Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures

Specific Contract

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FINAL REPORT

prepared for

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1. Introduction

1.1. Context of the Study

Communication (COM (2014) 445 final) "on Resource Efficiency Opportunities in the Building Sector" stated the Commission's intention to encourage a more efficient use of the resources consumed by new or refurbished buildings, be they commercial, residential or public, and reduce their overall impact during their full life cycle. The construction sector is the first consumer of raw materials while it generates the first stream of wastes.

A vast majority of Construction & Demolition Waste (CDW) is recyclable as shown in the report prepared for the Committee of Regions "Ambitious waste targets and local and regional waste management"[1] (2013) where it is stated that: *"from a quantitative point of view, the best practices in Europe show that recycling rates over 80% or 90% are feasible"*

These figures alone would indicate that progress is being made and that the EU target for recycled material is easily achievable, but with the exception of a few Member States that recycle up to 90%, the average rate for EU28 is below 50%. Some authors, such as Craven[2], show higher figures of recycling, around 60%, but they draw the same conclusion, namely, that the great difference among the different countries constitutes the main drawback to achieve the EU objective.

The Waste Framework Directive 2008/98/EC establishes a target of 70% of CDW to be recycled by 2020. Therefore, the Communication on Resource Efficiency Opportunities in the Building Sector is especially focused on an increase of the use of recycled materials and the reduction of CDW. This communication is aligned with many documents or schemes:

- the Raw Materials Initiative (COM(2008) 699) final launched in 2008 by the Commission aimed at boosting resource efficiency and promoting recycling,
- the Roadmap to a Resource Efficient Europe (COM(2011) 571) which requires that buildings should be refurbished or built with greater resource efficiency
- the Communication on “Strategy for the sustainable competitiveness of the construction sector and its enterprises” (COM (2012) 433 final).
- the Communication "For a European Industrial Renaissance" (COM(2014) 014 final) claiming for the re-industrialization of Europe.

[1] "Ambitious waste targets and local and regional waste management" (2013) Albrecht Gradmann (Ecologic Institute); Thomas Weissenbach and Hubert Reisinger (Umwelthbundesamt Österreich) and Francesca Montevecchi (RIMAS). Available online at http://cor.europa.eu/en/

[2] Craven, P. (2015). Are current EU C&D waste recycling targets and obstacle to growth? Waste management World, Feb 2015. Available at waste-management-world.com (acess September 2015)

To follow up the framework Construction 2020 of the Communication on “Strategy for the sustainable competitiveness of the construction sector and its enterprises” (COM (2012) 433 final), a High Level Tripartite Strategic Forum and 5 *Thematic Groups* gathering relevant stakeholders have been set up. These thematic groups are discussing and defining actions for the implementation of the Construction 2020 strategy.

Thematic Group 3 (TG3) “Resource Efficiency” is focusing on the environmental performance of buildings and the valorisation of CDW.

With regard to the part on CDW in the Communication on “Resource Efficiency Opportunities in the Building Sector”, TG3's recommendations included promoting economic instruments that provide incentives for recycling of CDW and studying specific waste streams to identify and promote cost-effective recycling practices, including the needs for infrastructure and technologies.

In December 2015 The European Commission adopted the “Circular Economy Package”, which includes revised legislative proposals on waste to encourage Europe's transition towards a circular economy. In this Circular Economy Package, Construction and Demolition Waste is identified as a key aspect. Along with this, at the Kick-Off Meeting (KOM), it was pointed out that the verification of data and methodologies is an essential part of the Circular Economy Package.

1.2. Objectives

This consortium will provide the Commission with a technical and economic study that should be used as a contribution to the objective of 70% of CDW being recycled by 2020. The main objective of the study will be supporting the Commission in carrying out their tasks, in particular those stemming from the policy process related to the Circular Economy and Resource Efficiency Opportunities in the Building Sector.

This technical and economic study will include relevant inputs and specific tools and/or guidelines for assessment of buildings and infrastructures prior to demolition and renovation, in order to improve the recyclability of CDW to be generated.

This study serves three main purposes:

1. The assessment of the current regulatory, technical and economic conditions within the Member States,
2. Analysis of the consequences and the opportunities of an audit prior to demolition and renovation projects to be performed with the aim of:
    a. preventing unnecessary waste,
    b. promoting reuse and recycling of materials and components
    c. Preventing unsafe management of hazardous waste from construction, demolition and renovation works
3. Maximization of the value and sustainable use of construction materials and waste as prescribed by the concept of Circular Economy which is “keeping the value as long as possible”.

The objectives of this study can be grouped into three categories, which are summarized below.

I. First objective:
   a. Assessment of current practices and conditions for audit of buildings and infrastructures prior to demolition or renovation within the EU.
   b. Compilation of the views from the relevant stakeholders with regard to pre-demolition/renovation CDW audit. Relevant stakeholders could be: Member States' authorities, building and infrastructure project sponsors, specifiers, building contractors, demolition contractors, recycling practitioners.

II. Second objective:
   a. Identification of key-factors which could drive the implementation of pre-demolition/renovation audits
   b. Definition of the conditions – upstream and downstream – for successful implementation of pre-demolition/renovation audits
   c. Identification of regulatory incentives or obstacles
   d. Assessment of the potential economic impacts on project costs and Life-Cycle-Costs of buildings and infrastructures

III. The third objective of this study is:
   a. to provide comprehensive and operational information
   b. to draft methodological, technical and best-practice guidelines to be implemented by contractors and project sponsors in order to support national authorities for the actual achievement of the EU 2020 target for CDW recycling

1.3. Structure of this report

The remainder of this report has been organized as follows:

- Section 2 sets out our approach to the study and
- Section 3 provides an in-depth analysis of current situation and needs for CDW assessment audits and
- Section 4 provides our proposal for guidelines and implementation measures to be taken.

The report is complemented by annexes which provide the following information

- Annex 1 provides a summary of the situation by country
- Annex 2 provides the background document to the evaluation and validation workshop
- Annex 3 provides the waste audit guidelines

2. Approach to the study

2.1. Introduction

The main task of the consortium was to conduct a review of the current situation in the EU regarding the current practices in assessing and managing the construction and demolition waste streams prior to demolition of buildings and infrastructures, especially focusing on the following key issues: the need for pre-demolition inventories, the waste management reporting, the final waste management report, the need for smart tools providing demolition process with reliable information on the valuable materials and subsequent reuse/recycling potential options in order to propose the best approach to the problem and possible ways to implement them.

2.2. Geographical scope

There is a great variety in the conditions on CDW Management throughout Europe, mainly due to legal, framework and market conditions.

The geographical scope of the study covers a great deal of Europe, with special focus on the investigated countries: United Kingdom, Austria, Denmark, France, Czech Republic, Finland, Belgium, Spain, Italy, Portugal, Sweden, Romania and Poland.

The selection of these countries tries to cover the different realities in the EU, as regards geographical and cultural differences. These countries have been chosen based on the consortium's experience and the information collected on available documents, and the work being carried out by the Consortium under "Resource Efficient Use of Mixed Wastes" study[3] and HISER[4] and ECORYS projects[5]. A brief summary of the findings for each of the abovementioned countries is provided in the following sections.

In principle, no countries from outside the European Union were explicitly considered originally, but the situation in other countries has been studied. A general revision of recent reports from other worldwide countries has been performed. For instance, recent information on Canada refers to the role of project designers as the ones to "schedule the waste audit early in the process so that opportunities resulting from the reuse of materials or reduction of waste can be incorporated."[6]

[3] Resource Efficient Use of Mixed Wastes http://ec.europa.eu/environment/waste/studies/mixed_waste.htm
[4] HISER project.- Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste - H2020 Program. Grant Agreement nº 642085
[5] ECORYS project. – Developing a common EU construction & demolition waste management protocol". project has been initiated by the European Commission under the framework of the "Construction 2020" Action Plan (part of "Strategy for the sustainable competitiveness of the construction sector and its enterprises" (COM (2012) 433 final), specifically relating to the activities of Thematic Group 3.
[6] A Guide to Waste Audits and Reduction Workplans for Industrial, Commercial and Institutional Sectors. As Required Under Ontario Regulation 102/94

Consultations are being sent to try to gather more detailed information on the procedure followed to try to find possible good practices in that country.

Regarding the USA, the situation varies with the different states. In general terms the Environmental Protection Agency (EPA) promotes a wide range of programs that support Green Building and the reuse or recycling of C&D building materials is an important component of Green Building. Also EPA and OSHA provide a strong regulatory framework for dangerous substances including asbestos. In the USA the concept "deconstruction" is being promoted in general, and this concept includes CDW materials inventories are a key issue[7],[8]. The situation between states shows significant differences. The EPA website collects reports for different states that can be consulted (https://www3.epa.gov/wastes/conserve/imr/cdm/statereports.htm). These reports although being an important source of information have not provided relevant information on the procedure or the best implementation methodology. Information on California State (being one of the most active States in "Green" aspects and regulations) is being revised at the moment.

Finally, it is important to consider also voluntary certifications such as BREEAM (UK, international), LEED (US, international), DGNB (Germany, Europe), HQE (France), GreenStar (Australia), VERDE (Spain), Miljöbyggnad (Sweden) and others. Those schemes are awarding credits for a responsible sourcing of materials (recycled and reused content) in the new buildings and sometimes also for their design for deconstruction and easy material separation. They are directly or indirectly promoting waste audits for renovation or demolition projects. The more important aspects of selected schemes are planned to be highlighted in Tasks 2 to 4.

All this information will be further refined to extract best practices and contribute if possible with the experience from other countries out of the European Union and voluntary certification schemes to identify the best practices to be included in the Guidelines for pre-demolition and renovation audits and proposals for their implementation.

A summary of the situation for each of the countries studied is shown in Annex 1.

2.3. Literature review

In the process of defining current Refurbishment, Demolition and Recycling sector, several bibliographical sources have been checked. Among them, apart from those already mentioned, the most important sources are listed below.

- EU, National and Regional Legislation
- HISER project and references
- Resource Efficient Use of Mixed Wastes and references

[7] A GUIDE TO DECONSTRUCTION (2003, Published by the Deconstruction Institute).
[8] Deconstruction Training Manual. Waste Management Reuse and Recycling at Mather Field (2001, Published by the Californian Environmental Protection Agency)

- Service Contract on Management of Construction and Demolition Waste -SR1 [ENV.G.4/FRA/2008/0112]
- Screening of Waste Management Performance of EU Member States [BiPRO, 2012]
- Study to improve hazardous waste management based on an assessment of Member States' performance [ENV/2014/SI2.689463/ETU/A2]
- EU Construction and Demolition Waste Management Protocol, version 2 from November 2015
- EDA Annual Report 2015
- Construction and demolition waste management practices and their economic impacts" - SYMONDS GROUP, 1999 [B4-3040/97/000659/MAR/E3]
- Scientific literature (from ISI Journals or peer reviewed publications)
- Dissertations from universities and universities of applied sciences
- Other projects and existing guideline documents, such as Gypsum to Gypsum; Ihobe white book and support tool; United Kingdom demolition guidelines, Belgium guidelines (mainly in Flemish and Brussels Capital region); Finnish library of the best practices prepared by the professional organisations and published by Rakennustieto; and other documents, reports, guidelines and tools referenced both in HISER and Resource Efficient Use of Mixed Wastes studies by Deloitte. These documents have been revised and mainly include what can be considered “existing practices” and methodologies.

2.4. Stakeholder consultation

The main action for collecting updated first-hand information is through dedicated interviews. Technical Sessions between TECNALIA and VTT were kept to establish reference information, assumptions and questions for undertaking interviews, to define a detailed design of dedicated interviews (including definition of template)

Dedicated interviews have been performed to contrast, correct/validate and extent the information defined in the Technical Sessions. Individual interviews were arranged mainly with regional authorities (and where possible with national authorities); industry; national associations and regional associations. Their geographical distribution is as follows:

- United Kingdom, Austria, France, Spain, Italy and Portugal by TECNALIA.
- Finland, Denmark, Czech Republic, Sweden and Romania by VTT
- Belgium and Poland by TECNALIA and VTT

In order to have and homogeneous and comparable feedback from interviewees, a questionnaire was prepared and sent to each of the stakeholders identified. The questionnaire was designed for:

- National authorities,
- Regional authorities,
- Industry,
- National associations and
- Regional associations

Over 100 key stakeholders were identified and sent an email with the questionnaire asking them also to disseminate the questionnaire to other interested parties. Further reminders were sent with a view to increasing the participation rate. In order to further increment the response of questionnaires, emails were complemented with telephone interviews.

Telephone interviews provided the study team with an opportunity to supplement and verify the information gathered from the questionnaires and desk-based research. In the following table this information is summarized by Country and stakeholder type.

Table 1 Interviews sent and answers received

Country	Interviews sent/planned and in brackets answers received for each stakeholder group identified					Total Questionnaires	
	National authorities	Regional authorities	Industry	National association	Regional association	Sent	Answered
United Kingdom	1 (0)	3 (2)	2 (1)	1 (0)	1 (0)	8	3
Austria	1 (0)	1 (0)	1 (1)	1 (0)	1 (1)	5	2
France	1 (1)	1 (0)	1 (1)	1 (0)	1 (0)	5	2
Belgium	1 (0)	2 (1)	2 (0)	1 (1)	1 (1)	7	3
Spain	1 (1)	4 (2)	5 (2)	1 (1)	1 (1)	12	8
Portugal	1 (0)	2 (1)	2 (1)	1 (0)	2 (1)	8	3
Italy	1 (0)	6 (2)	4 (1)	2 (1)	2 (1)	15	5
Poland	1 (0)	1 (0)	2 (1)	2 (0)	1 (0)	7	1
Finland	2 (1)	3 (1)	4 (3)	3 (0)	3 (0)	15	5
Sweden	2 (1)	2 (1)	4 (1)	1 (1)	1 (0)	10	4
Denmark	1 (0)	1 (0)	2 (2)	1 (0)	1 (1)	6	3
Romania	2 (1)	4 (0)	3 (0)	1 (0)	0 (0)	10	1
Czech R.	2 (0)	1 (0)	5 (3)	2 (1)	1 (1)	11	5
Totals	17	31	37	18	16	119	45

2.5. Workshops

Originally the only workshop planned was the validation one during task 5. But during task 1 a first workshop was organized with the help of the European Demolition Association, and was held during the "Annual Convention" in Glasgow on the 8th of June 2016. This workshop was intended to further refine gathered data in order to focus the objectives deemed important by Demolition industry for preliminary audits.

The assistance to the workshop was of 23 persons representing the following companies and representatives of national associations: TECNALIA; VTT; DELEK; SDA; RVA Group; MOURIK NV; TSCHERNING; CASO; VIB, AERTSSEN; ACLAGRO NV; EDA; BRE; IHOBE; VRN; SNED; FDA; Swedish Construction Federation; SANEERAUS; EKOKEM; RUDUS.

Although stakeholders were expecting a workshop with more information provided, the objective of the consortium was to allow the discussion and further refine information gathered previously. The activities performed during the workshop were:

- Open discussion on the general needs for audits; motivation to perform them; roles and cooperation between actors; monitoring activities
- Small table to be filled in to refine and extract information on preliminary audits, reporting and monitoring of information. 7 documents were filled in during the session.

The evaluation and validation workshop organized by the European Commission was held in Brussels in December 2016.

Workshops served as effective ways to obtain information on activities taking place in Member States as representatives travelled to this central location, without the need of the study team to travel to each individual Member State.

At the workshops the study team presented the information gathered to date and opened the workshop for discussions. A background document (provided as Annex 2 to this report) was circulated in advance to the workshop so that participants could have the information in advance.

Discussions and comments received after the workshops proved extremely helpful for the final report, particularly as some of the comments were from stakeholders who had not completed the questionnaire. The workshops also allowed the study team to reaffirm the objectives of the study and the direction that the Final Report would take.

3. In-depth analysis of current situation and needs for CDW assessment audits

3.1. Task 1. Stock taking action

3.1.1. Introduction

During task 1, stock taking action, it has been noted that when studying preliminary audits or inventories, their context should be considered, and the implementation of the pre-demolition audits should be described based on the regulations and best practices of the general CDW management process.

The strategies adopted by European Countries to reduce non-recovered waste are uneven and success rates are unequal. For instance, when considering countries or regions with reported high recycling rates such as the Netherlands, the region of Flanders in Belgium (the situation in both countries was taken as similar at the KOM), Denmark or Czech Republic, it seems that strategies around regulation are diverse; The Netherlands and Flanders have a landfill ban for recyclable waste materials, whereas the Czech Republic is planning to introduce it by 2023. Onsite sorting based on the European classification (or similar), and a waste audit depending on size and type of building are compulsory in Flanders and Czech Republic, while in Denmark they are conducted as part of PCBs screening. In The Netherlands, however, these practices are not enforced, and their success may be linked to the scarcity of natural aggregates. On the other end, Italy and Spain can be found as examples of low recycling rates. While Spain is one of the countries (especially some regions as the Basque Country) with strong regulations for compulsory pre-demolition audits, Italy has very little regulation around CDW. In some cases, as in Spain, these practices are hardly implemented. Several reasons have been found in literature and during interviews, including, but not limited to: lack of control and monitoring or lack of management infrastructures.

Preliminary waste audits or inventories

A pre-demolition audit or pre-demolition inventory assesses qualitative and quantitatively the waste that will be produced from a building to be demolished or refurbished. In a pre-demolition waste audit, in addition to the inventory, specific management options can be recommended for these waste materials, depending on different issues (such as legislation, economics or availability of treatment infrastructure). It is important that the term ‘audit’ be considered in the broad sense of the word, and include at least every initiative that results in a documented work.

In the case of hazardous waste (mainly asbestos and PCBs), most European countries follow similar practices and legally force their identification in the relevant demolition and refurbishment works. For example, asbestos content must be analysed in practice in all buildings built in Finland before 1994. An

exception to this general rule is Italy, which has not established by law the execution of this type of inventories including hazardous wastes.

However, for non-hazardous CDW, the type of works for which an audit or inventory is prepared vary greatly, due to the differences in national regulations in Europe.

Demolition contractors ordinarily perform their own waste inspection too, to set the price or to prepare more detailed demolition and waste management plan. It should be noted that this activity is not in the scope of this study because it does not guarantee the independency of the audit's results, and it rarely conforms to any regulation. These audits are based on the expertise and common practices of the contractor and his experience in similar buildings. Given that they constitute documentation for internal use, these audits cannot even be recorded in hard copies. Still, large contractors may have internal rules, templates, etc. for their audits and sometimes they make very detailed demolition and waste management plans (better than the official ones) based on this inspection. In Finland the contractors must have this information "on paper" by law for the future control inspection by authorities.

The regulations and guidelines concerning waste audits were identified in the Resource Efficient Use of Mixed Wastes study by Deloitte[9]. The following map shows the countries performing preliminary waste audits in Europe according to this study.

Figure 1 Countries performing waste audit in EU

[9] Resource Efficient Use of Mixed Wastes http://ec.europa.eu/environment/waste/studies/mixed_waste.htm

3.1.2. Legal and regulatory aspects

Summary

Legal and regulatory aspects have been examined mainly from previous experience of the consortium and challenged against information gathered from stakeholders. Reference regulations involved in the planning and execution of demolition and refurbishment activities include not only general regulation regarding generation and management of CDW and specific regulation on hazardous wastes (such as asbestos), but also regulations affecting safety and health issues, machinery, public procurement, accreditations, standardization, etc. Within the current legal framework throughout Europe, preliminary audits and/or inventories are generally developed together with (or as part as) the design and writing of the technical project of the corresponding works i.e. prior to the commissioning and starting of execution works.

By way of example, Spain has one of the most demanding regulations for these issues. Spain systematically requests an audit in all construction and demolition activities (including refurbishments), and sets the minimum content of this audit. In Finland and Czech Republic, it is also requested in most cases of construction and demolition (not in refurbishments), although the content is not as comprehensive as in Spain. In Belgium, in the region of Flanders, an inventory is required, but only in certain demolition cases. Other countries, such as Italy do not have a legal regulation in force requiring the elaboration of an inventory.

Most countries establish procedures for developing preliminary inventories, basically based on visual inspections complemented with either desk studies or computer applications. Although skilled specialists are required in most countries to perform this type of studies, there are no related accreditations or qualifications to support their expertise. Many times the inventories are produced again during the demolition/renovation when the waste is created and weighted on site. Ownership of materials and waste, as well as training requirements are in general considered to be insufficiently regulated in several countries. Waste audits can serve as contractual documents, especially if they are part of the demolition/renovation project.

Country based information

The following tables provide comprehensive information of the situation in each of the countries analysed.

Table 2 summarizes existing regulations or driving certifications for CDW management and preliminary waste audits. It is worth noticing that in the first column, CDW management regulations has been considered only when there are specific legislative acts related to the issue. Any specific mention to CDW management in more general regulations has been noted in the last column.

Even not being strictly regulations, standards have been shown to be also a tool used by some countries, mainly Austria, where national regulations prescribe the Austrian Standards to be followed.

Apart from this case, it is important to notice that there are also other general standards being the most important ones for C&DW audits the following:

- ISO 7518:1983: Technical drawings -- Construction drawings -- Simplified representation of demolition and rebuilding
- ISO 12006-2:2015: Building construction -- Organization of information about construction works -- Part 2: Framework for classification
- BS 6187:2011: Code of Practice for full and partial demolition
- ISO 16000-32:2014 Indoor air - Part 32: Investigation of buildings for the occurrence of pollutants. Even being addressed for Volatile Organic Compounds it can be used as a general base.

Many of the stakeholders consulted consider that waste audits represent a good opportunity to help preventing health and safety issues at work. Regarding these aspects once hazardous materials have been identified it is important to consider existing regulations, standards and guidelines. Usually most of the information can be found as guidelines from the national institutes for workers health and safety prevention. But there are also some standards being generated:

- ASTM E2625-09 “Standard Practice for Controlling Occupational Exposure to Respirable Crystalline Silica for Construction and Demolition Activities”
- OSHA 1926 standard “Safety and Health Regulations for Construction”

Table 2 CDW Management and preliminary audits regulations

Country	Specialized regulation on CDW Management	AUDITS			Documents referring to audits and other remarks
		Regulation	Standard	Guideline	
Austria	YES	YES	YES		Federal law[10] refers to ÖNORM B3151[11] for dismantling procedure and this last one to ÖNORM B2251[12]. Also ONR 192130[13] refers to "Investigation of pollutants in buildings before demolition". In Austria ISO 7518[14] "Technical drawings – Construction drawings – Simplified representation of demolition and rebuilding" is also used as a base reference.
Belgium	YES	YES (Specific regulation under development in Brussels Capital)		YES (Flanders)	Region Based. - Flanders: preliminary Audits are performed following instructions set in VLAREMA 2012[15]. Waste audit mandatory for specific buildings with 'minimal' requirements. OVAM[16] has published a guideline on how to perform waste audits. The waste audit should be present in a demand for a permit. - Brussels Capital: Order of the Government of the Brussels-Capital Region determining implementing rules of obligation sorting for producers or holders of waste other than household (2012)[17]. Asbestos inventory existence is controlled when assessing demolition permits. - Walloon Region: waste decree of 27 June 1996[18] and amendments. Does not specifically require waste audits.

[10] Federal Act on Sustainable Waste Management http://www.era-gmbh.at/fileadmin/img/downloads/Legal_framework/awg_2002_en.pdf
[11] Dismantling of buildings as a standard method for demolition https://shop.austrian-standards.at/action/en/public/details/532055/OENORM_B_3151_2014_12_01
[12] Demolition work – Works contract https://shop.austrian-standards.at/action/en/public/details/222115/OENORM_B_2251_2006_08_01
[13] Investigation of pollutants in buildings before demolition https://shop.austrian-standards.at/action/en/public/details/196838/ONR_192130_2006_05_01
[14] Technical drawings – Construction drawings – Simplified representation of demolition and rebuilding https://www.iso.org/standard/14287.html
[15] https://navigator.emis.vito.be/mijn-navigator?woId=43991
[16] Leidraad bij de opmaak van een sloopinventaris https://www.ibeve.be/documents/10810/11421/OVAM+Handleiding+voor+de+opmaak+van+een+sloopinventaris/83158482-778c-48c5-8896-bedeb4b06a78?version=1.1

Country	Specialized regulation on CDW Management	AUDITS			Documents referring to audits and other remarks
		Regulation	Standard	Guideline	
Czech Republic	NO	YES	NO	YES	Regulations discuss CDW, but there is no specific document dedicated to CDW Management - Act No. 183/2006[19] Coll., Building Code - Regulation No. 499/2006[20] Coll. on building documentation - Act No. 360/1992[21] Coll. on practice of profession of authorized architects and authorized engineers and technicians working in the field of building constructions - Guideline[22] published by the Ministry of Environment
Denmark	NO	YES	NO	YES	Statutory order No. 1309/2012[23] Act No. 698/1998, Environmental Protection Act[24]
France	NO	YES			Regulations include CDW, but there is no specific document dedicated to CDW Management Articles 46 of Law 2009-967[25] of 3 August 2009 (known as Grenelle 1 law) and 190 of Law 2010-788[26] of 12 July 2010 (known as Grenelle 2 law)

[17] 14 JUIN 2012. - Ordonnance relative aux déchets http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=fr&la=F&table_name=loi&cn=2012061402

[18] 27 juin 1996 - Décret relatif aux déchets http://environnement.wallonie.be/legis/dechets/degen019.htm

[19] Zákon o územním plánování a stavebním řádu (stavební zákon) https://www.zakonyprolidi.cz/cs/2006-183

[20] Vyhláška o dokumentaci staveb https://www.zakonyprolidi.cz/cs/2006-499

[21] Zákon České národní rady o výkonu povolání autorizovaných architektů a o výkonu povolání autorizovaných inženýrů a techniků činných ve výstavbě https://www.zakonyprolidi.cz/cs/1992-360

[22] Methodological Guidance of the Department of Waste for the management of production of construction and demolition waste and for its treatment (in Czech), Bulletin of the Ministry of Environment of the Czech Republic, No. 3, Vol. XVIII, pp. 4-14, March 2008 http://www.mzp.cz/web/edice.nsf/E99EABE7D8D9B7CBC12574120029E852/$file/72769394.pdf

[23] Bekendtgørelse om kortlægning af ekstern støj og udarbejdelse af støjhandlingsplaner https://www.retsinformation.dk/forms/R0710.aspx?id=139549

[24] Consolidated Environmental Protection Act http://www.lexadin.nl/wlg/legis/nofr/eur/arch/den/epa.doc

[25] LOI n° 2009-967 du 3 août 2009 de programmation relative à la mise en œuvre du Grenelle de l'environnement https://www.legifrance.gouv.fr/eli/loi/2009/8/3/DEVX0811607L/jo/texte

[26] LOI n° 2010-788 du 12 juillet 2010 portant engagement national pour l'environnement https://www.legifrance.gouv.fr/eli/loi/2010/7/12/DEVX0822225L/jo/texte

Country	Specialized regulation on CDW Management	AUDITS			Documents referring to audits and other remarks
		Regulation	Standard	Guideline	
Finland	YES	YES[27]	NO	YES	Regulations discuss CDW, but there is no specific document dedicated to CDW Management - Government Decree on Waste (179/2012)[28] - Act on Certain Requirements Concerning Asbestos Disposal Work (648/2015)[29] - Government Decision[30] on Construction Waste - Guidelines and templates are published by professional associations and municipalities
Italy	NO	NO	NO	NO	Regulations include CDW, but there is no specific document dedicated to CDW Management. d.lgs. 152/2006[31] is the reference for waste management.
Poland	NO	NO	NO	NO	Regulations include CDW, but there is no specific document dedicated to CDW Management. The main legal references for waste management are the Act on Waste[32] and National waste management plan[33]
Portugal	YES	YES	NO	NO	The Decree-Law 46/2008[34] establishes the need to produce a Prevention and Management Plan that has to estimate Waste to be produced, waste to be valorised and waste to be removed identifying it according to LER codes.
Romania	NO	NO	NO	NO	Regulations include CDW[35], but there is no specific document dedicated to CDW Management

[27] http://www.finlex.fi/en/laki/kaannokset/2011/en20110646.pdf
[28] http://www.finlex.fi/en/laki/kaannokset/2012/en20120179
[29] Act No. 648/2015 on certain requirements concerning asbestos removal work (in Finnish), Finnish Ministry of Social Affairs and Health http://www.finlex.fi/fi/laki/alkup/2015/20150684
[30] Finnish Government Decision No. 295/1997 on construction and demolition waste (in Finnish) http://www.finlex.fi/fi/laki/alkup/1997/19970295
[31] Decreto Legislativo 3 aprile 2006, n. 152 "Norme in materia ambientale" http://www.camera.it/parlam/leggi/deleghe/06152dl.htm
[32] Act on Waste of 14 December 2012 http://isap.sejm.gov.pl/DetailsServlet?id=WDU20130000021
[33] Resolution no 217 of the Council of Ministers of 24 December 2010 on the "National Waste Management Plan 2014
[34] Decreto-lei 46/2008, de 12 de Março http://www.ccdrc.pt/index.php?option=com_docman&view=download&id=2087&Itemid=739
[35] Emergency Government Ordinance no. 78/2000 on the regime of waste, approved with amendments and completions by Law no. 426/2001. http://www.scutulnegruspam.ro/files/Legea-426-2001.pdf

Country	Specialized regulation on CDW Management	AUDITS			Documents referring to audits and other remarks
		Regulation	Standard	Guideline	
Spain	YES	YES	NO	NO	Royal Decree 105/2008[36] establishes the need to perform preliminary audits. Regions are responsible for the implementation, developing the regulations to ascertain an effective implementation and monitoring, as well as sanctions. For example the Basque Country has done it with the Decree 112/2012[37] The National Framework for Waste Management[38], section 13, reinforces the strategies for achieving the European objectives (70% (by weight) of non-hazardous C&DW recycled for year 2020)
Sweden	NO	YES[39]	NO	YES[40]	Regulations include CDW, but there is no specific document dedicated to CDW Management - Building Code [SFS 2010:900][41] - Swedish Ordinance on PCB [SFS 2007:19][42]
United Kingdom	YES			YES	As part of building certificates (specially BREEAM)[43]

The Swedish Construction Federation publishes guidelines (which are continuously updated) for waste management during demolition (e.g. guidance for procurement of pre-demolition audit), the Ministry of Environment of Czech Republic published detailed guidelines for CDW management and waste audits, and many similar documents also exist in other countries.

[36] Real Decreto 105/2008, de 1 de febrero, por el que se regula la producción y gestión de los residuos de construcción y demolición https://www.boe.es/diario_boe/txt.php?id=BOE-A-2008-2486

[37] The development of these regulations and actual application is very different between regions. The Basque Country has been used as an example of best practices as is the region with higher development and real implementation. Even considering the clear regulation some Spanish regions show a very low recycling rate. For instance in Andalucía, 49% of C&DW are incorrectly managed, many times in an illegal way. Also the drop of the C&DW production has caused that some treatment plants are not receiving enough amounts to guarantee their economic feasibility.

[38] Plan Estatal Marco de Gestión de Residuos (PEMAR) 2016-2022 http://www.mapama.gob.es/es/calidad-y-evaluacion-ambiental/planes-y-estrategias/pemaraprobado6noviembrecondae_tcm7-401704.pdf

[39] Ds 2000:61, The Environmental Code http://www.government.se/contentassets/be5e4d4ebdb4499f8d6365720ae68724/the-swedish-environmental-code-ds-200061

[40] http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Avfall/Bygg--och-rivningsavfall/

[41] Plan- och bygglag (2010:900) https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/plan--och-bygglag-2010900_sfs-2010-900

[42] Förordning (2007:19) om PCB http://www.notisum.se/rnp/sls/lag/20070019.htm

[43] http://www.breeam.com/

The following table summarizes the implementation of preliminary audits in each of the studied countries, including limitations to implement the audits (when are they required) and stakeholder's opinion on real use of audits.

Table 3 Waste audits

Country	Audit			Real use	Limitations
	Mandatory	Regulated in regions	Voluntary		
Austria	YES			One of the most advanced countries on CDW management. A national wide guideline exists for more than 20 years and a detailed waste management plan which covers CDW is published and updated on a regular basis	Waste > 750t External Auditors for Building >3500m3
Belgium	YES Inventory in Flanders) NO (Brussels and Walloon region only asbestos inventory)	YES	YES	Preliminary audit not mandatory except in Flanders REAL USE (Flanders): Rarely performed, probably due to lack of surveillance from authorities and little awareness of the owners	Preliminary audit not mandatory. Flanders: Inventory mandatory for (partially) non-residential buildings with an enclosed construction volume over 1000m^3. Walloon Region: Working on regulation to plan the on-site management of waste and to perform an inventory of wastes
Czech Republic	YES				Exceptions are listed in the Regulation 499/2006 Coll. on building documentation
Denmark	YES				Only for building containing PCBs (built or renovated during 1950 – 1977 larger than 10 m2 or if the amount of waste generated is greater than more than 1 tonne of waste)
France	YES			Rarely apply, probably due to lack of surveillance from authorities and little awareness of the owners.	Audits are mandatory above a total surface of 1000m^2 In general CDW management is not planned before starting the project.

Country	Audit			Real use	Limitations
	Mandatory	Regulated in regions	Voluntary		
Finland	YES	YES			- Exceptions are listed. - Municipalities can have their own templates and requirements
Italy	NO	NO	YES	Not performed. Only some voluntary pre-demolition audits in some regions (as Veneto) have been found.	
Poland	NO	NO	NO		
Portugal	YES	NO	NO	Seldom performed	Decree-Law 46/2008 specifies a very simple inventory to be performed
Romania	YES				Part of the demolition documentation
Spain	YES	YES		Very rarely conducted and when conducted, lacking in sufficient quality, just a very simple assessment with no use for the objectives of the regulation. Main reasons according to stakeholders: lack of surveillance, and no need to submit the documents generated to the authorities except for the documents showing that waste has been managed.	Streams to be separated when present above: - Concrete (80t) - Bricks, ceramics (40t) - Metal (2t) - Wood (1t) - Glass (1t) - Plastic (0,5t) - Paper and cardboard (0,5t) Regions responsible for implementation and surveillance. They can change these values to lower ones.
Sweden	YES				Focused on Hazardous Wastes.
United Kingdom	NO	NO	YES		As part of building certificates (specially BREEAM)

CDW preliminary audits are performed to a great extent internally by contractors. These audits are private acts for their own use, mainly to set the price, and know what they are facing. These documents are not part of any contract, permit or official document, and therefore there is no control over them.

In many countries where audits are mandatory as France, Spain or Portugal the real implementation is very low. According to the stakeholders asked, the main reasons for this may be as follows:

- Lack of surveillance and monitoring from authorities.

- Not sufficient awareness of the owners (responsible to perform the preliminary audit set in regulations)
- Even in the cases where audits are mandatory, the contractor still prefers to perform its own internal audit. It is claimed that this is most often due to lack of quality control and no supervision by the authorities.

Next table summarizes available information on each country for audits, auditors and monitoring or audits. The information to fulfil this table comes from the regulations and guidelines summarized in table 2. It specifically includes:

- If audits are included in permits and/or in contracts. In cases where no information is available from regulations or guidelines it has been left blank.
- If auditors need to be independent, certified or if there is no requirement
- Skills of auditors according to schemes defining the audits
- If data from audit is checked with real data, and if justifications are required for differences

Table 4 Requirements for auditors and monitoring of audits

Country	Inclusion in Permit	Inclusion in Contract	Auditor							Monitoring		
			Independent	Certified	Not Determined	Skills				Checked with Real data	Justifications for differences	Other
						Architect	Civil Engineer	Chemist / material expert	Other (specify)			
Austria	YES	YES			YES				Expert or institution	NO	NO	
Belgium (Flanders)	YES	NO			YES	YES			Expert	NO	NO	Y
Belgium (Brussels C)	YES	YES			YES				Skilled specialist	Y	NO	
Belgium (Walloon R)	YES	YES			YES				Skilled specialist	NO	NO	
Czech Republic	YES	YES [44]	sometimes	YES [45]		YES [11]	YES [11]	sometimes [46]	sometimes structural engineer [12]	NO	NO	
Denmark										NO	NO	
France	--	--	Y						Skilled expert with professional insurance	YES	NO	
Finland	YES [47]	sometimes	sometimes	NO		n/a	n/a	n/a	n/a	NO	NO	
Italy	--	--	--	--	--	--	--	--	---	--	--	--

[44] Usual practice or Act 134/2016 on Public Procurement https://www.portal-vz.cz/getmedia/ac061a0a-d8c1-4ff1-b8d2-691aa89269b1/Zakon-c-134_2016-Sb-o-zadavani-verejnych-zakazek.pdf

[45] Through the Chamber of Architects or Chamber of Engineers and Technicians in Building Sector

[46] Methodological guidance including waste audits http://www.arsm.cz/dok/MN2008.pdf

[47] Act 132, Land Use and Building Act http://www.finlex.fi/en/laki/kaannokset/1999/en19990132.pdf

Country	Inclusion in Permit	Inclusion in Contract	Auditor							Monitoring		
			Independent	Certified	Not Determined	Skills				Checked with Real data	Justifications for differences	Other
						Architect	Civil Engineer	Chemist / material expert	Other (specify)			
Poland	--	--	--	--	--	--	--	--	--	--	--	--
Portugal	N	N			YES					NO	NO	
Romania	NO	Sometimes	NO	NO		n/a	n/a	n/a	n/a	NO	NO	
Spain	YES	YES				YES			Quantity Surveyor	NO	NO	
Spain (Basque Country)	YES	YES				Yes			Quantity Surveyor	YES	YES	
Sweden										NO	NO	
United Kingdom	N	N	YES						knowledge of buildings, waste and options for reusing and recycling	NO	NO	

Architects and designers have the knowledge of the building typologies, standardized details and compositions of multilateral elements (e.g. panel houses in Eastern Europe are highly standardized) and can perform the assessment efficiently. For instance, in Czech Republic only architects and civil engineers are authorized to provide technical documentation containing the waste audit. But it is important to note that these professionals usually do not have the knowledge on hazardous materials, demolition practices,… which are also important to perform a sound waste audit.

In France, the Regulation establishes that the client has to send the audit report to the contractor. In Portugal the management plan has to be accessible to authorities at the construction site.

In those countries, where the waste management documentation is not collected systematically by the authorities, it has to be stored for a limited number of years, to be submitted to the authorities upon request.

In Belgium, monitoring can be performed based on documentation received. In Flanders the holder of the permit is responsible to ascertain the compliance and take corrective actions, but this is rarely performed.

Even in countries where monitoring is considered, such as France, or some regions in Spain (Basque Country) this is still rarely performed.

In order to improve the ratio of audits performed and the correct management of CDW, the Basque Country (in Spain) requests the owner to deposit the amount of money needed to perform waste management according to the budget. This deposit is paid back when the monitoring against real data has been performed and necessary justifications provided. Public contractors or owners contracting certified companies do not need to deposit this fee.
Additional good practice was identified for instance in the Bulgarian legislation. The Article 11 of Bulgarian Waste Act 53/2012 declares that the final report prepared by the person exercising construction supervision (according to Bulgarian Spatial Development Act) "shall state the attainment of the recovery and recycling targets for construction and demolition waste". The targets formulated in Article 32 of the Waste Act are adapted from the WFD, which means that each contract has to prove 70% recovery.

Next table summarizes ownership of materials and waste, as well as the usual way to define contractors responsibility for each of the studied country. The information to fulfil this table comes from the regulations and guidelines summarized in table 2.

Table 5 Role of actors and cooperation between actors

Country	Ownership				Definition of contractors responsibilities		
	Material	Waste					
	Owner	Owner	Defined by contract	Other (specify)	Law	Contract	Other (specify)
Austria	YES	YES		Defined as client			
Belgium (Flanders)	YES	YES			YES		
Belgium (Brussels C)	YES	YES				YES	
Belgium (Walloon R)	YES	YES				YES	
Czech Republic[48]	YES			Legal entity producing waste	YES		
Denmark[49]	YES		YES				
France	YES	YES				YES	
Finland[50]	YES		YES		YES		
Italy	YES	YES				YES	
Poland	YES	YES				YES	
Portugal	YES			Waste producer		YES	
Romania[51]	YES	YES				YES	

[48] Act No. 185/2001 Coll., on Waste http://www.mzp.cz/ris/vis-legcz-en.nsf/0/2FE1CCCFB48F540EC125772D003BE2E6/$file/2001_185_ENrev.pdf
[49] Denmark: Act No. 698/1998, Environmental Protection Act http://faolex.fao.org/docs/texts/den39758E.doc Building and construction works take place on the responsibility of the builder. No additional definition of "waste owner"
[50] Act No. 646/2011, Waste Act http://www.finlex.fi/en/laki/kaannokset/2011/en20110646.pdf

Country	Ownership				Definition of contractors responsibilities		
	Material	Waste					
	Owner	Owner	Defined by contract	Other (specify)	Law	Contract	Other (specify)
Spain	YES			Waste producer	YES		
Sweden[52]	YES		YES				
United Kingdom	YES	YES				YES	

For example, in Romania contracts usually contain 15% margin for unforeseen work (e.g. hazardous materials not identified in the demolition plan)

While ownership of materials is clearly defined in the legislation, the ownership of CDW can result confusing. Explicitly consulting building owners and construction and demolition contractors, it has been found that there is an important lack of knowledge of their responsibilities between building owners. Construction and demolition contractors have a better understanding of their responsibilities, but still there is a lot of uncertainty with the transfer of responsibilities. It seems that it could be a good practice to clarify these definitions and explicitly refer them to CDW.

The following table summarizes authorities responsible in construction sector. In general these responsibilities are common to all processes, including preliminary demolition related activities (further development of legislation to implement preliminary audits, and monitoring of the outcomes).

Table 6 Responsibility of Authorities (Based on Pedro, J.B and cols "Comparison of tasks and responsibilities in the building control systems of European Union countries, RICS COBRA" Research Conference, University of Cape Town, 10-11th September 2009

Country	Authorities setting regulations and rules of their enforcement			Authorities responsible for checking, planning demands for permits		
	National	Regional	Local	National	Regional	Local
Austria	YES	YES				YES
Belgium	YES	YES	YES		YES	YES
Czech Republic	YES					YES
Denmark	YES					YES
France	YES			YES		YES
Finland	YES					YES
Italy	YES	YES	YES			YES
Poland	YES		YES		YES	
Portugal	YES					YES

[51] Emergency Government Ordinance no. 78/2000 on the regime of waste, approved with amendments and completions by Law no. 426/2001. http://www.scutulnegruspam.ro/files/Legea-426-2001.pdf

[52] Act No. 646/2011, Waste Act http://www.finlex.fi/en/laki/kaannokset/2011/en20110646.pdf provides definitions for waste producer and waste holder and indicates the obligation of a shipping document on hazardous waste, sludge in cesspools and septic tanks, sludge in sand and grease interceptors, contaminated soil and construction and demolition waste other than uncontaminated soil and Ds 2000:61, The Environmental Code http://www.government.se/contentassets/be5e4d4ebdb4499f8d6365720ae68724/the-swedish-environmental-code-ds-200061.

Country	Authorities setting regulations and rules of their enforcement			Authorities responsible for checking, planning demands for permits		
	National	Regional	Local	National	Regional	Local
Romania	YES					YES
Spain	YES	YES			YES	YES
Sweden	YES					YES
United Kingdom	YES					YES

General remarks

- Within current legal framework throughout Europe, the pre-demolition assessments (if they exist) are generally developed together with (or as part of) the technical documentation of the corresponding demolition/renovation works.
- Due to differences in national regulations throughout Europe, the types of works for which an audit or inventory is prepared and the level of detail are varying. This depends on several factors as the volume of waste to be generated, building size, building type, age of the building, contract type or expected hazardous waste.
- Audits or inspections may be performed multiple times in some countries. One is usually organized by the owner in order to obtain the demolition permit and the following one may be performed by the contractor immediately before the demolition for instance to set the price. These assessments are rarely regulated and generally based on their internal rules and experience. The level of regulation of those audits is different in each country. For instance the so-called “Study of CDW management” in Spain is further developed in the “plan of CDW management” by the contractor that will execute the works once commissioned.
- Waste audits can serve as contractual documents, especially if they are part of the demolition/renovation project. For example the “second” audit in Spain can be considered contractual, as it is part of the contract between the owner and the demolition company.
- In some countries, waste audits for infrastructures follow the same regulations as for buildings (Czech Republic), but the recommended methodology (e.g. material sampling) may differ.
- Audits for refurbishment activities are a voluntary condition in some countries. However, if refurbishment works require a technical project and/or it involves demolition of building structures, it may be required to include a waste audit (Spain, Czech Republic).
- In the case of asbestos and other hazardous wastes, most European countries follow similar practices and legally force the drawing up of an asbestos inventory, including demolition and refurbishment works. (Italy represents an exception to this requirement).
- According to the interviews held, even asbestos inventories are not always available.

In general it has been observed that there is a need for harmonization:

- It is important to set a common language, as well a similar waste assessment methodology. Using the same words with the same meaning: “predemolition waste assessment”, “waste owner”, “waste manager”, “waste auditor”
- Same measurements and metrics. Every country or every region can create his own benchmark and objectives but they should be based on the same methodology of how to calculate and how do the measurements.

- Auditors. A minimum set of requirements should be promoted: educative background and specific training, independence, hazardous materials, etc. adapted to each region's particular constructive typologies.
- Traceability. Strict surveillance at predemolition, during demolition and after final management of (at least) the main fractions including hazardous waste (asbestos).
- It has been observed that mere recommendations are not enough. Several countries will only implement procedures when it is mandatory or financially stimulated. The first option seems to be impossible at this moment. For the second, regional authorities should check TRACIMAT as an example of good practices.

3.1.3. Market issues

Summary

Market issues are usually based on statistics provided by authorities from different regions/countries. There is a need for improvement in the collection and generation of data and statistics for monitoring of CDW recycling and recovering targets that would lead to better policies and practices, and a comparison between Member States. This includes the need for tracking and tracing of all CDW generated. In some member states, the data refer to just treated waste, leaving out generated[53] waste, which means that not all waste streams are included in the statistics. The Commission has established that "an existing measurement method to assess what is actually recycled should be clarified. The Proposal for a new Waste Directive (WFD- proposal for a new WFD, COM/2015/0595 final - 2015/0275 (COD)), establishes the formula to be used by the MS to calculate the rate of recycling and preparation for re-use. CDW reporting should be improved by this measure in the future. However, there is enough information already to establish the market in each of the regions/countries and proceed with the second analysis during task 2.

Country based information

Differences in the reporting of data between Member States and the different methodologies used represent an important uncertainty to stablish a sound baseline for any market study. The commission is aware of these difficulties and the new Waste Framework Directive, COM/2015/0595 final-2015/0275 (COD) establishes the formula to be used by the MS to calculate the rate of recycling and preparation for re-use.

The main sources of the information used are:

- Eurostat data (last data available: 2012).
- United Nations data (Department of Economic and Social Affairs)
- "Resource Efficient Use of Mixed Waste" study. (Deloitte, 2016).
- "Management of Construction and Demolition Waste" – SR1. Bio Intelligence Service. European Commission (DG ENV, 2011)

[53] EC, Towards a circular economy: A zero waste program for Europe., 2014

The Consultations held have not provided sound data for this section. Most stakeholders and mainly authorities refer to official data.

Differences in the data reported from countries vary significantly according to the sources or studies. According to the report about "Management of Construction and Demolition Waste" by Bio Intelligence Service commissioned by the EC (2011), there are important differences between Member States. Generation per capita ranges from 0.04 tonnes per capita (Latvia) to 5.9 tonnes per capita (Luxembourg). The latest data available from Eurostat show that this tendency remains the same as can be seen in the following Figure. The main trends and countries with very high and very low production of CDW remain unaltered. Comparing CDW and GDP per capita it seems that in general the tendency is that the higher the GDP the more CDW is generated. The graph also shows that main discrepancies occur in smaller countries.

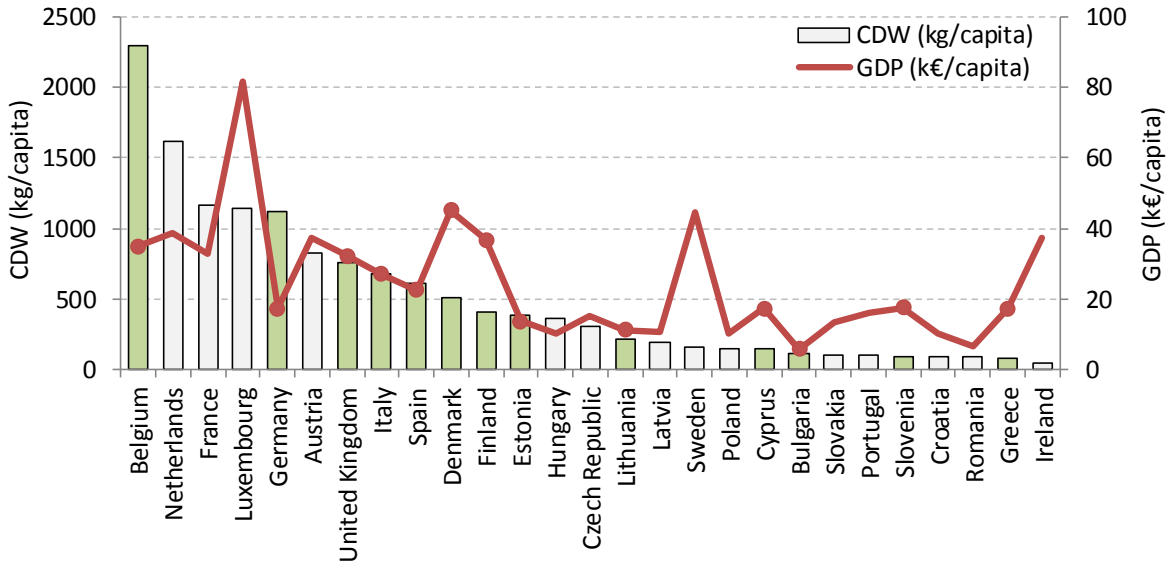


Figure 2 Relation of GDP to the generated CDW in 2012

Regarding CDW recovered important differences also arise. The following table compares the information provided by:

- Eurostat: Data for total waste
- Deloitte: Data from 2012
- Bio study: Data from 2005 to 2010

Comparing the three cases, it is clear that there are significant differences. The table shows the performance in recovery rates compared with WFD target objective (70%) for the three aforementioned studies. The table is divided also into 3 main parts.

- Countries with a mandatory preliminary audit
- Countries with voluntary or regional preliminary audits
- Countries not performing preliminary audits.

Table 7 Performance in recovery rates

Country		Performance in recovery rates compared to WFD target (70%)			
		Eurostat	Deloitte	Bio Int.	Other remarks
Mandatory audit	**Austria**				
	Czech Republic				Deloitte data does not include backfilling.
	France				
	Finland				The statistics for Finland classified excavated soil as mineral CDW, resulting in the high CDW generation and low recovery rates in 2012. The results are therefore not comparable to the other countries.
	Portugal				
	Romania				
	Spain				It is important to consider that Deloitte presents an extremely high backfilling percentage (>40%).
	Sweden				Sweden reported only part of the recovered CDW in 2012 because not all the treatment facilities were monitored. The quality of the data is therefore poor.
Voluntary / regional audit	**Belgium**				Deloitte data taken from those reported to the EC for the WFD.
	Denmark				
	United Kingdom				
No Audit	**Italy**				Surprisingly high values for what is being considered in the country the real situation.
	Poland				Stakeholders consulted consider Eurostat data as being overestimated.
	Outstanding >70%		Very good. 60%-70%		Good. 40%-60%		Poor <40%

According to the experts interviewed during the course of this study and HISER project, the main reasons for these discrepancies are the **unequal levels of control and reporting of CDW between Member States**, as well as **differences in definitions and reporting mechanisms**. Uncertainty about the inclusion of naturally occurring soil and stones, generated during construction activities (mostly in public works activities) in national CDW statistics was a major source of uncertainty in data on C&D waste in Bio Intelligence study.

The European Commission is aware of this divergence between data and has established that "the existing measurement method to assess what is actually recycled should be clarified. Some Member States currently report waste collected as waste recycled despite the significant material loss between these phases" (EC Towards a circular economy. A zero waste programme for Europe., 2014). Therefore, the proposal for a new Waste Directive (WDF-proposal for a new WDF, COM/2015/0595 final – 2015/0275(COD)), establishes the formula to be used by the MS to calculate the rate of recycling and preparation for re-use. CDW reporting should be improved by this measure in the future.

3.1.4. Technical and methodological aspects

Summary

Technical and methodological aspects have been relatively easy to find. There is plenty of information on all these aspects. However, it must be pointed out, that even though preliminary audits are mandatory in some countries, they are seldom available. According to HISER project, as a rough estimate, in Flanders a pre-demolition audit is present in only ca. 5% of the cases. However, in all countries, most of demolition contractors make their own pre-demolition audit or have it done by a professional for their internal use and to calculate the price of the works to be performed. According to EDA's Industry Report 2015, 63% of waste assessment is done by the demolition contractor, as opposed to a 5% where no one does it. Several interviews claim that audits do not provide enough detail. Sometimes doubts arise regarding the training of the people performing the audits and in some cases on the reliability of the audits. Regarding dangerous substances, the main focus is on asbestos. However, the legislation concerning PCBs and other hazardous wastes has been recently implemented in several countries. These aspects are by far the ones with higher consideration and control, but still there is the opinion in the sector that asbestos inventories should be more professional, regardless the estimated amount.

Country based information

The following table provides comprehensive information of the minimum content of the audit as required by regulation or voluntary schemes in each of the countries analysed.

Table 8 CDW Minimum content required by regulations or voluntary schemes used in each country.

Country	Reference (Regulation/ Standard/Guideline)	Waste Streams			Audit content (Mandatory / Recommended / Not Defined)										
		Hazardous	Non-Hazardous	Recyclable	Contamination and pollutants	Waste identification	Estimation of amounts	Location in building	Identification of reusable elements	Space allocation for on-site sorting	Waste Management	Identification of Waste processing facilities	Monitoring	Estimation of costs and materials value	Budget of CDW management
Austria	S	Y	Y	--	M	M	M	-	-	-	-	-	-	-	-
Belgium (Flanders)	G	Y	Y	Y	R	M	M	M	-	R	R	-	-	-	-
Belgium (Brussels C)	R	Y	Y	Y	R	R	R	R	-	R	R	-	-	-	-
Belgium (Walloon R)	R	Y	Y	Y	R	R	R	-	R	-	R	R	-	-	-
Czech Republic	R	Y	Y	Y	M	M	M	-	-	-	M	-	-	-	-
Denmark	R	Y	Y	--	-	M	M	-	-	-	M	-	-	-	-

Country	Reference (Regulation/ Standard/Guideline)	Waste Streams			Audit content (Mandatory / Recommended / Not Defined)										
		Hazardous	Non-Hazardous	Recyclable	Contamination and pollutants	Waste identification	Estimation of amounts	Location in building	Identification of reusable elements	Space allocation for on-site sorting	Waste Management	Identification of Waste processing facilities	Monitoring	Estimation of costs and materials value	Budget of CDW management
France	R	Y	Y	Y	M	M	M	-	M	-	-	-	-	-	-
Finland	R	Y	Y	--	M	M	M	-	-	-	R	-	-	-	-
Italy	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Portugal	R	Y	Y	Y	-	M	M	-	-	-	-	-	-	-	-
Romania	R														
Spain	R	Y	Y	--	-	M	M	-	R	M	M	-	-	M	M
Spain (Basque Country)	R	Y	Y	Y	-	M	M	R	M	M	M	M	M	M	M
Sweden	R	Y	--	--	-	-	-	-	-	-	M	-	-	-	-
United Kingdom	G	Y	Y	Y	-	M	M	-	R	-	M	M	M	-	-

General remarks for audit content.

- The testing and sampling requirements are mostly not defined in the legislation, however, methods to identify hazardous materials and contamination are usually recommended in guidelines (e.g. Czech Republic). The recommended sampling can be also different in infrastructures such as roads.
- It should be noted that the number of materials separated due to their dangerous nature is growing and the methods for the identification of contamination are better which can result in a slight decrease of recyclable materials, but in a better quality of the materials that are recycled.

Finally next table summarizes other important aspects concerning technical and methodological aspects of audits.

*Table 9Other requirements and normal practices in audits performed.(**N**ormal **P**ractice; **S**ometimes; **R**arely)*

Country	Do audits represent an important time constraint	Qualitative and quantitative methodology for assessment									
		Visual inspection of buildings	Comprehensive surveys	Sampling	Methodologies						
					Visual inspection of samples (if taken)	Chemical analysis	Mechanical testing	On-site inspections	Historical records / project documentation	Computer models or IT solutions	Other specify
Austria	NO	N	N	S	N	S	R	N	N	N	
Belgium	NO	N	N	S	N	S	R	N	N	N	
Czech Republic	NO	N		R	N	R	R	N	N	R	
Denmark					N						
France	NO	N	S	R	N	R	R	N	S	R	
Finland					N						
Italy	--	--	--	--	--	--	--	--	--	--	--
Poland	--	--	--	--	--	--	--	--	--	--	--
Portugal	NO	N	S	R	N	R	R	S	R	R	
Romania					N						
Spain	NO	N	S	R	N	R	R	S	S	S	
Sweden					N						
United Kingdom	NO	N	N	S	N	S	R	N	N	S	

Most countries allow visual inspections complemented with either desk studies or computer applications. There are a few different guidelines and supporting tools throughout Europe for the preparation of these audits; by way of example:

- A computer application in the Basque Country, supporting the estimation of wastes coming from works by applying some ratios that depend on the type of activity, type of building, size, etc. The demolition contractors interviewed claim that it tends to overestimate quantities and cannot forecast any peculiarity of the building)
- Online waste reporting and tracing system in Czech Republic is maintained by the Ministry of Environment.
- Methodological guidance on CDW management in Czech Republic.
- A “Demolition Protocol” was issued by civil engineers association in UK. BREE has also information procedures.
- In Belgium several Guidelines and tools are available: MEDECO (MEtré des DEchets de Construction); Guidance document for drawing up a demolition inventory (Flemish Region); Reuse of building materials-Practical guide (Walloon Region); …

Hazardous waste

- Inventories of hazardous substances (especially asbestos) indicate the presence of asbestos, but not always its location and amount. Also, there is an added obstacle in the hidden dangerous substances that usually lead to extra costs and in some cases to stop the works.
- Some industries consider that asbestos inventories should be more professional while others request less paper burden and a quicker answer from the public administration issuing the permit regarding the disposal of asbestos.
- The minimum content of these assessments generally include, identification (usually according to the classification based European List of Waste or European Waste Catalogue) and quantification (in weight and volume). This minimum content can be complemented with other aspects such as:
    - Indications about the planned management.
    - Information about the location in the building of the waste materials (for example in Flanders)
    - Description of the way in which the waste materials will be separated (Spain, France, Czech Republic), collected, stored and/or transported
    - A separate budget chapter associated to waste management (for example in Spain and France)
- Procedures for developing these inventories in most countries are stated in regulations, including the way to be performed and by whom. (for example Finland is an exception, as the laws are very general and just describe main principles and general obligations)

3.1.5. Economic dimension

General summary

In general it is relatively difficult to estimate the cost of the audit process itself, but it is considered to be below 5% of the whole demolition and treatment process activities. The influence of preliminary audits on the economy cannot be directly assessed, and several doubts have been raised about its economic benefits (especially when the contractor performs additional inspection after the official audit made by the owner or engineering company). Generally, the contractor has only limited possibilities to get economic benefits from the audits that were performed by someone else before the tender for demolition/renovation works. Existing data, and data provided during the interviews refer to the general process of material segregation. The general point of view is that selective demolition implies higher labour cost, as the separation of different fractions takes longer. Still, it is also considered that sorted materials provide a higher quality and better price. These factors show that segregation on site is in most cases economy driven, especially if there is a market demand on the recycled products (as in Belgium) or if lower fees are applied. Limited time for the works or limited space for segregation at the worksite hampers selective demolition. Preliminary audits, if performed considering also all these aspects are seen as an important tool to overcome these limitations.

On the one hand due to the low implementation of audits in general (except for those performed internally by the contractor) it is very difficult to get sound information on economic aspects related to audits and real costs. Even countries performing audits present important differences in the price set in

the audit for CDW management, mainly depending on who is performing the audit and on the scope of the audit. On the other hand several economic dimension aspects have been identified as part of the "needs for audits" and therefore will be further analysed during task 2.

Other remarks

- According to the consultation, waste audits are rarely available or detailed enough.
- Most industrial stakeholders consider that economic aspects should be carefully considered. In some countries (for example due to landfilling low taxes or cheap raw materials), the preliminary audits and onsite sorting does not pay off. Therefore the claim is to consider the whole CDW management process when considering drivers and barriers.
- Another reason for the low degree of audits implementation is that the mandatory waste identification and quantification duty can be imposed on the demolition companies and that is done during the waste production (as in Czech Republic). In such cases the importance of pre-demolition assessment by the owner or engineering office is lower.
- According to EDA's Industry Report 2015, waste assessment is done by the demolition contractor 63% of the times, while in 5% of the times, no one does it.
- It is a common claim that the cost of performing pre-demolition/renovation audits should be considered in the projects.
- There is an important concern on the higher costs associated in many occasions with errors during the preliminary audit, and special budget considerations to mitigate these effects are considered important, and in many countries a % or the budget is estimated for these errors.

3.1.6. Human and cultural aspects

General summary

The information regarding **Human and cultural aspects** has mainly been obtained from the questionnaires answered, and websites from Public bodies and associations have been a secondary source. In general, these aspects have been the most difficult ones to assess. In each country and region, there are different information and awareness raising activities organized by public administration or by associations, generally devoted to professionals. Some stakeholders consulted consider that public awareness should also be enhanced, mainly in countries with lower recycling rates. Many stakeholders considered that there is an important lack of information regarding preliminary audits, benefits, best practices, etc. An important concern was raised about the contractors and owners being almost completely unaware about the possibilities to reduce the waste production by re-selling the salvaged building parts. To some extent, this also applies to the different recycling options. During these interviews, it also came up that there is very little information exchange between the companies. Training of actors along the supply process is considered to be poor in some countries, but very little information regarding these aspects has been collected.

Other remarks

- Some stakeholders (e.g. authorities) consider that pre-demolition waste audits should be compulsory in demolition/refurbishment works. However, several industries and associations expressed concern about the additional costs and paperwork.

- It is a common claim that audits do not provide enough detail and are prepared by non-experts or non-independent professionals. This can lead in some cases to direct economic implications as for instance in the Basque Country (Spain) where the budget in these audits is used to establish a bail for issuing some work-permits
- CDW inventories and audits are generally requested to be performed by skilled specialists in most countries. In general, there are no related training activities or accreditations to become a skilled specialist, except for hazardous wastes such as asbestos (Czech Republic). In some cases, if the audit is part of the technical project (Spain, Czech Republic), only an authorized professional (usually an architect) is allowed to prepare the assessment. During the interviews, it has arisen that in spite of their general technical knowledge, this professional lacks specific training on demolition activities and processes, which often lowers the quality of the audit.
- In general there is an important lack of knowledge, especially between owners of their obligations.
- The contractors in general do not trust the results of audits performed by the owner or engineering company for the purpose of demolition/renovation permit and would rather prefer their own waste assessment. In order to avoid this lack of confidence the following measures have been proposed by several stakeholders:
    - Training programs and accreditation schemes should be available for skilled specialists.
    - Auditors should be independent.
    - Law enforcement and monitoring measures should be further enhanced
    - Quality assessment of preliminary audits, and clear responsibilities should be set.
    - More homogeneous reporting of data is deemed important not only in the preliminary audit and offer stage, but also on the general CDW management process.

3.2. Task 2: Needs for pre-demolition and/or renovation CDW assessment audits (Waste audits)

Scope of the work

The consortium analysed, identified and listed the needs for pre-demolition/renovation assessment tools with regard to the generated CDW streams in this Task. Pre-demolition or refurbishment audits have been used for many years to support planning of the demolition or renovation work and are starting to grow in importance due to different requirements and client's increasing commitment to sustainability.

The waste audits of buildings before demolition and major refurbishment form a specific task within pre-demolition or renovation assessment. They are needed to understand the types and amounts of discarded objects and substances that will be produced and to issue recommendations on how these materials can be managed. An assessment of the viable recovery routes for materials is sometimes given (including reuse and the potential reuse value, recycling on- and off-site and the associated cost savings and energy recovery). Waste audits should also consider any relevant legislation such as the requirements for environmental permits if waste is to be used on-site or any waste that may be hazardous and such needs to be managed in accordance with a specialized waste legislation. In order to understand the needs for waste audits their particular role in the whole CDW management process and their interaction with the particular actors is studied in this Task.

The content of this Task is based on the analysis of the data gathered during Task 1 and includes

- Definition of the role of waste audit in the CDW management process
- Identification of the key actors and their responsibilities
- Identification of the needs of different actors relevant for waste audit

The role of waste audit in the CDW management process

CDW management represents a complex process, where waste audits are just a small part, strongly interrelated with the rest of the process. A general scheme of the whole process showing actors involved and relations between stages and responsibilities is depicted in Figure 3.

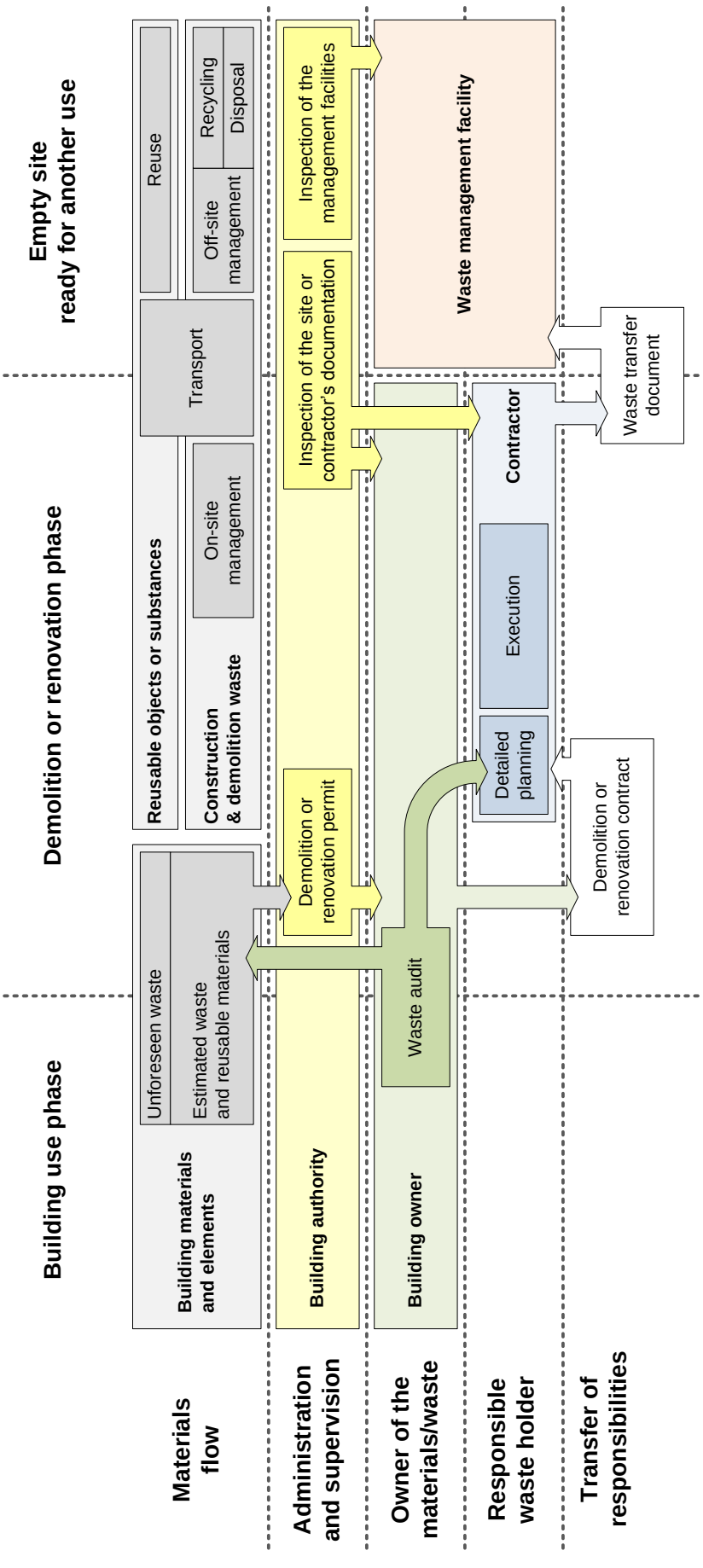


Figure 3 General process of CDW management and waste assessment

The waste audit is commonly performed before (and in order to secure) the demolition or renovation permit. Its findings should support the decisions of the authorities to approve the planned work. While in most of the EU countries the legislation is prepared at national level (exceptions exists such as Belgium or Italy), granting the permits and supervision of the demolition or renovation process is usually performed by the local authorities[54].

The level of the required monitoring of the process varies from occasional inspections (e.g. Finland) to the detailed comparison of waste audit recommendations to the real outputs (e.g. Basque Country). It was observed, however, that in the countries or regions with the most demanding regulations, those requirements are not strictly followed. Many countries developed electronic reporting and notification systems in recent years (e.g. Scotland, Czech Republic) to increase the efficiency of the process. These systems are not specifically used to monitor the audit results, but incorporate some of its essential parts (e.g. waste reporting in Czech Republic, responsibilities definition in Scotland), and therefore can be extended in the future.

Definition of the actors

Property owner is responsible of the identification and classification of waste as well as preliminary planning of handling of it;

Contractor is responsible for demolition/deconstruction/renovation operations defined in the contract with the owner. The contractor should contribute to the traceability aspects of waste;

National administration is usually responsible for the waste legislation and waste management planning, it may also collect the data about the generated waste and its treatment;

Local administration (building authority) issues demolition or renovation permits and should establish mechanisms to ascertain (directly or with the intervention of third parties) that waste audits are performed and their recommendations followed;

Auditor is an expert or a team of experts (auditors team) responsible to perform the waste audit. The auditor needs to be a qualified expert with appropriate knowledge about building materials (including hazardous materials), building techniques and building history. A qualified expert needs to be familiar with demolition techniques, waste treatment and processing as well as with (local) markets;

Waste manager is responsible that the waste received from the waste holder or producer will be managed and/or disposed adequately. The waste manager should also contribute to the traceability aspects of waste;

[54] Pedro, J.B., Meijer, F., Visscher, H. Comparison of tasks and responsibilities in the building control systems of European Union countries, RICS COBRA Research Conference, University of Cape Town, 10-11th September 2009

Products manufacturer may contribute to the waste audit providing solutions and/or requirements for the reused/recycled materials and components.

Designer/consultant planning the demolition or renovation works is typically contracted by the property owner to prepare the necessary documentation for the building authority to obtain the relevant permit.

Designer/consultant planning new buildings or infrastructures is (together with the new property owner) deciding about the use of recycled/reused products or materials. He can be involved in the demolition/renovation planning to specify and supervise the extraction of their products and materials.

Actors' responsibilities in different EU countries

According to the definition in Article 1 of Waste Framework Directive (WFD), the responsible waste holder means the producer of the waste or the natural or legal person who is in possession of the waste. The waste holder concept is used as an umbrella term that covers waste producers, waste collectors and waste processors. The interpretation of the definition of the waste producer in the demolition or renovation process varies among EU countries. The producer can be either the building owner or the contractor due to the rather general definition in WFD saying that "waste producer means anyone whose activities produce waste (original waste producer) or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste". For instance, in the Czech Republic, the producer is the one, who produces the waste by his economic activity and has to be certified, meaning that in the construction industry it is mostly the contractor. However, in some countries (e.g. Spain), the producer is the owner of the building or infrastructure. It is naturally required that the contractor takes care of the waste management, and therefore the transfer of the responsibilities has to be arranged in the contract.

Most of the countries refer to the WFD definitions in their legislation, however, several specific differences or clarifications of them were identified such as:

Belgium: The environmental legislation is divided by regions. Very little information at national level is available, but in general the owner of the residue is the responsible person[55]. In Flanders the inventory should be drawn up on the instructions of the owner of the building permit (VLAREMA art. 4.3.3).

Bulgaria: The Article 7 of Waste Act 53/2012 declares that: "Persons whose operations involve the generation of waste and waste holders shall treat waste themselves or shall submit such waste for collection, transport and treatment."

Czech Republic: The § 4 (1) x) of Act No. 185/2001 Coll., on Waste defines waste producer as a "legal entity producing waste in connection with its operation or a natural person authorised to conduct business who produces waste in connection with his business activity." The producer

[55] Information based on the preliminary study of the legislative initiatives and the interviews conducted.

(over certain amount) has to be a certified "legal entity", and therefore it is mostly the contractor.

Finland: The definition of waste producer according to the Section 6 (1) 4) of Finnish Waste Act is the same as WFD. However, the waste holder is described as "the waste producer, property holder or anyone in possession of the waste" indicating that the responsibility might be on the owner. The property owner is commonly treated as the person responsible for the waste management in Finland.

United Kingdom: England, Wales and Northern Ireland regulations require businesses to apply the waste management hierarchy. Scotland requires a transfer note to be signed by the transferor and transferee (possible electronic waste transfer notes). Extended producer responsibility schemes are also in used in UK[56].

The general needs for the waste audit

A waste audit is considered to give the client the assurance of the level of performance that can be achieved and will look at the potential for reuse and recycling. Whilst some demolition projects achieve high recycling rates (around 90%) many of the materials may be down-cycled, e.g. use in road aggregates. This may constitute a lost opportunity, so, for every material possible, it is important to encourage practices that facilitate the increase of value-added streams, thus increasing environmental efficiency and possible cost savings.

The objectives of the EU C&D waste protocol[57] are focused on the increased perceived quality/reliability of C&D waste management process and C&D recycled materials. They cover the five topics:

(1) Improved waste identification, source separation and collection,
(2) Improved waste logistics,
(3) Improved waste processing,
(4) Quality management,
(5) Policy and framework conditions,

The objectives of the protocol are based on the following needs: demand for C&D recycled materials, promotion of new business activities and players, increase of cooperation along the waste value chain, progress towards C&D waste targets, generation of reliable waste statistics increase of environmental performance.

[56] Resource Efficient Use of Mixed Waste by Deloitte
[57] EU Construction & Demolition Waste Management Protocol, Version 2, 30 November 2015

Those needs were used as a basis for the preliminary proposed structure of the outcomes of Task 2. They were reviewed by the consortium, extended and divided into sub-categories as follows:

Environmental and health protection

- Better working conditions, prevention of workers for exposure
- Prevention of hazardous materials circulation
- Health & safety improvements, on-site and during the future use (renovation)
- Reduction of noise and dust originating from the demolition or renovation process

Progress towards C&D waste targets

- Decreased disposal of recyclable waste
- Improved source separation, collection and processing
- Increased prevention and recycling

Generation of reliable waste statistics

- Improved waste identification
- Traceability of the waste streams

Increased environmental performance

- Decreased raw materials and energy consumption
- Decreased embodied carbon and energy in materials and buildings
- Improved life cycle impact of the buildings

Demand for C&D recycled materials

Increase of cooperation along the waste value chain

- Appropriate waste transport
- Off-site sorting practices
- Organization and transparency of waste operations

Economic performance

- Setting up the levels of performance of the contractor
- Allocation of space and resources for on-site management
- Estimation of the value of the separated materials

These needs, in general, are important for different actors (see Table 10) and are affected by the waste audits (see Table 11).

Table 10 The main effect of waste audits on the general needs identified in the EU C&D Waste Management Protocol

Needs	Actors							
	Property owners	Contractors	National administration (responsible for the overall CDW targets)	Local administration (responsible for the particular demolition or renovation process)	Waste management facilities	Product manufacturers	Designers/consultants planning the demolition or renovation works	Designers/consultants planning new buildings or infrastructures
Environmental and health protection		X	X	X				
Progress towards C&D waste targets			X	X[1]				
Generation of reliable waste statistics			X	X[1]				
Increase of environmental performance	X[2]					X[2]		X[2]
Demand for C&D recycled materials		X[3]			X	X		X
Increase of cooperation along the waste value chain					X	X[4]	X	X[4]
Economic performance	X	X	X[5]	X[5]				

[1] The responsibilities for collecting data and promoting the issues are mostly delegated by the national administration to the local administration.

[2] This need becomes important when the environmental certification scheme is used.

[3] Usually only if the recycled materials have any economic value for the contractor.

[4] This applies to limited cases when the recovered materials and elements are planned to be reused

[5] In the case of public projects

Table 11 The main effect of waste audits on the general needs identified in the EU C&D Waste Management Protocol

Needs	Waste Streams			Audit content Mandatory (M) / Recommended (R) / Not Defined (-)										
	Hazardous	Non-Hazardous	Recyclable	Contamination and pollutants	Waste identification	Estimation of amounts	Location in building	Identification of reusable elements	Space allocation for on-site sorting	Waste management	Identification of Waste processing facilities	Monitoring	Estimation of costs and materials value	Setting performance level for the contractor
Environmental and health protection	X			X						X		X		
Progress towards C&D waste targets	X		X						X					
Generation of reliable waste statistics	X	X	X		X	X		X		X	X	X		
Increase of environmental performance	X	X	X	X						X	X			
Demand for C&D recycled materials			X		X					X	X			
Increase of cooperation along the waste value chain							X	X	X	X	X	X		
Economic performance	X		X					X		X			X	X

4. Proposal for guidelines and implementation measures to be taken.

4.1. Task 3: Guidelines for pre-demolition and renovation audits (waste audits).

Introduction

A waste audit before demolition or renovation is a specific task within the project planning and is necessary to understand the type and amount of elements and materials that will be deconstructed/demolished and to issue recommendations on their further handling. An assessment of the viable recovery routes for materials can also be given (including reuse and the potential reuse value, recycling on- and off-site and the associated cost savings and energy recovery).

The waste audit should also consider any relevant legislation such as the requirements for environmental permits if waste is to be used on-site or any waste that may be hazardous and such needs to be managed in accordance with a specialized waste legislation.

Waste audits should ideally be performed before the call for tenders, and should be a part of the invite for tenders. But on a minimum base they should be performed before the demolition or renovation permit. Its findings support the decisions of the authorities to approve the planned work and should be revised in the light of final results of the construction, demolition or refurbishment process.

Relevance of waste audits

Performing a waste audit present a series of advantages (both economically and environmentally) providing important added value to the whole project. Special emphasis needs to be put on the following aspects about waste audits:

- Waste audits are the first step towards recycling
- Waste audits promote fair competition amongst contractors (when performed before the call for tenders and included in the invitation)
- Waste audits increase awareness and ease traceability processes. It is of major importance to know the materials that will be set free (as especially the hazardous ones as unexpected costs during the works can be avoided)
- Environmental and technical quality of materials can be steered:
    - Environmental aspects that will be improved include:
        - which contaminants are present
        - Contribute to the assurance that they are removed and do net end up in the environment
        - The achievement of higher environmental quality of recyclable waste materials
    - Technical quality aspects that will be improved include the identification of “higher quality” batches of recycled materials (for example concrete)

- Waste audits contribute to a better demolition waste management. Knowing the quantities and nature of materials expected leads to the optimisation of works (how many containers / on-site vs off-site sorting / etc

Participants of the waste audit

The main actors involved are included in the following list:

- **Property owner**
- **Authority**
- **Auditor**
- **Contractor**
- **Waste manager**
- **Products manufacturer**

Waste audit

The auditing process aims to deliver such documents that the owner can submit a demolition or renovation permit application and open a call for tenders. Furthermore, the outcome of the audit should also provide reliable estimates to contrast them with the results from waste management report. The proposed methodology to carry out a waste audit includes the following stages:

- Desk study
- Site visit
- Inventory
- Management recommendations
- Reporting
- Quality checking.

The desk study and site visit should serve to collect all the information needed to perform the inventory and provide the waste management recommendations.

Desk study or Preliminary (historical) research.

The desk study or preliminary (historical) research will gather information on the building itself and the activities that took place during service life. It aims to gather all the relevant information from the documentation of the building or other work. In this stage, the auditor should collect as much information available to plan correctly the site visit. After studying all the documentation, a first draft of possible materials and uncertainties should be produced. This information will need to be checked during the site visit. All this information can be complemented with computer models or IT solutions as those provided in several countries or regions or other tools self-developed by the auditors. All the information collected during this stage of the audit should be part of the report or be annexed to the final report.

Field survey

The field survey will usually include a general analysis of the building checking what was learned during the desk study. The site visit consists of visual inspections, comparisons with collected documents, planning of inspections and measurements, preliminary planning of deconstruction techniques and waste handling on site as well as communication between actors engaged by the owner to the process.

The field survey will need to implement non-destructive or destructive techniques in order to correctly assess the whole sort of materials. Destructive techniques are usually performed to be able to get to the 'core' structure of the building. Main destructive techniques will probably be: uncoating of surfaces, breaking parts, drilling to observe the composition at different depths or any other operation deemed necessary to get the whole information of the materials present in the building. Site visit should allow the auditor to complement the information collected during the desk-base study and take any sample required to perform the materials assessment.

The inventory and waste management recommendations are typically generated from the desk study and field survey.

Inventory of materials and elements

It is the duty of the waste holder to gain knowledge about the objects and substances intended to be discarded and their potential hazardous nature and contamination. The inventory of the waste materials and building elements is therefore the basic output of the waste audit requested by the waste holder and performed by the auditor.

Materials assessment, performed during the desk study and site visit, aims to present reliable data about the type and amounts of the demolition waste to be expected. In the inventory of materials and elements, materials assessment should be completed with the consideration of the ease of recovery of these materials. As regards buildings, it is advisable to provide in the inventory the materials assessment for each floor. In certain buildings like office buildings or hospitals the same elements reoccur in different rooms: in this case it can be sufficient to inventory one or two rooms in detail and for the others to register only deviations. All the necessary precautions not to extrapolate first impressions to the entire building need to be taken, for example performing systematic intermediate checking.

The materials assessment part of the inventory should include at least:

- Type of material
- Application in which it appears (example: wood in doors)
- Quantification

And it may also include:

- Inventory of elements
- Location
- Quality
- Reusability and recyclability of materials and elements

Waste management recommendations

The waste audit can be completed with recommendations on how to perform waste management on site. The issues to be considered may include the following:

- Recommendations on safe removal of hazardous waste
- Specific recycling routes for certain materials
- Recommendations regarding possible health and safety issues and other precautions

Reporting

The final report of the audit should be prepared by the auditor. The report, being the output of the waste audit should be checked for the quality of the waste audit itself. The report needs to include the information regarding the project itself, all the information collected in the previous sections and any information that can be useful for the owner, the contractor or any other stakeholder involved in the value chain of the project. The minimum sections of the report should include:

- **Scope of the report** (mandatory)
- **Summary of the field survey** (mandatory)
- **Inventory** of the materials (mandatory)
- **Waste management recommendations** (optional)

Quality Assessment of waste audits

The quality assessment of the waste audit is deemed essential so that the audit is considered reliable by all the stakeholders involved in the project. The proposed assessment is based in two main aspects:

- **Auditor skills and certifications**. Considering at least:
  - Skilled personnel.
  - Adequate educative background and specific training.
  - Independence.
- **Traceability.** Considering at least 3 stages:
  - Stage 1: Initial assessment during the waste audit. After the waste audit is performed (and registered) it has to checked for its quality.
  - Stage 2: Verification after or during demolition works. It is important to consider:
    - what happens with hazardous waste (to ascertain that they are correctly removed and disposed of).
    - The presence of hidden hazardous wastes
    - The amounts that were set free should be compared with what was estimated.
    - Materials that were collected together and materials that were separated
  - Stage 3: Verification with the management process. Considering not only the amounts and separation rates, but also the type of waste management performed.

The full document of the waste audit can be found in Annex 3 of this document.

4.2. Task 4: Proposal for implementation of the guidelines

In this task, the consortium proposes a set of actions for the implementation of the guidelines recommended for waste audits of buildings and infrastructures. These actions are based on existing best practices in some member states or regions, as shown in Task 2. The measures consist firstly ~~in~~ of a set of general recommendations that could be applied in the EU as a whole and secondly, more specific actions addressed to specific member states. The possibility to implement actions for specific countries in a flexible manner will not only take into account differences in construction and CDW management practices for CDW in Member States, considering the subsidiarity and proportionality principles.

The principles of the proposed implementation action plan are as follows:

Integration of existing European and national standards, guidelines and certification schemes so that the guidelines themselves are formulated as a generic framework with the clearly defined outputs, but methodologies are proposed to be implemented on a national or regional level.

Respect for the local diversity is emphasized especially in the parts of the implementation plan where the large variation of materials, components, construction, deconstruction and waste management practices exists.

Market driven solutions are preferred to encourage more environmentally efficient waste treatment, prevention and reuse, quality of the audit and quality of the separated materials.

Waste holder's liability for the environmental and economic damage caused by unidentified waste streams should be the motivation for the execution of waste audits. Waste holder should have the knowledge about the nature and amount of wastes he is responsible for.

The content of this Task is based on the analysis of the data gathered during Task 1, identification of the needs in Task 2 and proposed guidelines in Task 3. It includes:

- Overview of the most common measures
- Identification of issues hampering higher levels of on-site sorting related to audits
- Identification of the best practices in the sector to solve those specific issues
- Summary of the levels and forms of the implementation plan
- Proposed implementation of the guidelines and supportive measures

The implementation of the proposed guidelines is a hierarchical process that should take part at different levels from the European Union setting up the overall targets and protocols down to the professional association detailing the particular implementation guidelines that will be in line with the local building, demolition, renovation and waste treatment practices. The particular actors in the implementation process are listed in the Figure 4.

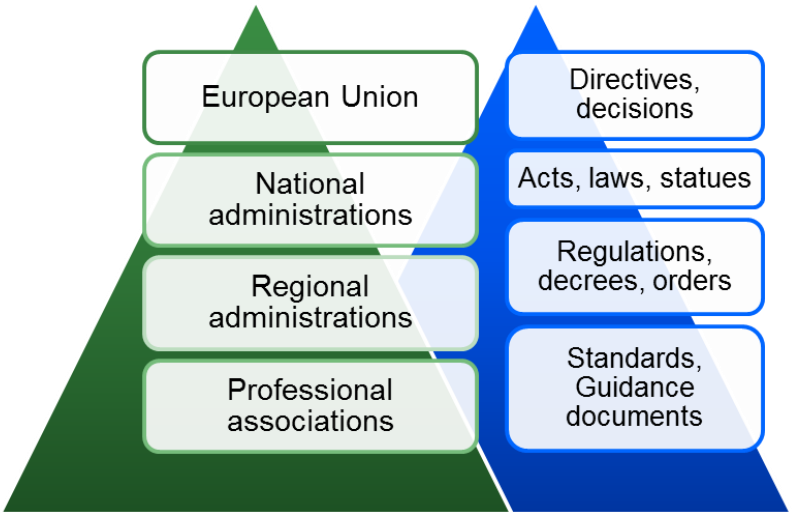


Figure 4 Implementation levels

Main challenges of the audit implementation process

The consortium has identified the following key points that greatly affect the efficiency of the performed waste audits:

Lack of knowledge and skills of the auditors: Auditors should be able to identify all the hazardous and non-hazardous wastes and contamination. They should be familiar with demolition activities and skilled enough to recommend proper waste management.

Conflict of interests: Auditors should provide the objective (preferably independent) evaluation including the wastes causing additional costs to the owner and/or the contractor.

Unclear responsibilities: The responsibility for the waste management (or the way how it is transferred from the owner to the contractor) should be clearly defined in the legislation and the roles of the actors as well (e.g. in standards).

Inefficient data collection: The data generated by audits, waste producers and waste management facilities should be systematically collected in a coordinated way to be comparable in the future.

Insufficient verification of the audit outcomes: The identified waste and recommended treatment should be verified during the demolition/renovation and the discrepancies should be explained.

Current practices to address the key issues of the waste auditing process

The already established practices to deal with the critical issues are listed below:

Increasing knowledge and skills of the auditors

- Certification, authorization and training of the auditors (e.g. Austria, UK)
- Guidance (co-)developed with Ministry of Environment and associations including templates (e.g. Finland, Czech Republic)

Ensuring reliability of the audit results

- Independent auditors (e.g. Austria, UK)
- Penalty paid by the owner to the contractor for any unidentified dangerous waste (e.g. Denmark)
- Deposit of the money before the demolition (e.g. Basque Country)
- Quality check of the waste audit by a third party (e.g. Tracimat-system Flanders, Belgium)

Clearly defined responsibilities

- Responsibility is usually defined in the contract (most of the countries)
- The waste holder is responsible all the time and no transfer of responsibilities is used (e.g. Finland, Romania)
- Contractor's liability is assumed automatically by law (e.g. Bulgaria, Czech Republic, UK)
- Transfer notes can be submitted electronically (e.g. Scotland)

Efficient data collection

- Recorded outputs and waste treatment have to be sent to the authorities (most of the countries)
- Contractors and other waste managers keep the records for possible inspections (e.g. Finland)
- Recorded outputs and waste treatment have to be sent to the waste holder (e.g. Spain, Portugal)
- Electronic reporting system for the waste producers and waste management facilities (e.g. Czech Republic)

Comparison of the audit results to the real waste generation and treatment

- Authorities compare the recorded outputs with the audit and the differences must be justified (e.g. Basque Country)
- Third party checks the outputs with the estimates of the waste audit. Differences must be justified (e.g. Tracimat-system Flanders, Belgium)

Proposed implementation of the guidelines and supportive actions

The basic framework for the implementation of the guidelines is already established in several EU documents:

- Waste Framework Directive (2008/98/EC) specifies the basic responsibilities of waste holder and waste producer, waste hierarchy and a classification of disposal and treatment operations;
- EU Construction & Demolition Waste Management Protocol (ECORYS, 2016) contains the basic definition of the waste audit and its content;
- European List of Waste (Commission Decision 2014/955/EU) contains the waste classification and defines the hazardous wastes (Commission regulation 1357/2014 defining hazardous properties);
- Construction Waste Measurement Protocol (ENCORD, 2013) defines the form and different levels of quantified outputs in the waste inventory;
- EU Construction Products Regulation (305/2011) defines the basic requirements for construction works and removes the trade barriers of construction products in the European single market;
- Eurocodes (EN 1990 to EN 1999) establish the rules for structural design;
- Others (e.g. Persistent Organic Pollutant Regulation, REACH, OSH Framework Directive …).

The consortium proposes the amendment of existing EU documents in order to support the implementation of the guidelines as follows:

- The definition of waste holder and waste producer has to be clarified for a situation, when the owner of property is contracting another legal or private entity to demolish or deconstruct this property.
- The procedures for CE marking (harmonized product standards, ETAs …) and Eurocodes should take into account possibility for deconstructed building products placed in the market.

At the same time, most of the Member States have defined the principles of pre-demolition audits or inspections in form of guidelines, recommendations, directives or standards. Those documents typically contain the basic elements of the waste audit. The most important national and regional documents and policies are as follows:

- Thresholds (minimum size, conditions, materials, …) for executing the mandatory audit or its parts (if any)
- Templates or electronic forms for waste audit reporting
- Methodologies for sampling and material identification and hazardous materials detection
- Required skills and certifications for the auditors
- Best practices in waste identification and reporting
- Regulations for waste sorting, landfill and waste treatment
- Incentives to support waste treatment, separation and reuse

The consortium proposes that the development of national or regional waste audit provisions (that are in line with the principles of the waste audit guidelines) is part of the waste management planning activities in the Member States. It is also recommended to establish a clear and transparent mechanism of verification of the audit outcomes (e.g. by comparing with the real outputs from demolition or renovation).

The following table summarizes the existing and recommended documents and policies to support the implementation of the waste audit guidelines.

Table 12 proposed implementation of the particular parts of recommended waste audit and selected supportive actions

Inventory		
Materials classification	EU	European List of Wastes (Eural code) for every type of material found, so general statistics are possible (and comparable with other member states)
Materials quantification	EU	Construction Waste Measurement Protocol
Components inventory	National/Regional administration	Thresholds, Templates
Location of materials/components	National/Regional administration	Specifications
Quality assessment	EU	Industrial standards
	National/Regional administration	Specifications, voluntary agreements, labels and certificates
Hazardousness	EU	European List of Wastes
Reusability and recyclability	Professional associations	Guidelines
Waste management recommendations		
Waste recovery and off-site treatment	EU	Waste Framework Directive (Annex I. and II.)
	National/Regional administration	Guidelines, Databases of waste management facilities
On-site sorting and treatment	Administration/Associations	National regulations, Guidelines
Valorization of materials/components	Professional associations	Best practices
Estimated cost of waste management	Professional associations	Best practices
Direct supportive actions		
Training and certification of auditors	EU	Definition of common requirements
	National/Regional administration	Training and certification programs
Methodological guidance	Professional associations and/or national/regional administration	Guidelines
Responsibility for the waste management	EU	Commentary to the Waste Framework Directive
Financial liability	National/Regional administration	Regulatory framework
Audits reporting	Administration/Associations	Specifications, templates
Audits quality assessment	National/Regional administration	Permits, inspections
Indirect supportive actions		

Diversion of waste from landfills	EU/National/Regional administration	Landfill regulations
Support for waste prevention and reuse	EU	Acceptance criteria for reused components End-of-waste criteria
	National/Regional administration	Support for the emerging markets
Improvement of recycled materials quality	EU	Industrial standards
	Professional associations	Imposed demands on the sorting and separation

4.3. Task 5: Stakeholders' consultation

Once the waste audit guideline and a draft implementation proposal were defined, consultation activities started. At the beginning of task 5 consultation activities have been focused in getting information from industry, industry associations and authorities. Main objectives of this consultation stage were to:

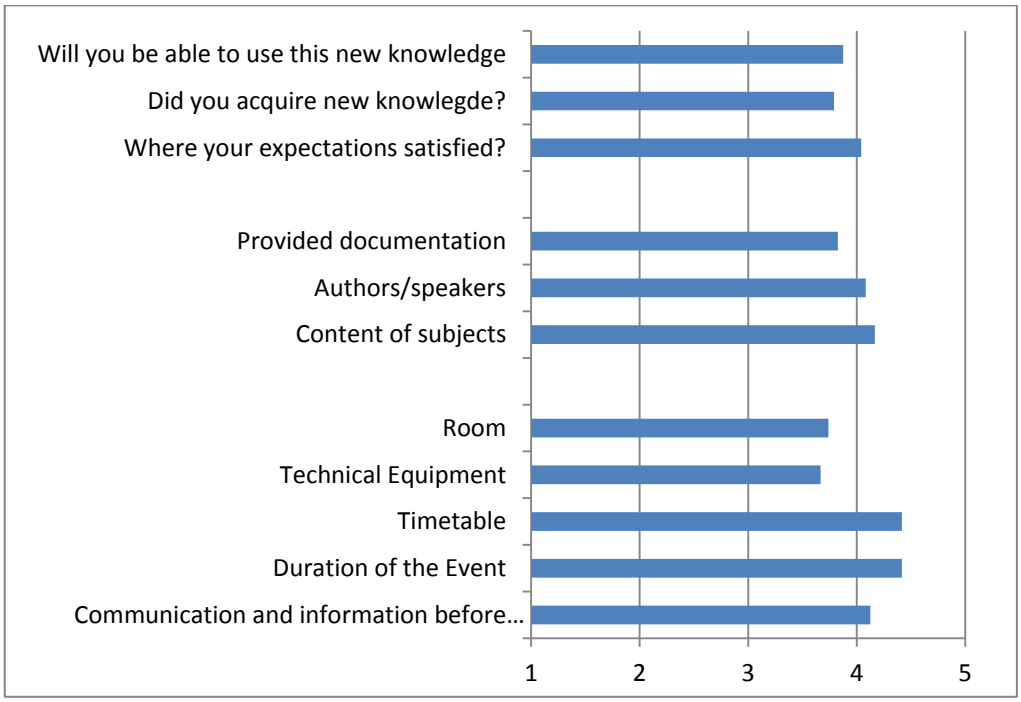
- Adapt the guidelines to make them usable for industry and authorities.
- Ascertain the applicability of the implementation proposal
- Complement supportive actions

The feedback obtained for the guidelines allowed the study team to:

- simplify the main part of the guideline and add more detailed parts as annexes,
- put special emphasis in quality assurance considering the auditor and the results and
- propose harmonized reporting schedules to ease data sharing.

As part of task 5, an evaluation and validation workshop organized by the European Commission was held in Brussels on the 9th of December 2016. During the workshop the project team presented the main conclusions of the study and open discussion forums after each of the presentations. At the end of the forum satisfaction questionnaires were distributed among the participants. The results of the 24 satisfaction questionnaires that were answered are summarized below

Figure 5 Implementation levels



The result of consultation activities has shown several topics of interest:

Hazardous substances

- In Austria a concrete list of materials/parts that may contain hazardous substances and/or impurities, together with an standardised form for pre-demolition audit is provided in the austrian standard B3151 (annex A).
- Parts with hazardous substances has to be removed before the demolition, therefore the „dismantling concept“ should be used and this should be checked afterwards to consider the building ready for demolition.
- For the future it is very important to introduce good documentation about what goes into constructions and buildings. Some kind of logbook that compiles all materials and their substance content. It is important to note that a substance not considered hazardous at the moment in some years can be found to be hazardous.

Actors

- There is the concern that some of the actors (mainly owners) are not aware of their responsibilities
- Competence of auditors is deamed critical. It is considered that common EU requirements would be of great importance. It is considered that auditors should meet several requisites
    - Training and experience
    - Need to professionalize them
    - Consider ethic issues.
    - Independent professionals.
    - Consider professional liability issues, for instance by means of professional insurances.

- Green Public Procurement is considered important for the exemplarity role they have
- The role of national and local authorities is stressed. The main problem is usually on the implementation of audits. Authorities have an important role in promoting implementation and checking. They also need to ban illegal landfilling.
- Confidence between different actors (for example contractors and auditors) should be enhanced.

Waste audits

- An important concern was the best way to perform audits. The main objective is that audits become practical and functional documents. They should be useful and user friendly taking into accounts the reader of the audit and focus on relevant issues. They should include as much detail as possible to ease the understanding and usage during later stages of the project (e.g. useful information for the waste management).
- Importance of quality verification of materials for recycling or reuse.
- The quality aspect of materials in a circular economy is essential and in order to ascertain that, all substances in a material must be identified, and not only asbestos and/or PCBs.
- Existing standards should be used when available and new standards should be generated.
- Several attendees considered that hazardous substances and materials have to be well identified and considered. The whole building should be inventoried (performing analysis of a few samples could not be enough). The auditor needs to use appropriate means and techniques to identify the existence, location and quantities of hazardous materials.
- Waste audit, considered as a whole should provide the information to cover also other audits as for example asbestos audit.
- A problem with having proper audits is that there is very little supervision.
- Waste audits are deemed to be a very important tool when considering health and safety issues.

Difussion activities

- It is very important to spread knowledge and make it easy to find information and help to actually follow the recommendations in practice.
- Waste audits should be a key tool for statistics and reporting.

ANNEX 1. Summary of the Situation by Country

United Kingdom

The recovery rate of non-hazardous CDW excluding excavation is around 85%. Waste management plans have been developed by each of the Government Bodies within England, Wales, Scotland and Northern Ireland. Government programmes have encouraged the use of recycled products in construction, as part of the environmental impact of the products. Many construction companies establish zero waste to landfill targets, but in general as it is difficult to ascertain the success of this premise the implementation degree is variable. Preliminary audits are required on a voluntary basis and in general tend to be linked to different certification schemes, mainly:

- BREEAM: has specific criteria related to CDW including requirements to have a management plan and set reduction targets avoiding landfilling. A pre-demolition audit must be undertaken for those projects including demolition activities. Some public procurement actions are requesting this certification.
- Code for Sustainable Homes: This code certifies the performances of new homes. It also includes specific requirements as having a management plan, reduction targets,… This certification is mandatory for social housing, and voluntary for the others.

Austria

Austria has already achieved CDW recovery rates higher than the WFD target (currently about 85%). Austria is one of the most advance countries in Europe concerning CDW management. CDW management has been in place for decades in Austria, with many initiatives both on state and local level (being a common example the guidelines from the city of Vienna). A nation-wide guideline exists for more than 20 years and a detailed management plan (covering also CDW) is updated regularly. Recycled Construction Materials Regulation has come into force in January 2016, laying down specific requirements to meet during construction or demolition of structures, such as the execution of a pollutant investigation and duties to separate the waste generated. Binding regulation is supported mainly by technical requirements (published in a system of rules) and standard guidelines for recycle materials. Non-legal guidelines (such as Federal waste management Plan or guidelines of the Austrian building material recycling association) have been also used as reference documents. The regulation that entered into force in 2016 refers in several parts to follow procedures in accordance with ÖNORM B 3151. This standard sets between other the estimation of mass of several components (asphalt, concrete, excavated material, wood, metals, dangerous substances and other major components), as well as to preview the possible contamination of the area. The documentation has to be also in accordance with ÖNORM B 3151 when more than 100 tons of CDW arises in the project. The building owner and the contractor are responsible to ensure that documentation is available at the construction site. All the documentation has to be kept by the building owner at least for seven years after the conclusion of the works.

Denmark

Denmark has already achieved CDW recovery rates higher than the WFD target (currently about 85 % according to the EC study 2015), and therefore have met the requirements set in the WFD. According to legislation [Statutory order No. 1309/2012, chapter 10] it is mandatory to pre-audit buildings/constructions that may contain PCBs. This concerns buildings/constructions built or renovated during 1950 – 1977 larger than 10 m^2 or if the amount of waste generated is greater than more than 1 tonne of waste. The result of PCB-screening/mapping must be notified to the municipality and must also include information on the amounts of other waste and waste types produced by the demolition/renovation with the information on how the waste will be handled. In the Danish Waste Management Plan several actions related to quality of CDW are addressed. Denmark has several activities ongoing related to CDW quality, one of these concerns traceability of waste streams from demolition.

France

According to 2012 data, CDW recovery and recycling rate of non-hazardous materials, excluding soil, can be estimated to be about 63%. Stakeholders consider as major strengths the close cooperation between authorities and professionals. Pre audit obligation was originally set in Law 2009-967 (known as Grenelle 1 law) and refined in Law 2010-768 (known as Grenelle 2 law). From march 2012 certain categories of buildings have to perform a diagnosis related to CDW before any demolition work. But even preliminary audits are mandatory above a certain surface and for certain cases, still the number of pre-audits perform is considered to be very low, and final destination of CDW is rarely tracked. This lack of preliminary audits performance is considered to be due to several factors. Stakeholders identify as major drawbacks that CDW management is not a priority for clients; insufficient resources allocated to ensure legislation enforcement, loopholes in the legislation (as for instance insufficient regulation of backfilling and ground raisings in town planning code). It is also important to consider that France has not been able to eradicate illegal landfilling. The national project RECYBETON preliminarily concluded that in some French regions the network of recycling platforms is not dense enough regarding the scattering of the C&D works.

Czech Republic

The utilization rate of CDW in Czech Republic has exceeded the WFD target since 2003 (e.g. it was 95.1% in 2012 according to the Waste Prevention Programme of the Czech Republic). The demolition/renovation permit requires pre-demolition/renovation inspection, identification of asbestos and other waste materials for most of the buildings and infrastructures [Regulation No. 499/2006 Coll. on building documentation]. In practice, however, it affects only the decisions concerning separation of asbestos, because the whole recycling industry and the well-established official waste tracing system relies on the identification of waste produced after demolition/renovation [Act No. 185/2001 Coll. on waste]. There is no systematic control and monitoring process on the quality of the audit reported for the permit and its outcomes have no other use. It is unlikely that the situation will change in the future without the clear need to further improve recycling, separation and recovery rates. The waste producers are obliged to avoid the production of waste [Act No. 185/2001 Coll. on waste], but the CDW prevention is not further supported.

Finland

The amount of non-hazardous CDW (excluding soils) was around 1.56 million tonnes in 2012 in Finland [Eurostat] and its calculated recovery almost reached WFD target (66 % in 2012). The renewed law to regulating asbestos work [684/2015] concerns the demolition permit, competence requirements and recording duties for registers. It requires investigation of asbestos content prior to demolition in buildings built before 1994 with further details in the decree 798/2015. In Finland, the Waste Act [646/2011] and Decree [179/2012] concern also the CDW in general. They require the waste holder to be aware of the origin, quantity, type and quality of waste and to provide this information to other waste management operators. Furthermore, the Land Use and Building Act [132/1999] and Decree [895/1999] define more detailed duties to the owners of waste and demolition/construction companies. The Act requires that a demolition work needs a building permit (exceptions listed) with the explanation on the capacity to handle resulting CDW and to reuse any usable building components. Many guidelines and templates concerning demolition activities are produced by the professional associations.

Belgium

Belgium is a federalised country. The three regions (Flemish Region, Brussels Capital Region and Walloon Region) implement European regulation, and follow similar strategies:

- Flemish Region is very active in CDW management, and the sector is very dynamic in terms of technical innovation and waste policy. The legal framework for the sustainable management in Flanders was established at an early stage. There is no specific obligation to perform selective demolition, but on-site sorting is mandatory for some streams. Waste audits are not mandatory in Flanders, but a pre-demolition waste inventory for (partial) non-residential buildings with an enclosed construction volume over 1000m^3 is mandatory. In the waste inventory hazardous and other waste fractions are identified.
- Brussels Capital Region is putting emphasis in preserving existing buildings and design of new ones. Selective demolition and reuse is set as the second step in their strategy. There is no obligation for selective demolition but inert waste has to be reused on-site or sent to a sorting centre. The government relies on the fact that selective demolition is economically favourable. Pre-demolition audits are on a voluntary basis. The Guide "Reuse of building materials[58]" explains the different steps for an audit. It is required to perform an asbestos inventory

Wallonia transposes the European Waste Framework Directive and its waste hierarchy obliging to high recycling rates of CDW. There is no obligation for selective demolition. Pre-demolition audits are on a voluntary basis

[58] http://www.cifful.ulg.ac.be/images/stories/Guide_reemploi_materiaux_lecture_2013.pdf

Spain

Spain has developed and implemented its first two national plans on CDW since 2001. It is currently being revised to integrate the new targets set by the Waste Framework Directive (WFD). Due to a lack of enforcement and supporting regulation, the first plan didn't succeed in diverting CDW from landfills. Compulsory segregation is established for a number of waste streams (metal, wood, glass, plastics, paper and cardboard, concrete, ceramics, and in the Basque Country also gypsum). Nevertheless, corresponding treatment infrastructures are lacking (particularly for plastics, glass and gypsum) and those materials end up mixed with the rest of non-recycled streams in a landfill on many cases. Actual legislations establish the responsibilities of the waste producers, holders, and managers. In addition information on hazardous wastes has to be included in demolition projects. A deposit is paid to the authorities, which will be returned when proof of lawful disposal/recycling of C&D wastes is provided (regulated at at regional level). Spain, and particularly the Basque Country, have strong regulations for compulsory pre-demolition audits (all construction, demolition and refurbishment works) and compulsory segregation. The inventory audit developed within the project (called "study of CDW management") is further developed in the so called "plan of CDW management" by the contractor that will execute the works once commissioned. The (first) waste audit is part of the technical project and can only be performed by an authorized professional (typically an architect). The second waste audit in Spain is part of the contract between the property and the demolition company. Nonetheless, these practices are hardly implemented, possibly due to lacking control and surveillance. There is also an important lack of control of unauthorised landfills.

Italy

CDW management varies considerably across territories. Waste management plans are developed at region level. At country level European Framework Directive has been transposed but there is no national general plan developed and no official definition for CDW. Italy lacks of any national or regional obligation for selective demolition or for any kind of sorting (nor on-site nor in sorting facilities). The only requirement set in Italy includes the obligation for separate collection and management of hazardous waste from C&D operations, but these residues are treated as the rest of hazardous wastes in Italian legislation, with no specific provision for them. Preliminary audits are not mandatory, but in some regions (as Veneto) they are used on a voluntary base. Illegal dumping of CDW is still a problem in Italy, but is considered in general as less important than illegal dumping of other wastes.

Portugal

In Portugal the Decree-Law 46/2008 sets the requirements for CDW streams supporting legislative measures to bridge knowledge gaps and promoting the application of waste hierarchy. It also pretends to create legal conditions for the CDW management focusing in preventing hazardous waste and promoting the obligation for sorting at source. The Decree created the conditions for several initiatives including the creation of innovative mechanisms in planning (the Plan for the Prevention and Management in public works and data recording in private works). CDW generation and treatment data are recorded yearly in the Integrated Map of Waste Registration. Preliminary audits are not requested in Portugal, and no region requesting them have been identified. The main barriers found in Portugal for CDW management have been identified as inexistent legal and technical specifications for selective demolition, the lack of enforcement of existing regulations, high costs associated to proper CDW management, lack of environmental awareness.

Sweden

Sweden shows a relatively good performance with recovery rates (about 50% - 60%) and could potentially meet the WFD target in by 2020 by intensifying their efforts and increasing recovery and recycling operations. In Sweden, pre-demolition audits focussing on health aspects (identification of asbestos) and hazardous wastes are required. Waste management in the demolition of buildings is regulated in the Building Code [SFS 2010:900] and guidance is given by the Swedish National Board of Housing, Building and Planning. An inventory of hazardous waste is required prior to the demolition of buildings. The management of hazardous and non-hazardous waste should be stated in the inspection plan submitted to the local authorities. Furthermore, the Swedish Ordinance on PCB [SFS 2007:19] requires identification of PCB-containing products in buildings and facilities. The guidance “Resource and waste guidelines during construction and demolition” is continuously updated by Swedish Construction Federation. It includes information on identification of hazardous material (e.g. asbestos, PCB) prior to demolition and in some cases exceeds the mandatory legal requirements.

Romania

The legislative background in Romania supports the authorization of demolitions [Law No. 50/1991], and a plan for CDW management may be part of the authorization process. However, the level detail by which requirements are formulated is in the jurisdiction of the local public authorities (LPA), with varying exigence levels depending on municipal resources. Legislation [Law No. 211/2011] implements the WFD waste hierarchy and obliges the LPA's to achieve 70% recycling rate for CDW by 2020. However, specialized CDW legislation does not exist to support achieving this target. The 2013 waste strategy document of the Ministry of Environment dedicates a chapter (5.7) to CD waste with the purpose of "providing some detailed information on the management of this waste stream through the life cycle analysis (LCA) applied to the waste hierarchy, and not only". The main outcome is to suggest the use of LCA analysis by LPA in order to identify the best strategies for reaching the 70% goal of Law [211/2011]. The real challenge seems to be to reduce the landfill rates on the general municipal waste streams, and improvement to the CDW recycling rates can only be expected within this broader framework.

Poland

In 2012 Poland adopted the Act on Waste implementing the EU Waste Framework Directive, but no specific legislation was developed concerning the construction and demolition waste. Poland reports very low levels of CDW generation. CDW management in Poland is under responsibility of construction companies that generate the waste. In Poland CDW issues are not deemed a priority for construction companies. It is considered to be a general practice the non-inclusion of a budget for CDW management in the investment, and many companies do not perform any previous plan before the starting of the project. The poor situation in Poland regarding CDW management is considered to be even more worrying as construction sector does not consider CDW issues a priority. Combining this with the lack of clear regulatory obligations and insufficient monitoring draws the actual picture in the country.

The following figures summarize the relation between generated CDW and recovered CDW with the auditing practices along Europe. As it can be observe it is difficult to establish a direct relationship between these concepts, but in general countries producing and recovering more CDW seem to implement some sort of auditing practices.

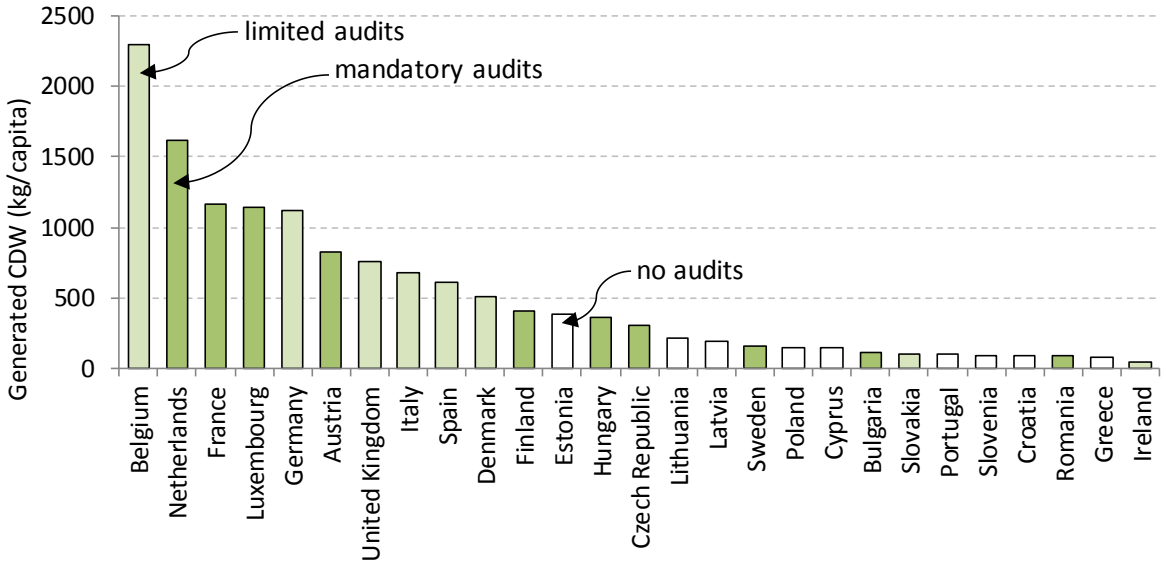


Figure 4 Relation of auditing practices to the generated CDW according to Eurostat data (2012)

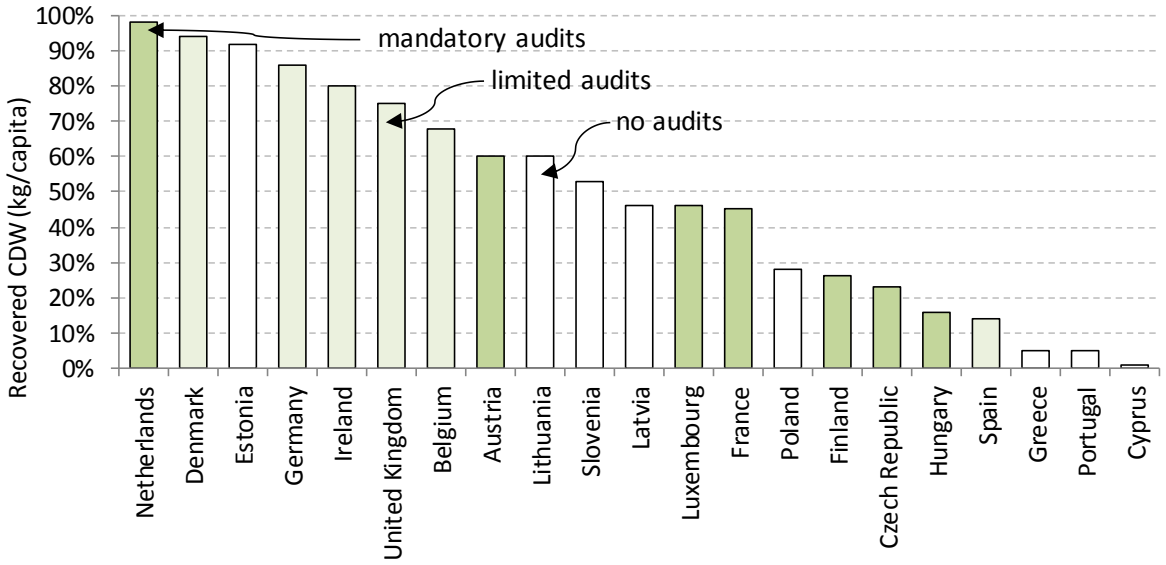


Figure 5 Relation of auditing practices to the recovered CDW according to BioIS study (2011)

ANNEX 2. Background Document to the Evaluation and Validation Workshop

Evaluation and Validation Workshop on Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures

Specific Contract

30-CE-0751644/00-00 – SI2.720069

BACKGROUND DOCUMENT FOR THE

EVALUATION AND VALIDATION WORKSHOP

9th December 2016

Evaluation and Validation Workshop

on Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures

- **WHEN AND WHERE**

The workshop will be held on the **9th December 2016 from 10.00 till 14.30**

at the **European Commission, DG GROW,** Avenue d'Auderghem 45, Belgium- 1040 Brussels.

- **TO WHOM IT IS ADDRESSED**

The target audience of the workshop is the construction and demolition industry in general as well as property owners and authorities.

- **BACKGROUND**

Communication (COM (2014) 445 final) "on Resource Efficiency Opportunities in the Building Sector" stated the Commission's intention to encourage a more efficient use of the resources consumed by new or refurbished buildings. The Waste Framework Directive 2008/98/EC establishes a target of 70% of Construction and Demolition Waste (CDW) to be recycled by 2020. In December 2015 The European Commission adopted the "Circular Economy Package", which includes revised legislative proposals on waste to encourage Europe's transition towards a circular economy. In this Circular Economy Package, Construction and Demolition Waste is identified as a key aspect. The present study is one of the 3 actions identified in the Circular Economy Package for the construction and demolition sector.

The main objectives of the study, which will be evaluated and validated during the workshop, are:

1. The assessment of the current regulatory, technical and economic conditions within the Member States,
2. Identification of key-factors which could drive the implementation of pre-demolition/renovation audits and assessment and definition of the conditions – upstream and downstream – for successful implementation of pre-demolition/renovation audits
3. To provide comprehensive and operational information and to draft methodological, technical and best-practice guidelines to be implemented by contractors and project sponsors in order to support national authorities for the actual achievement of the EU 2020 target for CDW recycling

- **KEY FINDINGS**

The strategies adopted by European Countries to reduce non-recovered waste are uneven and success rates are unequal. For instance, when considering countries or regions with reported high recycling rates such as the Netherlands, the region of Flanders in Belgium, Denmark or Czech Republic, it seems that the strategies around regulation are diverse; Flanders has a landfill ban for recyclable waste materials, whereas the Czech Republic is planning to introduce it by 2023. Onsite sorting based on the European classification (or similar), and a waste audit depending on size and type of building are compulsory in Flanders and Czech Republic, while in Denmark they are conducted as part of PCBs screening. In The Netherlands, however, these practices are not enforced, and their success may be linked to the scarcity of natural aggregates. On the other end, Italy and Spain can be found as examples of low recycling rates. The regulations and guidelines concerning waste audits were identified in many countries in the Resource Efficient Use of Mixed Wastes study by Deloitte[59] . While Spain is one of the countries (especially some regions as the Basque Country) with strong regulations for compulsory waste audits, Italy has very little regulation around CDW. In some cases, as in Spain, these practices are hardly implemented. Several reasons have been found in literature and during interviews, including, but not limited to: lack of control and monitoring or lack of management infrastructures.

Legal and Regulatory aspects

- Within current legal framework throughout Europe, waste audits (if they exist) are generally developed together with (or as part of) the technical documentation of the corresponding demolition/renovation works.
- Due to differences in national regulations throughout Europe, the types of works for which an audit or inventory is prepared and the level of detail are varying. This depends on several factors as the volume of waste to be generated, building size, building type, age of the building, contract type or expected hazardous waste.
- In some countries, audits or inspections may be performed more than once . The first is usually organized by the owner in order to obtain the demolition permit and the following one may be performed by the contractor immediately before the demolition for instance to set the price. These assessments are rarely regulated and generally based on their internal rules and experience. The level of regulation of those audits is different in each country. For instance the so-called “Study of CDW management” in Spain is further developed in the “plan of CDW management” by the contractor that will execute the works once commissioned.
- Waste audits can serve as contractual documents, especially if they are part of the demolition/renovation project. For example the “second” audit in Spain can be considered contractual, as it is part of the contract between the owner and the demolition company.
- In some countries, waste audits for infrastructures follow the same regulations as for buildings (Czech Republic), but the recommended methodology (e.g. material sampling) may differ.
- Audits for refurbishment activities are voluntary in some countries. However, if refurbishment works require a technical project and/or it involves demolition of building structures, a waste audit may be required (Spain, Czech Republic).

[59] Resource Efficient Use of Mixed Wastes http://ec.europa.eu/environment/waste/studies/mixed_waste.htm

- In the case of asbestos and other hazardous wastes, most European countries follow similar practices and legally force the drawing up of an asbestos inventory, including demolition and refurbishment works. (Italy represents an exception to this requirement).
- According to the interviews held, even asbestos inventories are not always available.

It has been observed that in some countries where waste audits are mandatory –such as as France, Spain or Portugal- the real implementation is very low. The main reasons identified for this seem to be:

- Lack of surveillance and monitoring from authorities.
- Not sufficient awareness of the owners (responsible for the waste audit, according to regulations)

Even in the cases where audits are available, the contractor still prefers to perform their own internal audits (often due to lack of quality and no supervision on the quality)

Which additional issues would you see as problematic for the implementation of waste audits? And why?

Technical and methodological aspects

According to EDA's Industry Report 2015, 63% of waste assessment is done by the demolition contractor, as opposed to a 5% where no one does it. Several interviewees claim that audits do not provide enough detail. Sometimes doubts arise regarding the training of the people performing the audits and in some cases on the reliability of the audits. Regarding dangerous substances, the main focus is on asbestos. However, legislation concerning PCBs and other hazardous wastes has been recently implemented in several countries. These aspects are by far the ones with higher consideration and control, but still there is the opinion in the sector that asbestos inventories should be more professional, regardless of the estimated amount.

General remarks

- Most countries allow visual inspections complemented with either desk studies or computer applications.
- The testing and sampling requirements are mostly not defined in the legislation, however, methods to identify hazardous materials and contamination are usually recommended in guidelines (e.g. Czech Republic).
- It should be noted that the number of materials separated due to their dangerous nature is growing and the methods for the identification of contamination are improved, which can result in a slight decrease of recyclable materials, but in a higher safety of the materials that are recovered.

- Inventories of hazardous substances (especially asbestos) indicate the presence of asbestos, but not always its location and amount. Also, there is an added obstacle in the hidden dangerous substances that usually lead to extra costs and in some cases to stop the works.
- The minimum content of these assessments generally include, identification (usually according to the classification based European List of Waste or European Waste Catalogue) and quantification (in weight and volume). This minimum content can be complemented with other aspects such as:
    - Indications about the planned management.
    - Information about the location in the building of the waste materials (for example in Flanders)
    - Description of the way in which the waste materials will be separated (Spain, France, Czech Republic), collected, stored and/or transported
    - A separate budget chapter associated to waste management (for example in Spain and France)

Market Issues and economic dimension

The European Commission is aware of divergences between statistical data and has established that *"the existing measurement method to assess what is actually recycled should be clarified. Some Member States currently report waste collected as waste recycled despite the significant material loss between these phases"* (EC Towards a circular economy. A zero waste programme for Europe., 2014). Therefore, the proposal for a new Waste Directive (WDF-proposal for a new WDF, COM/2015/0595 final – 2015/0275(COD)), establishes the formula to be used by the MS to calculate the rate of recycling and preparation for re-use. CDW reporting should be improved by this measure in the future.

In general it is relatively difficult to estimate the cost of the audit process itself, but it is considered to be below 5% of the whole demolition and treatment process activities. The influence of waste audits on the economy cannot be directly assessed, and several doubts have been raised about its economic benefits (especially when the contractor performs additional inspection after the official audit made by the owner or engineering company).

Segregation on site is in most cases economy driven, especially if there is a market demand on the recycled products (as in Belgium) or if lower fees are applied. Waste audits, if performed correctly, allow a quantitative justification for more selective demolitions and become a necessary step to select the most adequate demolition and treatment alternatives from an economical point of view.

It has been observed that:

- Most industrial stakeholders consider that economic aspects should be carefully considered. In some countries (for example due to landfilling low taxes or cheap raw materials), the waste audits and onsite sorting does not pay off. Therefore the claim is to consider the whole CDW management process when considering drivers and barriers.
- It is a common claim that the cost of performing pre-demolition/renovation audits should be considered in the projects.
- There is an important concern about the higher costs often coming from mistakes at the preliminary audit, and special budget considerations to mitigate these effects are considered important; in many countries a percentage or the budget is estimated for these errors

Have you faced these situations? Can you identify other relevant issues?

Human and cultural aspects

In each country and region, there are different information and awareness raising activities organized by public administration or by associations, generally focused on professionals. Some stakeholders consulted consider that public awareness should also be enhanced, mainly in countries with low recycling rates. Many stakeholders considered that there is an important lack of information regarding waste audits, benefits, best practices,... An important concern was raised about the contractors and owners being almost completely unaware about the possibilities to reduce the waste production by re-selling the salvaged building parts. To some extent, this also applies to the different recycling options. During these interviews, it also came up that there is very little information exchange between the companies. Training of actors along the supply process is considered to be poor in some countries, but very little information regarding these aspects has been collected.

General remarks

- It is a common claim that audits do not provide enough detail and are prepared by non-experts or non-independent professionals. This can lead in some cases to direct economic implications as for instance in the Basque Country (Spain) where the budget in these audits is used to establish a bail for issuing some work-permits.
- CDW inventories and audits are generally requested to be performed by skilled specialists in most countries. In general, there are no related training activities or accreditations to become a skilled specialist, except in very few cases. In general, authorized professionals (usually architects) are allowed to prepare the assessments. In spite of their general technical knowledge, this professional usually lacks specific training on demolition activities and processes, which often lowers the quality of the audit. In general, there is an important lack of knowledge, especially between buildings and infrastructures owners of their obligations.

The contractors in general do not trust the results of waste audit performed by the owner or engineering company for the purpose of demolition/renovation permit and would rather prefer their own waste assessment. This is usually due to lack of quality and supervision on the waste audit. In order to avoid this lack of confidence the following measures have been proposed by several stakeholders:

- Training programs and accreditation schemes should be available for skilled specialists.
- Auditors should be independent.
- Law enforcement and monitoring measures should be further enhanced
- Quality assessment of waste audits, and clear responsibilities should be set.
- More homogeneous reporting of data is deemed important not only in the preliminary audit and offer stage, but also on the general CDW management process.

Can you identify other relevant issues?

• NEEDS IDENTIFIED FOR WASTE AUDITS

The objectives of the EU C&D waste protocol[60] are focused on the increased perceived quality/reliability of C&D waste management process and C&D recycled materials.

The needs for waste audits identified in the stock taking task are summarized in the following list:

(1) Environmental and health protection
- Prevention of hazardous materials circulation
- Health & safety improvements, on-site and during the future use (in the case of renovation)
- Reduction of noise and dust originating from the demolition or renovation process

(2) Progress towards C&D waste targets
- Decreased disposal of recyclable waste
- Improved source separation, collection and processing
- Increased prevention and recycling

(3) Generation of reliable waste statistics
- Improved waste identification
- Traceability of the waste streams

(4) Increased environmental performance
- Decreased raw materials and energy consumption
- Decreased embodied carbon and energy in materials and buildings
- Improved life cycle impact of the buildings

(5) Demand for C&D recycled materials

(6) Increase of cooperation along the waste value chain
- Appropriate waste transport
- Off-site sorting practices
- Organisation and transparency of waste operations

(7) Economic performance
- Setting up the levels of performance of the contractor
- Allocation of space and resources for on-site management
- Estimation of the value of the separated materials

[60] EU Construction & Demolition Waste Management Protocol, Version 2, 30 November 2015

• WASTE AUDIT GUIDELINE

A waste audit before demolition or renovation is a specific task within the project planning and is necessary to understand the type and amount of elements and materials that will be deconstructed/demolished and to issue recommendations on their further handling. An assessment of the viable recovery routes for materials can also be given (including reuse and the potential reuse value, recycling on- and off-site and the associated cost savings and energy recovery).

The waste audit should also consider any relevant legislation such as the requirements for environmental permits if waste is to be used on-site or any waste that may be hazardous and such needs to be managed in accordance with a specialized waste legislation. It should be performed before (in order to secure) the demolition or renovation permit. Its findings support the decisions of the authorities to approve the planned work and should be revised in the light of final results of the construction, demolition or refurbishment process.

Participants of the waste audit

A general scheme of the waste management process showing actors involved and relations between stages and responsibilities are depicted in Figure 1 and the following list:

- **Property owner** is responsible for the identification and classification of waste as well as preliminary planning of its handling;
- **Authority** issues demolition or renovation permits and should establish mechanisms to ascertain (directly or with the intervention of third parties) that waste audits are performed and their recommendations followed;
- **Auditor** is an expert or team of experts (auditors team) responsible to perform the waste audit. The auditor needs to be a qualified expert with appropriate knowledge on building materials (including hazardous materials), building techniques and building history and familiar with demolition techniques, waste treatment and processing as well as with (local) markets;
- **Contractor** is responsible for demolition/deconstruction/renovation operations defined in the contract with the owner. The contractor should contribute to the traceability aspects of waste;
- **Waste manager** is responsible for a suitable management and disposal of the waste received from the waste holder or producer. The waste manager should also contribute to the traceability aspects of waste;
- **Products manufacturer** may contribute to the waste audit providing solutions and/or requirements for the reused/recycled materials and components.

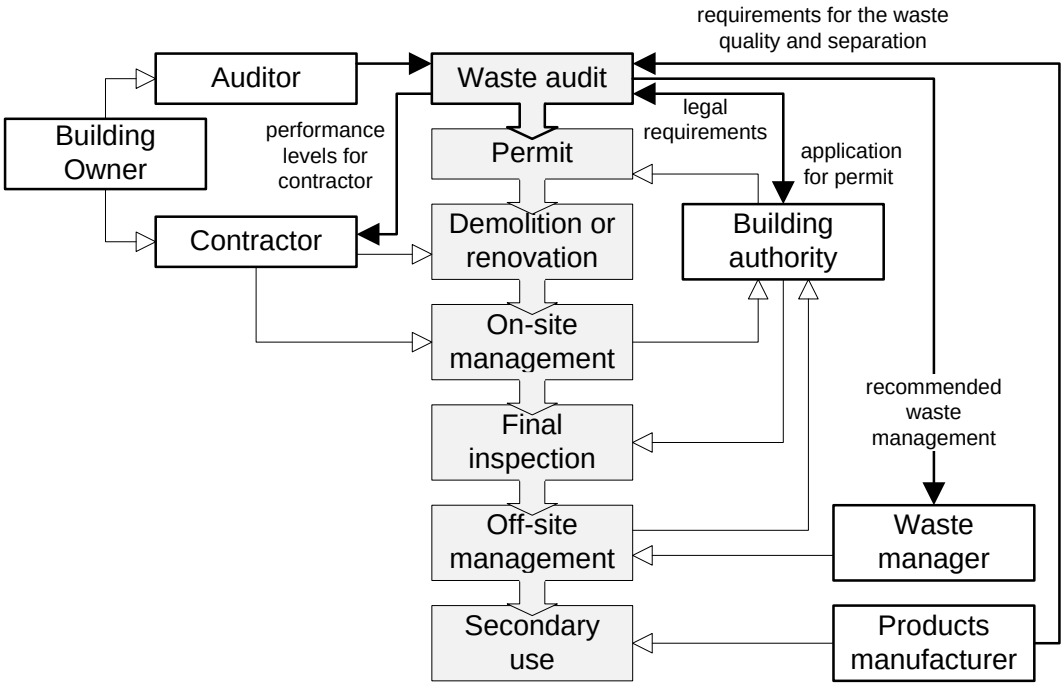


Figure 1 The role of waste audit participants in the waste management process

Waste audit

The auditing process aims to deliver such documents that the owner can submit a demolition or renovation permit application and open a call for tenders. Furthermore, the outcome of the audit should also provide reliable estimates to contrast them with the results from waste management report. An effective process for carrying out a waste audit should follow the steps depicted in Figure 2.

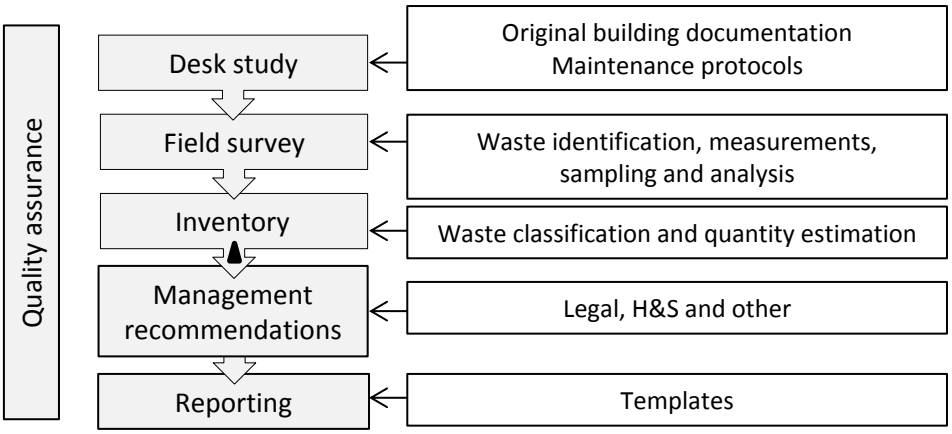


Figure 2 Example of the waste audit process

Inventory and waste management recommendations are typically generated from the desk study and site visit.

Inventory of materials and elements

It is the duty of the waste holder to gain knowledge about the objects and substances intended to be discarded and their potential hazardous nature and contamination. The inventory of the materials and building elements is therefore the basic output of the waste audit arranged by the waste holder (usually the owner of the building or infrastructure) and performed by the auditor. The inventory is typically based on the materials assessment provided by the desk study and/or the site visit

Materials assessment aims to present reliable data about the type and amounts of the demolition waste. It is based on desk study, site visit and additional activities aiming to ensure the quality of data. The demolition waste is produced through deconstruction and demolition activities and it may also include materials due to operation and use of the property. Materials assessment should be complemented with the consideration of the ease of recovery of these materials. As regards buildings, it is advisable to perform the materials assessment for each floor.

The materials assessment should include at least:

- **Type of material** to be classified as inert waste, non-inert, non-hazardous waste or hazardous waste. The material should be then classified according to the European list of wastes;
- **Quantification** in tonnes and/or in cubic meters.

Additional information can be required by the waste holder or building authority such as:

- **Inventory of elements** recommended for deconstruction and reuse. Their materials should not be excluded from the waste inventory (exceptions may exist e.g. if the audit is part of the approved deconstruction plan);
- **Location** of the waste materials (and elements) in order to maximize the efficiency and safety of demolition or renovation.
- **Quality** of the material to assess the impurities that could be present. The fewer impurities in the waste fraction, the higher the value it can have.
- **Reusability** in order to assess direct reusability of the material which depends on the nature of the material and material conditions.

Waste management recommendations

The waste audit can be completed with recommendations on how to perform waste management on site. The issues to be considered may include the following:

- **Recommended waste diversion** of each of the waste streams identified (reuse, recycling, backfilling, energy recovery and elimination) and estimation of the diversion rates . Different alternatives can be provided if there are some that represent similar advantages;
- **Recommended on-site sorting activities** that may include the description of the installation requirements for storage, handling, separation and for any other operation to manage the different sources of materials;
- **Valorisation** of the materials and deconstructed building elements assessed in the previous phase;
- **Estimated cost of waste management process** can be extracted from previous information after consulting different waste management facilities.
- **Recommendations regarding possible precautions** to take during the deconstruction phase or the waste management phase must also be done.

Reporting

The final report of the audit should be prepared by the auditor. It is advisable that a third party revises the report as stated in the quality assessment section. The report needs to include the information regarding the project itself, all the information collected in the previous sections and any information that can be useful for the owner, the contractor or any other stakeholder involved in the value chain of the project.

The final report is based on the desk-study report, minutes of the site visit, report of materials assessment and possibly on the report of site management recommendation. The main section of the final report includes the following information:

Scope of the report (mandatory)

Presentation of the project: Description of the project with detailed information of the works to be performed including not only parts directly affected by the works, but also those parts that should be kept.

- General description of the project
- Basic information about the owner and property
- Location of the site, including information about neighbourhood when relevant.
- History of major renovations and previous use(s)

Summary of the waste audit (mandatory)

Summary of the data collected during the audit including but not limited to:

- Waste fractions arising (in tonnes)
- Total waste arising (absolute in tonnes)
- Estimated waste recovery (in %)
- Summary of hazardous wastes identified in the building or infrastructure
- Description of the methodology followed, including the steps performed and the techniques employed.

- List of documents that were available, for instance hazardous substances assessment, any information on the building or the construction materials used originally, etc.
- Other supporting materials where available (pictures, site-plans and any other documents that could be useful for the correct performance of the project).

Inventory (mandatory)

The inventory of waste fractions and elements is the core part of the waste audit report.

- Inventory of materials (mandatory) is recommended to compile according to the reporting levels outlined in the Construction Waste Measurement Protocol[61] with the following options:

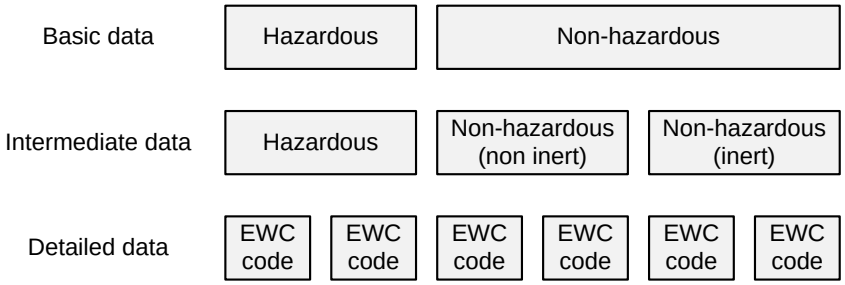


Figure 3 Levels of reporting of waste fractions

- Inventory of elements (optional) can follow the similar structure. It should be noted that the materials of the elements listed in this part cannot be excluded from the inventory of waste materials (with the exception of "certain reuse")

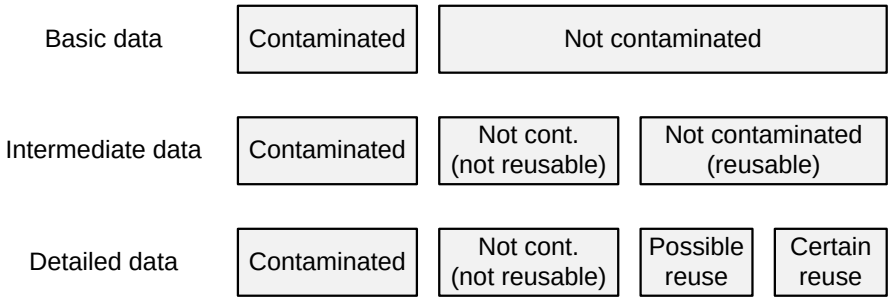


Figure 4 Levels of reporting of waste elements

If a more detailed assessment has been performed, a summary by level should also be included. The documents filled in with full details should be included as annexes to the report.

[61] Chapter 2.0 of Construction Waste Measurement Protocol, ENCORD 2013

Waste management recommendations (optional)

- Summary by type of outlet and recommended management of each waste stream.
- Detailed description of the waste management planning, including any supporting material as allocated spaces marked in a site-plan.
- Assessment of the reachable recovery targets and disposal rates that can be filled using recommended template.
- List of local waste management facilities (if possible) specifying their services.
- Waste traceability process and when possible person(s) or organization(s) responsible to perform waste traceability until the final outlet.
- Other information of interest for stakeholders involved in the project, included but not limited to legislative framework in the country and summary of responsibilities and liability of each of the stakeholders

Quality Assessment of waste audits

The quality assessment of the waste audit should be based in two main aspects

- **Auditor skills and certifications**. auditors should meet a set of minimum requirements:
  - Skilled personnel. Auditors should show combine knowledge and experience. Experience provides an important background that can complement educative background and specific training.
  - Adequate educative background and specific training. Auditors should have knowledge on construction, constructive systems, standardization, materials and hazardous substances.
  - Independence. Auditors and waste audits should be an independent process, so that the results obtained can be used by all the stakeholders involved in the process.
- **Traceability.** Waste audits should be considered as living documents that are revised periodically. It is important to ascertain the quality of the audit performed and this should be done combining an initial verification with further verifications in several stages.
  - Initial assessment during the waste audit.
  - Verification after sorting. The quantities assessed during the waste audit should be checked against the materials obtained after sorting. Discrepancies found in the figures should be notified and justified.
  - Verification with the management process. After reception at waste management facilities, the final figures of the materials received should be checked with the data predicted on the waste audit. Any discrepancy found should be notified and justified.

- **BEST PRACTICES TO ADDRESS CRITICAL PARTS OF WASTE ASSESSMENT AND IMPLEMENTATION PROPOSALS**

The following key points have been identified as those with greater effect on the efficiency of the performed waste audits:

- The required skills/knowledge of the auditor and its independence from the contractor (and the owner)
- Comparison of the real outputs from construction and renovation process with those estimated by the audit
- Definition of responsibilities and compensations in case of strong deviations

The common practices identified to deal with the critical issues are listed below:

(1) Increase in the quality of waste audits

- Detailed guidance including templates for the waste reporting
- Certification, authorization and training of the auditors
- Penalty paid by the owner to the contractor for any unidentified dangerous waste defined in the contract
- Independent auditor requirement

(2) Definition of the responsible waste manager (mostly the contractor)

- The waste holder is responsible all the time and no transfer of responsibilities is used
- Responsibility is usually defined in the contract
- Contractor's liability is assumed automatically by law
- Transfer notes can be submitted electronically

(3) Monitoring of the real amounts of wastes and their management

- Contractors and other waste managers keep the records for possible inspections
- Recorded outputs and waste treatment have to be sent to the authorities
- Recorded outputs and waste treatment have to be sent to the waste holder
- Authorities compare the recorded outputs with the general recovery targets
- Authorities compare the recorded outputs with the audit and the differences must be justified
- Electronic reporting system

(4) Encouraging the responsible behaviour of the waste managers

- Certification and training of waste producers, collection and management facilities
- Mandatory reporting
- Deposit of money

Can you identify other best practices?

Would you recommend any other issue to enhance waste audit implementation?

Suggestions for supportive actions and recommendations

The implementation of the Waste Audit Guideline and the European Demolition Protocol should be enhanced considering the different aspects studied in the key finding section.

Legal and regulatory framework

- It is recommended that the Waste Framework Directive is complemented with specific regulation at European level. This regulation should establish, at least, clear responsibilities along Europe defining actors, ownership, liability issues, as well as major types of waste fractions to be considered.
- According to the European Demolition Protocol "*public authorities should decide upon the threshold for pre-demolition audits (highly variable at the moment along the EU)*".
- In order to take into account the different realities of Member States, it is considered that recovery targets should be evaluated as improvement ratios instead of absolute figures.
- Establish the framework for surveillance and monitoring procedures to be followed in the whole European Union.

Technical and methodological aspects

- It is recommended that the minimum content of the audit and the minimum requirements for the auditor are aligned with European regulations. This minimum set of criteria should be periodically revised to adapt to EU situation.
- Promote the use of common templates for the reporting to help data interchange and comparison.
- Promote quality control activities of waste audits performance and results.
- Ensure that auditors have proper skills and training.
- Promote electronic document interchange.
- Include waste audits as part of contractual documentation and permit applications.

Market issues and economic dimension

- Continue the work already in progress to harmonize data reporting of countries.
- Promote higher added value solutions, with different instruments including mechanisms to introduce reused and recycled materials in the market.
- Promote the quality assurance of recycled material. Studies to ascertain performance of these materials, minimum requirements and requisites are recommended to be financed.
- Potentiate the market of recyclable materials. A common market framework is recommended to be established.
- Potentiate the reduction of landfilling, establishing ways to ascertain that the waste value chain is followed. Each member state should also consider the taxes applied and combine it with materials market.
- Potentiate the creation of offsite sorting facilities near highly populated areas with difficult access and lack of space. The cost of these offsite sorting operations could be included in the budget.

Human and cultural aspects

- Perform information campaigns focused on the different actors in the value chain, so that they know their responsibilities and rights
- Make actors aware of the benefits of waste audits to obtain higher quality materials, even if sorting operations are more complex to obtain the general recycling rate.
- Promote public campaigns, so that society also requires waste audits to be performed.

Should other options be considered?

For example: Builders and firms performing refurbishment activities could have some responsibility in audits.

Could builders or builder associations be involved in the waste management process for example paying for the performance of waste audits or in the training of waste auditors?

Producer's responsibility concept should be established?
Taxes could depend not only on size of the building, amounts of materials, complexity of systems,… but also on the documentation provided, that will in turn reduce the extent of waste audit.

ANNEX 3. Waste Audit Guidelines

Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures

Specific Contract

30-CE-0751644/00-00 – SI2.720069

WASTE AUDIT GUIDELINE

prepared for

DG GROW

2016

VTT tecnalia RPA Risk & Policy Analysts

Contents

Foreword

Construction & Demolition Waste (CDW) when studied in volume is the largest waste stream in the EU. Even a vast majority of CDW is recyclable, one of the common hurdles to recycling and re-using C&D waste in the EU is the lack of confidence in the quality of C&D recycled materials.

This guideline is aligned with European strategies for Construction sector and waste management. The guideline is aligned with the objectives of the Waste Framework Directive 2008/98/EC which stablishes a target of 70% of CDW to be recycled by 2020.

The guideline is also aligned with the Construction 2020 strategy[62], and the Communication on Resource Efficiency Opportunities in the Building Sector[63]. It is also part of the more recent and ambitious Circular Economy Package presented by the European Commission in 2015[64] that includes revised legislative proposals on waste to encourage Europe's transition towards a circular economy. In this Circular Economy Package, Construction and Demolition Waste is identified as a key aspect and the preliminary assessment is an essential part of construction and demolition waste management.

This guideline, developed under the specific contract 30-CE-0751644/00-00 – SI2.720069, intends to provide a methodology to perform this assessment in order to support national authorities for the actual achievement of the EU 2020 target for CDW recycling.

1. Introduction

This document provides guidance on best practices for the assessment of construction and demolition waste streams prior to demolition or renovation of buildings and infrastructures, called “waste audit”. The aim of the guidance is to facilitate and maximize recovery of materials and components from demolition or renovation of buildings and infrastructures for beneficial reuse and recycling, without compromising the safety measures and practices outlined in the European Demolition Protocol. This protocol states that:

- Any demolition, renovation or construction project needs to be well planned and managed in order to reduce environmental and health impacts while providing important cost benefits.
- Waste audits (or pre-demolition audit as defined in the European Demolition Protocol) is to be carried out before any renovation or demolition project, for any materials to be re-used or recycled, as well as for hazardous waste.
- Public authorities should decide upon the threshold for pre-demolition audits (highly variable at the moment along the EU)
- Waste audits take full account of local markets for C&D waste and re-used and recycled materials.
- A good waste audit must be carried out by a qualified expert (the auditor).

[62] Strategy for the Sustainable competitiveness of the construction sector and its enterprises, COM (2012) 433, http://eur-lex.europa.eu/procedure/EN/201859
[63] COM (2014) 445 final, http://ec.europa.eu/environment/eussd/pdf/SustainableBuildingsCommunication.pdf
[64] http://ec.europa.eu/environment/circular-economy/index_en.htm

The scope of the Guideline includes waste from construction, renovation and demolition works. It excludes, however, the design phase, as well as excavating and dredging soils. With regard to geographic coverage, this document has been developed for its application in all 28 Member States of the European Union. It includes good practice from across the EU that can be the source of inspiration for both policy makers and practitioners.

The guideline has the following target groups of stakeholders:

- Industry practitioners; construction sector (including renovation companies and demolition contractors), waste treatment, transport and logistics as well as recycling companies;
- Public authorities at local, regional, national and EU levels;
- Quality certification bodies for building and infrastructure;

1.1. Purpose of the waste audit

A waste audit before demolition or renovation of buildings and infrastructures is a specific task within the project planning and is necessary to understand the type and amount of elements and materials that will be deconstructed/demolished and to issue recommendations on their further handling. An assessment of the viable recovery routes for materials can also be given (including reuse and the potential reuse value, recycling on- and off-site and the associated cost savings and energy recovery).

The waste audit should also consider any relevant legislation such as the requirements for environmental permits if waste is to be used on-site or any waste that may be hazardous and such needs to be managed in accordance with a specialized waste legislation. Waste audits should ideally be performed before the call for tenders, and should be a part of the invite for tenders. But on a minimum base they should be performed before the demolition or renovation permit. Its findings support the decisions of the authorities to approve the planned work and should be revised in the light of final results of the construction, demolition or refurbishment process.

Performing a waste audit present a series of advantages (both economically and environmentally) providing important added value to the whole project:

- Waste audits are the first step towards recycling
- Waste audits promote fair competition amongst contractors)
- Waste audits increase awareness and ease traceability processes. It is of major importance to know the materials that will be set free (as especially the hazardous ones as unexpected costs during the works can be avoided)
- Environmental and technical quality of materials can be steered:
    - Environmental aspects that will be improved include:
        - which contaminants are present
        - Contribute to the assurance that they are removed and do net end up in the environment
        - The achievement of higher environmental quality of recyclable waste materials
    - Technical quality aspects that will be improved include the identification of “higher quality” batches of recycled materials (for example concrete)
- Waste audits contribute to a better demolition waste management. Knowing the quantities and nature of materials expected leads to the optimisation of works (how many containers / on-site vs off-site sorting / etc.

1.2. Participants of the waste audit

A general scheme of the waste management process showing actors involved and relations between stages and responsibilities are depicted in Figure 1 and the following list:

- The **property owner** is responsible for appointing an auditor to draw up a waste audit for the identification and classification of waste as well as preliminary planning of its handling;
- The **authority** issues demolition or renovation permits and should establish mechanisms to ascertain (directly or with the intervention of third parties) that waste audits are performed including a quality check system and their recommendations followed;
- The **auditor** or **Auditor team** is an expert responsible for the waste audit. The auditor must be a qualified expert with appropriate knowledge on current and historical building materials (including hazardous materials), current and historical building techniques and building history and familiar with demolition techniques, waste treatment and processing as well as with (local) markets;
- The **contractor** is responsible for demolition/deconstruction/renovation operations defined in the contract with the owner. The contractor should contribute to the traceability aspects of waste;
- The **waste manager** is responsible for a suitable management and disposal of the waste received from the waste holder or producer. The waste manager should also contribute to the traceability aspects of waste;
- The **products manufacturer** may contribute to the waste audit providing solutions and/or requirements for the reused/recycled materials and components.

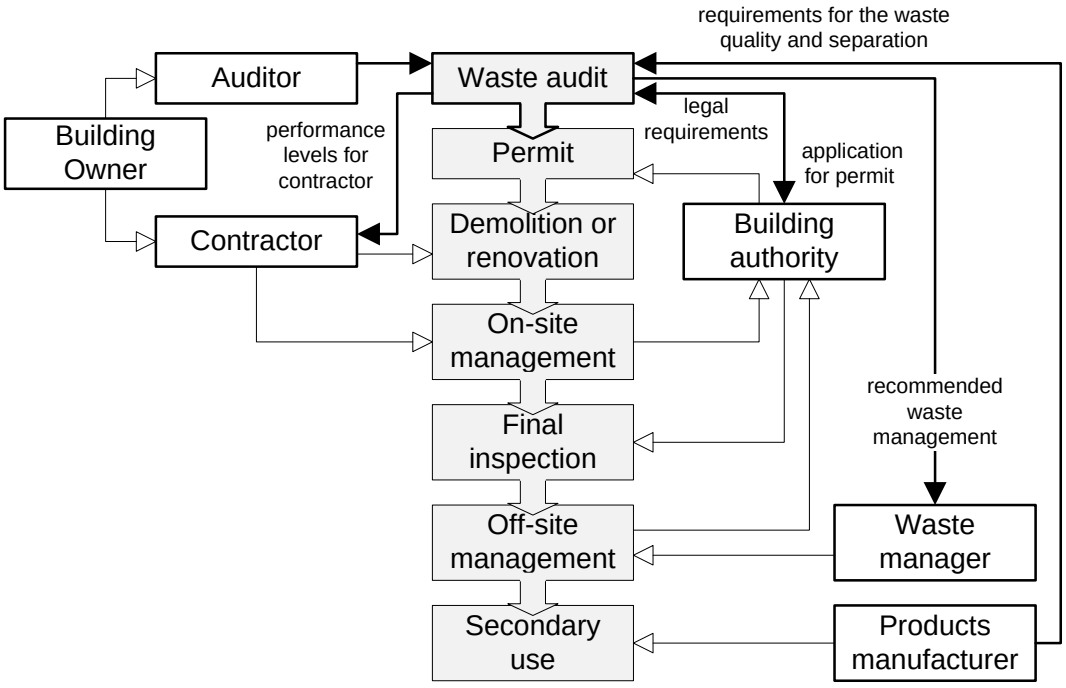


Figure 1: Role of waste audit participants in the waste management process

2. Waste audit

The waste audit aims to deliver a clear idea of the "to-be-demolished" building infrastructure, including estimates of waste materials that will be set free and recommendations on the waste management. It is a first step towards recycling and proper waste management. The auditing process aims to deliver the documents that the owner must attach to a demolition or renovation permit application to open a call for tenders. Furthermore, the outcome of the audit should also provide reliable estimates of waste materials to contrast them with the results from the waste management report.

2.1. Inventory of materials and elements

It is the duty of the waste holder to gain knowledge about the objects and substances intended to be discarded and their potential hazardous nature and contamination. The inventory of the materials and building elements is therefore the basic output of the waste audit arranged by the waste holder (usually the owner of the building or infrastructure) and performed by the auditor. The inventory is typically based on the materials assessment provided by the desk study and/or the field survey (see Annex B).

The assessment of materials aims to present reliable data about the type and amount of the demolition waste. It is based on desk study, site visit and additional activities aiming to ensure the quality of data. The demolition waste is produced through deconstruction and demolition activities and it may also include materials due to operation and use of the property. Materials assessment should be complemented with the consideration of the ease of recovery of these materials. As regards buildings, it is advisable to perform an assessment of the materials for each floor.

The materials assessment should include at least:

- The **type of material** to be classified as inert waste, non-inert, non-hazardous waste or hazardous waste, detailing the Eural code (from the European list of wastes) and description (since Eural code does not provide enough information);
- **Quantification** in tonnes, cubic meters and/or other relevant units of measurement.

Additional information can be required by the waste holder or building authority such as:

- An **inventory of elements** recommended for deconstruction and reuse. Materials of these elements should not be excluded from the waste inventory (exceptions may exist e.g. if the audit is part of the approved deconstruction plan);
- The **location** of the waste materials (and elements) in the building, in order to maximize the efficiency and safety of demolition or renovation.
- The **quality of the material** to assess the impurities that could be present. The fewer impurities in the waste fraction, the higher the value it can have.
- Its **reusability** in order to assess direct reusability of the material which depends on the nature of the material and material conditions.

2.2. Waste management recommendations

The waste audit can be completed with recommendations on how to perform waste management on site. The issues to be considered may include the following:

- **Recommendations on the safe removal of hazardous waste**
- **Recommendations regarding possible health and safety precautions** to take during the deconstruction phase or the waste management phase must also be done.
- **Identification of potential waste diversion** of certain identified waste streams (reuse, recycling, backfilling, energy recovery and elimination) and estimation of the diversion rates[65]. Different alternatives can be provided for each materials group or waste streams;
- **Identification of (economically or environmentally) beneficial on-site sorting activities** that may include the description of the installation requirements for storage, handling, separation and for any other operation to manage the different waste streams;

2.3. Reporting

The final report of the audit should be prepared by the auditor. The waste audit report will be signed by the auditor ascertaining the accuracy of the content. It is advisable that a third party revises the report as stated in the quality assessment section. The report must include the information regarding the project itself, all the information collected during the desk study and field survey and any information that can be useful for the owner, the contractor or any other stakeholder involved in the value chain of the project.

[65] Appendix 3 of Construction Waste Measurement Protocol, ENCORD 2013

3. Quality Assessment of waste audits

The level of the required monitoring of the process varies between countries or regions, from occasional inspections (e.g. Finland) to the detailed comparison of waste audit recommendations to the real outputs (e.g. Basque Country). It was observed, however, that in the countries or regions with the most demanding regulations, those requirements are not strictly followed. Many countries developed electronic reporting and notification systems in recent years (e.g. Scotland, Czech Republic) to increase the efficiency of the process. These systems are not specifically used to monitor the audit results, but incorporate some essential parts thereof (e.g. waste reporting in Czech Republic, responsibilities definition in Scotland), and therefore can be extended in the future. The quality assessment of the waste audit will be based in two main aspects as shown in the sections below.

3.1. Requirements for auditors

Auditors should meet a set of minimum requirements:

- Skilled personnel. Auditors should show combined knowledge and experience. Experience provides an important background that can complement education background and specific training.
- Adequate educative background and specific training. Auditors should have knowledge on current and historical construction, constructive systems, standardization, materials and hazardous substances. For instance, architects and designers have the knowledge of building types, standardized details and compositions of multilateral elements (e.g. panel houses in Eastern Europe are highly standardized) and can perform the assessment efficiently, but they lack from knowledge on materials and hazardous materials identification that will contribute to a successful audit process.
- Independence. The expert has to be neutral and independent (at least independent from the demolition company performing the demolition works), so that the results obtained can be used by all the stakeholders involved in the process.

3.2. Traceability

Waste audits should be considered as living documents that are revised periodically. It is important to ascertain the quality of the audit performed and this should be done preferably in 3 stages

- Stage 1: Initial assessment during the waste audit. After the waste audit is performed (and registered) it has to be checked for its quality (by third-party certified auditor, public bodies or professional associations).
- Stage 2: Verification after or during demolition works. It is important to consider:
    - what happens with hazardous waste (to ascertain that they are correctly removed and disposed of).
    - The presence of hidden hazardous wastes
    - The amounts that were set free should be compared with what was estimated. Discrepancies found in the figures should be notified and justified.
    - Materials that were collected together and materials that were separated
- Stage 3: Verification with the management process. Considering not only the amounts and separation rates, but also the type of waste management performed. Any discrepancy found should be notified and justified.

- what happened with hazardous waste
- which materials were separately collected / selectively collected but put in a mixed container
- how (and where) were measured the quantities

Appendix A: Glossary

Auditor means the expert or the team of experts (auditors team) performing the waste audit. It can be represented by the building owner or consultant (e.g. an architect or structure engineer) acting on behalf of the owner.

Authority means the national or regional administration responsible for granting the demolition or renovation permits and supervision of the demolition or renovation process.

Property owner means the owner of the building or infrastructure, the developer or the party stated by the national legislation as the original waste holder.

Deconstruction means removal of building elements from a demolition site in order to maximize their recovery and reuse.

Hazardous waste is a waste that due to its (intrinsic) chemical -or other- properties poses a risk to the environment and/or human health. Waste listed as hazardous in the European List of Waste are marked with and asterisk in the List of Waste.

Recovery means any activity carried out for the purposes of reclaiming, recycling or reusing the waste.

Recycling means a process where materials are collected, processed and re-manufactured into new products or use as a raw material substitute.

Reuse means using materials or building elements on more than one occasion, either for the same or for a different purpose, without the need for reprocessing.

Selective demolition means removal of materials from a demolition site in a pre-defined sequence in order to maximize recovery and recycling performance.

Waste means any substance or object that the holder discards or is required to be discarded[66] with the following exceptions: (a) uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is guaranteed that the material will be used for the purposes of construction in its natural state on the site from which it was excavated and (b) waste waters (such as trade effluent disposed of via tankers, foul sewers, surface water drains, water courses, etc.). Object is here the complete element or its part removed from the building or infrastructure during the demolition, deconstruction or renovation process, substance means the waste material that can be classified according to the European Waste Catalogue.

Waste audit means assessment of construction and demolition waste streams prior to demolition or renovation of buildings and infrastructures. It assesses both qualitatively and quantitatively the waste that will be produced from a building to be demolished or refurbished. In addition to the inventory, the waste audit may include recommendations for specific management options for these waste materials, depending on different issues (such as legislation, economics or availability of treatment infrastructure). It is important that the term 'waste audit' be considered in the broad sense of the word, and include at least every initiative that results in a documented work. For the purpose of this document, a waste audit should be considered as a qualitative and quantitative assessment of waste that will be produced from the construction, demolition/deconstruction or refurbishment activities including residual waste that is not part of the building. An important part of the waste audit is also the identification and removal of materials/components containing hazardous substances.

[66] Directive 2008/98/EC on waste and repealing certain Directives

Waste holder means the waste producer or the natural or legal person who is in possession of the waste[1]. The waste holder is the owner of the building or infrastructure, if not specified otherwise in the national legislation or the demolition/renovation contract. It is the duty of the waste holder to gain knowledge about the objects and substances intended for to discard and about their hazardous nature and contamination.

Waste producer means anyone whose activities produce waste[1]. The waste producer is the person or legal entity that executes the demolition/renovation work.

Inventory means the list of waste types and quantities.

Appendix B: Recommended waste audit process

An effective process for a waste audit should follow the steps depicted in Figure 2. A further description of each of the steps is provided in the following sections.

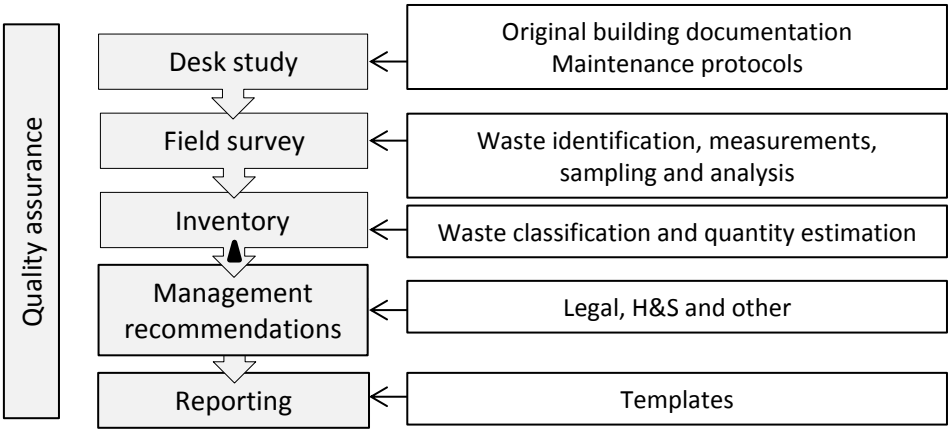


Figure 2 General scheme of the waste audit

Desk study

The desk study aims to gather all the relevant information from the documentation of the building or other work. It is of great importance to collect at least:

- The **age of the building or infrastructure** – this information allows understanding the history of the building and the type of materials and construction techniques to-be-expected. This knowledge is of importance if design documents are not available.
- The **design documents** - architectural plans and technical drawings, whether or not accompanied by tender specifications or as-built documentation of the construction and/or renovation works, contain information that is useful for planning the field survey and drawing up a waste inventory. They serve for preliminary identification of construction date/period, dimensions, construction typology, composition, type of materials, location of machinery and installations, details of hidden or difficult to access spaces, as well as planning of a field survey.
- The **documentation of the use** - in particular the history of maintenance and renovations is essential as the materials may be different from the year of the first building completion. Description of production activities and exploitation permits are a useful source to gather information on storage and use of hazardous products (whom might have caused pollution of other materials).
- A **list of dangerous substances** - If the assessment of dangerous substances does not exist, the auditor will have to take relevant measures to ascertain that health and safety issues are covered when performing the site visit.
- The **surroundings and accesses** – The knowledge of the environments is essential to plan the best strategy to perform waste management.
- The **local facilities** - The knowledge of local salvage yards

At this stage, the auditor should collect as much information available to plan the site visit correctly. After studying all the documentation, a first draft of possible materials and uncertainties should be produced. This information will have to be checked during the site visit. All this information can be complemented with computer models or IT solutions as those provided in several countries or regions or other tools self-developed by the auditors. All the information collected at this stage of the audit should be part of the report or be annexed to the final report.

Field survey

During the field survey all the rooms of the to-be-demolished building are visually inspected and inventoried on many occasions in a **destructive** manner. If necessary samples are taken for analysis. As every building is different, it is not possible to elaborate one specific global method for data collection. It is important to work systematically and methodical. A good and efficient approach consists of 4 parts:

- Site visit and general analysis of the building (checking what was learned during the desk study)
- General audit and inventory (the goal of the general audit and inventory is to have an idea (for every part of the building) of which materials occur and to collect the necessary information to identify, quantify and localize them in the building)
- Detailed audit and inventory (During this step the different rooms in the building are inventoried in detail (floor covering, lighting units, interior walls, false ceilings, etc.)

Sample taking and analysis (Not all materials can be visually identified. Suspicious materials need therefore to be sampled and analysed)

The site visit consists of visual inspections, comparisons of findings with collected documents, planning of inspections and measurements, preliminary planning of deconstruction techniques and waste handling on site as well as communication between actors engaged by the owner to the process. The auditor should aim to:

- Evaluate the consistency of the design documents and documents of the property owners with the actual situation;
- Identify locations, different structure and technical systems and their materials, with special care for materials that can look very similar, for instance in the cases of complex systems where a material can be covered by another material.
- Take measurements or confirm those obtained during the desk-study
- Make diagrams, take notes, take pictures of the different parts… and include them in the report to ease the understanding of the final report.
- Make sure to identify all the materials. In covered areas, it is important to remove a small part of the covering to make sure that the materials underneath are those expected.
- Take samples of the materials to ascertain the nature and quantity of the materials being studied. These samples should be visually inspected at the moment of collection and observations reported.

The site visit must implement non-destructive or destructive techniques in order to correctly assess the whole sort of materials. The destructive techniques will probably be: . opening of false ceilings and walls, opening of technical shafts, making a hole in wall and floor coverings, (partial) disassembly of technical installations (ventilation ducts …), uncoating of surfaces, drilling to observe the composition at different depths or any other operation deemed necessary to get the whole information of the materials present in the building. Considering mainly that it is highly probable that destructive techniques should be required, it is advisable that the field survey takes place when building is no longer in use.

If the desk-base study suggests the existence of hazardous substances at the site or if at any stage it is suspected that hazardous substances may be present, protocols to work with hazardous substances should be established and worker protection measures applied during the site visit, mainly during destructive stages.

The site visit should allow the auditor to complete the information collected during the desk-base study and take any sample required to perform the materials assessment.

The site visit can and should be complemented with some of the following operations:

- Chemical analysis of samples to confirm the identification of the materials.
- Mechanical testing to study properties of the materials in order to consider their reusability.
- Non-destructive testing performed on site to contribute to a better identification of materials and/or to find hidden materials. Possible techniques include NIR spectrometers, ultrasound equipment, metal detectors, flexible cameras for visual inspection of hollowed regions inside walls, etc.

Inventory of materials and elements

The minimum set of data to be included under this section should be a summary of the information shown above for the whole building. The information about constructive and non-constructive elements (such as pillars, beams, walls, slabs, etc. and also furniture, lightning, electronics, paper, etc.) and corresponding materials should also be organized to provide not only the total amount of waste, but also the total amount of the different types of materials. Even if this set of data is considered as the minimum data to get a full materials assessment, in order to take advantage of the full potential of waste audits it will by highly recommendable to:

- Separate the source of waste for the different levels of the building
- Consider the feasibility of separation
- Include photographs showing details and facilitating the interpretation of the report

It is advisable to perform this materials assessment not only for each building but also for each floor of the building. This information will be of great importance in order to assess and decide the waste management procedure to be implemented.

Materials assessment should be completed with the consideration of the ease of recovery of these materials. It is of great importance to estimate if it will be technically and economically separable in order to decide the different types of outlets to be proposed during the waste management planning stage of the waste audit.

All the information given above should be complemented with photographs to ease the work of the contractor when performing the construction, demolition or refurbishment activities. Photographs should be clear, and explicitly show the information they are intended to provide. For that purpose, it is a good practice to make notes on the photographs used in order to ease the location of the details that want to be shown.

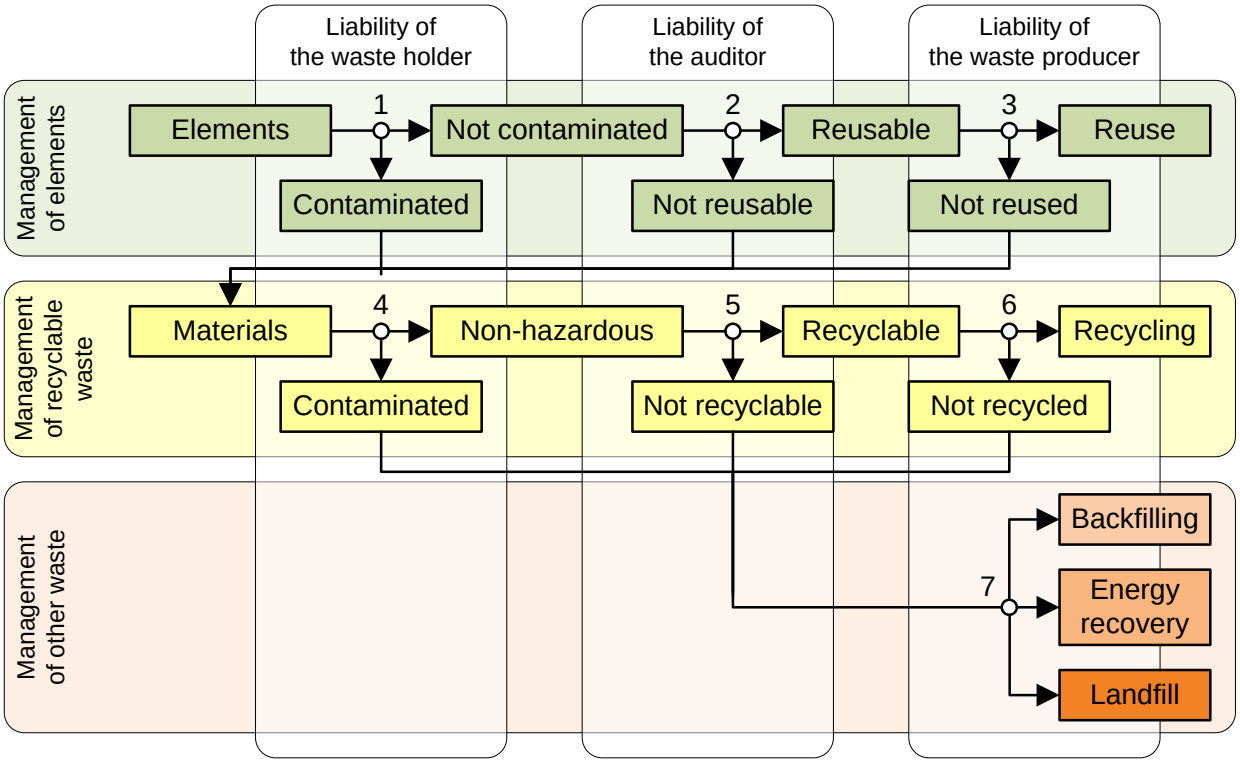


Figure 3 Decision-making process in formulation of the inventory and management recommendations

Waste management recommendations

These recommendations can include advise and guidelines for the safe removal of hazardous waste materials, re-use or recycling possibilities for certain (high value) materials present in the building, (legally binding) conditions for storage, transport and treatment of certain materials, recommendations deriving from the limitations of the field survey, etc.

The waste audit should specify the areas of the building potentially affected by contamination and the best way to deal with them before beginning the other activities of the project. If possible, a selective dismantling should be recommended in order to maximize the waste. Materials containing asbestos should be specifically considered and the waste audit should include a reference to the national legislation regulating the way to handle this waste material. It is advisable to prepare an environmental health and safety control plan describing the operations that should be performed to avoid contamination of the surrounding materials and environment including risk mitigation measures to be applied to minimize the exposition of workers and the environment. Any possible risk for workers should be specifically considered and reported to be included in a health and safety plan.

Reporting

The final report is based on the desk-study report, minutes of the site visit, report of materials assessment and possibly on the report of site management recommendation. The main section of the final report includes the following information:

Scope of the report (mandatory)

Presentation of the project: short description of the project with detailed information of the works to be performed including not only parts directly affected by the works, but also those parts that should be kept.

- General description of the project
- Basic information about the owner and the property
- Location of the site, incl. information about neighbourhood when relevant
- History of major renovations and previous use(s)
- Summary and conclusions of the desk study

Summary of the waste audit (mandatory)

Summary of the data collected during the audit including, but not limited to:

- Waste fractions arising (in tonnes, m^3 or other units)
- Total waste arising (absolute in tonnes, m^3 or other units)
- Summary of hazardous wastes identified in the building or infrastructure
- Description of the methodology followed, including the steps performed and the techniques employed.
- List of documents that were available, for instance hazardous substances assessment, any information on the building or the construction materials used originally, etc.
- Other supporting materials where available (pictures, site-plans and any other documents that could be useful for the correct performance of the project).

Inventory (mandatory)

The inventory of waste fractions and elements is the core part of the waste audit report. It can be reported using the templates in Appendix D and Appendix E and may contain the following parts:

- Inventory of materials (mandatory) is recommended to compile according to the reporting levels outlined in the Construction Waste Measurement Protocol[67] with the following options:

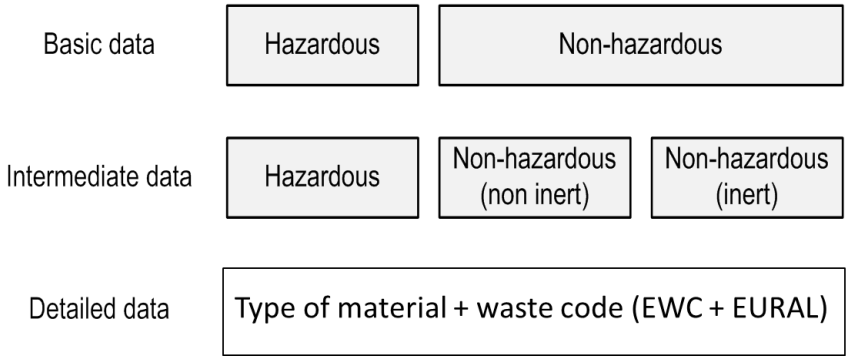


Figure 4 Levels of reporting of waste fractions

[67] Chapter 2.0 of Construction Waste Measurement Protocol, ENCORD 2013

- Inventory of elements (optional) can follow the similar structure. It should be noted that the materials of the elements listed in this part cannot be excluded from the inventory of waste materials (with the exception of "certain reuse")

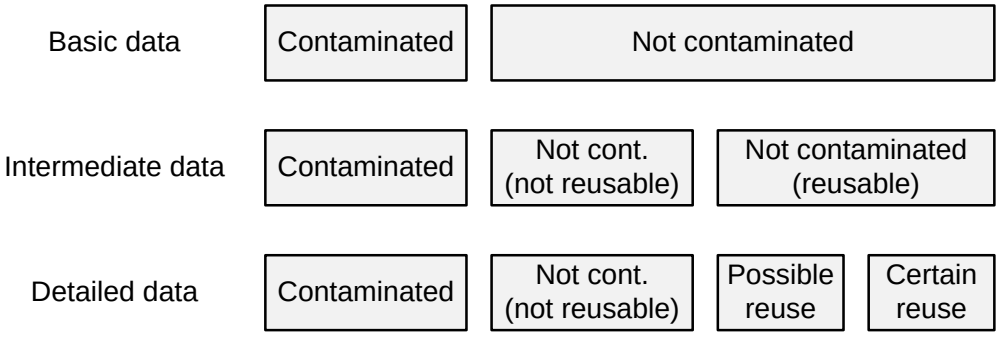


Figure 5 Levels of reporting of waste elements

If a more detailed assessment has been performed, a summary by floor/level can be included. The documents filled in with full details should be included as annexes to the report.

Waste management recommendations (optional)

- Summary by type of outlet and recommended management of each waste stream.
- Assessment of the reachable recovery targets and disposal rates that can be filled using recommended template (see Appendix F).
- List of local waste management facilities (if possible) specifying their services.
- Waste traceability process including recommended templates to be used (see Appendix G) and when possible person(s) or organization(s) responsible to perform waste traceability until the final outlet.
- Other information of interest for stakeholders involved in the project, included but not limited to legislative framework in the country and summary of responsibilities and liability of each of the stakeholders

guidelines / advise / focus of attention regarding the selective demolition works planned, for example: advise and guidelines for the safe removal of hazardous waste materials, re-use or recycling possibilities for certain (high value) materials present in the building, (legally binding) conditions for storage, transport and treatment of certain materials, recommendations deriving from the limitations of the field survey, etc.

Appendix C: European Waste Catalogue

2014/955/EU: Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council establishes a list of waste defined by six-digit code. The different types of wastes are divided into 20 chapters. The numbers of these chapters are the first two-digit numbers of the waste code.

Chapter 17 groups together "Construction and demolition wastes (including excavated soil from contaminated sites)", but some waste that can be found on a jobsite can be linked to other chapters. Anyway it is important to state that other sort of waste should be present in the building as furniture, fire safety equipment, etc. that has to be recorded in the waste audit.

The different types of waste that need to be identified, should fit in one of the following groups:

- **Inert waste** - waste that does not undergo any significant physical, chemical or biological transformation. Inert waste will not affect other materials, even if they come into contact in any way likely to produce environmental pollution or harm to human health. Leachability and pollutant content of this waste need to be negligible.
- **Non-inert non-hazardous waste** - This group of wastes can be divided into:

  Metals - In general metals are easily recyclable, but if they are polluted or there is a big mixture of metals, they may not be recyclable and could need to be landfilled.

  Wood - Wood should be further divided in untreated (clean) wood; wood treated without hazardous substances and wood treated with hazardous substances (which should be treated as hazardous materials)

  PVC - PVC can be mechanically recycled easily, but an appropriate sorting is key to optimize PVC recycling rates. Main types of PVC identified are: stiff PVC and soft PVC

  Plaster – Mainly represented by gypsum-based construction materials.

  Packaging materials - Packaging wastes are subject to specific regulation (Directive 94/62/EC and amendments)

  Mixed non-hazardous waste - has the same characteristics as household waste and can be treated by the same processes.

  Hazardous waste - Hazardous waste was defined in Directive 2008/98/EC as that showing one or more of the hazardous properties listed in Annex III. Hazardous waste is subjected to specific precautions for their disposal, and is regulated all along Europe.

Considering the different regulations in the different Member States, this section represents only the most common situation in European Countries and should be considered merely as a recommendation.

A non-exhaustive list of materials that can be present in construction and demolition activities is given below.

17 CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)

17 01 concrete, bricks, tiles and ceramics
17 01 01 concrete
17 01 02 bricks
17 01 03 tiles and ceramics
17 01 06* mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substances
17 01 07 mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 02 wood, glass and plastic
17 02 01 wood
17 02 02 glass
17 02 03 plastic
17 02 04* glass, plastic and wood containing or contaminated with dangerous substances
17 03 bituminous mixtures, coal tar and tarred products
17 03 01* bituminous mixtures containing coal tar
17 03 02 bituminous mixtures other than those mentioned in 17 03 01

17 03 03* coal tar and tarred products
17 04 metals (includingtheir alloys)
17 04 01 copper, bronze, brass
17 04 02 aluminium
17 04 03 lead
17 04 04 zinc
17 04 05 iron and steel
17 04 06 tin
17 04 07 mixed metals
17 04 09* metal waste contaminated with dangerous substances
17 04 10* cables containing oil, coal tar and other dangerous substances
17 04 11 cables other than those mentioned in 17 04 10
17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil
17 05 03* soil and stones containing dangerous substances
17 05 04 soil and stones other than those mentioned in 17 05 03
17 05 05* dredging spoil containing dangerous substances
17 05 06 dredging spoil other than those mentioned in 17 05 05
17 05 07* track ballast containing dangerous substances
17 05 08 track ballast other than those mentioned in 17 05 07
17 06 insulation materials and asbestos-containing construction materials
17 06 01* insulation materials containing asbestos
17 06 03* other insulation materials consisting of or containing dangerous substances
17 06 04 insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05* construction materials containing asbestos (7)
17 08 gypsum-based construction material
17 08 01* gypsum-based construction materials contaminated with dangerous substances
17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01
17 09 other construction and demolition wastes
17 09 01* construction and demolition wastes containing mercury
17 09 02* construction and demolition wastes containing PCB (for example PCB-containing sealants, PCB-containing resin-based floorings, PCB-containing sealed glazing units, PCB-containing capacitors)
17 09 03* other construction and demolition wastes (including mixed wastes) containing dangerous substances
17 09 04 mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03

02 WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATION AND PROCESSING

02 01 wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing
02 01 08* agrochemical waste containing dangerous substances

03 WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS AND FURNITURE, PULP, PAPER AND CARDBOARD
03 03 wastes from pulp, paper and cardboard production and processing
03 03 08 wastes from sorting of paper and cardboard destined for recycling

04 WASTES FROM THE LEATHER, FUR AND TEXTILE INDUSTRIES
04 02 wastes from the textile industry
04 02 22 wastes from processed textile fibres

08 WASTES FROM THE MANUFACTURE, FORMULATION, SUPPLY AND USE (MFSU) OF COATINGS (PAINTS, VARNISHES AND VITREOUS ENAMELS), ADHESIVES, SEALANTS AND PRINTING INKS
08 01 wastes from MFSU and removal of paint and varnish
08 01 11* waste paint and varnish containing organic solvents or other dangerous substances
08 01 12 waste paint and varnish other than those mentioned in 08 01 11
08 01 13* sludges from paint or varnish containing organic solvents or other dangerous substances
08 01 19* aqueous suspensions containing paint or varnish containing organic solvents or other dangerous substances
08 02 wastes from MFSU of other coatings (including ceramic materials)
08 02 02 aqueous sludges containing ceramic materials
08 04 wastes from MFSU of adhesives and sealants (including waterproofing products)
08 04 09* waste adhesives and sealants containing organic solvents or other dangerous substances
08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09

12 WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS
12 01 wastes from shapingand
12 01 09* machining emulsions and solutions free of halogens
12 01 14* machining sludges containing dangerous substances

13 OIL WASTES AND WASTES OF LIQUID FUELS (except edible oils, and those in chapters 05, 12 and 19)
13 02 waste engine, gear and lubricating oils
13 02 05* mineral-based non-chlorinated engine, gear and lubricating oils
13 05 oil/water separator contents
13 05 02* sludges from oil/water separators

14 WASTE ORGANIC SOLVENTS, REFRIGERANTS AND PROPELLANTS (except 07 and 08)
14 06 waste organic solvents, refrigerants and foam/aerosol propellants
14 06 02* other halogenated solvents and solvent mixtures
14 06 03* other solvents and solvent mixtures

15 WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED
15 01 packaging (including separately collected municipal packaging waste)
15 01 01 paper and cardboard packaging)
15 01 02 plastic packaging

15 01 03 wooden packaging)
15 01 04 metallic packaging
15 01 05 composite packaging
15 01 06 mixed packaging
15 01 10* packaging containing residues of or contaminated by dangerous substances

15 02 absorbents, filter materials, wipingcloths and protective clothing

15 02 02* absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances

16 WASTES NOT OTHERWISE SPECIFIED IN THE LIST

16 01 end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)

16 01 07* oil filters
16 01 13* brake fluids
16 01 14* antifreeze fluids containing dangerous substances

16 02 wastes from electrical and electronic equipment

16 02 09* transformers and capacitors containing PCBs
16 02 11* discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 13* discarded equipment containing hazardous components (2) other than those mentioned in 16 02 09 to 16 02 12
16 02 14 discarded equipment other than those mentioned in 16 02 09 to 16 02 13

16 05 gases in pressure containers and discarded chemicals

16 05 06* laboratory chemicals, consisting of or containing dangerous substances, including mixtures of laboratory chemicals

16 06 batteries and accumulators

16 06 01* lead batteries
16 06 02* Ni-Cd batteries

18 WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (except kitchen and restaurant wastes not arising from immediate health care)

18 01 wastes from natal care, diagnosis, treatment or prevention of disease in humans

18 01 09* medicines other than those mentioned in 18 01 08

20 MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS

20 03 other municipal wastes

20 03 01 mixed municipal waste
20 03 07 bulky waste

Appendix D: Recommended template for inventory of materials

Minimum content:

BUILDING: **Relevant information:**

Type of material	Material identification	Waste code (EWC and EURAL)	Location	Quantity	Unit	Observations or other information

Summary table:

Building	Type of material	Material identification	Waste code (EWC and EURAL)	Quantity	Units	Total quantity
	Inert waste					
	Non-inert, non-hazardous waste					
	Hazardous waste					

Recommended content. Detailed assessment

BUILDING: **Level:** **Other relevant information:**

Construction unit:									
Type of material	**Material identification**	**Waste code (EWC and EURAL)**	**Location**	**Quantity**	**Unit**	**Possible outlets[1]**	**Recommended outlet[2]**	**Precautions to take during the deconstruction phase[3]**	**Pictures and notes**

1 Reuse; recycle; backfill; energy recovery; elimination
2 The recommended outlet must be identified taking into account the hierarchy of waste treatment and the potential possibilities in the proximity of the jobsite
3 Ex: do not leave the frame on the plasterboards, be careful to remove the power plugs, …

Recommended content. Summary

Building	Level	Material to evacuate	Construction units	Quantity/ weight	Unit	Recommended outlet
Building ...	Ground floor, Level 1, Level 2...					
		TOTAL OF INERT WASTES				
		TOTAL OF NON INERT NON HAZARDOUS WASTE				
		TOTAL OF HAZARDOUS WASTES				

Appendix E: Recommended template for inventory of building element

Recommended content

BUILDING: **Level:** **Other relevant information:**

Construction unit:								
Element	**Units**	**Location**	**Reusable**	**Possible markets**	**Quantity**	**Materials identification and Waste codes**	**Precautions to take during the deconstruction phase**	**Pictures and notes**

Materials present in the different elements should be detailed using the templates provided in Annex D.

Appendix F: Recommended template for waste management recommendations

BUILDING:
Level:
Other information:

Construction unit							
Type of material	**Waste code (EWC and EURAL)**	**Location**	**Possible outlets[1]**	**Recommended outlet[2]**	**Precautions to take during the deconstruction phase[3]**	**Handling precautions**	**Legal storage /transport/treatment conditions**

1 Reuse; recycle; backfill; energy recovery; elimination
2 The recommended outlet must be identified taking into account the hierarchy of waste treatment and the potential possibilities in the proximity of the jobsite
3 Ex: do not leave the frame on the plasterboards, be careful to remove the power plugs, …

SUMMARY BY TYPE OF OUTLET AND POTENTIAL RECOVERING RATES CALCULATION

	Total wastes			
Type of material	Material/ Waste	Quantity	Unit	Comments
Reuse				
Total tonnage of material reused				
Percentage of material reused				
Recycling				
Total tonnage of material recycled				
Percentage of material recycled				
Backfilling				
Total tonnage of material backfilled				
Percentage of material backfilled				
Energy recovery				
Total tonnage for energy recovery				
Percentage for energy recovery				
Elimination				
Total tonnage of material eliminated				
Percentage of material eliminated				

Rate of reuse	%
Rate of recycling	%
Rate of backfilling	%
Rate of energy recovery	%
Rate of elimination	%

Appendix G: Recommended template for waste traceability

WASTE AUDIT				SORTING			MANAGEMENT					
WASTE STREAM	WASTE CODE (EWC AND EURAL)	TYPE OF MATERIAL	PREVIEWED IN WASTE AUDIT	NEED TO SEPARATE	GENERATED	DEVIATIONS	REUSE	VALORISATION	DISPOSAL	MANAGED	DEVIATIONS	JUSTIFICATIONS AND SUPORTING DOCUMENTS

Appendix H: Check list

Identification and statistics

Building information

Name, ID and contact details of the building / structure owner.	
Identification of the year of design / construction / refurbishment.	
Identification of the main refurbishment interventions, if any.	
Identification of the uses and activities carried on.	
Elements inventory, including types, quantities, location, text descriptions, drawings and photographs.	

Waste inventory

Present reliable data about types (inert; non-inert or hazardous) and quantities of waste (*t*, m^3 *or other units*).	
Exhaustive identification and quantification of hazardous materials and dangerous substances.	
Identification and quantification of contaminated materials.	
Use the European List of Waste to assure comparability of data across the EU.	
Include also materials due to operation and use of the property.	
Provide a clear and readable report, summarising quantities by waste type and stream.	

Demolition site boundary conditions

Identify sensitive areas around the demolition site (schools, hospitals, pedestrian areas, etc.).	
Identify accesses, surroundings and free spaces to plan the best strategy for waste management.	
Identify also near waste transfer stations, sorting and recycling services and waste management plants	

Auditor requisites

Educative background on building materials, constructive systems, demolition and hazardous substances.	
Providing specific training and experience.	
Professional liability is considered by means of specific insurances.	
Ethic issues (environmental and health and safety issues) are taken into account.	
Independent from building owner, contractors and demolition companies.	

Traceability and control

Add description of material, origin and quality to the European List of Waste codes.	
Guarantee efficient supervision by local authorities or by an independent third party.	
Certify that demolition waste is selectively collected and subsequently gone through a tracing system, thereby assuring the processing company of the quality of the recycled demolition waste	
Control traceability and deviations with the following 3 key documents: *(Pre-demolition) waste audit - On-site waste management report - Waste management final report*	

Implementation

Illegal landfilling is banned and violators are prosecuted.	
Administration includes the waste audits as mandatory requirement for the permits.	
Demolition works and documentation are periodically supervised by the administration.	
Green Public Procurement is regularly applied by the administration contracts.	
Administration promotes Waste Audits and disseminates Best and Worst Practices.	

Key aspects