Annex

Content

I Profile of the Partners

SME (Small/Medium Enterprises)	
	Consulting & Construction Logistics (CCL) (Germany) (administrative coordination) Individual planning and execution of logistical concepts for supply and dumping on construction sites to reach a progressive high-grade construction with economical success.
	**Otto-Rüdiger Schulze, Wood and building material recycling GmbH & Co. KG** (Germany) Schulze is involved in the processing of wastes of all kinds, particularly wastes from building projects. It also focuses on waste-management logistics on large-scale building sites, and consultation within the framework of the law on recycling and waste-management with regard to the utilisation of waste to preserve natural resources.
BBE Gartenmöbel & Holzhandlung	**Betziner-Bauholz-Entsorgung & Weiterverarbeitung (BBE)** (Germany) Our firm is active in the building timber field. We do not consider building timber used in form-work on building sites as waste, but as an important raw product which can be put back on to the market.
JOCOLAR sociedade de construções, Lda	**JOCOLAR** (Portugal) JOCOLAR works for private and public companies normally as a general contractor and their motivation is to improve the productivity on the construction sites through a better management of materials. JOCOLAR, with other SMEs, has the project to build a network in order to introduce a candidature together with other European partners in the framework of CRAFT.

	TEMUNDO (Portugal) It has built schools, fire department houses, and military barracks and was charged of the restoration of several historic buildings, national monuments and churches. TEMUNDO co-operates with JOCOLAR on the search of appropriate construction sites that will be object of scientific assessment through CEIFA Ambiente.
	Duarte & Filhos, S.A. (Portugal) It was the first SME of construction and real estate in Portugal to be certified by the norm NP EN ISO 9002, since April of 2000, currently by norm NP EN ISO 9001:2000. Today it has as vision *"to offer the best products and services of the high and the average-high segment of the real estate market of Braga"*, settling its behaviour in the values of the Tradition, Seriousness, Innovation, Professionalism, Ability and Continuous Improvement.
	Semural, Lda (Portugal) A company dedicated to the management of municipal, industrial and of construction and demolition waste, applying its experience, solutions, human resources and equipment to the service of the customer. Services: Lease of containers, transport of waste, global management, municipal solid waste management, landfill management

	CONSUR (Spain) It is formed by 5 companies located in Andalusia and dedicated to building construction and architecture. The activities of Consur can be summarised as follows: • Support and promotion of RTD and Innovation activities, in order get improvements in the competitiveness levels of their associates. • Development and implementation of Occupational Risk Prevention Systems and Environmental Management Systems in building construction companies. • Collaboration with public and private initiatives and activities related to RTD in the construction (and compatible) sectors. • To constitute an agile and effective link for innovation support. • To represent a differentiated organizational model, with a solid basement
	Brandis OG Sön A/S (Denmark) Is a construction company, which focuses on the careful reconstruction of buildings and pursues the goal of re-utilising and providing high-quality recycling for the sorted materials.
	Nordahl & Axelsen 2000 Aps (Denmark) Is a firm specialized in restoration of old windows using energy-efficient processes that at the same time reduces environmental impact and improves working environment.
	SA Groupe 1000 (France) Is a construction company that currently employs 11 workers.
RTD (Research and Technical Development)	
TECHNISCHE UNIVERSITÄT DRESDEN	**TU Dresden** (Germany) (Scientific administration)

	The Institute for Waste Management and Contaminated Site Treatment combines research topics in waste management, in contaminated site treatment and in systems analysis. It facilitates the approach to a wide area of related problems in environmental science. The principle focus of research is besides science on the engineering and the specialist economical aspects.
	Umbra GmbH (Germany) Umbra GmbH is a management consultancy and a research institute. The main objective of Umbra GmbH is to consult enterprises and public organisations in all kinds of environmentally or quality orientated management. Its main competencies lie in the implementation of management systems (ISO 9001, ISO 14001 and EMAS), the optimisation of business processes, the support of start-up entrepreneurs, industrial safety, the setting up of networks and the realisation of training and expert meetings.
	Centre of Studies, Information and Education for the Environment, Lda (CEIFA Ambiente) (Portugal) The main objective of CEIFA's activities is the development and implementation of innovative, scientifically founded, socially and ecologically compatible concepts adapted to local needs. For this purpose, CEIFA operates in Portugal and other countries as a „network generator". CEIFA is developing sustainable solution for construction waste and logistic concepts.
	TecMinho - University / Enterprise Association for Development (Portugal) TecMinho is a non-profit organisation aiming to promote the region's development by stimulating new technologies and by promoting the transfer of knowledge between the University, the Enterprises and the surrounding environment. Its main purpose is to support services in the field of innovation

	through Continuous Education/Training, Technology Transfer, Academic Entrepreneurship, Industrial Property Protection and International Human Resources Mobility. Technology Transfer, Academic Entrepreneurship, Industrial Property Protection and International Human Resources Mobility.
	**IAT (Andalusian Institute of Technology)** (Spain, Portugal) IAT is a technology and innovation centre created as a private non-profit foundation by the Association of Industrial Engineers of Western Andalusia. It is located in Seville and Málaga (Spain) and has been certified as being of public interest. Its goal is to improve the competitive capacity of the companies and organisations. Its main fields of activity include Innovation and Technology projects, training, in-company innovation management, quality management, industrial design and simulation, environmental adaptation and information technologies
	**Raadvad** (Denmark) Raadvad Centre is an independent, non-profit, institution. It is specialized in the restoration of buildings with traditional crafts, materials and constructions, the promotion of the preservation of the Danish architectural heritage, including its character, its authenticity end its reasonable use, the promotion of the most appropriate economical methods of maintenance and restoration of old buildings, the dissemination of expertise in converting historic buildings to new purposes, especially in connection with the architecturally, design- and building technically aspects.
	**GIP FCIP Franche-Comté – CAFOC** (France) CAFOC is a public training service, which depends on the French Ministry of National Education, Higher Education and Research. It forms part of an

	extremely decentralised adult education network throughout France (GRETA). Its principal activities are: the ongoing adult training in all fields, the training of all people who are involved in adult education, the search and the development for European and international projects in particular in the sector of the environment.

II Country specific situation and requirements

II.1 Germany

The disposal standard of construction waste is very high in Germany. There are extensive regulations, which go far beyond the demands of the EU. These are mostly observed.

The waste flow has to be documented exactly. An utilisation of the waste has to be preferred to elimination due to legal demands.

Responsible for the waste disposal are principal and building contractor, but they usually engage disposal companies. Most common is the regulation that each craft is responsible for the disposal of its own waste. Because of that, the waste is usually only separated into min-eral construction waste, mixed construction waste, scrap, wood and packaging on large con-struction sites, on small sites (less than 500.000 Euro project volume) not even that. There are different ways of considering waste separation and disposal in the invitation to tender and the contracts, but they are not used very often. A possibility for improvement would be the separated placing of the disposal to one of the crafts or a disposal company for the entire construction site. This could optimise the logistic.

The disposal costs vary a lot and depend, apart from the disposal way and the regional dif-ferences, on the existence of deleterious substances in the waste. The share of the disposal costs of the project costs is about 0,3 – 3 %. Savings are possible here by an unmixed collection.

Core of the German waste law is the commercial and industrial waste management act (KrW-/AbfG). It contains general principles about the waste treatment (utilisation above elimination) and is substantiated by numerous decrees like the wood waste decree.

One initiative for the promotion of the utilisation of construction waste is the “guideline recy-cling” of the Federal Ministry for regional planning, construction and urban development. It is valid for projects on public real estate and projects financed by the states. It is the aim of the guideline to describe the measurements, which are necessary for an environmental friendly handling of the construction waste during planning and

execution. There are more concepts and initiatives of this kind, but they are not binding. There were several model projects re-garding waste avoidance and utilisation. Their success speaks for an implementation of these concepts.

A disposal company needs several permissions; furthermore, a certification is necessary if it wants to call itself “Entsorgungsfachbetrieb”.

Until the utilisation of waste, there is a strict prohibition of mixture. I.e., the waste may not be mixed until the analysis, even if it has the same waste catalogue number, in order to exclude an utilisation of highly polluted material. In general, proofs have to be kept for the elimination and utilisation of waste that needs monitoring. For waste that does not need monitoring this is only necessary, if the authority demands this.

Some dumping grounds refuse the acceptance of mixed construction waste, if there is no refuse of acceptance protocol of a sorting plant. At other dumping grounds the fees for mixed construction waste that contains a lot of valuable material are higher than those for waste with less valuable material. These measurements shall support the utilisation of mixed con-struction waste in sorting plants.

Mineral construction waste, wood, metal, glass, excavation soil, plastics and packaging can be utilised to a great extent, paint, coating, roofing felt, slab from asbestos cement, polyure-thane foam tins etc have to be eliminated. Mixed construction waste has to be sorted in a sorting plant first, the sorting rests have to be eliminated on dumping grounds or in a waste incinerating plant. For packaging exist extensive logistic and taking back systems.

II.2 Portugal

There is presently little or no separation or recycling of construction and demolition wastes (CDW) in Portugal. Although regional and national data on CDW are lacking, an estimated 6 000 000 tons of CDW are produced every year, including excavations and road wastes.

Some separation and valorisation concepts have been developed and implemented in medium to large-size cities (Ecopontos e Ecocentros), for fluxes of urban solid wastes such as glass, paper, plastic packages, and batteries, and some industrial wastes such as oils, tyres and metals. However, no system has yet been implemented to consider CDW.

Additionally, some CDW fluxes, mostly from demolition, are sometimes integrated in the recycling circuits (e.g. metals). Iron and steel are the most common materials to be separately collected and recycled through scrap operators. Nevertheless, the most common destination for CDW is landfill or illegal dumping that covers an estimated 90% of all CDW.

Reasons for this scenario include a lack of specific orientation and legislation on CDW and insufficient adequate destinations available for it, both of which encourage unlawful practices. There are, for example, very few recycling plants equipped to treat CDW fluxes, which are frequently contaminated. There is also insufficient control over the transgressions that still proliferate.

CDW are typically either dealt with directly by the construction companies, or collected by companies which also deal with industrial wastes. These collector companies usually offer rental services of the containers, collecting them periodically or when full, for taking to the final destination. Other services such as environmental assistance or full waste management can also be provided, but usually by larger or more qualified companies.

Deposition costs for CDW are variable and depend on the pricing policy of landfills, and can go from 30-50 €/ton for common industrial wastes to around 2-6 €/ton for clean demolition wastes.

II.3 Spain

Construction and Demolition Waste (CDW), code: C.E.R 170000, mainly comes from the demolition of buildings, residential and urban development and by unwanted materials left over from new construction projects. Usually these waste products are called “rubbish” and in accordance with Spanish legislation, Law 10/1998 on Waste B.O.E 22 April 1998 – it is the responsibility of each Autonomous Region. For waste caused by small house renovations, responsibility lies with each town council.

Construction and demolition waste is produced in great quantities, and in volumes greater than that produced by domestic waste. This waste is mainly disposed of in authorised rubbish dumps. The underlying costs of waste disposal make any other ecological operation apart from recycling non-competitive. This contributes to a rapid silting of both town and specialised rubbish dumps.

In the worst cases, construction and demolition waste disposal is uncontrolled having both ecological and visual consequences. Inert rubbish dumps should comply with all requirements stated by the Governing Body 99/31/CE on behalf of the European Union, 26 April 1999 relating to Waste Disposal.

In Spain, there are many Autonomous Communities that dedicate a specific section to construction and demolition waste in their respective Solid Urban Waste Plans (SUWs). Up until now only scales using quantitative data regarding the volumes of waste produced in the country are available. Often the above mentioned is related to the middle of the nineties, where the economic situation, specifically in the housing sector was very different to that of the last two to three years.

There is a great variety and difference within the results in Spain: The business sector has come up with figures like 760kg/inhab/year in some of the region's capitals, figures which differ from those mentioned previously. It is because of this that it is advisable to make estimations using a mean ratio. This mean ratio consists of the mean waste produced between the highest values indicated above and in a way that reflects its expected occupancy within the Spanish economy, so that the generation of CDWs and the economic cycles are linked. At the same time, one should bear in mind the new Standards coming into effect, set by the Ministry for Public Works, regarding Technical Inspections of Buildings, which have the likelihood increasing levels of CDW. With these reasons as a basis, a sufficient probable average can be considered between 520kg/inhab/year y 760kg/inhab/year. As a mean figure for the calculation, the idea can be applied using other extreme values (450 y 1.000kg/inhab/year) as a way of measuring the maximum and minimum requirements of infrastructure. Although this gap may appear extremely wide, it is actually not like this for two reasons: The highest levels of uncertainty lie in the initial data and the great variability in the waste produced through construction and demolition annually, which depends on the economic cycle and the construction activities in each region.

In Spain at the moment there is only one network of twelve recycling plants and this is insufficient. For this reason it is necessary to create more ambitious environmental activities based on plant selection and the reusing and recycling of the waste produced.

The most common method of waste collection is to deposit it in metal containers or building skips, which theoretically should be covered and emptied as soon as they are full. There are some cities where there are companies that collect and distribute the rubbish in small polypropylene sacks that hold between 1 and 2 m^3. The different types of CDW collected are transported to the appropriate authorised dumping grounds and only 5% are submitted for recycling or reuse.

All the waste is deposited in dumping grounds specifically designed for each type of waste material, or is submitted to the recycling processes. Household waste can be deposited in dumping grounds made for SUW.

In Spain, the transposition from the Directive 91/156/CEE, finally approved by the Law 10/1998 on Waste, has been put into effect. This has created an important gap between the rest of the European Union in terms of waste management. Also the absence of a nation-wide agreed legal trademark has added to the increasing differences between the Autonomous Regions.

The situation is not the same in all the country, although there are a number of differences between the Autonomous Regions: Navarra, Cataluña, Madrid and the Basque Country are the places which are continuing to develop their own waste management systems and legislation.

II.4 France

The waste management of building site forms integral part of the French legal standards: many initiatives have appeared these 5 last years. The regulation relates to all the phases of the waste management of waste: production, transport and elimination.

The authorities should have finalized most of the departmental plans of waste elimination of building site but local problems slow down the device: the dechetery are not all reachable for free to the craftsmen, some cities do not have any solution for companies waste…

However, in some areas, regrouping platforms of building site wastes, mechanical and manual sorting offices of the waste produced by the building sites are developping; actors of collecting and regrouping die are mobilized to propose to the companies global and fitted solutions.

Within the framework of waste elimination, the territory has effective dies for wood, paperboard, glass and the majority of packing waste. Concerning rubble, some dies of inert waste recycling can valorize them as aggregates.

The transporting, transiting, regrouping and eliminating companies of building site waste are submitted to a particular monitoring and are subjugated with the same regulation as the other companies of waste management.

The observance of the environmental regulation involves costs for the company and the solutions, which are proposed to them, increase these costs. The waste management represents approximately from 3% to 5% of the building work costs. The waste management must be integrated into each level of the actors' chain: building owner, project superintendent and companies so that they find together the most adapted solutions. An important work was undertaken on the integration of the waste management in private and public markets.

Quantitative and qualitative data given in the analysis show that there is a lack of follow-up concerning building site waste. Tracing the waste generated by construction, demolition and renovation sites are a needed step in establishing an efficient policy of waste reduction.

Each person needs to feel responsible for any action concerning construction site waste segregation. Everyone must respect the rules established by those in charge of the project and make proper use of recycling bins.

II.5 Denmark

In Denmark there are next to no outlet problems for reprocessed construction and demolition waste. Generally, marketing of recyclable construction and demolition waste is organized in line with marketing of virgin materials. Thus, most reprocessing and recycling centers trade in both virgin and recycled materials.

Denmark has implemented all EU directives on waste. In the field of building and construction waste Denmark has one of the highest recycling rates in Europe. Now the focus in Denmark is to shift from quantities to quality of the management. The data on waste amounts, different fractions and disposal of waste from building and construction waste is good.

There is full control of the waste streams at large construction sites that are also subject to inspection. At small construction sites were small craft companies work there might be some illegal disposal of inert waste. At the construction site there will always be some leftover materials and some incorrect deliveries. It should be possible to reuse some of these materials, but there are only few of these arrangements, eg. Rockwool takes back clean leftovers. It is more difficult for the producer to take back complex materials such as windows since they often are produced especially for this construction site. There are still problems with hazardous fraction of building and construction waste. The concepts of selective demolition and environmentally correct design can still be improved.

In particular the Danish waste tax has been a very efficient instrument to increase recycling of construction and demolition waste as the rate of recycling has increased from 25% to 92% since 1990.

In 1996 the Minister for Environment and Energy entered an agreement with the Danish Demolition Association (a section under The Danish Constractors' Association – now called Danish Construction) on selective demolition of building materials. The agreement is called Environmental control agreement of Danish Demolition Industries, NMK 96.

The section has 26 members and coves approx. 85% of the demolition marked. When a company joins the agreement all its demolition activities with more than 10 tonnes of waste are covered. The goal of the Demolition Association is to promote the most suitable demolition of buildings and plants, and to contribute to the most suitable handling and delivering of residual products, waste and contaminated soil.

In the town Århus some craft companies started a project called "The Green Craftsmen". Waste is one of the focus areas. Questions asked are: Should they sort it, does the waste belong to the costumer or to the company, who is responsible on a large construction site etc.

In January 2003 Waste Centre Denmark was able to find 22 companies that sell used materials like windows, doors, sanitary equipment, floors, tiles etc. Crushed concrete and tiles are used on the same level as virgin gravel. Asphalt is recycled. There are next to no outlet problems.

Only very few incineration plants and landfills have a certified quality and environmental management system. However, it is believed that some form of quality/environmental management system has been introduced, though not certified under e.g. ISO/EMAS. The largest waste carriers are certified, whereas the small ones only are so to a limited extent. The same picture is seen in the recycling industry.

II.6 Summary

	Denmark	Germany	France	Portugal	Spain	unit
Organisation of the construction project						
Average share of the disposal costs of the construction costs in your country						
- New building	Not recorded	0,5	10-15	<3	10-15	%
- Modernisation		1-2		<3		%
Waste amount of the following waste types:	1*)				0,52 – 0,76	
Demolition waste	0,13	0,73	0,28	0,32		t/inh
Construction site waste	0,34	0,05	0,23			t/inh
Road rubble	0,07	0,18	1,6	0,02		t/inh
Soil excavation	0,12	1,6	unknown	0,26		t/inh
National and municipal general conditions						
Responsibility for the waste disposal - on the construction site - during transportation	Principal and building contractor, both constr. site and transport.	Principal and building contractor (construction site and transportation)	Principal. Subcontracted companies.	Principal and constructor, during transportation also transportation company	Construction company. Subcontracted company.	
National/regional goals for the reduction/recycling of construction waste*	Yes	Yes	Yes	Yes	Yes	
Institutions which work on recycling concepts for construction site wastes*	Ministry of Environment and Ministry of Housing The Municipalities' Dep. of Environment	Bundesministerium für Raumordnung, Bauwesen und Städtebau, LAGA, KWTB, TU Dresden, TU Berlin,...	Environmental Minister with the local administration and private institution	INR (national waste institute), Superior Technical Institute, Minho University, Porto University	Environment Minister in collaboration with the Autonomous Regions.	
Conditions which have to be met during the disposal of construction site waste*	Yes	Yes	Yes	Yes	Yes	

Municipal waste disposal plans / management concepts*	Yes	Yes	Yes	No	Yes	
Obligation for waste concepts concerning the construction site	Yes	Partly	No	No	Yes	
Taxes for the disposal of construction waste	50,6 €/t for landfill 44,6 €/t for incineration Recycled waste and hazardous waste is exempted from tax	0	0 for construction waste 18 €/t for toxic waste 9 €/t for non-hazardous waste	0	0	
Conditions concerning waste separation and disposal in the planning permission	Yes	No	No	No	Yes	
Supervision of the construction waste disposal*	Yes	Yes	Yes	No	Yes	
Conditions for the disposal plants*	Yes	Yes	Yes	yes	Yes	
Container services, disposal companies, disposal plants						
Size of disposal companies (few large companies or many small companies or both?)	Few large and many small	Few large and many small	Two large, many small	20% large, 80% small	Many small	
Usual costs of disposal for the following waste types: Demolition waste Construction site waste Road rubble Soil excavation	 Sorted waste: 13,5€/t + tax Unsorted: 117 €/t + tax	 1-120 100-200 1-150 1-20	 0-10 in dumping grounds, 10-30 in recycling plants	 2-6 30-50 8 1	 20	 €/t €/t €/t €/t
Usual way of disposal for the following waste types: Demolition waste	 Recycling	 Recycling				

Construction site waste Road rubble Soil excavation	Recycling Recycling Recycling	Dumping ground Recycling Recycling				
Services of the container services and disposal companies*	- Provision and transportation of containers - Sorting of mixed construction waste	- Provision and transportation of containers - Sorting of mixed construction waste	- Provision and transportation of containers	- Provision and transportation of containers - Waste collection - Disposal at destination	- Provision and transportation of containers	
Usual container types and sizes	- Container 7, 10 and 15 m³	- -Container 7 and 10 m³ - 240 l barrel - 1,1 m³ container - Big bags 0,5 – 2 m³	- Metal containers 7, 10, 15 and 30 m³ - Big bags 2 m³	- Metal containers 6, 12 and 20 m³	- Metal containers 3 and 7 m³ - Polypropylene sacks 1 and 2 m³	
Number of disposal companies which are certified after one of the following management systems: - Quality management - Environmental management	 3 3	No data but rather high	No data but very low	 <1 <1	<2%	 % %
Activities for the promotion of the utilisation of construction waste						
Self obligation of the associations in the field of construction and disposal*	Yes	Yes	No	No	Yes	
Reception systems for packaging*	Yes	Yes	Yes	No	No	
Recycling orientated concepts*	Yes	Yes	No	No	No	
Recycling centres*	Yes	Yes	Yes	No	Yes	
Consultation/training for the protagonists of the construction projects for the handling of construction waste*	Yes	Few	Few	No	Few	

III Waste Management Guideline

III.1 Introduction

III.1.1 The process of waste management

To push the thinking (behaviour) up to a more ecological and economic waste management at building sites and to guarantee the success of the waste management in a building project, all relevant actors should be trained before the beginning of the construction work.

Especially the responsible of the building contractors (site management), as well as the responsible civil engineers / architects of the planning- and architect offices have to be informed in time about the planned procedure, beginning with the basic investigations up to the documentation of the waste disposal.

It is not sufficient to transfer the necessary knowledge about recycling- and construction waste management only, it is also important to turn the generally existing resentiments against changes of the common policy into a high motivation during the preparation and the construction period.

The steps to an optimal waste management can be structured as follows:

1. Basic investigations and planning of the waste management at the building site:

- Examination of legal conditions regarding waste management
- Investigation of waste avoidance possibilities
- Design of a disposal- concept
- Design of a concept for control demolition (only for demolition measures)

2. Call for tenders and assignment of the disposal

- Design of the bill of quantities
- Development of contract clauses for the waste separation and disposal
- Investigation of savings by waste management (if necessary)

3. Waste management during construction period

- Determination of responsibilities for the disposal
- Employee information of all executing companies

- Control of sort-pure waste separation
- Organisation of container placement, internal/external waste transportation and – disposal

4. Documentation of waste disposal

- Documents to prove the disposal
- Implementation of a waste – and cost balance
- Final report

The extent to which the participating actors are integrated in the different training phases varies. While the owners have an influence on all phases of the waste management, the construction and disposal companies only play an important role during the construction period and concerning the documentation.

As part of the new service “Waste Management On Building Sites” the disposal companies should offer the owner to design the basic investigations as well as the planning of the strict waste separation. In this case, the disposal company would conduct the central disposal of the building site and therefore the disposal tendering would be cancelled.

III.2 New- and re-construction projects

III.2.1 Basic investigations and –planning

The basic investigations and - planning helps to create a disposal concept. This concept determines which fractions of waste have to be collected separately at the construction site and which re-utilisation or removal-process they should be conducted to.

For the design of the concept, all necessary information about the building project, planned work and deadlines have to be collected and considered.

In particular, the following steps are important:

1. Examination of measures to reduce the total waste amount
2. Investigation of local conditions (building analysis, existing vacant areas, infrastructure)
3. Investigation of waste types and amounts

4. Determination of the waste separation on the building site under consideration of ways of disposal.

In addition, the disposal concept – in the case of a re-construction project – has to be complemented with a re-construction concept, because the waste types, waste separation and -recycling depend on the disassembly-depth and the used demolition-technology.

III.2.1.1 Waste avoidance

Despite the possibilities of waste avoidance being very limited on building sites, a waste a-voidance obligation should be contained in the contract between the building owner and the construction company. This is a voluntary agreement, which can influence the good will of the participants.

On the building site, the construction companies can actively contribute to waste avoidance by applying the following measures:

- No packaging for weather-resistant building material
- Use of reusable packaging
- Use of taking-back systems for not used material and chemicals
- Proper storage of not-weather-resistant material and construction products on the building site
- Avoidance of rest contents by complete consumption and optimal emptying of bundles

A much higher impact than the building execution on both, quantitative and qualitative waste amount has the planning period.

Appropriate demands of the building owner guarantee for example the use of ‘ecological’ or recycled building material, the construction of ‘long lasting’ buildings, the labelling of the used material and the use of removable connections between structural elements of different life-time.

III.2.1.2 Investigation of local conditions

For a disposal concept, information about local conditions is necessary since the waste separation into numerous fractions needs corresponding vacant area, for example. In addition to that, one also has to consider the building site as well as road-infrastructure

and -quality, because this might cause certain restrictions for the waste transportation (e.g. with regard to container sizes, security regulations, distances...).

In France, regulations concerning the distances between the production waste place and the treatment waste place are prescribed from waste treatment department. Waste, which is produced in one department, has to be treated in this department. If it doesn't exist then it could be treated in another department.

For deconstruction, modernisation and repair projects also general information about the building is needed, which allows to determine type and composition of the used building materials.

General information about the building

From the building type and its use (e.g. residential building in slab method) and the time, in which the building was established respectively modernised / repaired, important data about the building structure and the assigned building materials (e.g. asbestos) can be derived. The necessary information can be found in documents (like construction drawings, building application and tender).

Now in France, asbestos inspections have to be done in all olds buildings (public and private buildings) where this type of materiel could have been used. If some asbestos is found, work has to be realized to remove it.

This data should be confirmed and/or specified by a detailed building inspection and this inventory should be recorded photographically. An on-site inspection is necessary in each case with buildings for which no or only insufficient construction documents are available (e.g. old buildings), or for those with a suspicion on contamination.

Building location

The location of planned and/or existing buildings can be of substantial importance for disposal logistics. With building projects in city centres with high inhabitant density possibly special safety regulations have to be considered, for example sufficient shut-off of the building site and security of the waste containers to avoid unauthorised use (by fence or/and use of containers with covers).

For the collection of information about the building location and its immediate/closer environment, a city map and a development plan can be used additional to a site inspection.

Infrastructure

The existing infrastructure in the periphery of the planned construction site, (e.g. the widths of the surrounding roads), should be considered likewise. It has to be clarified for example whether even larger disposal vehicles can reach the building site. Traffic obstructions caused by the delivery or the evacuation of containers should be avoided. Within closely populated areas (e.g. in city centres), this, however, is not always possible.

A route map for the collection of waste and containers in and near the construction site can help to organise the waste localization and transportation. On this plan, the localization of the containers and wastes, the suggested route to the site, best places to stop and turn the trucks, and the preferable timetable for collecting the containers and waste, based on the construction works and the local traffic can be represented.

Vacant areas

For the placement of the container, an appropriate space is required. Therefore it must be determined, how much vacant surface is available in the direct environment of the existing or planned building, without hindering the construction process.

It has to be clarified in advance which areas are needed for the construction site (construction and sanitary container, storage areas). Possibly a container site can be integrated. If the-re is not enough space for the containers (the exact total space requirement is known after the determination of the degree of waste separation, existing lawns as well as public areas like parking lots, sidewalks etc. should be taken into consideration. However, it has to be examined whether those areas are suitable to locate waste containers (sufficient distance to trees), and whether such a use is legal. During the planned period of use of public areas as container storage or as transportation ways for the disposal vehicles it also has to be examined, which fees are raised by the authorities, since these costs can become a severe cost factor, that can be underestimated – especially with construction measures during a longer period of time.

If there is very little space available, the choice of waste containers is limited and has to be adapted with regard to type/kind and seize. This might restrict the number of the different waste types to be separated.

This problem can be solved by a decentralised container placement at/in different locations and/or the use of smaller containers that have to be emptied more often. The

use of smaller containers, however, results in significant rise of specific transportation costs, therefore the profitability of this variant has to be examined.

If, in case of the modernisation of buildings, those buildings remain inhabited during the construction period, it is possible that restrictions can occur with regard to the selection of the container area. One has to consider that the tenants, if they have access, also use the containers to dispose their bulk waste. In this case one has to take measures to guarantee a clean and safe building site.

Therefore the container sites should not be located at an exposed location, it should not hinder the entrance to the buildings and in any case it should be fenced.

III.2.1.3 Determination of waste types and –amounts

To define the different waste fractions that have to be separated and collected on the building site, first all types of waste that arise during the construction period should be listed in-dependently of their way of disposal.

- Waste that results in building projects can principally be categorised as follows:
- Waste resulting from dismantling- and demolition activity (e.g. mineral construction waste, dismantled objects like heaters or windows)
- Waste that derives from the construction work like remaining and blend of the used material
- Packages of used material and assembly objects
- Litter of the construction worker places

Apart from type and extent of the building project, the total waste amount also depends to a high extent on the construction phase. For new building projects (above ground construction), for each 1000 m³ of enclosed space 20 – 40 m² of waste can be calculated as rule of thumb. 25 % of this arises during the carcass phase and 75 % during the development phase. For extensive modernisation projects, one can calculate 150 - 400 m³ waste each 0.5 million € construction volume. However, there can be significant deviations from this approximate value, for example, if the exterior installations are redesigned and large quantities of soil excavation arise.

The waste amount calculation should rather be volume based and not based on weight units, because this procedure is usually linked to smaller uncertainties (who knows the weight of a door or a heater pipe?). Moreover, during the construction period it is possible – if required - to run a daily waste balance on the basis of container seizes and

level of filling or it is possible to run a craft specific waste assignment according to the volume.

Construction waste:

A first rough estimation of the resulting waste types and amounts can be accomplished due to a general building description, how it is used during the tendering of building projects. Of course, the work that has to be done determines the resulting waste.

For demolition and modernisation/repair projects/measures, for a more accurate definition of the resulting waste types and –amounts one can use information from the bill of quantities that was used for the tender of the building project.

Apart from the detailed description of the construction work and assembly parts, the bill of quantities also contains the description of the disassembly work.

The objects, which can be dismantled, are mostly described by type and size, so that a volume-based calculation of the resulting waste is possible.

If some single measures are missing (e.g. the doors which can be dismantled are indicated only by height and width, but not by its material thickness) or the bill of quantities do not contain data about the different materials of which the disassembly objects consist, further information, that can be won - to a large extent - by a site inspection.

Apart from the wastes from disassembly work, specified explicitly in the bill of quantities, also the wastes, which result from assembly works, have to be considered.

To these belong, among other things, blend material, break remainders (e.g. tiles and masonry units) as well as resulting remainders which result from the hardening of the working material (e.g. paint, cement). For the estimation of these quantities of waste, experience and knowledge of specialists can be helpful. With these types of waste it should be considered that the resulting quantities depend very strongly on the work execution, causing a larger uncertainty in the prognosis of the waste volume.

With the determination of the waste volume that has to be disposed, the bulk density in the containers also has to be considered. For example, 10 doors with a volume of about 0.2 m³ need substantially more than a volume of 2 m³ in the container. Depending on kind and form of the waste, the volume in the waste container can increase by the factor 2 - 3. Due to the very different consistency and form of the wastes, no overall data can be given here. In principle however, the larger and "bulkier" a waste is, the higher the bulk density in the container. Therefore, for soil excavation, sand, roofing felt only

small surcharges are to apply. The waste volume is strongly influenced by container type and size.

For accessible container for example, windows can be stacked very closely, is the container for example too short for the disposal of doors, container volume remains unused. Additional to that, the loading method is important, which also finally reflects the motivation of the staff involved in the waste disposal in the long run.

In order not to under-estimate and to miscalculate the total disposal costs, all waste types should be multiplied with a security-factor of about 1,2 to 1,3.

The procedure to estimate the waste amount in new building projects is shown in the following example. The attached form/protocol can be used to determine waste amount for demolition and disassembly work, which also can be a component of reparation and modernisation measures.

For new building projects the stocktaking becomes much more difficult, since it is difficult to estimate the resulting waste quantity and -composition on basis of the tender documents only.

In this case, experiences from finished building projects should be considered, respectively one should collect information from experts of construction companies concerning the planned work.

In this case experiences from finished building projects should be referred to, respectively information according to planned construction works should be received from expert firms. If the desired data is not available, there is the possibility of asking the bidder in context of the tender of construction work to set up an estimation about waste types and amounts and to develop a disposal concept on this data.

Packing waste

The resulting packaging also depends on the intended construction works; the quantities however cannot be calculated on the basis of the building specification and the bill of quantities.

Depending on the product manufacturer, packaging types and -volume can differ, thus resulting types and quantities of waste have to be calculated roughly on basis of empirical values. There are also uncertainties in the estimation of recycled packaging because its share is not known in advance. If the collected information is not sufficient to estimate the different waste-fraction quantities, the total waste volume has to be estimated for all waste fractions and referred to the total construction project costs. As

rough index value for new building- and modernisation/reparation projects about 15 to 30 m³ packaging waste for each 0.5 million € construction costs can be calculated.

The described method is connected with large uncertainties, however the effects on the calculation of the total waste amount are comparatively small.

For two reasons: first, disposal costs are relatively low and the use of suitable taking-back systems is even free of charge; second, most packages can be collected in so called 'Big Bags' (plastic-bag with a volume of between 0.5 – 2 m³) that only need little space and can be used flexible.

During retreating demolition projects the building packaging can be quantitatively neglected.

Litter

The amount of litter that arises in the worker places and -offices depends directly on the number of workers employed on the building site as well as on the project duration. This litter is almost equal to residential waste but has a smaller share of organic material that can be composted. Up to now, on building sites this waste has not been collected separately. With the introduction of a concept to optimise waste separation in a building project of more than 0.5 Mio € cost volume and sufficient vacant areas, the litter should also be collected separately in the following fractions:

- Glass
- Paper, paperboard, printware
- Lightweight packaging
- Aluminium cans
- „Others"

Collection and disposal of glass- and lightweight packaging by take-back-systems is free of charge. Paper- / paperboard disposal causes certain disposal cost since this waste is collected together with printed wares .

As a rough value one can calculate per 10 workers and per one-month construction time:

- About 1 m³ printed wares, paperboard-/paper packing,
- About 1 m³ lightweight packaging,
- About 0.5 m³ glass, 

- About 0.5 m³ „others“.

III.2.1.4 Determination of waste separation and container logistics

After estimating waste types and –quantities, one has to determine in a second step the appropriate degree of waste separation (number and type of the different waste fractions that have to be collected separately) considering the regional re-use possibilities and –costs as well as the available vacant areas.

For the decision, in how many waste fractions it shall be separated, both, the range of the building project and the procedure of the co-ordination and control of the sort-pure waste collection are important factors.

If there is a disposal co-ordinator, who is permanently present on the building site, separated collection is realistic, even with more than 10 different waste fractions.

In Portugal and Spain, a disposal co-ordinator is still a very improbable entity to be encountered on the construction sites. Therefore, the number of waste fractions should be normally as the lowest number of essential fractions of separated wastes that can be handled and may have distinct destination. It would not be feasible to separate if there is no destination for the specific item separated.

The following procedure should be applied with the investigation of the frame conditions to determine the waste separation:

1. Allocation of the different waste fractions and –materials to the ‘waste key numbers’ and descriptions, concerning the waste catalogue.

2. Investigation of the regional ways of disposal for the different waste types,

3. Allocation of material with the same ‘waste key’ and the same way of disposal to the same waste fraction,

4. Determination of the waste that has to be collected separately under consideration of the disposal logistics, the organisation of the waste separation and the time of waste production.

Investigation of the ways of disposal

To succeed in the waste management objectives (minimisation of the waste amounts that have to be disposed and where possible the re-use on a high level), the respective ways of disposal for the different waste fractions have to be known. While examining the regional available ways of disposal, apart from the conditions concerning the

composition of the different waste fractions one also has to investigate the resulting costs and revenues.

Because of regional differences concerning the ways of disposal, different demands with regard to purity and cleanness of the different waste types are possible.

Depending on the way of utilisation, e.g. for material usage of wood, little share of chip boards (as far as they do not contain formaldehyde) can be contained in the wood fraction. In the case of mineral building waste, depending on the disposal plant, the share of ceramic material must not exceed a certain percentage.

Further conditions could exist with regard to the measurement of the material that has to be disposed (e.g. old metals), making it necessary to run an appropriate preparation on the building site.

To systematise, before the determination of the ways of disposal one should apply a classification of the waste concerning the European waste catalogue.

Since the allocation is not always clear, the regional disposal companies or the respective environment authorities have to be consulted to get the correct ‘waste key’ number.

For waste consisting of different materials (e.g. windows, heating pipes with isolation), the separation at the construction site should only be considered if the necessary time for this separation is small, the disposal costs can be reduced and the recycling quotas be raised.

The data received in this way allows determining the regional ways of disposal. It also has to be considered that not all possible ways of utilisation are available for a certain building project. To use the different ways of utilisation, disposal plants respectively collecting points should be available in the region to in order to keep the transportation distances low.

The disposal possibilities of the substantial construction waste types are listed in a register of disposal ways. Additional to the disposal ways, the register also contains the following information:

- Waste descriptions due to the European waste catalogue
- Often used trivial names
- The waste catalogue number due to the European waste catalogue
- Contacts/addresses of the responsible companies with regard to ways of utilisation, those only have a small popularity in Germany respectively with regard to special

take-back systems for construction waste (e.g. take-back of construction waste by Interseroh).

For many waste types, there are several disposal ways, making it necessary that economic aspects and local peculiarities have to be considered in the selection.

As an alternative the disposal way can be determined in a tender of disposal. In this case one has to collect offers from different regional disposal companies for the waste fractions that have to be disposed. Then, the selection of the disposal ways depends on the disposal cost; utilisation should be favoured, dumping avoided.

Waste fractions (Waste types that have to be separated)

The degree of waste separation at the construction site should be determined under consideration of the following basic rules:

- Waste amount per fraction
- Requirements for the need of supervision of the waste
- Period of waste production
- Appropriate container types
- Required container space
- Organisation of the waste management on the construction site
- Available ways of disposal
- Allocation of waste into waste fractions

In a first step, those waste types that can be collected together because of the same waste key and the same disposal way should be the same fraction. One has to consider that the waste key can change depending on the separation on the construction site and the disposal way. For example, if concrete is collected separately, it has a different waste key than if it is disposed together with other waste as ‘mixed building- and demolition waste’. Therefore, waste that can be utilised either as a mixed fraction or as a separated fraction, should be considered as waste that has to be separated.

From this procedure, depending on the building project might result between 5 and 50 different waste fractions. A reduction of the number of waste fractions that have to be separated should be done in a next step with regard to the waste amount per fraction.

If the total waste amount of a certain waste fraction – except hazardous waste - in a building project is very small (less than 2 – 3 m^3), a separate, sort-pure collection generally will not be economic. This is due to the fact that the disposal of quantitatively unimportant waste fractions causes relative high costs for the container rent and – transportation. Sometimes waste types that generate relatively high revenues can be collected in Big Bags without taking much space (e.g. copper cable).

Separating waste at the construction site into numerous fractions, not only economic calculations but also ecological aspects have to be considered. On the one hand each waste fraction requires a separate waste container, on the other transportation of each fraction causes certain emissions. This means that the higher environmental damage has to be balanced with a higher separation depth that causes it because a deeper separation requires more and smaller containers meaning more transportation traffic.

Independent of the waste amount per fraction, also the objectives with reference to waste ordinances in respect to the disposal of removable waste and hazardous waste have to be considered.

Therefore, additional to the classification of the waste fractions due to European waste catalogue a classification due to the need for supervision is necessary.

Whether the waste is classified as ‘waste to supervise’ or ‘waste to especially supervise’ can be checked with the list of disposal ways that has already been introduced.

The commercial and industrial waste management act says that hazardous waste has to be disposed separately and must not be collected together with the fraction of ‘mixed building waste’.

It is the same with ‘waste to supervise’, which have to be removed, like roofing felt that is not needed at the moment for example.

In this case the waste producer has to pay the higher cost (compared to the disposal as ‘mixed building waste’) that is connected to legal disposal.

Time period

Whether a separate collection of a certain waste fraction makes sense is determined not only by the total amounts of the fractions, but also the period of time in which this waste fraction is produced. In this period of time, the respective container for this waste fraction has to be rented and space is required.

Thus, the work termination of the different crafts has a large impact on the needed container seizes. For example, for a building project it does not make sense to use a 7

m³ container for wood if wood waste is only produced every 2 months. On basis of a list of the different crafts according to their work termination, a waste-referred timetable has to be developed.

For certain waste fractions that arise during the whole building project (e.g. ‘mixed building waste’ or ‘litter’) containers should be placed continuously.

Container logistics

Selection of suitable container for waste collection

After the determination of the waste fractions that have to be separated and their disposal ways, the next step is to determine for each waste fraction – under consideration of local conditions – the necessary container type, -size and the numbers of containers. Since the cost for container-rent and –transportation play an important role in the container selection, one should demand for information about price differences of the different container sizes and –types of the regional disposal companies.

As alternative to this procedure, it is possible to demand information from the disposal companies – independent of the container size and rent duration – about a standard price per disposed m³ waste, transport and rent included. In this case no additional rent costs would emerge, also with an extended container-use. But in this case, the disposal companies usually assume a minimal container-volume of a dimension of about 7 m³.

For the waste collection at construction sites, containers of a size between 1 – 40 m³ are used. Containers of a size of 7 m³ or 10 m³ are very common, because those guarantee a good relation of space requirement, transportation costs and rental period. For the waste that emerges in a short period of time and in large quantities (e.g. soil excavation) it has to be examined whether self-loading vehicles are less expensive and better to organise than the container-collection. For the different types of litter, either the use of 240-l-rubbish bins or 1.1 m³ large trashcans in different colours is suitable.

Lightweight waste (e.g. packaging or building polystyrene) should be collected in so-called ‘Big Bags’. Big Bags are robust, tear resistant plastic bags with a volume between 0.5 m³ and 2 m³ and can be fixed on a metal post. Waste collection with Big Bags has the advantage that there is no rental cost. Moreover those bags can be stored on the construction site until the work is finished respectively, until the number of Big Bags is large enough to guarantee an economic transport. Thus the transportation cost can be optimised in comparison to containers that need special vehicles. Furthermore, the space requirement of Big Bags is small and they can be moved to a different place in case of a shortage of space.

Selecting a container type it also has to be examined whether the containers have to be protected for foreign filling and weather impacts with regard to the container placement. In these cases one has to use closed respectively topped container. Moreover, special requirements on the waste collection and container type have to be considered in respect to some waste fractions like asbestos material or ‘hazardous waste’ for example. Information about those requirements can be taken either from the competent environmental authorities or from the disposal companies that are licensed to dispose this waste.

For a decentralised waste collection directly at the working place of the construction site or on the different building floors, additional appropriate containers should be placed there. For this, depending on the waste type smaller collection-containers like buckets or Big Bags can be used. For mineral construction waste bulk dumps should be used, for packing material skeleton containers or plastic bags. For the selection of those containers, especially practical handling and local conditions at the working place have to be considered. Full containers might have to be transported on narrow stairs and have to be light enough for one person to transport. In case that the container at the working places should be lockable in order that each craft only can use its ‘own‘ container, on larger construction sites there is the possibility to use dustbins (e.g. 240-l-volume)

Determination of space requirements for the containers

For the determination of the space requirements for the containers, first one should determine whether one central collection point or several waste collection points should be established, and whether additional to that a decentralised waste collection should be established inside the building. In this selection the distances between working places and container sites have to be considered, because the additional time spent on waste separation should be kept as small as possible. Otherwise a small acceptance among the workers is expected.

Determining the locations for the container sites it has to be considered that they have to be located as close as possible to the construction object respectively in direct neighbourhood to the intermediate storage facility and cutting facilities of wood, metal etc., with possible direct assignment of the produced reminders, to guarantee an easy access for the construction workers. Besides, the location should be chosen to be easily reached by the crane (swivel-ling range). Moreover, unhindered access and transportation/removal has to be guaranteed.

The required space results from the number of required containers at the same time. Therefore, to determine the total space requirement, the container sites of all containers have to be known. Furthermore, one has to assume that the construction site is organised

in a way that full containers are exchanged with empty ones in time. For an appropriate use of the available vacant area a sketch can be helpful.

If the container space requirement should be higher than the area available, smaller containers have to be used. In this case the following aspects have to be considered: On the one hand some special waste fractions need a certain minimum container size because of the dimension of the dismantled objects (e.g. windows or heating elements), making it impossible to use arbitrarily small containers. On the other hand, with only little space a flexible transportation/removal of the container is important in particular. Besides, smaller containers can cause higher specific costs because of the higher transportation expenditure.

If under optimisation of the container logistics the container site-space is not sufficient (e.g. in high building density area in city centres), the degree of waste separation has to be reduced, for example in a way that fractions with small total amount are assigned to the fraction ‘mixed construction waste’.

If the container sites only cover a part of the vacant area that can be used, it is also possible to use several containers for a waste fraction with high amount, to avoid a bottleneck in transportation.

Organisation of waste collection and –disposal

For the determination of the different waste types that have to be collected separately, the organisational basic conditions must not be neglected including the available personnel capacity. Therefore the following questions have to be clarified in advance of the building project.

- Who is responsible for the container placement and –emptying in time, and how much time he should be engaged in this task?
- Is it possible to separate the waste into the planned fractions at the working places with appropriate expenditure, or is it necessary to sort the waste afterwards at the container site, and is enough personal available?
- To what extent will the sort-pure waste separation be controlled?

III.2.2 Tender and assignment

An important assumption for low disposal costs and high recycling quotas is, that it is already determined in the tender, that the different crafts are not charged with waste

disposal, but the responsibility is only assigned to one single building company or the responsibility is directly assigned to only one single disposal company.

In both cases, all waste fractions of all crafts are disposed together at one central waste collection point on the construction site.

In a building project with a general company, there is the possibility to invite tenders for all disposal services at the construction site not by the building owner but by the general company.

Tendering bigger waste amounts, substantially lower disposal costs can be realised than if each craft organises itself the disposal of its waste - mostly as mixed construction waste -.

In the same time, in case of larger waste amounts the degree of waste separation and thus the recycling quota can be raised, also under economic aspects. Using larger containers generally cuts the disposal cost.

Advantages for the building owner in case of separated tender and assignment of the disposal are a better control of the regular disposal as well as the direct participation on the savings of the disposal cost.

But, on the other hand, the building owner has the disadvantage of an additional expenditure beginning with the tender up to the accounting and control of the disposal, which would be done by the building company in case of a ‘conventional’ procedure.

Consideration of the disposal in the tender

In general, the waste disposal can get a higher value in the tender by the following determinations:

1. Classification of the disposal costs as a separate position (this leads the bidders to focus more on the disposal costs and the building owner can decide about the procedure of whether to have a separate tender of the disposal or not),

2. Hint that the client can reduce the order-amount by the disposal costs and to as-sign the disposal services separately,

3. Obligation of the building companies to run a sort-pure waste separation and – collection into given fractions (this assumes that the separation depth is already determined at this time and the control of waste separation in the execution takes place to a sufficient ex-tent),

4. Demand of a share of mixed building waste < 15 volume- or weight-percent. The documentation has to be done by the general company respectively by the craft, which is responsible for all building waste. If more waste arises, penalties are possible,

5. Obligation to submit - together with the offer - a disposal concept which contains indications for all waste fractions concerning ways of disposal, disposal companies and –facilities, and which shows whether the disposal procedure belongs to the category ‚recycling' or ‚elimination' (not for building companies if the disposal services are tendered separately by the building owner),

6. Disposal by certified disposal companies only,

7. Submission of all disposal proofs with reference to waste ordinances at the assignment.

These measurements improve the conditions for a better waste separation and –recycling.

If a single craft (which is active during the whole construction period, respectively in new building projects starting at least in the development period) should organise the disposal in a building project, in which there is no general company assigned with the construction work, this already has to be noted in the tender documents.

Because the responsible craft, in general, cannot estimate the total waste volume of all crafts participating in the building project, the payment of the waste disposal might be on proof. For this purpose, the tender documents should demand the disposal costs for the different waste fractions, making the accounting on basis of these documents possible. In the tender documents of the different crafts, it also has to be pointed out that the disposal must not be calculated, but that they are obliged to separate waste and to use the containers provided.

There are no problems with the assignment of the disposal cost between the different crafts by this procedure. At many building sites, there is waste that cannot be allocated to a certain craft. The building owner itself at his own costs usually disposes this waste. The building companies, however, can go to court against a distribution of these costs-like it is the usual procedure in practice – as long as the building owner is not able to prove who is the responsible.

Tender of disposal by the building owner

The tender of disposal by the building owner (the general company respectively) causes additionally a certain personnel and financial expenditure, making it interesting for larger building projects only.

With the tender of the disposal, the building owner engages in a task that has been conducted generally by the building companies up to now. In principle, the building owner can reduce its expenditure by - similarly to most building companies – making a general contract for all building sites with one disposal company. This general contract should not last longer than one year because of the short-term changes in the disposal market. By demanding regularly offers of other disposal companies, the building owner can inform himself about the current market prices.

The quality of the tender documents finally depends on the information, which is available in advance, for the building owner, respectively the planners. In each case, he has to demand the standard prices from the disposal companies, for all waste types that are planned to be collected and disposed separately. A comparison of the different bidders becomes easier if the total amount of each waste fraction, the desired container size as well as container placement duration are known and thus a total price can be determined. As contingent position, prices for transportation costs and container placement should be demanded, classified according to the different container sizes. The accounting of the disposal should take place on prove because of the large uncertainties with the estimation of waste amounts.

Additional services of the disposal companies could exist in a multi-language labelling of the waste containers. With not fully fenced building sites or with modernisation projects in still inhabited buildings for example, the use of topped containers as well as the fencing of the container site is necessary. This however requires a guarantee that the containers are accessible for the use by the workers during the whole building project without higher organisational expenditure.

It also has to be examined whether because of the height of the disposal costs and the planned construction period, the engagement of disposal personal (e.g. disposal co-ordinators) can be financed. Moreover it has to be clarified whether the building owner, the (general) building company or the disposal company has to make disposal workers available. This depends essentially on the tasks that have to be done and the required presence on the building site. Higher qualified activities like control- and information activities, determination of weak points and determination of core numbers for example, could be conducted by employees of the building owner or the general building company.

With larger new building projects, it makes sense, from the organisational and financial point of view, that not the different crafts but the staff of the disposal company is

responsible for the on-site waste transportation out of the working places to a central container site. The ser-vice of the disposal company would in this case also cover the placement and the emptying of containers at the working places. The advantage for the building companies would be that better qualified personal is not employed in auxiliary activities (like waste transportation). The waste transportation also may happen in the evening or in the night after the construction work has stopped, because at this time the construction elevator is not needed to transport construction material and an obstruction of the building process is not given (is avoided). The regular filling of the waste container would remain the task of the crafts, because the possible variant 'simply to drop the waste at the point of occurrence' cannot be recommended out of pedagogical considerations, because it does not lead to a developed environmental consciousness of the building companies and their employees.

For modernisation-, reparation and smaller new building projects with only little available space at the working places, respectively shorter transportation distances to the central container site, the waste transportation on the building site can be conducted by the crafts. The main tasks for the disposal staff in this case would be the on-site waste separation and disposal, the management of the container site including the container placement.

Further tasks of the disposal personal concerning waste management on building sites, among others, might be:

- General cleaning of the building site,
- Detailed information of the construction companies about waste handling,
- Control of waste separation by photographic documentation,
- After-sorting of mixed waste,
- Disassembly of composite material,
- Application of the required permission to use public areas (e.g. as container site or as transportation ways),
- Free of charge re-establishment of all areas that are destroyed by the container and transportation vehicles (e.g. lawn),
- Regular participation in building consultations,
- On-site material transportation.

An important incentive for the implementation of a resource-saving waste management on building sites is the reduction of disposal cost, thus the total cost of the building project. If the building owner is not basically convinced that the disposal costs are

reduced by a central disposal and a sort-pure waste separation, he has to collect information via the tender and the contract negotiations, that allow him to judge the economic efficiency.

The following variants are possible:

Variant 1

- The crafts are indicated that the disposal will be assigned separately, the disposal is not to be calculated and they are obliged to a sort-pure waste separation.

- The building owner/planner estimates the disposal costs on its own under the assumption that each craft only disposes its own waste and that there is only a certain basic separation into 4 to 5 fractions. This variant requires an investigation of the waste composition for each craft and a comparison of the average price of different regional disposal companies. Because of the high share of mixed construction waste and the small waste a-mounts per craft, the disposal cost might be higher than with a central disposal (but in this case the additional expenditure of the planning/tender, the control and accounting of the disposal, costs of the disposal staff, if necessary, has to be considered). The determination of the degree of waste separation with the ’conventional’ procedure is subject to a certain ‘subjectivity’ because in practice, there are significant differences depending on building company and –project. To get more detailed information one has to interrogate the engaged building companies about the usually applied waste separation at the building site.

- The cost savings by a centralised building site disposal and the optimised waste separation result in the difference of the real accounted costs and the calculated costs in a ‚conventional’ building project.

Variant 1 should be applied at re-construction-, modernisation- and reparation projects, since these building projects allow at least an approximate estimation of the waste volume on the basis of the tender documents.

Variant 2

- Within the tender of the building works, a position ‘disposal’ is listed separately and the bidders are indicated that the client reserves himself to reduce the total order volume by the disposal cost and assign the disposal separately. The obligation to a sort-pure waste separation remains. In addition, a form sheet is added to the disposal documents in which the bidders have to enter in the waste types and –amounts and the disposal costs that result from their work. By a comparison of the estimations of the different bidders (of a craft), the building owner gets a basis for the tender of the disposal. Additional to that, the building owner cannot include plausible statements (like, for example, the statement: waste will not be produced) in the bidder-negotiations.

- The savings for the building owner result from the difference between the separated disposal costs and the real incurred costs and the costs accounted by the disposal company.

Variant 2 should be applied at new-building projects, because with such building projects, generally an estimation of the resulting waste amount is only possible if waste reference numbers of comparable projects are available for the building owner.

Tender of disposal by the building company

For most of the building companies it makes sense to make a general contract with a disposal company for all building sites, whose conditions are examined at least annually by a comparison with offers of other disposal companies.

A tender with reference to building site only makes sense for the general building company, respectively the main building craft, if waste of the whole building site has to be disposed, respectively if there are special requirements for the disposal company (e.g. employment of a disposal co-ordinator), which are not included in the general contract.

Contract design

In general, the essential clauses with regard to waste separation and waste recycling should be taken from the tender documents into the contract with the building owner.

For building projects, in which the waste of the whole building site is centrally disposed, the different crafts have to be obliged by contract to sort-pure waste separation into the given waste fractions and to transportation to the central collection points. In case of an inadmissible mixing of recyclable waste, that can be assigned clearly (photographically documented if possible) to one single / a certain craft, there should be planned penalties, after a certain period of time for after-sorting. The height of the penalties should be linked to the amount of mixed waste (e.g. 50 € /m³). If the after-sorting is conducted by the staff of the disposal company, it is also possible to agree by contract to charge the responsible these cost/expenses.

If different overall costs depending upon the craft are determined for the waste disposal, the-re is the disadvantage that there are - apart from penalties - no incentives for the crafts to avoid waste or to separate waste sort-purely. A small incentive could be created by a con-tract-agreement, that plans to participate the building companies on savings according to their building volume, if the total disposal costs of the building site (after the project is finished) are below an in advance defined value. If a craft-specific assignment of disposal costs is possible, the motivation of a sort-pure waste separation

can be pushed, because each craft can benefit of savings, independent of the behaviour of the other crafts.

For building projects with a general building company it is important to oblige the sub-companies by contract to separate waste and to orderly use of the placed containers. The sub-companies have to pay for this service overall costs or the accounting can be on proof. But this requires a clear assignment of the waste to the different sub-companies. This is possible for large new building projects, in which each craft has its own lockable waste container on each floor. The lump accounting of the disposal requires the availability of respective craft specific core numbers of other building projects for the general building company. Since, de-pending upon the craft, the share of the disposal costs on the total building volume differs strongly, a uniform percentage of 0.5 % for example referred to the craft-specific construction costs, cannot be justified.

The maximum share of mixed construction waste listed here refers to the whole building project. A calculation of these amounts to the different crafts would be unfair because there is also work that causes a share of mixed building waste of more than 15 %.

Example for the procedure: the bidders estimate the following waste amounts for the main building craft:

Company	**1**	**2**	**3**	**4**
Mixed construction waste:	200	150	300	20
Wood:	50	70	120	30
Mineral construction waste:	80	40	50	10
Scrap:	3	1	5	2
Amount	**333**	**261**	**475**	**62**

These indications help the building owner to estimate at least roughly the waste amount. In this case the data of company 1 should be taken for the tender of disposal for example, be-cause they are in the middle of the companies 1-3. Moreover it can be assumed that the data of company 4 is wrong and much too small. This should be subject in the tender consultations/negotiations and be considered in case of extraction of the disposal out of the order volume.

With indications of the crafts about disposal costs, the same procedure can be chosen. In this case however, there should be only a small span because the disposal prices per m³

differ only marginally. Furthermore the building owner can inform himself about the disposal costs in his region.

This approach shall be illustrated with an example. The building owner agrees with the crafts to be participated in the savings with 50 % as long as the total disposal amount is less than 50 000 €. After finishing the building project, the disposal cost amount to 35 000 €. The saved cost of 15 000 € are divided as follows: 7 500 (50 %) remain with the building owner, the other 7 500 are divided to all participating crafts according to their building volume.

For modernisation/reparation projects, that are relatively waste intensive, this means, with our experience, a building volume of more than 2.5 Mio. €. With a share of the disposal costs of the building project amount of 1-2 %, this means a disposal volume of 25 000 – 50 000 €. For new building projects, the total building volume should be at least 5 million €, since in this case the share of disposal costs in general is below 0.5 %.

In general, it makes sense to interview the building companies about the central waste management at the building site in order to find weaknesses and to implement optimisations in future building projects. An example for a questionnaire is listed afterwards.

III.2.3 Construction execution

During the execution it has to be guaranteed that the placed container are used according to their determination. Therefore, the following measures have to be taken during the execution:

- Determination of responsibilities for the waste separation and disposal
- Information of all workers at the building site
- Motivation of the workers
- Control of waste separation

Determination of responsibilities

To guarantee a sort-pure waste separation it is necessary that responsibilities are determined clearly. Therefore, at least for the following activities, responsibles have to be named.

- Preparation of training and creation of information material for the employees,
- Information of all participants of the building project about waste separation and –recycling measures.
- Sort-pure container filling,
- Control of keeping the different waste fractions separate
- Guarantee of taking appropriate measures in case of wrong separation,
- Information of the construction supervisor about problems with the waste separation (perhaps participation at construction consultations),
- In-time information of the transportation and disposal companies for container exchange.
- Establishment of a monthly waste balance with regard to the building site including recycling quotas and disposal cost.
- Control of the disposal documentation, in order to guarantee the use of the planned ways of disposal,
- Examination of the bills of the disposal company,
- Continual project support for a continual waste management optimisation.

At least one responsible for all questions concerning disposal should be present respectively available by phone at the building site, at smaller building projects at least from time to time, at larger building projects continually all the time.

The responsibility for the waste management at the building site has not to be taken exclusively by the building owner or the site supervision, but it is also possible to determine different persons for the different responsibilities.

In this case however, responsibilities of the respective persons have to be determined clearly and have to be known to everyone at the building site. For certain responsibilities, it can make sense to be taken by the building companies. This, for example, is the case for the information flow about waste separation at the building site to the workers and the sub-companies. This is because the waste problem can vary depending upon the craft, and the previous knowledge inside the different companies with reference to waste separation can be very different.

Information

The responsible for the waste management at the building site should inform the different building companies in detail about waste separation and –disposal in advance of the beginning of the work of the respective craft. Important training elements, with which all employees of the building companies should be familiar with, are in particular:

- Information about the type and number of the waste fractions that are to be collected and separated at the building site,
- Assignment of the different material to the respective waste fractions,
- Requirements to the separate-keeping of the different waste fractions in the respective working places,
- Requirements to the separation of composite material and the re-processing of waste,
- Ways of disposal,
- Disposal cost.

Additional to that, the polishers and site supervisors also should be trained about requirements of the documentation with reference to waste ordinances.

The verbal training should be supplemented by an information sheet which is available for all crafts that take part in the building project and which is also put up at the building site (e.g. at the central container site). This information sheet it should contain at least, which material is assigned to which container, and the phone number of the ‘waste manager’, the disposal company respectively, also should be listed.

Motivation

To realise a sort-pure waste separation at the building site, not only the building companies should be informed comprehensively about the waste management, but also to motivate the project management including its employees. It is to be made clear for the employees why they will have in future -in contrary to their previous behaviour, and possibly in contrary to their employers’ previous behaviour- to separate waste into different fractions already at the working places, although this, in general, means for them more work.

The following arguments can serve as motivation for the employees:

- Relief of stress on the environment (e.g. presentation of recycling quotas with and without waste separation)
- Waste law (legal obligation to waste separation and -recycling)
- Cost reduction (reduction of the disposal costs by stricter waste separation)
- Clean and save building site (by a sort-pure collection of waste already in the working places, and a establishment of a central container site)
- Competitive advantages (the building company stands out itself from the competitors by an exemplary waste separation at the building site; this can be used for advertising purposes)
- Protection of jobs (the listed advantages finally lead to a job protection)
- Penalties (in case of non sort-pure separation, employees could be forced to a after-sorting, for example)

Additional to that, there is the possibility to participate the employees at the cost savings, either by paying the money out proportionately, or by using the money for a company party. This approach however requires the existence of an approach to estimate the savings. As an alternative, a certain recycling quota can be determined as target that has to be exceeded.

Control

To guarantee a clean separation of the waste fractions, clear controlling measures have to be determined. The following questions have to be clarified in advance of the building project.

- Who controls the sort-purity of the waste fractions and who is responsible? (The responsible at the building site is to be known to all employees)
- When do controls take place, respectively in which interval should they take place?

Basically, it makes sense to control each filling of the container. But this complete control of the waste separation requires a continual presence of a responsible. To avoid a continual presence of one person that is exceptionally responsible for this task, the container site could be accessible only for some hours per day. If the containers are accessible during the whole period of work time, the control can take place in temporal intervals (e.g. once a day). In this case no additional worker has to be employed. In this variant, however, wrong filling is possible more often, making a good information and

high motivation of all workers necessary. Apart from that, it has to be determined exactly what to do in case of wrong filling.

Possible procedures in case of insufficient separation could be

- Information of the building supervisors about problems (perhaps during the building consultation when the building companies are present),
- Reprimance of the polluter, information about correct waste sorting at the same time,
- After-sorting (perhaps after work),
- Disposal of waste as expensive mixed fraction; in this case it has to be determined how to handle the higher costs
- Discovery of the reasons that lead to a wrong assignment of waste

Additional to the control of the container with regard to wrong filling, the whole building site including the working areas should be controlled with regard to forbidden waste storing. This should be documented photographically and the polluter has to be found, if possible.

III.2.4 Documentation

After finishing the building project, a documentation containing at least the following information has to be established by the responsible project supervisor:

- Record book including the required documentation with reference to waste ordinances
- Waste balance with reference to the building site, which shows the share of mixed building waste as well as recycling quotas,

Disposal costs including realised savings

IV Training Concept

IV.1 Introduction – aims, target groups, present state, European perspective

The main aim of the training concept is to present the most important measurements on construction sites, waste avoidance and the ways of their practical realization.

Target Groups are building apprentices, building craftsmen, site foremen, qualified building workers.

Present state is that the principle of waste avoidance is lacking as an integral element of planning and implementation of a construction project. As a rule, waste avoidance measurements (f.i. packaging avoidance or optimisation of material usage) are either not known or not implemented on the construction site. Results are hazardous emissions and high disposal costs. As a solution of this problem, a European Waste manual for building construction (WAMBUCO) is produced which can be used as an organisational and calculation aid in all areas of construction.

The results of the research project can be used as a basis for development of a training concept in the education of qualified building workers. This concept has to be developed both for initial vocational training and for continuing vocational training. It gives both - young apprentices and skilled workers - a chance to be successful on the labour market because the waste management on construction sites is an important basis for cost optimisation and practical environmental protection.

European perspective:

With the ever-increasing influence of the European integration process it is sensible to develop a common training concept for the whole Europe. The next reason for a common European training concept is that in spite of a widespread variety of vocational education forms there are a lot of research and education programmes of the EU (Erasmus, Lingua, Leonardo da Vinci) in order to harmonize and coordinate the developments.

Moreover, approaching the training concept solely from a national point of view would only exacerbate the deficits concerning creation of common, high-level environmental standards for saving resources and avoiding waste in Europe and not take into account important

experiences gained in other European countries. The common training concept will introduce a unified EU environmental standard in the educational training of the building industry.

IV.2 The structure and learning contents of the training concept

The training concept can be divided into five main parts:

- Part 1 – **Introduction** with the description of the present state concerning the waste avoidance on construction sites and the contribution of waste avoidance on construction sites to social and economic objectives;
- Part 2 - **Country specific waste management on construction sites** with the summary about differences and commons in some Members States of the EU;
- Part 3 - **Ways of waste avoidance and reduction on construction sites –** this part is the most important one of training concept. It includes theoretical and empirical (on –site trade specific experiments in Germany and Portugal) information regarding waste avoidance measurements on construction sites;
- Part 4 - **Best-Practice-Examples for waste avoidance and reduction on construction sites –** here are the examples from the Best –Practice-Projects from five EU countries presented, which participate in the WAMBUCO-project. They illustrate how the utilized concepts on construction sites can be implemented in practice;
- Part 5 – **Recommendations –** these recommendations are not merely a theoretical structure elaborated from a waste management viewpoint, but also an easily understandable instrument which can be used by the building practitioner to evaluate building work in terms of issues of waste management. They contain individual experiences of the enterprises participating in the WAMBUCO project.

IV.3 Methods of teaching

IV.3.1 Ways to increase motivation to learn waste avoidance measurements and to use them in practice

The main aims of the part 1 and part 2 are to call attention of apprentices to the waste avoidance problems on construction sites and to motivate them to change the current practice in the near future.

Firstly it is necessary to describe the present state in the different countries of the European Union. The degree of recycling of waste materials specific to building sites varies greatly throughout the EU. In the chapter **" Present state regarding construction site waste in Europe"** the fact has to be emphasized that in spite of differences regarding recycling rates of construction waste in all EU countries, building projects exhibit a lack of waste avoidance and separation. The European perspective has to be made clear, especially the necessity to know the situation on construction sites all over Europe und not only in the home country.

The aim of the chapter **"Contribution of European waste management on large size construction sites to economic and social objectives"** is to increase the motivation of apprentices to learn the principles of waste management with low-waste and recycling orientation on the construction site in order to carry out it in their future development. Motivation, apprentice intent to learn, is one of the most important factors in successful accomplishment.

Apprentice's motivation to learn and to realize the learning contents can be influenced through interest in the learning task, which can be promoted either by utilization apprentice's interest in themselves by relating material to be learned to the apprentice's life or by vividness and novelty. One of the few possibilities to practice it is giving apprentices and skilled workers clearly defined options for an attractive career development. The implementation of waste avoidance and separation measurements helps creating a safe and clean building site – an aspect that will further project a positive image. In turn it will increase the latter's ability to attract contracts and thus safeguard jobs. It can be made more convincing for apprentices through numbers and figures from the WAMBUCO project.

The second way of making material more interesting for apprentices is accentuating the novel and vivid of learning contents. The effect of novelty hereby is that the WAMBUCO project is the first one, which provides support to establish a unified waste disposal standard for the building industry within the EU on the basis of detailed waste processing figures for the individual building trades. The vividness of the learning contents can be achieved through real examples from projects occurred in the frame of WAMBUCO. Photos and detailed waste processing figures (f.i. waste indexes) can be helpful in the learning process.

Some photos of waste management within experimental programs are below:

The teacher can increase motivation if he connects the feedback with the apprentice's feeling of success. A very good example for realization of this factor is the experience of the Portuguese participants in the WAMBUCO project. At the end of experimental program in vocational training centres all participating apprentices received certificates:

The main ways of increasing motivation are:

I Interest in the learning task affects apprentice's motivation

II Interest can be promoted through:

- Relating to apprentice's life
- Accentuating the novelty and vividness of learning contents

III Feedback is an important factor to increase the intent to learn

IV Feeling of success increases apprentice's effort.

IV.3.2 Teaching methods according to the Training concept

The fact, this concept can be used for both initial and continuing education, influences the teaching methods used for its realization. The learners are adults who bring their own experiences and meaning systems to the learning situation. Teachers can use these experiences as a learning resource.

Referred to the present training methods, which are used to teach the parts 1 and 2 (**Introduction** and **Country specific waste management on construction site),** the concept can enable apprentices to use their previous knowledge as a resource. If it is the continuing vocational course, building workers collected their own experiences on construction sites. They can express their opinion regarding present state and waste management on construction sites (Chapter 1.1). The method, suitable here, is guided discussion (sometimes called step-by-step discussion). The teacher has a carefully prepared sequence of questions that are directed towards the end of drawing from the learners the knowledge that they have implicitly but which they may not have crystallized or related to wider theoretical perspective. In the initial vocational education the teacher may endeavour to proceed from experiences collected during practical work as a part of vocational training.

The initial apprentices can work in groups. For instance, the chapter **"Country specific waste management on construction site"** contains a scope on information. The way to make apprentices acquainted with this learning content is lecture-discussion. This method assumes a different form: a short lecture followed by discussion. In this chapter it is very important to determinate the basic or essential information from five countries

(participating in the WAMBUCO project) and to present it in the simplest, clearest, and most understandable form. Otherwise a great scope of information may confuse the apprentices and leads to decreasing attention and interest.

Chapter **"Ways of waste avoidance and reduction on construction site"** is the core of the training concept. The chapter **"Summary"** can be presented in different ways. One of the methods to introduce the most important measurements of waste avoidance on construction sites is the traditional method-lecture. In order to focus the attention of apprentices, the teacher can use some visual teaching aids such as photos or diagrams.

The chapter **„Results of on-site investigation"** is practice oriented. It is well known that in vocational education the main focus is laying on relationship between theory and practice. That is why the basis of all training concept parts are data collected from real building sites and from training programs with practical orientation.

The chapter **"Optimisation of material usage in building constructions "** is based on the data from experimental programs carried out in vocational training centres in Portugal and in Germany. The information about results from experimental programmes can be presented as a lecture. In this chapter this method is the most suitable one. The apprentices don't have any previous knowledge in this field because they didn't participate in experimental programs, which are described. They have firstly to learn the results and experiences collected during implementation of the programs. Some forms of visual stimuli may be useful in helping students to recall the information and ideas with which they have been presented. Hereby, there are a lot of visual aids – schemes of construction, which were built, diagrams, graphs that resumed the results and photos from experimental programs.

Below are some photos to set-up of experimental program in Portugal:

At the end of the session it is useful to provide the opportunity for group discussions or questions, or for handout to be distributed, in order to help apprentices memorizing ideas etc.

The chapter **"Estimation of amount and composition of expected waste on the basis of waste indexes"** shows the importance and usefulness of waste indexes. Firstly, it is necessary to define the term "waste index". For the better comprehension of the waste indexes importance some tasks can be developed. In these tasks apprentices can calculate with help of waste indexes - how much and which kind of waste will be

produced by setting up building constructions. On the other hand it is necessary to show the advantages, which follow from this prognosis about waste yield and composition.

The methods to impart the learning material of this chapter can be both teacher-centred and apprentice-centred. But because of the novelty of terms lecture – discussion or seminar are recommendable. It is often useful to use technique in conjunction with the lecture, especially to help dividing the session and retaining apprentice's concentration.

The chapter **"Packaging waste avoidance measurements"** is similar to the chapter 3.1. In this respect the teaching methods resemble them. For a change an interview can be organized with skilled workers (especially in initial vocational training courses). The resource person (skilled worker or site foreman) has knowledge to the situation on construction sites. He can describe the current state regarding packaging avoiding measurements in EU-countries.

The teacher can complete the learning contents of this concept through results and country studies implemented within the framework of WAMBUCO (s. "Country specific studies" in WAMBUCO).

The chapters **"Best-Practice-Examples for waste avoidance and reduction on construction site"** and **"Recommendations"** are based on experiences and data collected in WAMBUCO. Best-Practice-examples from the five participating EU

countries are selected to illustrate that the utilised concepts refer to practice-oriented research results.

Learning contents of chapter **„Recommendations“** are taken from researches within specific country studies in WAMBUCO. The teacher has to take into account that the apprentices (even if they are without previous work experiences and skills) are getting acquainted waste avoidance measurements on construction sites within this training concept. Hence, the teacher has to encourage them to develop their own ideas concerning realization of waste management on construction sites with low-waste and cost-optimised orientation. The methods of teaching that are more suitable here are all forms of discussion: lecture – discussion, guided discussion or group discussion.

At the end of the learning course role-play can be prepared and carried out. In vocational education it is possible to devise many learning situations in which role-play would be a most natural method to employ. The situations that are suitable for role-play may deal with work organization on construction sites, teamwork within every trade or cooperation between trades on construction sites with considering of waste avoidance measurements.

It is clearly seen that there is a great variety of teaching methods appropriate for the introduction of waste management as learning content into initial and continuing education. In dependence on the age, experiences and skills of apprentices some methods are more suitable than others. The teacher should use the experiences and previous knowledge of apprentices as a learning resource and choose the methods in accordance with it.

IV.3.3 Teaching aids according to the training concept

In the same way that teachers of adults in initial or continuing vocational training should be aware of and able to employ a variety of teaching methods, they should also be aware of and be able to use a variety of teaching aids. It is important to know that such a variety of aids exist and that it is useful to have some expertise in their use. Some of the teaching aids are listed below:

- Audio aids: audio cassettes, radio, records
- Audio-visual: films, tapes, slides
- Visual models, diagrams, drawings, graphs, illustrations, photos
- Learning aids: books, computer programs, handouts, role-play, work books/sheets.

Such variety of teaching aids and equipment ensures that students may be able to learn in accordance with their preferred learning style. Indeed, the greater the variety of appropriate aids employed the more likely it is that learning will be supported. Considerable research has already been conducted into the relationship between learning and audio-visual communications. It was ascertained that the audio-visual aids play a very important role in the learning process.

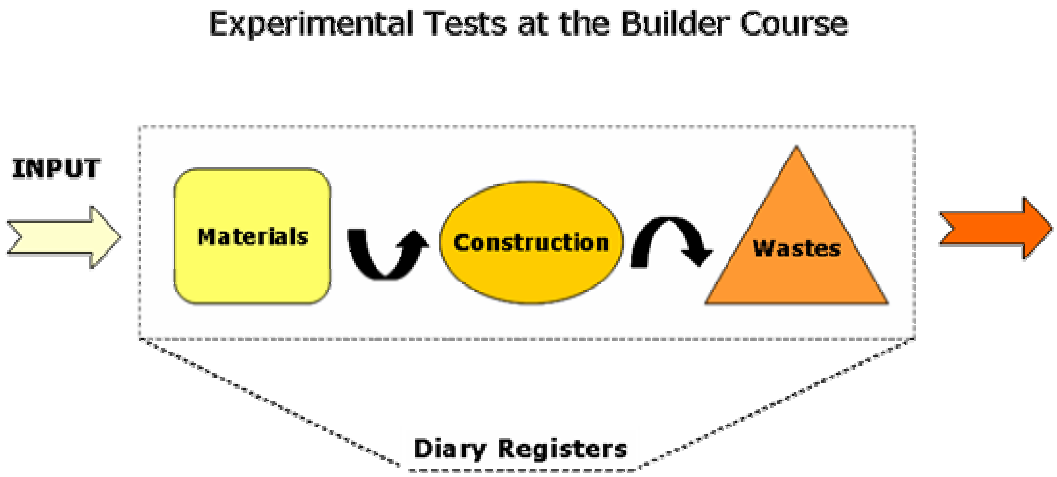
As for the present training concept, the great stress is laid on the visual aids. It follows from this that the bases of the training concept are results and researches within WAMBUCO. A multitude of different visual material results from the fact that the progress of the project was documented monthly in written and photographic form by the research institutions. Some of visual aids from WAMBUCO project can be used to facilitate the comprehension of the training concept.

Drawings and schemes:

This type of visual aids is very helpful for emphasizing of essential information. The schemes reflect complex connection in a simple and clear form.

Examples:

The scheme below demonstrates a work plan, which consisted in daily registers of every waste production concerning goal of experimental program:



Photos:

Photographs enable the relation to the real life and focus the audience's attention. They help students watching people, places, and different items. They provide information beyond the teacher's speech and the interest level of the students.

The photos from WAMBUCO illustrate on-site investigations regarding waste management on construction sites. There are many photos that document experimental programs, which are the basis of chapter Optimisation of material usage in building constructions.

Examples:

These photos can focus the attention of apprentices because they document the experiences in data collection

Fig. 1: Test - Series in Portugal:

Fig. 2: Test – Series in Germany

Diagrams, graphs, tables:

These visuals illustrate complex concepts that are difficult to visualize. They reinforce the key components of verbal message and aid the audience's comprehension.

Examples:

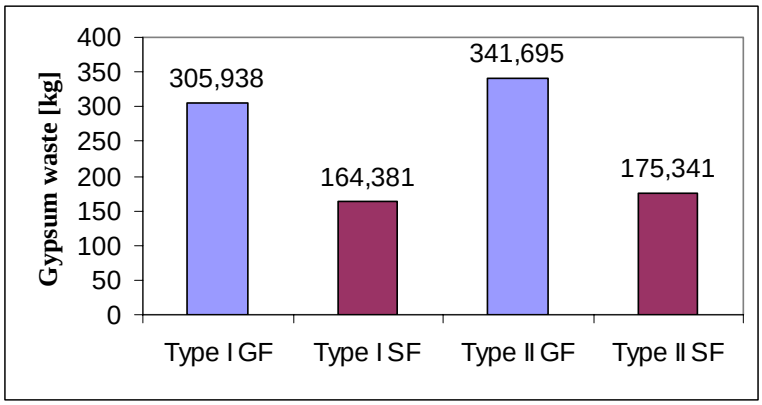


Fig. 3: Illustration: Correlation between gypsum waste yield and plasterboard format

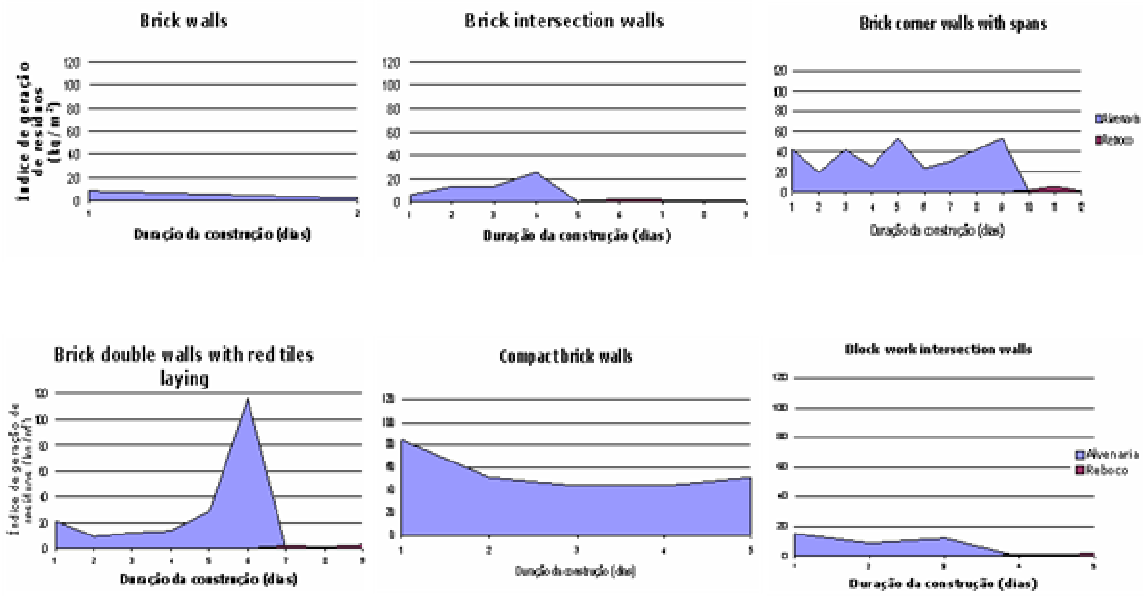


Fig. 4: Illustration: Comparison of construction waste production between six different types of masonry walls

The advantages of using visual teaching aids are:

- Focusing the audience's attention
- Reinforcing the key components of the verbal message
- Stimulating and maintaining interest
- Illustrating complex concepts that are difficult to visualize
- Aid the audience's comprehension
- Increasing retention.

IV.4 Conclusions

The actual discussion of problems of the labour market – and consequently of vocational education and training as preparation for it – is stamped by the experience of different challenges. These challenges or so-called mega trends are under others: growing internationalisation of economy, worldwide use of resources and of environmental conditions and possibilities of systemic rationalization. All industrialized countries are confronted by these challenges, and the consequences are modifications of educational structures and contents. The present training concept is a result of these modifications. Unlike conventional training concepts, this one has European perspective and contains new information concerning efficient economic and environmental strategies on construction sites. The reasons for a common European concept (instead of several national concepts) are related to WAMBUCO and to experiences in connection with it.

The present training concept is aimed for both young building apprentices without any skills and skilled building workers. It is necessary in order to make both target groups competitive on the labour market. Nowadays, the building industry is confronted not only by the increase of costs for building material and for waste disposal, but also with the extension of legal requirements regarding the environmental protection. Only building enterprises with low waste and cost orientation will be competitive on the market in the future.

The main recommendations regarding the teaching methods and aids consider, that there are two different target groups. Here, the issue is not which methods and aids are the best, the issue is which methods and aids are useful for the efficient realization of the training concept within the vocational education in the building sector. By choice of teaching methods and aids it is of importance to use the experiences and previous knowledge of apprentices as a learning resource. It is necessary to employ the methods and aids, which can increase apprentice's motivation and guarantee high learning effectiveness.

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V Innovative technologies to prevent/minimize the amount of waste

In the following chapter best practice applications about avoidance or utilization of building waste in Europe will be presented. The described procedures or techniques were identified by the partners of the project or applied to the examined building sites of the project. For each example information about the following points will be given:

- Possibilities for waste avoidance
- Conditions for re-use
- Handling of separation and collection
- Costs

V.1 Material: wood

Investigating country: Germany

Potential for waste reduction											
Low									X		High
Potential for re-use											
Low									X		High
Potential for recycling											
Low									X		High
Costs/Valorisation											
High Costs									X		High value

Carport made of used wood

Possibilities for waste avoidance

Wood is a versatile material, which is used in many ways on the construction site. It is part of the building itself (windows, doors, roof trusses etc.) and it is used as an aid (e.g. shuttering formwork). While auxiliary constructions are made for the moment, the "main" constructions are made to last for years, even centuries. But both should be used as long and often as possible.

Treating or covering the wood with chemicals usually achieves this. Another way is to take the natural qualities into consideration. Some trees have wood, which is naturally weather resistant, like larch or oak. It also makes a difference, which part of the tree trunk is used. The inner part of the trunk is soaked with natural resin, which makes it more resistant against water.

If a direct re-use is not possible anymore, the wood can be recycled easily.

Conditions for re-use

A re-utilisation of construction wood regarding firmness and shrinkage and swelling is principally possible. Constructions like shuttering formwork, construction barriers or pallets can be used three or four times. The constructions have to be viewed closely regarding abrasion. If necessary, the constructions need to be dismantled carefully.

Also high-order constructions, like floor joists, windows, doors or even roof trusses, can be re-used. Old constructions are often of very high quality and may be preferred out of aesthetic reasons.

Coverings may be flaked off, but residuals may remain in the wood. This has to be taken into consideration regarding the way and place of re-use.

If the constructions are not in a state to be re-used directly and the wood is not treated, the wood may be used for glued wood constructions. The used wood is preferable to new wood, since the moistness has already reached an optimum. A disposition to crack initiation has shown itself and can be taken into consideration. About 70% of the used construction wood can be used this way.

Recycling is possible either energetically or materially. For a material recycling the wood needs to be free of any foreign substances. Then it can be made into wood chipping, which in turn are the basis for chipboards or bridle way covering. Another acceptor of untreated wood for a material recycling is the paper industry. Furthermore, it can be used as mulch for soil covering or as a structural element for composting sewage sludge . Wood, which has been treated in any way, can only be recycled energetically. For that it can be made into pellets or briquettes , which will be fired in gasification or incineration plants.

Handling of separation and collection

For a re-use the constructions have to be dismantled as carefully as possible. This is also advisable for recycling, since the wood has to be stored separately in three divisions: not contaminated, contaminated and impure. Only the not contaminated wood can be recycled materially. If it is mixed with contaminated (chemically treated or coated) wood, it has to be burnt as well.

In order to prepare the wood for recycling, it has to be separated from any other material and sized down. This is usually done in five steps:

1. Breaking the wood into a manageable size
2. Removal of metal with a magnet
3. Screening of small mineral material

4. Manual selection of foreign material (paper, stones, foil etc.)

5. Breaking the wood into the desired fractions

Costs

If the wood is re-used, there are no disposal costs – apart from collecting the wood on the construction site- and the expanses for new wood can be saved. So, valorisation is high.

If the wood is recycled, there are no disposal costs apart from collecting the wood on the construction site.

V.2 Material: Roof tiles Investigating country: Denmark

Potential for waste reduction										
Low										High
Potential for re-use										
Low										High
Potential for recycling										
Low										High
Costs/Valorisation										
High Costs										High value

Possibilities for waste avoidance

When restoring an old house with roof tiles long term experiences says, that it is possible to re-use and recycle about 40-60% of the old tiles. This is even the case when the tiles are about 100-150 years.

The existing tiles are careful rushed down the roof in skids . All complete tiles are reused at the same house, covering one side of the roof . Broken tiles are transported to crushing. On the other side of the roof new roof tiles are laid.

If there are no interest for re-using the roof tiles at the same house, as where they came from, there are about 10 roof tiles collecting and re-use firms or organisations in Denmark, which buy or collect old complete roof tiles. In some cases it is the local authorities in a town with many old houses, which runs this re-use centre for roof tiles and other building elements. In other cases it is private firms who do it as a business. One firm has even a web site where all their "products" various types and sizes of roof tiles are illustrated and priced.

As clay for bricks and roof tiles is a limited resource in Denmark, the re-use and recycling of old bricks and tiles is both saving this valuable resource and saving resources and money for the crushing etc.

Conditions for re-use

The recycling of roof tiles has been practised in Denmark for many years. On listed buildings it has been standard for 90 years. Therefore there is a lot of experience and a well-known practice for how to do.

One problem could be, that the new roof tiles are of a different length or size than the old, so it is difficult to combine the old and the new types. In this case, the tiles are also often collected carefully and sold or transported to one of the above mentioned roof tiles depots.

Handling of separation and collection

The roof tiles are easy to separate, when there is used lime mortar without cement to tighten the roof. There's no need for machinery etc. The human eye can see if the tiles are cracked, deteriorated or have broken edges. A little knock with the handle of a hammer will reveal through the sound if the tile has an invisible crack or interior damage.

All the damaged tiles are sorted to crushing.

Costs

If the roof tiles are re-used, there are no disposal costs – apart from collecting the tiles on the construction site- and the expenses for transportation.

V.3 Material: Lead white paint Investigating country: Denmark

Potential for waste reduction											
Low					X						High
Potential for re-use											

Low	**X**										High
Potential for recycling											
Low	**X**										High
Costs/Valorisation											
High Costs										**X**	High value

Possibilities for waste avoidance

Lead white is a pigment, which has been known since the classical antiquity. It was originally made by placing shreds of lead in an acid saturated vapour. The result and product was the extreme toxic white powder, lead acetate, also called lead white. This fine powder could be used as a white pigment in white linseed oil paint, where the lead substance accelerated the oxidation of the linseed oil, so the paint would harden quicker.

Until about 1960, the lead white paint was used widespread both as a white coloured paint, both exterior and interior, and as a primer for coloured paints. So nearly all painters work in houses older than 1960 contains this extreme poisonous lead white pigment.

When this old paint layers peels, or because of other reasons, the paint layer is removed by scraping, by heating or by sanding, this poisonous material is spread to the nearest environment, to the lungs of the workers or to the waste deposition.

In order to avoid this dangerous waste, you can first and foremost avoid all unnecessarily paint removal for instance on old windows or doors or on painted wooden facades. That means if the old paint layers are not entirely loose, you only need to remove the absolute peeling parts. In this way, half or more of the poisonous lead white paint is left at the existing wood, where it makes no harm.

In any way it is very important to carry out the paint removal on old windows etc. in a way, where you have no dust and no vapour from the old paint. The paint removal has to be done in special rooms with mechanical air extraction from tubes near the working place. You can also “bind” the lead white dust by pouring for example linseed oil at the old paint layers, before you sand it.

All lead white paint dust or shells should be careful collected and brought to hazardous chemical waste destruction.

Conditions for re-use

It is not possible to re-use or recycle old lead white paint.

Handling of separation and collection

The partial removal of old peeling lead white paint must be done with extreme caution, because of its toxicity. Especially the dust from sanding is very dangerous for the worker and the environment – that means for instance the people, living in the house.

The paint removal should be done as a "wet process" using linseed oil as the fluid. This will both bind the toxic dust and at the same time impregnate the wood with linseed oil. The scraping should be done with constantly sharpened scrapers.

All lead white paint dust or shells should be careful collected and brought to hazardous chemical waste destruction. Cloth, used for drying up the surplus oil, should also be brought to chemical waste.

Costs

The disposal costs are quite high, but the amount in kilogram or tons is low.

V.4 Material: Old bricks Investigating country: Denmark

Potential for waste reduction											
Low										X	High
Potential for re-use											
Low										X	High
Potential for recycling											
Low										X	High
Costs/Valorisation											
High Costs									X		High value

Possibilities for waste avoidance

When restoring old houses, existing outer or inner masonry wall (one stone thick) sometimes has to be removed of architectural reasons. In this case the old bricks are collected in a container. The normal procedure is to crush the old bricks and use the material for landfill.

But in Denmark a firm has developed a brick-cleaning machine. Here the old bricks are sorted in complete bricks and broken bricks. The complete bricks are cleaned for mortar, stacked and later sold. The broken bricks are crushed and used as landfill. The complete bricks is at the same, or better, quality as new bricks, and they suits very well

to new masonry in old houses, for instance half-timbering houses where new bricks looks wrong.

The mortar can even be reused as supplementary binding agent in new mortar.

In this way, the building waste and the waste costs are reduced to a minimum. The Danish case story, Type II, is dealing with and describing this process.

As clay for bricks is a limited resource in Denmark, the re-use and recycling of old bricks is both saving this valuable resource and saving resources and money for the crushing etc.

Conditions for re-use

So far, there is only one brick-cleaning machine in Denmark, but more machines are planned. To clean the bricks by hand is too expensive because of the wages for the workers, but in other countries with lower wages this could be possible. Anyway it is also a prospect to export the automatic cleaning machine to other countries.

Handling of separation and collection

It is important, that the mortar, which is used in the masonry, is a lime mortar without cement. The cement makes the mortar joints very hard and difficult to separate from the bricks. But most of all old masonry and bricks are build up with lime mortar.

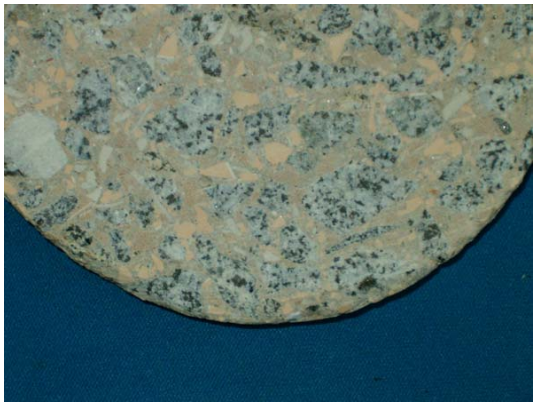
The old bricks are quite robust and are therefore able to expose a rather rough treatment by for example an excavator or a loader tractor.

Costs

As there at the moment are only one brick cleaning machine in the country, the transportation costs are rather high, but you can on the other hand unload the bricks without deposition costs.

V.5 Material: Ceramic Waste investigating country: Portugal

Potential for waste reduction											
Low									X		High
Potential for re-use											
Low			X								High
Potential for recycling											
Low									X		High
Costs/Valorisation											



High Costs							**X**				High value

Possibilities for waste avoidance

Ceramic materials are used widely in construction. It is used for floor and wall covering as well as structural walls and roofing. The porous ceramic materials are the burnt red clay tiles for roof and bricks for walls and sometimes for slabs. The non-porous ceramic materials, usually glazed, are normally used for final finishing of interior or exterior walls and floors.

Wastes occur in hollow red clay bricks when openings are made for embedded water and electrical facilities besides the cuts that are made to fit the final pieces in a wall construction. Hence the avoidance can be made with a good planning of the embedded installations avoiding unnecessary circuits. A drastic reduction may occur if a different brick with an opening is used, vertical and horizontally, where the installations are going to be fitted. In this way cutting of bricks are avoided completely saving manpower too. Half bricks would also reduce the wastes from wall construction bricks by avoiding cuts on site.

Solid bricks can be reused in demolishing works or rehabilitation works. Such reutilizations require usually a cleaning of the brick to get rid of old mortars or other contaminations. In such cases the old brick can replace new ones and great savings can be achieved.

Wastes from wall and floor tiles occur usually when cutting is involved. Hence, adopting adequate sizes of tiles and areas to be covered will drastically reduce the wastes. This has to be done in design stage, which is not a common practice at the time being. One other way for reducing the wastes would be the adoption of adequate equipment for cutting that could reduce wastes.

Conditions for re-use

The re-use can occur in the case of roof tiles as there is no binding and cementing agent involved or in the case of sold bricks reclaimed from demolitions or rehabilitation works. This can become a common practice if the forms and shapes are maintained in production for a considerable time in the case of tiles and mechanical cleaning is performed in the case of solid reclaimed bricks.

The wall and floor tiles, when crushed, can be easily used in the base course of pavements on the site. They can also be crushed and used as secondary aggregate for mortars and concrete. Experience has shown that no reduction of strength occurs when such materials are used as aggregate. Water absorption may become in some cases a problem as the porosity of crushed glazed tiles is slightly higher than primary

aggregates (around 4% compared to around 2%). They can be used successfully for special effects in concretes and mortars too.

The recycling of red clay bricks is more difficult. When clean, they can be crushed and used for unbound architectural pavements for gardens. Crushed bricks can be used also for base and sub-base of pavements on construction site avoiding thus the transportation and disposal. They can be used as secondary aggregate for concrete and mortars for partial replacement of primary aggregate. However, this usually reduces the engineering properties of concrete, hence, requiring higher amounts of cement for achieving a given strength and durability.

Handling of separation and collection

In new construction the separation and collection of ceramic wastes is relatively easy and no special care is needed besides the existence of small containers on the site for such purposes.

In the case of demolition or rehabilitation works no re-utilisation is foreseen. Recycling would be the only possible usage after being crushed. The best usage is for base and sub-base of pavements and in some cases as partial replacement of primary aggregate in concrete. There is no need to collect separately from other mortars or concrete elements in such cases. The presence of gypsum is highly undesirable for reutilization of such materials. Hence, all care should be taken to avoid all sorts of contamination by paints, gypsum and wood.

In order to prepare the ceramic wastes for recycling, it has to be separated from any other material and sized down. This is usually done as follows:

1. Crushing the ceramic wastes into an adequate size

2. Removal of metal with a magnet

3. Screening of contamination from gypsum, wood and paint

Costs

If the ceramic waste is recycled, there are no disposal costs – apart from collecting on the construction site - and it would reduce the costs of primary aggregate that it will replace. So, valorisation is relatively high.

In the case of reutilization of roof tiles the savings are even higher as the final product, i.e. roof tile, is saved.

V.6 Material: Debris Investigating country: Spain

Potential for waste reduction											
Low								X			High
Potential for re-use											
Low									X		High
Potential for recycling											
Low								X			High
Costs/Valorisation											
High Costs			X								High value

Possibilities for waste avoidance

Construction and demolition waste is produced in great quantities, and in volumes greater than that produced by domestic waste. This waste is mainly disposed of in authorised rubbish dumps. The underlying costs of waste disposal make any other ecological operation apart from recycling non-competitive . This contributes to a rapid silting of both town and specialised rubbish dumps.

The majority of construction and demolition waste can be considered inert or easy to assimilate. At the same time, although its level of contamination is relatively small, its visual impact is often great due to its large quantity. Also the level of environmental control used in its disposal on the ground can cause environmental problems. Another negative ecological impact comes from inadequate management of construction site waste that is not recycled.

The majority of waste comes from the construction and demolition of buildings and can qualify as inert, there are exceptions but a only a small part is harmful and non inert, for example, asbestos, mineral fibres, solvents and some additives in concrete, certain paints, resins and plastics.

The volume of this inert material can be reduced into 1/3 percent using a mobile debris grinder located at the building site. When the debris is smashed into small pieces re-using and re-cycling is more feasible at the building site. On the other hand, less volume of debris is moved from the building site to the dumping ground reducing the cost of waste management.

Conditions for re-use

The efficiency of the re-cycling process is highly concerned with the quality of the final product, which depends on the initial debris. The key issue is to get a homogenous debris characteristics and composition which not very often occurs. It only happens on those building sites that have implemented a waste management system based on waste

separation at the building site. It can be achieved through techniques of selective separation of waste at the building site through different containers.

Handling of separation and collection

Waste management techniques based on waste separation at the building site are welcome. A high quality of recycled debris can be achieved through techniques of selective separation of waste at the building site through different containers.

Costs

With an average power of 4 kWatt, a production of 1 to 2 m^3/hour of crushed debris, a weight of 250 kg and low maintenance programme, a low cost of implementation is foreseen.
The machine is moved easily in the building site and it is equipped with a pipeline that deposit the crushed debris in the most interested place, being able to pump the materials up to 300 meters far from its location.

The machine working hours can be easily scheduled in order to optimise the initial investment taking into consideration the building process. Furthermore, if the materials are not recycled at the building site, it can be moved to the dumping ground or to other building sites with a reduced volume ($V^{final}=1/3+V^{initial}$), reducing the transportation cost.

V.7 Material: milt Investigating country: France

Potential for waste reduction											
Low											High
Potential for re-use											
Low											High
Potential for recycling											
Low									X		High
Costs/Valorisation											
High Costs			X								High value

Possibilities for waste avoidance

Many liquid substances are implemented in a construction site. Among them, milt is a common problem that needs to be resolved. Milt is a very fluidised mix of cement, little elements (like sand) and water, it results from buckets washing and concrete batching and mixing plants. If wastewater is directly rejected on the ground, it can migrate

through the ground and pollute subsoil waters. If milt is directly rejected in cleansing networks, it can cause a network clog due to its high charge in suspended matter. The first step to avoid the liquid rejections is storing the liquids under good conditions, which means using retention vats.

Conditions for recycling

There is no solution for milt re-using. However, milt can be recovered in elutriating (or decantation) vats, where the suspended matters fall at the bottom of the vats. The resulting clear water can be recycled as water for the manufacture of freshly mixed concrete, whereas the waste deposits, called mud, are eliminated as inert waste after drying.

Handling of separation and collection

Wastewater treatment involves the installation of a wastewater outlet connected to the sewer network. This outlet contains a decantation vat and a recycling tank of water. The tools and the rejections of milts must pass via the decanter.

Costs

Milt recycling involves the investment in a decanter, which price oscillates between 1000 and 3000 euros.

As a conclusion, liquid rejections on a building site are numerous:

- Oils of dismantling,
- Milt,
- Paintings, solvents, varnishes and other adhesives used in second work phases,
- Fuels and lubricants used for the machines

But milt is very specific: as it becomes a mud, it is really important to regard this liquid rejection as a waste of a construction site.

VI Building waste aspects of environment friendly RESTORATION AND CONSERVATION OF OLD BUILDINGS or DEMOLITION OF OLD BUILDINGS before erecting a new

VI.1 Restoration and Conservation

For the European perspective, the erection of new buildings is not the only building activity, which causes building waste. In the larger number of historic cities, in other parts of existing cities, building owners and authorities prefer to keep and reuse the existing buildings at the spot, for economical, architectural, environmental and practical reasons.

In some European countries restoration and renovation covers about 70-75% of the total activity in the building sector, and erection of new buildings only 25-30%. This is also the case in the historic centres in nearly all cities in Europe, for instance Seville, Barcelona, Madrid, Lisbon, Porto, Paris, Bordeaux, Lyon, Avignon, Amsterdam, Bruxelles, Rome, Naples, Firenze, Bologna, Copenhagen, Stockholm, Göteborg, Oslo – and many other cities in Europe.

The building waste aspects of restoration and renovation of old buildings forms therefore an important part of the whole building waste situation in Europe, especially for two reasons:

1. The restoration and renovation of old buildings, creates considerably less buildings waste than erection of new buildings, especially when the restoration is carried out as described in this Manual under the heading *Careful Conservation*.

2. The restoration and renovation of old buildings will be increased in the coming years in whole Europe, at the expense of the erection of new buildings

In the WAMBUCO project the Danish RAADVAD-center has worked especially with the building waste aspects of restoration and renovation, including recording and documentation of the real and exact waste amounts and compiled Best Practice Sheets for careful repair of windows, doors, plaster on exterior masonry, roof tiles and masonry of bricks.

VI.1.1 Careful Conservation compared with Rough Renovation

It is very important to distinguish between the two concepts: Rough Renovation and Careful Conservation, because these two ways of treating an old building partly has importance for the preservation of the appearance and partly has importance for the amount of building waste.

Rough Renovation consists of a very rough and extensive removal of existing materials and elements in the house, interior walls, floors, ceilings, decorations, windows, doors, kitchens etc.

Too often one can see owners, architects and contractors who assume that this is the cheapest and easiest way of reusing an old building. But this is not true. The not unimportant building waste charge at the disposal sites, which has been imposed in many European countries, plus the expenses to sort out the various waste materials at the building site in order to reduce the very high costs for unsorted waste, makes really a economic difference between the two ways of doing restoration. The balance moves from rough renovation – with a lot of building waste – to careful conservation and repair – with a minimum of building waste.

In careful conservation, as many as possible of the existing materials and elements are kept in the building, and instead of replacement, they are repaired. Too often the existing materials and elements are wrongly evaluated as being in a very bad condition, which they seldom are, they are just old and patinated of age.

In careful conservation one consistently repairs rather than replace or renew, uses consistently the same traditional materials as original, uses consistently the same constructions and structures as originally and uses consistently the necessary specialized craftsmen and conservators. It is also important to keep the wear, the tear and the patination of the building after a careful conservation. Besides far more less building waste and longer lifetime for the materials, careful conservation has conclusively importance for the aesthetic appearance.

VI.1.2 Example 1: Window restoration

The original wooden window is repaired and energy improved to meet modern standards for insulation. Rotten wood is replaced and repaired, broken hardware is replaced, and old paint layers are stripped. The old window is painted with linseed oil paint. Inside, the old window is completed with an inner double-glazing in a secondary frame supplied with hard-coated energy glass.

Most old windows are painted with the poisonous lead white paint. The removal of old peeling lead white paint must be done with extreme caution. Especially the dust from sanding is very dangerous for the worker and the environment – that means for instance the people, living in the house.

The paint removal should therefore partly be done as a “wet process” using linseed oil as the fluid, partly only the detachable paint is removed. All fixed paint layers are left and kept at the wood. Here the lead white paint will not harm the environment. The oil

will both bind the toxic dust and at the same time impregnate the wood with linseed oil. The scraping should be done with constantly sharpened scrapers. All lead white paint dust or shells should be carefully collected and brought to hazardous chemical waste destruction. Cloth, used for drying up the surplus oil, should also be brought to chemical waste.

The waste amount for the original window is documented to be about 2.5 kg per window. Some of this is if the old lead white painted window is discarded, the lead white paint on it will pollute the environment.

At replacement and renewal of old windows instead of careful repair, the waste amount increases to 52.6 kg. – which is an amount of 20 times as much. This refers partly to the packing of the new thermal windows partly to the removal and disposal of the old window. The original window is cut into pieces and the waste is sorted in wood, glass and metal hardware. The wood is sent to incineration, but as the paint is not removed, this may cause harm to the environment. The glass is recycled to road fill and some to glass wool. Also the vacuum impregnation of the new thermal window causes environmental problems because of the poison and the organic solvents.

The remaining lifetime for the repaired old window is about 100 years. When the original wooden window is replaced with a new thermal window made of wood and

supplied with coated energy glass, the remaining lifetime for the new window is about 30 years.[1].

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[1] There are thousands of examples, especially among the listed buildings, of original old windows in old buildings in Europe, which have reached a lifetime og 200-250 years. As we can see at the actual 200 years old windows, how and with which materials and methods they have been maintained and repaired,

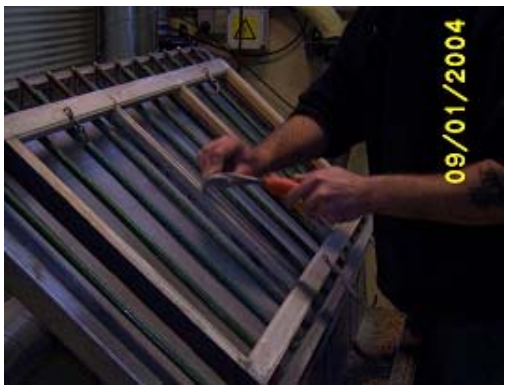
we can assume as certain, that if we use the same materials and methods to day, we wil obtain the same lifetime of the windows and the repairs.

The Danish Ministry of Energy launched in 2000-2002 “Projekt Vindue” (Project Window), where a huge research about old windows, new windows, energy, daylight, environment impact, lifetime, economy was undertaken The project has its own homepage www.projekt-vindue.dk where all the sub-projects, scientific reports, minutes, etc are placed.

During this project it was pointed out, that a normal thermal-pane or energy-thermal-pane has a average lifetime of 17-20 years. Even the lifetime for a new thermal window of plastic, aluminium or wood could be longer, the thermal pane has to be changed after 17-20 years – which in practice affects the whole window.

The treatment of the window at NORDAHLs:

The window glass is removed carefully for reuse in the restored window.



The old paint is stripped with hand tools.

It is proven from research carried out together with the Technical University of Denmark, that an old window in old houses, which is energy improved, has a loss of heat for the whole window of 63 kWh/m² window per year. For a new wooden thermal window of similar size and with the most advanced energy-panes, the loss of heat is 84 kWh/m² window per year. For similar new wood/aluminium or plastic windows the loss of heat is 108 kWh/m² window per annum. This means, that there are no reasons – or valid arguments – for changing original old windows, in order to save energy or heat, more in fact the contrary.[2]

VI.1.3 Example 2: Reuse of roof tiles

When restoring an old house with roof tiles, long term experiences says that it is possible to re-use and recycle about 40-60% of the old tiles. This is even the case when the tiles are about 100-150 years old.

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[2] See www.projekt-vindue.dk/rapporter. For instance Kampmann, Thomas: Vinduers varmetab, Energi- og lydforhold for nye og gamle vinduer i bygninger før 1950 or Oxebvad, Christian: Bliv varm på dit vindue.

See also: Kampmann, Thomas: Totaløkonomi for nye og gamle vinduer på www.bygningsbevaring.dk/ forskning or Kampmann, Thomas: Vinduers samlede miljøbelastning, samme sted.

Also the Technical University of Denmark (BYG-DTU) has made a special window-wep-page with all the research-reports from the project and other relevant issues:http://www.byg.dtu.dk

The existing tiles are carefully rushed down the roof in skids. All complete tiles are reused at the same house, covering one side of the roof. Broken tiles are transported to crushing. On the other side of the roof new roof tiles are laid.

The roof tiles are easy to separate, when there is used lime mortar without cement to tighten the roof. Here, there is no need for machinery etc. The human eye can see if the tiles are cracked, deteriorated or has broken edges. A little knock with the handle of a hammer will reveal through the sound if the tile has an invisible crack or interior damage. All the damaged tiles are sorted to crushing.

If there are no interest for re-using the roof tiles at the same house, as where they came from, there are about 10 roof tiles collecting and re-use firms or organisations in Denmark, which buy or collect old complete roof tiles. In some cases it is the local authority in a town with many old houses, which runs this re-use centre for roof tiles and other building elements. In other cases private firms do it as a business. One firm has even a web site where all their "products" various types and sizes of roof tiles are illustrated and priced. As clay for bricks and roof tiles is a limited resource in Denmark, the re-use and recycling of old bricks and tiles is both saving this valuable resource and saving resources and money for the crushing etc.

The recycling of roof tiles has been practised in some European countries for many years. Therefore there is a lot of experience and a well-known practice for how to do. One problem could be, that the new roof tiles are of a different length or size than the old, so it is difficult to combine the old and the new types. In this case, the tiles are also often collected carefully and sold or transported to one of the above mentioned roof tiles depots.

If the roof tiles are re-used, there are no disposal costs – apart from collecting the tiles on the construction site- and the expenses for transportation.

VI.2 Demolition of old Buildings

In certain European countries it is very seldom to be able to build a new house on bare and virgin field. In far the most cases, it is necessary to remove and demolish an existing building, if you want to build a new one.

In many places, for instance in the thousands of historic centres of nearly all European cities – larger as well as smaller - it is impossible to get permission to tear down an existing building, so you have to restore it instead of building new. But in former industrial areas or harbour areas, it is often possible to build new office- or dwelling houses, after having demolished the old buildings.

Therefore the building waste aspects of environment friendly demolition of old buildings forms an important part of the whole building waste situation in Europe, especially of two reasons:

1. Also most of the new erected buildings are going to be demolished at one time, so the building waste aspects of this should be taken in regard when choosing building techniques, materials and constructions.

2. Demolition is the most extreme waste management situation, with the largest amounts and the most complicated waste streams following. If ever one can manage a demolition project in an environment friendly way, with a maximum of reuse and recycling and a minimum of actual waste to deposit, waste management on new buildings are far less complicated.

VI.2.1 Selective and environment friendly demolition vs. environmental impact demolition

Only a few years ago, all demolition tasks in most European countries were carried out by destruction and incineration of all demolition materials and deposition at garbage dumps. But to day more and more demolition firms takes care of most possible reuse and recycling of the demolition waste. The new demolition and recycling system is called *environment friendly demolition and selective removal*. Here the demolition products are even reused, recycled or deposited under correct and environment friendly conditions at authorized municipal waste disposal sites.

By increased reuse and recycling of building waste, the demand for garbage dumps are reduced, the need for raw materials are reduced and the social demand for poorer technology is considered.

Before the start of a selective demolition, a careful planning phase is carried out, where it is calculated in which fractions the sorting out of the materials will take place and where the fractions are going to be received - on grounds of largest possible reuse – and less possible waste to deposit.

The goal is that 80% of the destruction products will be reused or recycled and maximum 5% will be deposited at authorized municipal waste disposal sites.

Reuse means to take care of, sort and clean the materials or elements, so they can be used again to the same or related purposes, for instance a brick, a wooden beam, a door or a window.

Recycle means to take care of, sort and clean the materials or elements, so they can be either crushed or sieved and thereafter used as gravel, grit or fill. Metal or plastic can be melted to be recycled as substitute or addition for primary materials.

NB.: In some European countries (for instance Denmark and Sweden) incineration is not regarded as recycling or reuse, but burnable demolition products with a positive heating value is obligated to be burnt at authorized power plants to be utilized for central heating and electricity.

Selective demolition is carried out in the following phases:

1. *Stripping of the object is carried out by hand:*
   Removal of waste for special treatment
   Removal of left furniture, equipment and fixtures
   Removal of electric installations and equipment

2. *Demolition of constructions carried out as machine work*
   Taking down the roof construction
   Taking down the carcass
   Sorting out reusable or recycling materials: Bricks, mortar, wood, iron and metal

3. *Demolition of reusable construction elements or materials by hand and hand machines*
   Genuine and usable windows, doors, casing, staircases
   Usable floorboards, timber beams,
   Usable metal elements, radiators, pipes, cast iron elements
   Usable gypsum boards, glass walls,

4. *Clear away the site, carried out as machine work*
   Dig up the foundations
   Removal of oil tanks
   Clear of for trees, shrubbery and plants

All this materials and elements are sorted at source, that means sorted at the building site. The receiving stations are able to sort the unsorted waste, although this is a rather expensive undertaking. Dumping the waste on unauthorized places, aside from causing harm to the environment, costs heavy fines and notification at the police. The best way out from these economic and environmental impacts is to make a selective demolition and careful sorting of the demolition waste at source.

During the demolition all sorted demolition materials are registered, documented and weighed (some at the lorries), while noting the site (address), date, handling, waste fraction, conveyer, amount, quantity and weight. At the receiving station, the receiving authorities repeat these data, so nothing should be lost on the way. The goal is to achieve 80% of direct reuse and recycling.

VI.2.2 Example 1: Respectively sorted and unsorted waste management

In the actual demolition project carried out in February 2004, which was one of the Danish case stories for the Wambuco project, the concrete amounts were:

Fractions	Quantity [t]	Price [€]	Total costs [€]
Concrete, bricks	1429.65	11.-	15,726.15
PVC	0.22	115.-	25.30
Iron/metal	50.62		
Garden waste	4.00	46.-	184.00
Inflammable	98.68	105.-	10,361.40
Branches, stumps	3.60	110.-	396.00
Gypsum	2.56	77.-	197.12
Asbestos	1.88	270.-	507.60
Unsorted building waste	4.96	117.-	580.32
Sum	1,545.55		27,978.19

If all the demolition materials were delivered as unsorted building waste, the account would have looked like this:

Fractions	Quantity [t]	Price [€]	Total costs [€]
Unsorted building waste	1,545.55	117.-	180,829.35

The difference between selective demolition and sorting at source and delivering unsorted building waste to the disposal station is in other words 152,851.16 Euro ! From this amount there is of course a deduction for manpower and machinery, but there should still be a considerable motivation for the contractor to do a selective demolition and sorting at source.

Conclusion

How to motivate the contractors to do selective demolition and careful sorting at source of the demolition waste?

First by the legislation and a consistent control and monitoring by organizing and authorizing the waste disposal stations, and by various economic fees for the various waste fractions with the lowest fees put for the highest recycling.

The system is that materials with a high grade of reusability get imposed a low fee and materials with a low grade of reusability a high fee. When the waste receiving stations both takes a fee for the sorted and unsorted waste, and are able to resale the reusable and recycled materials and elements, a good economy to finance this activity can be established. For the contractor it will pay them to do selective demolition and sorting at source, because the alternative, delivering unsorted materials or dumping in the nature, is far more expensive. Also the contractor can resale the reusable materials and elements such as timber, windows, doors etc. There are firms and regular shops, which are specialized in these goods.

Secondly, by constantly raising awareness in the population, especially among the children, for waste collecting, waste sorting and avoiding any waste drop in the environment.

VI.2.3 Example 2: Special treatment of the old bricks

One of the problems with reuse of big quantities of demolishing waste has been the reuse of old bricks from masonry buildings. As cleaning of the stones by hand or machines has been too expensive in labour wages, the only possibility to recycle the bricks has been to crush them to gravel (for instance tennis gravel).

Now this problem has been solved thanks to inventive people in the small Danish town, Svendborg. Here has a full automatic, effective and usable brick-cleaning machine been brought to light. The machine can clean bricks in all sizes for lime mortar, so the bricks can be reused to the same purpose as original: masonry.

Therefore the 750 tons of bricks from the Danish demonstration demolition project were transported in lorries to the Brick Cleaning Factory in Svendborg. Here the bricks were stripped for mortar and cement by the special brick-cleaning machine.

After that, the bricks were stacked on pallets and sold. As the whole cleaning process is mechanized and effective organized, the price for cleaning is lower than the sales price for new bricks. This is also due to the excellent quality and durability of the old cleaned bricks.

The Brick-Cleaning Machine in Svendborg.

There are plans to develop a smaller and portable brick-cleaning machine, so the cleaning and the sorting can take place at the building site – as sorting at source.

VII Glossary

Aggregate	A mixture of sand and stone and a major component of concrete
Architect	One who has completed a course of study in building and design, and is licensed by the state as an architect
Area wells	Corrugated metal or concrete barrier walls installed around a basement window to hold back the earth
Asbestos cement	Shingles, tiles, siding, board or pipe containing asbestos material tightly bound within a solid matrix not easily crumbled by hand but easily crumbled and friable by equipment during landfill disposal
Asbestos waste	Waste containing friable asbestos fibres or asbestos dust as defined in the "Special Waste Regulation“ See also: Asbestos cement
Asphalt	Black petroleum residue, which can be anywhere from solid to semisolid at room temperature. When heated to the temperature of boiling water, it becomes pourable. It is used in roofing materials, surfacing roads, in lining the walls of water
Backfill	A trim board placed against the wall around the room next to the floor
Base or baseboard	A trim board placed against the wall around the room next to the floor
Bid	A formal offer by a contractor, in accordance with specifications for a project, to do all or a phase of the work at a certain price in accordance with the terms and conditions stated in the offer
Bidding	Getting prices from various contractors and/or subcontractors
Bidding requirements	The procedures and conditions for the submission of bids
Bin	Common terms for storage containers for residential, commercial, institutional or industrial solid waste and recyclables See also: Storage Container - Container
Bitumen	Any of various mixtures of hydrocarbons occurring naturally or

	obtained through the distillation of coal or petroleum.
Block out	To install a box or barrier within a foundation wall to prevent the concrete from entering an area
Building construction	Construction projects above the ground, e.g. houses
Bulky Waste	Large items of solid waste, other than white goods, which because of their bulk/size require special collection and management. Examples include stumps, furniture, large auto parts, hot water heaters, furnaces, and perhaps remodelling materials from residential sources. Bulky wastes are normally generated by residential sources.
Cement	The grey powder that is the "glue" in concrete
Ceramic tile	A man made or machine made clay tile used to finish a floor or wall
Collection	The act of removing accumulated solid waste from the point of collection and transporting it to a solid waste management facility; collection may also occur at centralized points where generators deliver their solid waste.
Commercial Collection	Comments the collection of solid waste and recyclables from a business or industrial complex (generators of commercial, institutional and industrial, nonprocess, non - hazardous solid waste) generally using specialized containers and collection vehicles.
Concrete	Hardened recyclable mixture of cement with sand and gravel
Construction & Demolition Wastes (C&D Wastes)	Solid waste materials resulting from the construction, remodelling, repair, or demolition of buildings, bridges, pavements, and similar structures. Normally, construction and demolition materials from residential sources are not included in the definition of C&D wastes.
Construction and demolition (C&D) debris	Building materials and solid waste from construction, deconstruction, remodelling, repair, cleanup, or demolition operations that are not "hazardous". This term includes, but is not limited to: asphalt, concrete, Portland cement, brick, lumber, wallboard, roofing material, ceramic tile, plastic pipe, and

	associated packaging.
Construction completion	The stage in cleanup when physical construction of all cleanup remedies is complete, all immediate threats have been addressed, and all long-term threats are under control. Though long-term cleanup actions may still be operating, the site is often ready for economic, social, or environmental reuse.
Construction Contract	A legal document which specifies the what when where how much and by whom in a construction project
Construction drywall	A type of construction in which the interior wall finish is applied in a dry condition, generally in the form of sheet materials or wood panelling as contrasted to plaster
Construction equipment	Heavy power machines which perform specific construction or demolition functions
Construction material	All the substances you use up while building, e.g. concrete, wood...
Construction site waste	Non-mineral construction waste
Construction waste	Collective noun for construction site waste, demolition waste, road rubble and soil excavation
Construction work	The construction, rehabilitation, alteration, conversion, extension, demolition or repair of buildings, highways, or other changes or improvement to real property, including facilities providing utility services. The term also includes the supervision, inspection, and other on-site functions incidental to the actual construction.
Container	Common terms for storage containers for residential, commercial, institutional or industrial solid waste and recyclables See also: Storage Container
Contractor	A company licensed to perform certain types of construction activities electrical, plumbing
Controlled Area	For self - delivery collection systems, a controlled area is one established by an integrated solid waste management system where non - containerised materials such as green wastes or white goods are deposited in a specially - designated and

	controlled area at a drop - off centre, or some other solid waste management facility.
Controlled waste	Certain hazardous waste, liquid waste and refuse which is approved for disposal at the disposal site but which, because of its inherent nature and quantity, may require special handling and disposal techniques to avoid creating health hazards, nuisances or environmental pollution
Corrugated cardboard	Recyclable waste which includes, but is not limited to, containers or materials used in containers consisting of three or more layers of craft paper material and having smooth exterior liners and a corrugated or rippled core, but excluding containers which are impregnated or contaminated with a material which will render the corrugated cardboard not marketable
Deconstruction	The process of taking apart a structure with the primary goal of preserving the value of all useful building materials, so that they may be reused or recycled.
Disposal	For diversion purposes, disposal is all waste created by all businesses and residents which is disposed at Board-permitted landfills, at transformation facilities, or is exported from the State. The Board tracks tons of waste disposed by each jurisdiction using its disposal reporting system.
Diversion	The redirecting of material waste in the waste stream either at point of generation or some other time before final disposal.
Drywall	See also: Gypsum board
Dumping ground	Place where it is legal to leave the waste lying on the ground
Extras	Additional work requested of a contractor, not included in the original plan, which will be billed separately and will not alter the original contract amount, but increase the cost of building the home
Fire rated	Descriptive of materials that has been tested for use in firewalls.
Gypsum board	Includes, but is not necessarily limited to, new construction off-cuts or scraps and old wallboard that has been painted, covered in vinyl or ceramic tiles and is removed during renovation, but excluding wallboard associated with asbestos

Hazardous waste	Gaseous, liquid and solid waste which, because of its inherent nature and quantity, requires special disposal techniques to avoid creating health hazards, nuisances or environmental pollution
Industrial Solid Waste	Solid waste, which is similar in physical, chemical and biological characteristics to commercial and residential solid waste, is non - hazardous, non - process related, and would normally be generated by offices, warehouses, cafeterias and shipping activities in industrial operations. Frequently referred to as "light industrial" solid waste.
Insulation	Any material high in resistance to heat transmission that, when placed in the walls, ceiling, or floors of a structure, and will reduce the rate of heat flow
Integrated Solid Waste Management	Is defined as a management system composed of the following actions, steps, methods, processes and facilities
Landfill	A controlled site for the deposition of solid waste on land.
Leachate	The liquid effluent produced by the action of water percolating through a landfill. May contain traces of any materials disposed of in the landfill.
Management	The efficient use of resources and the effective control of systems in the execution of a plan.
Masonry	Stone, brick, concrete, hollow tile, concrete block, or other similar building units or materials
Mixed construction debris	Several types of construction and demolition debris combined in one container. Mixed debris can be taken to a material recovery facility for recycling. Household garbage, food, liquid and hazardous wastes are not acceptable.
Mixed construction waste	Mixture of construction site waste and demolition waste See also: Construction site waste
Mortar	Mixture of lime and/or cement with sand and water, used either as a binding material for bricks and stone or as a plaster
Packaging waste	Waste comprised of materials, or items, used to protect, contain, or transport a commodity or product and usually considered a type of consumer waste.

Pallets	Wooden platforms used for storing and shipping material
Permits	Formal authorization issued by a local government for profit business venture to provide a service within the legal jurisdiction of that local government, also called licenses. Permits may be as simple as authorization
Planning permission	Permission given by the local authority
Prevention principle	This principle allows action to be taken to protect the environment at an early stage. It is now not only a question of repairing damages after they have occurred, but to prevent those damages to occur at all. This principle is not as far-reaching as the precautionary principle. It means in short terms: it is better to prevent than repair.
Punch list	A list of discrepancies that need to be corrected by the contractor
Recovery	Principle of waste management policy including reuse, material recycling and energy recovery See also: Recycling
Recycling	Is the collection and separation of materials from waste and subsequent processing to produce marketable products.
Reduction	The design, manufacture, acquisition and reuse of materials so as to minimise the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption use and waste generation.
Remediation	Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.
Request for Proposals (RFP)	Is a document used to solicit technical and cost proposals from potential service providers
Request for Qualifications (RFQ)	A document used to obtain statements of qualifications (including experience, references, financial stability and condition, and availability of equipment) from bidders prior to issuance of a final solicitation
Residue Disposal	The disposal, in an environmentally safe manner, of the remains of the solid waste stream after source reduction, reuse, recycling and resource recovery activities.

Reuse	The repeated or continued use of a product in its original form.
Roll - Off Container	Container used for the storage, collection and transport of commercial, institutional or industrial solid waste. The container is pulled onto the tilt - frame of the collection vehicle with a cable by winch, reeving cylinders, or by hooks and taken to a solid waste management facility for emptying. Normally, an empty roll - off container is delivered to a customer at the time of collection, rolled off and left for future use. Frequently referred to as a "box".
Roll - Off Service	A system for storing and collecting solid waste. The container used for storage is transported to the point of collection by a special collection vehicle. The roll - off container is then "rolled off" the collection vehicle and left for filling. When it is ready to be serviced an empty container is delivered to the point of collection, rolled off and the full container is loaded onto the collection vehicle and taken to a solid waste or recyclables management facility.
Rubble	A recyclable mixture of gravel, brick, concrete block, road asphalt and rock originating from demolition or construction sites
Scrap metal	Recyclable ferrous and non-ferrous metallic materials which include, but are not limited to, sheet metal, siding, roofing, rebar, flashings, pipes, window frames, doors, furnaces, duct work, wire, cables, bathtubs, fencing, bicycle frames, automotive body parts, machinery, garbage cans, metal furniture and tire rims
Soil excavation	Soil which needs to be taken away to have place for the foundation of a building
Source Reduction	Source reduction is any action that reduces the amount of solid waste to be collected and managed.
Source Separation	Similar materials that are separated from other waste according to categories such as wood, drywall, metal, etc.
Special Wastes	Wastes (not hazardous) that require special handling considerations during disposal
Stationary Compactor	Powered machines that remain stationary when in operation, and are designed to compact solid waste into a container. Smaller stationary compactors are used in apartment complexes or institutions. Larger stationary compactors are used in

	commercial, industrial and solid waste facilities, including drop - off centres
Storage Container	A term used to identify a container used to store solid waste. Storage containers are used in residential, commercial, institutional and industrial applications. In each case, the containers are designed for their particular use. Frequently, generators use other non - specially designed containers to store solid waste.
Sub contractor	A contractor who specializes in a particular trade such as waterproofing.
Toxic waste	Refuse posing a significant hazard to the environment or to human health when improperly handled; includes carcinogenic, mutagenic, teratogenic or phytotoxic wastes, or wastes harmful to aquatic species, or poisonous wastes.
Waste	Any discarded, rejected and unwanted surplus or abandoned matter.
Waste collection	The periodic or on-demand removal of solid waste from primary source locations using a collection vehicle and followed by the depositing of this waste at some central facility or disposal site.
Waste Composition	The characteristics and quantification of the materials, which make up the waste stream.
Waste disposal	The collection, sorting, transport and treatment of waste as well as its storage and tipping above or under ground.
Waste minimisation	Measures and/or techniques that reduce the amount of wastes generated during any domestic, commercial and industrial process.
Waste Reduction	Reduction is a term encompassing all solid waste management methods source reduction, recycling, composting that result in the reduction of solid waste going to a combustion facility or landfill