastes are usually grouped together under "CDW"; however these waste streams are produced by different processes, while they have quite different characteristics, both in terms of quantities, composition and potential for recovery.
- Composition of CDW includes materials, such as concrete, generally inert materials, asphalt, paper, glass, plastic, wood, bricks etc, depending on the source. Building and construction waste can be absorbed in various applications/technical projects after appropriate treatment. Such engineering projects are:
    - ✓ buildings' construction
    - ✓ road construction
    - ✓ geotechnical works
    - ✓ flood defenses
    - ✓ concrete production
    - ✓ rail projects
    - ✓ temporary works.

Quantitative analysis

Volume of CDW produced depends on factors, main of which are population growth, city or regional planning, state of construction industry as well as landfill fees.

Construction waste (originating from new constructions) is usually less mixed, less contaminated, and its recovery potential is higher than demolition waste because of these characteristics. Its share in the total quantities of CDW is generally low. On the other hand, demolition waste, which represents the highest amounts of CDW, tends to be more contaminated and mixed, and therefore is more difficult to recover.

Data about generation of different kind of CDW are reported in paragraph 11.3.1.

Recovery techniques

No data found.

Environmental and economic impacts of CDW waste management

Recycling of CDW and the use of their, after treatment, products apart from the environmental benefits due to the restriction of the use of primary materials as well as the illegal and uncontrolled deposition in open spaces, has also economic benefits. Initially new jobs created both in the part of management and research on these materials. Secondly, it is crucial the fact that a supplier of CDW can take back pure secondary material at the same time he goes to the treatment plant, without being forced to go to the quarry. So, the benefits have to do with both time and money savings.

The management costs range from 2,00 € -25,00 €/tn depending on the purity of the materials carried to the treatment plant including separation of various categories of wastes and their treatment till final product, which can be purchased at half the cost of a primary quarry material (an average of 3€/tn).

Drivers / barriers to increase recycling

Provided in section 11.4.2

11.5.2 Recycled materials from CDW

CDW can be reused or recycled in many sectors, one of which is in civil engineering works. Those wastes, after the appropriate treatment, can be used as secondary materials for the production of new concrete mixtures, as base or sub base in road construction, as aggregates for the production of bituminous mixtures or as secondary filling material in geotechnical works. In Greece, and especially in the Universities of Thessaloniki and Thrace, recycled aggregates have been used for the production of new concrete mixtures. CDW's composition is not steady, while there is no CE for those materials, so since they generate from building of different age, different concrete category etc utilization of those materials in civil engineering works and especially in concrete and road works demands every time laboratory tests in order to certify their use as alternative aggregates.

11.5.3 Market conditions / costs and benefits

There are no significant financial incentives for CDW recycling while at the same time the uncontrolled dumping of CDW and the breaching of legislation by many actors in the CDW management chain, especially the waste holders and the collection services not affiliated to any CDW management system as laid down in legislation, hampers any efforts towards the direction of increasing CDW recycling.
The recycling of CDW is perceived as a cost to pay, since alternatives are not well developed in Greece and the market for recycled CDW is not developed.
Although it is considered uneconomical at the moment to recycle CDW in Greece, especially due to lack of other financial incentives supporting recycling and/or punishing landfilling and dumping, there is a possibility that resource scarcity issues might become more prominent in the future and ultimately the recycling of CDW would become more favorable.

12. HUNGARY

12.1 Legal Framework – Waste Management Plans and Strategies

12.1.1 National Legislation concerning CDW

National Regulatory concerning CDW in Hungary are:

- Act on Environmental Protection (A környezet védelmének általános szabályairól szóló 1995. évi LIII. Törvény)
- Act on Waste (A hulladékról szóló 2012. évi CLXXXV. törvény)
- Governmental Decree on Hazardous waste (A veszélyes hulladékkal kapcsolatos tevékenységek végzésének feltételeiről szóló 98/2001. (VI. 15.) Korm. Rendelet)
- Ministerial decree on the List of waste (A hulladékjegyzékről szóló 72/2013.(VIII. 27.) VM rendelet)
- Ministerial decree on construction and demolition waste (Az építési és bontási hulladék kezelésének részletes szabályairól szóló 45/2004. (VII. 26.) BM-KvVM együttes rendelet)
- Act on the Formation and Protection of the Built Environment (Az épített környezet alakításáról és védelméről szóló 1997. LXXVIII. törvény)
- Government decree on building and construction activity (Az építőipari kivitelezési tevékenységről szóló 191/2009. (I. 15.) Korm. Rendelet).

Particularly, Ministerial decree 45/2004 details rules for CDW management. Requires the waste producer to complete a waste registration form after the construction or demolition work is completed. It does not apply to hazardous waste. According to the Government, the Regulation is lacking guidance on where and how recycled construction materials can be used, or prohibition of their use. It is planned to address these issues in an amendment of this Regulation.

The waste type has to be summarized and exceeding quantities to limits in Regulation 45/2004 (VII. 26) have to be separated for recovery/recycling and treatment method has to be described in the Demolition Waste Registration card (the template is reported in DELOITTE study).

Detailed rules for the management of CDW have to be submitted to the relevant Environmental Authority.

After completing the construction activity a Construction waste registration card (Annex 3 of this document) has to be completed showing the types and quantities of generated waste. Waste transfer notes have to confirm the validity of the data. These two documents have to be submitted to the building authorities together with a request for the occupancy permit.

12.1.2 Waste management plans (WMP) and Strategies

Section 2.4.5 of the current **National Waste Management Plan** (NWMP) 2014-2020 is dedicated to CDW. The NWMP has been established within the Government Decree 2055/2013. (XII. 31) on the National Waste Management Plan.
There are 7 regions in Hungary, each region's Environmental Authority is responsible for developing a Waste Management Plan. 270 days after the Regional Plans have been published, the municipalities have to prepare and submit Local Waste Management Plans.
The **National Waste Prevention Program** (NWPP) is part of the NWMP. The NWPP sets targets and measures to be implemented in order to achieve the required level of waste prevention. One of the main goals of the NWMP is to decouple the relationship between economic growth and environmental impacts caused by waste generation. Section 4.4.2.1 is for CDW and includes the following: the program draws attention to the alternative utilization possibilities of unused/dysfunctional buildings and structures. The building\area previously used for production can be refurbished for housing, storage, cultural purposes keeping the main structural features of the building.
The National Environmental Program (NEP) 2014-2019 specializes in environmental awareness in order to enhance sustainable lifestyles, with regards to production and consumption. This program contains a section on CDW describing the targets as well as the recommended measures to be implemented in order to achieve them.

12.1.3 Legal framework for sustainable management of CDW

12.1.4 Targets

Section 92 of ACT CLXXXV of 2012 on Waste define that: the combined share of preparing for re-use and the recycling of non-hazardous construction and demolition waste - other than soil and stone - and other material recovery, including waste used as substitutes in backfilling operations, shall be increased by 31 December 2020 to 70 per cent relative to the total volume produced at the national level.
This target agree with the CDW target within the National Waste Management Plan 2014-2020 and the National Environmental Program (NEP) 2014-2019.
Measures planned to be implemented in order to achieve this target are:

- Increase the use of products made of recycled CDW;
- Enable the competitiveness of these products on the market;
- Establish selective demolition; increase the capacities of CDW recovery facilities; development of a new enforcement regulation; and creation of economic and legal instruments necessary for increased utilization of CDW.

The NEP provides to avoid landfilling CDW, too.
The measures necessary to achieve these targets which shall be implemented by the relevant Ministries of Hungary, are as follows:

- Regulating the use of CDW for backfilling;
- Developing selective demolition criteria and implementing in use;
- Increasing the capacity of CDW treatment facilities and establishing compulsory CDW recycling;

- Reviewing and updating related legislation (e.g. public procurement, reporting systems, and guidance documents).

12.1.5 End of Waste (EoW) status

The criteria for End-of-Waste (EoW) are established in Article 7, paragraph 9 of the Waste Act 2012 CLXXXV6. These criteria are similar to the ones defined in the European Waste Framework Directive.
Therefore, there is a lack of CDW specific EoW criteria and associated evaluation with no detailed rules for EoW for CDW in existing legislation. In connection with the utilization of recycled construction materials, the current level of Government regulation is also lacking justification of the EoW status.

12.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non legislative instruments that contribute to create conditions for a sustainable management of CDW are BREEAM and LEED.
According to the Government Regulation 312/2012, a demolition plan has to be prepared and it includes the description of:
- Demolition technology
- Outcomes of the building inspection.

In Hungary, there is a range of technical guidelines, standards and code of practice for use of CDW in construction applications, particularly as recycled aggregates in concrete productions.

12.3 CDW management performance – CDW data

12.3.1 CDW generation data

EUROSTAT database reports the data shown in Table 41 for CDW generated between years 2010 and 2014.

Table 41. EUROSTAT database for CDW generated between years 2010 and 2014

	2010	2012	2014
Mineral waste for construction	2.958.097	2.918.973	1.887.959
Metal wastes, ferrous	150.547	90.446	40.493
Metal wastes, non-ferrous	2.778	9.037	2.317
Glass wastes	2.631	3.651	590
Plastic wastes	5.304	6.495	3.513
Wood wastes	3.870	5.130	1.987
Total	**4.072.214**	**4.038.081**	**3.673.479**

DELOITTE document reports different amount of CDW generation data, supplied by Central Hungarian Statistical Office. As written in it, the data downloaded from public database, could be incorrect due to possibilities of waste producers providing data two times for the same time period, or not providing any information, delayed data or other issues.

12.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 42.

Table 42. EUROSTAT database for Mineral waste from construction between years 2010 and 2014

Mineral waste for construction	2010	2012	2014
Landfill / disposal (D1-D7, D12)	939.070	490.560	331.348
Deposit onto or into land	929.090	490.560	331.348
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	359	1.347	2.479
Incineration / energy recovery (R1)	34	94	51
Recovery other than energy recovery	1.434.971	1.431.518	2.071.360
Recovery other than energy recovery - backfilling	175.178	175.601	309.568
Recovery other than energy recovery - except backfilling	1.259.793	1.255.917	1.761.792
Total waste treatment	**2.374.434**	**1.923.520**	**2.405.238**

The new national Waste Management Plan 2014-2020 NWMP 2014-2020 shows a summary of non-hazardous CDW treatment from 2004-2013 (Table 43) and states the following conclusions:

- The amount of landfilled non-hazardous CDW has decreased since 2004, where 91% was landfilled to 47 % in 2011;
- A major part of CDW ends up at municipal landfills. Sometimes, this form of deposition is required, but in many cases CDW is transported to municipal landfills due to their closer location. Landfilling CDW at municipal landfills significantly reduces their life span;
- The proportion of recovered CDW is growing every year. However, the recovery figures include backfilling;
- Around 60% of hazardous CDW is estimated to be landfilled.

Table 43. Non-hazardous CDW treatment from 2004-2013

Non-Hazardous CDW treatment methods	2010	2011	2012	2013

Non-Hazardous CDW treatment methods	2010	2011	2012	2013
Landfill	1.232.657	2.076.371	757.639	708.909
Material recovery	2.933.919	2.338.761	3.050.797	3.062.943
Energy recovery	182	75	134	58
Incinerated	178	198	169	240
Total CDW generated	4.166.936	4.415.405	3.808.739	3.772.150

Other waste data source, such as Central Hungarian Statistical Office, reports different amount of CDW treatment data, just because they received data from other different sources.

12.3.3 CDW exports/imports data

Export and import of waste for treatment does not play a significant role in Hungary, although there has been an increase in both areas due to the termination of boarders within the Schengen area and globalization of the recovery market. The most often exported CDW type is 17 04 05 iron and steel. No other information has been found.

12.3.4 CDW treatment facilities data

Currently there are 70 compliant landfills in Hungary, their total available capacity in June 2013 was 69,000,000 m3 (source Annex 2 of the NWMP).
In the future, the landfill capacity is expected to be reduced and only five landfills are expected to be developed.
The CDW recycling/recovery operators in Hungary are mostly carrying out pre-treatment activities. The use of mobile recycling/recovery facilities is high. The NWMP 2014-2020 states that the following 5 facilities have recycled the following amounts of CDW in 2011:

- Kaposvár 56,600 tons
- Kecskemét 124,200 tons
- Bodrogkeresztúr 52,000 tons
- Szolnok 28,970 tons
- Eger 125,470 tons.

The number of treatment facilities, waste contractors, and other authorizations regarding CDW Category 17 released by the National Environmental and Nature Protection Inspectorate, the National General Directorate for Disaster Management, are reported in the Annex 4 of DELOITTE document.

12.3.5 Future projections of CDW generation and treatment

As written in the above paragraph, the amount of CDW landfilled has been significantly reducing and the recycling/recovery rate (including backfilling) have increased in recent years. Additional landfill diversion is expected due to the implementation of the Landfill Tax. The amount of generated CDW is closely related to the crisis of development in the

construction industry, which started in 2009. A negative impact is expected due to improvements in the reporting system as it will include lower quantity waste producers.
Another important condition is the 2014-2020 EU budget cycle, which is likely to have a beneficial effect on long term construction investments. On this basis, in the first part of the period around 4 million tons of CDW is expected with an increase in the second period. The recovery rate will rise due to the measures put in place as a greater proportion of the CDW will be diverted from disposal to recovery.

12.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

12.4 C&D waste management in practice

12.4.1 CDW management initiatives

To improve waste management in Hungary and to achieve the targets set out in the various EU Directives between 2014-2020, the required financial resources are set by the Environment Efficiency and Energy Operational Program 26 (KEHOP), the Economic Development and Innovation Operational Programme27 (GINOP) and the Regional and Local Development Operational Programme28 (TOP) available.
Different research projects have been developed in Hungary, with the aim to develop a common approach to a sustainable CDW management and particularly to develop and disseminate tools for recycled aggregates management planning. The working group of the Ministry of Agriculture is developing a guidance for separate collection of CDW and CDW management.

12.4.2 Drivers / barriers to increase CDW recycling

Table 44 shows a list of problems to be addressed, as states by Ministry of Agriculture:

Table 44. Drivers / barriers to increase CDW recycling

Problem	Description	Solution concept
Lack of selective demolition practices	Dismantling priorities: - quickness - cost effectiveness The sorting of materials does not fit in this practice…	Technical guidelines and standards are needed
Recycling is not economical, and it is difficult to sell the product on the market	- Inhomogeneity - The qualification is expensive - The prices of primary raw materials are law - Recycling = waste management activity	Ensure the competitiveness of secondary raw materials - increase the price of primary raw materials OR/AND - positive incentive:

Problem	Description	Solution concept
	- Environmental preliminary study!	decrease VAT for recycled materials
The principles of green procurement are not applied by the construction projects	The goal of the tenderer: to offer the lowest price possible, other important criteria such as environmental protection and sustainability are neglected	- establishment of the legal environment for green public procurements - Compulsory minimum rate of the use of recycled products / materials coming from CDW should be set by construction projects
The detailed rules of a quality assurance system are missing (special rules for secondary raw materials)	- Which ingredients of CDW can be used as secondary raw materials? - What are the detailed quality requirements? - How to handle the contaminated CDW? Etc.	Standards and industry-specific guidelines have to be defined regarding to all relevant sectors
The detailed rules of the end of waste criteria are missing	It is unclear in certain cases when and how the waste can obtain the status of product / secondary raw material.	The clarification / development of an EU-wide regulation could be helpful
Slow connections between the construction sector and environmental authorities	- Complex process, difficult to follow - Too late notifications about constructions and demolitions - Slow (or no) feedbacks (illegal landfilling)	- legislative amendment. Environmental authorities to be informed before the C&D activities, authorization for inspection, verification about the takeover of the waste for treatment
CDW used as technological materials for protection and securing landfills	- Can be used as a legal "loophole". No need to pay landfill tax - It is shown as „recycling" in the data system	- Defining the maximum rate of using CDW as technological material
The definitions in different acts are not always in accordance	Ministerial decree on construction and demolition waste (2004) – Act on Waste (2012)	Harmonization of terminologies and definitions

12.5 CDW sector characterization

12.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

CDW materials produced and recycled in Hungary are:

- Concrete
- Tar
- Mixture of concrete, stone and tar
- Rubble
- Bricks
- Mineral construction waste.

In road construction, CDW materials are generally used in the following application:

- Earthworks
- Pavement structure layers
- Reclamation layers
- Backfilling.

Other possibility of uses are: preparing of bricks and concrete, foundation and floor coverings.

Quantitative analysis

No data found.

Recovery techniques

No data found specific for Hungary.

Environmental and economic impacts of CDW waste management

No data found specific for Hungary.

Drivers / barriers to increase recycling

See Section 12.4.2

12.5.2 Recycled materials from CDW

The Table 45 shows, for each kind of CDW materials, the respective recycled product and its possibility of use (from DELOITTE study).

Table 45. CDW materials and its possibility of use (from DELOITTE study)

Waste	Recycled product	Possibility of use
Concrete	Crushed concrete	Road slabs without bond, smaller roads boards. Cement road slabs. Agricultural roads,

Waste	Recycled product	Possibility of use
		the preparation of concrete additive, filler, drainage layers.
Tar	Crushed tar	Upper road slabs without binder, lower road foundation. Road slabs with a binder. Agricultural roads. Additive for preparing asphalt.
Mixture of concrete, stone and tar	Crushed mixture of concrete, asphalt, stone	Upper road slabs without binder, binder with higher road slabs, agricultural roads.
Rubble	Construction sand and rubble (less than 25% brick content)	Stabilized backfilling and foundations. Sports ground for foundation.
Bricks	Construction sand and rubble (brick content above 25%)	Additive for preparing blocks. Concrete and lightweight concrete aggregate. Stabilization. Backfilling, foundations. Floor coverings.
Mineral construction waste	Crushed mineral material	Backfilling, foundations, the lower layer, drainage sports fields.

12.5.3 Market conditions / costs and benefits

CDW materials in Hungary are not competitive with primary building materials, due to the cost of CDW collection, pre-treatment and recycled CDW production.

13. IRELAND

13.1 Legal Framework – Waste Management Plans and Strategies

13.1.1 National Legislation concerning CDW

In Ireland, legislation concerning the management of CDW forms part of the general waste legislative framework and is supported by:

- Policy Documents issued by the Department of Environment, Community and Local Government (DECLG)
- Regional Non-Hazardous Waste Management Plans prepared by local authorities
- National Hazardous Waste Management Plans published by the Environmental Protection Agency (EPA)
- Planning Guidelines for Future Developments published by DECLG
- Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects published by DECLG
- Industry Support Documentation published by the Training and Employment Authority (FAS) and the Construction Industry Federation (CIF)

Ireland has transposed the revised EU Waste Framework Directive 2008/98/EC on Waste (WFD 2008/98/EC) into national law in 2011. More specifically, the European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011) amended the Waste Management Act 1996 (No. 10 of 1996) and subsequent amendments in order to bring Irish legislation in line with WFD 2008/98/EC (from [122] to [130])

Additional key waste regulations that have an impact on CDW management are given below:

Industrial Emissions Licenses

The European Union (Industrial Emissions) Regulations 2013 (S. I. No. 138 of 2013) and EPA (Industrial Emissions) (Licensing) Regulations 2013 (S. I. No. 137 of 2013) placed a number of additional waste activities (such as biological and thermal treatment facilities above a certain capacity) under the licensing regime of EPA. However, these regulations have a limited impact on CDW management ([131] - [132]).

Waste Licenses

The Waste Management (Amendment) Act 2001 (No 36 of 2001) [130] and the Waste Management (Licensing) Regulations 2004 (S.I. No. 395 of 2004) [133] provide the legal framework under which Waste Licenses are obtained and maintained. CDW facilities governed by the above acts and regulations include landfills and material reclamation facilities which are capable of handling more than 50000 tonnes of non-hazardous waste per year.

Waste Facility Permits and Certificates of Registration

Waste Management (Facility Permit and Registration) Regulations 2007 (S.I. No. 821 of 2007) and subsequent amendments provide the legal framework under which Waste Facility

Permits or Certificates of Registration are issued by local authorities. Waste Facility Permits are issued either for CDW facilities where concrete and brick crushers are being used to recover up to 50000 tonnes of inert CDW per year or CDW materials reclamation facilities which are capable of handling less than 50000 tonnes of non-hazardous waste per year. Finally, Certificates of Registration are issued for small scale CDW material reclamation facilities which are processing less than 10000 tonnes per year and generating less than 15% of residual waste ([134]e [135].

Hazardous Waste Regulations

The following list of regulations transposed a number of EU directives related to asbestos waste, batteries and accumulators, lead, mercury, polychlorinated biphenyls (PCBs), waste oils, and general hazardous waste into national law.

- Waste Management (Hazardous Waste) Regulations 1998 (S.I. No. 163 of 1998) and subsequent amendments ([136]e [137])
- Fluorinated Greenhouse Gas Regulations 2011 (S.I. No. 279 of 2011) [138]
- Control of Substances that Deplete the Ozone Layer Regulations 2011 (S.I. No. 465 of 2011) [139]
- Persistent Organic Pollutants (POPs) Regulations of 2010 (S.I. No. 235 of 2010)[140]
- European Union (Installation and Activities using Organic Solvents) Regulations 2012 (S.I. No. 565 of 2012)[141]
- European Union (Paints, Varnishes, Vehicle Refinishing Products and Activities) Regulations 2012 (S.I. No. 564 of 2012)[142]
- Safety Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013)[143]
- European Communities (Metallic Mercury Waste) Regulations (S.I. No. 72 of 2013) [144]

European List of Wastes

From 1 June 2015 waste classification in Ireland is based on the European List of Wastes (Commission Decision 2000/532/EC) as it was amended by Commission Decision 2014/955/EU. Chapter 17 of the list deals with CDW (including excavated soil from contaminated sites).([145]e [146])

Landfill Levy

A levy of €15/tonne on waste deposited to landfills was introduced in 2002 under the Waste Management (Landfill Levy) Regulations 2002 (No. 86 of 2002). The Landfill Levy was gradually increased between 2008 and 2013. It is currently set at €75/tonne in accordance with the Waste Management (Landfill Levy) Regulations 2015 (No. 189 of 2015). The Landfill Levy applies to CDW deposited at authorized and unauthorized landfills. It excludes non-hazardous CDW materials (such as concrete, bricks, tiles and road plannings) with particle sizes of up to 150 mm and excavation soil (such as clay, sand, gravel or stone) which are used for landfill site engineering, restoration or remediation purposes ([147]e [148].

Planning Regulations

Based on the Planning and Development Act 2000 (No. 30 of 2000) [149], planning authorities have the power (when they think it is appropriate) to impose conditions related to management of CDW to new developments which require planning permission. In addition, they are required by the Protection of the Environment Act 2003 (No. 27 of 2003) [150] to pay careful attention to the Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects[125] and ensure that all necessary measures are taken for CDW to be recycled or managed correctly. The above obligation extends to include record keeping, tracking of waste flows, waste audits and the submission of summary audit reports to the relevant local authority [151].

13.1.2 Waste management plans (WMP) and Strategies

The National Hazardous Waste Management Plan (NHWMP) was published by EPA in 2014. It covers a six year period (2014-2020) and sets out the priorities that should be undertaken within its lifetime. These are prevention of hazardous waste, improved collection rates for certain types of hazardous waste, steps that are required to improve Ireland's self-sufficiency in hazardous waste management and the continued identification and regulation of legacy issues (such as risk assessment and regulation of historic unregulated waste disposal sites) ([152]).

The National Waste Prevention Programme (NWPP) was published by EPA in 2004. The latest version of the NWPP has the title Towards a Resource Efficient Ireland and covers a period of six years (2014-2020). The programme gives a strong emphasis on resource efficiency and waste prevention. Its main objectives are (a) to implement EU and national waste legislation, (b) promote sustainable waste management, (c) reduce waste rates including hazardous waste, (d) manage hazardous waste through efficient regulation and (e) encourage the transition from a waste management orientated economy to a green circular economy ([153]).

Regional Non-Hazardous Waste Management Plans prepared by local authorities were first introduced in 1998. For the purposes of non-hazardous management planning, Ireland is divided into 3 regions. These are: Connacht-Ulster, Easter-Midlands and Southern. The plans cover the following 8 areas of strategic interest: policy and legislation, prevention, resource efficiency, coordination, infrastructure planning, enforcement and regulation, protection and other wastes. The current status of CDW management (including backfilling and pre-treatment infrastructure of CDW as well as authorization of waste facilities which also handle CDW) in each region is described in each of the Regional Non-Hazardous Waste Management Plans (0 - 0).

The National Construction and Demolition Waste Council (NCDWC) was established in 2002 as a voluntary construction industry initiative. Its role was to assist in achieving a target of 50% recycling by the end of 2003, which would be followed by a progressive increase to 85% by 2013 **(**See Section 13.1.4**).** This included setting up 5 sub-committees to recommend improvements to CDW management based on (a) infrastructure and facilities (b) markets for recycled materials and specifications, (c) project best practice and waste management, (d) review of the regulatory framework and (e) information, public awareness and funding. NCDWC run a number of successful waste prevention programmes when it was in operation. However, no CDW programmes are known to be active at present ([151] - [154]).

The Green Public Procurement (GPP) Action Plan: Green Tenders published in 2012 by DECLG aims to assist public authorities to successfully plan and implement green public procurement by highlighting existing best-practices and actions which boost green public procurement. It recommends that during the procurement process for public infrastructure projects all construction materials should be assessed for environmental impact (embodied energy, CO_2 etc.), resource use, responsible sourcing, durability, recyclability, construction waste and disposal. The above policy was further strengthened in 2014 by the GPP Action Plan: Guidance for the Public Sector published by EPA ([155] e [156]).

13.1.3 Legal framework for sustainable management of CDW

According to the Construction and Demolition Waste Management in Ireland Report [151] existing pieces of legislation which promote the sustainable management of CDW are listed as follows:

National/Regional Obligation for Selective Demolition

No specific National/Regional Obligation for Selective Demolition exists.

National/Regional Sorting Obligation (on-site or in sorting facility)

No specific National/Regional Sorting Obligation (on-site or in sorting facility) exists. However, Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects [125] state that "special attention should be paid to the sorting/segregation arrangements employed to separate the demolished structure into individual material fractions".

National/Regional Separate Collection Obligation for Different Materials (such as iron, steel, plastic and glass)

No specific National/Regional Separate Collection Obligation for Different Materials (such as iron and steel, plastic and glass) exists.

Obligation for Separate Collection and Management of Hazardous CDW

Waste Management (Hazardous Waste) Regulations 1998 (S.I. No. 163 of 1998) and subsequent amendments impose an Obligation for separate collection and management of some hazardous CDW (such as batteries and accumulators, PCB's etc.) ([136]e [137])

Related Green Public Procurement Requirements

No specific legislation exists. However, the GPP Action Plan: Green Tenders [155] sets a non-mandatory target of 50% of public contracts for construction projects to use its criteria.

13.1.4 Targets

According to the Construction and Demolition Waste Management in Ireland Report [151] existing pieces of legislation which promote the sustainable management of CDW are listed as follows:

National/Regional Obligation for Selective Demolition

No specific National/Regional Obligation for Selective Demolition exists.

National/Regional Sorting Obligation (on-site or in sorting facility)

No specific National/Regional Sorting Obligation (on-site or in sorting facility) exists. However, Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects [125] state that "special attention should be paid to the sorting/segregation arrangements employed to separate the demolished structure into individual material fractions".

National/Regional Separate Collection Obligation for Different Materials (such as iron, steel, plastic and glass)

No specific National/Regional Separate Collection Obligation for Different Materials (such as iron and steel, plastic and glass) exists.

Obligation for Separate Collection and Management of Hazardous CDW

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Related Green Public Procurement Requirements

No specific legislation exists. However, the GPP Action Plan: Green Tenders [155] sets a non-mandatory target of 50% of public contracts for construction projects to use its criteria.

13.1.5 End of Waste (EoW) status

At present, no End of Waste (EoW) criteria exist in Ireland. However, Article 6 of the WFD 2008/98/EC [127] has been transposed into national law by Article 28 of the European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011) [128]. According to the above two documents, in the absence of EoW criteria at Community level, member states (i.e. EPA of Ireland) may decide case by case whether certain waste has ceased to be waste taking into account the applicable case law. An application under Article 28 for EoW status for crushed rubble (also known as builders fill) was made in 2012. This material seems to be suitable as general filler and for construction of unbound haul roads. However, no decision by EPA has been made to date [151].

13.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non legislative instruments in Ireland dealing with CDW include:

- Best Practice Guidelines on the Preparation of Waste Management Plans for Construction & Demolition Projects published by DECLG in 2007. Their main aim is to promote an integrated approach to CDW management, during the whole duration of a construction project. According to the above document, when an old building or structure requires demolition as part of a new construction project, a Demolition Plan must be prepared. This will form part of the overall Waste Management Plan for the project [125].
- Introduction to Site Waste Management and Environmental Awareness Training Course developed in 2002 by the Construction Industry Federation of Ireland. It aims to help construction companies and contractors to better manage their CDW. The course covers all issues in relation to managing CDW, its impact on the environment and the problems caused by bad practice. Legal compliance with environmental policy and waste management is also addressed [158].
- EPA Viewpoint on the use of European Waste Catalogue (EWC) Chapters 17 and 19 (12 codes) published in 2014 [159]. It provides guidance on 12 codes from Chapters 17 and 19 of the EWC ([145][146]).
- Guidelines for the Management of Waste from National Road Construction Projects published by the National Roads Authority (NRA) in 2008. This document provides guidelines which ensure the effective management of waste throughout the duration of such projects [160].
- Building Research Establishment Environmental Assessment Method (BREEAM) published by the Building Research Establishment of UK (last updated in 2014). It has specific topics related to CDW which include requirements to have a waste management plan, set waste targets and divert waste from landfill [161].
- Leadership in Energy and Environmental Design (LEED) [162] is one of the most widely used green building certification programmes all over the world. It was developed by the United States Green Building Council (USGBC) and it has a number of rating systems for the design, construction, operation and maintenance of green buildings. The Materials and Resources Section of the latest version (Version No. 4) directly addresses source reduction, recovery and re-use, recycling and re-buying of CDW material strategies as these are described by the United States Environmental Protection Agency (USEPA) [163].

- Design out Waste: A design team guide to waste reduction in construction and demolition projects published by the Waste Resources Action Programme (WRAP) of UK in 2015. This document provides information on the five key design principles (re-use and recovery, off site construction, materials optimization, waste efficient procurement and deconstruction and flexibility) that should be used during the design process and how these can be applied to minimise waste [164].

13.3 CDW management performance – CDW data

13.3.1 CDW generation data

In Ireland, up to and including 2011 CDW collection data (not generation data) was obtained on an annual basis. From 2012 onwards, CDW generation data is obtained on a biennial basis in accordance with Regulation EC No. 2150/2002 On Waste Statistics [165]. According to the Construction and Demolition Waste Management in Ireland Report [151] CDW generation data for 2012 has been obtained and its reporting to the Statistical Office of the European Union (EUROSTAT) is under way. However, the National Waste Report for 2012 [166] published by EPA does not contain any information on CDW.

CDW collection or generation data is obtained by EPA or the Central Statistics Office (CSO) through surveys. More specifically, EPA is responsible for obtaining data from authorised waste facilities and local authorities. In addition, EPA is responsible for obtaining data from authorised industrial facilities which may generate CDW that is re-used or recovered on-site. These are known as Pollutant Release and Transfer Register (PRTR) surveys. Finally, CSO is responsible for obtaining data from enterprises. It should be noted, that not all enterprises on CSO's register are surveyed. Initially, data for a sample of enterprises is obtained and then statistical analysis is used to estimate the figures for the whole population.

CDW generation data for the period (2008-2011) is shown in Table 46.

13.3.2 CDW treatment data

In Ireland, up to and including 2011, CDW treatment data was obtained on an annual basis. From 2012 onwards, CDW treatment data is obtained on a biennial basis in accordance with Regulation EC No. 2150/2002 On Waste Statistics [165]. According to the Construction and Demolition Waste Management in Ireland Report [151] CDW treatment data for 2012 has been obtained and its reporting to the Statistical Office of the European Union (EUROSTAT) is under way. However, the National Waste Report for 2012 [166] published by EPA does not contain any information on CDW.

CDW treatment data is obtained by EPA through surveys. More specifically, EPA is responsible for obtaining data from authorised waste treatment facilities, local authorities and landfill facilities. In addition, EPA is responsible for obtaining data from authorised industrial facilities which may generate CDW that is re-used or recovered on-site. These are known as Pollutant Release and Transfer Register (PRTR) surveys.

There is an ongoing discrepancy between the reported quantity of CDW collected and the reported quantity of CDW managed (i.e. recovered or landfilled) as shown in Table 46 (based on data published by EPA ([167]- [170]). In 2011, this discrepancy was 21% for the soil and stones fraction and 7% for the non-soil and stones fraction (i.e. metal, wood, plastic, glass, gypsum-based waste, rubble and mixed or other waste). According to EPA, part of the gap between the reported CDW collected and the reported CDW treated (recovered/landfilled) may be attributed to a less than 100% reporting rate of authorised waste treatment facilities. Lack of full compliance of the sector to its obligation for providing accurate data to the local authorities on an annual basis (including lack of attention to maintenance of good records) may also contribute to the above described gap.

According to the National Waste Report for 2011 [170], a recovery rate of 98% was reported for soils and stones. This did not include an estimated 11987 tonnes of CDW in storage at the end of 2011 and an estimated 92870 tonnes of CDW treated at non reporting waste permitted facilities. A recovery rate of 97% was reported for Other CDW. This did not include an estimated 45968 tonnes of CDW in storage at the end of 2011. It should be noted that these extremely high recovery rates do not take into account the above mentioned discrepancies.

Table 46. CDW Collection and treatment data in Ireland for years 2008 to 2011 (Based on National Waste Reports from 2008 to 2011 [[167]- [170]] published by EPA)."

Official CDW Data (tonnes)	**Year**			
	2008	**2009**	**2010**	**2011**
CDW (Soils and stones) Collected	10.500.000	3.770.549	2.517.194	1.975.844
CDW (Soils and Stones) Recovered	8.366.060	4.371.833	1.685.658	1.400.472
CDW (Soils and Stones) Disposed	229.013	39.092	34.811	33.574
CDW (Soils and stones) Managed (Recovered + Disposed)	8.595.073	4.410.925	1.720.469	1.434.046 (3)
Discrepancy	1.904.927	-640.376	796.725	436.941
Recovery Rate	79% (1)	99% (2)	98% (2)	98% (2)
Other CDW Materials Collected	3.000.000	1.323.117	947.489	1.027.847
Other CDW Materials Recovered	1.852.853	727.477	847.796	934.841
Other CDW Materials Disposed	1.215	16.833	9.811	25.202
Other CDW Materials Managed (Recovered + Disposed)	1.854.068	744.310	857.607	960.043 (4)
Discrepancy	1.145.932	578.807	89.882	67.804
Recovery Rate	62% (1)	98% (2)	99% (2)	97% (2)

Total CDW collected	**13.500.000**	**5.093.666**	**3.464.683**	**3.003.691**
Total CDW managed (recovered/landfilled)	**10449141**	**5.099.310**	**2.578.046**	**2.498.946**
Discrepancy	**3050859**	**5.644**	**886.637**	**504.745**

1 Calculation was based on quantity recovered divided by quantity collected.
2 Calculation was based on quantity recovered divided by quantity managed.
3 Excludes 11987 tonnes in storage at the end of 2011 and 92870 tonnes treated at non reporting waste permitted facilities.
4 Excludes 45968 tonnes in storage at the end of 2011.

13.3.3 CDW exports/imports data

In Ireland, most of the generated CDW is treated within its borders. Metals, contaminated soil and asbestos are the main exceptions. Metals are pre-treated and sorted in Ireland. Next, they are exported abroad (mainly in the UK) for further treatment. According to the Construction and Demolition Waste Management in Ireland Report 384 a relatively small quantity of metals from CDW (approximately 330000 tonnes) were exported in 2011.

ENVA Ireland Limited Facility at Portlaoise is the only facility in Ireland licensed to treat contaminated soil. It has a licensed capacity of 40000 tonnes per year and in 2012 received 4246 tonnes of contaminated soil (54% of the total reported contaminated soil). The remaining reported contaminated soil of 3610 tonnes was exported to Germany (3621 tonnes) and the Netherlands (17 tons) [166].

Currently, in Ireland there is no dedicated hazardous waste landfill facility in operation. As a result of this, 4255 tonnes of asbestos and 252 tonnes of other hazardous CDW were exported in 2012 [166].

13.3.4 CDW treatment facilities data

In Ireland, a number of landfills have closed prematurely over the last eight years due to the current financial climate. Currently, there are eight operational landfill facilities authorised to accept non-hazardous and/or inert CDW. All eight of them are licensed and regulated by EPA. Their current combined total remaining consented capacity (including CDW) is estimated to be 14829000 tonnes. CDW is commonly used as a recovery material on these landfills (i.e. rubble for temporary haul roads, woodchips for daily cover or bedding for temporary works and inert fine material for daily cover).

Currently, there is enough treatment capacity to treat non-hazardous CDW in Ireland. An estimated 5.1 million tonnes of authorised and mainly active backfilling capacity for the recovery of soil and stones exists, from which 1.1 million tonnes (22%) are utilised. In addition, an estimated 4.25 million tonnes of backfilling capacity have been authorised but are not currently available.

For other non-hazardous CDW materials estimates are more difficult to obtain. This is due to the fact that these materials are often treated at pre-treatment facilities and in many cases are mixed with similar materials from municipal and non-municipal waste. An estimated authorised pre-treatment capacity of 10 million tonnes exists [151].

Finally, there is a lack of treatment capacity when it comes to treatment of contaminated soil. As a result, Ireland has to export significant quantities abroad.

13.3.5 Future projections of CDW generation and treatment

Currently, there is no reliable data on future projections of CDW generation and treatment. This is due to the fact that CDW generation data is directly related to the performance of the construction and development industries. These have been severely affected by the economic recession of 2008. Financial data for 2014 shows an increase in construction activity. However, this is still significantly lower when compared to pre-2008 levels [151].

13.3.6 Methodology for CDW statistics

From 2012 onwards, the methodology used for collecting data on CDW generation and treatment complies with EUROSTAT guidelines [151] .

13.4 C&D waste management in practice

13.4.1 CDW management initiatives

Based on published literature the following initiatives were identified:

- STRIVE (Science, Technology, Research and Innovation for the Environment Programme 2007-2013) Report Series No. 26 (Development of An Audit Methodology to Generate Construction Waste Production Indicators for the Irish Construction Industry) authored by Kelly and Hanahoe and published by EPA [171] recommended the integration of an audit tool into CDW management plans. This would provide a basic methodology for measuring waste performance on-site. In addition, the report recommended submission of the audited data to the local authorities during the construction phase in fulfillment of planning requirements.
- EPA Research Programme (2014-2020) Report No. 146 (A Review of Design and Construction Waste Management Practices in Selected Case Studies-Lessons Learned) authored by Kelly and Dowd [172] developed a waste reduction toolkit for design teams. It includes: (a) principles for designing out waste, (b) procurement and tendering for waste reduction, (c) materials optimisation and standardisation, (d) off-site and modern methods of construction, (e) CDW re-use and recycling opportunities and (f) deconstruction and flexibility.
- DEMCON 20/20 project was a local initiative established in 1998 by Cork City Council. Its aim was to establish a recycling facility for CDW at a local landfill site (Kinsale Road landfill), develop new markets for recycled CDW, reduce landfill deposits of CDW in the Cork region and build a new local amenity centre. The recycling facility has been successfully constructed and operated during the time-span (1998-2002) of the project.

However, a target of 650000 tonnes of CDW diverted from the Kinsale Road landfill during the project's time-span was not achieved due to the relatively high percentage (70%) of poor quality soil, for which there is limited demand [173].

- Ballymun Regeneration was a local initiative established in 2001 by Dublin City Council. Its aim was to recycle and recover at least 50% of the 300000 tonnes of rubble arising from the demolition of 36 tower blocks built in 1960's [174].
- Mullingar Civic Amenity Centre was a local initiative by the Westmeath County Council. The aim of this project was to build a facility located in the area of Mullingar, where local residents can bring (for a small fee) their recyclable waste. A high amount of recycled CDW material was used during its construction. More specifically, 4200 m^3 of recycled crushed concrete were used for the construction of sub-base and capping layers, while 24 m^3 of recycled asphalt planings were used for the construction of the surfacing layer. Finally, 24 tonnes of crumb rubber were used as part of the landscaping. The facility became operational in 2012 [206].
- Wise Project is a local initiative (worth €3.6 million) established in 2015 by Rediscovery Centre and Dublin City Council. Its aim is to redesign and retrofit the old Boiler House building located in Ballymoun area by using best practice energy standards. This will transform the original building (constructed to dissipate heat and associated with an inefficient district heating scheme) into a national prevention, re-use and recycling educational centre [207].

13.4.2 Drivers / barriers to increase CDW recycling

Factors which act both as drivers and barriers for increasing CDW recycling include legislation and regulation, number of regional treatment facilities, landfill levy, construction work contracts, statistical data and recycling process and techniques. More specifically:

- Ambitious national and regional targets for re-use, recycling and recovery of CDW set in 1998, implementation of these targets prior to the adoption of WFD 2008/98/EC [127] targets, introduction of the Landfill Levy in 2002 and an obligation to prepare CDW management plans for projects above a certain level acted as a driver for increasing CDW recycling. However, the use of recycled materials from CDW is not adequately supported by public procurement. In addition, certification of construction projects using recycled materials from CDW acts as a barrier [151].
- Currently, it is relatively easy to obtain a license for CDW backfilling operations in Ireland. However, future regulation is expected to get tougher on CDW backfilling operations following the publication of the Regional Non-Hazardous Waste Management Plans(0- 0). It will require from contractors to demonstrate the suitability of potential sites. In addition, they will have to provide evidence that backfilling operations will have a limited impact on the environment [151].

- The landfill levy proved to be a powerful instrument for encouraging recovery and recycling of CDW. However, the costs associated with sorting, recovery, recycling and development of new construction materials from CDW act as a barrier [151].
- Publication of the GPP Action Plan: Guidance for the Public Sector [156] document which includes recommendations for waste management acted as a driver for increasing CDW recycling. However, waste management only forms a small part of the tender process and is often ignored. In addition, preliminary studies on CDW material management and pre-audits on demolition sites are rarely performed. Finally, lack of control of the recycling rate on which the winner of the contract is committed also acts as a barrier [151].
- Compliance with national and European legislation on data collection regarding CDW generation and treatment acted as a driver for increasing CDW recycling. However, ongoing discrepancies between CDW collection/generation and treatment data suggest that there are still barriers for increasing CDW recycling [151].

The main factor which acts as barrier for increasing CDW recycling is the amount of resources allocated to legislation enforcement. There are no resources specifically allocated for enforcement of CDW legislation. In addition, due to the low levels of construction activity over the last eight years, enforcement of CDW legislation has not been given high priority compared to other forms of waste such as End of Life Vehicles (ELV's) [151].

13.5 CDW sector characterization

13.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

In Ireland, CDW is mainly used as a recovery material on landfills. More specifically, rubble is used for temporary haul roads, inert fine material is used as daily cover and woodchips are used either as daily cover or as bedding for temporary haul roads [151].

Quantitative analysis

In 2012, 629554 tonnes of CDW were accepted for recovery at 18 landfills. This represented an increase of 76855 tonnes (14%) from 552669 tonnes accepted at 14 landfills in 2011.

Recovery techniques

The recovery technique used in Ireland during demolition projects is described by Byrne and O'Regan [208] as follows: Soft striping (i.e. removal of materials that can be salvaged such as doors, windows, plumbing and sanitary components) is performed. If these materials have a market value they are re-used. Next, metals and timber are removed and handed to specialist recycling facilities. Metals are separated from timber and then exported abroad for further treatment and processing, while most of timber is re-used in Ireland. The remaining mixed waste is sent to recycling facilities for processing. Plastics such as High-Density Polyethylene (HDPE) or Polyvinyl Chloride (PVC) are recovered, packed and sold as plastic grade. HDPE in particular can be reprocessed in Ireland and used in the production of new plastic pipes and drains. Finally, building rubble (i.e. mix of concrete, masonry, bricks and tiles) is either crushed on-site and re-used as backfill material or sent to landfills.

Environmental and economic impacts of CDW waste management

During the last 15 years considerable changes in the management of CDW took place in Ireland. This has led to a more sustainable system of CDW management as opposed to the previous over reliance on landfilling. Most of CDW is now either separated on-site or pre-treated to separate it into various fractions, which are then either recovered, exported for treatment or disposed. In 2011, only 2% of the total CDW managed was disposed. When it comes to hazardous CDW 100% of asbestos, 100% of other hazardous CDW and 46% of contaminated soil were exported for treatment. However, there are some concerns related to illegal activities such as dumping of CDW fines as well as sales of CDW materials due to the ongoing discrepancies in data between the reported quantity of CDW collected and the reported quantity of CDW managed [151].

Drivers / barriers to increase recycling

Please refer to Section 13.4.2.

13.5.2 Recycled materials from CDW

In Ireland, the market for CDW materials such as concrete, bricks, metals, plastics and glass is well developed. However, use of these materials is still quite low. The use of recycled aggregate in construction industry is also quite low with most of it used for backfilling operations. This is mainly due to lack of confidence in its use and the large supply of low cost good quality virgin aggregate, for which demand has significantly dropped over the last years [208]. The cost of recycled aggregate is estimated to be €1/tonne compared to €3.5/tonne for virgin aggregate [151].

A number of infrastructure projects in which recycled aggregate was used during their construction are reported below [151]:

- A section of the M50 motorway
- Mullingar Civil Amenity Site
- Edenderry Civic Amenity Site
- Civic Amenity Site at Kyletalesha Landfill
- The Aviva Stadium which has a capacity of approximately 52000 spectators

13.5.3 Market conditions / costs and benefits

Market conditions

The Landfill Tax has encouraged the recycling and recovery of CDW in Ireland. However, it was not introduced as an environmental tax like in UK, but as a way to fund the repair of residential buildings affected by pyritic heave [209].

Costs and benefits

There is no published data on the costs (perceived/actual) and benefits of recycling and recovery of CDW in Ireland. Although, it is generally accepted that CDW is a problem (especially when it comes to unfinished or unoccupied housing developments that may have to be demolished in the near future), its recycling and recovery are considered to be a low priority due to the associated cost, time and quality of recycled products ([151],[209]).

14. ITALY

14.1 Legal Framework – Waste Management Plans and Strategies

14.1.1 National Legislation concerning CDW

National Regulatory concerning CDW in Italy are:

- D.lgs. 152/2006 e ss.mm.ii, "Norme in materia ambientale 8Codice ambiente)", which is the main legislation on waste;
- D.M 5/2/98 (amended by Decreto 5/4/06 n.186), "individuazione dei rifiuti non pericolosi sottoposti alle procedure semplificate di recupero ai sensi degli articoli 31 e 33 del Decreto Legislativo 5 febbraio 197, n.22", dealing with the distinctin between dangerous and non-dangerous waste;
- D.Lgs. 36/2003 of 13/01/2003 "Attuazione della direttiva 1999/31/CE relativa alle discariche di rifiuti", art. 2., lett e), which defines inet wastes and their management in landfill;
- D.M 27/09/2010 (amended by D.M. 24/06/2015) "Definizione dei criteri di ammissibilità dei rifiuti in discarica, in sostituzione di quelli contenuti nel decreto del Ministero dell'ambiente 03/08/2005", which establishes inert waste categories for which laldfill recovery is allowed, whithout previous characterization, and sets the eluate concentration limits for inert waste acceptability in landfill;
- D.M. n.203 del 8/05/2003 "Norme affinchè gli uffici pubblici e le società a prevalente capitale pubblico coprano il fabbisogno annuale di manufatti e beni con una quota di prodotti ottenuti da materiale riciclato nella misura non inferiore al 30% del fabbisogno medesimo"; which sets a quota of 30% for recycled materials and products in public procurement. This is mandatory only when there are recycled materials and products with the same characteristics of materials manufactured from virgin materials;
- Circolare 15/7/05 n. 5205 Green Publc Procurement – "Indicazioni per l'operatività nel settore edile, stradale e ambientale, ai sensi del Decreto Ministeriale 8 Maggio 2003 n. 203"; which sets green public procurement rules for construction activities (including roads works);
- DM 161/2012 "Regolamento materiali da scavo" amending art. 186 Codice Ambiente; which sets the rules for re-use of excavated materials through "Piani di utilizzo" (an administrative document describing the use of excavated materials);
- DL 69/2013 (amended by L.98/2013), Art. 41 c. 2 and Art. 41-bis c. 1 e 5, which sets the rules for the "Piani di utilizzo";
- D.L. 12-9-2014 n. 133 (entered into force on 13th september 2014) Art. 34 comma 9, which allows the re-use in situ of excavated materials whenever these materials are in line with the concentrations of pollutants as set by the legislation.

14.1.2 Waste management plans (WMP) and Strategies

Italy has not developed a national waste management plan, as art.196 of D.Lgs.152/2006 provides that plans are developed at regional level. However, general criteria for the implementation of regional plans are defined in article 199 of legislative decree 152/2006.

According to national criteria, regional plans on waste management must include several provisions, such as:

- ✓ measures to ensure a reduction in the quantity, volume and hazardousness of waste;
- ✓ identification of ATOs;
- ✓ number and types of waste management plants that must be built in the region to ensure the proper management of waste (within each ATO);
- ✓ provisions to avoid soil and water pollutions, arising from waste landfilling;
- ✓ criteria to be followed by provinces in order to identify the areas not suitable for the location of plants;
- ✓ measures to prevent waste production and encourage reuse, recycling and recovery;
- ✓ measures to promote waste collection and management within the regional territory.

With Decreto Direttoriale of 7th October 2013, the Ministero dell'Ambiente e della Tutela del Territorio e del Mare has adopted the "Programma Nazionale di Prevenzione dei Rifiuti", which dissociates economic growth from environmental impact related do waste production. Based on data of Istituto Superiore per la Protezione e la Ricerca Ambientale (Ispra), the Programma sets the prevention targets up to 2020, and each national region has to integrate the owner regional planning with the national Programma indications.

With particular reference to CDW management plan, the association Green Building Council Italia has published in 2012 the "Guida per la Redazione del Piano di Gestione dei Rifiuti da Costruzione" which defines the minimum content of the CDW management plan, as:

- general information
- waste management targets
- measures for waste reduction, re-use, recovery and recycling
- measures for contaminated reduction
- measures of communication and education
- monitoring plan.

Examples of CDW management plan are in Lazio and Piemonte Regions.

14.1.3 Legal framework for sustainable management of CDW

No data found

14.1.4 Targets

The "Programma Nazionale di Prevenzione dei Rifiuti" of the Ministero dell'Ambiente e della Tutela del Territorio e del Mare, based on data of Istituto Superiore per la Protezione e la Ricerca Ambientale (Ispra), sets the prevention targets up to 2020 starting form data recorded on 2010:

- Reduction of 5% of urban waste generation per Pil unit;

- Reduction of 10% of hazardous special waste generation per Pil unit;

- Reduction of 5% of non-hazardous special waste generation per Pil unit.

With particular reference to CDW generation, art. 181 of D.Lgs. n.152/2006 sets that "by 2020, the preparing for re-use, recycling and other material recovery (including backfilling operations using waste to substitute other materials) of non-hazardous construction and demolition waste, excluding naturally occurring material defined in category 17 05 04 in the list of waste, shall be increased to a minimum of 70% by weight", according to the European target set by Waste Framework Directive 2008/98/EC.

14.1.5 End of Waste (EoW) status

The framework of "end-of-waste" is included in the Art. 184-ter of D.Lgs 152/2006 as emended by D.Lgs 205/2010. According to it, "a waste ceases to be such when it was subjected to a recovery, including recycling and preparation for re-use".

A waste, to cease to be such, has to meets the specific criteria, in accordance with the following four conditions:

a) The substance or object is commonly used for specific purposes;
b) There is a market or demand for such a substance or object;
c) The substance or object fulfills the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
d) The use of the substance or object will not lead to overall adverse environmental or human health.

EoW criteria can be determinated through one or more Decrees of Environmental Ministry "in accordance with Community criteria" or, in the absence of Community criteria, "case by case" for each kind of waste.

To this day, European Community has adopted only three EoW implementing Regulations, respectively for copper scrap, glass scrap and Iron, steel and aluminum scrap. So, according to art.184-ter of D.Lgs 152/2006, in the interim, it shall apply the provision laid down by the Decrees of Environmental Ministry on 5th February 1998, 12th June 2002 n.161, and 17th November 2005 n.269.

The art. 4 of Legge 11th August 2014, n. 116,"Disposizioni urgenti per il settore agricolo, la tutela ambientale e l'efficientamento energetico dell'edilizia scolastica e universitaria, il rilancio e lo sviluppo delle imprese, il contenimento dei costi gravanti sulle tariffe elettriche, nonchè per la definizione immediate di adempimenti derivanti dalla normative europea", sets that it's possible to adopt simplified procedures for EoW, provided that all requirements, criteria and prescriptions have to be respected, with particular referring to:

a) quality and characteristic of waste to will treat;

b) specific conditions to be respect in the course of activities;

c) necessary requirements to ensure that waste will be treated without endangering human health and without using methodology that could harm the environment, with specific reference to monitoring minimum obligations;

d) destination of EoW according to the identified uses.

Furthermore, the Legge n.116/2014 requires entities and companies, who already carry out recovery operations of "materia prima seconda" or secondary raw material derived by specific waste typologies (according to D.M 5th February 1998, 12th June 2002 n. 161 and 17th November 2005 n. 269, and art.9-bis of Law 30th Dicember 2008 n. 210), to adapt their owner activities at particular provisions.

As of today there is only one material within CDW for which EoW criteria are being developed: aggregates made from CDW for paving roads ("granulato da conglomerato bituminoso"). ANPAR is lobbying to develop EoW criteria also for aggregates used for other construction works and in particular for the construction of buildings. According to interview made with different stakeholders the development of end of waste criteria would be much quicker if it was led by initiative/input from EU Commission.

14.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non legislative instrument that contribute to create conditions for a sustainable management of CDW is LEED.

With regards to waste management, art.196 of D.Lgs. 152/2006 sets the rules for regional plans for waste management. It makes Regions responsible for waste management planning. Provinces according to art.197 are mainly responsible for controlling waste management activities. So, each region and/or province, has approved guidelines, recommendations or other instruments for CDW management and control.

The istitutions that have establish regulations about CDW management are:

- Liguria Region
- Veneto Region
- Lazio Region

- Indipendent Trento Province
- Bologna Province
- National Association of Recycled Aggregate Producers (ANPAR).

Liguria Region, with D.G.R. n. 734 of 20th June 2015, has adopted the "Linee guida circa la caratterizzazione dei rifiuti da costruzione e demolizione, prodotti nell'ambito di attività edili di piccole dimensioni ed avviati ad impianti di recupero in base alle procedure semplificate di cui al D.M. 5.2.1998". This measure introduce the criteria for CDW delivery produced among construction activities of small dimensions, and send to recovery facilities according to D.M. 5.2.1998 simplified procedure.

In Veneto Region, the Regional Council has approved the following documents:

- Guideline on "Modalità operative per la gestione dei rifiuti da attività di costruzione e demolizione. D.Lgs. 03.04.2006 e s.m.i., n. 152; L.R. 3/2000". This document provides a set of operative indication for a suitable management of issue about production and management of CDW as in the production site, as in treatment plans, focusing on the **selective demolition** as most effective solution to reduce the amount of CDW and encourage sorting and recovery of waste separate fractions;
- Guideline on "Modalità operative per la gestione e l'utilizzo nel settore delle costruzioni di prodotti ottenuti dal recupero di rifiuti".

Lazio Region has drawn up, in collaboration with ARPA Lazio, the DGRL n. 34 of 26th January 2012 "Approvazione delle Prime linee guida per la gestione della filiera di riciclaggio, recupero e smaltimento dei rifiuti inerti nella Regione Lazio". This document establishes the main guidelines for CDW management, from the yard production up to the treatment, as in recovery plans as in landfill. The guideline introduces the drafting of the "**Piano di Gestione dei Rifiuti**", which is a conceptual design for work organization, and the "**Selective demolition**" to ensure CDW recovery. It also defines criteria for the construction and the management of waste facilities, and for acceptance procedure of waste in entrance to recovery plans.

The autonomous Trento Province with deliberation n. 1333 of 24th June 2011, "Legge provinciale 14 aprile 1998, n. 5 (Disciplina della raccolta differenziata dei rifiuti). Approvazione delle Linee guida per la corretta gestione di un impianto di recupero e trattamento dei rifiuti e per la produzione di materiali riciclati da impiegare nelle costruzioni e delle Norme tecniche e ambientali per la produzione dei materiali riciclati e posa nella costruzione e manutenzione di opere edili, stradali e recuperi ambientali" has approuved two guidelines:

A) Linee guida per la corretta gestione di un impianto di recupero e trattamento dei rifiuti e per la produzione di materiali riciclati da impiegare nelle costruzioni, which is a support document for management and control activities of a CDW recovery facility for the production of construction and environmental materials;

B) Norme tecniche e ambientali per la produzione dei materiali riciclati e posa nella costruzione e manutenzione di opere edili, stradali e recuperi ambientali. This document reports the basic principles for the use of recycled materials derived form CDW treatment, with particular reference to potential use, technical and environmental characteristics.

The Bologna Province has submitted the "Accordo di Programma in materia di residui edili da costruzione e demolizione" (approved by the Consiglio Provinciale with Delibera n 70 of 24.07.2001 and amended with the Delibera consiliare n. 90 del 23.07.2002), with the aim to promote an efficient, affective and economic management of CDW, based on the collaboration of both public and private entities, involved in waste cycle management. In 2004 it was published the "Manuale per la gestione dei rifiuti da costruzione e demolizione in Provincia di Bologna in applicazione dell'Accordo di Programma" with the purpose to encourage and promote the knowledge and the application of the "Accordo". The manual gives instruction for: selective demolition, grouping and transporting different kind of CDW, recovery and landfilling of each CDW fraction, suitable operating of recovery facilities to obtain high quality recycled materials. This is the approach to encourage the building economic operators, which could organized production processes in most efficient way, producing less waste and avoiding transport and disposal costs, and recycling more materials.

The Edili Group of Industrial's Association of Udine Province, proposes the guideline "Linee Guida per la Gestione degli Scarti di Cantiere" with the aim to provide rationalized solutions about CDW management problems.

There are also the "Linee Guida per la Gestione dei Rifiuti da Costruzione e Demolizione" and the Circolare 01/2015 of ANPAR (Associazione Nazionale Produttori Aggregati Riciclati) which propose the management procedure of CDW and their acceptance in recovery facilities.

Finally, starting from the above mentioned documents, among the activites planned in the new "Programma Triennale 2014-2016" of Sistema Nazionale della Protezione dell'Ambiente (SNPA) del Sistema Agenziale, it has been create a Work Group on the topic "Recovery of inert waste". This group has the duty of define criteria and technical recommendation for CDW recovery, with particular regard to the characteristics pf materials for upper and lower roads and to the verifications necessary for environmental respect in the use of recycled materials. So they have drawn up two technical rules integration proposals:

- Linee Guida su modalità operative per la gestione dei rifiuti inerti, in particolare da attività di C & D. This document provides a set of operative indication for a better management of CDW. Particularly, following the European principle on waste hierarchy, the guideline provides operative arrangements aimed to enhance CDW through a regulated management. In this contest, particolar attention is assumed by the encouragement of the "selective demolition" as efficient solution for decrease CDW amount and for encourage sorting and recovery of selective CDW fractions.

- Linee Guida sulle modalità operative per la gestione e l'utilizzo nel settore delle costruzioni di prodotti ottenuti dal recupero di rifiuti inerti. This document defines the Technical Norm for construction products as planned in DM 5.2.98, differentiate between "prodotti di recupero" and "rifiuti tal quali".

14.3 CDW management performance – CDW data

14.3.1 CDW generation data

CDW national generation are estimated based on information within Modello Unico di Dichiarazione Ambientale (MUD) database, relating to the annually declarations done by the entities identified pursuant to art.189 of D.Lgs. 3th April 2006 n.152, such as traders, businesses and Institutions carrying out recovery poperations and waste disposal, etc. MUD data are subjected to a specific estimation methodology by ISPRA (Figure 10 and Figure 11); particularly, CDW generation data are estimated through removing MUD declarations of intermediate steps of waste management cycle in order to avoid duplication of data, taking into account inventory CDW amount at the end of previous year, and excluding imported CDW.

According to ISPRA "Rapporto rifiuti speciali 2016", the largest contribution to special waste generation is ever constituted by CDW, as according to ATECO 2007 economic activities classification (ATECO Code 41-42-43) (Table 47), as according to the European list of waste LoW (CER Code 17) (Table 48).

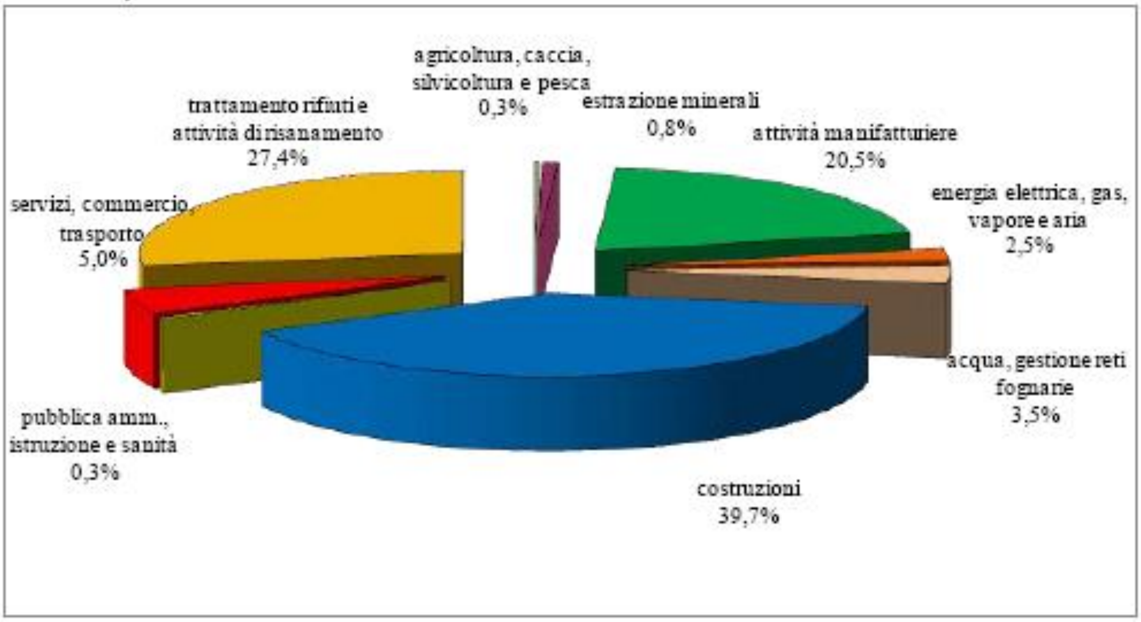

Figure 10. Percentage distribution of special waste generation according to the economic activities cataloguing (year 2014). By ISPRA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723583

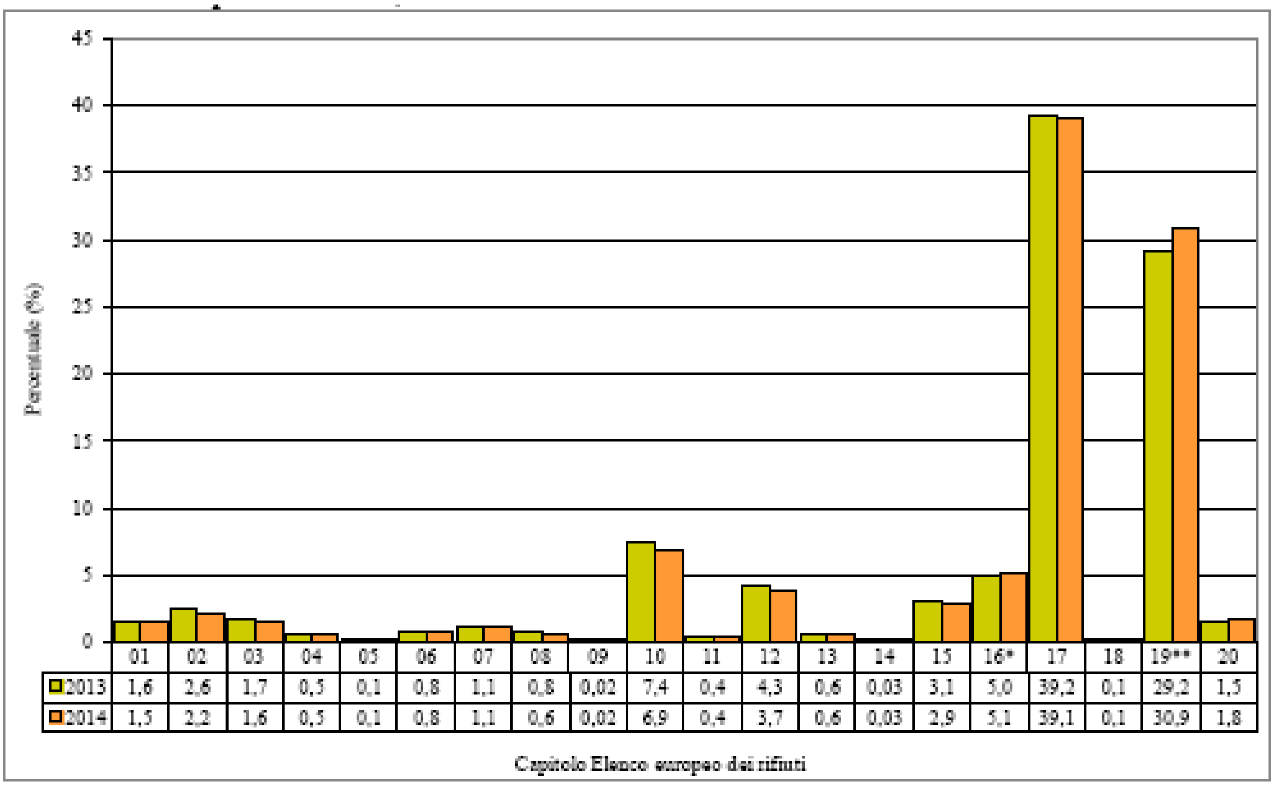

Figure 11. Percentage distribution of special waste generation according to the European list of waste (year 2014). By ISPRA

Table 47. CDW generation data according to the economic activities cataloguing – by ISPRA

	2012	2013	2014
Total Construction Waste (Code 41-42-43)	**53.072.414**	**49.314.540**	**51.846.344**
Non-hazardous construction waste (Code 41-42-43)	52.651.192	48.933.338	51.491.288
Hazardous construction waste (Code 41-42-43)	421.222	381.202	355.056

Table 48. CDW generation data according to the European list of waste – by ISPRA

	2012	2013	2014
Total CDW (Code 17)	**52.483.733**	**48.716.865**	**51.004.654**
Non-hazardous CDW (Code 17)	51.629.207	47.939.874	50.214.864

	2012	2013	2014
Hazardous CDW (Code 17)	854.526	776.991	789.790

ISPRA reports also the regional and the geographic macro-area breakdown for CDW generation (Table 49). With regards to the geographical macro-area, the northern Italian records production values per capita higher than the national average, in line with the productive and industrial fabric present in the territory. Southern Italy is the macro region with the highest increase of special waste produced, between 2013 and 2014, with + 12%. The increase mainly concerns the CDW (+ 27%), amounting to approximately 72% of the increase of macro geographical area waste.

Table 49. Regional and the geographic macro-area breakdown for CDW generation – by ISPRA

	NORD		CENTRO		SUD	
	2013	2014	2013	2014	2013	2014
Total CDW (Code 17)	**31.880.076**	**31.972.142**	**8.520.658**	**8.590.247**	**48.587.386**	**10.442.265**
Non-hazardous CDW (Code 17)	31.450.496	31.425.195	8.417.998	8.508.364	8.071.380	10.281.305
Hazardous CDW (Code 17)	429.580	546.947	1.022.660	81.883	115.272	160.960

With regards to the amount of different kind of CDW generation, EUROSTAT database reports the following data between years 2010 and 2014 (Table 50).

Table 50. EUROSTAT database with regards to the amount of different kind of CDW generation between years 2010 and 2014.

	2010	2012	2014
Mineral waste for construction	35.800.652	33.811.563	34.088.304
Metal wastes, ferrous	5.243.807	4.170.348	3.620.960
Metal wastes, non-ferrous	638.680	499.803	397.084
Glass wastes	47.872	60.650	72.265
Plastic wastes	26.864	36.451	28.366
Wood wastes	296.237	172.742	184.059
Total	**59.340.134**	**52.965.743**	**51.683.579**

14.3.2 CDW treatment data

In the ISPRA document "Rapporto Rifiuti Speciali", data related to waste management are analyzed by type of management: R1 – energy recovery; from R2 to R11 – material recovery; R13 – "mass reserve"; D1 – disposal in landfill; D15 – preliminary deposit; D10 – incineration; D8, D9, D14 – other disposal operations.

With this approach, CDW constitute the 63% of recovered waste and the 19% of disposed waste, for the 2014 year.
Given that the CDW generated in the year 2014 in Italy amounted to about 68,087 million of tons (including the waste remained in storage at the plants and from producers to December 31), they are treated as in the Table 51.

Table 51. CDW generated in the year 2014.

	Non-hazardous CDW [tons]	Hazardous CDW [tons]	TOTAL CDW [tons]
Recovery	56.556.960	111.400	56.668.360
Landfill	3.071.420	487.920	3.559.340
Energy recovery	437.000	0	437.000
Incineration	4.599.000	2.823.000	7.422.000
		Total	**68.086.700**

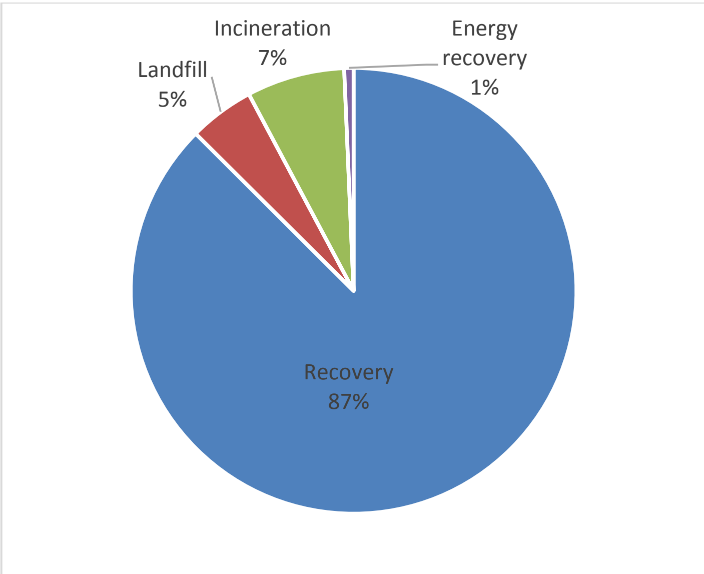

Figure 12. Percentage distribution of non-hazardous CDW treatment (year 2014)

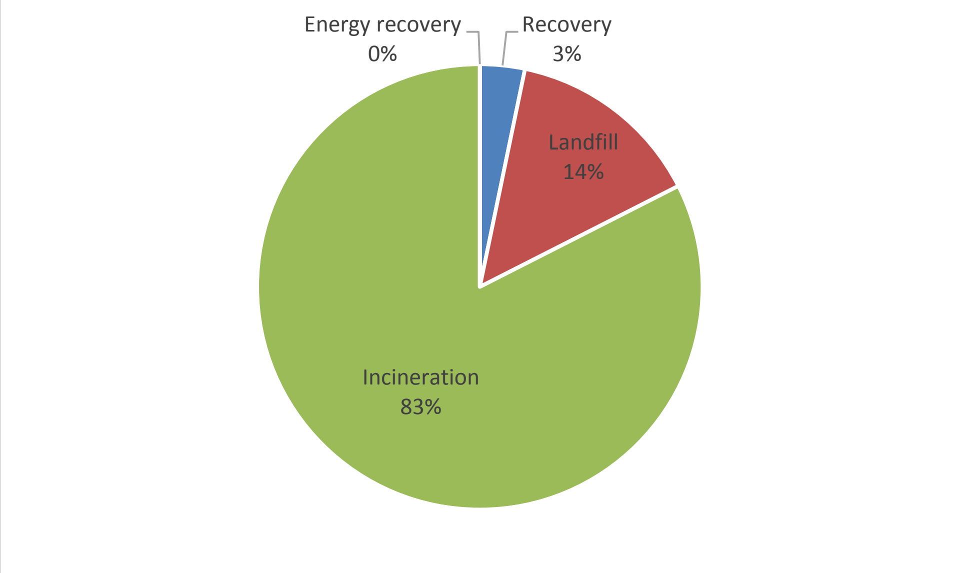

Figure 13. Percentage distribution of hazardous CDW treatment (year 2014)

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 52.

Table 52. EUROSTAT - Mineral waste from construction.

Mineral waste from construction	**2010 [tons]**	**2012 [tons]**	**2014 [tons]**
Landfill / disposal (D1-D7, D12)	1.009.838	919.878	1.049.201
Deposit onto or into land	1.009.838	919.503	1.049.201
Land treatment and release into water bodies	0	375	0
Incineration / disposal (D10)	2.684	2.720	4.375
Incineration / energy recovery (R1)	0	0	25
Recovery other than energy recovery	30.117.566	29.942.525	30.335.770
Recovery other than energy recovery - backfilling	337.196	160.290	316.790
Recovery other than energy recovery - except backfilling	29.780.370	29.782.235	30.018.980
Total waste treatment	**31.130.088**	**30.865.123**	**31.389.371**

14.3.3 CDW exports/imports data

Total amount of special waste exported in 2014 is 3,2 millions of tons and the largest quantities of waste is destined for Germany and China: more than 245 thousand of tons of CDW (about 36% of the total amount of special waste) are exported in German.
CDW represent 3,9% of exported non-hazardous waste and 27,2% of exported hazardous waste.
Imported special waste in Italy in 2014 are about 6,2 millions of tons, and they are exclusively non-hazardous waste. CDW represent 49,4% of the total amount of non-hazardous waste, corresponding to about 3 millions of tons.

14.3.4 CDW treatment facilities data

The number of operating landfills that have disposed of special waste decreased from 404 in 2013, to 392 in 2014 (Figure 14); the reduction is not attributable exclusively to the permanent closure of plants, but it is also attributable to the temporary non-operation of landfills especially medium and small size. This practice has been observed, even in previous censuses, especially with regard to landfills for inert waste, whose activities are often linked to exigent circumstances such as the opening / closing of yards in the different regional contexts.
In 2014, most of the landfill is located in the North with 228 plants, 58 are located in the Centre and 106 in the South; it should be noted, therefore, a non-uniform distribution throughout the country which follows the course of the production of special waste, closely linked to the industrial fabric of the country.
The data by geographic macro-area show that of the 12 operating plants in less surveyed nationwide, 8 are located in the South, 3 North to the Centre and only 1.
46.4% of all operating systems are made up of landfills for inert waste (182), 50.5% landfills for non-hazardous waste (198) and only 3.1% for landfills hazardous waste (12). The 182 landfills for inert waste are located: 118 in the North, 14 in the Centre and 50 in the South. In some territories like the Valle d'Aosta region or South Tyrol, characterized by extensive mountainous areas, the number of plants for waste aggregates is particularly important; these landfills, mostly managed by municipalities, are small and dedicated to the disposal of inert waste generated within the municipal area, often for use by residents. Landfills for inert waste mainly functioning on their own at the extraction of the minerals service companies.
In the last year examined, the number of landfills for inert waste and waste operating hazardous remained virtually unchanged.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723583

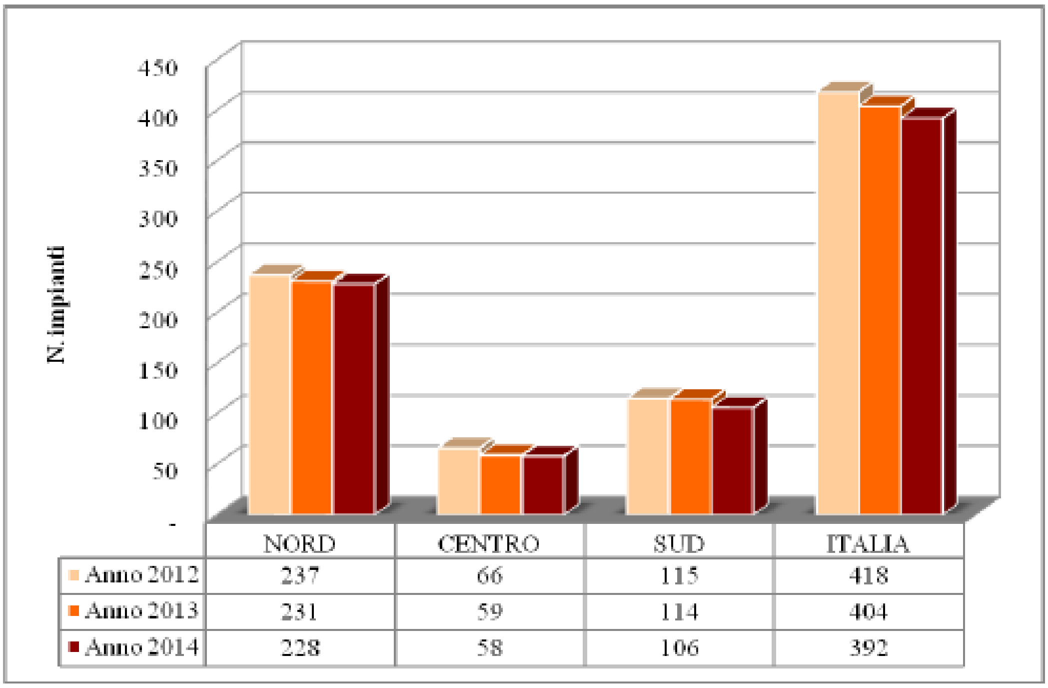

Figure 14. Special waste disposal plans in Italy – by ISPRA

14.3.5 Future projections of CDW generation and treatment

An important opportunity for the sector's development is the application of the rules on GPP in the different areas of use of recycled aggregates. Italy with the publication of Law 221/2015 was the first country among the EU Member States, to impose an obligation of CAM application for procuring public stations, raising on the importance of green purchasing play as a tool strategic. The law also provided for in Article 23 of program agreements and incentives aimed at supporting the recycling sector.

With the Public Contracts Code (Legislative Decree no. 50/2016), then, it was confirmed the inclusion mandatory CAM in the calls for tender, providing a minimum of 50% or 100% of the auction value in relation to the categories of contract and where, not secondary, it promotes the identification of actions to reduce waste. Also in the Official Gazette no. 16 of 21 January 2016 was published the Decree of the Ministry of Environment of 24 December 2015 in which they are CAM issued for the award of planning services and work for the new construction, renovation and maintenance of buildings and for the management of the public administration sites that provide, among the criteria for the evaluation of the projects participating in public tenders, also properties related to the concrete. For concrete, and related components materials packaged at the construction site, it is in fact provided for a minimum of recycled matter content of at least 5% by weight, as the sum of the percentage of recycled material contained in the individual components (cement, additions, aggregates, additives), consistent with the limits imposed by the specific technical standards. So today all regulatory instruments seems to be developed, necessary for proper dissemination and implementation of GPP in the construction industry.

The use of recycled aggregates in the construction sector, however, is still not very developed because the vast majority of recovered material is used in infrastructure projects.

Therefore, in view of the centrality of their role, it is hoped to be a part of the Ministry CAM resume and complete the assignment of services to design and construction of the new construction, renovation and maintenance of infrastructure (roads, railways, airports, etc.) and on the other hand that public administrations apply the provisions giving the market momentum of recycled aggregates, directing and stimulating demand, and require the application of the rating systems for the sustainable construction industry and for the infrastructure that promote and recognize purchasing strategies of green products based on logic circular economy.
Within some regional plans some proposals for simplification in the field of analysis of incoming waste and certification of the resulting products, have been presented.
The application of these proposals involves the establishment of strict management procedures, almost exclusively in the context of possible environmental quality procedures (ISO 14001, EMAS) and product (CE marking, system 2+).
The best results are possible in a context that integrates the construction procedures and with those of the recovery. It's important that some of the proposals made at individual level region are taken up and possibly reworked by other regions with a view to an optimization work and synthesis.

14.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document is described in paragraph 14.3.1.

14.4 C&D waste management in practice

14.4.1 CDW management initiatives

Emilia Romagna Region has recently adopted the Regional Plan for Waste Management: among the many tools available in the field to ensure that a proper and environmentally sustainable waste management and boost the economic development of the relevant business sectors, the Plan promotes the development of a <u>project dedicated to the valorization of CDW activities</u>. The purpose of the Project are:

- A better understanding of the sector and encourage the proper application of legislation on the recovery of inert waste and the use of recycled products;

- Define actions and instruments to regulate and promote an inert waste management, which contextually ensures environmental protection and high technical performance of produced materials;

- Encourage the use of recycled aggregates for the various types of works, depending on the performance characteristics, with reference also to the field of public works (Green purchasing).

The Provincial Environmental Agency commissioned the IFEU Institute (Institut für Energie- und Umweltforschung Heidelberg) to develop the study "**Recovery of CaseClima demolition**

materials". The project was funded by the European Union Programme "Regional Competitiveness and Employment FESR 2007-2013". With the present study, it's firstly detected the current situation of Bolzano Province, making a rough estimate of building and materials types used to in the past for CaseClima buildings. On this basis it is estimated in the second part of the study the extent to which the waste management system is required on other flows and other compositions of waste.

SNAP-SEE Project. The project focuses on developing and disseminating tools for aggregates management planning in Southeast Europe (SEE). It builds on the results of the Sustainable Aggregates Resource Management (SARMa) project. Due to regional differences in historical development, there are diverse approaches to aggregates policies, planning and management in SEE, which is hindering resource efficiency and economic development in the region:

- differences among mineral policies;
- aggregates policies and plans are distributed among many different legal documents, making coordination and a comprehensive understanding difficult;
- authorities in SEE countries do not have the understanding of either sustainable aggregates resource management (SARM) or planning for sustainable supply mix (SSM) and;
- there is almost a complete lack of coordination on planning supply from primary and secondary aggregates sources.

The primary result was to develop a Toolbox for Aggregates Planning to support national/regional, primary and secondary aggregates planning in SEE countries, which include:

- SNAP-SEE Vision for a transition to integrated, comprehensive sustainable aggregates planning in SEE;
- Handbook on Capacity Building and Stakeholder Consultation;
- Handbook on Data and Analysis Methods;
- Aggregates Planning Scheme, containing planning modules that embody the principles, approaches and action necessary to achieve the goals of the Vision [11].

Osservatorio Recycle, promoted by Legambiente, has the aim to tell and deepen the already ongoing innovation in the production of recycled aggregates.

RECinert® Project, promoted by S.O.A. society since 2001, applies solutions for the treatment of inert waste, for the production of recycled aggregates and for the certification of these destined for road-building and environmental sectors. The project offers to companies in the construction-road sector, demolition and earth moving, its know-how for the implementation of CDW collection centers for the production of certified recycled

[11] For more details see the project website: http://www.snapsee.eu/

aggregates to handle in the Partnership Agreement, ensuring the essential services (design, start-up, training, transformation and product certification). During 2012 the company has adopted a specific product certification procedure of exclusive brand registered and enrolled in the Repertoire of the Recycling held by the Ministry of Environment (RI-inerte® - RECAL® - BITUMgreen®). These products, classified as recycled aggregates conform to ministerial standards to guarantee the obligations of the PA Green Economy in the field of "green purchasing" and of the limited use of natural resources in accordance with national and EU Directives, subjected to analysis of the life cycle, have gained recognition of an environmental label for construction sustainable (LCA®).

Gyproc Saint-Gobain, among the European Programm LIFE+, has developed **Gy.Eco Project** for the recycling of gypsum waste which, commonly, are sent in landfill. The project proposed, as an alternative to landfill, a recovery service of gypsum waste used for the production of Secondary Raw Materials (MPS). The project has enabled the development of a network of collection sites of waste gypsum and recovery plants. The quantities of waste gypsum that are recovered every year in Italy through GyEco, is equivalent to about 20% of the annual amount of waste gypsum.

This project led, in the course of 2015, the signing of a Memorandum of Understanding (MOU) between the National Association of Manufacturers Recycled Aggregates (ANPAR) and Gyproc Saint-Gobain, for the management of CDW gypsum. The MOU aims to:

- Offer to the building market alternative to disposal of gypsum waste in landfills;

- Promote products based on gypsum in the building market;

- Promote proper management of gypsum CDW, aimed at the recovery of the same waste.

14.4.2 Drivers / barriers to increase CDW recycling

Although the recycling of inert waste present a number of advantages:
• for public administrations and local authorities, which can safeguard the territory, increasing recycling and limiting recourse to landfill and the opening of new quarries of natural aggregates;
• For the construction sector, which can deliver its waste at recycling facilities at a lower cost than the use of landfills and, at the same time, supplies of materials that, with the same performance, have better prices than the natural materials;
• to environmental protect and human health safeguard;
there are still many obstacles which do not allow the sector to gain momentum and, therefore, become an active component in the circular economy mechanism.
In the following main barriers are analyzed:
- Distrust in the use of CDW derived products.
Although now recycled aggregates guarantee the same performance characteristics of natural aggregates used in road works, their origin from waste leads into potential user an

instinctive mistrust, based, unfortunately, on unlawful practices that occurred sometimes in the country;

- Lack of reliable data on the production of inert waste.

The absolute prerequisite for proper planning of inert waste management activities is the quantification of the produced volumes. In the case of CDW, and more generally of inert waste, such quantification is particularly difficult. The official production data of CDW provided by ISPRA are in fact only estimates and it is conceivable that there are still illegal practices;

- Lack of updated technical tools (Specifications tender)

Among the main reasons for the reduced mass production of recycled aggregates and dissemination of their use, may be counted the absence or deficiency of specific tools, such as special Specifications tender, updated with the harmonized European standards in the sector;

- The absence of "recycled aggregate" in the price lists of building works

The introduction of "recycled aggregate" in the price lists of the building works would help to facilitate use (a few are today the Chambers of Commerce that have been updated);

- Lack of source separation of waste and use of selective demolition practices

Traditionally the demolition in Italy does not provide for a special effort in the selection activities at the source of the various types of waste. On larger construction sites it tends to separate the dangerous component of waste (in particular materials containing asbestos and man-made vitreous fibers), the ferrous fraction and sometimes even the wood, while little is done on the remaining waste. CDW management Protocol drawn up by the European Commission DG GROW dwells on the need to identify the different types of waste by means of preventive audits, on the basis of which it is appropriate to draw up a plan waste management;

- Lack of taxation of mining

Among the economic instruments used mainly abroad to promote the market for secondary raw materials, it has an important role the tax on the extraction of virgin materials. In fact, the resulting increase in virgin materials cost would facilitate their use only for the applications where higher performance aggregates (eg. Concrete) are required, leaving to the recycled aggregates and to reused lands (treated or not depending on their characteristics) other applications (eg. road construction and fills);

- Lack of prohibition or obligation to contribute to the landfilling of inert waste

Another political tool, which has shown great effectiveness in the countries in which it was adopted, is the introduction, in national legislation, of the ban on landfilling of inert waste, which would favor the consequent development of recycling activities. Even the introduction of a tax on landfill would produce results through a more competitive recovery, although much would depend on the level of such fee;

- Requirement analysis performance for waste sent for recovery / recycling

The current regulatory framework provides for the obligation of performing the analyses for waste sent for recovery / recycling and the exemption for waste sent for disposal, with clear penalties for the recovery / recycling, particularly for the waste produced by micro renovations of civil building.

- Adoption of End of Waste criteria

The Waste Directive 98/08 / EC introduces the concept of End of Waste with the objective of setting technical and environmental criteria to determine when, downstream of certain recovery operations, a refusal ceases to be such and become a product no longer subject to waste legislation. The definition of precise and clear criteria should encourage the production of products recycled and reward those who invest more on the quality of its products. However, to date the End of Waste criteria, for waste from construction and demolition, have not yet been defined at European level and it is now clear that the intention of the Commission give freedom to that effect to the various Member States.

- CE marking

The relevant harmonized European standards for recycled aggregates are introduced, for several years now, the concept that products put on the market must be evaluated for their performance characteristics and not according to their nature. Only the CE marking of aggregates is able to ensure the end user on the characteristics of the material purchased. In a correct performance of the market, it is up to the user to request (in their intended function) minimum requirements for clusters, and to assure manufacturer. It is believed that if the designers and directors of the work, which provides the use of aggregates, they impose the accompaniment of the material with the required documentation (labeling and DoP), most of the problems in the market of recycled aggregates would be resolved.

14.5 CDW sector characterization

14.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

<u>CONCRETE</u>

Concrete waste can arise from different sources: returned concrete which is fresh (wet) from ready-mix trucks, production waste at a pre-cast production facility and CDW, which is the most significant source.

Main application of concrete waste is the production of recycled aggregates, which are commonly used:

- in the roads construction industry, in the underpinning or as filling in the detected, and

- for the production of new concrete for non-structural elements.

In the first case, the material is subjected to special treatment: iron removal, trituration, elimination of light fractions. The material that is produced is then used in road foundations: by the way has excellent characteristics because it gives the same stabilizing effect.

In the second case, instead, the product is obtained by trituration of the concrete. The aggregates thus obtained are used in place of those from natural rock and used for the production of construction elements in concrete.

BRICKS

Bricks are highly durable materials and they can be re-used after a building selective demolition, or otherwise they can be recycled into mix inert used as substrate for the construction of roads.

The re-use of post-consumer bricks is an expensive process as it needs preventive removal of mortar and plaster and often the percentage of material to be discarded because not cleanable, is high. Maximize and optimize the re-use of building materials can be planning the disposal of the building or its components in the initial project.

The recycling of production bricks scraps, is more prevalent: the factory waste are ground and used as "smagranti" in subsequent production cycles.

TILES AND CERAMICS

Tiles and ceramics waste are generally used, mix to other inert CDW, to produce recycled iner used in bound form or unbound: the aggregates are used "loose" or mixed with binders, to form mixed cemented or asphalt.

The prevailing use sectors relate to the construction of civil engineering soil works, of discovered bodies, environmental recoveries, of fills and filled, of road and railway works, of road, rail and airport foundations, of civil and industrial yards, of layers of foundation of the transport infrastructure, of the accessories layers with capillary function antifreeze and draining.

ASPHALT

The asphalt, recovered with milling, reusable products are of high technical features as part of the same road construction from which they come (wear layers and connection composed of natural stone aggregates and bitumen).

WOOD

Timbers are generally separated in the demolition phase, in order to be able to be re-used.

Otherwise, wood waste are separated during treatment process in plans and, if non contaminated, they could be used for energy recovery.

GYPSUM

Three sources of gypsum waste exist: production waste, construction waste and demolition waste.

Waste gypsum under CER 170802 "Building materials made from different plaster from those mentioned in 170801", consist essentially of gypsum plaster and drywall. These materials, although they represent a modest amount compared to the total CDW, are the focus of numerous issues, both from the environmental managers and producers.

Even though gypsum is considered to be "fully and eternally recyclable" by the gypsum industry, only production and construction gypsum waste is currently recycled. Recycling of gypsum products that are collected from demolition and renovation projects can be contaminated with other materials, such as paint, fastenings, screws, wood and insulation materials among others, which can render recycling difficult.

Quantitative analysis

The average composition of the CDW in Italy is dominated by the inert fraction, being constituted by 75-90% of aggregates (largely bricks and concrete, more sand, chalk and excavated earth), for 4-8% from plastic , wood, paper and cardboard; to 3-7% by metals. Regarding the composition of the inert fraction, the most reliable data are derived from detection of the types of inflow waste recycling plant: fragments of concrete mixes also reinforced, bricks, coatings and ceramic products, industry waste prefabrication of non-reinforced concrete, fragments of road and railway superstructure, cold milled asphalt, plaster, enticements, soil and excavation rocks. Ceramic materials account for about 45% of waste conferred in recycling facilities.

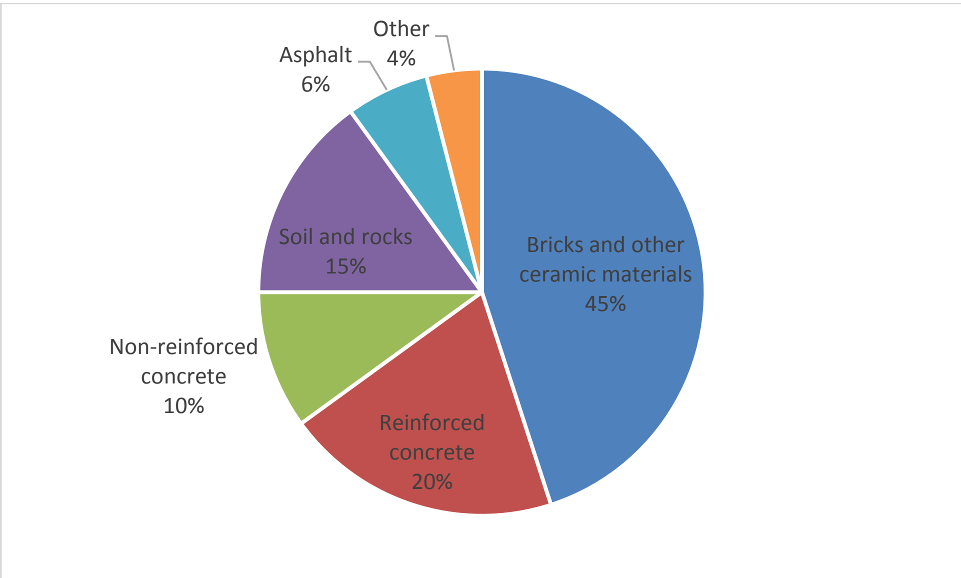

Figure 15. CDW Inert fraction composition at recycling plans – ANPAR 2012

In renovation, inside of which demolitions is more than 90%, almost exclusively bricks and other ceramic materials (remakes of roofs, displacement of internal partition walls, replacement of coatings, etc.) are produced. In the whole demolitions, instead, the concrete equals the percentage of bricks. Concrete represents 30% of the total debris, while the remaining 25% is made up of asphalt, soil and excavation rocks and other scraps.

Recovery techniques

As results from previous paragraphs, possible destinations for inert waste are:

• Recovery on site mobile plant

• Recovery of stationary treatment plant

• Disposal landfill for inert.

At recovery facilities, inert CDW and of those from other assets, are shredded and prepared for use in the construction industry. The CDW recovery plant should be able to split the incoming material basically into three streams:

- Re-usable stone material (95%);
- metal fraction (0.1%);
- Junk fraction (paper, plastic, wood, impurities, etc.).

Stationary plans are characterized by the greater complexity, due to the simultaneous presence of different grinding systems able to produce different particle sizes of material. Stationary plans are generally equipped with transport systems to tape the different fractions into defined areas of the plant.

As regards the plant organization, the layout must identify:

• waste, distinct from those entering the plant and those produced by;

• worked in the characterization pending before their final qualification of "Materia Prima Seconda" (MPS)

• secondary raw materials qualified as MPS after characterization;

• the placement areas of the equipment and used machinery;

• the movement areas (if present) of loading / unloading;

• the emission / discharge points.

The phases necessary to obtain a good quality product are:

- quality control of incoming material;
- Preliminary separation of the fine fraction, which is not relied upon to crushing;
- size reduction (crushing);

- separation of metals;
- refining;
- removing the light fraction.

Mobile plans, deriving from traditional crushing plants aggregate quarry and cost-effective in large scrap yards, typically have simple reduction in volume of the individual elements entered in the system; It is to be checked case by case basis, if with appropriate technological features, it can be ensured an adequate granulometric assortment of materials in output to the treatment, and the elimination of non-inert fractions. This type of system provides a substantial advantage as the ability to shoot down any shipping costs in the case of on-site reuse of the material to be used to grind, but it's necessary to review their product characteristics, in order of their reintegration in the production cycles.

Environmental and economic impacts of CDW waste management

In Italy CDW recovery has been in the past considerably slowed due to multiple factors, including: a territory very rich in natural building materials and cutting stones that have historically fed almost all of the requirements; the reduced cost for the landfill; a broadcast of interventions of micro-demolition; poor culture of recycling. However, even in Italy, on the basis of CDW production and management data of the last years, the percentage of the preparation for reuse and recycling of CDW appears more than 75% today.

To facilitate the market penetration of these important recycling products appears the approach of Green Public Procurement (GPP), or green purchasing for public works for which it will need to have the use of a significant percentage, more than 30 % of recycled materials. In this regard the "Minimum Environmental Criteria" are being developed at the Environmental Ministry, for purchases related to certain product categories including construction and maintenance roads, street furniture, construction: the supply of recycled materials will become so short decisive for the award of tenders in the public sector.

The current recycling management requires, always more often, the selective separation of waste in the demolition phase, the collection and temporary storage, and the transport to the treatment plans and CDW process for the production of recycled inert materials. Sorting and recycling provide an important alternative to the traditional landfill and an obvious choice in terms of environmental sustainability.

From the comparative analysis of the recycle processing operations with respect to the processing of natural aggregates, it is possible to identify an obvious environmental advantage, connected to an increasingly widespread practices of CDW recovery and recycling, summarized in the following points:

- A significant reduction of the exploitation of non-renewable raw materials, replaced for multiple fields of application of recycled aggregates with equal technical performance,

- A reduction of energy consumption, water and CO_2,

- Reducing the ecological footprint for specific construction waste such as ceramics, mortar, concrete and bricks,

- An improvement of an increasingly important factor in economic and environmental terms as the ''land use": the increase in the CDW recycling rates allows for a significant limitation of the landfill contributions by making the potential use of portions of territory to the noblest purposes.

Increasing the percentages of recycled material means contribute substantially to the slaughter of the impacts and an overall enhancement of natural resources with a view to better and better environmental sustainability and economic opportunity in full compliance with the Community objectives.

Drivers / barriers to increase recycling

See Section 14.4.2

14.5.2 Recycled materials from CDW

D.M. 2/5/98 (as amended by Decree of 4/5/06 n.186) contains all the instructions for carrying out the CDW recovery activity in a simplified regime. In particular, paragraph 7.1.4 specifies what may be the characteristics of raw materials and/or obtained products: secondary raw materials for the construction industry with characteristics according to Annex C of the Circular of the Minister of Environment and Territory Protection of 15/07/2005 n.5205, depending on their intended use:

C1: Body of detected;

C2: road foundations;

C3: layers of foundation (of the transport infrastructure and of civil and industrial yards);

C4: environmental recoveries, fills, filled;

C5: layers accessories having antifreeze functions, capillary, drainage, etc..

The parameters that give more problems and affect the quality of the final products are:

• Quality of fine fractions (it is estimated by the sand equivalent): the presence of dirty fine fractions, such as silt and clay, responsible of plastic behavior of the mixture;

• shape index: presence of elongated granules;

• resistance to fragmentation (Los Angeles test): presence of soft elements, such as eg. the bricks, important parameter for the determination of the variability of the particle size of the recycled material.

Most of the recycled building products, obtained from the recycling of polymers, rubber, glass, paper, wood and aggregates consists of coatings for floors and for thermal and acoustic insulation and of vertical closures coatings. The construction market offers a large number of recycled products, which tends to grow steadily over time.

With regard to aggregates for concrete, to the above must be added the stipulations contained in D.M. 14/1/2008 "Approval of new technical standards for buildings".

14.5.3 Market conditions / costs and benefits

No data found

15. LATVIA

15.1 Legal Framework – Waste Management Plans and Strategies

15.1.1 National Legislation concerning CDW

In Latvia, policy planning regarding waste management is carried out at national and regional level.
Current national legislation on waste in generally are:

- **Latvian Waste Management Act**, which transposed at national level the Waste Framework Directive, entered into force the 18 November 2010. The document includes issues like the distribution of competences and all requirements regarding the establishment, management, closure and recultivation of landfills and dumps. It includes the prohibition of illegal dumping;
- **Law on Waste Management** (01.03.2001., Amendments 13.03.2008.), which includes: definitions, objectives, exclusions, classification of waste, waste management hierarchy, waste management permits and inspections, competencies/roles of state and municipal authorities, waste trans-boundary movements (imports/exports), etc..

About CDW, up today, there are no specific national legislation.

15.1.2 Waste management plans (WMP) and Strategies

Waste management purposes are included in the following national planning documents:

- **Sustainable Development Strategy of Latvia to 2030** (approved by the LR Saeima on 10 June 2010);
- **Latvian National Development Plan 2007-2013** (Regulations of the Cabinet of Ministers No. 564 "Regulations Regarding the Latvian National Development Plan 2007-2013" of 4 July 2006);
- **Latvian Strategic Development Plan 2010-2013** (approved by the ordinance of the Cabinet of Ministers No. 203 of 9 April 2010) as well as the Basic Guidelines for Environmental Policy 2009-2015 (approved by the ordinance of the Cabinet of Ministers No. 517 of 31 July 2009);
- **Environmental Policy Strategy 2009-2015**, adopted in 2015, and prioritizing a new financing model for the use of revenue from the natural-resources tax, creating a deposit system for waste management, improving standards in waste-water management, and improving research and development capacities.
- **Waste Management State Plan 2013-2020**, adopted in 2013 and subjected to a review in 2017. The waste prevention programme is a part of the waste management plan and therefore it will be revised at the same time. The effectiveness of the measures in the national waste prevention programme will be evaluated according to the following quality indicators:

- ✓ the impact of waste prevention measures on waste generation and on the waste producers (sociological assessment);
- ✓ the potential reuse of waste.

15.1.3 Legal framework for sustainable management of CDW

Low on Waste Management provides favorable conditions for sustainable management of CDW, in terms of separation collection and management of hazardous waste form construction and demolition operations.
In 2008 the Ministry of Environmental Protection and Regional Development has developed "Guidelines on promotion of green procurement in state and municipal institutions" and "Guidelines on promotion of environmentally friendly construction", according to the Green Public Procurement.

15.1.4 Targets

No specific target are sets for CDW by the State Waste Management Plan. Only the Latvian regulation n.598 of the Cabinet of Ministers establishes "Reuse, recycling and material recovery of at least 75% of construction and demolition waste by weight, including backfilling".

15.1.5 End of Waste (EoW) status

According to the European Commission report "Support to member states in improving waste management based on assessment of member states' performance", provisions about the EoW principle are outlined in the Latvian Waste Management Act of 18 November 2010, although no complimentary information was identified.

15.2 Non legislative instruments (best practices, guidelines, recommendations…)

On June 8 2010, the Latvian construction company RE&RE in close cooperation with the charity Zaļās mājas (The Green Home) and the most active supporters of the sustainable construction practices, among other Knauf, Ramirent, Saint-Gobain, a letter of intent to establish an organization to facilitate the sustainable construction practices in Latvia. The purpose of the establishment of organizations is to provide qualitative and lasting instruments intended exclusively for the issues of the sustainable construction and for implementation and maintenance of the Latvian adaptation the BREEAM Europe Commercial system of the assessment and certification.
The main action lines of the organization shall be the raising awareness regarding the sustainable construction practices, related educational issues, maintenance of the Latvian System for Assessment and Certification of Sustainable Construction (i.e., the Latvian adaptation of BREEAM), as well as local and international cooperation to facilitate the development of the sustainable construction practices in Latvia.

The established set of guidelines considers full lifecycle of architectural objects: starting from planning, blueprinting and constructing to dismantling or remodelling of a particular unit. It centres on sustainable development, for example, by laying down the principles of how to determine the environmental friendliness as well as social and economic viability of buildings, construction processes and maintenance.
There are already plans for a second edition of the document, in the preparation of which a wider range of public and professional bodies will be thoroughly involved.

Among the main principles highlighted by the working group for sustainable construction and maintenance, there are:
- conscientious utilisation of environmentally friendly sources of energy;
- use of environmentally friendly, harmless types of materials and other resources;
- efficient use of water;
- prudent methodology of land use planning for neighbourhoods, residential districts, clusters of office blocks, etc.;
- area improvement and landscaping;
- optimum architectural and structural solutions;
- introduction of buildings that promote the health and well-being of their inhabitants;
- the need to decrease harmful emissions and to handle waste efficiently.

15.3 CDW management performance – CDW data

15.3.1 CDW generation data

EUROSTAT database reports the data reported in Table 53 for CDW generated between years 2010 and 2014.

Table 53. EUROSTAT CDW generation data.

	2010 [tons]	2012 [tons]	2014 [tons]
Mineral waste for construction	18.498	4.492	452.236
Metal wastes, ferrous	202	1.02	326
Metal wastes, non-ferrous	0	0	4
Glass wastes	4	0	17
Plastic wastes	0	0	43
Wood wastes	0	455	30
Total	**21.551**	**7.509**	**454.281**

However, DELOITTE factsheet reports that data availability and reliability is an issue in Latvia and this data may not necessarily reflect the current situation in Latvia. In June 2015, the Latvian Environment, Geological and Meteorological Centre has started undergoing discussions with EUROSTAT regarding the validity of reported figures over the past years. As this review is not yet completed and data is not yet available, data cross-checking for these figures is not possible at the date of the current study.

15.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 40.

Table 54. EUROSTAT database for "Mineral waste from construction"

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	13.441	6.708	9.588
Deposit onto or into land	13.441	6.708	9.588
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	0	0
Incineration / energy recovery (R1)	0	0	4
Recovery other than energy recovery	133.271	148.615	103.839
Recovery other than energy recovery - backfilling	0	0	11.298
Recovery other than energy recovery - except backfilling	133.271	148.615	92.541
Total waste treatment	**146.712**	**155.323**	**113.431**

15.3.3 CDW exports/imports data

Importing construction waste from other countries of the European Union is allowed only for regeneration purposes. No construction and building demolition waste is brought into Latvia from other countries for regeneration. According to the Latvian Environmental, Geological and Meteorological Centre, in practice, Latvia imports CDW from their Baltic Member State neighbors, in particular Lithuania.

15.3.4 CDW treatment facilities data

According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", In Latvia there are no landfill for inert waste, while there are 11 landfill for non-hazardous waste and 2 landfill for hazardous waste.

15.3.5 Future projections of CDW generation and treatment

Future projections of CDW generation and treatment do not exist on the national level, in large part because the existent data is not reliable in its current stage to draw up projections.

15.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

15.4 C&D waste management in practice

15.4.1 CDW management initiatives

See paragraph 15.2

15.4.2 Drivers / barriers to increase CDW recycling

Main obstacles to sustainable CDW management are:
- Absence of C&D Legislation
- Poor of national data transparency and reporting
- Lack of national resources for CDW development
- Lack of deterrents aimed at landfilling
- Underdeveloped market for recycled CDW (aggregates)
- Lack of communication on CDW management practices.

Main drivers are:
- EU-funding for CDW projects
- Tighter enforcement on illegal dumping and the introduction of stricter landfill costs
- Better communication on CDW management practices
- Incentives towards favourable use of recycled aggregates.

15.5 CDW sector characterization

15.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

CDW is referred to as waste from construction, renovation and demolition, as well as debris and damaged materials resulting from the construction process, or materials used in the construction site temporarily. Usually the construction waste from residential buildings contains concrete, wood, metal, plaster panels, oil, chemicals and roof trim materials.

Quantitative analysis

See paragraph 15.3.1

Recovery techniques

To ensure a quality construction waste recycling process, the owner of the construction waste must sort such as follows:

- separate other household waste and hazardous waste, including asbestos;
- concrete and reinforced concrete constructions (larger than 100x70 cm, thickness of up to 30 cm);
- concrete and reinforced concrete constructions (larger than 100x70 cm, thickness from 30 cm to 70 cm);
- concrete and reinforced concrete constructions (larger than 100x70 cm, thickness exceeding 70 cm) as well as all T-shape and double T-shape beams;

- all types of construction waste (smaller than 100x70x30 cm) by sorting them.

Owners and carriers of the construction waste are strictly prohibited to remove and store away construction waste in household landfill sites and the managers of the household landfill sites are prohibited from accepting such. In the construction waste recycling company the delivered construction waste is weighted and the type of construction waste is registered by filling in the form "Construction waste acceptance waybill" delivered by the cargo carrier; two copies of which shall be retained by the carrier. The construction waste recycling company is entitled to handle the construction waste after weighing the waste and accepting it for recycling. The construction waste carrier must deliver the "Construction waste acceptance waybill register" to the Environmental Department monthly, by the 15th date of the following month. If the construction waste recycling company refuses to accept the construction waste due to its low quality or any other reason, such shall be confirmed by an entry in the construction waste acceptance waybill by specifying that it is permitted to take the construction waste to the household landfill site for storing away.

When construction waste is accepted for storing away in the household landfill site, the construction waste acceptance waybill containing the entry by the construction waste recycling company regarding its refusal to accept the construction waste for recycling shall be required. One copy of the construction waste acceptance waybill shall be left with the person accepting such cargo at the landfill site.

If the construction waste delivered to the construction waste recycling company or the household landfill site contains substances hazardous to the environment and human health, the construction waste shall be returned to the supplier to handle, according to the provisions of Part One of Section 14 of the Law of the Republic of Latvia "Waste Management Law".

Environmental and economic impacts of CDW waste management

No data found

Drivers / barriers to increase recycling

See paragraph 15.4.2

15.5.2 Recycled materials from CDW

DELOITTE factsheet reports that the most commonly used recycled material from CDW are metals, because of their relatively easy reintegration via closed loop recycling. Bricks, glass and concrete is usually backfilled or landfilled (depending on quality), while wood is used for recovery via incineration.

15.5.3 Market conditions / costs and benefits

There are currently no types of financial incentives to recycle CDW. Therefore, drivers towards better CDW management and market conditions for recycled CDW such as: End-of-Waste criteria, EPDs, GPP, etc. is either underdeveloped and poorly communicated to relevant actors, or inexistent.

16. LITHUANIA

16.1 Legal Framework – Waste Management Plans and Strategies

16.1.1 National Legislation concerning CDW

Main National Legislation in Lithuania are:

- **Law on Waste Management** of 16 June 1998, Nr. VIII-787, with last amendments in 2011, which transposes the Waste Framework Directive;
- Order of the Minister of Environment No D1-367 on the **Requirements on waste generation and management account**, adopted 3/05/2011;
- **National Strategic Waste Management Plan** for the period of 2014-2020, approved by the Resolution of the Government of the Republic of Lithuania, with the last amendments in June 2016;
- **Requirements for regional and municipal waste management plans** approved by the order of the Minister of Environment No D1-1004 and adopted 16/12/2010;
- Order of the Minister of Environment No 699 on the **Environmental Protection Requirements for Waste Incineration**, adopted 31/12/2002 with the last amendments on 14 October 2011;
- Order of the Minister of Environment No 217 on the **Rules on Waste Management**, adopted 14/07/1999 with the last amendments on 3 May of 2011;
- Order of the Minister of Environment No. 444 on the **Rules on Construction, Operation, Closure and Care after closure of Landfills of Waste**, adopted 18 October 2000, as amended;
- **National Waste Prevention Programme**, adopted in 2013.

16.1.2 Waste management plans (WMP) and Strategies

The main objectives of the National Waste Management Plan are:

- to prevent the effects of waste pollution by the recovery of material and energy;
- to ensure a waste management framework that would address the issues of the general population, guarantee environmental quality and agree to the standards of market economy;
- to set waste management targets, action plans and evaluation measures, in order to implement WFD in the required time frame.

16.1.3 Legal framework for sustainable management of CDW

Waste management legal framework in Lithuania has been strengthened since the 2000's and in 2006, the order by the Minister of Environment No. D1-637 "For the rules of construction waste management" set requirements for construction and demolition waste management. Waste quantities, waste codes and waste treatment activities shall be indicated. Rules clearly indicate requirements for the records on CDW on site. It is also indicated the strict obligation to establish separate collection of municipal solid waste, inert waste (concrete, bricks, ceramic and others), recyclable waste (packaging, paper, glass, plastic and others), hazardous waste and non-recyclable waste. Non-hazardous waste can be temporarily stored on site for one year, and hazardous waste - for 6 months. The builder must provide the documents of waste transportation to an appropriate waste treatment facility for the commission which evaluates the quality of building at the time of works have been finished. Requirements of waste shredding, reuse of waste on site, waste transportation, recovery and disposal are also set in the rules as well as specific requirements for management of asbestos waste.

16.1.4 Targets

The National Waste Management Plan states:
"CDW management system should be organized by the way to ensure that by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight."

16.1.5 End of Waste (EoW) status

There is no EoW criteria established in Lithuania for CDW stream. There is a direct use regulation for metals, scraps, glass and copper.

16.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non legislative instruments that contribute to create conditions for a sustainable management of CDW is BREEAM certification. In November 2016 the second international conference Green Buildings – Vilnius 2016 took place, with the aim to helps investors, developers, design and construction teams and occupiers to use natural resources more efficiently.

16.3 CDW management performance – CDW data

16.3.1 CDW generation data

EUROSTAT database reports the data reporting in Table 55 for CDW generated between years 2010 and 2014.

Table 55. EUROSTAT CDW generation data.

	2010 [tons]	**2012 [tons]**	**2014 [tons]**
Mineral waste for construction	227.330	313.056	392.140
Metal wastes, ferrous	10.904	12.192	17.231
Metal wastes, non-ferrous	387	76	288
Glass wastes	310	188	77
Plastic wastes	132	1.921	211
Wood wastes	5.101	2.084	1.765
Total	**356.772**	**419.136**	**434.737**

16.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 40.

Table 56. EUROSTAT database for "Mineral waste from construction"

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	86.034	52.591	44.989
Deposit onto or into land	86.034	52.591	44.989
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	25	227	13
Incineration / energy recovery (R1)	0	0	0
Recovery other than energy recovery	234.810	404.445	530.431
Recovery other than energy recovery - backfilling	0	66.113	113.364
Recovery other than energy recovery - except backfilling	234.810	338.332	417.067
Total waste treatment	**320.869**	**457.263**	**575.433**

16.3.3 CDW exports/imports data

No data found.

16.3.4 CDW treatment facilities data

According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", In Lithuania there are 3 landfill for inert waste, while there are 11 landfill for non-hazardous waste and 0 landfill for hazardous waste.

Even if those are the official data reported by EUROSTA, in Lithuania there are more than seven hundreds of landfills, six hundreds of them being less than 1 ha. Most landfills, especially small ones, are illegal. CDW is disposed in such landfills, particularly in those situated a bit further from big towns, however, to evaluate the disposed quantities is almost impossible, because the waste quantity and class in these landfills are not registered in the National Waste Accounting Database. However, in the National Strategic Waste Management Plan it is planned to close all landfills which fall short of the environmental requirements and to manage waste by regional principle. It is planned to establish ten regional non-hazardous landfills and one hazardous landfill where disposing inert CDW will be prohibited. However, presently most of CDW is still disposed in the household waste landfills.

16.3.5 Future projections of CDW generation and treatment

Two scenarios can be seen in the future household CDW waste management system: to organize inert waste landfills and to deliver CDW to recycling companies, taking into consideration that until 2012 in Lithuania it is expected to manage the waste regionally, while disposal of inert CDW in new landfills will be prohibited. In this case, an adequate system of CDW collecting needs to be established. A CDW collecting system located far away from recycling companies could be integrated into a regional waste management system. In this case, separate sites for inert CDW should be organized at the Waste Transfer Stations (WTS). Two scenarios are possible: CDW collected in the station would be transported to recycling companies or mobile crushing equipment should be used, i.e. the waste would be treated in WTS. It is important to evaluate the forecast CDW amounts in each WTS territory, the distances between recycling companies, demand of recycled products in WTS regions, etc. he system should be evaluated not only in the economic, but also in environmental aspects (e.g., the influence of transportation on air pollution, etc.).

16.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

16.4 C&D waste management in practice

16.4.1 CDW management initiatives

See paragraph 16.2

16.4.2 Drivers / barriers to increase CDW recycling

In Lithuania, it is not profitable to recycle CDW. Three main problems are defined in the CDW management system in Lithuania. There are illegal disposal, insufficient sorting of CDW at source and unlimited landfilling. The landfill and recycling company waste management costs differ only 2 times. This could be one of the most practical reasons why CDW is disposed in landfills. In fact, the average difference between sorted and unsorted waste costs in Lithuania is a little higher; however, more important is the difference of costs of waste management in landfills and in recycling companies.

16.5 CDW sector characterization

16.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Lithuanian CDW system is structured, with two CDW streams from different sources – domestic and industrial construction and demolition activities. The household waste stream comprises about 7% of the total CDW stream. Municipalities are responsible for household CDW management and industrial waste producers are responsible for their own waste management.

The composition of construction and demolition waste may be different, depending on a building being demolished. When constructions of unfinished buildings are demolished, demolition waste consists of concrete, metal, ceramics. In case the old buildings, that are not rehabilitated and cannot be exploited, are demolished, demolition waste of these buildings demolished consists of concrete, ceramic bricks, tiling or slating, wood, thermal insulation materials, metal and various finishing materials.

Quantitative analysis

See paragraph 16.3.1

Recovery techniques

Two main reprocessing methods are employed during the reprocessing of buildings' demolition waste:

(1) Waste reprocessing in concrete breakstone production line or in a special site;

(2) Waste reprocessing at a location where waste is created, i.e., at a construction site or at location where building is being demolished.

Despite the type of a building being demolished and reprocessing method, main reprocessing stages of thendemolition waste are the same: initial preparation of construction and demolition waste, crushing, sorting, metal separation, initial sieving, milling, metal separation, sieving. During demolition of the buildings, excavators, hydraulic alligator shears, metal separation aggregates are used most often. After the demolition works waste is reprocessed by employing special equipment used for the milling and sorting. Shredders, milling machines, magnetic separators, sieving machines as well as air separators, that separate thermal insulation materials, wallpaper and other impurities from concrete pieces, are used in reprocessing processes. After thorough implementation of all breakstone production stages, coarse and fine aggregates of various fractions are obtained.

According to the European legislation, in Lithuania, the recycling technologies may be of tree levels:

- level 1: mobile crusher and sieving plant;
- level 2: level 1 plus metal removal and more complex sorting/sieving;
- level 3: level 2 plus hand sorting, washing plant and facilities for other CDW streams (wood, etc.).

Recycling technologies used in Lithuania could be attributed to various levels.

In Lithuania there are companies, such as JSC "Bionovus", JSC "Vaidva", that provide services not only for the demolition of various buildings, for the collection as well as reprocessing of construction waste, but also sell the breakstone produced from the demolition waste.

JSC "Aviridis" (technologies of level 3) accepts all CDW of Waste Catalogue code 17, i.e. not only inert, but also wood, plastic, glass, hazardous (asbestos and others) waste. The JSC "Bega", JSC "Mitnija", "Visagino statybininkas" use semi-mobile crushers with a magnetic metal separator, which could be classified as a second level. The other companies use level I technologies when mobile equipment is used to recycle only inert CDW. Consequently, 90% of recent recycling technologies in Lithuania are used only to manage more or less sorted inert CDW.

Collection service is another important aspect of recycling. Only one of the recycling companies (JSC "Aviridis") provides such services. Most collectors are the companies, managing household landfills. They are renting containers to collect CDW. All CDW covered by code 17 are collected in one container, therefore recycling without special sorting is impossible. It is one of the factors stimulating CDW landfilling.

Environmental and economic impacts of CDW waste management

No data found

Drivers / barriers to increase recycling

See paragraph 16.4.2

16.5.2 Recycled materials from CDW

CDW in Lithuania are treated to obtain coarse and fine aggregates of various waste fractions. These aggregates, depending on their fraction, are used for the construction of passages and roads, passing ways, sidewalks, as well as for the manufacturing of new construction products.
The most popular and the most expensive breakstone is produced without small fractions, because for the production of this breakstone additional production stages are required, such as cleaning and separation from fine and very fine particles, and this requires additional energy consumption. However, nowadays in Lithuania crushed concrete is utilized only for the base of motorways.

16.5.3 Market conditions / costs and benefits

The analysis has shown that the technological recourses in Lithuania can be used to recycle sorted inert CDW. To install the level III recycling centres where all sorts of CDW are accepted, big investments are needed. To install such a site costs 10 times more than to buy a good mobile crushing equipment. Besides, the sorting of CDW at recycling sites is less favourable (by waste management hierarchy) to the environment than sorting CDW at the source. Therefore, the system's improvement should be concentrated not to establish new recycling companies or recycling sites, but to increase the capacity of existing private recycling companies, stressing the importance of separate sorting and collection and the control of illegal disposal.

17. LUXEMBURG

17.1 Legal Framework – Waste Management Plans and Strategies

17.1.1 National Legislation concerning CDW

Main CDW National Legislation in Luxembourg are:

- **Law on Management of Waste** (LMW) n.24 of 21 March 2012, which transposed the WFD in Luxembourg law. Particularly, as reported in DELOITTE Factsheet, the Article 26 "Inert Waste, Construction Waste and Demolition Waste" forecast:
  - ✓ Obligations to prevent generation of waste prior to a construction operation (Par. 1)
  - ✓ Building site waste must be collected selectively "to the extent possible" and in case that it is collected in mixed form, it must be submitted to sorting (Par. 2) these obligations apply to works executed by physical persons as long as they are "feasible" (Par. 4)
  - ✓ Obligation to carry out a pre-demolition audit: Prior to any demolition, materials used in the building to be demolished must be identified and listed in a pre-demolition inventory. The inventory must precise selected collection of each material and corresponding treatment in line with waste hierarchy. Contamination by other materials must be avoided. Particular attention must be paid to dangerous substances (Par. 3). These obligations apply to works executed by physical persons as long as they are "feasible" (Par. 4).
  - ✓ Municipalities are obliged to set up infrastructure for selective collection of building site wastes, in particular construction and demolition wastes.
  - ✓ Reuse of collected inert wastes is mandatory in public tender facets relating to construction of roads and other buildings (Par. 7)
  - ✓ A Grand-Ducal regulation can define quality norms for material coming from recycling of inert wastes. These norms may vary according to different use of those materials (Par. 8)
  - ✓ Waste disposal is carried out exclusively within the network of regional landfills. This network is established in compliance with the General Waste Management Plan and the corresponding Sectoral Directive Plan. Other landfills are forbidden (par. 9a)
  - ✓ Regional landfills must be equipped with infrastructures allowing recycling of recoverable inert waste (Par 9b)
  - ✓ The Sectoral Directive Plan on Inert Waste provides that inert waste must be disposed of at the closest landfill to the building site
  - ✓ Authorisation and registration obligations of companies or bodies that collect or transport inert waste from road works, excavation and demolition works (Article 32).
- The Grand-Ducal Regulation of 24 February 2003 on landfilling of waste, as amended.26 The Regulation transposes the 1999 Landfill Directive and notably:
  - ✓ Sets out criteria and procedures for admissibility to landfilling of inert waste;
  - ✓ Prohibits landfilling of inert wastes containing hazardous substances in significant quantities;
  - ✓ Provides distinction between landfilling and backfilling (see detail in 2.4).

17.1.2 Waste management plans (WMP) and Strategies

In 2010, Luxembourg adopted a **General Waste Management Plan** (Plan général de gestion des déchets).
About CDW, Chapter 24 "Construction site waste" covers three categories of waste: inert waste (including construction and demolition waste), assimilated waste (including packaging) and hazardous waste; Chapter 23 covers "Inert Waste" and concentrates on construction and demolition waste.
Luxembourg used the term "inert waste" to designate "non-
The **Sectoral Directive Plan on Inert Waste** provides that inert waste must be disposed of at the closest landfill to the building site.
Luxembourg's **Waste Management Act** of the March 21st 2012 was implemented in 2012 and lastly modified in December 2014. It is the main act transposing the requirements of the WFD into domestic law. Nearly all requirements of the WFD have been directly transposed into national legal
requirements.
The **Waste Prevention Program** of 2010 establishes, for Inert waste (construction and demolition waste) that "the prevention of inert waste can be achieved through reducing construction activities
(e.g. through restrictions on the construction of certain structures such as garages and control rooms, utility rooms and general services rooms) and by integrating waste management considerations into the planning phase".

17.1.3 Legal framework for sustainable management of CDW

The Law on Management Waste provides:

- Obligation of sorting on site, at national level
- Obligation of provide facilities to collect separately CDW, at municipal level
- Reuse of collected inert wastes is mandatory in public tender facets relating to construction of roads and other buildings.

17.1.4 Targets

Luxembourg's objective for 2020 is 70% recovery, the same as in the EU directive.

17.1.5 End of Waste (EoW) status

The Law on Management Waste of 2012 (LMW) defines "end-of-waste" status exactly in the same words ad the Waste Framework Directive (WFD).
In application of the possibility given to Member States by the WFD, the 2012 LMW provides that Grand-Ducal regulations can precise criteria on when certain substances or objects cease to be waste (article 7 par. 2 of the 2012 LMW) and, unless abovementioned regulations have been taken, decisions can be taken on a case-by-case basis, deciding that certain substances or objects cease to be waste (article 7 par.2 of the 2012 LMW).

As of today, no specific regulations précising criteria for end-of-waste for specific materials have been identified in Luxembourg, apart from EU regulations on that issue (that are directly applicable in Luxembourg).

17.2 Non legislative instruments (best practices, guidelines, recommendations…)

The **SuperDrecksKëscht®** in Luxembourg are activities and campaigns of the Ministry for Sustainable Development and Infrastructure, the Chambre des Métiers (Chamber of Trade) and Chambre de Commerce (Chamber of Commerce) regarding the national waste management. The SuperDrecksKëscht® is a trademark which was developed within the frame of the waste management obligations of Luxembourg. The orientation is based on the strategy provided by the EU with the hierarchy prevention before preparation for re-use, before recycling, before any other use (as for instance energetic use), before disposal of waste. The task of the SuperDrecksKëscht® consists in using and implementing the most recent information in order to achieve a sustainable high-quality material management in the ecological and economic sense. Carrying out these tasks allows showing the lead in the ecological restructuring of our society.
SuperDrecksKëscht label is attributed also to construction sites which are managed according to the waste prevention and management rules of SuperDrecksKësch: These construction sites are accompanied and audited by counsellors of SuperDrecksKëscht.

17.3 CDW management performance – CDW data

17.3.1 CDW generation data

EUROSTAT database reports the data reported in Table 57 for CDW generated between years 2010 and 2014.

Table 57. EUROSTAT CDW generation data.

	2010 [tons]	2012 [tons]	2014 [tons]
Mineral waste for construction	556.095	523.346	521.386
Metal wastes, ferrous	7.054	7.817	2.238
Metal wastes, non-ferrous	452	987	280
Glass wastes	1.235	802	1.867
Plastic wastes	1.194	1.708	2.035
Wood wastes	13.088	15.334	16.033
Total	**8.866.757**	**7.079.473**	**5.979.254**

Most of the CDW in Luxembourg is constituted by excavation material, like soils and rocks.

17.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 58.

Table 58. EUROSTAT database for "Mineral waste from construction"

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	10.749	7.012	8.494
Deposit onto or into land	10.749	7.012	8.494
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	0	0
Incineration / energy recovery (R1)	0	0	0
Recovery other than energy recovery	528.548	517.516	488.214
Recovery other than energy recovery - backfilling	15.000	0	78.659
Recovery other than energy recovery - except backfilling	513.548	517.516	409.555
Total waste treatment	**539.297**	**524.528**	**496.708**

17.3.3 CDW exports/imports data

The only data found are those listed in the DELIOTTE Factsheet.
It reports that Luxembourg exports an important part of its CDW. In 2012, the country exported 386 345 tons of CDW. The quantities of exported non-hazardous and hazardous CDW are almost the same, around 190 000 tons and 197 000 tons. The contaminated soils (category 17 05 03*) represent the majority of exported hazardous CDW: 174 100 tons.
Luxembourg imported 57 772 tons of CDW, among which aluminium (17 04 02) and iron and steel (17 04 05) are the most imported materials. Luxembourg imports very small quantities of hazardous CDW (less than 2 000 tons in 2012).

17.3.4 CDW treatment facilities data

According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", In Luxembourg there are 12 landfill for inert waste, while there are 2 landfill for non-hazardous waste and 0 landfill for hazardous waste.

17.3.5 Future projections of CDW generation and treatment

No data found.

17.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

17.4 C&D waste management in practice

17.4.1 CDW management initiatives

See paragraph 17.2

17.4.2 Drivers / barriers to increase CDW recycling

The use of CDW recycled materials are not much diffused in Luxembourg. Generally, CDW are treated to obtain recycled aggregates, but they contain a certain degree of impurity, which changes from one construction site to another.
Furthermore, improved sorting and washing seems to be material-intensive and cost-intensive which leads to the inefficiency of the recycling process. There is a very low profit margin with the present processes. Besides, the limited quantities of material available in Luxembourg make it difficult to improve the processes and stimulate research in this field.
Finally, in the last centuries, Luxembourg's growth and wealth was driven by the steel industry and large reserves of blast-furnace slag, which are by-products from the steel production processes, had been made.

17.5 CDW sector characterization

17.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Among all the CDW materials, concrete represents approximately 30% of total amount of CDW. This amount of concrete waste is the quantity of recyclable concrete.

Additionally, currently in Luxembourg, for concrete waste, there is a high tendency of downcycling of concrete waste for use in road construction, foundation and substructure construction.

In the last decades, Luxembourg profited from these reserves for use in road and railway construction, but they are almost entirely spent. Therefore, the recycled concrete aggregates are used as slag replacement in road and foundation construction, drainage system, etc.

Most of glass waste in CDW is recovered by recycling industries, either to produce glass or isolation materials, while wood coming from the construction sector is sorted and recovered, either recovered through energy recovery or in cogeneration with pellet production.

Quantitative analysis

See paragraph 17.3.1

Recovery techniques

No data found

Environmental and economic impacts of CDW waste management

No data found

Drivers / barriers to increase recycling

See paragraph 17.4.2

17.5.2 Recycled materials from CDW

Main recycled materials from CDW in Luxembourg are recycled concrete aggregates.
The quality of the recycled concrete aggregates generated in Luxembourg depends on several factors.
In Luxembourg, its origin is mainly from demolition of buildings, thus already the initial material is not pure concrete demolition and it has a considerable rate of contamination. Its minor constituents are bricks, tiles, ceramics, soils, gypsum, insulating material, timber, metals, etc. Considering these constraints, the recycled concrete in Luxembourg has an average quality.
The recycled concrete aggregates have to submit a certification of adequacy delivered by an organization approved in the framework of the directive 'Beton mit rezykliertem Zuschlag' from DAfStb (Deutscher Ausschuss für Stahlbetonbau; engl. German Committee for Structural Concrete).
In general, the following are the fields of application for recycled concrete aggregates in Luxembourg:

- Huge quantities are used in road constructions and foundation and substructure construction.
- Slight, minor quantities are used for the base or fill for drainage structures or piping systems. They are used to replace sand and gravel for the levelled assembly of extern piping of various systems.

17.5.3 Market conditions / costs and benefits

Currently, there are no state/legislation incentives to recycling. Construction companies do not benefit from any state aids or financial support from the state in exchange for recycling.
Yet, it is less expensive for companies to sort materials (and recover them) than not to do so. In fact, the treatment of waste represents a cost for the construction companies. The current market prices provide both incentives to prevent waste generation and for sorting waste that has been produced, as follows:

- Incentive to prevent waste generation: The price is based on the quantity of waste (volume/weight); the less waste is produced, the less the construction company pays to the waste treatment company ("déchetterie")

18. MALTA

18.1 Legal Framework – Waste Management Plans and Strategies

18.1.1 National Legislation concerning CDW

The Waste Regulations (L.N. 184 of 2011) [210], which implement the EU Waste Framework Directive (2008/98/EC) [211] in Maltese Law is still in effect. Everything included in this directive is valid for Malta and provides the legal foundation for CDW management.

Further applicable laws include:

- Legal Notice 168 of 2002 focusing on Waste Management (Landfill) Regulations
- Legal Notice 382 of 2009 focusing on Deposit of Waste and Rubble (Fees) (Amendment) Regulations
- Legal Notice 344 of 2005 focusing on Abandonment, Dumping and Disposal of Waste in Streets, and Public Places or Areas Regulations
- Legal Notice 295 of 2007 focusing on Environmental Management Construction Site Regulations
- Approved Supplementary Planning Guidance concerning inert waste disposal in quarries.

18.1.2 Waste management plans (WMP) and Strategies

The Waste Management Plan (WMP) is still in place for the Maltese Islands (2014-2020), which takes a resource management approach. There is a separate section for CDW which analyses the current situation and sets future targets. A Waste Prevention Plan (WPP) was also created, with an extensive section concerning the prevention of CDW.

A strategic document specifically targeting CDW released by the Maltese government is 'Recycling of Construction and Demolition Waste in Malta – Strategy for short-term implementation' [212], consisting of the theoretical basis and analysis of the potential of recycling CDW in Malta.

18.1.3 Legal framework for sustainable management of CDW

At the moment, there are few legal frameworks concerning the sustainable management of CDW. There is, however, an obligation for the separate collection and management of hazardous waste from C&D operations outlined in LN 184 of 2011. This is a national obligation.

18.1.4 Targets

The WMP aims to:

- Minimise CDW through reuse activities and to promote the recycling and recovery thus minimising the impacts on raw materials.
- Recover 70% of CDW by 2020

In the WMP suggested that the possibility of shifting from recovery to recycling and prevention should be assessed.

18.1.5 End of Waste (EoW) status

The Council Regulation (EU) No 333/2011 on EoW of scrap metal and Commission Regulation (EU) No 715/2013 on EoW of copper scrap are relevant to Malta. These regulations are relevant for CDW, though they do not refer specifically to CDW materials.

Currently, no EoW criteria has been created for Malta. The decision would have to be made case by case as designated by regulation 6 of S.L. 504.37, Waste Regulations 2011.

18.2 Non legislative instruments (best practices, guidelines, recommendations…)

According to a news article [213], there are currently construction and tunnel project underway that would result in a sizable amount of CDW, which would 'increase the political pressure for land reclamation projects like the ones being proposed in Portomaso in St Julian's and Jerma in Marsascala'. It is possible that this kind of solution will be more popular in the coming years, having been suggested in 2006 during a similar construction boom as the one that is happening in Malta currently.

18.3 CDW management performance – CDW data

The last published information on CDW management was taken from2004-2011. The table can be seen below. Currently, CDW is considered the largest share of waste that is generated by the Maltese islands.

Table 59. CDW management over the period 2004 to 2011 [214]

	Recycled	Recovered	Landfilled	Disposed at sea	Others	Total
2004	19,916		2,580,454	210,404		**2,810,774**
2005	15,332		1,970,883	357,942		**2,344,157**
2006	101,756		2,061,340	329,426		**2,492,522**
2007	243,818		2,110,641	146,205		**2,500,664**
2008	173,982		1,522,000	300,360		**1,996,342**
2009	63,463		462,584	74,370		**600,417**
2010	114,149		688,061	290,120		**1,092,330**
2011	139,144	3,611	422,057	149,120	2,125	**716,057**

Landfilling is still the preferred option of management, although a percentage of that which is landfilled in understood as backfilling (permitted as inert landfills). This percentage was then moved to 'recovered' in 2011. The intension is for 'backfilling spent quarries, together with recycling recyclable CDW [to] aid Malta [in achieving] its 2020 target of recovering 70% inert [CDW] [214].

18.3.1 CDW generation data

There seems to be an increase in construction projects currently taking place in Malta, possibly resulting in an estimated 2 million cubic metres of construction waste from the Paceville mega-projects alone [216]. This means that there will be more discussion on CDW in the coming year, including a possible redirection of the waste to either recycling or dumping.

In a news release [215] by the National Statistics Office – Malta (NSO), new numbers were reported for all waste generation, including construction and demolition waste. These numbers can be found in the Table 60.

Table 60. CDW generation data

CDW generation (tons)	2010	2011	2012	2013	2014
Mineral waste from construction & demolition (NHAZ)	746.666	643.412	500.883	541.909	145.531
Mineral waste from construction & demolition (HAZ)	0	0	5	0	0

There has been a clear decrease in mineral waste from construction and demolition for non-hazardous waste. From the news release, it is unclear why exactly this decrease in generation is occurring, however the economic market and consequently the demand could have something to do with this.

Eurostat released information for the construction sector in Malta, as in Table 61.

Table 61. Generation of waste by waste category - EUROSTAT

Generation of waste by waste category - Construction	2008	2010	2012	2014
Total Waste	**1.698.659**	**988.070**	**1.044.089**	**1.241.079**
Chemical and medical wastes (subtotal)	0	0	:	0
Recyclable wastes (subtotal, W06+W07 except W077)	31.176	28.957	:	36.487
Equipment (subtotal, W077+W08A+W081+W0841)	0	0	:	0
Animal and vegetal wastes (subtotal, W091+W092+W093)	0	0	:	472
Mixed ordinary wastes (subtotal, W101+W102+W103)	0	0	:	2,721
Common sludges	0	0	15	28
Mineral and solidified	1.667.483	959.114	:	1.201.371

The total waste generated from construction has stayed largely the same, with a large portion coming from mineral and solidified waste.

18.3.2 CDW treatment data

The Table 62 shows the Eurostat data for the treatment of the mineral waste generated from construction and demolition activities. As seen from the previous table, mineral and solidified waste is the largest portion of waste derived from construction and demolition, therefore the treatment for this fraction is more readily available.

Table 62. Eurostat data for the treatment of the mineral waste generated from C&D activities

	2014	2012	2010
Total waste treatment	**1,068,245**	**507,563**	**491,912**
Deposit onto or into land	1,325	1,536	128,280
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	0	328
Incineration / energy recovery (R1)	0	0	4,747
Recovery other than energy recovery - backfilling	548,290	392,945	0
Recovery other than energy recovery – except backfilling	518,629	113,082	358,557

Currently, the majority of the mineral waste is being used for backfilling operation or recovery activities other than backfilling. The last category more likely refers to the export of CDW to other countries with better facilities to process them.

A certain percentage of the mineral waste from CDW is landfilled, although there is discussions in the news on the need for stricter checks in consideration of the amount of illegal landfilling that was and is occurring in Malta. The illegal landfilling criterion includes the ban on landfilling clean inert CDW within Malta [217]. However, it is still unclear why CDW is being sent to landfill instead of the other treatment options mentioned in Table 63.

Table 63. CDW treatment data

CDW landfilled (tonnes)	2010	2011	2012	2013	2014
Mineral waste from construction & demolition	2.139	922	1.536	860	1.325

18.3.3 CDW exports/imports data

According to the Deloitte report, the last available data for CDW was taken in 2012, showing 26.891 tonnes for CDW exported for recovery or disposal (this consisted mainly of recyclable materials for which there are no recycling options available in Malta) [220]. The majority of CDW generated in Malta is exported for recycling or other uses as Malta does not have a lot of the facilities needed to process the CDW.

18.3.4 CDW treatment facilities data

There are numbers on inert mineral waste, which refers to waste which is mainly made up of stones, concrete, bricks, tiles and ceramics from construction & demolition. It also includes clean geological material from excavation work which should be kept in mind, as shown in Table 64.

Table 64. Inert waste treatment

Waste category		Final treatment	2010	2011	2012	2013	2014
EWC-Stat code	Description						
10.2	Mixed and undifferentiated materials	Disposal at sea	353	0	0	0	0
12.1	Mineral waste from construction and demolition	Disposal in quarries	634,500	393,112	0	0	0
12.1	Mineral waste from construction and demolition	Recycling	119,412	136,329	113,082	83,892	20,158
12.1	Mineral waste from construction and demolition	Backfilling in quarries	0	0	392,945	173,800	97,782
12.2, 12.3, 12.5	Other mineral wastes	Disposal at sea	34,120	8,800	0	0	0
12.2, 12.3, 12.5	Other mineral wastes	Backfilling in quarries	0	0	0	622,732	73,789
12.2, 12.3, 12.5	Other mineral wastes	Recycling	0	0	0	282,466	397,327
12.7	Dredging spoils	Disposal at sea	256,000	140,320	1,037,680	663,940	433,017
Total			**1,044,385**	**678,561**	**1,543,707**	**1,826,831**	**1,022,074**

Notes:

1. Disposal at sea of mixed and undifferentiated materials refers to maize.
2. Dredging spoils data for 2013 was revised.
3. All waste categories included in this table are non-hazardous.

Source: MEPA

Disposal at sea of materials was completely stopped by 2012, although dredging spoils are still disposed at sea at a large scale. The final treatment of the mineral waste from CDW shifted from disposal in quarries to recycling and backfilling in quarries. There has been less generation of CDW which has caused the above numbers to fall as well, however there is a heavy lean towards backfilling in quarries. This could be due to two reasons: there is no mandatory recycling scheme in place in Malta and the financial incentive to recycling may not be attractive enough to cause a shift in treatment.

18.3.5 Future projections of CDW generation and treatment

Similar to what was stated in the EC document on Malta, there is currently no publication of future projections, thought there is a plan put in to place to start this in the current WMP (valid till 2020).

18.3.6 Methodology for CDW statistics

The methodology for the collection of the CDW statistics has been explained at the end of the news release. This also explains why certain waste values may not equal the total amount of waste reported.

18.4 C&D waste management in practice

18.4.1 CDW management initiatives

For the rehabilitation of buildings instead of new constructions, there were two initiatives reported by the Deloitte report:

- 'Economic incentives in the form of lower tax rates for first time buyers purchasing old property, so as to promote the restoration and rehabilitation of such properties instead of demolition' (2014), and
- 'Incentives for the rehabilitation of village cores and protected buildings' (2012) [220].

There was also a ban on landfilling [217] of clean inert CDW initiated in 2003. By 2016, 2 million tonnes/year had been diverted to backfilling.

18.4.2 Drivers / barriers to increase CDW recycling

There have been cases of illegal dumping of CDW, which has been found not to be uncommon. A trial was just completed in Malta. The biggest barrier would still be the lack of implementation of the existing legal framework, though there seems to be a greater effort to combat the illegal dumping.

Similarly to many European countries, there is no established market for recycled CDW and as raw materials are still cheaper, there is no financial incentive.

There is a lack of treatment facilities in Malta, causing an increase in illegal dumping sites. However, there is an adequate network of facilities for receiving CDW intended for recovery or backfilling.

18.5 CDW sector characterization

18.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Both the government and the private sector are involved in the management of CDW in Malta. The market forces are led by the private sector; however there are definitions and obligations that emanate from national legislation for the collection, sorting, transport, treatment and final disposal of CDW [220].

The performance of CDW recovery is high and Malta has reached the target of the Waste Framework Directive, but the quality of recycling is considered low and the products are largely used as backfilling material. A large percentage is used for screed and concrete production.

There are no specific numbers for the different CDW materials at the moment from Malta. However, there are numbers from one of the main waste treatment plants on the final treatments of the total waste output, including many CDW materials. Table 65 gives an idea about the final treatment of several materials.

Table 65. Sant'Antnin Waste Treatment Plan (SAWTO) – total waste output

tonnes

Waste category		Final treatment	2010	2011	2012	2013	2014
EWC-Stat code	Description						
6.1	Metallic wastes, ferrous	Exports for recycling	0	1,324	1,162	1,319	994
6.2	Metallic wastes, non-ferrous	Exports for recycling	0	82	83	85	62
6.3	Metallic wastes, mixed	Exports for recycling	2,192	232	210	348	150
7.1	Glass wastes	Exports for recycling	333	0	1,308	2,846	3,155
7.2	Paper and cardboard wastes	Exports for recycling	7,376	8,357	6,043	6,193	6,557
7.2	Paper and cardboard wastes	Incineration	0	21	0	0	0
7.4	Plastic wastes	Exports for recycling	1,936	2,104	1,829	1,713	1,727
7.5	Wood wastes	Landfill	1	0	0	0	0
8 (excl. 8.1, 8.41)	Discarded equipment	Exports for recycling	0	0	0	18	18
9.2	Vegetal wastes	Landfill	2,456	0	0	0	0
10.2	Mixed and undifferentiated materials	Exports for recycling	324	0	0	0	0
10.3	Sorting residues*	Landfill	8,481	35,551	41,955	40,228	34,093
10.3	Sorting residues*	Anaerobic digestion plant	0	9,192	9,989	12,092	8,672
10.3	Sorting residues*	Exports for energy recovery	0	1,367	1,029	0	0
10.3	Sorting residues*	Exports for recycling	0	1,188	0	645	837
Total			**23,099**	**59,418**	**63,609**	**65,486**	**56,266**

* waste which is generated from waste treatment operations (secondary waste).
Note: All waste treated at Sant' Antnin Waste Treatment Plant is non-hazardous.
Source: WasteServ Malta Ltd.

The majority of the waste in terms of materials (metals, paper and cardboard, plastics, etc.) is exported for recycling.

The news release includes numbers from private pre-treatment facilities and other facilities as well. Please check the [215] for more data.

There is some specific information on limestone from Malta - Guidance on the excavation of limestone with a view to reduce construction and demolition waste is planned, as are discussions between all relevant stakeholders during the revision of local plans to limit unnecessary waste. There is an emphasis on promoting the value of limestone resources at the excavation stage and on harnessing the potential of technology to make the process more resource efficient. For more information, see [218].

Product description and applications

The mineral CDW recycling sector does exist in Malta, with the waste being crushed and generally used as screed or for concrete production.

Other CDW is used for backfilling and Maltese stone is being reused as it is considered a high-quality material and cultural significance.

Quantitative analysis

As mentioned later, there is currently only a market for recycled minerals CDW in Malta. This is shown by the Table 66, showing that there tons being recycled is largely consistant.

Table 66. Recycled mineral CDW

	2006	2007	2008	2009	2010	2011	2012
Recycled mineral CDW (tonnes)	101.756	277.230	176.159	66.583	119.412	136.32	113.802

Table 67 depicts the imports of construction materials in Malta. This refers to new materials being imported.

Table 67. Import of construction materials in Malta [221]

Building material	Value of imports (EUR)	Quantity of imports (t)
Bricks and tiles	2 421 640	2 184
Cement	15 765 500	264 080
Lime	94 170	407
Plastics (pipes, fittings, windows, door, floorings)	4 768 360	1 396
Plasters (gypsum, etc.)	1 642 350	12 236
Natural stones (various shapes and sizes)	231 380	3 181
Asphalt and bitumen	4 649 090	4 250

Recovery techniques

There is an increasing recognition that Maltese stone is a finite resource and actions are being encouraged to reuse this stone as much as possible. This is further helped by the recognition that Maltese stone is considered a high quality material.

Environmental and economic impacts of CDW waste management

The economic crisis has had a significant negative impact on construction in Malta.

Drivers / barriers to increase recycling

There is a recycling sector for mineral CDW in Malta; however, there is no sector for non-mineral CDW. The materials that can be recovered are all exported for recycling. However, the lack of market for CDW recycling and the lack of financial incentive in one of the greatest barriers to the increase of recycling. Additionally, the need to export all CDW for recycling does not simplify the process.

18.5.2 Recycled materials from CDW

At the moment there is no recycling sector of non-mineral CDW materials. Specific materials that can be salvaged from construction sites are exported. The mineral CDW recycling sector does exist in Malta, with the waste being crushed and generally used as screed or for concrete production.

There are also reuse practices in place that are enforced via the development planning permissions. This specifically relates to the reuse of old/weathered stone for the maintenance of old buildings and also for the construction in Urban Conservation Areas (UCA's) [220].

18.5.3 Market conditions / costs and benefits

The waste management sector is considered an emerging market, expected to grow in case resource scarcity becomes a larger issue [219]. However, as CDW does not have a financial gain involved, it is difficult to motivate the private construction sector to change established habits at the moment. Additionally, there is no strict legislation in place when regarding CDW treatment, perhaps causing a concern for market equality in case certain companies which to participate/initiate voluntary schemes.

19. NETHERLANDS

19.1 Legal Framework – Waste Management Plans and Strategies

19.1.1 National Legislation concerning CDW

The **National Waste Management Plan** sets out the policy for waste management in the Netherlands. The Second Waste Management Plan covers the period 2009-2017, looking ahead to the period up to 2021. The National Waste Management Plan covers all waste to which the Environmental Management Act applies. This Act stipulates that all authorities must observe the National Waste Management Plan.

The **Environmental Management Act** of 1 May 2004 sets out an integrated approach to environmental management in the Netherlands and provides the legal framework by defining the roles of national, provincial or regional, and municipal government.

The Act stipulates the tools to be used in environmental management and, in Section 10 it deals with waste management, set that the Dutch Minister shall adopt a waste management plan at least once every four years and given a set of prescription to do it.

In order to implement Directive 2008/98, the Minister of the Environment submitted a proposal in May 2010 to amend the **Environmental Protection Act**, the Law on environmental taxes and the Law on economic offenses. The so-called Implementation Act EG-regulation directive waste was then implemented on December 12 2010.

Based on the Environmental Protection Act, some decrees are made:

- **The Decree on landfills and waste bans**: Waste is usually recovered or incinerated and may usually not be dumped. For a number of waste materials a landfill ban exists, laid down in the Decree on landfills and bans waste (BSSA).
- **The Decree on notification of industrial and hazardous waste**: In the Notification of industrial and hazardous wastes the rules about disposal, transporting and receiving waste are pointed out. The decision applies from 1 January 2005. 10
- **Arrangement collectors, transporters, dealers and brokers of waste**: In accordance with the Environmental Management Act, waste is issued only by companies that have a license to take over this waste or companies authorized to collect waste. It is also laid down in the Environmental Management Act that only the owner of the waste is allowed to dispose of the waste. So it is not allowed (for example, as a contractor, consultant or carrier) to act as a disposer of waste of others. Transporters, collectors, dealers and brokers of waste must be registered.

19.1.2 Waste management plans (WMP) and Strategies

In the Netherlands the entire policy for waste can be found in the National Waste Management Plan (LAP). LAP2 will expire in December 2017. LAP3 covers the period 2017-2023, looking ahead to the period up to 2029.

In October 2016 the draft LAP3 was sent to the European Commission. The standstill period ends on 12 January 2017. LAP3 sets out the main points of waste policy. For example, it covers the national objectives for the separate collection of waste and general principles for the use of instruments such as licensing and enforcement. The sector plans flesh out the policy framework for specific categories of waste.

Concretely LAP-2 includes the following quantitative and qualitative objectives (from DELOITTE Factsheet):

- Encouraging waste prevention, such that the total waste production in 2015 may not be greater than 68 Mt and in 2021 not more than 73 Mt.
- Increasing the recovery of the total waste from 83% in 2006 to 85% in 2015.
- Increasing the recovery of all household waste from 51% in 2006 to 60% in 2015.
- Increasing the recovery of total HDO (trade, services and government) waste from 46% in 2006 to 60% in 2015.
- At least maintain the already in 2006 achieved rate of 95% recovery of CDW, despite the expected increase in the production of this waste stream in the coming years (24 Mt in 2006 to 32 Mt by 2021).
- At least maintain the already in 2006 achieved rate of 90% recovery of industrial waste, despite the expected increase in the production of this waste stream by 16 Mt in 2006 to 18 Mt by 2021.
- Reduction (indicative objective) of 20% environmental impact in 2015 for each of the seven priority streams.
- Optimal utilization of the energy-content of waste that cannot be reused.
- Better utilization of the waste heat from waste incineration.
- Realization of a levelled European playing field for waste management.
- Promoting of market forces and shaping special responsibility of the government for landfilling.
- Using the Cradle-to-Cradle (C2C) concept as a source of inspiration in the seven priority streams.

About CDW, the LAP2 sets that:

- Construction and demolition waste is released during the construction, renovation and demolition of buildings and other construction works including in civil engineering.
- This sector plan covers mixed construction and demolition offered by companies in the construction sector, but also similar composed industrial and household waste, such as waste that is unseparated released during construction, demolition or remodeling of private households.
- The minimum standard for the processing of CDW is sorting or otherwise processing. The object of the treatment in this respect is to get as much mono streams as possible to be separated which are suitable for recycling, with the restriction that the resulting residue must at least be able to be burned. The sorting process is arranged - if present in the mixture to sort - at least to separate as mono stream:
- All the components as mentioned in art. 4.1 of the Building Regulations 2012
- Stone-like material,
- Wood,
- Plastic,
- Metal,

- Sieve sand, and
- Hazardous waste marked other than those specified in Chapter 17 of the Waste List under the Regulations for European Waste Catalogue.
- The minimum standard for sorting residue for which recycling is not possible or where the recycling route is so expensive that the cost of delivery by the producer / disposer is more than € 175, per ton, is incineration as a disposal method.

19.1.3 Legal framework for sustainable management of CDW

All the above mentioned legislation and all the non-legislative instruments described in paragraph 2.2 contribute to create good conditions for a sustainable management of CDW.

19.1.4 Targets

In Netherland, the European target of 70% recovery of CDW by 2020 is already passed for many years, so in the National Waste Plan it's fixed that "At least maintain the percentage already achieved in 2006 in Netherlands of 95% recovery of CDW, despite the expected large increase in the production of this waste stream in the next few years (from 23 Mtonnes in 2006 to 31 Mtonnes by 2021)".

19.1.5 End of Waste (EoW) status

The Netherlands uses the EU defined EoW criteria. Any waste that fulfils the criteria for the 'end of waste' has no longer the status waste.
Moreover, for waste for which no European end-of-waste criteria is developed European Member States themselves may introduce schemes with end-of-waste criteria. For the following waste a Dutch regulation applies: Recycling Aggregates from stony waste: Regulation No IENM / BSK-2015/18222 of February 5, 2015.

19.2 Non legislative instruments (best practices, guidelines, recommendations…)

Rijkswaterstaat Environment is part of Rijkswaterstaat, the executive of policies and regulations of the Ministry of Infrastructure and the Environment. Rijkswaterstaat Environment performs various knowledge and implementation tasks relating to the environment. Rijkswaterstaat Environment also manages programmes for other clients than the Ministry of Infrastructure and the Environment, such as local authorities and other ministries.
To evaluate policy effectiveness, Rijkswaterstaat monitors quantities and characteristics of waste streams, transboundary movement, waste treatment and processing activities, and (inter)national market developments. To gather this data, Rijkswaterstaat coordinates the monitoring activities of various organisations and compiles the results in a central database. Monitoring activities also include developing indicators and waste output scenarios. The generated data is analysed and processed to deliver monitoring reports to the Dutch government and the EU (Eurostat).
To formulate sound and reliable policy advice, Rijkswaterstaat executes research (e.g. lifecycle analyses), contracts external experts and/or analyses third-party research.

Rijkswaterstaat also regularly consults private and public stakeholders to take into account their views and experiences.
It thus bridges the gap between policy and practice. Rijkswaterstaat uses different methods for stakeholder consultation, such as participatory workshops and network meetings.
Thus, Rijkswaterstaat has extensive experience with knowledge and data management. It is continuously developing its knowledge base, promoting knowledge exchange and correct use of information sources.
Rijkswaterstaat has developed a web-based tool. With it, businesses can assess their own material or object status. This e-tool will show whether the assessed material or object is a by-product (Article 5 of the Waste Framework Directive) or if it has end-of-waste status (Article 6 of the Waste Framework Directive). This e-tool will help the waste industry (as collectors of waste) and manufacturers. They can use it to make proper decisions about many different types of waste-derived products or production residues.

The program **Waste To Raw material** (VANG) is the effort by the government to encourage the transition towards a circular economy. The common goal is to bring more sustainable products on the market, consume consciously and recycle more and better. The VANG program has eight operational objectives. These objectives include sustainability at the front of the chain, improving waste separation and collection, directing existing waste policy to a circular economy and addressing specific chains and waste streams, but is does not describe a part specifically focused on CDW.

REBus (Resource Efficient Business Models) is a project financed by EU Life+ with the goal of acquiring knowledge about the potential of circular business models and investigating whether they can help achieve the target of 15% resources and costs savings. REBus Netherlands aims to inspire purchasers and market participants to focus on retaining the value of raw materials throughout the supply chain from the very first request for a product or service. This includes the possibilities for reuse and recycling. The goal is to learn how new business models can be used for circular procurement and what the effects of this are on sustainability.
In the Netherlands, REBus is working with other governments and progressive companies to explore models that make circular procurement possible within five industries: IT, office furniture, construction, textiles and catering. By conducting pilot projects, REBus is learning more and more about what is needed for circular procurement. REBus also applies the knowledge gained in new pilot projects and stimulates participants to share their knowledge.

Other numerous initiatives for CDW management are described in DELOITTE Factsheet, such as research projects and private initiatives. More interesting are:
- **ADR Technology**: the development of advanced innovative technologies for turning demolition concrete into clean aggregates and cement, started by the Delft University of Technology and 13 partners and is European-funded.

- **Neptunus**: offers a demountable building concept. In this innovative proposition, houses are built for 10-20 years and take them completely apart afterwards. It works in a lease construction.
- **Slim Breken (Smart Chrusher)**: a new breaking technology to better separate concrete granulates into its three components (proposition by Koos Schenk).

19.3 CDW management performance – CDW data

19.3.1 CDW generation data

EUROSTAT database reports the data in Table 68 for CDW generated between years 2010 and 2014.

Table 68. EUROSTAT CDW generation data.

	2010 [tons]	2012 [tons]	2014 [tons]
Mineral waste for construction	20.444.617	21.855.155	19.430.472
Metal wastes, ferrous	677.693	701.882	840.968
Metal wastes, non-ferrous	175.932	163.898	193.205
Glass wastes	78.805	48.543	82.367
Plastic wastes	32.173	34.091	26.576
Wood wastes	1.306.264	1.321.587	1.376.779
Total	**78.063.887**	**81.354.111**	**90.734.851**

19.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 69.

Table 69. EUROSTAT CDW treatment data.

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	49.286	61.419	37.653
Deposit onto or into land	49.273	61.419	38.652
Land treatment and release into water bodies	13	0	0
Incineration / disposal (D10)	534	3.383	8.565
Incineration / energy recovery (R1)	7.728	6.589	102.217
Recovery other than energy recovery	20.055.549	21.559.847	19.986.937
Recovery other than energy recovery - backfilling	0	0	0
Recovery other than energy recovery - except backfilling	20.055.549	21.559.847	19.989.937
Total waste treatment	**20.113.097**	**21.631.238**	**20.135.372**

19.3.3 CDW exports/imports data

The National Waste Management Plan gives some indication about export/import waste.
Cross-border transport of waste: (Temporary) removal

- Shipments from the Netherlands to landfill are not allowed on the grounds of national self-care.
- Shipments from the Netherlands in other types of (temporary) removal than landfill are in principle not allowed because recycling is possible. However, this prohibition does not apply to sorting residue under the condition that it appears from the notification that components such as wood, paper, metals, glass and plastic are not suitable for recycling. In this case, transmission for incineration is basically permitted.
- Shipments to the Netherlands for landfill are in principle prohibited under national laws and / or on the basis of national self-sufficiency.
- Shipments to the Netherlands for incineration as a disposal method are in principle not allowed.
- Shipments to the Netherlands for other types of (temporary) removal than incineration and landfilling are in principle not allowed.

Cross-border transport of waste: (Temporary) recovery

- Shipments from the Netherlands for recycling and for interim recovery followed by recycling is permitted in principle, unless eventually much of the transferred waste material is landfilled that the degree of recovery does not justify the transmission or when the degree of recycling is less than is common in processing of waste in the Netherlands.
- Shipments from the Netherlands for other types of (temporary) recovery than recycling or interim recovery followed by recycling is not allowed in principle because recycling is possible.
- Shipments to the Netherlands for (temporary) recovery is permitted in principle if the processing is in accordance with Dutch standard minimum.

About exports/imports data, the only one found are those listed in the DELIOTTE Factsheet:
Export

- In 2012, 710,405 tonnes of CDW were imported into The Netherlands.
- Around 70% of this was hazardous CDW.
- Moreover, 45% of the total was ground and stones that contain hazardous substances.
- Since 2006, the export of CDW has dropped drastically, in 2006 the CDW export was 705,952 tonnes.

Import

- In 2012, 232,113 tonnes of CDW were exported out of The Netherlands.
- Around 85% of this was non-hazardous CDW.
- Since 2006, the import of CDW has drastically risen by more than 300%, in 2006 the CDW import was 215,812 tonne.
- 70% of the CDW that was imported in 2012 was recycled.

19.3.4 CDW treatment facilities data

The Dutch approach to waste management is that landfilling is only allowed for waste streams for which no recovery or incineration is possible. This approach is known as 'the order of preference'.
According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", In Luxembourg there are no landfill for inert waste, while there are 38 landfill for non-hazardous waste and only 1 landfill for hazardous waste.

19.3.5 Future projections of CDW generation and treatment

Efforts have shifted to encouraging companies and governments to start applying the concepts of "by-product" and "end-of-waste" themselves. This is accomplished by providing information and through discussions in meetings, as well as by means of so-called legal rulings (opinions of the Ministry of Infrastructure and the Environment concerning a specific case given at the request of a company). This policy will be given a significant boost in 2017 through an explanation of the concepts of "waste", "by-product" and "end-of-waste" in the third National Waste Management Plan (LAP3).

19.3.6 Methodology for CDW statistics

The methodology for CDW statistics of data reported in this document follows Eurostat guidelines.

19.4 C&D waste management in practice

19.4.1 CDW management initiatives

See paragraph 19.2.

19.4.2 Drivers / barriers to increase CDW recycling

The introduction of a circular economy in the construction sector creates opportunities for innovation. The scope of a circular economy for the construction sector extends beyond the mere reuse of waste. A circular economy for the construction industry calls for the following three questions to be considered with respect to each building:
1) How can we minimize the use of construction materials? This involves not only the need for raw
materials, but also the options for reuse and transformation of the building itself;
2) How can we meet the remaining material requirements as sustainably as possible? The use of sustainable construction materials should be considered here, as should reuse;
3) How can we meet the material requirements still remaining as efficiently as possible?

With this aim, market will encourage CDW recycling and it will be a driver for it.
The introduction of tax on landfilling and burning waste is an enabler of more recycled CDW.
Even if in Netherland there are many initiatives about CDW management or in construction sector in general, sometimes there is a lack of maturity of these initiatives.

19.5 CDW sector characterization

19.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

The composition varies for different user groups:

- Housing
- Utility
- Road and waterworks.

Main component is the stone fraction, which accounts for 89, 96 and 99% respectively. The high recyclability grade of 98% for the total construction and demolition waste market is achieved due to the good recycling possibilities of stone rubble.

Processed stone rubble can be used in new concrete, road foundations, waterworks and ground works. The trends and expectations for the future show a growth of 80% in construction and demolition waste for the year 2005-2025.

Main products and applications of CDW are:

- Secondary asphalt for reuse in hot mixtures
- Secondary aggregates for new concrete
- Cement bound asphalt granulate road base
- Cement bound granulates for road base
- Secondary aggregates for new road base
- Secondary sand for sub base.

Quantitative analysis

See paragraph 17.3.1

Recovery techniques

During the demolition process the aim is to separate different materials on-site, since recycling of gypsum, wood, plastic is only possible when separated properly and is hard to separate afterwards. The extra work on-site saves in processing costs afterwards. Besides separation, processing on-site is also possible with mobile equipment. Transportation to a processing plant is no longer necessary, material can be directly used on-site, transported to a temporary storage location or to the end-user.

A demolition license is required when the waste generated in the process exceeds 10 m^3. In the application for a license the use of mobile processing equipment must be stated. Beside the license, national governmental rules on handling and processing CDW, like the Bouwstoffenbesluit are active.

Excavators, shovels, skid steers and dozers are used for on-site transportation of bulk materials. Except for the dozers, these machines can be equipped with a quick coupler and act as a tool carrier. Tool carriers are able to use different attachment types for demolition, separation and processing activities. Special case are the extended reach equipment, tool carriers exceptional long booms to get to hard to reach places. Processing wood is done with shredders, grinders or chippers, while stone is being processed by crushers. Separation based on size difference, screening, can be done with drum sieves. Separation based on density difference, sifting, with a wind shifter. Transport over the roads is done with trucks.

The theory behind crushing is based on fracture mechanisms and propagation models. These different mechanisms are applied in different variants. In practice, the most common variants are the impact, jaw and cone crusher. For processing of recycling materials, only the impact and jaw crusher type are used in mobile equipment. This equipment can be a complete plant, or only an attachment for a tool carrier, which is called a bucket crusher. Automation of the crushing process in complete plants allows high throughput capacities and therefore low cost per unit material. There are bottlenecks that could occur which limit production.

Reinforced concrete is hard to crush and could clog the device. One of the solutions is to use a tough primary crusher, which enables extraction of iron by a magnetic overbelt. The secondary, more vulnerable crusher then delivers the desired end-product.

The use of an online marketplace for trading processed waste materials, such as granulate, offers advantages. A map shows the location, the quantity and the quality of the material. The client is able to find the nearest location with his required materials and can get directly in touch with the supplier. The total amount of transport kilometers can be limited, when using this trading method.

For large projects, combination equipment can be used, whether integrated in one installation or the combination and interaction of different single-piece equipment. A separate jaw crusher, impact crusher(s), wind shifter and drum sieve versus a complete processing plant. Also important factors to look at are the flexibility, scalability, robustness etc [225].

Drivers / barriers to increase recycling

See paragraph 2.4.2

19.5.2 Recycled materials from CDW

Main product obtained from CDW recycling are granulates, different each other depending on their composition: mixed granulates, concrete granulates, hydraulic granulates, asphalt granulates.

The reuse of Commercial and Non-residential Building CDW is already widespread (>95%), albeit that in many cases materials are not reused at the same or a higher level. The reuse rather involves, for example, construction rubble being processed to granulate to be used as a foundation material in Soil and Civil Engineering. The bulk of the material is subsequently reused at the same level in the Soil and Civil Engineering sector; after one road life cycle, the rubble is reusable in other road projects. The need for such foundation material in the Soil and Civil Engineering sector is expected to decrease, as this sector increasingly tends to use residual material from other sources. This "saturation" in Soil and Civil Engineering generates an incentive for developing more circular uses for construction materials in the Commercial and Non-residential Building sector.

Since February 2015, recycled aggregates have an EoW status. The criteria of the EoW status for aggregates describe details about:

- Requirements of the stony waste to be recycled into aggregates
- Production control
- Product quality
- Declaration of Conformity
- Quality assurance

The requirements of the stony waste contains:

- Quality
  - ✓ No hazardous waste
  - ✓ No asbestos, tar, residential waste, gypsum, ground, carbon black and timber
- Registration
  - ✓ Date of receipt, quantity, name and address of the supplier, and whether the offered stony waste is accepted or rejected
- A check on the presence of tar and polycyclic aromatic hydrocarbons
- A visual observation for asbestos.

An other recycled material is Styrofoam47: Waste processor Sita collects EPS from the construction industry. It is broken down into smaller pieces and mixed together with new Styrofoam, which makes it 100% recyclable without any loss of quality.

19.5.3 Market conditions / costs and benefits

As natural resources are getting more scarce, prices for raw materials are increasing. This market mechanism and environmental government policy together stimulate the recycling of waste materials.
Although the annual volumes of construction and demolition waste seem to have stabilized for the last five years, a scenario study predicts a growth of 80% for 2025. The economical viability of mobile

crushing depends greatly on the market prices of recycled aggregate. These prices depend on demand and supply, a growth of 80% in supply would require at least the same growth in demand,

for prices not to collapse. Therefore, focus should be on quality and on new applications. High quality granulates are an advantage in a high competition market, while new applications ensure sufficient sales possibilities. Also the development of applications for low quality products is important, to prevent them being disposed as landfill.

Starting from 1 April 2014, a waste disposal tax has been imposed on the disposal and incineration of waste. The reintroduction of the waste disposal charge has resulted in a manifest and immediate reduction in the volume of waste deposited. As of 1 January 2015, this tax was expanded to include waste that is incinerated.

20. POLAND

20.1 Legal Framework – Waste Management Plans and Strategies

20.1.1 National Legislation concerning CDW

In contrast to the term "waste", the term CDW is not defined in the Act of Waste. The only mentioning of the term is in the national WMP; it says that CDW is the "construction and demolition waste from buildings and road infrastructure generated in residential and industrial construction, as well as in railway industry and road industry, at the construction development and modernization stage and at the dismantling stage" [226]. Poland adopted the European waste catalogue, meaning CDW falls within the group number 17.

The responsibilities of local authorities regarding waste management are set forth primarily by the provisions of three acts of parliament - Act on waste (2001); Act on packaging and packaging of waste (2005) and Act on maintaining cleanliness and order in municipalities (2011).

European Directives concerning waste management are implemented in Poland through the Act on Waste 2012. Previously the regulations concerning waste management were set forth in the Act on Environmental Protection and Development of 31 January 1980. The Waste Act adopted in December 2012 is the third in a series of laws wholly devoted to the issue of waste management in Poland.

This Act defines terminology associated with waste management – it defines terms such as waste producer, owner of waste, waste broker, waste dealer and others. According to Article 27, a waste producer is obliged to manage waste that his or her actions generated. Nevertheless, a waste producer can choose to transfer his obligation to manage the waste to a company which has a permit to collect waste. This transfer must be documented a confirmation a waste was either recovered or disposed [227].

Under the Act on Waste, municipalities have been obliged to the following [228]:

- To include the whole population in the organized system of municipal waste collection and the system of separate collection of waste by 2015 the latest
- To create conditions for the operation of a system of separate gathering and collection of municipal waste
- To ensure proper conditions for the construction, maintenance and operation of installations and equipment for the recovery and disposal of municipal waste
- To initiate and facilitate the creation of points for the collection of waste arising from electric and electronic equipment.

Furthermore, under the Act on packaging and packaging of waste, each entity that releases packaged products on the market is obliged to ensure the appropriate level of recovery and recycling of packaging waste. The Act sets the required annual recovery levels for packaging, recycling in general, and for individual packaging. Companies that fail to meet the required goals might face financial sanctions.

20.1.2 Waste management plans (WMP) and Strategies

The national WMP is devised by the MoE in cooperation with the Ministry dealing with water management regulations. Regional WMPs are developed by the region authority – the Marshall Office. All WMPs aim to achieve the objectives of the environment policy, meaning, contribute to improved environment. These plans contain the analysis of CDW management situation, forecast change in waste management, targets and objectives of waste management and strategies to prevent waste generation.

The national WMP currently in force is called the National Waste Management Plan 2022 [226]. In July 2016, the Council of Ministers adopted the resolution on this plan making it legal in the period 2016-2022. The WMP 2022 represents the update of the national WMP 2014 which was binding in the period 2011-2016. The WMP 2022 contains waste prevention program.

Regarding the CDW, the WMP 2022 states the following objectives:

1) increasing awareness among investors and companies producing waste from construction and demolition of buildings and infrastructure road on the proper handling of abovementioned waste, in particular in the field of selective collection and recycling;

2) maintain the level of preparation for reuse, recycling and other forms of recycling construction and demolition waste at a minimum of 70% by weight.

The WMP also sets several courses of actions – these are:

- Information and education activities to raise awareness among investors and CDW producing entities to create streams to deal with CDW
- Introduction of a system of incentives to promote the selective collection of CDW waste
- Introduction of a system of incentives to promote the use of recovered CDW
- Continue to monitor CDW generated and its treatment
- Develop technical infrastructure for selective collection, recovery and re-use of CDW.

The Plan assumes that Poland's modern waste management system should embrace the following range of services [228]:

- Mechanical-biological conversion of mixed municipal waste, storage of mixed and recycled waste and composting of green waste in regions > 150,000 residents
- Thermal conversion of mixed municipal waste in regions > 300,000 residents.

Moreover, local governments are obliged to arrange min. 5 / max. 15 waste management plants per region by 2014. As for landfill sites, their absorptive capacity should be sufficient for a period of min. 15 years of utilization.

Poland employs the national WPP published by the MoE in 2014. The WPP sets number of objectives regarding the waste prevention. In regards to the CDW, it provides an example of possible measure which obliges materials' suppliers to accept returns of surplus materials within a certain period at the price of purchase. It does not further specify any measures dealing with CDW, however, few principles are recommended: (1) optimisation of use of construction materials; (2) use of modern equipment that apply zero-waste or low-waste technologies; (3) compliance with the parameters of technological processes; and (4) analysis and verification of applied technologies and standards of material use in terms of waste reduction [229].

Companies in charge of collecting waste are forced to produce collection contract and permit from the Marshall Office. The permit and contract are to follow the guidelines and be in correlation to the list of waste. The amount of waste that is collected by the company will be mentioned in a reporting document produced by the developer monthly. Once a year, the developer will forward the justification to the Marshall office. The report must include all construction sites that are worked with. A simplified inventory of waste also known as waste transfer declaration is expected from construction sites that generate less than 5 tonnes of non-hazardous waste or 100kg of hazardous waste per year. Generated waste is disposed by the waste collection company through contracts with small construction sites while the latter are not required to produce other report than the aforementioned contract. Collected data are then used for preparation of reports to the MoE by Marshall Offices.

20.1.3 Legal framework for sustainable management of CDW

Though provisions on separation of waste in general exist in Poland, they do not specify any provisions on the CDW in particular. Only from 2012, there is an obligation to sort hazardous waste both while collecting it and managing it. The special focus is put on asbestos. While there is no obligation to separate CDW during private construction activities (with an exception of hazardous waste), it is mandatory to sort CDW that is municipal waste. Furthermore, there is a public procurement law which states that special requirements must be fulfilled during public construction work. Preparing the information on waste generated, methods used to generate the CDW and its management are few of these requirements. In case the contractor neglects this obligation, he or she might face penalties.

20.1.4 Targets

Polish targets regarding the preparation for re-use, recycling and recovery are identical to those of the EU, meaning, Poland aims to achieve level of 70% by weight in re-use, recycling and other forms of CDW recovery.

20.1.5 End of Waste (EoW) status

The Act on Waste defines criteria and status of End-of-Waste. Individual type of waste is no longer seen as waste in case it fulfils specific criteria. The criteria are as follows:

- The substance or object is commonly used for specific purposes
- There is an existing market or demand for the substance or object
- The use is legal – meets technical and legal requirements
- The use of it will have no negative environmental or human health impact
- The waste meets requirements defined by EU legislation.

There are no criteria established especially for CDW in Poland.

20.2 Non legislative instruments (best practices, guidelines, recommendations…)

The non-legislative instruments that are dealt with in Poland can be divided into three main topics that together include all the various instruments. The first main topic relates to the two key sustainability initiatives. Those initiatives serve as an instrument by putting together certain standards that must be met in order to earn the initiatives certification. They are BREEAM, DGNB and LEED.

Over 400 buildings had such certification in 2015.

The second topic is a set of guidelines for various actors. Among those belong:

- Guidelines for municipalities regarding implementation of municipal waste
- Guidelines on waste management for households
- Guidelines on backfilling operations

The last topic revolves around the objectives and requirements set in national WMP and the development of Program for Asbestos Abatement in Poland 2009-2032. The main goals of this program are to get rid of and dispose asbestos containing products, minimize negative health effects cause by asbestos and to eliminate effects of asbestos on the environment.

The Programme objectives will be implemented progressively until 2032 when the country is expected to be free of asbestos. Of the 14.5 million tonnes of asbestos containing waste estimated as in 2008, it was planned to dispose [229]:

- about 28%, i.e. 4 million tonnes, by the end of 2012
- about 35% of waste, i.e. 5.1 million tons, between 2013-2022
- about 37% of waste, i.e. 5.4 million tons between 2023-2032

20.3 CDW management performance – CDW data

20.3.1 CDW generation data

According to data from the Central Statistical Office, in 2011, 8.236.900 tons of waste from construction and demolition was generated. In subsequent years, the amount of waste generated decreased significantly to 5.756.200 tons in 2012 and 5.741.600 tons in 2013. The change in the amount of generated CDW constitute a 30% change in comparison. Significant differences in the amount of waste generated in 2011-2012 were caused due to extensive construction projects, such as the organization of EURO 2012. By 2020, the Polish authorities expect to witness a drop of 1-2% annually of CDW generation.

After 2020, it is forecasted that the amount of CDW will stabilize, meaning, the generation of CDW will range from about 6,8 million tons to 7,3 million tons. It was mentioned in the report on implementation of the national WMP that in the period 2011-2013, there was over 730 facilities for CDW treatment which when combined can process over 59 million tons a year[228].

The Table 70 illustrates the amount of CDW generated in the period 2011-2013 by type of CDW. The amounts are stated in thousand tons. Figure 16 shows the generation of CDW in period 2004 to 2012.

Table 70. Amount of CDW generated in the period 2011-2013 by type

EWC	Waste	2011	2012	2013
1701	Concrete, Bricks, tiles and ceramics	679,1	481,9	608,6
1702	Wood, glass and plastics	15,7	16,0	23,1
1703	Bituminous mixtures, coal tar and tarred products	24,5	14,7	67,0
1704	Metals (including their alloys)	635,7	568,8	545,5
1705	Soil (including excavated soil from contaminated sites), stones and dredging spoil	6859,4	4349,3	4475,5
1706	Insulation materials and asbestos-containing construction materials	5,8	4,4	2,8
1708	Gypsum-based construction material	0,1	0	0
1709	Other construction demolition waste	16,6	321,1	19,1
	Total	**8 236,9**	**5756,2**	**5741,6**

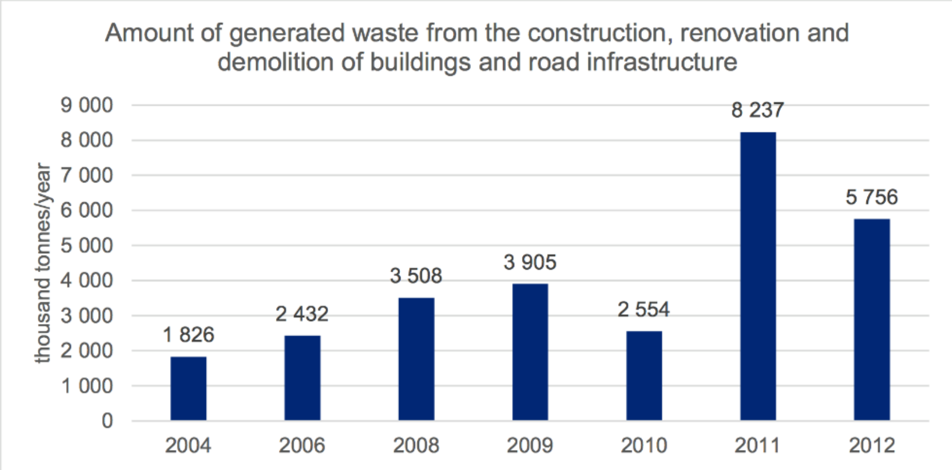

Figure 16. Generation of CDW in period 2004 to 2012 [229]

20.3.2 CDW treatment data

According to the WMP 2022, in 2011-2013, more than 70% construction and demolition waste generated underwent preparation for reuse, recycling and other forms of recovery. Nevertheless, the up to date data are not available. In 2013, 5.616.800 tonnes of CDW underwent recovery processes – this amount constitutes more than 97,8% of the CDW. The recovered waste is mainly used in the construction of new road and rail infrastructure. They are also used for backfilling and hardening of construction sites and road technology. Asphalt waste containing hazardous substances are used to pave roads, roadsides and squares. The Table 71 illustrates mineral CDW generation and treatment [229].

Table 71. Mineral CDW generation and treatment [229]

	Generation	Treatment						
		TOTAL	Energy recovery	Incineration	Recovery other than energy recovery: Recycling	Recovery other than energy recovery: Backfilling	Landfilling	Other forms of disposal
Hazardous	29 215	3 558	0	2 381	827	0	350	0
Non-hazardous	3 481 085	3 012 801	2 749	32	2 043 436	733 703	232 881	0

Source: Study "Environment 2014" of Central Statistical Office based on data provided by the Ministry of Environment

20.3.3 CDW exports/imports data

According to a study *Environment 2014* conducted by Central Statistical Office Inspectorate of Environmental Protection, import of CDW reached level of 2000 tons in 2013. The CDW imported within the EU accounted for 50%. Polish export of CDW was identical to its import, i.e. 2000 tons.

20.3.4 CDW treatment facilities data

The Marshall Offices are the authority responsible for administrative management dealing with CDW treatment facilities. Local governments are obliged to arrange min. 5 / max. 15 waste management plants per region by 2014. As for landfill sites, their absorptive capacity should be sufficient for a period of min. 15 years of utilization [228]. Companies working with waste recovery must obtain a permit for waste treatment activities.

A company or an individual who requires waste collection services has a right to examine how the waste was treated after the collection. The amount of collection companies is assumed to be sufficient, on the other hand, treatment facilities might be lacking in particular regions. Poland still struggles with an insufficiently developed network of plants due to a limited number of sites. There is also a dire need for treatment facilities as currently the majority of facilities focuses on mixed waste. The most common method of disposal of CDW in Poland is landfilling. The recovered CDW is then often used for road and railroad construction.

20.3.5 Future projections of CDW generation and treatment

During 2010 and 2011, Poland invested heavily in major road infrastructure as well as in other constructions. These projects were responsible for generating extraordinary amounts of CDW. The national WMP 2014 forecasted that after the economic crisis, the construction and demolition activity will increase in Poland. The projections were that by the year 2022, the amount of generated CDW per year will revolve around 5,6 million tons [229]. According to the national WMP 2022, the Polish authorities expect to witness a drop of 1-2% annually of CDW generation compared to years 2010-2011. After 2020, it is forecasted that the amount of CDW will stabilize, meaning, the generation of CDW will range from about 6,8 million tons to 7,3 million tons [226].

20.3.6 Methodology for CDW statistics

The Marshall Offices are responsible, among other activities, for collecting information regarding the waste generation in their respective region. Waste holders submit their data to the Marshall Office which uses the data to prepare a report on implementation of the regional WMP. The reports are covering a period of 3 years and the last deadline for submission was on December 31, 2014 – meaning the next report is due in December 2017. The MoE developed guidelines for reporting the implementation of regional WMP. Regarding the CDW, the Marshall Offices should quantify in the report the amounts of CDW generated, recovered, recycled and disposed. The methodology used to gather data on CDW in Poland is in compliance with EUROSTAT guidelines on waste statistics [229].

20.4 C&D waste management in practice

20.4.1 CDW management initiatives

The initiatives to improve CDW management in Poland are rather rare. There were attempts [230] to collect plastic packaging waste generated during the construction work; however, the initiative did not bear fruit. The reason behind the lack of CDW management initiatives might be the unwillingness of construction companies to try recovered materials. The Polish Green Building Council aims to encourage sustainable development in construction field by promoting BREEAM and LEED certification. In Poland, there is no obligation to separate CDW (with an exception of hazardous waste) and thus the majority of construction companies does not want to pay additional costs for sorting of the waste and its proper recovery.

20.4.2 Drivers / barriers to increase CDW recycling

It is not surprising that the high standards in Poland are justified by several measures. When it comes to general public, people seem to demand recovered materials more than they did in past. Simultaneously, construction companies use recovered materials for road construction, railway infrastructure, land levelling and backfilling. In case of construction of a new building, building companies might increase their level of competitiveness by preventing the generation of waste and by separating waste at the construction as investors are often concerned with certification of a building such as BREEAM or LEED. From the legislative perspective, Poland set waste recycling targets identical to those of the EU. It also provides financial and human resources to fight illegal landfilling and strengthen CDW management by conducting frequent inspections [229].

It is true that official statistics illustrate high level of compliance with WMP and high rates of CDW recycling. Nevertheless, these statistics might not be perfectly reliable since there are still difficulties in tracking the CDW data – mainly reporting them to the authorities. At the moment, cases of abandoning waste represent 142.000 tons of waste. Even though Poland recognizes an issue of insufficient enforcement and monitoring and aims to prevent it by enlarged resources, the insufficient controls and insufficient financial penalties for non-compliance prevail. A measure to improve efficient CDW management would be to employ mandatory regulations dealing with recovery of CDW, however, there are neither obligations to recycle CDW nor obligation to use recovered CDW in Poland. Consequently, the use of recovered CDW or recycling is not a priority for construction companies. Most of the construction companies do not consider CDW management and its related costs to the financial plan of the project. The costs of CDW management are seen as costly and the priority is to keep the budget at the lowest possible cost. Last, there are no extended producer responsibility scheme related to construction materials is implemented in Poland.

20.5 CDW sector characterization

20.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements. It is used for construction of buildings, roads and infrastructure.

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes.

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass, generally used for covering roofs, floors, walls, showers, or other objects such as tabletops. Tiles are often used to form wall and floor coverings, and can range from simple square tiles to complex mosaics. Tiles are most often made of ceramic, typically glazed for internal uses and unglazed for roofing.

Asphalt is a sticky, black and highly viscous liquid or semi-solid form of petroleum. It may be found in natural deposits or may be a refined product; it is a substance classed as a pitch. The primary use (70%) of asphalt/bitumen is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete.

Wood is a porous and fibrous structural tissue found in the stems and roots of trees, and other woody plants. It is an organic material, a natural composite of cellulose fibers which are strong in tension embedded in a matrix of lignin which resists compression. Wood has been used for thousands of years for fuel, as a construction material, for making tools and weapons, furniture and paper, and as a feedstock for the production of purified cellulose and its derivatives, such as cellophane and cellulose acetate.

Gypsum is a soft sulfate mineral composed of calcium sulfate bihydrate. It is widely mined and is used as a fertilizer, and as the main constituent in many forms of plaster, blackboard chalk and wallboard. Among other uses, gypsum is used in buildings construction.

Quantitative analysis

The quantitative data concerning the production in Poland are available only for concrete, gypsum, and asphalt [231]. The tables Table 72 Table 73 Table 74 illustrate this production.

Table 72. Concrete production in Poland

	Concrete production (million m^3)		**Growth rate 2006/2008**	**Population (million inhabitants)**		**Production per capita**		**Cement consumption (million tons)**		**Growth rate 2006/2008**
	2006	2008		2006	2008	2006	2008	2006	2008	
PL	14.2	15.8	11.27%	38.16	38.12	0.37	0.41	14.5	16.8	15.86%

Table 73. Gypsum production in Poland

	2005 (tons)		2008 (tons)	Population in 2008		Production per capita		Share to the EU production		Growth rate 2005/2008
PL	1.048.000	1.499.901	38.115.641	0.0393	5.2%	43.1%	1.048.000	1.499.901	38.115.641	0.0393

Table 74. Asphalt production in Poland

	2005 (million tons)		2008 (million tons)	Population in 2008		Production per capita		Share to the EU production		Growth rate 2005/2008
PL	15	15	38.115.641	0.4	5.2%	0%	15	15	38.115.641	0.4

Recovery techniques

- **Concrete**: Landfill, recycling into aggregates for read construction or backfilling, recycling into aggregates for concrete production, re-use of precast elements
- **Brick**: Landfill, recycling, re-use
- **Tile**: Landfill, recycling, re-use
- **Asphalt**: Landfill, recycling in a stationary plant, in-site recycling, material recovery
- **Wood**: Landfill, recycling into derived timber products, energy recovery
- **Gypsum**: Landfill, recycling into new plasterboards (in substitution of natural or synthetic gypsum)

Environmental and economic impacts of CDW waste management

In many EU countries (Poland included), landfilling remains preferred method of non-hazardous CDW disposal. Nevertheless, landfilling might have severe negative impacts on environment in general and human health in particular. Though landfilled concrete, bricks and tiles prove to have negligible impact on groundwater pollution, asphalt, gypsum and wood from construction and demolition sides leave footprints on the environment. As the surface of wood used in construction is often treated with chemicals, its landfill is associated with release of methane emissions which is a greenhouse gas. Landfilling of gypsum poses a threat to environment due to the fact that it releases dangerous hydrogen sulphide gas if in contact with organic waste and exposed to rain. In some cases, asphalt landfill might prove problematic due to the use of tar in the past. If asphalt contains tar, it is hazardous waste and must be treated as such. Tar-free asphalt is not a significant risk to the environment if landfilled. The important issue at hand is not only the focus on CDW impact on groundwater pollution but also the fact that landfills cover considerable area of land which could be used otherwise.

Regarding the treatment of CDW, the preparation for re-use of nearly all CDW does not come without cost. The majority of CDW must be crushed in order to be recycled and it causes several issues – first, it creates dust which might cause serious health problems for workers and second, noise production can have negative consequences for both humans and fauna surrounding the treatment facility.

The clear benefit of re-use of CDW is that there is no need for virgin aggregates to be extracted and be processed. Resources of wood and gypsum are becoming scarce and price of them is increasing significantly. In these two cases, recycling might become encouraged due to financial aspects. For instance, due to a limited amount of raw gypsum, the price of raw gypsum increased more than 50% in the last 3 years [231]. On the other hand, in case of bricks, tiles, cement and asphalt, cost of production from recycled materials does not differ significantly from cost of production from virgin materials.

The re-use of recovered CDW avoids the manufacturing processes which are usually associated with high energy consumption and emissions. For instance, the most negative environmental impacts of concrete derive from cement production. The direct re-use of concrete blocks avoids the production of concrete and potentially also the cement production. Moreover, the carbon footprint for recycled asphalt is lower than for asphalt made of raw materials.

Drivers / barriers to increase recycling

Provided in section 20.4.2

20.5.2 Recycled materials from CDW

As previously mentioned, recycled CDW aggregates are mainly used for construction of roads, railroad infrastructure and for backfilling. Widely recycled CDW include polystyrene, shredded glass, paper and mineral wool shredded with paper.

20.5.3 Market conditions / costs and benefits

The Decree of the MoE on fees for use of the environment defines the fees for landfilling. The Decree specify rates for each waste code; fees for CDW landfilling range from 11.67 PLN to 165.54 PLN (about 2.7 EUR to 38.7 EUR) for tonne of waste [229].

21. PORTUGAL

21.1 Legal Framework – Waste Management Plans and Strategies

The European Commission (EC) and the European Environment Agency (EEA) agreed to enhance efforts to improve knowledge on implementation of waste policies through tasks to review municipal solid waste, management in EEA member countries, using indicators, country factsheets and relevant European Commission studies. Together, these instruments establish a range of waste management targets and broader goals for the years to 2020.

The Legal framework in the field of waste management includes 16 acts, most of which have already been transposed in Portuguese legislation, as indicated in the Table 75:

Table 75. European legislation on CDW management

European Law
1) Framework Directive on waste no. 75/442/EEC, as amended by Directive no. 91/156/EEC.
2) Directive no. 91/689/EEC on hazardous waste.
3) Directive no. 75/439/EEC on the disposal of waste oils, as amended by Directive no. 87/101/EEC and Directive no. 91/692/EEC.
4) Directive no. 91/157/EEC on batteries and accumulators containing certain dangerous substances
5) Directive no. 93/86/EC on the marking of batteries.
6) Directive no. 2000/76/EC on the incineration of waste.
7) Directive no. 94/62/EC on packaging and packaging waste.
8) Directive no. 96/59/EC on the disposal of biphenyls and polychlorinated terphenyls (PCB and PCT)
9) Decision no. 2000/532/EC, as amended by Decision no. 2001/119 establishing a list of wastes (replacing Decision no. 94/3/EC establishing a list of wastes Decision no. 94/904/EC establishing a list of hazardous waste).
10) Regulation no. 259/93 on the supervision and control of shipments of waste within, into and out of the European Community.
11) Directive no. 86/278/EEC on the protection of the environment, and particular of the soil, when sewage sludge is used in agriculture
12) Directive no. 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment, as well as
13) Directive no. 2002/96/EC on waste electrical and electronic equipment (WEEE).
14) Directive no. 78/176/EEC on waste from the titanium dioxide industry.
15) Directive no. 82/883/EEC on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry
16) Directive no. 92/112/EEC on procedures for harmonizing the programmes for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry.

European Law
17) Framework Directive on waste no. 75/442/EEC, as amended by Directive no. 91/156/EEC.
18) Directive no. 91/689/EEC on hazardous waste.
19) Directive no. 75/439/EEC on the disposal of waste oils, as amended by Directive no. 87/101/EEC and Directive no. 91/692/EEC.

In the following sections the legal framework governing CDW management and waste management plans in *Portugal* are explored.

21.1.1 National Legislation concerning CDW

<u>Overview of National legislation in Portugal</u>

- Decree-Law 46/2008 of 12 March (Decreto-Lei 46/2008, de 12 de março) [232],that establishes the legal framework for waste management resulting from construction works or demolition of buildings or collapses, including prevention and reuse and the operations of collection, transport, storage, treatment, recovery and disposal.
- Ordinance 40/2014 of 17 February (Portaria 40/2014, de 17 de junho)[233],establishes the rules for the correct removal of materials containing asbestos, and for packaging, transport and management of the respective CDW generated, regarding the protection of the environment and human health. This Ordinance also aims at clarifying aspects related to the inventory of materials containing asbestos and their characterisation, in the project phase (Ministérios da Saúde, da Solidariedade, Emprego e Segurança Social do Ambiente, Ordenamento do Território e Energia, 2014);
- Decree-Law 73/2011 of 17 June (Decreto-Lei 73/2011, de 17 de junho)[234],transposes the Waste Framework Directive 2008/98/EC, and introducesthe target of incorporating at least 5% of recycled materials or materials containing recycled components, regarding the total amount of raw materials used in public construction works (Ministério do Ambiente e do Ordenamento do Território, 2011);
- Decree-Law 26/2010 of 30 March (Decreto-Lei 26/2010, de 30 de março)[235], obliges the CDW holder from private construction works (with mandatory permit) to keep record on CDW generated (Presidência do Conselho de Ministros, 2010).
- Decree-Law 183/2009 of 10 August (Decreto-Lei 183/2009, de 10 de agosto)[236], establishes the criteria to accept codes 17 01 01, 17 01 02, 17 01 03, 17 01 07, 17 02 02 and 17 05 04 of European LoW in landfills for inert wastes without testing (Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional, 2009);
- Decree-Law 18/2008 of 29 January (Decreto-Lei 18/2008, de 29 de janeiro)[237], establishes the elaboration and implementation of a CDW prevention and management plan for all public construction works (Ministério das Obras Públicas, Transportes e Comunicações, 2008);

- Ordinance 417/2008 of 11 June (Portaria 417/2008, de 11 de junho)[238], defines the documentation which certifies CDW transport and reception at private waste management facilities (Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional, 2008);
- Ordinance 209/2004 of 3 March (Portaria 209/2004, de 3 de março), transposes Decision 2000/532/EC and its amendments concerning the European LoW (Ministérios da Economia, da Agricultura, Desenvolvimento Rural e Pescas, da Saúde e das Cidades, Ordenamento do Território e Ambiente, 2004)[239].
- Ordinance 335/97 of 2 September (Portaria 335/97, de 2 de setembro)[240], regulates the transportation of waste (Ministérios da Administração Interna, do Equipamento, do Planeamento e da Administração do Território, da Saúde e do Ambiente, 1997).

21.1.2 Waste management plans (WMP) and Strategies

Implementation of environmental policies, especially waste policies, is one of the European Commission's key priorities, as confirmed by its proposal for a 7th Environment Action Programme (EC, 2012) and the Roadmap to a resource efficient Europe (EC, 2011). While the EU's Waste Framework Directive (EU, 2008) and Landfill Directive (EU, 1999) set binding targets for recycling municipal waste and diverting biodegradable municipal waste from landfill, EEA analysis indicates large differences in municipal waste management performance between countries (EEA, 2009).

The national Waste Management Plan for 2014-2020 (Resolution of the Council of Ministers 11-C/2015 of 16 March; *Resolução do Conselho de Ministros 11-C/2015, de 16 de março*)[241] includes also the national Waste Prevention Strategy. In this plan, a general description of CDW and the target set on article 11 of the WFD are included. However, there are no new specific measures regarding CDW prevention or CDW management.

Apart from the WMP, there are no other strategic documents/plans in place in Portugal with reference to CDW. However, article 4 of Decree-Law 46/2008 of 12 March, regarding the legal framework for CDW management, established that *'the quantitative and qualitative goals to be achieved in accordance with the goals set by national or EU law applicable to CDW, as well as the priorities, targets and actions for its management will be set out in a specific plan for CDW management, approved in accordance with article 15 of Decree-Law 178/2006 of 5 September (republished by Decree-Law 73/2011 of 17 June)'*. This plan is being prepared by the Portuguese Environment Agency with specific objective to analyze and implement the EU and national targets for CDW [242].

21.1.3 Legal framework for sustainable management of CDW

Concern about the amount of CDW generated and its environmental impact is growing. For this reason, governments and public authorities are reviewing their policies on how these wastes should be managed. In order to improve this management, it is necessary to know the composition and magnitude that should be dealt with, as well as some estimating method of waste generated in a project, in a region or a country.

Despite all the problems that CDW may cause, and difficulties on their treatment, when waste is properly managed become resources, or products that contribute to saving raw materials, conservation of natural resources, avoid climate change and thus to sustainable development, in accordance with the principles of the circular economy.

Waste management

Portugal is facing multiple problems with MSW management and is attempting to tackle them by passing legislation in order to improve the performance of waste management systems. The country has made substantial progress in the waste domain from the situation that existed at the end of the last century when depositing in open dumps was the dominant (if not exclusive) treatment method. Portugal has an average level of waste generation compared to other EU countries (514 kg/cap in 2010). Waste management is currently dominated by landfilling, but Portugal has invested in many other treatment options including incineration, composting and MBT technology. The drivers behind the developments in MSW include the national legislation, which predominantly transposes the EU Directives, and the National Waste Management Plans (PERSU)[243]. There have been two PERSUs in Portugal: PERSU I was ratified in 1997 and covered the period until 2006, when PERSU II came into play which targeted the period 2007-2016. PERSU I set both quantitative and qualitative targets for Portugal's MSW management system following in parallel the developments at the EU level. The main objective of the PERSU I was to eliminate open dumps and divert the waste, according to specific quantified targets, to recycling, incineration and composting. This has been a difficult task, as in 2001, more than 340 dumps were yet to be closed (Magrinho et al., 2006). Despite the plan's success in eradicating the open dumps, most of the targets set were not achieved (Ribeiro et al., 2011). Therefore, by taking into account the need to modernize the MSW system, PERSU II was ratified in 2006. PERSU II aims to eliminate inefficiencies observed in the implementation of the previous plan:

- Adapt EU legislation to Portuguese reality;
- Rationalize the costs;
- Encourage participation of all stakeholders, based on input from all of them;
- Support incineration with energy recovery and MBT as solutions to MSW treatment;
- Introduce separate collection of organic wastes and other measures to divert them from landfills, and
- Maximize by-products utilization. The quantitative targets included in PERSU II are adopted from EU legislation. The legal framework governing waste management has been consolidated over the last few years, with systems for managing certain specific flows, and placing the onus on producers to pursue targets for prevention, separate collection, recycling and other forms of recovery (SOER, 2010). Besides the general frameworks such as PERSU, there are various other decrees regulating specific waste streams or treatment

options (ETC/SCP, 2006). The Ministry of the Environment is responsible for all waste legislation. The organization of the waste management system involves three other types of organizations (Magrinho et al., 2006):

- Municipalities which are responsible for collection of (normally only mixed) waste;
- SGRSU which are entities dealing with waste treatment;
- SPV which is the Portuguese Green Dot System responsible for recycling packaging wastes.

21.1.4 Targets

In Portugal, Decree-Law 73/2011 of June, 17, namely article 7 (principle of the waste hierarchy), paragraph 6, transposes from the WFD the 70% target of preparing for reuse, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous CDW excluding naturally occurring material defined in category 17 05 04 of European LoW.

In order to achieve the mentioned target, article 7 - paragraph 8 defines within the context of public construction works that when technically feasible, it is mandatory to use at least 5% of recycled materials or materials containing recycled components of the total amount of raw materials used. Aside from that statement, there are no other targets in Portugal regarding CDW management.

Also based on historical *Municipal waste management* (MSW)[244] data for Portugal and EU targets linked to MSW in the Waste Framework Directive, the Landfill Directive and the Packaging Directive, the analysis undertaken for each country includes:

- *The historical performance on MSW management based on a set of indicators,*
- *Uncertainties that might explain differences between the countries' performance which are more linked to differences of what the reporting includes than differences in management performance,*
- *Relation of the indicators to the most important initiatives taken to improve MSW management in the country, and*
- *Assessment of the future possible trends and achieving of the future EU targets on MSW by 2020.*

The launch of the second national waste management plan (PERSU II) in 2006 aims at tackling the inefficiencies of the previous national plan and aligning the country with EU standards and targets;

- Increasing the incorporation of waste in the economy – from 56 % in 2012 to 68 % in 2020 and 86 % in 2030 (GGC).
- Achieving 47 kg per person per year of recyclable waste recovered after sorting, by 2020 (PERSU 2020, GGC).

- Increasing the preparation of construction and demolition waste for reuse, recycling and other forms of material recuperation to 70 % by 2020 (PNGR 2020).
- Increasing the preparation of municipal waste for reuse, recycling and other forms of material recuperation to 50 % of the recyclable content, until 2020 (PERSU 2020).
- Reducing waste production by 18 % by 2020 (PNGR 2020).

21.1.5 End of Waste (EoW) status

The Decree-Law 73/2011 of 17 June has set requirements for substances or objects resulting from a production process, which can be considered as by-products and not waste. The Decree-Law also establishes conditions for end of waste (EoW) criteria. The by-product and EoW criteria, are explained respectively in articles 44 a) and 44 b). Both concepts introduce a distinction between waste and non-waste, but they have different legal context.

Regarding article 44 a), a by-product or a non-waste material is a substance or object resulting from a production process, whose principal purpose is not its production when the following conditions met:

- the material's or substance's future application is determined;
- the substance or object can be used directly without further processing, aside from that which takes place via normal industrial practice;
- the production of the substance or object is an integral part of a production process;
- the substance or object fulfils the relevant health and environmental requirements in regards to its intended use, meaning that they do not lead to overall adverse impacts from an environmental or human perspective.

The classification of a by-product must be made by stakeholders, through sectorial associations or individually, at the Portuguese Environment Agency, by submitting a specific application form. The application is evaluated within 90 days with a submission fee of € 5 000.

The by-product classification does not apply to waste that is excluded from the scope of national waste management legal framework (Decree-Law 73/2011 of 12 June), nor to the consumption of waste generated in production activities (e.g. empty packages).

Prior to the submission of the application form, it is essential to evaluate if the substance or object has the potential to be classified as a by-product. To date, none of the existing classifications of by-products in Portugal is applicable to CDW[242].

Taking into account article 44 b), EoW criteria can apply to certain waste that has undergone a recovery operation, including recycling, and complies with specific requirements developed in accordance with the following conditions:

- the substance or object is commonly used for specific purposes;

- a market or demand exists for such a substance or object;
- the substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
- the use of the substance or object will not lead to overall adverse environmental or human health impacts;
- the criteria may include limit values for pollutants and take into account any adverse environmental effects of the substance or object.

In the absence of common EU criteria, the National Waste Authority may, after consulting the directly interested economic operators or their representative structures, set specific requirements that must be fulfilled in order a certain object or substance to be considered a by-product or qualify for EoW status. In the present case, Portuguese Environment Agency should:

- prepare an Ordinance specifying the requirements for waste declassification;
- communicate the decision to the European Commission through the Portuguese Institute for Quality, in accordance with Decree-Law 58/2000 of 18 April (Decreto-Lei 58/2000, de 18 de abril), which provides the rules to administrative procedures in these cases.

Once it is declassified, the waste legal framework is no longer applicable to that specific object or substance, but the legislation concerning products or substances applies, namely the Regulation (EC) 1272/2008 (classification, packaging and labelling) and the Regulation (EC) 1907/2006 (REACH - EU regulation concerning the Registration, Evaluation, Authorization and restriction of Chemicals).
Currently, no specific EoW criteria for CDW exist in Portugal [242].

21.2 Non legislative instruments (best practices, guidelines, recommendations…)

Any other instruments that may specify how the country is addressing the question of CDW management are highlighted, as these instruments might be creating conditions for a sustainable management of CDW.

Instruments

- Description Sustainability standards that cover CDW (e.g. BREEAM)
- Level of occurrence (Yes/No) Key Scope/Exemptions Yes/LiderA Sustainability Assessment System/PTPC Portuguese Technological Platform to Construction/SBTOOLPT Adaptation of the assessment tool for sustainable construction SBTool International
- Year established and policy reference LiderA: 2005/ PTPC: 2011/ SBTOOLPT: not available

Identification of technical guidelines/standards/ codes of practice for use of CDW in construction application

- Description of guidance/ tool: *Code of practice RERU (Outstanding Regime for Urban Rehabilitation).*
- Scope: Consists in a set of rules, releasing the works of urban rehabilitation from certain technical standards for the construction (because these standards are oriented to new construction).
- Year established/ produced: 2014 Decree-Law 53/2014 of 8 April (Decreto-Lei 53/2014, de 8 de abril).
- National or regional (specify if regional): National.
- Description of guidance/ tool: *Best Practices Guide for Municipalities Sustainable Development*
- Scope: Supports municipalities on implementation of eco-conscious measures, promoting in Public Administration more efficient and responsible actions in terms of energy and environment.
- Year established/ produced: 2013.
- National or regional (specify if regional): National.

21.3 CDW management performance – CDW data

In this section the performance of CDW management in Portugal is presented. This section particularly seeks to gather all available data and information about CDW generation and treatment, exports/imports, and treatment facilities.

21.3.1 CDW generation data

In Portugal, CDW generation data are recorded every year in the Integrated Map for Waste Registration (MIRR) of the Integrated Registration System developed by the Portuguese Environment Agency (SIRAPA), namely in on-line forms available to waste producers.
Data can be disaggregated by economic sector, taking into account the National Classification about Economic Activities, Rev. 3 (fully integrated at 4 digit level with the NACE Rev. 2.). However, it is not possible to separate data by type of activity (e.g. new construction, demolition).
Households are not included in the data, because municipal waste systems operators have no means and capacity to do such evaluation and distinction of the proportion of waste resulting from households and businesses (industry, commerce and services).
The annually reported CDW data in SIRAPA can be obtained from two sources: Statistics Portugal (INE – Instituto Nacional de Estatística) and the Portuguese Environment Agency (APA – Agência Portuguesa do Ambiente). According to the Waste Statistics Regulation, data presented between 2008 and 2012, has some methodology differences.

21.3.2 CDW treatment data

Similarly to CDW generation data, CDW treatment data are recorded every year in the platform MIRR of SIRAPA, namely in the on-line forms available for the waste management companies.

Data can be disaggregated by economic sector, taking into account the National Classification about Economic Activities, Rev. 3 (fully integrated at 4 digit level with the NACE Rev. 2.). However, it is not possible to disaggregate the data by type of activity (e.g. new construction, demolition).

Taking into account the data recorded every year in SIRAPA, data to quantify CDW treatment can be obtained from two sources: Statistics Portugal and the Portuguese Environment Agency. Statistics Portugal presents data between 2008 and 2012, according to Waste Statistics Regulation. CDW treated on-site are not reported in the data for recycling. There is no estimated volume for CDW treated per year on-site in Portugal. This fact can interfere with the quality of the data reported, although this interference cannot be quantified.

21.3.3 CDW exports/imports data

The European legal framework of trans-boundary movements of waste is the Regulation (EC) 1013/2006 from the European Parliament and the Council of the European Union of 14 June. The national Decree-Law 45/2008 of 11 March (Decreto-Lei 45/2008, de 11 de março), ensures the implementation and the compliance with the Regulation.

The Portuguese Environment Agency provided data on trans-boundary movements of CDW for exports (2013-2014) and imports (2012-2013)[242], the first two tables below illustrate export data (the first table organized by LoW code and the second table by country). The consecutive tables outline import data (the third table organized by LoW code and the fourth table by country). In the case of exports and imports alike, hazardous CDW represent a small percentage of the total, always less than 1.4% of the annual amount of CDW generated.

Table 76. Export data organized by LoW code. Source: APA (2015)

CDW exports (tonnes)					
LoW code		2013		2014	
17 01 02	Bricks	0.39	0.39	4.94	20.44
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	-		15.50	
17 02 01	Wood	-	5.00	0.35	183.67
17 02 03	Plastic	5.00		183.32	
17 04 01	Copper, bronze, brass	1 957.51	3 535.02	3 433.87	5 602.92
17 04 02	Aluminium	551.63		1 139.09	
17 04 03	Lead	23.69		2.44	
17 04 04	Zinc	180.28		167.70	
17 04 05	Iron and steel	243.92		307.46	
17 04 06	Tin	-		9.20	
17 04 07	Mixed metals	131.69		-	
17 04 11	Cables other than those mentioned in 17 04 10	446.30		543.16	
17 09 02*	CDW containing PCB	0.67	0.67	-	-
Total			**3 541.08**		**5 807.03**

Table 77. Export data organized by country. Source: APA (2015).

CDW exports (tons)		
Country	**2013**	**2014**
Belgium	26.70	-
Brazil	162.00	-
China	999.98	2673.10
Korea (Republic of)	20.80	
France	75.31	-
Germany	22.90	-
Greece	-	68.54
Hong Kong	-	141.62
India	779.46	464.42
Italy	23.60	49.38
Netherlands	24.88	-
Spain	1332.25	2364.05
Switzerland	41.16	25.12
Thailand	52.84	-
Total	**3541.08**	**5807.03**

Regarding 2013-2014 export data, the most representative four-digit chapter of the LoW is 17 04 (metals, including their alloys).

Table 78. Data organized by LoW code and the fourth table by country.

CDW imports (tonnes)					
LoW code		2012		2013	
17 01 01	Concrete	909.70	2 563.92	-	144.50
17 01 07	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	1 654.22		144.50	
17 02 01	Wood	43.18	54.82	103.44	111.27
17 02 02	Glass	4.56		0.60	
17 02 03	Plastic	7.08		7.23	
17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	5.88	5.88	-	-
17 04 01	Copper, bronze, brass	360.60	4 072.70	717.13	4 296.43
17 04 02	Aluminium	201.12		88.36	
17 04 03	Lead	176.40		46.81	
17 04 04	Zinc	263.37		105.20	
17 04 05	Iron and steel	1 886.58		2 888.09	
17 04 07	Mixed metals	965.88		359.98	
17 04 11	Cables other than those mentioned in 17 04 10	218.75		90.86	
17 05 03*	Soil and stones containing dangerous substances	47.50	539.44	-	-
17 05 04	Soil and stones other than those mentioned in 17 05 03	491.94		-	
17 06 01*	Insulation materials containing asbestos	9.74	18.86	-	72.40
17 06 04	Insulation materials other than those mentioned in 17 06 01 and 17 06 03	9.12		5.32	
17 06 05*	Construction materials containing asbestos	-		67.08	
17 08 02	Gypsum-based construction materials other than those mentioned in 17 08 01	-	-	6.96	6.96
17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	218.09	218.09	267.66	267.66

CDW imports (tonnes)		
LoW code	2012	2013
Total	**7 473.71**	**4 899.22**

21.3.4 CDW treatment facilities data

According to the national Waste Management Plan (Resolution of the Council of Ministers 11-C/2015 of 16 March), Portugal has landfills for inert CDW disposal distributed as described in the following table. These inert CDW landfills are compliant with EU legislation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723583

Table 79. Data landfills in Portugal for inert CDW disposal. Source: APA (2014b).

Territorial unit	Inert disposal landfills		Capacity[56]	
	Sector	N.º		
Portugal mainland	Public	3	Licensed capacity (tonnes): Expected operating capacity (tonnes): Anticipated useful life (years):	103 156 100 437 37
			Licensed capacity (tonnes): Expected operating capacity (tonnes): Anticipated useful life (years):	420 000 399 869 13
			Licensed capacity (tonnes): Expected operating capacity (tonnes): Anticipated useful life (years):	160 000 133 132 13
	Private	7 (quarries)	*n.a.*	
Autonomous Region of Azores	Private	4	*n.a.*	
Autonomous Region of Madeira	Private	2	*n.a.*	

Data regarding the inert CDW landfills were only available for Portugal's mainland. Lack of information can also be observed: i) concerning the capacity of the landfills and if it will increase or decrease, despite the fact of the slowdown of the construction sector for the last years has decreased the amount of CDW generated; ii) the amount of CDW planned to be used for covering/rehabilitation of existing landfills; and iii) data on mobile and fix treatment units available.

Regarding the facilities for CDW treatment, while quarries can use CDW for landscape rehabilitation purposes and furthermore be considered as a backfilling operation, it has not been reported as such. There are also sorting facilities. No consistent information for the CDW treatment capacity is available, and therefore it is not possible to evaluate the relation between CDW generation and treatment. A study for the CDW stream conducted by the Portuguese Environment Agency (APA, 2015) indicates the number of licensed operators by treatment code (R or D) for 2009. Regarding the operation R5 (recycling/reclamation of other inorganic materials) and considering only the mainland of Portugal, the distribution is the Table 80:

Table 80. Treatment facilities data. Source: APA (2015).

LoW 4-digit code		Number of facilities
17 01	Concrete, bricks, tiles and ceramics	17
17 02	Wood, glass and plastic	7
17 03	Bituminous mixtures, coal ta rand tarred products	8
17 04	Metals (including their alloys)	6
17 05	Soils (including excavated soil from contaminated sites), stones and dredging spoil	13
17 06	Insulation materials	4
17 08	Gypsum-based construction material	6
17 09	Other construction and demolition wastes	17

21.3.5 Future projections of CDW generation and treatment

There are no projections available about future CDW generation, treatment, planning of management operations or planned waste management infrastructures.

21.3.6 Methodology for CDW statistics

There are two sources of CDW management data in Portugal, namely Statistics Portugal (from 2008 to 2012) and the Portuguese Environment Agency (only for 2009).

Statistics Portugal reports to Eurostat data regarding CDW management according to the respective guidelines, with few adaptations.

Regarding waste generation, the data was collected according to national legislation through the national waste registration platform, the MIRR.

Waste producers and waste management operators are obliged to report data through the MIRR platform, being identified according the following criteria:

- all businesses and individuals running local units (establishments) with 10 or more employees which generate non municipal waste;
- all businesses and individuals responsible local units which generate hazardous waste;
- all businesses and individuals performing waste management as their economic activity;
- all businesses and individuals performing waste collection and transportation as their economic activity;
- all businesses responsible for municipal waste management systems;
- all businesses responsible for separate systems for the management of specific waste streams;
- all businesses and individuals which participate on waste markets whether as traders or brokers;
- all businesses which produce and/or place on markets specific products that require registration according the legislation on specific waste streams like packaging, used tires,

mineral lubricants, end of life vehicles, batteries and accumulators, electrical and electronic equipment, etc.

Although data reported by waste producers is provided by local units, data matching on waste is made at the business level. It is currently not possible to have a single code to identify the local units, as it is challenging to match data at local units' level. Therefore the sample size and selection is made at the business level (enterprise), as well as the matching of quantities of waste generated by local units and the businesses sample selected from the statistical office registers database (statistical units register). The specification of the scope of the data and the respective statistical units for sampling/stratification and estimations is done at business level (enterprises).

Concerning waste treatment, data on quantities treated are based on the information reported by the waste producers and waste operators according to the specific web forms. The data reported by producers and waste operators include a registration code declaring the waste management operation (R or D codes). The amounts of waste generated and managed or treated do not match because a significant number of businesses identified as final treatment or end of cycle of waste management some of the R and D codes are not covered (namely: D8; D9; D11; D12; D13; D14; D15; R12 and R13).

In collaboration with the Portuguese Environment Agency, Statistics Portugal made recent changes in Waste Statistics for the 2012 reference year, taking into account the following aspects:

- Taking into account the experiences from previous years, reported outliers, which correspond to higher than the maximum or lower than the minimum values compared to previous years of reported waste quantities, are excluded or re-examined;
- Data from waste operators were superimposed with data reported by waste producers in order to increase the coverage of reporting (including data from businesses which not report and fill in the webform for waste producers) and also to improve the data quality for some replies. Validation of data was performed by comparing the different forms of reporting (both from waste producers and waste management operators) in order to eliminate duplications and to avoid double counting which results from the integration of data.

21.4 C&D waste management in practice

In Portugal, according to the *Management and C & Waste Report of the Euorpa DG ENV*, the generation of CDW in Portugal can be estimated at 1.09 t / hab / year.

21.4.1 CDW management initiatives

Since the adoption of the *Thematic Strategy on the Prevention and Recycling of Waste*, the Commission has taken continuous action to make the EU waste legislation more cost-effective in order to provide the basis of sustainable growth.

Waste prevention remains a clear priority in waste management. Since the adoption of the Strategy, the Waste Framework Directive (WFD) introduces a number of new provisions aiming to maximize prevention efforts, in particular, through national waste prevention programmes. The Commission will publish prevention guidelines and update its set of best practice examples from across the EU.

In this section the "on the ground" CDW management in Portugal is presented. Current and specific CDW obligations, initiatives, voluntary agreements and any other management practice are outlined

a) **Description of initiative:** RCD Valor
   Scope: Investigates the replacement of the natural soil as backfill materials in structures reinforced with geosynthetics (walls and embankments), regarding economic and environmental sustainability in the construction sector.
b) **Description of initiative:** Multi Valor RCD – Optimization of the Process of Recovery of CDW Trough Mechanical, Physical, Chemical and Environmental Characterization.
   Scope: Extend the range of marketed products and improve their quality. Optimization model of the production process. Comply with legal requirements in terms of recovery. Demonstrate for the companies the potential of CDW.
c) **Description of initiative**: SUPREMA - Sustainable application of construction and demolition recycled materials in road infrastructures
   Scope: The promotion of the sustainable use of CDW in pavement base and sub-base layers and in capping layers, by improving the knowledge concerning the mechanical and environmental characteristics of these materials, their performance as unbound aggregates and the determination of parameters to be used in pavement design.

21.4.2 Drivers / barriers to increase CDW recycling

Drivers and barriers to increasing CDW recycling were identified essentially through communication with relevant stakeholders and are presented in the table below. The stakeholders contacted and that gave their contribute to the present task are: the Portuguese Environment Agency, three Commissions for Coordination and Regional Development (Norte, Centro and Algarve), the Portuguese Association of Waste Management Operators and Recyclers (APOGER), the Industrial Association of Construction and Public Works (AICCOPN), the National Association of Portuguese Municipalities (ANMP) and two environmental non-governmental organizations (Quercus [253] and GEOTA – Grupo de Estudos de Ordenamento do Território e Ambiente). Additionally, a background document addressed to stakeholders, produced by the Portuguese Environment Agency, entitled "How to achieve the target of 70% of recovery of CDW in 2020?" was used.

21.5 CDW sector characterization

The following actors are involved in the management of CDW in Portugal: national waste authority (Portuguese Environment Agency), regional waste authorities (five Commissions for Coordination and Regional Development), construction companies, private waste management companies, municipalities and MSW management systems. National and regional authorities are responsible for licensing and monitoring of CDW policies and management activities.

The construction companies existing in Portugal are organized in classes of qualification. It is possible to conclude that, regarding the maximum values of permissible works, the small and medium sized enterprises are the most relevant in the Portuguese construction sector.

In 2013 FCT-UNL produced a report regarding the CDW management in 48 municipalities from the North Interior Region of Portugal. The construction companies were contacted by surveys and telephone, with the main goal of identifying the means by which companies implement the planning and management practices of CDW. The study concluded that large construction companies which responded to the survey affirmed that they comply with legal requirements through the following practices and documents: i) Environmental Management Plan to the construction work; ii) Plan for the Prevention and Management of CDW (in the case of public works); iii) consideration of construction methods oriented to selective demolition; iv) imposition of contractual provisions in contracts for subcontractors; v) construction site planning, taking into account the logistics directed to the management of CDW; and vi) consideration of the best available technologies that enable to extend the life cycle through the reuse of materials.

Concerning the construction phase, those companies said that they implemented some kind of action in respect to the management of CDW, namely: i) sorting and minimizing the generation and the hazardousness of CDW; ii) reusing uncontaminated soils and rocks; iii) reusing materials on site; iv) recycling on site; and v) transportation to licensed waste management companies, including landfills.

Additional procedures to those required by law were also confirmed the companies: i) recording environmental monitoring and measurement data (including transportation); ii) operational control procedures (work instructions); iii) a work waste generation map; iv) a general waste management plan; v) a recording map regarding CDW management companies and permits; and vi) training and awareness of workers.

21.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

The construction industry in *Portugal* does not have a tradition in re-using or recycling wastes, which are generated in construction and demolition activities. In Portugal, about 7.5 million tons of waste are produced every year [249], representing 20% of the total volume of waste generated[250]. In this context, in order to preserve the environment and guarantee a sustainable growth, a great number of environmental regulations and initiatives have been developed. Most of these laws seek to minimize and control CDW production.

Product description and applications

Nowadays, a greater effort is being made to try to recover and reuse this kind of materials. As a result, the CDW material recovery in Europe has evolved from 28% at the beginning of the decade [252] to current 50%. After of the previous data, a summary about the characteristics of these materials as wastes is presented [296].

Concrete

Concrete is the predominant material in foundations and structures. It can be recycled as aggregate for new concrete, but to do this, it needs to be cleaned of masonry waste as well as wood, metals and plastics. It can also be used in the modification of the landscape, for example in gardened zones or in civil works as sub-bases of roads or filling of embankments. Depending on the type of work and the subsequent use of the waste, the crushing treatment will be different. On the other hand, the dust produced in the extraction of stones can be used as an aggregator and achieve a stony appearance in the manufacture of monolayer mortars. It can also be recycled into prefabricated concrete elements such as beams, pillars, joists, panels, alveolar slabs, pipes or pieces of urban furniture. Ultimately, they could be placed in vats next to other inert debris and taken to landfill and debris.

Bricks, tiles and ceramic waste

This material forms part of the main component of products fundamentally used in walls of facade and interior partitions, mainly bricks, tiles, and ceramics. They therefore account for a fraction of the CDWs. It is very usual to cut these pieces or to do rubs to facilitate the passage of the facilities, so it is advisable to prepare a space for the storage in order to be reused in the same work or in other place. If the recycling is not viable, it can be stored as debris or rubble from work site together with other inert CDWs (aggregates, soil ...) and can be deposited in controlled landfills. Stoneware can also be recycled, although the process is more complicated because of its diversity and small amount. Thus, it can ultimately be used as filler or storage material in controlled landfills. Porcelain waste can be used as filling of works and highways or for the manufacture of pre-crushed recycled concrete.

Asphalt waste

In construction, they originate mainly in the installation of waterproofing systems for roofs and basement walls. They can be recycled as asphalt or as fill mass in the work outside it, in a plant, by cold or hot processes. Efficient selective collection must be carried out without deterioration of the material. For this, it is necessary to carry out a pretreatment for the separation of other materials adhered in the contact zone, mainly residues of thermal insulation (glass fiber, polystyrenes) or separating layers (geotextiles, mortars ...). Subsequently a grinding should be carried out to achieve a uniform size for use in other mixtures.

Wood waste

Represents a significant proportion in CDW in Europe. The wood content in mixed CDW varies in between different EU countries and can reach up to 40% by weight, especially in countries where significant amounts of wood are used in the building sector. Wood waste includes clean lumber, but also painted or treated wood, plywood, pallets and furniture etc. Intact, massive wood parts might be reused for furniture, flooring, cabinets or other specialist reuse. Waste wood can be used for material recycling or energy recovery, depending on the quality and characteristics of the waste wood. The mixture of different wood qualities in CDW, like hardwood and softwood, engineered wood fractions (chipboards, particleboards etc.) and painted and/or treated wood complicates the material recycling, especially for higher grade applications.

<u>Gypsum waste</u>

Gypsum waste is usually generated in the trim and plaster coatings phases. Concrete elements (columns, walls, joists, etc.) must be covered with plaster because their sulfate content renders them unusable as components of a new concrete. They should be stored in rubble dumps. This type of gypsum waste from renovation, refurbishment and demolition works is more likely to present a certain degree of contamination, which can be in the form of nails, screws, wood, insulation, wall coverings etc. For this waste to be recyclable, it is required that the equipment processing the waste is capable of separating such contamination from the gypsum to arrive at a pure recycled gypsum.

Quantitative analysis

In the next figure, a data example of the composition of CDW generated in the coastal region, in the north of Portugal is shown:

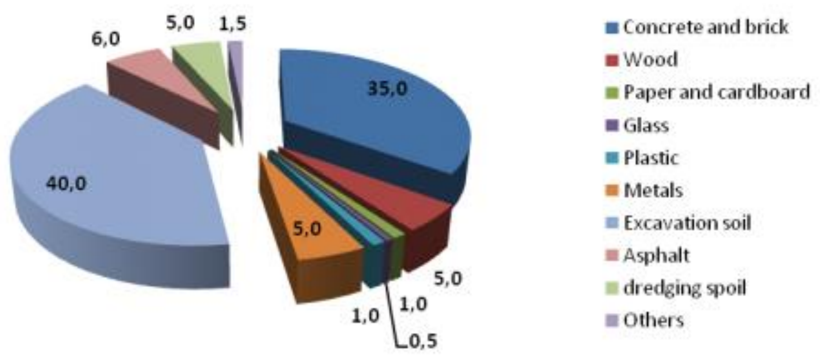

Figure 17. Composition of CDW generated in the coastal region, in the north of Portugal (Source: Pereira et al.)[251]

Depending of final use the different materials in study (Concrete, bricks, tiles and ceramic, asphalt, wood, gypsum), there are a number of treatment requirements that should be evaluated for use these material as waste. These requirements are related with the specific characteristics for each material for can be used as demolition and construction wastes

Recovery techniques

<u>CONCRETE</u>

Although an important fraction of concrete waste is still landfilled within the EU, this practice is being increasingly discouraged. The main options in Portugal for re-use, recycling and other material recovery of concrete waste are described below.

✓ **Re-use**

Concrete can be re-used in various ways in its original form. An example is to leave the concrete structure in place while modernizing the inside space or façade/curtain wall of the building.

Another option is the re-use of specific concrete elements with little processing: pre-fabricated elements and concrete blocks are cut in smaller elements and cleaned of mortar. This requires the careful and therefore time-consuming dismantling of the building to avoid damaging the elements and the transportation to the other construction site.

✓ **Recycling and other material recovery**

Concrete can be reprocessed into coarse or fine aggregates.

The first step is to remove all impurities such as insulation and steel reinforcement before crushing and grading. As a consequence, an effective sorting out at the construction site or at the treatment facility is essential to maximize the recycling potential. Mobile sorters and crushers are often installed on construction sites to allow on-site processing. In other situations, specific processing sites are established. Sometimes machines incorporate air knives to remove lighter materials such as wood, joint sealants and plastics. Magnet and mechanical processes are used to extract steel, which is then recycled.

Once sorted and processed, these aggregates can be used as such in road works, or reintroduced into the manufacturing of concrete. These different possible applications are described below.

Coarse aggregates can be used for road base, sub-base and civil engineering applications. Finish research has found that recycled concrete specified to an agreed quality and composition in the sub-base and base layers can allow the thickness of these layers to be reduced due to the good bearing properties of the material. Indeed, for such an application the unbound cementitious material present in recycled aggregates has proved superior behavior than virgin aggregates such that the strength is improved providing a very good construction base for new pavements.

Therefore, the use road construction sector represents one of the main applications for recycled concrete aggregates and can significantly contribute to reaching the 70% target (the demand of recycled aggregates for road construction could already buffer up to 75% of the concrete waste generated).

Coarse aggregates can also be used as a filling material in quarries (referred to as backfilling) which is in practice especially in Eastern Europe whereas in Western Europe quarries are rehabilitated into leisure spaces. Crushed concrete can also be used in earthwork constructions, to build streets, yards and parking areas, as backfilling for pipe excavations, environmental construction, foundations for buildings, etc.

Fine aggregates can also be obtained from concrete waste and used in place of natural sand in mortars. However, the use of recycled concrete fine aggregates could affect directly the mortar content and therefore its workability, strength and can cause shrinkage due to high water absorption. This could increase the risk of settlement and dry shrinkage cracking. For these reasons, recycled fine aggregates are not used in the production of structural concrete. Moreover, the contamination of concrete with gypsum may hinder the recyclability of the material, as cleaning represents important additional costs, both economic and environmental.

The above applications are often referred to as "down-cycling"[254] as opposed to reintroducing recycled concrete directly into concrete production, where it can be used as a substitute to natural aggregates. Both coarse and fine recycled aggregates can be used in concrete production. However, as cement is not recyclable, this option still requires the consumption of virgin cement. Technically, the use of recycled aggregated in the production of concrete is limited for structural reasons.

BRICKS, TILES AND CERAMIC

✓ **Recycling**

A high proportion of ceramic CDW is well suited to being crushed and recycled as a substitute for newly quarried (primary) aggregates in certain lower grade applications such as engineering fill and road sub-base. This practice has been common (though not necessarily widespread) in several MS for many years[255].

Using bricks, tiles and ceramics waste from demolition sites raises however some issues. Indeed, if the technical criteria for the use of granulated ceramic material are few, it needs to be absolutely free of contaminating elements such as mineral wool, concrete, heavy metals and PAHs77 (Polycyclic Aromatic Hydrocarbons) that may leach and cause ground water pollution. This often mixed and contaminated fraction needs therefore to go through cleaning, crushing and sieving processes before further recycling.
The different recycling options promoted by the European Tiles and Bricks Association[256] are described below:

- To fill and stabilize minor roads, especially in wet areas such as woods and fields. The practice is common in countries that lack adequate stone supplies such as Denmark. The material is generally used uncrushed.
- Crushed clay bricks, roof tiles and other masonry can be used on larger road building projects, especially as unbound base material. It is used to build roads in countries such as Germany, Denmark, the Netherlands, Switzerland and UK. In Germany, the maximum brick content for such use is 30%, due to quality requirements for frost attacks and impact resistance. The material replaces natural materials, such as sand and gravel, which are normally used in large amounts for this purpose.

- Aggregates for in-situ. Crushed clay bricks and other masonry can also be used to level and fill pipe trenches. The fine crushed material will replace natural materials such as sand.
- Crushed clay bricks, tiles and other masonry can also be used as aggregate in concrete. The crushed material replaces other raw materials such as sand. This is commonly practiced in Austria, Denmark, Switzerland and especially the Netherlands[296].
- Tennis sand produced by crushing red bricks and roof tiles. The fine surface layer is laid over courser-grained layers that can comprise crushed clay brick matter. The process is most efficient when it occurs at brick or tile factories where there is an abundance of scrap material.
- Crushed bricks and tiles can also be used as plant substrates. The material may be mixed with composted organic materials and is especially suited for green roofs: the porosity of the material allowing retaining water plants can rely on during dry periods.

✓ **Re-use**

Extracting roof tiles and storing them for re-use is not difficult and bricks that are left over from building projects can also be diverted to other uses among which the incorporation into new buildings : for example, a new architectural trend in Berlin is to reuse facing bricks in new buildings. To do that, building deconstruction is imperatively required. However, these materials are often contaminated which raises several issues:

- Cleaning bricks is time consuming, difficult and dusty work that, if mechanized, is apparently rarely successful.
- Cement rich mortars are difficult to remove. In countries like Greece, where mortar from ancient constructions is a full ceramic material, it does not need to be removed.
- Excess mortar dust can inhibit the adhesion between mortar and bricks and lead to weaker masonry, depending on the mortar composition.
- Bricks may vary in quality. It is therefore difficult to assess the strength and load-bearing capacity of masonry made from recycled bricks. European and national standards are very strict and it is extremely difficult to be sure that re-used bricks used in new structures will be durable.
- Due to the difficult nature and high labor costs associated with the process, the use of re-used bricks may be more expensive than the use of new bricks.

<u>ASPHALT</u>

Landfilling and energy recovery not being recognised as interesting options by the Asphalt Industry because of the associated costs and the loss of a "secondary raw material", the recovery and recycling of reclaimed asphalt have become more widespread in the last decades. If reclaimed asphalt is free of contamination, it can be guaranteed that the total amount of this reclaimed asphalt can be recovered or recycled as a construction material.

Strict guidelines on the nature of the reclaimed material (size distribution, bitumen content, filler content, bitumen viscosity or hardness, etc.) are enforced in the asphalt industry to guarantee good quality end materials.

A distinction is made in the following subsection between recycling, where the reclaimed asphalt is reprocessed into new mixes, and other forms of material recovery.

✓ **Recycling**

Recycling means adding the reclaimed asphalt to new asphalt mixes, with the aggregates and the old bitumen performing the same function as in their original application. Therefore, reclaimed asphalt replaces virgin aggregates and part of the binder. If asphalt is known as 100% recyclable material, the recycling rate depends on the applied technique.

The recycling processes can be divided into two major methods: hot or cold mix recycling techniques. These can be further sub-divided into stationary plant or in-situ recycling. Stationary plant recycling (or "Offsite recycling") consists in removing the material from the site to a plant located elsewhere which recycles the reclaimed asphalt in order to re-introduce it either on the original project or on other projects. In-situ recycling allows the reclaimed material to be incorporated directly back into the new asphalt pavement under construction or maintenance.

The recycling options that are further described in this chapter are available since 1975 and are considered at the point of being able to deal with the current amount of recycled asphalt.

Within both the cold and hot recycling process, screening and crushing of the reclaimed asphalt could be needed and special storage facilities at the mixing plant may be necessary. Modern plants are engineered to facilitate the addition of reclaimed material.

The maximum amount of recycled material that can be incorporated in the new mix is determined by the mixing equipment but also by some parameters related to the old asphalt like consistency of material, moisture content, etc. To achieve the highest levels of recycling it is necessary to either confirm the lack of variability in the feedstock or to have precise data on its range of properties. The requirements for reclaimed asphalt are formulated in the European Standard EN 13108-8 "Reclaimed asphalt".

✓ **Other forms of material recovery**

Material recovery refers to the utilization of reclaimed asphalt as road base course material, with the recovered aggregate and bitumen performing a lesser function than in the original application. To this end, reclaimed asphalt has to be crushed and sieved into different fractions for more accurate mix designs.

WOOD

The main existing options for recovery are the following:

- Energy recovery
- Recycling in the production of derived timber products
- Other forms of material recovery: landscaping, animal bedding, equestrian surfaces, composting, etc.

Before the recovery of wood waste, pre-treatment steps are usually required.

✓ **Pre-treatment**

The pre-treatment applied to bulk wood CDW are the following:

- Manual sorting to remove contaminants
- Single-stage, two-stage or three-stage crushing
- Segregation of ferrous and non-ferrous materials (by magnets or cyclones)
- Segregation of minerals like concrete through sieving
- Segregation of light-weight elements like plastics through single-stage or multi-stage air sieving

✓ **Energy recovery**

Ways to obtain energy from wood waste can be:

- In small heating systems
- In heating systems requiring authorization
- In facilities for gasification
- In facilities for the production of cement and cement clinker
- In municipal waste incinerators

Energy recovery is, most of the time, the only option available for wood waste contaminated with hazardous substances. Moreover, it is encouraged by European (Directive on the production of electricity from renewable energy sources) and national policies on renewable energies.

✓ **Recycling into derived timber products**

In the past few years, the wood recycling has known improvements along with the development of companies dedicated to this activity. Wood CDW can be remanufactured into high added-value products such as medium density particle boards or fibre boards or even wooden plastic that can contain a high proportion of recycled materials.

The particle board production in the EU-27 is estimated to be around 30 million m3. 1m3 of particle boards necessitating 0.65 tons of wood on average, 19.5 million tons of wood are needed each year to sustain the European production of particle boards. The share of post-consumer recycled wood input into this production shows high geographical differences (from 20% in France to 80% in Italy), and is estimated to reach 24% on average (5 million tons). This represents 25% to 50% of the CDW wood generated in Europe. This estimation is in line with the average EU-27 recycling rate of 31% proposed by the JRC [298].

✓ **Other forms of material recovery**

Other forms of recovery of non-contaminated wood waste include:

- Landscaping, where recycled wood can be used as decorative mulches, surface material for pathways, or impact absorbing playground surfaces
- Equestrian surfaces, for both indoor and outdoor arenas
- Animal bedding products

The extent of such applications in the EU is currently unknown. However, WRAP's study shows that the production of animal bedding and equines surfaces is the third most important end user industry of recycled wood.

GYPSUM

This point will focus only on gypsum construction waste due to the aforementioned reasons. Gypsum construction waste consists in pieces of plaster and fibreboards that had to be cut off to fit special arrangements in the building, of damaged boards during transportation or because of the weather when they are stored outside. Such waste represents around 5%[259] of plasterboard used on construction sites and is considered to be clean (free of paints and nails) and recyclable into the manufacturing process for the production of new plasterboards as described below.

✓ **Recycling**

The collected plasterboard stream has to undergo several steps in the recycling process. First, paper layers of the plasterboards are removed as much as possible, then gypsum is crushed into powder and eventually this powder is sent back to plasterboard manufacturers so that they can make new plasterboards from it.

The gypsum powder is estimated to represent 94% of the total plasterboard waste collected [260]. The remaining 6% refer to paper and cardboard (and the related contaminants) composing plasterboards and can be re-used in various ways such as composting (as very little gypsum is left on the paper) or heat generation.

There is always a residual paper fraction that remains in the powder and which hinders the improvement of the introduction rates of recycled powder into the processes that are currently in place. The associated risks are the damage of the manufacture machinery and an effect on the acoustic or thermal quality of the final product.

According to Eurogypsum, between 5 and 10% of gypsum powder resulting from construction plasterboard waste is re-integrated in the closed-loop system. This figure is a European average and huge differences exist between MS. Indeed, recycling practices exist in Denmark, Germany and other Northern European countries while recycling is limited in Greece and Spain or is not applied at all in Eastern Europe countries. In some MS where comprehensive gypsum recycling schemes have been established (e.g. Denmark) overall recycling rates of 65% can be achieved.

Environmental and economic impacts of CDW waste management

✓ **Environmental Impacts**

<u>*CONCRETE*</u>

This point describes the environmental and economic impacts of concrete by focusing on the impacts of the various treatment options, including the benefits of re-use and recycling of concrete CDW.

<u>Direct impacts of landfilling</u>
When landfilling concrete, the release of constituents into groundwater is low. The chemical analysis of water samples show dissolved substances at levels much lower than the very stringent limits set by the World Health Organization for drinking water. Only the sulphate ion (S042-) is regularly found at high concentrations, but always much lower than the levels found in many popular brands of mineral waters.

The major environmental impact of landfilling comes from the use of space for the storage of inert CDW. This is particularly relevant in countries where land is scarce and disposal costs are expensive.

<u>Direct impacts of reprocessing into aggregates</u>
Recycling of concrete involves processing into coarse or fine aggregates, through processes that are similar to those used with natural aggregates (screening, crushing and transportation).

The emissions of dust and particles produced during the crushing step of concrete but also during the storage phase before re-using, are probably the most important environmental impact during the treatment of concrete CDW [263] and can cause serious health problem for workers. The activities that can generate dust are the following:

- Loading of aggregate onto storage piles (batch or continuous drop operations).
- Wind erosion of pile surfaces and ground areas around piles.
- Load-out of aggregate for shipment or for return to the process stream (batch or continuous drop operations).

The emissions from the sorting processes can be controlled by spraying water on the piles of crushed concrete to avoid dust dispersion into the air. The noise from the machines at the crushing step of aggregates, both virgin and recycled, for the production of concrete is one of the major health concerns. Indeed, at some work stations it can reach 85Db55 during the production process. Efforts have been made to mitigate the effects on workers thanks to quieter machines and the use of hearing protection inside concrete plants which is compulsory. When concrete is being placed, it is usually compacted by vibration which can damage workers hands and can be avoided through the re-use of concrete.

Net benefits of re-use and recycling

The benefits of re-use and recycling of concrete depend on the material that recycled concrete substitutes.

- **Substitution to coarse or fine aggregates**

After recycling into coarse or fine aggregates, waste concrete simply replaces virgin aggregates (crushed rocks, gravel, sand) that would otherwise have been extracted from quarries and processed. Recycling therefore avoids the use of natural resources and land space in quarries. Quarrying activities might also generate biodiversity issues, which are avoided through recycling.

On the other hand, avoided impacts related to transportation and processing of virgin aggregates are not significantly different from those generated to prepare recycled aggregates. In some cases, however, recycled aggregates can be locally available, reducing the transportation distances. This would result in positive net benefits, particularly in fuel consumption and greenhouse gases emissions[264] .Overall, the environmental benefits of recycling of concrete into coarse or fine aggregates are probably moderate.

- **Re-use – Substitution to manufactured concrete**

The direct re-use of concrete blocks avoids the production of concrete, and therefore the associated impacts of cement production. Indeed, most environmental impacts of concrete production originate from the production of the cement composing it (at least 80% of the impacts during the production process).

BRICKS, TILES AND CERAMIC

Direct impacts of landfilling

Landfilling bricks, tiles and ceramics does not raise serious environmental issues especially for the release of pollutants into water except when these materials are coming from C&D activities and therefore often contaminated with potentially dangerous fractions: insulation wool, mortar, concrete.

The major environmental impact of landfilling comes from the use of space for the storage of inert CDW, particularly in countries where land is scarce.

Direct impacts of recycling as a road works material

As presented in the above sections, the recycling of bricks, tiles and ceramics involves processing steps (crushing, sieving, transportation) in almost all cases, except for the use for minor roads where crushing is not necessary. These processes are therefore similar to the processing of natural materials which balances the environmental effects.

The production of dust and particles during the crushing, sieving, transportation and storage steps is avoided , for example by spraying water on the crushed materials, by covering the conveyor belts and machineries, by enclosing dust producing processes and maintaining cleanliness of the industrial vehicles used for loading and transporting recycled bricks, tiles and ceramics [266].

The noise from the aforementioned processes is a serious concern for the workers health and can be mitigated through appropriate personal training and equipment and through the use of quieter machines.

Net benefits of re-use and recycling

- **Substitution to coarse and fine aggregates**

The use of recycled bricks, tiles and ceramics in the form of coarse and fine aggregates in the different recycling options developed in the above sections replaces virgin materials that would have been extracted and processed, which thus saves the use of raw aggregates and land space used for quarries. However, the use of raw materials is not really the issue since it is largely available locally in Europe and the extraction of clay for construction products represents only 5% of the total mineral extraction. Such a material is therefore not threatened by intensive exploitation. Finally, the impact of transportation of raw materials that is avoided through the use of recycled coarse and fine aggregates is limited since clay brick and tile plants are often situated alongside clay deposits or sand quarries, minimizing the energy spent on transportation.

- **Re-use – Substitution to bricks, tiles and ceramics produced from virgin materials**

The direct re-use of reclaimed bricks and tiles avoids the manufacturing processes, the associated energy consumption and gaseous emissions. Indeed, the Ceramic Industry is very energy intensive with an energy share of up to 30% of production costs [267] .

As an example, the specific energy consumption for the brick and roof-tile industry varied in 2001 between 1.4 and 2.42 GJ per ton [268] which represents between 80 and 138 CO2 equivalents per ton considering that the most commonly fuel used in this industry is natural gas61. This amount of CO2 equivalent is avoided thanks to the re-use of bricks and roof-tiles.

However, it must be noted that the specific energy consumption for the production of 1 m^2 brick wall was reduced by 40% from the 1990s to 2007, as the initially required 190 kWh were reduced to 115 kWh.

The re-use of bricks and roof tiles also allows avoiding gaseous emissions to the atmosphere that normally occur during the manufacturing process. They are mainly of three kinds:

- Emissions coming from ceramic conversion of the raw material in the kiln. The emissions are HCl (hydrochloric acid), HF (hydrofluoric acid), SOx (sulphuric acid) and C02.
- Exhaust gas emissions from combustion processes (from drying and firing plants).
- The emissions are CO (carbon monoxide), CO2, NOx (nitrogen oxides) and particles. Emissions of VOC's (Volatile Organic Compounds) due to the use of organic substances (additives).

ASPHALT

Direct impacts of landfilling

According to the EAPA111, asphalt pavement (new or containing reclaimed asphalt) does not leach significantly. Therefore the major environmental impact is the use of land space, as for the other studied fractions.

However, a potential complicating factor may be the presence of contaminants such as tar 112, whose higher concentrations of PAH's (polycyclic aromatic hydrocarbons) and/or phenol content and associated effects on human health (carcinogenic) led to the end of its use. Although it has been replaced entirely by bitumen for asphalt mixes in Europe, it may still be encountered in various proportions in some areas when old pavements are removed. In this case, RAP is classified as hazardous waste and must be managed according to the European legislation.

Direct impacts of recycling

For both recycling in a stationary or mobile plant, reclaimed asphalt might have to go across the crushing and screening steps before being reintroduced into the manufacturing process. This is expected to produce particles and may raise health concerns if the machinery is not covered. However, these impacts are also related to the processing of raw materials. Moreover, when the reclaimed asphalt is obtained from milling operations (by a milling machine) the particle size might be the right one and then no additional crushing is needed.

The direct impacts of transportation are highlighted only when RAP is being sent back to asphalt manufacturer (i.e. for recycling in stationary plants). Fuel consumption and greenhouse gases emissions are comparable to the ones associated with the transportation of raw materials.

Direct impacts of material recovery

They are similar to the ones developed in the above subsection: related to transportation of both reclaimed asphalt and recycled aggregates and the production of particles and noise. These impacts are estimated to be the same as for virgin aggregates.

WOOD

Impacts of landfilling

As for other organic materials, landfilling of wood CDW leads to emissions of methane which is a greenhouse gas showing a global warming potential of 72 over 20 years, while carbon dioxide's is 1. Moreover, landfill of wood is associated with the unnecessary use of land and may lead to the contamination of the water table in the case the contaminated fractions has not been properly removed or isolated from the environment. The sources of contamination come from the surface chemicals that are used as glue, varnish, coating or wood preservatives to increase the material durability.

Impacts of energy recovery

Both Directive 2001/77/EC on the production of electricity from renewable energy sources and the Renewable Energy Directive favor the recycling market of waste wood and in particular wood CDW.

Impacts of recycling into derived timber products

Compared to incineration, recycling of wood CDW allows avoiding the production of particulates, carbon monoxide and various volatile organic compounds, i.e. PAHs, from the inefficient burning of wood. These hazards should however be limited when incineration takes place in a plant compliant with the Waste Incineration Directive. To ensure good quality products made from secondary wood, the standard limits for toxic elements in recycled wood are the same as for raw materials. The limit values of chemical contamination in supplied material have to comply with existing regulations.

GYPSUM

Direct impacts of landfilling

The main environmental issue associated with gypsum waste management is the production of the dangerous hydrogen sulphide (H2S) gas when plasterboard waste is disposed of in landfills. H_2S gas is a dangerous gas that is lethal in high concentrations and releases odors in low concentrations. The plasterboard waste itself is not dangerous, but when mixed with organic waste, and exposed to rain in an anaerobic environment, H_2S gas can be released. For this reason, the EU has decided that plasterboard waste and other gypsum-based products can no longer be disposed of in simple inert landfills but in controlled cells where no organic waste is accepted. However, this would require gypsum waste to be collected separately or sorted afterwards, which is not always the case. Therefore, in many cases gypsum waste is landfilled under improper conditions thus posing an environmental risk. Moreover, landfills use can also be a problem in some areas (around highly populated urban centres) due to use of land space. At last, transportation of waste to the landfill implies environmental impacts.

Direct impact of reprocessing plasterboards waste collected from construction sites

The processing of plasterboards waste collected from construction sites need energy-relying steps before further re-introduction into the manufacturing process. Other related impacts include dust and noise production, as well as transportation of construction plasterboard waste from the construction site to waste processors, and of recycled gypsum to plasterboards manufacturers.

Net benefits of recycling gypsum powder resulting from plasterboard waste collected from construction sites

Net benefits are low to medium as the production of plasterboards from recycled gypsum or from virgin material mainly are likely to have similar environmental impacts. The benefits are to avoid the use of natural resources, that is to say virgin mineral gypsum extracted from quarries, avoiding quarrying activities (thus reducing land use and avoiding potential biodiversity losses). Despite gypsum is estimated in good supply presently, there is only a limited amount available within the EU, so steps to preserve the natural gypsum resources should be encouraged.

✓ **Economics Impacts**

CONCRETE

Despite the environmental benefits of recycling concrete, its limited production costs do not encourage re-use and recycling. Nevertheless, using recycled concrete can also show economic advantages, depending on the local situation. The identified factors include:

- Proximity and quantity of available natural aggregates
- Reliability of supply, quality and quantity of CDW (availability of materials and capacity of recycling facility)
- Government procurement incentives
- Standards and regulations requiring different treatment for recycled aggregate compared to primary material
- Taxes and levies on natural aggregates and on landfill

Recycled concrete aggregates in Europe can sell for 3 to 12 € per ton with a production cost of 2.5 to 10 € per ton. The higher selling prices are obtained on sites where all CDW is reclaimed and maximum sorting is achieved, there is strong consumer demand, lack of natural alternatives and supportive regulatory regimes.

BRICKS, TILES AND CERAMIC

The harnessed extraction of clay and the development of new manufacturing techniques maintain clay bricks and tiles as competitive building materials that have good quality, long life, and minimal maintenance requirements and provide energy efficient solution during the use phase. The reduced costs of bricks, tiles and ceramics produced from raw materials are therefore not encouraging the development of recyclingb[270]. The SMEs would also decrease the chances for developments in recycling (heavy financial burden to SMEs while relatively small financial gains) except with the development of specific recycling facilities covering larger areas in a MS.

ASPHALT

The processes for the preparation of reclaimed aggregates (crushing, sieving) being the same as virgin materials, the production costs are estimated to be identical. On the other hand, the availability of virgin aggregates explains why the supply costs for these materials are limited which therefore does not encourage asphalt producers to turn to reclaimed asphalt as a substitution. However, landfilling and incineration for energy recovery are not considered as viable asphalt management options according to the industry as asphalt is an added-value material that is easily recycled thanks to the existing techniques [271].

WOOD

Due to the competition of utilization and the limited supplies, the market price for recycled wood is going up. The margin of the market price is influenced by the following elements:

- The regionally available amount of waste wood
- The intensity of the competition between material and energy recovery
- Seasonal variations (winter stock etc.)

In general, the prices for sorting, storage and treatment of specific waste wood fractions are not an incentive to the development of waste wood recovery.

GYPSUM

Two main economic factors push towards gypsum recycling: raw material price and landfilling costs increase.

- Gypsum raw material is not threatened by intensive extraction yet but the available amount is finite which is calling for saving measures such as recycling.

The first effect is the increasing price of raw gypsum material as observed in some plants where it has gone up with more than 50% the last 3 years[272].

- The other economic aspect linked to gypsum waste management is the cost associated with landfilling. The effect of the increasing landfill costs is assumed to be the development of recycling practices among gypsum waste producers and gypsum manufacturers.

Drivers / barriers to increase recycling

Taking into account that some countries have achieved higher recycling targets and exhibit more advanced CDW management systems than others, it is expected that countries with higher recycling rates would exhibit similar barriers and drivers in their effort to improve performance, and countries with lower recycling rates might also face similar barriers and drivers with each other. The drivers as well as the barriers in the following points are presented in a random order and are not ranked in relation to significance and improvement potential.

Drivers

Market conditions

- Economic incentives play a crucial role in driving CDW management performance, measures such as landfill taxes and charges for unsorted CDW favor selective collection and recycling of CDW.
- The existence of quality standards and norms which apply to recycled CDW and ensure the circulation and marketing of a high quality product, ready for use in new construction projects.

Recycling capacity

- Adequate number and extensive network of CDW treatment facilities covering satisfactorily the countries.

Legislative framework

- Strong legal framework that enables a good level of CDW management leading to higher recycling rates of CDW.
- In addition to the strong legal framework, the effective and strong enforcement of the implementation of legal obligations (including sufficiently high sanctions in case of non-conformity) is also considered as an important driver.

Barriers

Market conditions

- Low prices of natural raw materials undermine the market circulation of recycled materials which usually bear higher costs due to the treatment and recycling processes.
- Lack of trust in recycled CDW materials, despite the fact that they fulfil requirements and quality standards equal to the primary raw materials.
- Small market for recycled materials, as a direct result of both the above barriers in the use of recycled CDW by the construction sector actors.
- In some countries which are achieving high recycling rates, the market may not be able to absorb the quantities of recycled CDW in the future.
- In some countries low prices of natural raw materials.

Recycling efficiency

- Mixed CDW materials and/or the presence of hazardous substances in CDW makes recycling difficult.

Legislative framework

- No overarching legislation, especially in the case of MS with decentralized waste management.
- Non-specific CDW legislation, relying mostly in soft steering frameworks such as Waste Management Plans or Local government regulations.

21.5.2 Recycled materials from CDW

One of the main issues for the incorporation of recycled materials at construction works is the higher price of recycled materials in comparison to natural raw materials.

In Portugal, the Decree-Law 46/2008 of 12 March, which establishes the legal framework for CDW management, outlines that the incorporation of CDW at construction works must comply with national or EU standards or in their absence with technical guidelines defined by the National Laboratory for Civil Engineering (article 7). This entity has established four technical requirements to date, namely:

- E 471/2009 - Guide for the use of recycled coarse aggregates in concrete: establishes the minimum requirements that the coarse recycled aggregates covered by EN 12620 must comply with in order to be used in concrete;
- E 472/2009 - Guide for the production of recycled hot mix asphalt86: classifies reclaimed asphalt materials covered by EN 13108-8 and provides guidelines for their use in hot mix recycled asphalt;
- E 473/2009 - Guide for the use of recycled aggregates in unbound pavement layers: establishes the requirements that recycled aggregates covered by EN 13242+A1 and

EN 13285 must comply with in order to be used in unbound sub-base and base pavement layers;

- E 474/2009 - Guide for the use of construction and demolition recycled materials in embankments and capping layers88: establishes the minimum requirements that construction and demolition waste must comply with in order to be used in embankment and capping layer of transport infrastructures.

In the meantime, the National Laboratory for Civil Engineering, together with the Portuguese Environment Agency, are developing the following technical standards which are set to be applied to the CDW in construction works:

- Materials for rural, agricultural or forestry roads;
- Materials for filling ditches (backfilling);
- Materials for sub-base and base layers resulting from asphalt mixtures.

21.5.3 Market conditions / costs and benefits

Economic instrument is indubitably perceived as effective for encouraging or forcing contractors to conduct environmentally friendly construction practices. The initiatives that have been analyzed from of point of view that presents financial incentives for increased recycling, such as landfill taxes, shows particularly good practices and results in terms of CDW prevention and management in the waste market.

In Portugal, direct financial incentives to recycle CDW do not exist. However, a landfill tax for inert CDW exists, established in the Decree-Law 46/2008 of 12 March (CDW legal framework; with the main purpose of divert these wastes from landfill disposal. Currently this tax is € 4.28 per tonne. Case studies are not available on this subject.

In Portugal, aggregates and other natural raw materials scarcity is not a problem. At present, there are two major obstacles regarding CDW recycling identified by the stakeholders. Firstly, Portugal's economy still faces difficulties and the construction sector has not recovered yet. Secondly, the prices of the recycled materials are higher than natural raw materials. Currently EoW criteria for aggregates and/or other materials do not exist. In Portugal the role of construction materials producers and construction operators insurers (in the process of marketing and use of recycled CDW as construction materials) is not clear.

Regarding the recycling contents and recyclability, the environmental product declarations (EPDs) and the Green Public Procurement (GPP) criteria for construction products only consider general principles, they are not specific for CDW.

22. ROMANIA

22.1 Legal Framework – Waste Management Plans and Strategies

22.1.1 National Legislation concerning CDW

The regulations on management of waste are generally similar to those set out by the European Community law. The general framework in this field is ensured by Government Emergency Ordinance No. 78/2000 on the regime of waste, further supplemented by rules on landfills, waste incineration, shipment of waste, waste electrical and electronic equipment, end-of-life vehicles, packaging waste and waste from batteries and accumulators, etc. Transitional periods for implementing certain EU provisions concerning waste have been agreed upon in areas such as shipment of waste, landfills, waste electrical and electronic equipment, incineration of waste and packaging waste [273].

According with Deloitte document [274], current national legislation on waste in generally are:

- **Government Decision no. 856/2002** on waste management, approves waste categories, including hazardous waste
- **Decision no. 349/2005**, sets the legal framework for landfilling of waste and establishes criteria of selection procedures, obligations and sanctions.
- **Law no. 211/2011** on waste regime [republished in 2014]

This law is the transposition of the WFD into the national legislation. It defines waste and extended producer responsibility, it enforces waste hierarchy, waste management and prevention plans at the national, regional and local levels. With respect to the construction and demolition waste, the Law on waste regime establishes that the waste producers and the authorities of the local public administration must reach until 2020 a level of preparation for reuse and recycling of minimum 70% by weight of the quantities of non-hazardous waste from construction and demolition activities.

22.1.2 Waste management plans (WMP) and Strategies

Romania has adopted a National Waste Management Strategy (2014-2020) with the Decision nr. 870 of 06/11/2013. This is the second National Waste Management Strategy Romania adopts, the first one being 3 years before joining the EU. The Strategy sets the national framework for waste management and aims to gear Romania towards a "recycling society" by:

- Prioritising the efforts of waste management according to the waste hierarchy;
- Encouraging waste prevention and reuse for more resource efficiency;
- Developing and extending infrastructure for separate collection of waste in order to improve the quality of the recycling;
- Developing recycling and recovery technology;
- Reducing the quantity of waste on landfills.

The Strategy contains a specific section on CDW where it recalls the recycling objective of 70% and it suggests the implementation of the waste hierarchy. It also requires:

- Strict separation of construction and demolition waste from other waste categories;
- Removal of dangerous content;
- Controlling the actual composition of the waste generation instead so that it can be sent to the treatment plant with an inert material and substances that hinder the recovery process;
- Construction and demolition waste processing in sorting stations (recovery of various recyclable materials);
- Construction and demolition waste processing technologies crushing, grading and / or sorting according to density mobile stations, semi-mobile or stationary;
- Use the fine fraction (8-40 mm) results for various construction work, in particular for the construction of road infrastructure.

In order to achieve the short term objectives of the National Waste Management Strategy, strategic action plans were developed in the National Waste Management Plan (Decision nr.1470/200419), elaborated in the period 2003-2013. This plan contains details regarding the actions necessary to be developed to reach the objectives set in the Strategy, the way to develop these actions, including terms and responsibilities. The Plan contains objectives and measures for waste management and contains specific targets for certain waste flows, including CDW such as: supporting reuse and recycling and developing treatment facilities for dangerous CDW. The National Waste Management Plan is approved through Governmental Decision and it is revised every five years.

Each of the 41 Counties in Romania plus Bucharest have the duty to establish a **Municipal Waste Management Plan.** This plan is based both on the National and Regional Waste Management Plan and it develops strategies applied to only a selection of cities and rural areas identified administratively as belonging to the same County.

22.1.3 Legal framework for sustainable management of CDW

According with Deloitte [274] document there is no specific national legislation on CDW management. There has been an attempt to adopt such piece of legislation in 2014 setting new obligations for waste management actors, but the proposal was rejected.

22.1.4 Targets

Romania has the same re-use, recycling and recovery targets of CDW as the ones outlined in the WFD. Article 17 of **Law nr. 211/2011 on waste regime** set as an objective for waste producers and public authorities to reach until **2020 a level of preparation for reuse and recycling of minimum 70%** by weight of the quantities of non-hazardous waste from construction and demolition activities. Not reaching this target, or the other targets established by the Waste Framework Directive, will allow the European Commission to take the member states to court. The same target is explicitly mentioned in the recently adopted National Waste Management Strategy and in the National, Regional and County Plans [274].

22.1.5 End of Waste (EoW) status

The EoW principle is defined in **Law no. 211/2011** transposing the Waste Framework Directive. One of the objectives of Project LIFE ENV/RO0007279 was to develop a Methodology10 on EoW status of certain construction and demolition waste (class 17 01), which had the purpose to:

- define the criteria for EoW for the aggregates resulting from the treatment of inert CDW from class 17 01;
- to establish the point where aggregates resulting from the treatment of inert CDW, after applying the EoW criteria, cease to be governed by specific waste legislation;
- ensure potential users of aggregates resulting from the treatment of inert CDW that there were produced in accordance with reference standards in the field and can be used with confidence in the areas indicated by the manufacturer;
- provide the information necessary to demonstrate compliance with the provisions of Art.6 of the WFD;
- ensure an adequate degree of environmental protection.

The Methodology also specifies under what conditions certain categories of CDW cease to be waste and obtain the status of "products" while ensuring a high level of environmental protection, in parallel with the achievement of economic environmental benefits. For example, only inert CDW from class 17 01 will be accepted for treatment and processing: 17 01 01, 17 01 02, 17 01 03, 17 01 07. Also, an inspection of the truck transporting this type of waste will be done on the treatment site. A proof of the origin of the CDW transported needs to be kept for a three years period and has to specify the composition and of the waste. The quantity of waste is required to be reported to the national authorities.

22.2 Non legislative instruments (best practices, guidelines, recommendations…)

In this section, any other instruments that may specify how the country is addressing the question of CDW management maybe highlighted, as these instruments might be creating conditions for a sustainable management of CDW.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723583

Table 81. Non legislative instruments.

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further detail, information source, related web-site
Sustainability standards that cover CDW (e.g. BREEAM)	Yes BREEAM LEED	2014	Liberty Technology Park Cluj was granted the first BREEAM Major Refurbishment certificate in September 2014. https://rogbc.wordpress.com/2014/09/17/liberty-technology-park-cluj-was-granted-the-first-breeam-major-refurbishment-certificate-with-a-very-good-rating-in-romania/
Extended producer responsibility scheme in operation?	No	N/A	N/A

22.3 CDW management performance – CDW data

22.3.1 CDW generation data

EUROSTAT database reports the data shown in Table 82 for CDW generated between years 2010 and 2014.

Table 82. EUROSTAT CDW generation data.

	2010 [tons]	2012 [tons]	2014 [tons]
Mineral waste for construction	65.862	781.430	----
Metal wastes, ferrous	12.309	4.676	----
Metal wastes, non-ferrous	140	177	----
Glass wastes	26	1	----
Plastic wastes	78	73	----
Wood wastes	17.128	482	----
Total	**237.502**	**1.325.341**	----

22.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 91.

Table 83. EUROSTAT CDW treatment data

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	442.116	257.848	
Deposit onto or into land	442.092	257.848	
Land treatment and release into water bodies	24	0	

Incineration / disposal (D10)	54	0	
Incineration / energy recovery (R1)	1.474	10	
Recovery other than energy recovery	260.519	529.522	
Recovery other than energy recovery - backfilling	0	0	
Recovery other than energy recovery - except backfilling	260.519	529.522	
Total waste treatment	**704.163**	**787.380**	

22.3.3 CDW exports/imports data

No data found

22.3.4 CDW treatment facilities data

According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", in Romania there aren't landfill for inert waste, while there are 103 landfill for non-hazardous waste and 11 landfill for hazardous waste.

Even if those are the official data reported by EUROSTAT, in Romania the majority of CDW is disposed on municipal landfills or illegally.

22.3.5 Future projections of CDW generation and treatment

No data found

22.3.6 Methodology for CDW statistics

According to Art. 49(1) of Law no. 211/2011, all CDW operators are obliged to report the volume of CDW: waste producers, waste owners, waste management operators, public authorities, brokers etc.

The National Environmental Agency (ANPM) collects data on a yearly basis via questionnaires. These questionnaires are sent to all the operators mentioned by Law and the data gathered is consolidated by ANPM. According to ANPM, waste management operators report annually the total volume of collected CDW. County Environmental Agencies (APM) also play a role in consolidating data and sending it to ANPM. ANPM reports the final consolidated data to EUROSTAT.

Monitoring the CDW volumes in Romania is very challenging. Firstly, most of the times, CDW is mixed with the municipal waste and no separate collection containers are provided for CDW. Secondly, a large number of business operators generating CDW, do not report it. Moreover, the local authorities are not involved at all in collecting the data. The ANPM mentions in its 2012 Annual Report that the data gap is also due to the lack of specific legislation on C&D and of the difficulty in identifying those waste holders. The quality of the reported data is globally very uncertain and underestimated.

22.4 C&D waste management in practice

The current practice in Romania on C&DW management follows the trends and technologies in Europe and is presented in the next Figure 18 [275]

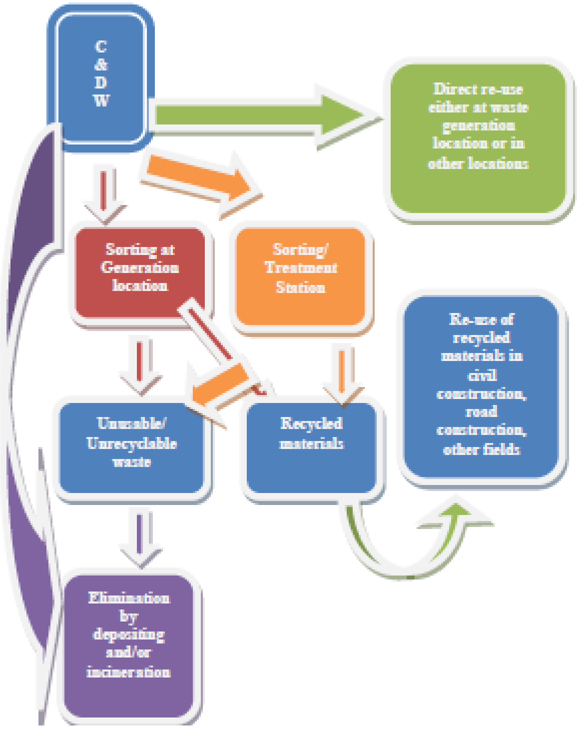

Figure 18. Methods of C&DW management used in Romania

In literature, it is well known the fact that the traditional treatment of construction and demolition waste (further on referred to as C&DW) was landfilling, usually in landfills used for municipal solid waste [275].

The same situation has been frequently encountered in Romania, where, currently, there is no landfill dedicated to CDW. However, as throughout Europe, there is an increase in scarcity of landfill space, as well as increased costs in environmental protection in conformity with European regulations, therefore a like solution is less and less attractive for states. In which concerns Romania, we shall refer to the situation of Bucharest, which, as stated before, accounts for 65% of the construction projects. Currently, Bucharest has 3 municipal solid waste landfills: Glina, Chitila and Vidra. Glina, the largest of landfills, with a surface of 119 ha, out of which 110 are used for waste depositing, and out of these 37 actually belong to the former non-ecological landfill. A recent declaration of the Romanian Ministry for Environment [277] states that approximately 93% of all Romanian landfills are not in conformity with environmental regulations, and according to European requirements, they have to be in conformity by 2010.

22.4.1 CDW management initiatives

Table 84. CDW management initiatives

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organisation	Levels of performance e.g. tonnes recycled	Further information/ web-site
Introduction of waste management requirements in the construction and demolition authorisations	To urge all C&D actors to collect, sort and treat CDW	2011	Local (Medias)	Public and Private	The levels are not available but according to the interviewed stakeholders the initiative was very successful.	Interview with Dumitru Ungureanu, Environnemental Consultant, Asroserv, 24 April 2015
The acquisition of a mobile installation of pilot pant for mechanical treatment of inert waste	Contribute to proper management of CDW; reduction and elimination of illegal dumping of CDW	2011	Local (Medias)	Public and private	The levels are not available but according to the interviewed stakeholders the initiative was very successful.	http://www.gestiunedeseuri.ro/activitati-proiect/activitatea-6.3.-achizionarea-unei-instalaii-mobile-pentru-tratarea-deeurilor-din-construcii-i-demolri-pregtirea-personalului-etc-36.html
The acquisition of an onsite installation of pilot pant for mechanical treatment of inert waste	Contribute to proper management of CDW; reduction and elimination of illegal dumping of CDW	2014	Local (Buzau)	Public investment	The levels are not available but according to the interviewed stakeholders the initiative was very successful.	http://life-dcd.ro/documente/?did=21

22.4.2 Drivers / barriers to increase CDW recycling

The Table 85 is a brief description of the barriers and driver for Romania. These points are primarily derived from Deloitte's study **Errore. L'origine riferimento non è stata trovata.**

Table 85. Drivers / barriers to increase CDW recycling

Factor/characteristic/element inCDW recycling chain	Drivers	Barriers
Infrastructure	Public and private instruments Building treatment infrastructure within a maximum of 30 km area from urban area in order to improve cost-effectiveness of recovery	Lack of infrastructure for waste treatment , recycling Infrastructure are located too far from urban centres making transport very expensive
Landfill tax	Increase of the landfill tax	Very low landfill tax does not create incentives for recycling
Market conditions	Incentives for economic operators to choose recycled over natural Reduce the over-exploitation of natural aggregates	Natural aggregates are considerably less expensive than recycled aggregates
Legislation	Propose and adopt legislation defining recovery and treatment obligations for all stakeholders involved in the management of CDW Define EoW by law	Lack of legislation on the recovery of CDW Lack of specific legislation on EoW
Definition and statistical data	Harmonisation of the data reporting Better traceability of data Involve local and regional authorities in data collection	Data very uncertain; definition of CDW is not the same for all actors reporting the data Waste holders do not report and are difficult to identify

22.5 CDW sector characterization

According with Deloitte document [274], currently, in Romania, there are not enough facilities for the treatment, recovery and recycling of CDW. There are only few operators or public authorities that recover/recycle this type of waste and that operates crushers, transforming concrete and bricks in materials that have a subsequent use. The lack of

infrastructure increases the transport costs and deters waste holders to recover the generated CDW.
Now, in Romania, involvement in the recovery and recycling of CDW is voluntary. It is not obligatory by law for builders or owners of a construction to achieve performance or recycling targets.

22.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

No data found

Quantitative analysis

No data found

Recovery techniques

No data found

Environmental and economic impacts of CDW waste management

No data found

Drivers / barriers to increase recycling

See section 22.4.2

22.5.2 Recycled materials from CDW

The main CDW product is recycled aggregates, used for backfilling and road building**Errore. 'origine riferimento non è stata trovata.**.
The EoW criteria is in place for aggregates and according to stakeholders, it seems to hinder the secondary raw materials market. It is expected that, in the absence of concrete measures, aggregates resulting from the treatment of C&D inert waste and secondary materials to not become a sought commodity. The LIFE project developed in 2012 a methodology for EoW in Romania detailed in section 2.3.Market conditions / costs and benefits
It is currently more expensive in Romania to buy secondary raw materials than primary ones. One of the main reasons is that the large number of pits in Romania leads to an abundance of supply of natural aggregates, and to low prices. For this reason, using recycled CDW for new constructions is not very well perceived in as the actors in the construction sector tend to prefer the use of primary raw material, which they perceive as having higher quality than secondary (recycled CDW) materials. This mentality could be changed if the quality of the secondary raw materials is certified.
Furthermore, the lack of infrastructure and high cost of transportation, combined with the lack of financial incentives to recycle CDW deters consumers to buy recovered materials. The life cycle analysis performed by the LIFE project has concluded that the purchase of

secondary raw materials resulting from CDW treatment is cost-effective only if the treatment plant is situated within a 30km area.

Table 86. Quantity of exploited minerals (in tons) Source: European mineral statistics, 2004-2008

Year	2004	2005	2006	2007	2008
Sand and gravel	14 547 501	17 030 886	21 817 371	26 276 857	31 377 110
Stones	2 585 894	2 328 165	3 373 384	5 905 842	4 635 010

23. SLOVAKIA

23.1 Legal Framework – Waste Management Plans and Strategies

23.1.1 National Legislation concerning CDW

The Ministry of Environment is the key actor and the governmental body responsible for waste management in Slovakia. The Act on Waste is a comprehensive act that implements European Directives concerning waste management and regulates waste management in Slovakia. This Act defines terms necessary for the proper waste management. Paragraph 40c of the Waste Act 223/2001 refers to the CDW as "wastes that arise as a result of construction, safety work as well as maintenance, refurbishment or demolition work"[278].

The Act currently in place is rather recent – it was adopted on March 17, 2015 and came into force on January 1, 2016. The Act brought new rules on the waste management and introduced new concepts. It abrogated the Recycling Fund and paying of recycling fees by producers and importers[296]. At the same time, it introduced the concept of extended responsibility, meaning, producers and importers will be responsible for individual products from bringing them to the market until their disposal. It is done so to ease the burden from Slovak municipalities. Peter Žiga, Slovak Minister of Environment, claims that this scheme will lower the expanses on waste by approximately €30 million [280]. Another novelty in the Act is a requirement to develop information system that can monitor waste streams effectively. Last but not least, it implements stricter rules on illegal dumping of waste with the goal to reduce waste dumping which is currently as much as 75%. Officially, there are about 2.500 illegal dumps in Slovakia; however, the estimations are that the actual numbers are much higher and may reach even as much as 7.000 illegal dumps [280].

Other legislative instruments include Regulation 525/2003 which requires regional and district offices to be in charge of waste management and environmental protection in their respective territories; Decree 283/2001 which defines procedures for preparing and submitting reports on waste generation and waste treatment; the MoE also provided a notice 75/2001 which specifies methods for the analytical inspection of waste; Act 17/2004, Law 434/2013 and Act 582/2004 deal with fees for waste handling in general and fees for depositing waste in landfills in particular; last, Regulation 237/2000 states that before any construction work starts, an individual or a company must obtain a permission which can be given only if a project contains a CDW management plan for disposal or recovery treatment.

Moreover, Slovakia employs Act 119/2010 on Packaging. This Act sets rules for both individuals (entrepreneurs) and legal entities which (1) use packaging to pack products or fills the packaging with products, (2) place products in packaging on the market (with the exception of producers and importers of packaging who supply the obliged persons). These are then required to [280]:

- register in the register of Ministry of Environment of the Slovak Republic
- communicate the changes to this register
- keep records of the quantity and types of packaging materials

- fill in the registration file of packaging and packaging waste
- send the annual report to the ministry
- ensure the collection of packaging waste and their recovery and recycling at least in the amount of specified limits, e.g. by the way of an authorized organization.

23.1.2 Waste management plans (WMP) and Strategies

Similar to the Czech Republic, Slovakian WMP structure is designed in a way that the national WMP assists to define regional and consequently municipal WMPs. The national WMP (2016-2020), developed by the MoE, concerns with the CDW in two sections of the plan[281]. First, it describes what CDW is and states the amounts of CDW produced in years 2010, 2011, 2012, and 2013. This section illustrates several CDW statistics. The average CDW production between 2010 and 2013 was 2.6 million tons. Further, it states that the biggest share of CDW comes from the dredging soil – in 2013, it accounted for 58% of all CDW. Regarding the handling of CDW, the process of recovery or recycling occurred in only 36% of CDW – mostly concrete, iron and steel. On the other hand, out of all the landfilled waste, 55% was CDW.

Second, the WMP sets goals regarding the CDW. The ultimate goal is to reach European requirement of recovering at least 70% of CDW. To meet this goal, Slovakia aims to:

- Develop legislation limiting landfilling of recyclable CDW
- strengthen the use of uncontaminated dredging soil and other natural material
- define the EoW criteria for CDW
- ensure that publicly financed construction projects use recovered materials
- financially support technology which contributes to recycling of CDW.

Slovakia adopted and has in force the first Waste Prevention Plan for 2014-2018. Section 4.3.5 sets measures, which aim to prevent CDW from landfill. The following table summarizes measures and strategies Slovakia developed to achieve the target of recovering at least 35% of CDW for the period of 2011-2015.

Table 87. Measures to recover, recycle and reuse CDW in Slovakia, 2011-2015[282].

Action	Responsible enforcing and monitoring authority	Responsibility for implementation	Time of completion
Uncontaminated soil and other naturally occurring material excavated during construction works not to consider to be waste (when the material is used for construction in its natural state)	District Environmental Offices	Waste producers	On-going
Increase the control over separation of waste streams in place of generation	MoE SR	Slovak Environmental Inspection, District Environmental Offices	On-going
Promote research and development in the field of recycling, reusing or recovering materials from construction and demolition waste	MoE SR	MoE SR, Universities	On-going
Set criteria for defining end-of- waste for CDW	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic	In the time of approval of the new Waste Act 19/2015
To adapt technical standards for construction materils and their use to increase the proportion of recycled CDW and construction products containing incinerator ashes.	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic	On-going
Support the construction and operation of CDW recovery facilities	MoE	MoE	On-going
To use recycled CDW in construction financed by public funds (mostly road works), provided that they comply with functional and technical requirements; and also to include this as a requirement in the public procurement conditions	All sectors, MoE	Suppliers	On-going
To propose an amendment to the Building Act, which impose an obligation to check the management of CDW of a project at the final inspection	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic	MoE, Ministry of Transport, Construction and Regional Development of the Slovak Republic and Building Authorities	In the time of approval of the new Waste Act 19/2015

23.1.3 Legal framework for sustainable management of CDW

There are several topics related to the sustainable management of the CDW, which are dealt with through legislation. The legal framework includes The Waste Act 223/2001 on obligation of separation of CDW in § 40, the new Waste Act 79/2015, and the Green Public Procurement (GPP).

Though there is no requirement for pre-demolition audit, it is recommended to assess the hazardous properties of future CDW before commencing or maintaining refurbishment or demolition. It is done in accordance with § 19 of the Regulation no. 283/200139 as amended by 310/201340, with focus on removal of materials with asbestos. The Waste Act 223/2001 deals with the topic of sorting obligation in Annex 1. It says that in case that CDW exceeds the total amount of 200 tons per year, there is an obligation to separate it. Furthermore, from January 2016, there will be a specific condition to sort organic waste, plastics, glass, metals, paper, tyres and WEEE from municipal waste. The same act deals with the topic of separate collection and management of hazardous waste from construction and demolition operations, with the requirement, from waste producers, to develop a WMP only if they produce more than 10 tons of hazardous waste or 100 tons of non-hazardous waste annually. Last, the National Action Plan for Green Public Procurement in the Slovak Republic for 2011- 2015 provides a strategic objective to increase the proportion of GPP used in Slovakia to 65% at the level of central government bodies and by 50% at the level of self-governing regions and municipalities.

23.1.4 Targets

According to the national WMP (2011-2015), Slovakia aims to follow the EU standards, meaning, the level of preparation for re-use, recycling and recovery should be:

- at least 35 % by weight by January 1, 2016
- at least 55 % by weight by January 1, 2018
- at least 70% by weight by January 1, 2020

23.1.5 End of Waste (EoW) status

Regulations regarding the EoW of CDW is non-existing in Slovakia. The amendment 343/2012 states that particular waste ceases to be waste, if it undergoes preparation for reuse or is considered as waste suitable for domestic utilisation. Simultaneously, certain waste ceases to be waste, if it undergoes any recovery and meets established criteria. These criteria derive from the European Directive and are as follows:

- Substance or object is commonly used for specific purposes
- For such substance or object, there is a market demand
- Substance or object fulfils the technical requirements for the specific purposes and meets the existing regulations and standards applicable to products
- The substance or object will not lead to overall adverse of environment

23.2 Non legislative instruments (best practices, guidelines, recommendations…)

The Slovak association supporting recycling of CDW – ZRMS, is a member of international European Quality Association for Recycling which aims to exchange best practices among members and supports spreading the idea of quality protection and quality assurance of recycled building materials on European level. At the same time, there are several projects, researches and products which enable recycled CDW to be re-used. For instance, Stered produces an insulation from textile waste from end-of-life vehicles.

In the period 2007-2013, the Operational Programme Environment financed by European Funds supported waste management infrastructure in Slovakia with about €570 million.

Environmental awareness of the public is rather low and is in dire need of substantial improvement. One important tool might be to not only raise awareness but also to involve citizens.

23.3 CDW management performance – CDW data

23.3.1 CDW generation data

The amount of waste generated by the construction and demolition sector in years 2010-2013 amounted to average 2.6 million tons, which accounts for 26.2% of the total amount of waste [283]. Compared to the EU average – 33%, the percentage in Slovakia is rather low. It can, however, be caused by the lower level of construction activity in Slovakia in comparison to other EU member states. The following table illustrates CDW generation in Slovakia in period between 2010-2013 [284]. The detailed types of CDW waste data were not available. It is also important to note that numbers generated by the MoE differ from the data generated by the EUROSTAT.

Table 88 Amount of generated CDW for period 2010-2013.

	2010	2011	2012	2013
Amount of generated CDW	2.883.760	2.983.325	1.617.007	2.942.857

Table 89 Generation and management of CDW in period 2010-2013[256].

	2010	2011	2012	2013
Material recovery	1 633 381	985 795	714 534	1 059 220
Energy recovery	534	367	762	796
Other recovery	400 700	200 100	146 526	141 428
Landfill	633 276	914 600	659 181	1 633 240
Incineration without energy recovery	225	374	134	434
Other disposal	60 002	639 163	60 811	51 142
Other treatment	155 639	242 924	35 055	56 594
Total	**2.883.760**	**2.983.325**	**1.617.007**	**2.942.857**

The graph in Figure 19 summarizes the CDW management in Slovakia in 2013. It is notable that the goal of the European Commission to recover at least 70% of CDW is far from being met. In the period 2010 – 2013, the level of CDW recycling reached only 47%. The highest percentage was achieved in 2012 when it reached 53%. As up-to-date data are not available, it is difficult to evaluate the progress made [285].

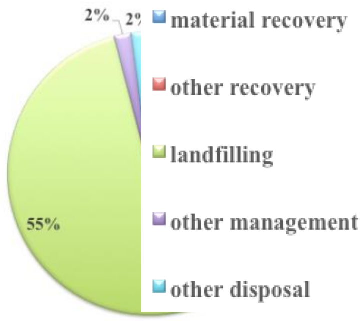

Figure 19. CDW management in Slovakia in 2013.

The MoE of Slovakia has published a report on the waste management in Slovakia, in 2013. The report states export and import of the waste in general, the data on CDW in particular is missing.

In 2013, the MoE in Slovakia approved 135 cross-border transports of waste. It was in accordance with both national and European legislation and regulations. Both Import and Export of waste were measured, but without stating the exact amount of CDW. Slovakia imported 250,164 tons of waste in 2013. Austria was the provider of the biggest amount, which was 128,500 tons of waste. The export section was also measured, but with no distinction to how much of that was CDW. 118,889 tons of waste were exported. Notably, according to the report, 63.7% of the total amount of waste designated to export went to the Czech Republic [286].

23.3.2 CDW treatment data

Permission of state administration body – district or regional environmental office – is needed for operation of waste management installations such as collection, recovery and disposal. In 2012, there were 17 functioning landfills for inert waste in Slovakia. 89 landfills were for non-hazardous waste and 12 were for hazardous waste. The following table summarizes the number of landfills in separate regions of Slovakia.

Table 90 Landfills in Slovakia, 2012.

Region	Inert waste landfills	Non-hazardous waste landfills	Hazardous waste landfills	Total
Bratislavský	2	8	2	12
Trnavský	1	8	2	11
Trenčiansky	3	11	1	15
Nitriansky	3	12	2	17
Žilinský	2	14	0	16
Banskobystrický	2	13	1	16
Prešovský	1	14	1	16
Košický	3	9	3	15
Total	**17**	**89**	**12**	**118**

Currently, there are approximately 60 recovery treatment facilities. According to the national WMP, this number of treatment facilities is not sufficient and must be increased to meet European targets for re-use, recycling and recovery.

23.3.3 CDW exports/imports data

No data found

23.3.4 CDW treatment facilities data

No data found

23.3.5 Future projections of CDW generation and treatment

It is foreseen that Slovakia will aim to improve its targets regarding CDW management, as they are eligible to receive financial support through European Structural Funds and operational program for environmental quality 2014-2020. The treatment facilities for recovering CDW exist in Slovakia; however, it might be inevitable to promote the recovered CDW as valuable material suitable for construction.

23.3.6 Methodology for CDW statistics

In Slovakia, the government regulation 442/1992 serves as the basis for monitoring system in charge of collection of waste treatment data. Two organizations are operating the aforementioned system. They are the Waste Management Centre and the Environmental Management of the Slovakian Environmental Agency. The system includes several elements for achieving the goal. The generation and management of the waste data is done by the regional waste information system RISO. The data collected from the RISO reports is sent by the waste producers according to a limit on the obligation to report data. It is forwarded to EUROSTAT by the Statistical Office of Slovak Republic. Another element is the packaging waste information system called PACKAGING and the last one is WEEE information system which is called ELECTRO. Further legislation backs up the current record keeping operation.

In comparison with the data by EUROSTAT, the Slovak MoE data generation is more comprehensive. It is possible that the MoE in Slovakia include excavation waste in the CDW report and therefore the numbers are higher. In comparison to the WFD, Slovakia is using three additional treatments [282].

23.4 C&D waste management in practice

23.4.1 CDW management initiatives

There are several non-legislative instruments by which Slovakia is addressing the CDW. These instruments are not legally binding but they are standards of sustainability that gain preferences when applied. The environmental management system ISO 14001 is in force since 2013 and together with the EMAS serve as standards for 1292 companies in Slovakia. Out of those, the construction sector represents 24%. Other sets of standards such as BREEAM and LEED are held by 32 buildings in Slovakia, 27 of which are in a specific part of Bratislava.

The SKGBC is an association that are sharing best practices, organizing seminars and conferences and support sustainable construction. Slovakia also has an extended producer responsibility that derive from the Waste Act 79/2015 and it is binding on a national level. The extended producer responsibility for electrical and electronic equipment, batteries, packaging, vehicles, tyres and other non-packaging products passes the responsibility to the producer to finance the collection of the product from the customer.

There are several standards upheld in Slovakia for recycled construction materials. Regulation 133/2013 on construction products requires the recycled construction material to have a declaration of conformity with the relevant standards for construction products and prove harmless for the environment and human health. The standards for recycled CDW called Standard STN IN 933-11 dictate that recycled aggregates must have a declaration of conformity with the same standards of being harmless for human health and for the environment. Standard STN EN 1744 provide the assessment method for chemical properties of aggregates. It assesses sustainability of recycled material for various uses and storage conditions. The last set of standards is dictated by § 19 of the Regulation no. 283/2001 as amended by 310/2013 and it is the requirement to identify hazardous properties of future CDW [282].

23.4.2 Drivers / barriers to increase CDW recycling

Slovakia does not reach European targets yet, however, there are several drivers that motivate the progress in CDW recovery. First, legislation has been shifting towards meeting national targets regarding the CDW. It includes stricter rules on illegal dumping of waste, extended waste producer responsibility or development of information system. Second, both governmental and non-governmental organizations share knowledge and raise awareness through organizing seminars. In the educational sector, environmental protection is part of the curriculum. Last, landfill fee is increasing annually[285].

The reason Slovakia scored rather low on the CDW recovery scale is that many barriers prevail in Slovakia. Even though the fee of landfill annually rises, it is still considerably low. Inspections in the constructions are rather rare and sanctions are not adequate, thus, the implementation of the legislation falls behind. In recent years, the lack of End of Waste criteria and the unwillingness to build from "waste" contributes to unsatisfactory results. In Slovakia, recovered CDW is not seen as proper material, which is to be used further. Moreover, the location of recovery facilities is often far from the site, consequently, the cost of transportation increase and people are not willing to invest in it[285].

23.5 CDW sector characterization

23.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements. It is used for construction of buildings, roads and infrastructure.

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes.

A tile is a manufactured piece of hard-wearing material such as ceramic, stone, metal, or even glass, generally used for covering roofs, floors, walls, showers, or other objects such as table tops. Tiles are often used to form wall and floor coverings, and can range from simple square tiles to complex mosaics. Tiles are most often made of ceramic, typically glazed for internal uses and unglazed for roofing.

Asphalt is a sticky, black and highly viscous liquid or semi-solid form of petroleum. It may be found in natural deposits or may be a refined product; it is a substance classed as a pitch. The primary use (70%) of asphalt/bitumen is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete.

Wood is a porous and fibrous structural tissue found in the stems and roots of trees, and other woody plants. It is an organic material, a natural composite of cellulose fibres which are strong in tension embedded in a matrix of lignin which resists compression. Wood has been used for thousands of years for fuel, as a construction material, for making tools and weapons, furniture and paper, and as a feedstock for the production of purified cellulose and its derivatives, such as cellophane and cellulose acetate.

Gypsum is a soft sulphate mineral composed of calcium sulphate dehydrate. It is widely mined and is used as a fertilizer, and as the main constituent in many forms of plaster blackboard chalk and wallboard. Among other uses, gypsum is used in buildings construction.

Quantitative analysis

The quantitative data concerning the production in Poland are available only for concrete, gypsum, and asphalt [288]. The following tables illustrate this production.

Table 91 Concrete production in Slovakia.

	Concrete production (million m3)		Growth rate 2006/2008	Population (million inhabitants)		Production per capita		Cement consumption (million tons)		Growth rate 2006/2008
	2006	2008		2006	2008	2006	2008	2006	2008	
SK	2.9	3.7	27.59%	5.39	5.40	0.54	0.69	2.3	2.6	13.04%

Table 92.Gypsum production in Slovakia.

	2005 (tons)	2008 (tons)	Population in 2008	Production per capita	Share to the EU production	Growth rate 2005/2008
SK	107.500	152.000	5.400.998	0.0281	0.5%	41.4%

Table 93. Asphalt production in Slovakia.

	2005 (million tons)	2008 (million tons)	Population in 2008	Production per capita	Share to the EU production	Growth rate 2005/2008
SK	1.8	2.2	5.400.998	0.4	0.8%	22.2%

Recovery techniques

- **Concrete**: Landfill, recycling into aggregates for read construction or backfilling, recycling into aggregates for concrete production, re-use of precast elements
- **Brick**: Landfill, recycling, re-use
- **Tile**: Landfill, recycling, re-use
- **Asphalt**: Landfill, recycling in a stationary plant, in-site recycling, material recovery
- **Wood**: Landfill, recycling into derived timber products, energy recovery
- **Gypsum**: Landfill, recycling into new plasterboards (in substitution of natural or synthetic gypsum)

Environmental and economic impacts of CDW waste management

In many EU countries (Poland included), landfilling remains preferred method of non-hazardous CDW disposal. Nevertheless, landfilling might have severe negative impacts on environment in general and human health in particular. Though landfilled concrete, bricks and tiles prove to have negligible impact on groundwater pollution, asphalt, gypsum and wood from construction and demolition sides leave footprints on the environment. As the surface of wood used in construction is often treated with chemicals, its landfill is associated with release of methane emissions which is a greenhouse gas. Landfilling of gypsum poses a threat to environment due to the fact that it releases dangerous hydrogen sulphide gas if in contact with organic waste and exposed to rain. In some cases, asphalt landfill might prove problematic due to the use of tar in the past. If asphalt contains tar, it is hazardous waste and must be treated as such. Tar-free asphalt is not a significant risk to the environment if landfilled. The important issue at hand is not only the focus on CDW impact on groundwater pollution but also the fact that landfills cover considerable area of land which could be used otherwise.

Regarding the treatment of CDW, the preparation for re-use of nearly all CDW does not come without cost. The majority of CDW must be crushed in order to be recycled and it causes several issues – first, it creates dust which might cause serious health problems for workers and second, noise production can have negative consequences for both humans and fauna surrounding the treatment facility.

The clear benefit of re-use of CDW is that there is no need for virgin aggregates to be extracted and be processed. Resources of wood and gypsum are becoming scarce and price of them is increasing significantly. In these two cases, recycling might become encouraged due to financial aspects. For instance, due to a limited amount of raw gypsum, the price of raw gypsum increased more than 50% in the last 3 years . On the other hand, in case of bricks, tiles, cement and asphalt, cost of production from recycled materials does not differ significantly from cost of production from virgin materials.

The re-use of recovered CDW avoids the manufacturing processes which are usually associated with high energy consumption and emissions. For instance, the most negative environmental impacts of concrete derive from cement production. The direct re-use of concrete blocks avoids the production of concrete and potentially also the cement production. Moreover, the carbon footprint for recycled asphalt is lower than for asphalt made of raw materials.

Drivers / barriers to increase recycling

Provided in section 23.4.2

23.5.2 Recycled materials from CDW

No information was found regarding the re-use of CDW. There are standards, for instance, for aggregates which must not cause any harm to human health and to environment and have a declaration of conformity – STN EN 933-11.

23.5.3 Market conditions / costs and benefits

The price for taking CDW for further recycling ranges between €8 and €14. The selling price of recycled CDW materials such as recycled bricks, separate soil fraction, recycled concrete and recycled bitumen ranges between €1 and €4.

24. SLOVENIA

24.1 Legal Framework – Waste Management Plans and Strategies

24.1.1 National Legislation concerning CDW

Current national legislation on waste in generally are [288]:

- Environmental Protection The Decree on Waste;
- The Decree on Waste - A framework decree governing waste management more specifically is the Decree on Waste5 of 31 December 2011.on Act which regulates the protection of environment from the impact of pollution as a prerequisite for sustainable development;
- The Decree on the management of waste arising from construction work;
- Decree on waste landfill11 of 22 February 2014;
- Decree on the implementation of the Regulation (EC) No. 1013/2006 on shipments of waste12 of 8 August 2007.

24.1.2 Waste management plans (WMP) and Strategies

Slovenia prepared its National Environment Protection Action Programme in 1999, which among others, includes details on the overall waste management. The National Environment Protection Action Programme is a framework underlying the adoption of the Strategic Guidelines on Waste Management and the preparation of several Operational Programmes which are as follows:

- Operational Programme for reduction and prevention of pollution caused by waste from the titanium dioxide production for the period from 2004 – 2007,
- Operational Programme for management of batteries and accumulators for the period 2003 – 2006,
- Operational Programme management of waste oils for the period from 2003 – 2006,
- Operational Programme disposal of polychlorinated biphenyls and polychlorinated terphenyls for the period from 2003 – 2006,
- Operational Programme for the management of packaging and packaging waste for the period from 2003 – 2007,
- Operational Programme for the construction waste management for the period 2004 – 2008.
- The targets set under the Operational Programme for the construction waste management for the period 2004 – 2008 were as follows:
    - ✓ separate collection at the source and reuse of at least 30 % of the construction waste,
    - ✓ strict separation of waste arising from the construction work and asbestos-containing construction waste from the other waste arising from the performance of construction works,
    - ✓ materials recovery (recycling) and use of building materials of at least about 40 % of construction waste,
    - ✓ incineration or use as fuel wood in construction waste,

- ✓ reuse of around 40 % of construction waste from excavation,
- ✓ the use of residual waste from the processing of the construction waste (about 10 %) and of construction waste from excavation works (about 40 %) in terms of depositing it into or onto land as a waste recovery operation, namely as organic soil, i.e. to fill natural depressions or excavation spaces of surface installations within their rehabilitation,
- ✓ disposal of unusable waste residues from the processing of construction and demolition waste (20 %) and construction waste from excavation works (20 %) in landfills for non-hazardous waste and landfills for inert waste,
- ✓ disposal of construction waste containing asbestos waste – firmly bound asbestos waste – in landfills for non-hazardous waste.

24.1.3 Legal framework for sustainable management of CDW

Table 94. Legal framework for sustainable management of CDW.

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further details, information source, related web-site
National/regional obligation for selective demolition?	NO	n/a	n/a
National/regional sorting obligation (on-site or in sorting facility)?	No.	n/a	n/a
Obligation for separate collection and management of hazardous waste from C&D operations? Please specify	Yes. Asbestos is considered as hazardous waste. It needs special treatment and disposal.	▪ 2008 – Decree on the management of waste containing asbestos ▪ 2006 – Decree on the conditions for the disposal of materials containing asbestos in the demolition, reconstruction or maintenance of buildings and in the maintenance and decommissioning of	▪ http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED4787 ▪ http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV7057

		plants	
Related Green public procurement requirements	Yes.	▪ 2012 - Decree on green public procurement	Green public procurement is enforced for the public sector in Slovenia. In the construction segment, only provisions related to the construction of buildings are determined (with Annex 7 Basic environmental requirements for buildings). There is one provision mentioning the use of recycled materials: 'Tender for construction which will use more than 30 % of recycled construction materials shall be scored with additional points'. URL of Decree on green public procurement: http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED5194 URL of Annex 7 Basic environmental requirements for buildings: http://pisrs.si/Pis.web/npb/2014-01-3639-2011-01-4404-npb5-p7.pdf

24.1.4 Targets

According with Deloitte document[288], National targets concerning CDW are set by the Decree on waste as the 70 % CDW recovery and recycling objective ('by 2020 the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70% by weight'). For purposes of calculating the achievement, reference is made to the Commission Decision of 18 November 2011 establishing rules and calculation methods for verifying the fulfilment of the objectives set out in Article 11(2) of Directive 2008/98/EC of the European Parliament and of the Council.

24.1.5 End of Waste (EoW) status

24.2 Non legislative instruments (best practices, guidelines, recommendations…)

In this section, other instruments that may specify how the country is addressing the issue of CDW management are highlighted, as these instruments might be creating conditions for a sustainable management of CDW.

Table 95 Non legislative instruments.

Description	Level of occurrence (Yes/No) Key Scope/Exemptions	Year established and policy reference	Further detail, information source, related web-site
Building certification standards that cover CDW (e.g. BREEAM)	YES. 2 buildings in Slovenia are BREEAM	1990	URL of BREEAM website with filtered Slovenia:
BREEAM	certified		http://www.breeam.org/projects/explore/map.jsp?sectionid=0&projectType=&rating=&certNo=&buildingName=&client=&developer=&certBody=&assessor=&addressPostcode=&countryId=705&partid=10023&Submit=Search
Environmental taxes related to waste management **Waste disposal tax**	YES. Waste disposal tax is paid for environmental pollution due to waste disposal at inert waste landfills, at non-hazardous waste landfills and at hazardous landfills.	2014	URL to list of environmental taxes : http://www.fu.gov.si/en/taxes_and_other_duties/areas_of_work/environmental_taxes/ URL to details of tax for environmental pollution caused by waste disposal: http://www.fu.gov.si/fileadmin/Internet/Davki_in_druge_dajatve/Podrocja/Okoljske_dajatve/Opis/Podrobni_opis_Okoljska_dajatev_za_onesnazevanje_okolja_zaradi_odlaganja_odpadkov_na_odlagaliscih.pdf
Extended producer responsibility scheme in operation?	NO.	n/a	n/a

24.3 CDW management performance – CDW data

24.3.1 CDW generation data

EUROSTAT database reports the data shown in Table 96 for CDW generated between years 2010 and 2014.

Table 96. EUROSTAT CDW generation data.

	2010 [tons]	2012 [tons]	2014 [tons]
Mineral waste for construction	622.431	109.807	98.923
Metal wastes, ferrous	57.900	4.170	3.825
Metal wastes, non-ferrous	132	139	251
Glass wastes	553	3.851	3.449
Plastic wastes	3.338	274	189
Wood wastes	3.731	2.308	1.231
Total	**1.509.476**	**535.154**	**815.010**

24.3.2 CDW treatment data

Data published by EUROSTAT deals with different waste categories but becoming from all the economic activities. Therefore, only for the category "Mineral waste from construction", data can be considered reliable, as in the Table 97.

Table 97. EUROSTAT CDW treatment data

Mineral waste from construction [tons]	2010	2012	2014
Landfill / disposal (D1-D7, D12)	41.012	23.144	12.611
Deposit onto or into land	41.012	23.144	12.611
Land treatment and release into water bodies	0	0	0
Incineration / disposal (D10)	0	18	12
Incineration / energy recovery (R1)	2	974	0
Recovery other than energy recovery	645.203	288.404	511.724
Recovery other than energy recovery - backfilling	11.973	4.050	0
Recovery other than energy recovery - except backfilling	633.230	284.354	511.724
Total waste treatment	**686.217**	**312.540**	**524.347**

24.3.3 CDW exports/imports data

The Table 98 summarizes the official CDW export/import data gathered from the Statistical office of the Republic of Slovenia. Data represent the summarized amount of waste under Code 17 of the List of Waste, as no data was available for the Construction activity (Section F – Construction, NACE, Rev. 2). CDW import and export data are not broken down into hazardous and non-hazardous waste.

Table 98. Official CW generation data (Source:Deloitte).

Official CDW generation data		2008	2009	2010	2011	2012	2013
Export	Waste delivered abroad - exports outside the EU (tonnes)	n/a	575	652	1,095	378	221
	Waste delivered abroad - exports to the EU (tonnes)	20,247	3,656	3,435	17,292	12,985	20,824
Import	Waste from abroad - import from EU (tonnes)	n/a	n/a	69,328	98,017	131,339	136,889
	Waste from abroad - import outside the EU (tonnes)	n/a	n/a	60,831	20,943	22,143	16,027
Total		20,247	4,231	134,246	137,347	166,845	173,961

24.3.4 CDW treatment facilities data

According to EUROSTAT database about "Number and capacity of recovery and disposal facilities by NUTS 2 regions", in Slovenia there are;

– 0 landfill for inert waste,
– 0 landfill for non-hazardous waste,
– 0 landfill for hazardous waste.

24.3.5 Future projections of CDW generation and treatment

As observed during the ReBirth project, there are limitations to the statistics, especially considering waste from building demolition and renovation activities where the quantities are poorly reported, as well as regarding the reported quantities of waste disposed of on illegal dumps, or the use of recycled aggregates or products. Infact, the statistics say that, in Slovenia, more CDW is recycled than actually generated.

24.3.6 Methodology for CDW statistics

Statistical data on CDW is collected and analysed by the Statistical Office of Republic of Slovenia25. Statistical data concerning waste is gathered based on:
– The National Statistics Act,
– The Annual Programme of Statistical Surveys,
– The Decree on waste.

24.4 C&D waste management in practice

24.4.1 CDW management initiatives

The initiatives listed below were identified based on a review of the relevant literature and stakeholder interviews.

Table 99. CDW management initiatives (Source:Deloitte)

Description of initiative	Scope	Year established	National, regional, local (specify which local area/region)	Public sector and/or Industry lead organisation	Levels of performance e.g. tonnes recycled	Further information/ web-site
ReBirth project Slogan: Waste is the beginning of something new. The overall objective of the project was to contribute to an increased and improved recycling of industrial waste and construction/demolition waste in the construction sector. This was promoted through open, thoughtful, rational, timely and fact-based communication and open dialogue planned to raise awareness of recycling possibilities for industrial waste and building rubble in the construction industry at the national, regional and local levels.	C&D waste	2011	National, regional and local (in Slovenia).	Public sector and industry lead organisations were partners (Environment - LIFE Programme).	Unknown.	URL of the project: http://en.re-birth.eu/
SARMa project The main objective of the project was to develop a common approach to (a) sustainable aggregate resource management (SARM); and (b) sustainable supply mix (SSM) planning, at three levels: regional, national and transnational. The project objective was also to build the foundation for a Regional Centre on sustainable aggregates management and supply.	Aggregates (crushed stone, sand and gravel).	2011	Local, regional, transnational.	Several ministries, institutes and universities were partners (South East Europe Programme).	Unknown.	URL of the project: http://www.sarmaproject.eu/

24.4.2 Drivers / barriers to increase CDW recycling

Table 100. Drivers / barriers to increase CDW recycling

Factor/characteristic/element inCDW recycling chain	Drivers	Barriers
EoW status	Chamber of Commerce and Industry of Slovenia is representing construction stakeholders and is actively participating in discussions for legislation and regulation changes, including the EoW status.	According to interviewed stakeholders, there is no clear line between waste and End of Waste; the regulation should provide more specific definitions.
Legislation and regulation	Chamber of Commerce and Industry of Slovenia is actively	Several laws and decrees are governing waste segment in

	participating in discussions for legislation and regulation changes.	Slovenia, but the provisions are sometimes contradictory. According to interviewed stakeholders the Government should align the various laws and prepare a standard document that would govern waste.
Statistics	Cooperation between Slovenian Statistical Office and Slovenian Environment Agency at statistical research on waste generation, treatment and management. Also according to Annual Research Quality Report on Research for Waste Generation in 2013 Eurostat is committing for increasing the quality and comparability of data between member states and is therefore organizing various workshops.	Because of the unreconciled different decrees that govern waste management, the waste statistics is inconsistent (e.g. greater quantity of recycled CDW than actually generated). One of the underlying reasons is also that investors have no obligation to report on generated CDW if, pursuant to another legislation, they are obliged to prepare a Construction Waste Management Plan or obtain environmental permits.
Green procurement	A sound basis for the use of recycled CDW.	Provisions regarding the use of recycled CDW are not binding, but rather optional, with only provisions regarding the construction of buildings being defined (additional points for bidders claiming that recycled construction material will constitute more than 30% of all construction material used).
Waste Management Strategy		The last Operational Programme for Waste Management was for the period 2004 – 2008. According to the interviewed stakeholders Slovenia would need a new strategy with clear targets and prompt monitoring of status to boost a more sustainable waste management
Interest for CDW regulations	Chamber of Commerce and Industry of Slovenia and some other private Organizations are	According to the interviewed stakeholders, there is a lack of interest at the Government

	actively promoting reuse of CDW and changes of regulation.	level in regulating CDW

24.5 CDW sector characterization

24.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

No data found

Quantitative analysis

No data found

Recovery techniques

No data found

Environmental and economic impacts of CDW waste management

No data found

Drivers / barriers to increase recycling

See Section **Errore. L'origine riferimento non è stata trovata.**

24.5.2 Recycled materials from CDW

According with Deloitte document, the main CDW products are recycled aggregates. Slovenia has recycling plants that treat mostly R1 waste (recycling of by-products, waste and residues from extractive activities), R2 waste (recycling of CDW) and R4 waste (recycling of industrial waste). Aggregates produced from these plants are used for backfilling purposes, concrete production and other construction purposes.
End-of-Waste criteria for aggregates have not been established. So far, the criteria have been adopted for iron, aluminium, copper and glass, but, according to the provided information, the amounts of waste that comply with the EoW status are still not included in CDW generation reporting (statistics).
According to the desktop-research results and the interviews, no information is available on the subject of requirements and standards used for recycled aggregates. CDW processors are required to possess environmental permits, but no control has been established for CDW treatment and aggregate recycling otherwise required for recycled construction material to be legally sold on the market47. No other satisfactory information could be retrieved regarding materials recycled from CDW.
Provisions on the use of CDW-recycled materials from the Green Public Procurement regulation are optional (additional points are awarded to bidders that include in their tender more than 30 % recycled construction material of all material used).

24.5.3 Market conditions / costs and benefits

Slovenia provides a financial incentive for CDW recycling through waste disposal taxation. The tax is payable for waste put on industrial (state revenue) and public dumping grounds (revenue of local communities). The tax base is EUR 0.0022 per kg of inert waste, EUR 0.011 per kg of non-hazardous waste, and EUR 0.022 per kg of hazardous waste. Tax payers are landfill operators.

The initiatives for using CDW as secondary material are those mentioned in Section 6.1. CDW management initiatives.

Prices of recycled aggregates in Slovenia are lower than the prices of natural aggregates. When collecting construction waste from which recycled aggregates are produced, collectors charge more for mixed construction waste than for separated construction waste. The transportation of CDW to the processor and of recycled aggregate from the processor to the place of use has a large impact on the price. This is why, in practice, the recycling and use often take place on the site itself.

25. SCANDINAVIAN COUNTRIES -DENMARK – FINLAND- SWEDEN

25.1 Legal Framework – Waste Management Plans and Strategies

25.1.1 National Legislation concerning CDW

Sweden

The legislations concerning CDW in Sweden can be found in the Swedish Environmental Code (Miljöbalken) and the Planning and Building Act (Plan och Bygglag). The Miljöbalken makes no special mention of CDW but lays down more generalized requirements about the conditions of the environment indirectly monitoring CDW management as well. The Miljöbalken (in its 2nd and 15th chapters) describes the waste hierarchy (prevention, re-use, recycle, energy recovery and disposal) similar to the European Commission's Waste Framework Directive (2008/98/EC).

The Planning and Building Act of Sweden through the process of granting permission to applications for construction and demolition activities, control the treatment and disposal of waste. According to this law, the application is to be followed by a control plan. Despite a scheduling of the demolition or construction activities, the waste-related aspects within a control plan are limited to a documentation of the safe-handling and sound disposal of hazardous CDW (summarized from Plan och bygglag (2010:900). The control plan is often preceded by an inventory of waste arising from the demolition of the building elements in consideration and its handling. It is foremost the builder's responsibility to draft the control plan and execute construction or demolition in accordance to it.

Denmark

The legislations supervising the recycling of CDW consist of the Environmental Protection Act no. 879 26/06/2010; Statutory Orders on waste, recycling of residual products and soils from building and sorted un-contaminated CDW (Order no. 1309/2012, Order no. 1662/2010). There is in addition a circular on the use of crushed asphalt in road construction [3]. The Waste Order (Affaldsbekendtgørelsen, BEK 1309:2012) stipulates that the builder notify the municipality 14 days before the demolition work is to commence.

Finland

The legislations tied up with CDW in Finland, similar to Denmark comprise acts and decrees. The Waste Act, Land use and building Act, Environmental Protection Act (646/2011, 132/1999, 527/2014). For all the above mentioned acts there are decrees issued by the execution authority. Just like the PBL in Sweden and the Waste Order in Denmark, Landuse and building decree in Finland requires the builder to notify the authorities prior to demolition; also providing details about the amount of waste and how it is going to be handled and so on.

While making a general comparison about the core ideas or focus points of the legislations for the three countries, it is observed that:

- Sweden focuses more on hazardous waste from demolition waste whereas Denmark is focussed on recycling specially to prevent the leaching from contaminated soils. Finland however seems to be very focussed on the reuse of building elements after demolition.

25.1.2 Waste management plans (WMP) and Strategies

The CDW waste generated in Sweden in voluminous and varied; plans for the management of such waste include high quality recycling and material re-use. This sector also consists of a large percentage of hazardous waste- which was estimated to a share of 10% according to the waste statistics of 2008 [290].

25.1.3 Legal framework for sustainable management of CDW

The Deloitte waste management study has adopted a few parameters to describe sustainable waste management of CDW. These parameters range from the stages of demolition till waste collection; however a parameter for the green public procurements is included as well. The Table 101 explains the national and regional obligations present in Denmark, Sweden and Finland that relates to the sustainable waste management parameters.

Table 101. National and regional obligations in Denmark, Sweden and Finland

National or regional obligation towards ↓	**Denmark**	**Sweden**	**Finland**
Selective demolition	Selective demolition of buildings owned by the government is carried out according to the guidelines laid down in NMK96. Was established in 1997 during the government's Action Plan for Waste and Recycling 1993-97. In the coming future, the competencies of the demolition companies will be assessed.	During building demolition components in contact with and containing with hazardous materials are dealt with selectively. "Building code (SFS 2010:900) § 6, Paragraph 10: The monitoring plan prepared before demolition must declare how hazardous waste has been surveyed and how it will be managed" [291].	Comprises of the Land Use and Building Act 132/1999 , Land Use and Building Decree 895/199 - Waste Decree 179/2012. The Act 132/1999, oversees the recycling of usable building parts and waste after demolition. The 895/199 decree looks into the ecological footprint of a finished building and the reusability of its components. Permits before construction and demolition form a part of this decree. The Waste decree entails planning for the reclaiming and reusing of waste in an environmentally responsible manner.
Sorting (on-site or a	Action Plan for Waste and Recycling	The Waste Ordinance SFS 2011:927	The Land Use and Building Decree

separate sorting facility)	1993-97 demands the sorting of CDW on-site or at a registered sorting facility. Requirements for waste sorting are mentioned in the Order nr. 1309, 18/12/2012. CDW from the commercial sector that is recyclable should be sorted at source while residential CDW is deposited at the municipal recycling centre.	(general) and the Building Code (SFS 2010:900) established in 2011 mentions the need for sorting CDW. The Swedish Waste Management Plan from 2012-17 requires that the contractors develop methods for source-sorting and identify solutions for reuse by organizing a common collector or retailer for surplus construction material or CDW.	895/199 states the need to notify the CDW waste generated, sorting methods used and hazardous waste obtained. But the CDW is sorted according to the Waste Decree.
Obligation to separately collect different materials (iron and steel, plastic, glass, hazardous waste etc.,)	The government's Action Plan for Waste and Recycling 1993-97 stipulates the need for the municipality to make arrangements to separately collect different waste fractions.	Combustible waste is to be sorted separately (NFS 2004:4). The Building Code (SFS 2010:900) prescribes the need for a monitoring plan before demolition that declares the surveyed hazardous waste quantities. In the Swedish Ordinance on PCB (SFS 2007:19) looks into the management of PCB contaminated construction products.	The legislations (Waste Act 646/2011, Government Decree on Waste 179/2012), require that hazardous waste be separately collected and managed. The sorting obligation applies to all wastes classified as hazardous (e.g. asbestos, PCB; also solvents, paints, oils).
Green public procurement	-	Is implemented when the municipality is the constructor.	As guidance, 14 procurement areas (with most relating to buildings) have been established in the National Plan for Green Public Procurement (in 2013).

25.1.4 Targets

Sweden:

- The Swedish Environmental Protection Agency (SEPA) has allocated a milestone target for the construction and demolition waste (within a total 5 milestones) [2] .This milestone target echoes the European Commission's Waste Directive (2008/98/EC) to take measures for the re-use, recycling or material-recovery of at least 70% (by weight) of non-hazardous CDW.
- The preparation for recycling, re-use and material recovery of non-hazardous CDW for at least 70% by weight must be done latest by 2020 (Environmental quality goal).
- The handling of waste and material in the infrastructure sector must have an increased focus on environmental and health concerns (SEPAs goal).
- To adopt a waste-specific approach towards CDW recycling as opposed to the weight-based recycling and recovery targets. The 70% target can be achieved by the recycling of heavier CDW which does not necessarily imply holistic material recovery [5].

Denmark:

- According to the Danish waste management plan for 2013-18, the waste management goals are to obtain CDW of better quality (to reduce contaminants deteriorating the environment) and at the same time maintain a high recycling rate (at least 70%) in Denmark.
- Changes in legislation are under preparation to enable better recycling of asphalt, concrete and brick. The proposed changes will be backed by scientific studies on the recycling of these materials.
- An inter-ministerial report on the mapping of PCB is in Danish buildings has been prepared.
- Studies on the environmental, social and economic dimensions of different CDW have been made such as an LCA (Life Cycle Analysis) study on the reuse of bricks has been published. A socio-economic assessment of bricks is currently being pursued. A feasibility of the recovery and recycling of concrete has been reported.
- The pros and cons of recycling impregnated wood and the potential for recycling wind turbine blades and district heating pipes is being studied.

Finland:

The waste management study document by Deloitte states that there are none of the national goals or targets set for the recovery of CDW in Finland. The target of recycling a minimum of 70% CDW has been stipulated by the National Decree on Waste (179/2012) echoing the EC Waste Directive. There are recommendations towards adopting a waste-specific approach towards recycling and recovery contrary to the weight-based approach.

Additionally, it has been recommended that backfilling not be recognized as a recovery operation [292].

25.1.5 End of Waste (EoW) status

There are no national EoW criteria set for any types of waste so far nor is there any preparatory work going on in Denmark, Sweden or Finland [291][293][294].

25.2 Non legislative instruments (best practices, guidelines, recommendations…)

The Deloitte report [291][293][294] describes the non-legislative instruments in every European country on the basis of instruments such as landfill tax, sustainability standards covering CDW for private and public sector, extended producer responsibility with relation to CDW. A description of such instruments for Denmark, Sweden and Finland is provided in the Table 102.

Table 102. Non legislative instruments in Denmark, Sweden and Finland

Non-legislative instruments characterized as: ↓	Denmark	Sweden	Finland
Landfill tax	The tax was established in 1987 and currently amounts to DKK 475/tonne (EUR 64/tonne). The tax is larger than the landfill fee for recyclable waste, DKK 366 /tonne (EUR 49 /tonne). . Landfill of hazardous waste was formerly excluded from the tax but has since 2010 been integrated in the taxing system; and the taxation fee is the same. The taxation has promoted the development of recycling technologies and decreased the amounts to be landfilled.	Law on landfill tax SFS 1999:673 exempts certain waste categories such as excavated soil that is deposited on landfill sites for inert waste. Reclaimed asphalt as well as construction and demolition waste is subject to the tax. A refund is granted for waste that is not disposed and subsequently removed, e.g. for recycling.	Was introduced in Finland as a legislative measure in 1996.
Sustainability standards covering CDW	DGNB (Danish Green Building Council) from 2011, in its sustainability certification of buildings oversees the entire life cycle including the recovery,	The Swedish version of BREEAM adopted in 2013 recognizes CDW management and its reuse. Points are awarded for on-site waste management,	The most used sustainability assessment schemes include PromisE (developed in Finland), BREEAM and LEED. BREEAM was established in 1990 and LEED in

	recycling options for CDW.	the re-use of recycled mineral fractions and the re-use of façade, load bearing elements. The LEED certification provides points for the use of recycled materials in construction. "Miljöbyggnad" (an environmental certification system for buildings), managed by Sweden Green Building Council for Swedish conditions proposes to reward CDW recycling.	1998.
Sustainability standards covering the public sector	There is no official Danish sustainability standard for buildings for the public sector. However, the Energy Agency in 2015 launched a free-of-charge Life Cycle Assessment (LCA) tool for buildings, including end-of-life. Furthermore, the Energy Agency has issued the publication "Bæredygtigt byggeri" –which includes guidance on the importance of including the whole life cycle of the building, including the CDW and considerations about resources and recycling.		

Extended producer responsibility	Extended producer responsibility programs are operated by Rockfon A/E for rock wool material.	-	-

25.3 CDW management performance – CDW data

25.3.1 CDW generation data

Figures **Errore. L'origine riferimento non è stata trovata.**,Figure 20Figure 21 have been collected from the Deloitte waste management document [291][293][294] for Denmark, Sweden and Finland respectively.

The Danish CDW waste statistics are collected every year by the Danish EPA through a system called National Waste Data system (ADS). The ADS system (updated from the earlier ISAG) requires that along with waste handling facilities, all other actors coming in contact with CDW must report the quantities of the waste handled.

Table 103. CDW generation data, Demark (Danish ISAG system). Source: Construction and Demolition Waste Management in Denmark [293].

CDW generation data	2007		2008		2009	
	tonnes	% (w/w)	tonnes	% (w/w)	tonnes	% (w/w)
Non-suitable for incineration	123 949	2	105 866	2	89 237	2
Concrete waste	1 568 950	27	1 451 830	24	1 283 870	26
Bricks	331 858	6	220 562	4	203 867	4
Other CDW	481 704	8	734 057	12	619 626	12
Asphalt	781 217	14	883 570	15	948 585	19
Soil and stone	1 725 739	30	1 961 028	33	1 391 549	28
Other recyclable CDW	400 562	7	229 636	4	89 686	2
Other fractions	352 747	6	422 242	7	343 339	7
TOTAL	**5 766 726**		**6 008 791**		**4 969 758**	

Year	2010			2012		
Waste type	Generated	Source separated for material recycling*,	Off-site sorted for material recycling*	Generated	Source separated for material recycling*	Off-site sorted for material recycling*
06.1 Metal waste, ferrous	50 000	50 000	37 176	33 000	33 000	29 762
06.2 Metal waste, non-ferrous			4 766	28 000	28 000	4 904
06.3 Metal waste, mixed	22 500	22 500	1 717	79 000	79 000	771
07.1 Glass waste	5 000	5 000	12	2 000	2 000	181
07.4 Plastic waste	150	150	111	200	200	540
07.4 Wood waste	125 000			300 000	0	
12. Mineral waste from construction (excluding 12.4 and 12.6)	900 000	608 659		700 000	428 381	
12.1 CDW, other sectors	14 283			144 770		
12.8 Mineral waste from waste treatment	101 900		(included in 608 659 tonnes)			47 562
(10.2 Mixed waste, not specified)				25 000	0	0
TOTAL	1 218 833	686 309	43 782	1 311 970	570 581	83 720

Figure 20. Amounts of CDW generated in 2010 and 2012 included in the definition of CDW according to the WStatR. Source: Construction and Demolition Waste Management in Sweden [291]

The Swedish EPA (Naturvårdsverket) is responsible for reporting the waste statistics, the collection of which is done by a consortium called SMED (Svenska MiljöEmissionsData). The waste data is collected using methods such as waste factors (kg/m^2 of a certain type of waste), estimated by the turnover of construction and demolition companies and CDW data from environmental reports of companies.

Waste category	2010, Mtonnes	2012, Mtonnes
Non-hazardous CDW		
CDW from buildings	1.24	1.20
Soils	4.00	3.50
Dredging spoils	3.50	2.07
Hazardous waste		
CDW from buildings	0.19	0.17
Soils	0.45	0.72
Dredging spoils	0	0
Total (non-haz. and haz. CDW)	**9.38**	**7.67**

Figure 21. Generated hazardous and non-hazardous waste in Finland by VAHTI. Source: Construction and Demolition Waste Management in Finland [293]

25.3.2 CDW treatment data

Denmark has already achieved the 70% target of CDW recycling and recovery. The largest fraction of CDW is concrete waste- 90% of which is recycled as un-bound road subbase roads replacing natural gravel.

Year	2008	2009	2010	2011	2012	2013
Generated CDW (tonnes)	n/a	n/a	1 218 833	n/a	1 311 970	n/a
Recycled CDW (tonnes)	n/a	n/a	121 432	n/a	178 358	n/a
Backfilled CDW (tonnes)	n/a	n/a	608 659	n/a	475 943	n/a
Landfilled CDW (tonnes)	n/a	n/a	21 476	n/a	14 755	n/a
Energy recovery if any (tonnes)	n/a	n/a	240 746	n/a	413 924	n/a
Unknown treatment (tonnes)	n/a	n/a	226 520	n/a	228 990	n/a
Recycling rate (%)	n/a	n/a	59.9	n/a	49.9	n/a

Figure 22. CDW generation and recovery (prepared by SEPA). Source: Construction and Demolition Waste Management in Sweden [291]

From Figure 22 it can be seen that a large portion of the CDW from 2010 and 2012 fall into the unknown treatment category, this can be interpreted as the un-reported statistics from waste facilities. These numbers could also represent internal recycling operations within industries.

Statistics Finland released a notice on the treatment of wastes from housing construction in 2011 where 1.7 million tons of waste generated in housing construction were used or transported to pre-processing for utilization. The mineral waste used or treated for utilization amounted to 1.3 million tons and metal waste to 100 000 tons. Energy production used 250 000 tons of wood waste from construction. Around 250 000 tons of construction waste ended up at landfill sites. In 2011, the total amount of construction waste was 2.2 million tons. The figures do not include soil waste or dredging spoils generated in construction. Onsite recovery or internal recycling is not reported according to the WStatRegulation. However, on-site incineration is reported as disposal or energy recovery if existing. When the waste is received at a treatment facility, the origin of the waste is determined on a rough activity level. Wastes from construction activities are classified in their own category. As a result there is no problem in the traceability of CDW in Finland. There is no information on temporary storage, but this is not so significant because temporarily stored material is recorded as soon as it reaches a treatment facility. In most areas the following construction and demolition wastes are collected separately and treated: wood waste, metal, gypsum, mixed waste, brick and concrete, soil and gravel

25.3.3 CDW exports/imports data

The Danish EPA reports that import of CDW consist of metals from Sweden and the export consists of metals to Germany and the UK. ADS reported that in 2013, Denmark exported 84,006 tons and imported 16,060 tons of CDW.

In Sweden, the county administrative boards are the responsible authorities for the operative control of transboundary waste shipments to and from Sweden; the SEPA is however the main authority who approves the import or export. In 2013, 23,362 tons of CDW was imported to Sweden from Denmark, Switzerland, Estonia and Germany. The main waste types imported were glass, plastic and wood containing or contaminated with dangerous substances (17 02 04*), and wood (17 02 01). In the same year, 2,484 tons of CDW was exported to Germany, Denmark and Norway, the main waste types being cables containing oil, coal tar and other dangerous substances (17 04 10*), and soil and stones (17 05 04). In 2014, in total 23 362 tons were imported and 2 485 tons were exported. The data on exported/imported amounts are mainly based on information from building and demolition companies and information from environmental reports from waste management facilities. Regarding wood (17 02 01), it is unsure whether the wood waste really emanates exclusively from the building and demolition sector. Contrary to Denmark, Sweden seems to import more waste than export; the waste composed of impregnated wood, plastic is maybe required as fuel for the waste incinerators.

Finland exports a small amount of mixed CDW to Estonia for sorting and recycling. A very small amount of PCB-containing demolition waste is imported to Finland for disposal.

25.3.4 CDW treatment facilities data

According to the Danish Waste Association (Dansk Affaldsforening) has reported 39 landfills in Denmark with a capacity between 10,000 tons- 12.3 million tons. It is expected that the lack of landfill capacity could lead to transporting waste over longer distances thus increasing the disposal costs.
In Sweden there are 30 landfills for inert CDW. The remaining capacity is 636,000 tons as of January 2014; the landfill capacity is expected to decrease as no new are planned. 405,000 tons CDW were used for covering and rehabilitation on the existing landfills, was reported recovered. 200,000 tons are reported as input to sorting plants for mixed CDW. The number of treatment facilities only dedicated to CDW is unknown as CDW is mixed with waste from other sectors in these treatment facilities (landfills, sorting facilities, material recycling facilities, incineration facilities, etc.), but the number of so-called A-, B- and C-classified facilities which to some extent receive and treat CDW in Sweden is estimated to be around 1,250. However, mostly stationary recycling facilities are used for asphalt recycling, but no recycled asphalt is included in the statistics today as Eurostat does not ask for information on internal recycling. A

rough estimation of what amounts of asphalt which are not directly processed on-site, and subject to internal recycling, is from 800,000 to 1 Mtons annually. There is, however, an on-going discussion between SEPA and the industry on the issue. For the time being, there is insufficient capacity for the use of more advanced separation technologies that can handle CDW. Thus, to maintain and increase the recycling of CDW the Swedish system depends to a large extent on the sorting of wastes at source.

Several different sized treatment facilities are extensively located across Finland and treat mixed CDW containing concrete, plastics, bricks, wood and metals. The combined capacity of eight large-scale facilities based on their environmental permits is around 680,000 tons. In addition, these facilities also treat other types of wastes. The possibility of pre-treatment creates an opportunity to accept larger quantities of waste. In addition to the mixed CDW treatment facilities, Finland has a number of other recycling facilities operated both by private companies and by some municipalities that can treat also source separated waste fractions such as mineral waste (e.g. over 100,000 tons). However, more detailed information of their capacity regarding source separated CDW has not been compiled in available reports. Considering the amount of CDW generated, there is sufficient treatment capacity in place in Finland. Specific inert CDW landfills are not reported. As for general inert landfills, 4 landfills with a capacity of 496,000 tonnes are operating in Finland. Figure 23 shows the distribution of landfills for hazardous, non-hazardous and inert waste.

	Landfill for hazardous waste	Landfill for non-hazardous waste	Landfill for inert waste
Total number of existing landfills	22	90	4
Number of these landfills complying with the directive	20	88	4
Number of landfills closed (no more depositing) between January 2010 and 31 December 2012	3	10	0
Number of landfills re-equipped		11	
Rest capacity (tonnes)	18 060 728	48 667 821	496 000

Figure 23. Total landfill distribution in Finland (Source: Finnish Environment Institute)

25.3.5 Future projections of CDW generation and treatment

A 2015 Danish report prepared by the EPA on waste projection, has forecasted the generation and treatment of waste, required to evaluate the future treatment capacities and the fulfilment of policy targets. The projection model is applied for two scenarios; a business as usual scenario (BAU) where no new waste policies are implemented, and a scenario where targets in the Danish Government's resource strategy 'Denmark without waste' from October 2013 are fulfilled. The activity within the building and construction sector is expected to increase by 45% from 2012 to 2030 (more than GDP), and the amount of waste is expected to increase to year 2030 with 43% calculated from the baseline for year 2012 in the BAU scenario and respectively 47% in the scenario with resource strategy fulfilled. According to the report, it is concluded that

capacities for recycling of materials from building and construction appear sufficient for a very long period.
There are no studies so far projecting the future of CDW in Sweden and Finland.

25.3.6 Methodology for CDW statistics

The Swedish and Finnish methods follow the Eurostat guidelines however as per a statutory order in Denmark, a system called ADS (Waste data system) has the duty to report waste statistics.
The Danish EPA is in charge of collection of statistical data of data. All waste producers, receivers, exporters and importers in Denmark are, according to the Statutory Order on Waste data system no 1306/2012, obliged to give information of waste amounts, waste origin, planned treatment and waste receiver. The waste is classified according to the LoW codes and the waste producer is classified according to industry or NACE code. The statistics are based on total reports from every waste operator in Denmark. The report includes information about waste producer, recipient, waste type, and treatment, weight in metric tons. The report includes all types of waste including CDW. The statistics are published yearly, and raw data are available to the public on the system's website (https://www.ads.mst.dk). The quality of waste data is checked through checking with earlier data- and own control systems at the Danish EPA. In case of uncertainty, direct contacts are taken to the stakeholder in order to ensure correct raw data.
In Sweden, the methodology used for gathering data on CDW generation and treatment follows the Eurostat guidelines by SEPA. The same methodology has been used for 2010, 2012 and now 2014. Compared to other sectors, the uncertainties in the current method are rather high, and potential methodologies have been assessed. In 2016, the method for data collection of treated CDW amounts underwent change where waste management facilities (A- and B-classified) were under obligation to report the received CDW and corresponding treatment method. SEPA is also considering implementing increased reporting requirement for C-classified facilities but no decision has been made yet.
In Finland, the methodology used for gathering data on CDW generation and treatment follows Eurostat guidelines, when reporting is under WStat regulation requirements.

25.4 C&D waste management in practice

To fulfill the recycling target by 2020 it is basically required that the re-use and recovery of CDW increase with a subsequent decrease in energy recovery. High quality recycling requires homogeneous waste fractions that could be implemented when waste material is sorted at source during and after building demolition. To ensure lesser contamination from PCBs, PCAH and so on, an inventory assessment prior demolition is to be taken. However as the current guidelines for waste-handling during demolition concentrates on the reduction of hazardous CDW and waste prevention, focus should be laid on preparation for recycling as well. It is advised that the demolition plan pay heed to the recycling of mineral fractions such as concrete, bricks and stones.

CDW sorting

Denmark: According to the Statutory Order no. 1309/2012 (Affaldsbekendtgørelsen) on waste, CDW is to be sorted on site into 10 waste fractions (concrete being one of the fractions). Sorting on-site can be neglected if the waste arising from the construction and demolition operation is less than 1 tonne; if for a certain reason sorting is impossible on the site then sorting takes place in a stationary facility approved by the municipality.

Finland: The Finnish Government Decree 179/2012 on waste requires the CDW holder to organize separate collection of waste to ensure a significant amount of waste can be reused, recycled or recovered. Separate collection of waste is obligatory for a few waste types which include a mineral and ceramic waste group containing concrete, brick and tiles.

Sweden: Sorting guidelines are given by the Swedish Construction Federation (Sveriges Byggindustrier) [295] for on-site sorting obligatory for 9 waste types. The sorting aspects are subjected to change depending on the material type, hazardous composition and desirable method of disposal in the site vicinity. The ordinance on Landfilling of Waste (2001:512) prohibits the disposal of unsorted combustible waste at a landfill site. Exceptions were made in 2005 regarding the organic waste. The exception for landfilling of organic and combustible waste is given in SEPA regulations and guidelines on the handling of combustible and organic waste. Combustible CDW need not be sorted at source if circumstances are such that sorting on-site is not possible.

Denmark	Finland	Sweden (Acc. To Sverigesbyggindustrier)
Natural stone, e.g. granite and flint	Concrete, brick, mineral tile and ceramic waste	Products and materials for re-use
Non-glazed tiles (Brick and roof tiles)	Gypsum-base waste	Hazardous waste
Concrete	Non-impregnated wood waste	Electronic waste
Mixtures of stone materials, and non-glazed tiles and concrete	Metal	Wood
Iron and metal	Glass	Plastic for recycling
Gypsum	Plastic	Combustible
Stone-wool	Paper and cardboard	Scrap and metal
Soil	Soil and waste rock material	Fill material
Asphalt		Waste to be landfilled
Mixture of concrete and asphalt		

25.4.1 CDW management initiatives

Most of the CDW management initiatives for Sweden, Denmark and Finland are acquired from the Waste studies reports prepared by Deloitte for the European Commission [291][293][294].

Initiative	Details
Sweden	
Guidelines on the hazard classification of asphalt by the Swedish EP	Established in 2013, a national initiative
Guidance on waste prevention	Skåne (southern province in Sweden) has prepared 2 reports of the reduction of CDW.
Guidance for the reduction of CDW and aspects included in public procurement	Established by Swedish association of Local authorities and regions
Project Constructivate	Convened by Mistra Closing the Loop, this project aims to determine the path for the effective recycling of CDW. The project focusses on rules and regulations, design of logistics and business models. The project works on the traceability of materials during the time of demolition and the economic motivation for contractors to demolish properly.
Denmark	
Quality of CDW, Initiatives for CDW management – Prepared by Danish EPA	The quality of CDW was determined by the level of contamination by PCB. More stringent regulations on demolition have been proposed to get a better idea about the material recovery potential. Better possibilities for the recycling of concrete and new methods for handling impregnated wood, masonry [7].
Finland	
ReUse-project financed by the Finnish Ministry of the Environment	Reuse of structural elements: obstacles and opportunities. Established in 2014.
Rudus/Betoroc; Mixture of concret eand bricks	Recycling of reclaimed concrete in earth construction that was established in 1996.
Zenrobotics Recyclers (Finnish SME)	Development of robotic recycling system (ZRR) which picks raw materials (wood, plastics, metal, stone, concrete etc) from construction and demolition waste.

	Waste material spread on a conveyor belt and the ZRR system will autonomously sort the waste. Established first in 2007.
HISER-project "Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste" (2015-2019)	HISER's main goal is to develop and demonstrate novel cost-effective technological and non-technological holistic solutions for a higher recovery of raw materials from ever more complex construction and demolition waste due to the variety of materials used. The solutions obtained will be validated in demolition work and five case studies throughout Europe. The environmental and economic impact of the solutions obtained in the HISER project will be quantified from a life cycle perspective (LCA/LCC). Recommendations will also be put forward to define new European policies and standardization standards to implement the best solutions in the construction sector.
Project on wood recycling financed by the Finnish Ministry of the Environment	Development of new recycling concepts and new products from wood waste.
European Regional Development Fund project on recycling of gypsum and felt roof waste	Study on collection systems and treatment processes of gypsum and felt roof waste – analysis of barriers & economics

25.4.2 Drivers / barriers to increase CDW recycling

Barriers to increase recycling

The table below is a brief description of the barriers Sweden and Finland faces at fulfilling vital features attributive to high recycling rates in a given recycling chain. These points are primarily derived from Deloitte's study [291][293].

	Sweden	**Finland**
Legislation	The EU WFD targets for recovery: As the target is weight-based it promotes foremost the recovery of mineral waste fractions but does not target the fractions causing larger environmental impacts. The target does lay focus on high-quality recycling instead considers backfilling	Legislations relating to health and safety impede the progress in recycling. Lack of EoW criteria for CDW. The recycling targets are not country-specific especially to factors like climate, material availability, housing

	as a recovery measure. The definitions of recycling and recovery are very fitting for the building scenario but does not emphasize on the recycling of asphalt and track ballast (from infrastructure operations) that have a high recycling rate.	types etc.
Economics	SEPA has surveyed in 2015 that waste sorting increases treatment costs when compared to waste combustion. The long transportation distances to cover during waste treatment and recycling is not feasible on the long run.	Good availability of natural sands and aggregates reduces the demand for recycled alternatives. The market for recycled materials is thus lacking.
Sorting and recycling process techniques	On-site sorting is better than off-site sorting as automated sorting is not available in all the facilities.	As there is a lacking market for recycled materials, there is no motivation to establish standards or guidelines for waste sorting.
Quality	The presence of hazardous waste and contamination in CDW negatively influences quality. There is no standardization/ certification (CE marking) for secondary raw materials in construction.	There is a difference in the quality of recycling resulting in the utilizing of CDW in low-grade applications.
Work contracts	Several stakeholders' involvement does not help in waste prevention.	

The barriers for vital features in the recycling chain in Denmark are:

- Market conditions are not very well developed for CDW as it is not economically feasible because of the cost intensive recycling process, transportation. At the same time it is hard to ensure regular supply and a good quality secondary material.
- Recycling process and techniques: high-grade use of recycled CDW requires advanced sorting techniques. The supply of CDW has to match the demands, this requires intensive planning.
- Quality: The lack in clarity while interpreting PCB related criteria leads to larger contamination leading further to large and avoidable costs.

Benefits to increase recycling

	Sweden	Finland
Legislation		Material specific recycling targets: 70 % of construction and demolition waste must be recycled as material by 2020. Government Decree 591/2006 promotes the utilization of crushed concrete.
Economics	The landfill tax and the large transportation distances have reduced the landfilling of CDW.	Reduced landfilling owing to landfill tax.
Sorting and recycling process techniques	Landfill taxes and ban of landfilling of combustible waste fractions promote sorting of waste and improves quality of CDW..	Benefits the environment.
Quality		Use of efficient selective dismantling enables the separation of unwanted fractions from CDW and improves quality.
Work contracts	Several stakeholders' presence in the planning stage will ensure a uniform improvement in the recycling rates.	

The benefits for vital features in the recycling chain in Denmark are:

- Market conditions: The availability of economic support (by means of loans) while pursuing CDW recycling is an advantage. The cooperation between the stakeholders of industry and waste-management are advantageous as well.
- Economic: The taxation on non-reusable CDW and a tax on natural resources ensure an increase in the recycling rate.
- Recycling process and techniques: substituting natural resources with recycled- reduced exploitation.
- Quality: Implementing selective demolition on a larger level and the practice of on-site sorting.

25.5 CDW sector characterization

The CDW sector characterization for Denmark, Sweden and Finland are similar to each other with respect to the operations involved right from the stages of demolition, waste sorting and treatment.

The sector for Denmark and Sweden consists of the following actors (as is explained in [291][293][294]):

Sweden	Denmark
Building companies	Building owners
Demolition companies	Architects and consulting engineers
Waste transport companies	General contractors
Waste sorting or treatment companies	Specialized demolition contractors
End-users (incl. waste incinerators, landfill companies)	Waste handling companies and recyclers
Authorities (permitting, monitoring)	Transport companies
	Municipal authorities

The CDW sector in Finland consists of construction and demolition companies as waste producers. It is the municipalities that monitor and control the sorting and treatment procedures of CDW, often giving guidelines based on national legislation. The guidelines are mainly about separating the hazardous components from the non-hazardous and sending the waste to the respective treatment facility. The sorting is done on-site by the demolition contractors.

The waste-treatment, logistics and demolition operations are mainly carried out by private contractor companies.

25.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications, recycled new products and recovery techniques

CDW material	Application
CONCRETE	Concrete waste in Denmark, Sweden and Finland is used mainly as filling in the unbound road layers. The rate of concrete recycling however varies across the countries with Denmark achieving nearly 90%. In a few isolated cases across all three countries, aggregates are reclaimed from waste concrete and used to produce new concrete. Technical specifications for the use of reclaimed aggregates for the unbound use in road filling, is given by the Swedish Transportation Administration.
BRICKS	Similar to concrete waste, bricks are used as filling materials in roads, landfill covers in all 3 countries. Where selective demolition is possible, bricks are re-used in new construction.

TILES and CERAMIC	
ASPHALT	The most important criteria for asphalt recycling established by the Swedish EPA are the carcinogenic PAH-16 or PAH-7 are below 300 and 100 mg/kg respectively. In Denmark, technical guidelines on the use of reclaimed asphalt in unbound application have been published by the Danish Road Directorate.
WOOD	It is very common in Finland to produce chipboard from waste wood after the removal of nails. This is achieved by crushing plywood, chipboards and lumber by several actors. The recycling of wood is prevalent in Sweden whereas, the energy recovery from combustion of waste wood is also common.
GYPSUM	In Finland the gypsum recovered from waste plasterboards are recovered for use in the production of new plasterboards. The same is common in Sweden where according to recycling companies, the recycling of gypsum into new plasterboards is cheaper than landfilling.

Product description and applications

See section25.5.1

Quantitative analysis

See section25.5.1

Recovery techniques

See section25.5.1

Environmental and economic impacts of CDW waste management

See section25.5.1

Drivers / barriers to increase recycling

See section25.4.2

25.5.2 Recycled materials from CDW

See section25.5.1

25.5.3 Market conditions / costs and benefits

The following is the quality control process during the receipt of crushed concrete and alternative material for use in unbound layers for roads (as given by the Swedish Transportation Administration):

The crushed concrete that is to be used in road construction should have its properties declared and receipt controlled. Where the product is not certified then the monitoring during receipt is done by conducting a few tests, the delivery of material is accompanied by a demolition certificate.

If the crushed concrete product is not certified the producer must show a declaration of control conducted by the producer for certain properties like purity, strength and abrasion resistance. The declaration containing the details on the properties cannot be more than a year old.

The market in Sweden for recycled aggregates for road filling is dominated by demolition, waste-management companies, quarries and construction companies. These are sold as material alternative to natural gravel for purposes such as road-filling, landscaping, landfill covers and so on.

26. SPAIN

26.1 Legal Framework – Waste Management Plans and Strategies

The European Commission (EC) and the European Environment Agency (EEA) agreed to enhance efforts to improve knowledge on implementation of waste policies through tasks to review municipal solid waste, management in EEA member countries, using indicators, country factsheets and relevant European Commission studies. Together, these instruments establish a range of waste management targets and broader goals for the years to 2020.
The Legal framework in the field of waste management includes 16 acts, most of which have already been transposed in the Spanish and Portuguese legislation, as indicated in the Table 104:

Table 104. Legal framework in the field of waste management

European Law
1) Framework Directive on waste no. 75/442/EEC, as amended by Directive no. 91/156/EEC.
2) Directive no. 91/689/EEC on hazardous waste.
3) Directive no. 75/439/EEC on the disposal of waste oils, as amended by Directive no. 87/101/EEC and Directive no. 91/692/EEC.
4) Directive no. 91/157/EEC on batteries and accumulators containing certain dangerous substances
5) Directive no. 93/86/EC on the marking of batteries.
6) Directive no. 2000/76/EC on the incineration of waste.
7) Directive no. 94/62/EC on packaging and packaging waste.
8) Directive no. 96/59/EC on the disposal of biphenyls and polychlorinated terphenyls (PCB and PCT)
9) Decision no. 2000/532/EC, as amended by Decision no. 2001/119 establishing a list of wastes (replacing Decision no. 94/3/EC establishing a list of wastes Decision no. 94/904/EC establishing a list of hazardous waste)
10) Regulation no. 259/93 on the supervision and control of shipments of waste within, into and out of the European Community.
11) Directive no. 86/278/EEC on the protection of the environment, and particular of the soil, when sewage sludge is used in agriculture
12) Directive no. 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment, as well as
13) Directive no. 2002/96/EC on waste electrical and electronic equipment (WEEE).
14) Directive no. 78/176/EEC on waste from the titanium dioxide industry.
15) Directive no. 82/883/EEC on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry

16) Directive no. 92/112/EEC on procedures for harmonising the programmes for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry.

In the following sections the legal framework governing CDW management and waste management plans in Spain are explored.

26.1.1 National Legislation concerning CDW

Overview of National legislation in Spain

- Royal Decree 180/2015, of 13 March, on waste shipments, which develops Article 25 of Law 22/2011 and regulates waste shipments, was approved in March 2015.
- Law 22/2011, of 28 July, with the modifications incorporated in Law 5/2013, of 11 June, on Waste and Contaminated Soils incorporates Directive 2008/98/EC, of the European Parliament and of the Council, on waste and repealing certain directives, into Spanish legislation.
- Royal Decree 105/2008, of 1 February, on Construction and Demolition Waste production and management. This legislation specifically covers production and management of CDWs. It establishes a jurisdiction on the production and management of CDWs, in order of emphasis, the prevention, reutilization, recycling, forms of recovery and the assurance that all waste is properly treated thus contributing to a sustainable development in the construction sector.
- Royal Decree 1481/2001, of 27 December, regulating the disposal of waste by landfill.

In Spain the management of CDW depends from the Autonomous Regions with the exception of the waste originated from minor house works; therefore, the Autonomous Regions have defined their management CDW plans referring to the National legislation.

Overview of the relevant legislation at Regional level

- Andalucía
  Decree 73/2012, of 20 March, on approval of the Regulation of Waste in Andalucía.
- Aragón
  Decree 262/2066, of 27 December, on approval of the Regulation of production, property and management of the CDWs in Aragón. It also establishes a jurisdiction on the public service of valorisation of debris in Aragón.
- Basque Country
  Decree 112/2012, of 26 June, on regulation of the production and management of CDW in Basque Country.
- Canarias
  Decree 112/2004, of 29 July, on regulation of the procedure and requirements for the grant of authorisation related to waste management. Furthermore, it sets down the Registration of the Waste Management Association of Canarias.
- Cantabria

Decree 72/2010, of 28 October, on regulation of the production and management of CDWs in Cantabria.

- Castilla la Mancha
  Decree 189/2005, of 13 December, on approval of the waste management plan concerning construction and demolition of Castilla La Mancha
- Castilla y León
  Decree 11/2014, of 20 March, on approval of the regional waste management plan «Plan Integral de Residuos de Castilla y León»
- Extremadura
  Decree 20/2011, of 25 February, establishing a jurisdiction on the production, property and management of the CDWs in Extremadura.
- Galicia
  Law 10/2008, of 3 November, on waste management in Galicia.
- Madrid
  Order 2726/2009, of 16 July, of the Council of Environment, Housing and Land management, for CDW management in Madrid.
- Navarra
  Foral Decree 23/2011, of 28 March, on regulation of the production and management of CDW in Navarra.
- Valencia
  Law 10/2000, of 12 December, for waste in Valencia.

26.1.2 Waste management plans (WMP) and Strategies

Implementation of environmental policies, especially waste policies, is one of the European Commission's key priorities, as confirmed by its proposal for a 7th Environment Action Programme (EC, 2012) and the Roadmap to a resource efficient Europe (EC, 2011). While the EU's Waste Framework Directive (EU, 2008) and Landfill Directive (EU, 1999) set binding targets for recycling municipal waste and diverting biodegradable municipal waste from landfill, EEA analysis indicates large differences in municipal waste management performance between countries (EEA, 2009).

In Spain the management of CDW depends from the Autonomous Regions with the exception of the waste originated from minor house works; therefore, the Autonomous Regions have defined their management CDW plans referring to the National Plans. The National waste management plans are referred hereunder:

<u>Overview of waste management plans at National level in Spain</u>

The National waste management plans are referred hereunder:

National Integrated Waste Plan (PNIR) for 2008-2015, approved by the Council of Ministers in December 2008, is intended to serve as a guide for the development of specific policies to improve waste management by reducing its generation and promoting its correct treatment.

Among its objectives, the Plan includes the treatment of domestic and similar waste (domestic urban waste), waste covered by special legislation (hazardous waste, vehicles, end-of-life tyres, batteries and accumulators, electrical and electronic appliances, waste from construction and demolition, sludge from sewage treatment plants), polluted soil, and non-hazardous agricultural and industrial waste. It also takes into account a reduction in biodegradable waste disposal.

The document gathers, in an integrated manner, specific chapters for:

- Municipal wastes
- Hazardous wastes
- End of life vehicles
- End of life tires
- Sewage sludge
- Construction and demolition wastes
- PCB/PCT and PCB/PCT containing equipment
- Wastes from accumulators and batteries
- Electric and electronic equipment wastes
- Wastes from extractive industries (mining activities)
- Wastes from agricultural plastics
- Non-hazardous industrial wastes
- Contaminated soils

The **II National Plan on Construction and Demolition Waste** (II PNRCD) is included in the PNIR.

State Waste Framework Plan (PEMAR) for 2016-2022, approved by the Council of Ministers in November 2015, is intended to guide the management policy in Spain, pushing the measures required to improve the identified deficiencies and promoting more sustainable measures to ensure the achievement of the legal objectives. This plan includes the household, commercial and industrial waste as well as waste with specific legislation, wastes from agriculture and sanitary waste. It includes also a chapter related with contaminated soils.

State Waste prevention programme 27.11.2013, was elaborated as response of the statement in article 29 of the Directive 2008/98/CE that all EU members should prepare waste prevention programmes no later than 12 December 2013. The main aim of this plan is to achieve a 10% reduction in weight of the waste generated in 2010 by 2020.

<u>Overview of waste management plans in Spain at regional level</u>

- Asturias
  Strategic Waste Plan of Asturias for 2014-2024.
- Baleares
  Approval of the Director Sectorial Plan for the management of CDW, bulky waste and end of life tires in Mallorca.
  Director Sectorial Plan for the management of non-hazardous waste of Menorca.
- Castilla y León
  Integrated Waste Plan of Castilla y León (BOCyL of 24 March 2014)
- Catalonia
  General programme on prevention and management of waste and resources of Catalonia (PRECAT 2020) for 2013-2020.
- Madrid
  Regional plan on Construction and Demolition Waste in Madrid for 2006-2016.
- Murcia
  Waste Plan of Murcia 2015-2020.
- La Rioja
  Director Waste Plan of La Rioja 2007-2015.
- Navarra
  Waste Plan of Navarra 2017-2027.

26.1.3 Legal framework for sustainable management of CDW

As already mentioned in section 1.1, Royal Decree 105/2008, of 1 February, on Construction and Demolition Waste production and management, establishes a jurisdiction on the production and management of CDWs, in order of emphasis, the prevention, reutilization, recycling, forms of valorisation and the assurance that all waste is properly treated thus contributing to a sustainable development in the construction sector.

In this line, the waste producer should provide at least the following information in order to obtain the building licence.

- An estimation of the amount of CDW generated, coded as per the European List of Waste (Commission Decision 2000/532/EC).
- Measures for the waste prevention.
- Measures for the reuse, valorisation or disposal of the waste generated.
- Measures for the separation of waste generated during the construction or demolition.
- The drawings of the installation for the storage, handling, separation and other procedures of CDW management.
- The technical specifications for the storage, handling, separation and other procedures of CDW management.

- Assessment of the cost for the CDW management.
- In refurbishment, renovation or demolition works, an inventory of the hazardous waste generated must be done.

According to this Royal Decree 105/2008, the CDW should be separated in fractions when the estimated amount of waste to be generated exceeds the following amounts:

- Concrete: 80 t
- Bricks, ceramics, tiles: 40 t
- Metal: 2 t
- Wood: 1 t
- Glass: 1 t
- Plastic: 0,5 t
- Paper and cardboard: 0,5 t

26.1.4 Targets

Following the Council Resolution of 7 May 1990, which invited the Commission to establish proposals for action at Community level, the Priority Waste Streams Programme was initiated. CDW was identified by the Member States as one such stream, even though at the time relatively little was known about the nature or volumes of the flows concerned.

The objectives of the Priority Waste Streams Programme respond to the waste management hierarchy, which prefers waste prevention or reduction to re-use, re-use to recycling or recovery (including the use of waste as a source of energy), and all of these to final disposal via landfill or incineration without energy recovery. Although not expressed in these terms in any of the key documents, the hierarchy is generally summarized as:

(i) Prevention or reduction (sometimes termed avoidance or minimization);
(ii) Re-use;
(iii) Recycling or materials recovery;
(iv) Energy recovery;
(v) Disposal in a safe manner.

It was known that most CDW had traditionally been landfilled, frequently in the same landfills as were used to dispose of municipal solid waste (MSW). Furthermore, it became clear that the volume of CDW, most of which is inert, was roughly equal to that of MSW. Given the increasing scarcity of landfill space, and the increasing costs of improved environmental protection involved in modern landfill engineering and management, it was obvious that action to re-use or recycle CDW would reduce the proportion going to landfill, thereby relieving the pressures on MSW disposal as well as respecting the hierarchy of waste management practices set out in the Framework Directive on waste (75/442/EEC as amended by 91/156/EEC) and the Fifth Environmental Action Programme.

In *Spain*, the Council of Ministers approved the 2016-2022 State Framework Plan on Waste Management (PEMAR) in November 2015, establishing the strategic lines of action and measures necessary to advance towards a so-called circular economy and meet the European targets on waste. This is a key instrument for applying the waste management hierarchy and for advancing towards a circular economy, which reincorporates materials containing waste into the production process for the manufacture of new products. It also fosters coordination between administrative authorities, improved transparency and information on waste, inspections, control and social awareness.

In order to achieve progress in the efficient use of resources, the law incorporates:

- A prevention target: 10% reduction in the weight of waste generated by 2020 compared with 2010.
- And recycling and repurposing targets to be reached by 2020 for municipal waste: 50% preparation for reuse and recycling.
- And construction and demolition waste: 70% preparation for reuse, recycling and other repurposing of material.

26.1.5 End of Waste (EoW) status

The 22/2011 Law on Waste and Contaminated Soil transposes the WFD via its definition of the EoW principle and outlines the following conditions:

- Ensure that there is a market or demand for such substances and objects;
- Substances or objects meet technical requirements for specific purposes, that existing legislation and standards are applicable to products;
- Ensure an adequate degree of environmental protection.

At the national level, *Spain* has not concretely developed an EoW status for any waste flow. Concrete discussions on how to integrate a set End of Waste status for various waste flows for aggregates are taking place. Important national actors, such as the National Federation of Aggregates are playing an important role in these discussions. Although a EoW status for waste flows is under discussion at national level, on the regional level, the Basque Country has outlined an EoW status for (recycled) aggregates via their regional Order 12/01/2015 on the use of recycled aggregates from the recovery of CDW . This Order outlines the specificities of aggregate use, which is introduced in Decree 112/2012 for CDW management in the Basque Country. The specifications within this document are described hereunder:

- Define recycled aggregates from CDW as those that have arisen from the treatment of inorganic material previously used in construction;
- Outline limits that are used to prohibit the use of recycled aggregate (i.e. contamination with pollutants, subject to contaminated soil, etc.);
- Outline the permitted uses allowed for recycled aggregates;

• Outline under what conditions aggregates cease to be waste and obtain the status of products to be used in various applications (fabrication of bricks, concrete, etc.).

26.2 Non legislative instruments (best practices, guidelines, recommendations…)

Besides the waste management plans, there are not many non-legislative instruments, as best practices, guidelines, recommendations, in Spain at national or regional level.

A relevant instrument is a quick reference guide for manufacturers, companies, technicians, public bodies and local authorities' administration concerning the correct management and reuse of CDW in Spain. This technical guide has been prepared by the Spanish Association of CDW recycling ("RCD asociación") and comprises of the following chapters:

- Legal framework concerning CDW.
- Stakeholders/main players
- Control procedures in the local authorities (quick estimation of the CDWs generated in a work site, control of works with technical project, control of minor house works)
- Software tool RCDCAUTION to request, through the recycling plants, a bank guarantee for the CDW management at the work site.
- Production of aggregates and recycled materials.
- Recommendations of the Spanish guide concerning the recycled aggregates (GEAR). Applications such as asphalt mixtures, precast elements, landfill, concrete.

26.3 CDW management performance – CDW data

26.3.1 CDW generation data

According to data reported by the Spanish Federation of Construction and Demolition Waste (FERCD, Feburary 2015), the production of CDW in Spain has fallen by 56% during the period 2009-2013 in all the Autonomous Regions.
In 2013, the CDW production was stabilized for the first time in the period 2009-2013 with an estimation of 20 MMt.
The average of the production in this period was 0,66 t/inhabitants/year, accounts for 0,43 t/inhabitants/year by 2013.

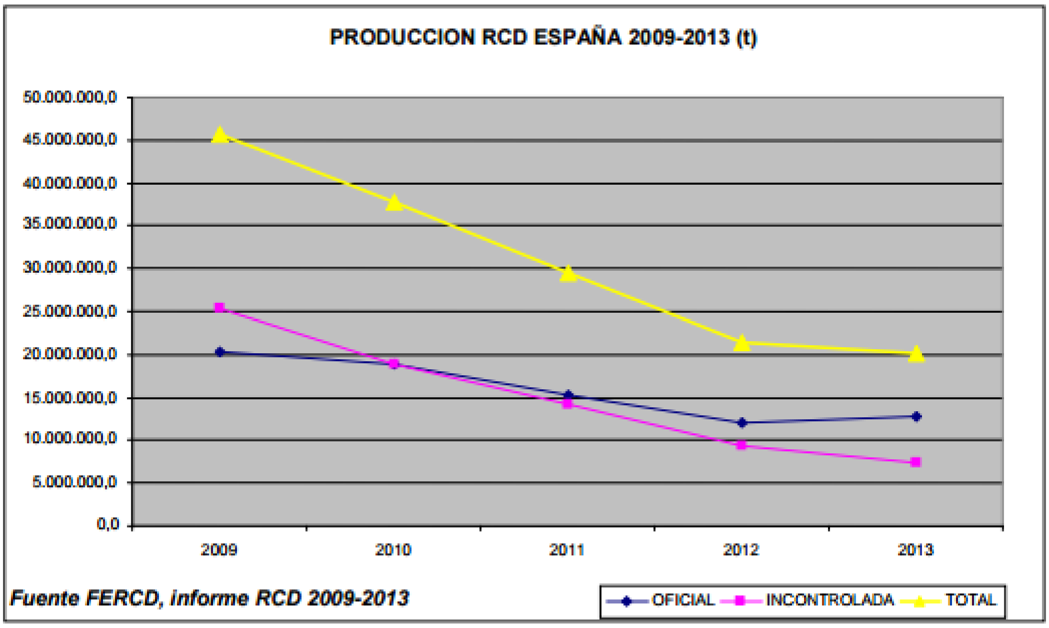

Figure 24. CDW generation data

The Table 105 outlines CDW generation in each Autonomous Region according to data provided by FERCD (February 2015).

Table 105. CDW generation in each Autonomous Region according to data provided by FERCD (February 2015).

Autonomous Region	2009	2010	2011	2012	2013	Total (t)	t/inhabitant/year
Andalucia	7.605.494	7.147.007	4.704.554	3.103.321	3.069.482	25.629.857	0,61
Aragón	1.979.878	1.168.069	923.688	683.196	654.275	5.409.107	0,80
Asturias	951.886	809.162	655.034	423.598	377.358	3.217.037	0,60
Baleares	964.737	993.807	750.256	450.947	421.315	3.581.061	0,65
Basque country	2.611.812	1.966.714	1.593.064	1.180.977	1.108.399	8.460.967	0,77
Canarias	1.246.394	1.406.239	1.070.912	961.934	1.011.563	5.697.042	0,54
Cantabria	401.180	321.815	303.663	230.320	215.935	1.472.912	0,50
Castilla y Leon	2.507.093	2.048.843	1.591.79	1.170.824	1.084.242	8.402.082	0,66
Castilla La Mancha	2.025.206	1.635.849	1.406.308	807.951	557.828	6.433.142	0,61
Catalonia	8.995.875	6.553.387	5.455.215	3.977.642	3.761.340	28.703.458	0,76
Extremadura	736.189	557.425	375.728	308.447	324.936	2.302.725	0,42

Autonomous Region	2009	2010	2011	2012	2013	Total (t)	t/inhabitant/year
Galicia	2.063.198	1.668.903	1.317.964	1.016.091	1.110.939	7.177.096	0,51
La Rioja	384.699	397.569	310.957	247.476	213.786	1.554.487	0,96
Madrid	6.184.962	5.389.727	4.616.262	3.593.399	3.128.468	22.912.820	0,71
Murcia	1.192.550	804.576	630.062	465.980	477.473	3.570.640	0,49
Navarra	716.133	564.770	389.831	300.823	279.724	2.251.281	0,70
Valencia	5.178.651	4.382.313	3.335.126	2.535.646	2.388.645	17.820.382	0,70

In the period 2009-2013, recycling is stabilized in 33% of the CDW production, the landfill increases without treatment being 26% of the production in 2013 as well as the uncontrolled landfill decreases being 35% of the production in 2013.

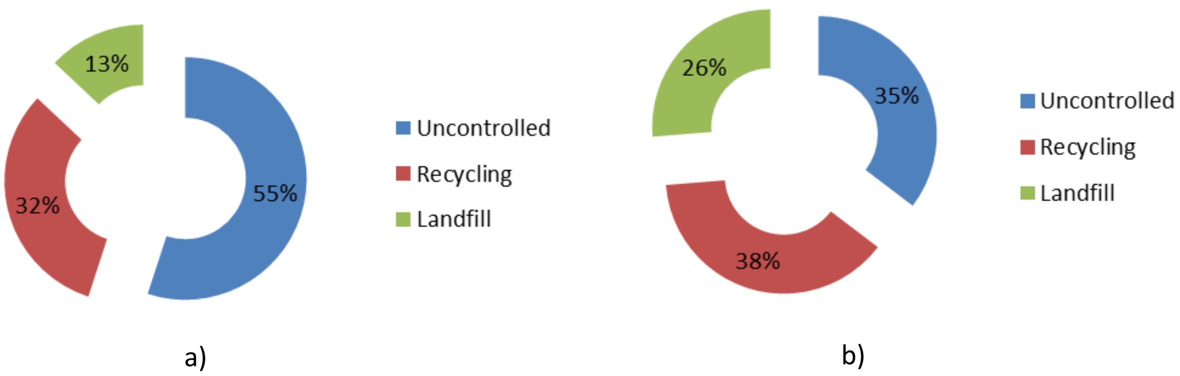

Figure 25. a) CDW management 2009 (Source: FERD) b) *CDW management 2013 (Source: FERD*

In the period 2009-2013, 43% of CDW production is associated with refurbishment works, 21% with residential construction works, 14%, corresponds with non-residential works and 23% related to civil works. CDW coming from refurbishment works accounts for 47% of the production by 2013.

26.3.2 CDW treatment data

The table below shows the CDW treatment data reported in the Spanish Statistical Office for 2012. There are no up-to-date data available.

Table 106. CDW treatment data reported in the Spanish Statistical Office for 2012

	Waste generated (t)	Recovery (t)	Backfilling (t)	Incineration (t)	Landfill (t)
Non-hazardous waste	27.637.698	19.007.146	4.328.999	0	4.301.553
Hazardous waste	66.156	3.878	0	0	62.278
Total	**27.703.854**	**19.011.024**	**4.328.999**	**0**	**4.363.831**

26.3.3 CDW exports/imports data

Waste Imports data

The table and graph below outlines the evolution of the amount of waste imported from EU and third countries for the period 2008-2012 (source: PEMAR). There are no up-to-date data available

Table 107. Evolution of the amount of waste imported from EU and third countries for the period 2008-2012 (source: PEMAR)

Year	Recovery	Disposal	Total
2008	150.643	255.369	**406.012**
2009	140.863	90.324	**231.187**
2010	186.464	63.712	**250.176**
2011	255.290	64.106	**319.396**
2012	305.703	25.141	**330.844**

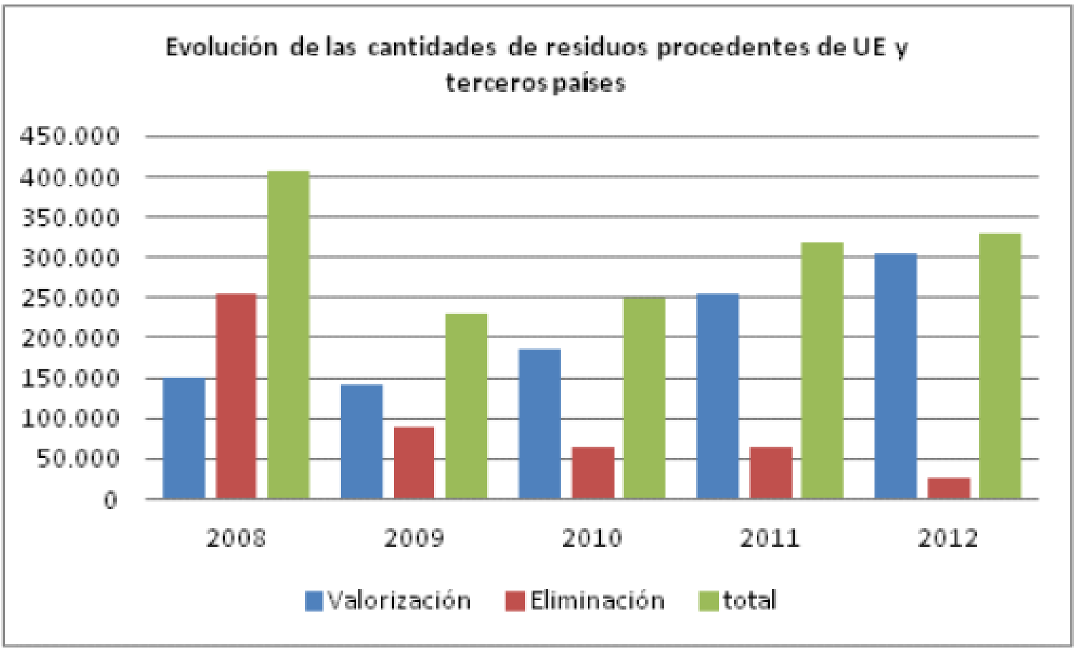

Figure 26. Evolution of the amount of waste imported from EU and third countries for the period 2008-2012 (source: PEMAR)

From the above data it can be observed that the amount of waste going to recovery have been increased during the period 2008-2012, while the quantities of waste going to disposal have been decreased between 2008 and 2009.

The Table 108 shows the quantities of treated waste from EU and third countries divided by Autonomous Regions for 2012 (source: PEMAR).

Table 108. Quantities of treated waste from EU and third countries divided by Autonomous Regions for 2012 (source: PEMAR).

Autonomous Region	Exports data from EU (2012)		Exports data from third countries (2012)		Total	Percentage (%)
	Recovery (t)	Disposal (t)	Recovery (t)	Disposal (t)		
Andalucia	13.676,00	926,41			14.602,41	7,23
Aragón	10.174,06		243,24		10.417,30	5,16
Asturias	418,68				418,68	0,21
Basque country	50.854,33		1.848,71		52.703,04	26,12
Cantabria	132,874				132,84	0,07

Autonomous Region	Exports data from EU (2012)		Exports data from third countries (2012)		Total	Percentage (%)
	Recovery (t)	Disposal (t)	Recovery (t)	Disposal (t)		
Castilla y Leon	41.914,17		17.616,04		59.530,21	29,50
Castilla La Mancha	158,08				158,08	0,08
Catalonia	4.725,37	1.073,08	2.671,72	21.311,80	29.781,97	14,76
Extremadura	41,92				41,92	0,02
Galicia		193,33	1.911,50		2.104,83	1,04
La Rioja	4.482,14				4.482,14	2,22
Madrid	149,98				149,98	0,07
Murcia	14.464,37		7.147,19		21.611,56	10,71
Valencia	2.975,31	1.497,56	1.001,35	139,40	5.613,62	2,78
Total	**144.167,25**	**3.690,38**	**32.439,75**	**21.451,20**	**201.748,58**	**100,00**

From the waste imported and treated in Spain, 84% corresponds to hazardous waste, as it is shown in the following table (source: PEMAR).

Table 109. Waste imported and treated in Spain)

	Total (t)	Hazardous waste (t)	%	Non-hazardous waste (t)	%
Third countries	30.000	8.045	27	21.956	73
EU	300.844	268.430	89	32.413	11
Total	**330.844**	**276.475**	**84**	**54.369**	**16**

<u>Waste exports data</u>

The table and graph below outlines the evolution of the amount of waste exported to other EU members and third countries for the period 2008-2012 (source: PEMAR). There are no up-to-date data available.

Table 110. Evolution of the amount of waste exported to other EU members and third countries for the period 2008-2012 (source: PEMAR)

Year	Recovery	Disposal	Total
2008	77.666	21.429	99.095
2009	60.336	10.017	70.353
2010	59.63	10.208	69.820
2011	115.712	0	115.712
2012	53.570	13.521	67.091

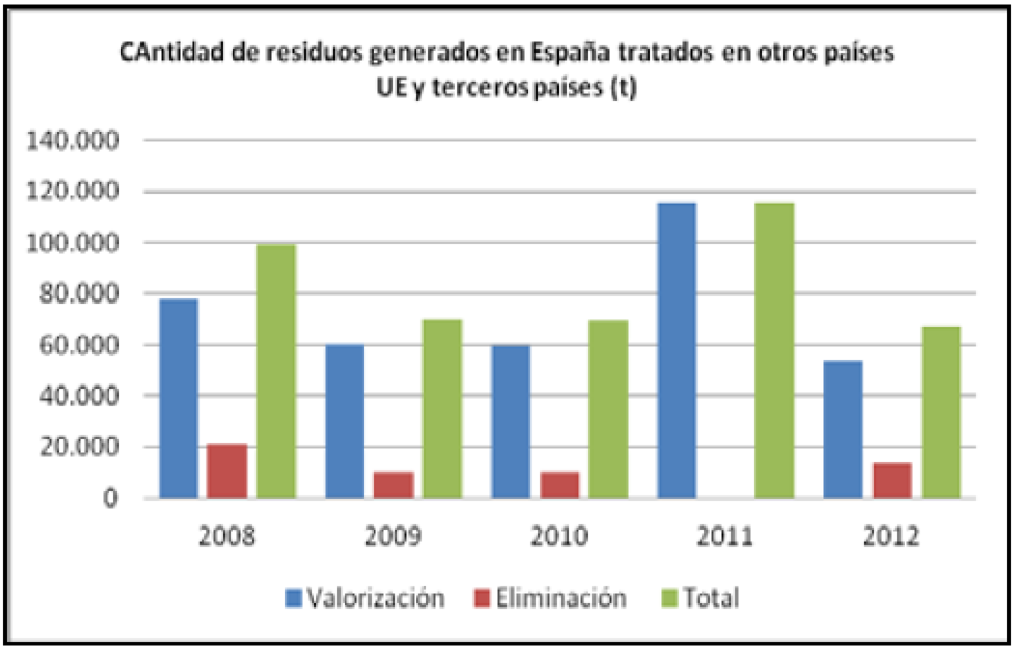

Figure 27. Evolution of the amount of waste exported to other EU members and third countries for the period 2008-2012 (source: PEMAR)

The Table 111 shows the quantities of waste generated in the Autonomous regions and treated in other EU members and third countries for 2012 (source: PEMAR).

Table 111. quantities of waste generated in the Autonomous regions and treated in other EU members and third countries for 2012 (source: PEMAR).

	Exports data from EU (2012)	Exports data from third countries (2012)		

Autonomous Region	Recovery (t)	Disposal (t)	Recovery (t)	Disposal (t)	Total	Percentage (%)
Andalucia	7.230,55	143,92			7.374,47	10,99
Aragón		0.79			0,79	0,00
Asturias		160,79			160,79	0,24
Basque country	5.109,29	1.399,74			6.509,03	9,70
Canarias			1.322,26		1.322,26	1,97
Cantabria	12.747,46				12.747,46	19,00
Castilla y Leon	60,34	6.000,00			6.060,34	9,03
Castilla La Mancha		26,78			26,78	0,04
Catalonia	21.204,71	5.173,90	4.981,30		31.359,91	46,74
Ceuta	200,00				200,00	0,30
Extremadura		70,56			70,56	0,11
Galicia		363,52			363,52	0,54
Madrid	648,70	88,27			736,97	1,10
Murcia		19,90			19,90	0,03
Valencia	65,84	75,50			141,34	0,21
Total	**47.266,89**	**13.520,67**	**6.303,56**		**67.091,12**	**100,00**

From the CDW generated in Spain and treated in other countries, 88% corresponds to hazardous waste, as it is shown in Table 112 (source: PEMAR).

Table 112. CDW generated in Spain and treated in other countries

	Total (t)	Hazardous waste (t)	%	Non-hazardous waste (t)	%
Third countries	6.364	54	1	6.310	99
EU	60.727	58.859	97	1.868	3
Total	**67.091**	**58.913**	**88**	**8.178**	**12**

26.3.4 CDW treatment facilities data

The Table 113 outlines the CDW treatment facilities in Spain for 2013, divided by Autonomous Region. (Source: waste treatment specialist EMGRISA).

Table 113. CDW treatment facilities in Spain for 2013, divided by Autonomous Region. (Source: waste treatment specialist EMGRISA).

Autonomous Region	**Number of transfer plants**	**Number of treatment plants**	**Number of mobile treatment plants**	**Number of landfill**
Andalucia	92	119	21	71
Aragón	18	6	1	5
Asturias	3	4	5	1
Baleares	6	2	N/D	1
Basque country	N/D	N/D	11	N/D
Canarias	0	23	N/D	7
Cantabria	12	4	12	2
Castilla y Leon	0	45	0	3
Castilla La Mancha	N/D	28	27	12
Catalonia	12	50	0	57
Ceuta	N/D	N/D	N/D	N/D
Extremadura	16	21	1	0
Galicia	3	43	21	5
Madrid	10	14	0	4
Melilla	N/D	N/D	N/D	N/D
Murcia	2	4	32	19
Navarra	N/D	7	3	7
Valencia	N/D	N/D	N/D	N/D
Total	**174**	**386**	**134**	**196**

*N/D= No data available

26.3.5 Future projections of CDW generation and treatment

Table 114.Future projections of CDW generation and treatment

	2016	2018	2020
%CDW non-hazardous destined for the reuse, recycling and other recovery treatments (except clean soil).	60	65	70
% Disposal of non- hazardous CDW in landfill.	40	35	30
% clean soil (LER 17 05 04) from land and restoration works, conditioning or backfilling.	75	85	90
Disposal of soils (LER 17 05 04) in landfill (%) with respect the total volume of natural material excavated.	25	15	10

26.3.6 Methodology for CDW statistics

The Spanish Statistical Office is the body in charge of reporting CDW statistics at National Level. Autonomous Regions collect and report CDW statistics following the ELoW codes, following the methodology defined in the Decision 2011/753/EU. This data is then collected and compiled by the Spanish Statistical Office. Besides that, there are other organizations like the Spanish Federation of Construction and Demolition Waste (FERCD) or the Council of Ministers who report their own statistics.

26.4 C&D waste management in practice

26.4.1 CDW management initiatives

See section 1 & 2, mainly related with plans, strategies and non-legislative instruments for waste management.

26.4.2 Drivers / barriers to increase CDW recycling

<u>Main barriers to sustainable CDW management in Spain</u>

- Tough recovery from a hard hit economy
  - The economic crisis greatly hurt Spain's construction and demolition sector. CDW waste generation levels have risen and fallen with Spain's economic growth.
  - As indicated in the PEMAR, this economic crisis has furthermore left treatment centres without sufficient CDW supply to properly function (as many treatment centres are running below treatment capacity), and consequently, a wavering and unpredictable demand for prepared material.
- Lack of regulations (pre-demolition audits)
  - Many experts indicated that the lack of regulations on selective demolition and pre-demolition audits is considered to be a great source for CDW management issues. This

general lack of monitoring provides minimal incentives for waste and C&D actors to follow legislation and to be accountable of their actions.

- Market conditions for recycled aggregates
- Lack of markets for CDW (aggregates) deters development and promotion of the use of viable recycled waste.

- Lack of awareness of the advantages of recycled aggregates
  - This low awareness is directly related to the lack of markets for CDW (and vice versa). As waste actors are not well-informed about the advantages of using recycled aggregates in construction and renovation works, it is difficult to create a strong uptake in the market for CDW. Interviewed stakeholders indicated that many actors in the construction and renovation industry do not regard end-of-life CDW as a viable product to be used in construction and renovation works, especially since this waste material has a reputation to be highly contaminated and unprofitable to use.
- Availability of landfills and low landfill cost
  - Stakeholders generally believe that the landfill cost is not strict enough, and regardless of this perceived low price (EUR 5-40 depending on region)5, and the declared availability of 195 regulated landfills, illegal dumping is still not eradicated.
- Absence of GPP
  - It is a currently discussed topic on the national scale. The National Federation of Aggregates would be in support of envisioning a framework for obliging a 5-10% requirement for the use of recycled aggregates in construction works. However, this objective is currently difficult to obtain, as the use of recycled aggregates is only at about 1% and because there is not enough support to prioritise this objective.
- Lack of awareness
  - Stakeholders indicated that issues such as illegal dumping and improper management in light renovation works. In light renovation works that may not necessarily be carried out by professionals, there is a risk that the individual in charge may not comply by the proper measures for disposal. In regards to illegal dumping, there is no concrete way to harmoniously sanction all cases of illegal dumping.
  - Consumers are generally uneducated on how to act near a project site or how to conduct small renovation works on their households

<u>Main drivers to sustainable CDW management in Spain</u>

The following recommendations outline the main drivers in order to address the above mentioned obstacles:

- Leverage record low CDW levels to focus on other initiatives
  - The economic crisis, which drastically lowered the amount of CDW generated from the years of 2007-2009 could have potentially opened a door for the implementation of various initiatives, one being voluntary certification schemes. The LEED certification gained a slim level of recognition during the early years of the economic hit thanks to theoretically less expensive maintenance fees and increased value on its asset portfolio. However, as the amount of LEED certified buildings has only 252 registered buildings, with an even smaller 97 that have achieved the LEED certification, this initiative has not been considered as a driver in CDW management, although it potentially could be an advantageous tool. A stakeholder indicated that measures should be explored on how to leverage low CDW generation levels as an incentive to focus on other voluntary measures.
- Promote regulations (pre-demolition audits)
  - Although selective demolition exists on certain regional levels, such as in the Basque Country (Decree 112/2012), this is not a national practice, which greatly hinders the possibility to obtain good quality of CDW.
  - A positive driver towards promoting regulations consists of a mandatory financial deposit, required by law prior to demolishing buildings. Upon proving that the demolished building's CDW was lawfully managed, the deposit is reimbursed. While this system facilitates good management, as financial incentives are set in place, tighter monitoring needs to be set in motion in order to ensure that all actors are following through. At this stage, it is not clear whether this deposit scheme functions.
- Jump start the creation market conditions for recycled aggregates
  - On the national level, substantial levels of natural minerals are cheaper to excavate than to utilise recycled aggregates. Informal discussions are arising regarding taxing natural (raw) aggregates, however in practice certain stakeholders believe that this could further hinder the market for recycled aggregates, as current demolition practices leave demolition waste with relatively high levels of contaminants that are expensive to eliminate. Measures to promote the use of quality schemes should be implemented.
  - Green public procurement is not yet developed, although it could help the recycled aggregate market.
  - One of the objectives in the PEMAR is to include environmental costs within the cost for natural aggregates in order to make recycled aggregates more competitively priced.
- Increase availability of landfills and address low landfill cost issue
  - The introduction of a national entrance tax for landfills should be established nation-wide (Currently this is implemented on a regional level in Catalonia, Madrid and Murcia). Furthermore as outlined within the PEMAR a harmonisation of taxes

throughout all regions is foreseen, as certain regions' lower landfill taxes may unintentionally facilitate an influx of waste exports to those regions.

- Increase awareness
  - National, regional and local campaigns on the importance of properly disposing CDW and on conveying aggregates as viable construction material (to change its current perception as a waste material) could be advantageous. Targeted marketing efforts could be aimed at CDW actors on more technical subjects.

26.5 CDW sector characterization

26.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

In *Spain*, CDW recycling plants produces aggregates and recycled materials for the construction sector in an 80%, in addition to recover, other sub-products like wood, metals, plastics, etc. in a 20%. The utilisation of recycled aggregates is becoming more and more common in the construction sector, in a wide range of applications like embankments and backfills, layers of asphalt pavements or concrete. The composition of the recycled aggregates in Spain shows a high percentage of concrete and ceramic materials. Each one of these applications forces different levels of requirements for the recycled aggregates properties. In the next figure, a data example of the Recycled materials in Spain is shown:

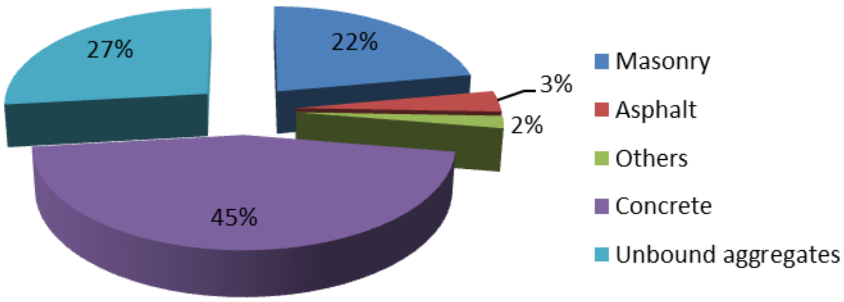

Figure 28. Recycled materials in Spain (Source: Spanish Association of CDW recycling (RCD)

Product description and applications

<u>Concrete</u>

Concrete is the predominant material in foundations and structures. It can be recycled as aggregate for new concrete, but to do this, it needs to be cleaned of masonry waste as well as wood, metals and plastics. It can also be used in the modification of the landscape, for example in gardened zones or in civil works as sub-bases of roads or filling of embankments. Depending on the type of work and the subsequent use of the waste, the crushing treatment will be different. On the other hand, the dust produced in the extraction of stones can be used as an aggregator and achieve a stony appearance in the manufacture of monolayer mortars. It can also be recycled into prefabricated concrete elements such as beams, pillars, joists, panels, alveolar slabs, pipes or pieces of urban furniture. Ultimately, they could be placed in vats next to other inert debris and taken to landfill and debris.

Bricks, tiles and ceramic waste

This material forms part of the main component of products fundamentally used in walls of facade and interior partitions, mainly bricks, tiles, and ceramics. They therefore account for a fraction of the CDWs. It is very usual to cut these pieces or to do rubs to facilitate the passage of the facilities, so it is advisable to prepare a space for the storage in order to be reused in the same work or in other place. If the recycling is not viable, it can be stored as debris or rubble from work site together with other inert CDWs (aggregates, soil ...) and can be deposited in controlled landfills. Stoneware can also be recycled, although the process is more complicated because of its diversity and small amount. Thus, it can ultimately be used as filler or storage material in controlled landfills. Porcelain waste can be used as filling of works and highways or for the manufacture of pre-crushed recycled concrete.

Asphalt waste

In construction, they originate mainly in the installation of waterproofing systems for roofs and basement walls. They can be recycled as asphalt or as fill mass in the work outside it, in a plant, by cold or hot processes. Efficient selective collection must be carried out without deterioration of the material. For this, it is necessary to carry out a pretreatment for the separation of other materials adhered in the contact zone, mainly residues of thermal insulation (glass fiber, polystyrenes ...) or separating layers (geotextiles, mortars ...). Subsequently a grinding should be carried out to achieve a uniform size for use in other mixtures.

Wood waste

Represents a significant proportion in CDW in Europe. The wood content in mixed CDW varies in between different EU countries and can reach up to 40% by weight, especially in countries where significant amounts of wood are used in the building sector. Wood waste includes clean lumber, but also painted or treated wood, plywood, pallets and furniture etc. Intact, massive wood parts might be reused for furniture, flooring, cabinets or other specialist reuse. Waste wood can be used for material recycling or energy recovery, depending on the quality and characteristics of the waste wood. The mixture of different wood qualities in CDW, like hardwood and softwood, engineered wood fractions (chipboards, particleboards etc.) and painted and/or treated wood complicates the material recycling, especially for higher grade applications.

Gypsum waste

Gypsum waste is usually generated in the trim and plaster coatings phases. Concrete elements (columns, walls, joists, etc.) must be covered with plaster because their sulfate content renders them unusable as components of a new concrete. They should be stored in rubble dumps. This type of gypsum waste from renovation, refurbishment and demolition works is more likely to present a certain degree of contamination, which can be in the form of nails, screws, wood, insulation, wall coverings etc. For this waste to be recyclable, it is required that the equipment processing the waste is capable of separating such contamination from the gypsum to arrive at a pure recycled gypsum.

Quantitative analysis

No data found.

Recovery techniques

No data found.

Environmental and economic impacts of CDW waste management

Environmental impact

CONCRETE

The Table 115 outlines the environmental impacts for each option for the management of concrete:

Table 115. Environmental impacts or each option for the management of concrete

Landfill	**Recycling as aggregates for direct re-use with no further processing**	**Recycling as aggregates for structural concrete**	**Re-use of concrete blocks**
• Transportation of waste to the landfill • No significant release of pollutants to water. Use of land space	• Transportation of waste concrete , raw materials and aggregates. • Processing of waste concrete into aggregates: dust production and noise during crushing and sieving steps • Extraction of raw	• Transportation of waste concrete, cement, recycled aggregates and raw materials. • Processing of waste concrete into aggregates: dust production and noise during crushing and sieving steps	• Transportation of waste concrete, cement and raw materials. • Processing of concrete blocks: energy for cleaning and decontamination • Transportation of concrete to the new

Landfill	Recycling as aggregates for direct re-use with no further processing	Recycling as aggregates for structural concrete	Re-use of concrete blocks
	materials (rocks and gravel for aggregates): land-use for quarries, production of dust, use of natural resources • Quarrying (land use , biodiversity) • Use of Resources Processing of raw materials into aggregates: dust production and noise	• Transportation of cement and recycled aggregates • Production of cement: energy consumption, greenhouse gases and pollutants emissions • Concrete production • Extraction of raw materials (rocks and gravel for aggregates): land-use for quarries, production of dust, use of natural resources • Quarrying (land use , biodiversity) • Use of Resources • Processing of raw materials into aggregates: dust production and noise	construction site • Extraction of raw materials (rocks and gravel for aggregates): land-use for quarries, production of dust, use of natural resources, biodiversity • Processing of raw materials into aggregates: dust production and noise • Production of cement • Concrete production •

CERAMICS, BRICK, TILES

The Table 116 outlines the environmental impacts for each option for the management of bricks, tiles and ceramics:

Table 116. Environmental impacts or each option for the management of bricks, tiles and ceramics

Landfill	Recycling in minor road works with no further processing	Recycling in heavy roads works with further processing	Re-use of bricks, tiles and ceramics CDW
• Transportation of waste to the landfill • No release of pollutants to water if the fraction is not contaminated (bricks, tiles and ceramics are made of clay, a	• Transportation of bricks, tiles and ceramics waste • Transportation of recycled material • Use of recycled aggregates: dust production when	• Transportation of bricks, tiles and ceramics waste • Production of aggregates from bricks, tiles and ceramics CDW: dust production and noise	• Transportation of bricks, tiles and ceramics waste • Processing of bricks, tiles and ceramics waste: energy for cleaning and decontamination

Landfill	Recycling in minor road works with no further processing	Recycling in heavy roads works with further processing	Re-use of bricks, tiles and ceramics CDW
natural material). Use of land space	loading, unloading the trucks and spreading the material on the roads • Extraction of raw materials (rocks and gravel for aggregates): land-use for quarries, production of dust, use of natural resources • Transportation of raw materials and aggregates. • Biodiversity impacts • Use of resources • Production of aggregates from virgin materials: dust production and noise during crushing, sieving steps • Use of virgin aggregates: dust production	during crushing and sieving steps • Transportation of recycled material • Use of recycled aggregates: dust production when loading, unloading the trucks and spreading the material on the roads • Extraction of raw materials (rocks and gravel for aggregates): land-use for quarries, production of dust, use of natural resources • Transportation of raw materials and aggregates. • Biodiversity • Use of resources • Production of aggregates from virgin materials: dust production and noise • Use of virgin aggregates: dust production	• Transportation of bricks, tiles and ceramics to the new construction site • Extraction of raw materials (clay material): land-use for quarries, use of natural resources • Biodiversity • Transportation of raw materials • Bricks, tiles and ceramic production: important initial energy consumption (energy intensive industry), associated greenhouse gases emissions • Transportation of bricks, tiles and ceramics to the construction site

ASPHALT

The Table 117 summarises the environmental impacts of the different end of life options for asphalt:

Table 117. Environmental impacts of the different end of life options for asphalt

Landfill	**Recycling in a stationary plant to make new asphalt**	**In-situ recycling to make new asphalt**	**Recovery of reclaimed asphalt as a road base course in the form of aggregates**
• Transportation of waste to the landfill • Potential PAH releases to water (when contaminated with tar) Use of land space	• Transportation of waste asphalt • Processing of waste asphalt into aggregates: particles generation and noise during crushing and screening steps • Production of new asphalt from reclaimed asphalt: fuel consumption for heating and associated greenhouse gases emissions (the energy consumption may be lower for the cold mix recycling method as the fuel consumption associated with the extra dryer of the hot mix recycling method is avoided) • Transportation of recycled asphalt • Extraction of raw materials (sand, stone and gravel): land-use for quarries, production of dust, use of natural resources, biodiversity • Transportation of raw materials • Processing of raw materials into aggregates: dust production and noise	• Processing of waste asphalt into aggregates: particles generation and noise during crushing and screening steps • Production of new asphalt from reclaimed asphalt: fuel consumption for heating and associated greenhouse gases emissions • Use of binders for fluxed asphalt in cold recycling processes • Extraction of raw materials (sand, stone and gravel): land-use for quarries, production of dust, use of natural resources, biodiversity • Transportation of raw materials • Processing of raw materials into aggregates: dust production and noise • Production of asphalt from raw materials: fuel consumption for heating and associated greenhouse gases emissions • Transportation of asphalt made from	• Transportation of reclaimed asphalt • Processing of waste asphalt into aggregates: dust production and noise during crushing and sieving steps (not relevant when the material is resulting from milling operations, therefore meeting the size requirements) • Transportation of recycled aggregates and virgin aggregates. • Extraction of raw materials (sand, stone and gravel): land-use for quarries, production of dust, use of natural resources, biodiversity • Transportation of raw materials • Processing of raw materials (rocks, stone, gravel, sand) into aggregates: dust production and noise •

Landfill	Recycling in a stationary plant to make new asphalt	In-situ recycling to make new asphalt	Recovery of reclaimed asphalt as a road base course in the form of aggregates
	• Production of asphalt from raw materials: fuel consumption for heating and bitumen production, and associated greenhouse gases emissions (the energy consumption may be lower for the cold mix method as the required temperature is lower that for the hot one, avoiding an extra fuel consumption) Transportation of asphalt made from virgin materials	virgin materials	

WOOD

The Table 118 summarises the environmental impacts of the recylcing and recovery options of waste wood.

Table 118. Environmental impacts of the recylcing and recovery options of waste wood..

Landfill	**Energy recovery** (Substituted material: fossil fuels or any other source of energy)	**Recycling into derived timber products (**Substituted material (in the same proportion): aggregates from rocks and gravel extracted from quarries)
• Transportation of wood waste to the landfilling site • Release of methane to the atmosphere (except when burnt in flare for its complete combustion, therefore replaced by CO_2)	• Transportation of wood waste to the incineration plant • No release of pollutants the air thanks to appropriate air control equipment and dust filters • Energy consumption based on	• Transportation of waste wood to wood manufacturers • Production of timber products from waste wood: energy consumption for the cleaning, cutting, crushing

Landfill	**Energy recovery** (Substituted material: fossil fuels or any other source of energy)	**Recycling into derived timber products (**Substituted material (in the same proportion): aggregates from rocks and gravel extracted from quarries)
Use of land space	fossil fuels resources (energy recovery from wood waste is encouraged and considered as a renewable energy) as the heat produced can be used to heat surrounding buildings or to produce electricity. Release of CO_2, particulates, VOCs (volatile organic compounds), PAHs (polycyclic aromatic hydrocarbons) compared to other material incineration.	steps, noise production • Exploitation of forests: energy consumption for logging and associated greenhouse gases emissions (or release considering that trees act as carbon sinks) • Transportation of virgin wood to the manufacturing plant (may be substantial when considering tropical wood from South America or South East Asia) • Production of timber products from wood: energy consumption for the cleaning, cutting, crushing steps, noise production.

GYPSUM

The Table 119 summarises the environmental impacts of the different end of life options for gypsum waste.

Table 119. Environmental impacts of the different end of life options for gypsum waste..

Landfill	Recycling of plasterboards for re-introduction of the gypsum powder into the manufacturing process
• Transportation of waste to the landfill • Production of H2S (bad smell and toxic to human health) when mixed with biodegradable waste (the European legislation requires specific cells in inert landfills to avoid H2S emissions)	• Transportation of construction plasterboard waste from the construction site to waste processors • Processing of plasterboard waste into gypsum powder: dust production and noise during

Landfill	Recycling of plasterboards for re-introduction of the gypsum powder into the manufacturing process
• Use of land space	crushing and sieving steps, additional energy consumption for the removal of paper • Transportation of recycled gypsum to plasterboards manufacturers • Extraction of raw materials (mineral gypsum): land-use for quarries, production of dust, use of natural resources, energy consumption • Transportation of raw materials • Consumption of resources • Land use and biodiversity issues due to gypsum extraction Processing of raw materials into powder: dust production and noise

Economic impacts

CONCRETE

Despite the environmental benefits of recycling concrete, its limited production costs do not encourage re-use and recycling. Nevertheless, using recycled concrete can also show economic advantages, depending on the local situation. The identified factors include:

- Proximity and quantity of available natural aggregates
- Reliability of supply, quality and quantity of CDW (availability of materials and capacity of recycling facility)
- Government procurement incentives
- Standards and regulations requiring different treatment for recycled aggregate compared to primary material
- Taxes and levies on natural aggregates and on landfill

CERAMICS, BRICK, TILES

The harnessed extraction of clay and the development of new manufacturing techniques maintain clay bricks and tiles as competitive building materials that have good quality, long life, minimal maintenance requirements and provide energy efficient solution during the use phase. The reduced costs of bricks, tiles and ceramics produced from raw materials are therefore not encouraging the development of recycling[12].

[12] www.tiles-bricks.eu

ASPHALT

The processes for the preparation of reclaimed aggregates (crushing, sieving) being the same as virgin materials, the production costs are estimated to be identical. On the other hand, the availability of virgin aggregates explains why the supply costs for these materials are limited which therefore does not encourage asphalt producers to turn to reclaimed asphalt as a substitution. However, landfilling and incineration for energy recovery are not considered as viable asphalt management options according to the industry as asphalt is an added-value material that is easily recycled thanks to the existing techniques.[13]

WOOD

Due to the competition of utilisation and the limited supplies, the market price for recycled wood is going up. The margin of the market price is influenced by the following elements:

- The regionally available amount of waste wood
- The intensity of the competition between material and energy recovery
- Seasonal variations (winter stock etc.)

In general, the prices for sorting, storage and treatment of specific waste wood fractions are not an incentive to the development of waste wood recovery.

GYPSUM

No data have been found.

Drivers / barriers to increase recycling

CONCRETE

The barriers and drivers identified are summarized below:

- Use of recycled concrete aggregates in road works: a high potential in the short and mid-term

Nowadays, concrete is mainly recycled into aggregates for road construction and the potential for improvement is still wide but considering that the need for such infrastructures will reach its maximum at some point65 and that the demand for aggregates will be sustained mainly through the maintenance and the replacement of roads, research has to be encouraged to find alternatives that will allow to achieve the 70% target and more in the long term.

- Sorting at source: separation for an improved material quality

An effective sorting out of mixed CDW is necessary to produce a higher non-contaminated concrete CDW fraction, to make easier the further recycling of this specific waste stream and improve the overall recycling rates.

- Landfilling ban: a driver towards the development of alternatives

[13] EAPA

The landfilling ban at the European level following the example set by the Netherlands would incentivise concrete waste producers into more re-use and recycling.
This goes hand in hand with the funding of research for the development of new options and for the improvement of the existing options (in terms of energy consumption, efficiency and costs). Moreover, the ban of disposing of concrete waste in landfills is likely to ensure a more regular waste supply for recycling industries.
According to the European Ready Mixed Concrete Organization, the goal of "zero landfill" of concrete can be achieved if the structure of a building is carefully planned and designed, and if the building undergoes successful renovation and deconstruction.

- Quality certification for recycled materials: a secure framework for the re-use and recycling of concrete waste

Quality certification of secondary materials (obtained after concrete waste has been processed) is expected to act as a proof that these materials can meet high security standards and achieve the same properties as virgin materials. Therefore, it is one of the solutions to promote the use of recycled aggregates and concrete blocks by contractors and manufacturers. CEN standards for aggregates already establish such requirements for aggregates used in concrete, mortar, and other applications.

- Building conception: designing for the end of life

Acting at the design phase of a building is another way of tackling the issue of CDW. Indeed, a careful design of the buildings and infrastructures would allow the dismantling and maximise the potential for re-use and recycling. Such an approach is also likely to lengthen the service life of buildings, decreasing the amount of concrete waste produced and therefore improving the current re-use and recycling rates.

- Green building systems: promoting the use of former concrete waste

Green building systems can encourage the re-use of concrete elements and the use of structural concrete made of increasing recycled aggregates by integrating such criteria in their rating charts. This would influence public perception regarding the quality of recycled concrete and promote large possibilities for its use, by specifically addressing the recycled concrete issue in the system.

CERAMICS, BRICK, TILES

Some potential drivers and barriers are summarised below.

- Landfilling ban: a promotion for existing and developing recycling options

The landfilling ban at the European level following the example set by the Netherlands would greatly encourage bricks and tiles waste producers to process their waste stream through the existing recycling chains and even fund research for the development of more efficient and highly demanding recycling techniques.
Moreover, the ban of disposing of bricks, tiles and ceramics waste in landfills (or the increase of landfill taxes) is likely to ensure a more regular waste supply for recycling industries.

- Building conception: designing for the end of life

Designing for the deconstruction of buildings would make easier the reclamation of bricks and tiles, improve the quality of the waste stream and therefore increase the re-use of these elements for new construction projects.

From another point of view, projects could be designed for longer life span, leading to the reduction of the waste stream.

ASPHALT

The barriers and drivers identified are described below.

- Investments

Asphalt recycling plants need to be modified to be able to introduce more reclaimed material in the manufacturing process. Moreover, the improvement of the recycling rates and the efficiency of the process (reducing the energy consumption would reduce the costs of recycled material) goes hand in hand with scientific research. All these actions represent substantial investments that may require financial support.

- Increasing cost of virgin materials: a driver towards the systematic use of reclaimed asphalt

Even if the availability of virgin materials is not yet the issue, the increasing cost of virgin materials would push asphalt producers to turn to reclaimed asphalt as a secondary raw material. This would create a demand and economic opportunities that would drive the improvement of recycling rates.

- Landfilling ban: a driver towards the systematic recycling of reclaimed asphalt

Though landfilling is not commonly practiced for asphalt waste, a landfilling ban (as already enforced in the Netherlands) or high landfill taxes would therefore lead to higher amounts to be managed by waste producers and asphalt manufacturers. The expected direct effect is the shift towards the obligation of applying the existing recycling techniques that are readily available to deal with important amounts of reclaimed asphalt.

- Increasing the communication to asphalt producers to promote recycling

Even though asphalt producers are well aware of the economic benefits that can come from recycling RAP in certain parts of Europe, a better communication from national environmental agencies towards the Asphalt Industry would highlight such benefits in other countries. A way of delivering this message would be the organisation of workshops and conferences where asphalt producers would measure the benefits in practical and economic terms.

Finally, it should be noted that the name "asphalt waste" does not stimulate the use of reclaimed asphalt. The word waste is mostly associated in a negative way. Indeed, using waste in the production of new products is often seen as a potential problem. Considering reclaimed asphalt as a product, as aggregates, would stimulate its re-use and recycling.

- Presence of contaminants preventing recycling

Before the use of asbestos was prohibited, asbestos fibres were used in the production of asphalt. This was for example the case in France before 1997, and this raises the issue of recycling asphalt that was produced before this date: difficulties linked to the identification of asphalt containing asbestos were raised by some experts[14].

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[14] Laurent Chateau, ADEME,

WOOD

Recycling could be improved by measures to promote efficient sorting of wood CDW to avoid contamination, to make greater amounts of wood waste available for the industry and as a consequence achieve better recovery rates from wood CDW.

As a result of the European strategy of security and sustainable energy and the Landfill Directive, the use of waste wood for either material or energy recycling are expected to play a dominant role in wood waste management and stimulate the competition between material recycling and energy recovery. However, incentives to use waste wood as a renewable energy source might hinder the 70% recycling target, as energy recovery is not included in the target. This issue is amplified in countries where wood represents an important fraction of the CDW stream.

GYPSUM

Gypsum CDW recycling faces several barriers and the only recycling opportunity accounts for 5 to 10% of gypsum waste from plasterboards. Therefore, to achieve the 70% target, signification actions must be undertaken.

The main barriers are:

- The high availability and the low costs of raw gypsum material
- The low availability of gypsum waste due to un-adapted C&D processes. Indeed, though the techniques exist, they are not implemented because they would represent a financial burden to the C&D sectors.
- The lack of knowledge on recycling or other material recovery options. Indeed, manufacturing processes currently in place do not allow the re-introduction of a higher recycled gypsum powder content.

In order to overcome those barriers several options should be considered, the following paragraphs describe potential actions.

- Sorting at source: separation for an improved material quality

The recyclability of gypsum-based products and especially plasterboards could be enhanced thanks to deconstruction which would therefore make the sorting process easier. Indeed, gypsum based interior partition elements are easily dismantled and a further effective sorting would produce a higher non-contaminated gypsum CDW fraction, make easier the further recycling of this specific waste stream and improve the overall recycling rates.
Therefore, the characterisation of gypsum waste, i.e. the identification of gypsum waste material from other elements is the key point to increase the amount of potentially recycled gypsum.

- Gypsum waste collection: increasing the potential for recycling

Actions to ease the gypsum waste collection could also be considered to increase the amounts of CDW Building conception: designing for the end of life

- Green building systems: promoting the use of former gypsum waste

As for concrete waste, green building systems (e.g. HQE – Haute Qualité Environnementale in France, BREEAM - BRE Environmental Assessment Method in the UK, German Sustainable Building Certificate) can encourage the recycling of plaster elements and the use of plasterboards made of increasing recycled gypsum powder by integrating such criteria in their rating charts. This would influence public perception regarding the quality of recycled plaster elements and promote large possibilities for their use, by specifically addressing the recycled plaster issue in the system. Recommendations on gypsum products are also provided by the Commission in its GPP background report on wall panels.

- Increasing landfilling costs: a driver towards the development of alternatives

Nowadays, the operation of landfills is regulated at the EU level by Decision 2003/33/EC151 on Waste Acceptance Criteria, which was adopted to strengthen the waste regulations established by Directive 1999/31/EC152. This directive requires the implementation of the Waste Acceptance Criteria (WAC) for high sulphate content products by July 2005 which states that gypsum-based and other high sulphate-bearing materials having more than 10% sulphate in any one load is considered as waste and is therefore accepted in landfills. Moreover, "non-hazardous gypsum-based materials should only be disposed of in landfills for non-hazardous waste in cells where no biodegradable waste is accepted.
Increasing landfilling costs would encourage the development of new recycling techniques as waste producers would only be able to sustain such costs to a certain point. In the same way, it will improve the sorting out of gypsum construction waste and produce a higher feedstock for existing options. The recycling of gypsum waste would turn into a business opportunity as the demand for gypsum products is likely to increase with the population and the need for new houses, schools, hospitals, offices and shops. However, to optimise the effect of such driver, these costs should be harmonised all across the EU.

- Promoting R&D initiatives to explore new recycling options

Concerning construction waste, it is estimated that up to 25% of gypsum virgin material can be replaced by recycled gypsum powder for the production of plasterboards[15]. Therefore the target set at 30% by the European gypsum industry as the percentage of recycled material being re-introduced into the manufacturing process seem to be achievable.
To achieve the 70% target, promoting R&D on production techniques and investments in gypsum facility to increase the amounts of waste gypsum that can be used in the production of new gypsum seems essential in order to improve current processes and allow the re-introduction of a larger part of recycled gypsum in building elements.

26.5.2 Recycled materials from CDW

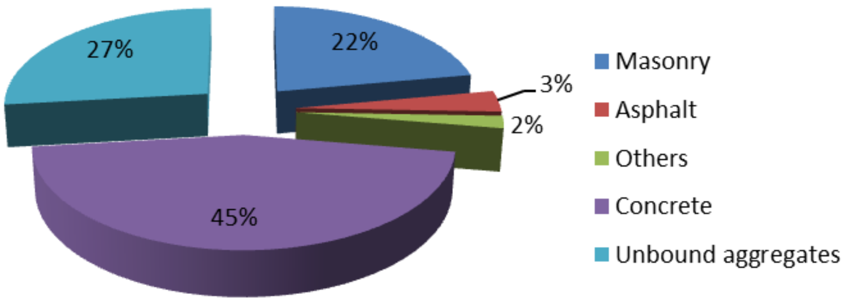

Figure 29. Recycled materials in Spain (Source: Spanish Association of CDW recycling (RCD.

[15] [Lund, 2008]

CDW recycling plants produces aggregates and recycled materials for the construction sector in an 80%, in addition to recover other sub-products like wood, metals, plastics, etc. in an 20%.

The utilisation of recycled aggregates is becoming more and more common in the construction sector, in a wide range of applications like embankments and backfills, layers of asphalt pavements or concrete. The composition of the recycled aggregates in Spain shows a high percentage of concrete and ceramic materials. Each one of these applications forces different levels of requirements for the recycled aggregates properties. Further information concerning technical regulation and legislation for the recycled aggregates in Spain will be provided in Deliverable D1.4.

26.5.3 Market conditions / costs and benefits

The landfill taxes in Spain are managed by municipalities, differing among the different municipalities. For example, there are some municipalities that apply a flat rate for landfill, while others apply different tariffs depending on the waste nature.

- Among the municipalities which have a flat rate for landfill, it can be found different prices ranging from 1€/t (Navarra) and 25,20 €/t (Madrid).
- Among the municipalities which have different tariffs, the inert landfill have cheaper tariff (20-10 €/t) than mixed waste (8-30 €/t).

Also the plants dedicated to the production of recycled aggregates supports the deposit of inert waste.

Table 120. Some examples for the costs for CDW landfilling in a recycling plant.

	Madrid	Albacete	Córdoba
Recycled CDW	10€/t	16€/t	8,50€/t
Reinforced concrete from CDW	5€/t	20€/t	6,70€/t
Bulk concrete	3,50€/t	9€/t	4€/t
Very dirty debris	-	25€/t	30,05€/t
Ceramic-concrete 0-40mm	3,50€/t	3€/t	

On the other hand, comparing the price of natural aggregates with the price of recycled aggregates, the first ones can range from 6- 12€/t for aggregates and 5-13 €/t for sands, while the price decreases for the recycled aggregates (see table below).

Table 121. Comparing the price of natural aggregates with the price of recycled aggregates.

Cost of the recycled aggregates		
	Madrid	Córdoba
Graded aggregate of 0-20mm	3€/t	2,40€/t

Cost of the recycled aggregates		
Graded aggregate of 0-40mm	4€/t	4,20€/t
Concrete aggregates 20-40mm	4€/t	4,20€/t
Ceramic-concrete 0-40mm	3,50€/t	3€/t
Ceramic-concrete 20-40mm	1€/t	3€/t
Filling material 0-6mm	2€/t	1,80€/t

27. SWITZERLAND

27.1 Legal Framework – Waste Management Plans and Strategies

27.1.1 National Legislation concerning CDW

Switzerland has several regulations regarding waste management:

It has recently introduced its revised Ordinance for Avoidance and Disposal of Waste (VVEA), which replaces the Technical Ordinance for Waste (TVA). It contains general waste regulation and classification, including CDW-specific rules such as maximum content of harmful substances for cement production, on-site sorting and rules of reporting. [316]

Swiss standard SN 670 071 regulates general recycling of mineral CDW into RC construction materials.

SN 670 902-11-NA regulates geometrical properties of mineral aggregates and is part of the Swiss version of EN 933-11. [317]

SN 670 102b-NA regulates aggregates for concrete production and has integrated the use of recycled aggregates according to EN 933 under compliance with the BAFU guideline.

SN 670 119-NA regulates aggregates for use in hydraulically bonded and loose applications, e.g. construction of roads, train tracks etc. It is part of the Swiss version of EN 13285. [317]

BAFU (Federal Agency for Environment) regulations:

The *Guideline for the use of mineral construction waste* (2006) [317] regulates how mineral construction waste is to be sorted, labelled, treated and quality controlled before it is used to create new RC materials.

SIA 430 regulates disposal of CDW on-site and separation of waste streams

27.1.2 Waste management plans (WMP) and Strategies

Swiss VVEA states that the cantons plan their waste management individually. However, for certain waste streams, including CDW, several cantons may join together in a regional effort.

The plan is revised every five years and contains measures for prevention, treatment and landfilling of the waste. [316]

27.1.3 Legal framework for sustainable management of CDW

The legal framework for sustainable management of CDW is rather complex in Germany as well as in Switzerland, as countrywide legislations are not in place yet. The table below sets out regulations and frameworks in place.

Table 122.Legal framework

National or regional obligation towards	Switzerland
National or regional obligation for selective demolition	//missing info: no access to SIA 430
National or regional sorting (on-site or in sorting facility)	VVEA defines sorting categories for on-site sorting (VVEA Art. 17) on a national level
National or regional separately collect different materials (iron, steel, plastic, glass, hazardous waste etc.,)	
Green public procurement requirements	Depending on canton

27.1.4 Targets

The Swiss Agency for Environment (BAFU) released the manifesto "Green Economy" in 2013 stating that requirements for new construction materials and building techniques should be examined considering their entire life cycle to improve recyclability. [320]

27.1.5 End of Waste (EoW) status

No data found

27.2 Non legislative instruments (best practices, guidelines, recommendations…)

Both the ARV Association for Building Material Recycling and Waste Information Switzerland offer comprehensive leaflets regarding a variety of subjects.

27.3 CDW management performance – CDW data

27.3.1 CDW generation data

Data claims that Swiss CDW amounted to approx. 7,5 million tonnes in 2015 [319], although BAFU claims in its guideline[317](p. 5) that Switzerland produces a rough 10 million tonnes of CDW every year.

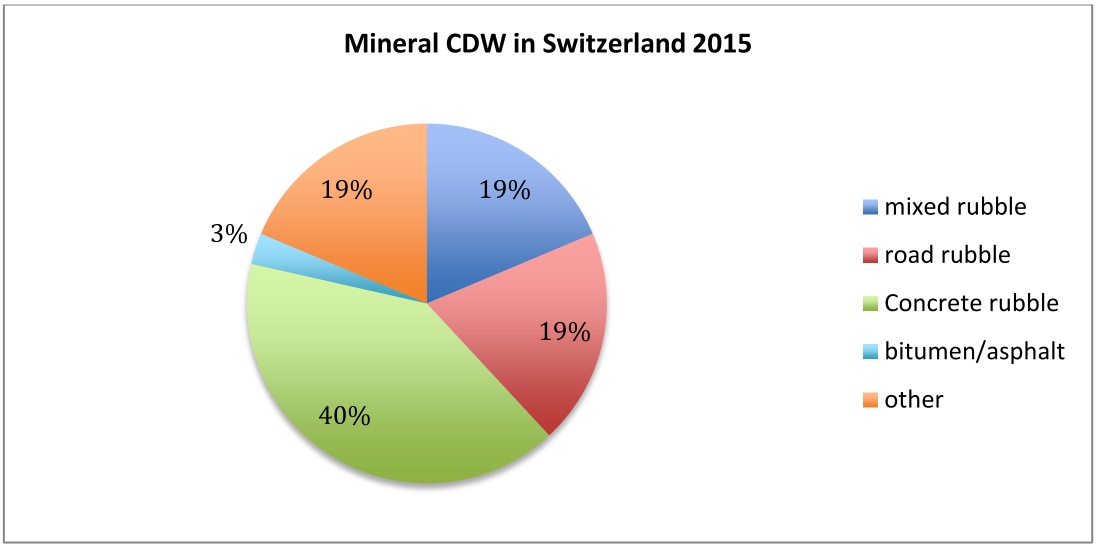

Figure 30. Groups of waste in Switzerland 2015, source: Wüest & Partner AG: Bauabfälle in der Schweiz – Hochbau; Studie 2015, p. 27

<u>Hazardous Waste</u>

Owners have to report type, quantity and disposal concept of their CDW to their competent authority if

CDW volume is projected to exceed 200 m³

CDW is expected to contain polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAH), lead or asbestos

Authorities can request proof that the proposed concept has been implemented correctly. [316]

27.3.2 CDW treatment data

No central data found

27.3.3 CDW exports/imports data

No data found.

27.3.4 CDW treatment facilities data

No data found.

27.3.5 Future projections of CDW generation and treatment

It is estimated that volume of Swiss CDW will increase by 20 % from 2015 to 2025 [319]

27.3.6 Methodology for CDW statistics

The data is derived from building stock and activity in construction, demolition and renovation sectors. [319]

This methodology suggests that Switzerland lacks a central CDW treatment data collection, which could depict actual CDW streams more precisely.

27.4 C&D waste management in practice

27.4.1 CDW management initiatives

No data found.

27.4.2 Drivers / barriers to increase CDW recycling

No data found.

27.5 CDW sector characterization

27.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

No data about specific CDW material groups has been found.

Product description and applications

Quantitative analysis

Recovery techniques

Environmental and economic impacts of CDW waste management

Drivers / barriers to increase recycling

27.5.2 Recycled materials from CDW

No data found.

27.5.3 Market conditions / costs and benefits

No data found.

28. UNITED KINGDOM

28.1 Legal Framework – Waste Management Plans and Strategies

28.1.1 National Legislation concerning CDW

Waste legislation in the UK applies to all types of waste. No specific pieces of legislation or regulation are exclusively related to CDW[321]. The UK has transposed the revised EU Waste Framework Directive 2008/98/EC on Waste (WFD 2008/98/EC) [321] into national law [323]-[325] in 2011. A summary of key regulations regarding management of waste in the four regions of the UK (England, Wales, Scotland and Northern Ireland) are given below:

England and Wales

The requirements of WFD 2008/98/EC [321] are applied in England and Wales by the Waste (England and Wales) Regulations 2011 [323] and subsequent amendments [326]-[327] including in Wales, The Waste (Wales) Measure 2010 [328]. They set out the requirements for waste management plans, waste prevention plans, waste hierarchy implementation and carrying of waste/duty of care [321].

Scotland

The requirements of WFD 2008/98/EC [321] are applied in Scotland by The Waste (Scotland) Regulations 2011 [324] and subsequent amendments [329].

Northern Ireland

The requirements of EU WFD 2008/98/EC [321] are applied in Northern Ireland by the Waste Regulations (Northern Ireland) 2011 [325] and subsequent amendments [330]-[331].

Hazardous Waste in UK

The Hazardous Waste (England and Wales) 2005 Regulations [331] and subsequent amendments [332], The Special Waste (Scotland) Regulations 1997 [335] and subsequent amendments [336]- [337] and The Hazardous Waste Regulations (Northern Ireland) 2005 [338] and subsequent amendments [339]-[341] make provisions for the controlled management of hazardous waste from the point of production to the final point of recovery or disposal. They transpose the requirements of the Hazardous Waste Directive 91/689/EC (HWD 91/689/EC)[342] replaced by WFD 2008/98/EC [321] into national law. They provide an effective control system for hazardous wastes and ensure that they are properly managed from their point of production to the final point of recovery or disposal.

Landfill Legislation in UK

The Environmental Permitting (England and Wales) Regulations 2010 [343] and subsequent amendments [344]-[358], The Landfill (Scotland) Regulations 2003 [359] and subsequent amendments [360]- [363] and The Waste Management Licensing Regulations (Northern Ireland) 2003 [364] and subsequent amendments [365]- [371] transpose the current requirements of the Landfill Directive 1999/31/EC (LD 1999/31/EC) [372] into national law. They set out standards for the design and operation of landfills.

European List of Wastes

The List of Wastes (England) Regulations 2005[373] and subsequent amendments[374], The List of Wastes (Wales) Regulations 2005[375], The List of Wastes Regulations (Northern Ireland) 2005 [376] and subsequent amendments [377] and The Special Waste (Scotland) Regulations 1997 [378] and subsequent amendments [379]-[380] transpose the European List of Wastes (Commission Decision 2000/532/EC)[381] into national law. The European List of Wastes [381] is used to classify a material substance either as waste or as hazardous waste.

UK Landfill Tax

The Landfill Tax[382] applies to the disposal of waste in landfills. It was introduced as an environmental tax in 1996 by the UK Government to increase diversion of waste from landfills. The cost for this is currently £84.40/tonne standard rate and £2.65/tonne lower rate. The lower rate is paid on "inactive waste" such as rocks or soil.

UK Aggregates Levy

Aggregates levy [383] is a tax that applies to the commercial exploitation of aggregate (digging, dredging or importing rocks, sand or gravel). It was introduced as an environmental tax in 2002 by the UK Government to encourage the recycling of aggregate. The levy is charged at a flat rate of £2 for every tonne of aggregate extracted. It is also applied at a proportional rate for quantities less than a tonne.

28.1.2 Waste management plans (WMP) and Strategies

In the UK, Waste Management Plans (WMP) have been developed by each of the Government Bodies of England, Wales, Scotland and Northern Ireland. A summary of WMP in the four countries of the UK is given below:

<u>England</u>

Waste Management Plan for England [384] published by the Department for the Environment, Food and Rural Affairs (DEFRA) in 2013, contains a small section which specifically deals with CDW. This highlights the EU target to be reached in 2020 (i.e. at least 70% by weight of CDW should be subjected to material recovery) and the current performance against it (England and UK are already achieving an estimated recovery rate of 93% at the time of publication in 2013).

Wales

Towards Zero Waste-One Wales: One Planet Plan [385] published by the Welsh Assembly Government in 2010 is the Overarching Waste Strategy Document for Wales and deals with management and prevention of waste. It contains some information which specifically refers to CDW and suggests that Wales have met their re-use, recycling and recovery target for CDW of at least 85% by 2010. In addition, it sets a new target of at least 90% by weight for reuse/recycling of non-hazardous CDW by 2019/2020.

Construction and Demolition Sector Plan (for Wales) [386] published by the Welsh Assembly Government in 2012 considers both the management and prevention of CDW. It is intended to support the Overarching Waste Strategy Document [385] by detailing outcomes, policies and delivery actions for organisations, companies and individuals involved within the construction and demolition sector in Wales. The document examines both the management and prevention of CDW[321].

Scotland

Scotland's Zero Waste Plan [387] published by the Scottish Government in 2010 sets out the vision for waste policy in Scotland. Although this plan considers CDW, it does not contain a specific section on CDW [321]

Northern Ireland

Delivering Resource Efficiency Plan [388] published by the Department of the Environment (Northern Ireland) in 2013 focuses on both waste management and prevention. The document contains a specific section for CDW which describes the current performance of recycling. It states than in 2009/2010 non-hazardous CDW waste excluding uncontaminated stones and soil accounted for 1.2 million tonnes, of which 70% was diverted from landfill. Finally, it includes the EU recovery rate target of 70% for all non-hazardous CDW by 2020 [321].

28.1.3 Legal framework for sustainable management of CDW

According to the Construction and Demolition Waste Management in United Kingdom Report [321] existing pieces of legislation which promote the sustainable management of CDW are listed as follows:

National/Regional Obligation for Selective Demolition

No specific National/Regional Obligation for Selective Demolition exists.

National/Regional Sorting Obligation (on-site or in sorting facility)

The Waste (England and Wales) Regulations 2011 [323] and subsequent amendments [326]-[327], The Waste (Scotland) Regulations 2011 [324] and subsequent amendments [329] and The Waste Regulations (Northern Ireland) 2011 [325] and subsequent amendments[330]-[331] introduced a duty on organisations that collect waste paper, metal, plastic and glass that from 1 January 2015 this should be done by way of separate collection where it is technically, environmentally and economically practicable (TEEP).

The Environmental Permitting (England and Wales) Regulations 2010 [343], The Landfill (Scotland) Regulations 2003 [360] and The Waste Management Licensing Regulations (Northern Ireland) 2003 [364] set out the regulations covering waste management licenses, permits, exemptions and carriers.

Environment Agency (England) (EAE) and Natural Resources Wales (NRW) Position Statement: Landfilling of gypsum waste including plasterboard [389] (publication withdrawn 6 July 2016), Scottish Environment Protection Agency (SEPA) Technical Guidance Note: The Disposal in Landfill for Non-Hazardous Waste of Gypsum Wastes [390] and Northern Ireland Environment Agency (NIEA) Technical Guidance Note: The Management for Non-Hazardous Waste of Gypsum Wastes [391] state that non-hazardous gypsum-based materials (e.g. plasterboard) must not be landfilled with biodegradable waste. Producers of gypsum waste should separate it for recovery and recycling whenever possible, either on-site or through a licenced waste facility. Where this is not possible and wastes containing gypsum are sent to landfill, they must be deposited in a separate cell in which no biodegradable waste is accepted.

National/Regional Separate Collection Obligation for Different Materials (such as iron and steel, plastic, glass)

The Waste (England and Wales) Regulations 2011 [323] and subsequent amendments [326]-[327], The Waste (Scotland) Regulations 2011 [324] and subsequent amendments [329] and The Waste Regulations (Northern Ireland) 2011 [325] and subsequent amendments [330]-[331] introduced a duty on organisations that collect waste paper, metal, plastic and glass that from 1 January 2015 this should be done by way of separate collection where it is technically, environmentally and economically practicable (TEEP).

Obligation for Separate Collection and Management of Hazardous CDW

The Hazardous Waste (England and Wales) Regulations 2005 [331] and subsequent amendments [332], The Special Waste (Scotland) Regulations 1997[335] and subsequent amendments [336]-[337] and The Hazardous Waste Regulations (Northern Ireland) 2005 [338] and subsequent amendments [339]-[341] make provisions for the controlled management of hazardous waste from the point of production to the final point of disposal or recovery. These regulations are related to all hazardous waste including CDW.

Related Green Public Procurement Requirements

Greening Government Commitment targets (UK) [392] (Published 8 August 2014) sets out the targets that Central Government Departments and their Agencies must meet by 2015. This includes reducing greenhouse gas emissions, reducing the amount of generated waste and ensuring Government buys more sustainable and efficient products and engages with its suppliers to understand and reduce the impacts of its supply chain.

Wales procurement policy statement 2012 [393] contains 9 policy principles for the Welsh Public Sector. One of these is related to economic, social, environmental impact. This states that value for money should be considered as the optimum combination of whole-of-life costs in terms of generating efficiency savings, good quality outcomes for the organization and also benefits society and the economy, whilst minimizing damage to the environment.

Scottish Sustainable Procurement Action Plan [394] (Published 28 October 2009) sets out 10 key steps and associated actions to sustainable procurement. It outlines an approach to successful sustainable procurement which means identifying more sustainable ways of meeting requirements and designing appropriate sustainable procurement specifications. The approach should address the social, economic and environmental implications of product and service choices. It should embrace whole life costing and address how aspects such as design, manufacturing materials, operating costs, energy consumption, waste and recycling options support a more sustainable approach.

Northern Ireland Public Procurement Policy 2014 [395] outlines 12 guiding principles to govern the administration of public procurement in Northern Ireland which reflect the statutory obligations related to equality of opportunity and sustainable development.

28.1.4 Targets

CDW targets vary across the four countries (England, Wales, Scotland and Northern Ireland) of the UK with different targets being adopted [396].

England

In England a target of 70% is set for re-use, recycling and recovery of CDW by 2020 in accordance with WFD 2008/98/EC [321], [396]. In addition, a joint Industry/Government target was set to halve CDW to landfill by 2012 based on a 2008 baseline[321].

Wales

In Wales a target of 90% is set for re-use, recycling and recovery of CDW by 2019/20. In addition, a proposed annual target of 1.4% reduction in CDW generation throughout the time period leading to 2050 is set [396].

Scotland

In Scotland a target of 70% is set for re-use, recycling and recovery of CDW by 2020 in accordance with WFD 2008/98/EC [396].

Northern Ireland

In Northern Ireland a target of 70% is set for recovery of CDW by 2020 in accordance with WFD 2008/98/EC[396]. In addition, a target of 85% resource efficiency for the Northern Irish economy by 2025 has been set by the Sustainable Development Strategy for Northern Ireland [397]. This includes the progressive reduction of quantities of biodegradable waste going to landfill and a general waste reduction in all sectors, encourage and motivate businesses regarding resource efficiency and waste minimisation and promote materials re-use, recycling and recovery through initiatives such as the Waste and Resources Action Programme (WRAP).

Industry targets across the UK

In addition to the above targets set by the Government Bodies of the four countries of the UK, construction companies as well as high profile construction projects (London Olympics 2012, Crossrail etc.) have set their own targets for diverting CDW from landfill [321]. More specifically, UK Contractors Group has set targets for their members which include:

a) Divert at least 90% of CDW from landfill with the ambition of achieving zero non-hazardous CDW to landfill by 2020.
b) 50% Reduction in construction waste by 2020 based on a 2010 baseline.

The National Federation of Demolition Contractors on the other hand, has tasked its members to achieve a reduction of CDW sent to landfill. This led to an audited result of 94% achieved in 2014 [321].

Building Research Establishment Environmental Assessment Method (BREEAM) schemes for assessing, rating and certifying the sustainability of buildings award credit points for minimizing waste (which are measured by m^3 or tonnes/100 m^2 floor area and diversion of waste from landfill) [321].

28.1.5 End of Waste (EoW) status

End of Waste (EoW) criteria have been established in the UK since 2011 [321]. The waste producer has to check whether its waste derived product meets the requirements of EU EoW Regulations for iron, steel and aluminium scrap [398], glass cullet [399] or copper scrap [400]. If no EU EoW Regulation is relevant to the waste derived product, then waste producers must undertake an EoW Test. An EoW Test is met by either complying with a Quality Protocol (England, Wales and Northern Ireland) or carrying out an EoW Test Assessment.

A Quality Protocol sets out EoW criteria for the production and use of a product from a specific type of waste. Compliance with these criteria is considered sufficient to ensure that the fully recovered product may be used without undermining the effectiveness of EU WFD 2008/98/EC [321] and therefore without the need for waste management controls. More specifically, a Quality Protocol indicates how compliance should be achieved and points towards good practice for the storage, transportation and handling of the fully recovered product. In addition, the Quality Protocol aims to provide increased market confidence in the quality of products made from waste and hence encourage greater rates of recovery and recycling.

Quality Protocols which are relevant for CDW include: aggregates from inert waste [401], flat glass [402], lubricating oils [403], waste plasterboard[404] and non-packing plastics [405].

It should be noted that producers and users are not obliged to comply with the above Quality Protocols. If they do not, then the material will be considered to be waste (unless on a case-by-case basis can be demonstrated otherwise) and waste management controls will apply to its handling, transportation and use[401]- [405].

In addition, the above protocols do not affect the obligation of producers to hold an environmental permit (including an exemption) and to comply with its conditions when storing and processing waste [401]- [405]

In Scotland, SEPA does not automatically recognise the validity of the above protocols. In some cases, regulatory position statements are issued (for example when it comes to recycled gypsum from plasterboard [406]). In other cases the Quality protocol is valid (for example when it comes to recycled aggregate from inert waste [401]).

28.2 Non legislative instruments (best practices, guidelines, recommendations…)

Non legislative instruments in the UK dealing with CDW include:

- Building Research Establishment Environmental Assessment Method (BREEAM) (last updated in 2014). It has specific topics related to CDW which include requirements to have a waste management plan, set waste reduction targets and divert waste from landfill [407].
- Code for Sustainable Homes (last updated in 2010). It has specific issues related to CDW waste which include requirements to have a waste management plan, set waste reduction targets and divert waste from landfill [408].

- Building Research Establishment (BRE) Home Quality Mark (HQM) (introduced in 2015). This is a standard for new homes. It includes measures and practices for improving efficiency by effectively managing and reusing waste materials [409].
- Royal Institution of Chartered Surveyors (RICS) SKA rating. This is an environmental assessment method, benchmark and standard for the fit-out of non-domestic buildings. It includes measures for reducing waste sent to landfill, designing out waste, increase recycling of CDW and preparing a site waste management plan [410].
- CEEQUAL international evidence-based sustainability assessment, rating and awards scheme for Civil Engineering, infrastructure, landscaping and public realm projects (last updated in 2012). It was established following work promoted by the Institution of Civil Engineers (ICE) UK and operated with a group of 14 industry shareholders. CEEQUAL contains a section on the use and management of physical resources which covers topics such as minimising material use and waste, responsible sourcing of materials, using re-used and/or recycled materials, durability and maintenance, future de-construction or disassembly, design for waste minimisation, waste from site preparation, policies and targets for resource efficiency and on-site waste management [411].
- The Construction Waste Measurement Protocol published by the European Network of Construction Companies for Research and Development (ENCORD) in 2013. This document is a guide for measuring and reporting waste from construction activities [412].
- Northern Ireland Government Construction Clients Sustainability Action Plan (2012-2015) (introduced in 2012). It has a number of topics related to CDW including where projects should report and measure their performance and set percentage waste to landfill reduction target for each year to achieve at least 75% recycling or re-use of Construction, Demolition and Excavation Waste (CDEW) by 2020 using a 1998 baseline [413].
- Guidance Note 4: Bulk Inert Materials/Aggregates-Re-use and Recycling published by the Department of Finance and Personnel, Government of Northern Ireland (published in 2006 and amended in 2009). The aim of this guide is to promote the re-use and recycling of bulk inert materials in construction in order to reduce consumption of natural resources, energy, transport costs and waste going to landfill [414].
- Guidance Note 6: Demolition, Dismantling, Recovery and Re-use published by the Department of Finance and Personnel, Government of Northern Ireland (published in 2007 and amended in 2012). The aim of this guide is to minimise the amount of waste sent to landfills from the demolition and dismantling of buildings and structures [415].
- ICE Demolition Protocol is a national protocol first published by ICE in 2003 and updated in 2008. It provides a framework for delivering on sustainable construction. More

specifically, it shows how the production of demolition material can be linked to its specification and procurement as a high value material in new construction. In addition, it shows how resource efficiency can be driven through the planning process [416].

- Waste and Permitting Guidance published by the National Federation of Demolition Contractors (NFDC) in 2012. It provides guidance to UK NFDC members on environmental permitting [417].
- Technical Memorandum 56 (TM56): Resource Efficiency of Building Services (introduced in 2014) is a national guidance produced by both Chartered Institute of Building Services Engineers (CIBSE) and WRAP. It aims to help Engineers and Consultants to better understand the principles and importance of resource efficiency [418].
- Scottish Ecological Design Association (SEDA) Design for Deconstruction is a regional (Scotland) guide for how to apply design for deconstruction (published in 2005). It aims to minimise construction waste, CO_2 emissions and construction costs through the use of reclaimed materials [419].
- SMARTWaste is a national online reporting platform managed and owned by BRE (introduced in 2008). It is a web based tool for companies designed to monitor and measure CDW as well as other environmental impacts [420].
- measuRE is a national Built Environment reporting tool which allows users to monitor resource efficiency (introduced in 2014). It replaced the Waste Landfill Reporting Portal and covers use from construction activities and corporate operations [421].
- Net Waste Tool is a national online resource managed and owned by WRAP (Waste & Resources Action Programme) (introduced in 2008). It is a wed based tool for companies designed to forecast construction waste arisings, develop site waste management plans, reduce the costs of construction waste, optimise waste disposal strategy, measure reductions in waste to landfill (including carbon impact) and increase re-use and recycling of CDW [422].
- BREMAP is a national online map for finding the nearest CDW facility by postcode (introduced in 2008). It is managed and owned by BRE [423].
- Recycled and Secondary Aggregates Suppliers Map is a regional map (Scotland) system for aggregate producers who have complied with the Quality Protocol: Aggregates from inert waste[401]. It was developed in 2014 [424].
- Environment Agency Carbon Calculator is a regional (England and Wales) online calculator (excel spreadsheet) developed by Environment Agency (England and Wales) in 2014. It is used for construction projects including material and waste management routes [425].
- Considerate Constructors Scheme (CCS). This is scheme in which construction companies and suppliers voluntarily register and agree to abide by the Code of Considerate Practice, designed to encourage best practice beyond statutory

requirements. The main areas of concern are: the general public, the workforce and the environment including CDW management [426].

28.3 CDW management performance – CDW data

28.3.1 CDW generation data

CDW data in the UK is collected on an annual basis. The data is collected through the Environment Agency (England), Natural Resources (Wales), Northern Ireland Environment Agency (NIEA) and Scotland Environment Protection Agency (SEPA) using waste management data from licensed waste management facilities. In addition, data from other sources such as the recycled aggregates industry is used. Finally, the above data is occasionaly supplemented by surveys on CDW or CDEW arisings conducted on either England, Wales or Northern Ireland [427]- [429].

Table 123 based on DEFRA's Diggests of Waste and Resource Statistics (2015) [430] and (2016) [431] provides information regarding generation of CDW (excludes excavation waste) in UK for years 2010 and 2012.

Table 123. Generation of Non-Hazardous and Hazardous CDW and Recovery Rate for Non-Hazardous CDW in UK (Years 2010 and 2012).

Year	Non-Hazardous CDW (tonnes)	Non-Hazardous CDW Recovery (tonnes)	Non-Hazardous CDW Recovery Rate (%)	Hazardous CDW* (tonnes)
2010	45419000	39129000	86.2	1018000
2012	44786000	38759000	86.5	1057000

*includes dredging

The above data shows that in 2010 and 2012 the UK achieved Non-Hazardous CDW recovery rates of 86.2% and 86.5%, respectively. These rates are above the 70% target which the UK must meet by 2020.

28.3.2 CDW treatment data

UK estimates on recovery rate of Non-Hazardous CDW were calculated in accordance with WFD 2008/98/EC [321]. However, the methodology used for calculating data is not identical across all UK countries. Although absolute values of CDW are subject to a relatively high level of uncertainty, sensitivity analysis suggests no significant impact on the final recovery rates 1]. It is estimated that the majority of CDW in the UK is turned into an End-of-Waste aggregate product under exemption. Finally, there is no available data regarding storage of CDW.

28.3.3 CDW exports/imports data

Some waste materials have an export/import market. In 2013 the UK has exported 13.2 million tonnes of scrap metal worth more than £4.3 billion, while importing 0.5 million tonnes. Part of this metal originated from CDW [321]. Wood waste is also exported mainly for use as biomass in Germany and Sweden. According to Wood Recyclers' Association (WRA) over 600000 tonnes of wood waste were exported in 2014. Some of this wood may have come from CDW [432]. In addition, 1.8 million tonnes of Refuse Derived Fuel (RDF) were exported from England and Wales in 2013. Some of this may have been derived from CDW 1]. Finally, approximately 50% of packaging waste in 2011 was exported with a small quantity coming from CDW [433].

28.3.4 CDW treatment facilities data

CDW treatment data in the UK is collected on an annual basis. DEFRA is responsible for collecting and combining data from treatment facilities authorised by mandatory permit or license from the environment agencies (EAE, NRW, SEPA and NIEA) of all four UK regions. The permit or license defines the capacity limit of the facility with the exception of some small scale incinerators for which the permit or license does not set a limit (some CDW such as insulation foams and plastics may be sent for incineration). Table 124 adopted from Construction and Demolition Waste Management in UK Report 1] and shown below provides information on the number of treatment facilities in the UK and their capacities (UK and England only).

Table 124. Number and capacity of treatment facilities in UK that accept CDW.

Facility Type	Measure	UK	England	Wales	Scotland	Northern Ireland
Energy recovery	Number of facilities	27	13	3	8	3
	Capacity (tonnes/year)	2893000	2111000			
Incineration	Number of facilities	87	65	1	15	6
	Capacity (tonnes/year)	8385000	7992000			
Recovery other than energy recovery (includes backfilling)		3542	1895			
Deposit onto or into	Number of facilities	594	478	25	71	20

Facility Type	Measure	UK	England	Wales	Scotland	Northern Ireland
land (landfill)	Rest (remaining) capacity (m^3)	633203000	505438000			

*Energy recovery refers to facilities where the main purpose is generation of energy or formal R1 accreditation has been awarded.

28.3.5 Future projections of CDW generation and treatment

No future projections of CDW generation and treatment are available at national level 1]. When it comes to regional level, the Welsh Government Construction and Demolition Sector Plan [386] provides information on the development of CDW treatment capabilities (such as allowing businesses to use household recycling centres).

28.3.6 Methodology for CDW statistics

The CDW recovery rates given in Section 28.3.1 were submitted to the Statistical Office of the European Union (EUROSTAT). However, the estimation methodology was not able to use accurate data regarding aggregate production or identify specific European Waste Classification for Statistics (EWC-STAT) codes in generation and treatment of CDW. DEFRA is aware of the above limitations and is currently aiming to address them in conjunction with the industry in time for the 2016 Data submission.

28.4 C&D waste management in practice

28.4.1 CDW management initiatives

- Carpet Recycling UK is a national initiative established in 2008. Since then, it helped to divert 567000 tonnes of carpet waste from landfill to recycling or energy recovery [434].
- Envirowise (now part of WRAP) is a UK Government-funded programme established in 1994 that provides free advice and practical guidance to help businesses of all sizes and sectors boost resource efficiency and ultimately save money [435].
- Enabling Zero Waste is a regional (Constructing Excellence in Wales) initiative designed to work with the construction industry. It was established in 2013 in order to provide practical, positive and active intervention via professional waste management solutions for achieving zero waste send to landfill [436].
- **Demolition and Refurbishment Information Datasheets (DRIDS)** provide informative and practical guidance around the materials and products found on modern demolition sites. It was established in 2013 by the NFDC[437].

- WASTE is a regional (England) action plan for halving construction, demolition and excavation waste to landfill. It was published in 2011 by the Strategic Forum for Construction [438].
- BRE Dealing With Difficult Demolition Wastes Guide provides practical guidance for improving the recovery of certain types of waste arising from demolition that are difficult to reuse, recycle or recover (such as carpet underlays, insulated concrete formworks, industrial batteries, structural insulated panels and smoke alarms). It was published in 2013 [439].
- UK Contractors Group (UKCG) supports its members in practising effective waste management by reducing waste production and diverting waste from landfill. UKCG members have agreed to report data through the WRAP. In 2012 UKCG members diverted 91% of all construction and demolition waste away from landfill [440].

28.4.2 Drivers / barriers to increase CDW recycling

Factors which act as drivers for increased CDW recycling include schemes such as BREEAM, Government sponsored programmes such as WRAP and the Landfill Tax. More specifically:

- BREEAM awards credits to projects that meet targets for diverting CDW from landfills. This has led to an increase in recycling with construction contractors demanding better performance from their waste management subcontractors [321].
- WRAP has developed a number of projects aiming to increase recycling of CDW. Working together with the government and the construction industry they provide assistance to companies in diverting CDW from landfills. In addition, they provide assistance in financing recycling plants [321].
- The increase of the Landfill Tax has been a major driver for increased CDW recycling. It made the option of landfilling certain types of CDW more expensive compared to recycling. This generated more investment to the waste management industry [321].

Factors which act as barriers to increase CDW recycling include environmental permitting and exemptions, health and safety concerns, transport costs, on-site separation constraints of CDW and aggregates levy. More specifically:

- Environmental permitting and exemptions can be restrictive to recycling CDW since they tend to apply to relatively small quantities. Although the environmental permitting process has been simplified over the recent years, it still acts as a deterrent for medium scale recycling of CDW. This is particularly the case when it comes to on-site recycling [321].
- Commonly used products and materials for buildings and structures may become hazardous waste over time raising health and safety concerns. Although such wastes

should be dealt with via the appropriate hazardous waste route, there are problems in clearly identifying non-recyclable hazardous from recyclable non-hazardous materials. In addition, there are CDW products and materials which may become hazardous during reprocessing. Hence, there is a tendency for all of them to be treated as non-recyclable [321].

- Transportation of CDW over long distances to appropriate recycling centres increases costs and CO_2 emissions and acts as a barrier for increasing recycling rates [321].
- Time and space are the main constraints when it comes to onsite separation of CDW [1].
- The Government assumed that the Aggregate Levy would increase the market price of aggregates used in construction by an amount in line with the levy and hence provide recycled aggregate producers with a margin to cover the costs of making recycled aggregate from CDW. However, buyers (i.e. construction companies) of aggregates were well aware that the levy was not applied to the recycled aggregates and therefore expected their price to be lower than that of primary aggregates. In addition, the levy was applied to the producer at the point of production, and not on the purchaser at the point of sale. This gave the opportunity to the primary aggregate producers to view the levy as an operational overhead and decide on how it would be allocated across their product range. Consequently, the market price of primary aggregates used for concrete or asphalt (which face low levels of competition from recycled aggregates) increased at a higher rate than the levy. On the other hand, the market price of primary aggregates used as sub-base course in highway construction (which face high levels of competition from recycled aggregates) increased at a lower rate than the levy [321].

Factors which act both as drivers and barriers for increasing CDW recycling include demonstration of technical performance, leadership and verification, market conditions, waste infrastructure and reliability of data.

- Over the last decade, there was a significant increase in the amount of guidance and information available to the construction and demolition industries for improving their CDW recycling performance. However, construction companies are reluctant to use recycled products without certification of tested performance. This practically excludes the use of materials derived from CDW for structural applications [321].
- Many construction companies have set zero waste to landfill targets for the CDW they produce. However, these targets are quite difficult to achieve onsite. In addition, recycling performance is highly dependent on the CDW receiving facility [321].
- In many cases, the Landfill Tax made it cheaper to recycle and recover CDW rather than sending it to landfills. However, the price volatility of certain markets such as plastics can profoundly influence their recycling future [321].

- Over the last decade, there was a significant investment increase in waste infrastructure. However, there is still space for improvement especially when it comes to rural areas [321].
- Over the last decade, there was a significant improvement on accurate CDW data at site, company, regional and national levels. However, there is still limited high quality detailed information when it comes to different types of CDW materials (especially at national level) [321].

28.5 CDW sector characterization

28.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

The main CDW product in the UK is recycled aggregate which is mainly used as unbound recycled aggregate for pipe bedding, sub-base and base courses in highway pavement construction. However, research conducted in Northwest England over the last ten years [441]-[444] demonstrated the potential for using recycled aggregate as a replacement for virgin aggregate in a number of different precast concrete products (i.e. concrete building blocks, paving blocks and flags). Replacement levels of both fine and coarse virgin aggregate by either Recycled Concrete Aggregate (RCA) and Recycled Masonry Aggregate (RMA) were recommended. In addition, BS 8500-2:2015+A1:2016[445], the complementary British Standard to BS EN 206:2013+A1:2016 [446] sets out the requirements for the use of either Crushed Concrete Aggregate (CCA) (previously described as Recycled Concrete Aggregate) or Recycled Aggregate (RA) in structural and non-structural concrete.

Other CDW products include wood waste which is used for animal bedding or panel-board manufacture and gypsum plasterboard which is used in the manufacture of new plasterboard.

Quantitative analysis

According to the Minerals Production Association (MPA) 29% (61 out of 210 milliontonnes) of aggregates used in the UK in 2014 came from recycled or secondary sources [447].

Recovery techniques

Recovery techniques are described by Quality Protocols. For CDW the following Quality Protocols exist: aggregates from inert waste [401], flat glass [402], lubricating oils [403], waste plasterboard [404] and non-packing plastics [405] (Please refer to Section 28.1.5).

Environmental and economic impacts of CDW waste management

During the first five years of the Quality Protocol: Aggregates from Inert Waste [401] being in operation an estimated reduction of 1.9 million tonnes of waste sent to landfill was achieved. A corresponding saving to the construction industry of approximately £1 billion through the avoidance of disposal fees and landfill tax was also achieved. The net benefit is estimated to exceed £3 billion by 2020[448].

WRAP case studies suggest significant net savings by achieving good practice waste reduction and recovery. As an example, cost savings of approximately £309 K can be made during the construction of a new £13.5 million Integrated Waste Facility (IWF). The additional costs required to achieve the above savings are estimated to be £21 K yielding a net cost saving of £288 K. This represents a reduction of 2.12% on the overall construction cost. In addition, CO_2 savings of 431 tonnes are projected [449].

DEFRA has compiled an extensive list of emission factors for material consumption and waste including those associated with CDW. This data can be used to estimate CO_2 equivalent savings through reuse, recycling and recovery onsite and at company, regional and national level [450].

Drivers / barriers to increase recycling

Please refer to Section28.4.2.

28.5.2 Recycled materials from CDW

The main CDW product in the UK is recycled aggregate which is mainly used as unbound recycled aggregate for pipe bedding, sub-base and base courses in highway pavement construction. The Aggregates Levy [383] has significantly increased the use of recycled aggregates. According to Minerals Production Association (MPA) 28% (55 out of 198 million tonnes) of aggregates used in the UK in 2013 came from recycled or secondary sources [451]. However, use of recycled aggregate in concrete products is still very limited. Although a lot of research has been carried out over the last 20 years in the UK [441]- [444] and [452]- [456] and specifications exist for its use in concrete (BS 8500-2:2015+A1:2016 [445]) ready-mix and precast concrete manufacturers are reluctant to use it. This is mainly due to concerns regarding contamination levels of harmful substances (i.e. chloride content, gypsum plaster, bitumen, glass, metals, plastics and wood).

28.5.3 Market conditions / costs and benefits

Market conditions

The Landfill Tax [382] has encouraged separation of inert waste (which is subjected to a lower rate), recycling and recovery of CDW. An exemption applies when it comes to inactive waste (mainly CDW) used for filling quarries. Landfill Site Operators (LSO) can contribute money to the Landfill Communities Fund (LCF) which finances local community projects. LSO contributing to the LCF are able to claim a credit (4.2% in 2016/17) against their landfill tax liability. The percentage is called the diversion rate and is set each year by Government. The credit LSO are entitled to is 90% of their contribution to LCF. They then either bear the remaining 10% themselves or can ask an independent third party to make up the difference [457].

The Aggregates Levy [383] enabled more investment in recycling infrastructure and allowed recycled aggregate producers to have a higher unit of production cost and still compete against primary aggregate producers. However, the Government's expectation for recycled aggregates to be cheaper because of the levy does not seem to be the case [321].

Costs and benefits

Costs (perceived/actual) and benefits of recycling and recovery of CDW are listed below.

- Capital investment and time are required to set up and operate recycling and recovery facilities. However, this leads to reduced material and disposal costs [321].
- Capital investment and time are required to train staff and change its mentality regarding on-site recycling. However, this leads to market differentiation by aligning with the client's corporate social responsibility objectives [321].
- Capital investment and training are needed for meeting the requirements of quality protocols, environmental permitting and/or exemptions from permitting. However, this leads to reduced CO_2 emissions [321].
- Capital investment and time are needed for developing and maintaining site waste management plans, other plans and pre-demolition audits. However, this fulfills the requirements set by planning authorities [321].
- Capital investment and time are required for measuring and monitoring CDW arisings and their recycling/recovery management. However, this contributes towards achievement of sustainability standards. In addition, it meets legal requirements. Finally, it improves site management and staff engagement and development [321].

29. TAIWAN

29.1 Legal Framework – Waste Management Plans and Strategies

29.1.1 National Legislation concerning CDW

The Construction and Planning Agency, Ministry of the Interior has set up a "Recycling green concrete label of green building" to encourage the use of CDW in construction work.
The Environmental Protection Administration (EPA), Taiwan Government provides the policy to guide the recycling of the CDW.

29.1.2 Waste management plans (WMP) and Strategies

The development of the city provides a large number of job opportunities to promote the migration of the population to the city. The growth of the population leads to the increase in the number of new construction projects, together with the urban renewal of the old buildings, the demolition of illegal structures, and the removal of waste from the Government. The amount of production is very impressive, but for the narrow, thick space buried in Taiwan, the case will undoubtedly cause serious environmental problems.
Construction waste, including metal chips, glass debris, plastic, wood and bamboo chips are still available as the waste resources. In order to increase its reuse value, in 1991, the Ministry of the Interior announced the "Recycling management construction of waste" including: increasing CDW resources recycling pipeline; reducing the construction of waste disposal of the situation occurred. In 1994, the Government began to control the amount of the construction project as well as the CDW generated. In 1997, they announced the delivery of waste to build the removal of vehicles should be installed satellite positioning system (GPS) to implement the management of the construction waste.
Using the concept of urban mine and sustainable material management, the Government has completed the "Construction Waste Management Strategy" to encourage the operators to implement waste reduction and sorting operations at the construction site, implement the construction of waste flow management and enhance the resources of the recycling organizations, set up technology to promote the development of renewable green building materials industry, and then produce environmentally friendly renewable green building materials, reduce the consumption of natural resources and reduce the environmental effects. By the ways, this can make the national health living in high quality green building environment, and further to achieve the establishment of resource recycling green city goal.

29.1.3 Legal framework for sustainable management of CDW

In Taiwan, the CDW has been considered as a useful resource that is greatly recyclable and reusable. This kind of waste can be recycled as the aggregate that is commonly used in many construction activities, especially in concrete production.

The CDW does not allow to be dumped to any public area. It should be reused in order to: (1) reduce the environmental impacts due to the generation of CDW and (2) reduce the use of natural resources then reduce the overall cost of final products.
The ministry of Interior has set up a recycling green concrete label of green building to encourage the use of CDW in construction work.

29.1.4 Targets

No data on this topic was available.

29.1.5 End of Waste (EoW) status

No data on this topic was available.

29.2 Non legislative instruments (best practices, guidelines, recommendations…)

Taiwan local Government strongly encourages the use of CDW in the construction industry.
Many research works and projects have been conducted using CDW as a part of construction material. These works were carried out not only in the local area but also in international cooperation.
Discussion on this topic has been performed regularly through workshop, conference, experience sharing in order to improve each activity regarding the recycle of CDW.
Build-up the SOP and guidelines for recycling and reusing of CDW. Do the technical transfer from research to the industry and work-field.
The Ministry of Interior and Environmental Protection Administration (EPA) have the policy to guide the recycling the CDW.

29.3 CDW management performance – CDW data

29.3.1 CDW generation data

Generally, there is a thousand ton of CDW is generated each year, but no specific data were found.

29.3.2 CDW treatment data

In Taiwan, the primary treatment options for CDW is including:

- Reuse directly as a material for backfilling.
- Recycling into fine or coarse aggregates for making construction materials, e.g. concrete, brick.

There are some companies collecting the CDW and producing construction materials, but no published data were found.

29.3.3 CDW exports/imports data

No data on this topic was available.

29.3.4 CDW treatment facilities data

Fish port project used thousand ton of CDW
Many recent construction projects are ongoing

29.3.5 Future projections of CDW generation and treatment

No data on this topic was available.

29.3.6 Methodology for CDW statistics

The information reported here collects from the local CDW recycling companies and report from previous projects.

29.4 C&D waste management in practice

29.4.1 CDW management initiatives

The agreement and close connection between the Government & Construction commission, the scientific research & association, the academy, the engineering society, the business & industry.

29.4.2 Drivers / barriers to increase CDW recycling

- - Local Government strongly encourages the recycling of CDW
- - However, turning CDW into construction material costs money
- - Considering the low quality of CDW as compared to natural resource

29.5 CDW sector characterization

29.5.1 CDW materials (CONCRETE, BRICKS, TILES AND CERAMIC, ASPHALT, WOOD, GYPSUM)

Product description and applications

- High-performance concrete for building
- Concrete for producing tetrapod
- Construction bricks for building
- Tiles and ceramics for building and pavement

Quantitative analysis

No specific data on this topic

Recovery techniques

The CDW is recycled into fine and coarse aggregates for the production of concrete, bricks.

Environmental and economic impacts of CDW waste management

- Less using natural resources
- Low CO2 emissions
- Reduce the pollution due to the generation of waste

Drivers / barriers to increase recycling

- Local Government strongly encourages the recycling of CDW
- However, turning CDW into construction material costs money
- Considering the low quality of CDW as compared to natural resource

29.5.2 Recycled materials from CDW

Major recycled materials from CDW are concrete, construction bricks, and ceramics

29.5.3 Market conditions / costs and benefits

No data about this topic

30. CONCLUSION AND RECOMMENDATIONS

This Deliverable outlines CDW management situation in each European country, with the aim to identify obstacles to recycling and potential deficiencies in CDW management practices that could lead to non-compliance with EU waste legislation, more specifically the waste hierarchy and the recovery target for CDW established in Art. 11 of the Waste Framework Directive.

Therefore, after the collection of the information, reported in this deliverable, the reliability of official CDW statistics will be assessed, in Deliverable D1.2 by comparing with data coming from other studies in progress at the time of writing.

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