REPORT 7
THE STATE OF DECONSTRUCTION IN NORWAY

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SUMMARY

This paper presents the status in Norway on deconstruction related issues. The share of the building and construction waste that is being reused or recycled is currently rather low, and Norway is far from a forerunner with regard to deconstruction related issues. The annual production of waste related to building and construction works has been estimated to be about 1.5 million tons of building waste from the construction, renovation and dismantling of buildings, and about 22 million tons from the construction of bridges, ports, roads, railroads, airports etc.

Important laws and regulations concerning waste handling are referred to, and waste charges and taxes are commented. Several initiatives taken by the trade and the authorities to promote reuse and recycling of building materials are presented, and three examples of deconstruction projects in Norway are shown. These three are the ADISA principles developed by the GAIA architects, the RESIBA project which aim is to make recycled aggregate a competitive product, and Pilestredet Park which is a project on the conversion of an old hospital in Oslo centre into a small town with nearly 1,000 apartments, a college and many offices and shops.

Currently, Norway lies behind many other European countries with regard to reuse and recycling of building and construction materials. Many promising deconstruction initiatives however indicate that the general awareness about deconstruction related issues is increasing, and that more reuse and recycling will take place in the future.

KEY WORDS: Deconstruction, Reuse, Recycling, Buildings

1.0 INTRODUCTION

There is a growing interest for deconstructed related issues in Norway. Waste handling is attracting increasing attention, and several initiatives are taken by trade and the authorities to encourage recycling of building and construction waste. Several pilot projects on reuse and recycling are also being undertaken.

Reuse of buildings and building materials was common in former days in Norway. Log houses are very well suited for deconstruction and transport, and in Norway as well as in other countries with tradition for log houses, removing of houses was rather widespread. The logs in many of the old log houses in Norway show marks from having been removed once or several times. It was common practice several places in Norway to expand houses by adding a new unit. Houses were often given as wedding presents, or removed in connection with inheritance or sale of property. Some rural districts in Norway even made business on fabricating log houses and storing them in order to wait for the demand for temporary houses that would rise when a town or city in the vicinity was struck by fire.

Figure 1 Removing of a log house. Dismantling (left) and assembling (right). Photos: K.I. Edvardsen.

A growing interest for protecting the cultural heritage arose in the early 19th Century. Many buildings were removed to save them when other forms of protection did not succeed. A stave church in an inland valley in Norway (Valdres) was the first building to be saved this way. This specific church was actually removed to Schlesien, Preussen (now Poland) where it was assembled in 1844 [1]. From the turn of the century, several outdoor museums in Norway started collecting old houses to save them and exhibiting them to make them available for visitors.

1.1 Waste Impact of the construction industry

Deconstruction status in Norway
The share of the building and construction waste that is being recycled or reused in Norway is currently rather low. Little has been done up to now to reduce the amount of building and construction waste when designing and constructing buildings. For the Oslo region, it has been estimated that between 25 and 50 % of the waste are recycled or reused, while the corresponding share is estimated to be close to zero for the rest of the country [2]. In Denmark, in contrast, as much as 90 % of the building and construction waste is being recycled or reused, and only 10 % disposed of. It thus seems to be a long way to go before Norway can be said to be a forerunner with regard to waste handling and reuse and recycling.

1.2 Waste statistics; percentages of C&D waste reused, recycled, or landfilled

Building and construction waste
The statistical information about the Norwegian building and construction related waste is rather weak, and large uncertainties are involved in the estimation of the annual waste volumes being generated in the building sector.

Statistics Norway and Green Warriors of Norway has analysed the average waste volumes being generated during building works as seen from Table 1. The figures vary significantly within each type of waste. The amount of wood being generated during renovation works, as an example, is estimated to range from 2.3 kg per square metre to 42.6 kg per square metre. The large variations may be explained by different types of constructions used in the case buildings in the surveys, as well as different routines and practise on the building site with regard to minimising the waste volumes.

Table 1 Building related waste. Waste volumes (kg per square metre) being generated per square metre floor space during construction, renovation and demolition of buildings [3].

	Construction	Renovation	Demotion
Concrete and brick	6.5 - 15.7	18.8 – 40.4	387 – 1164
Wood	2.8 - 1.1	2.3 – 42.6	23.6 - 98.5
Paper/plastic	0.3 - 2.6	0.1 - 1	0.3 - 6.5
Metals	0.2 - 1.2	0.2 - 4	3.3 – 29
Plaster boards	0.8 - 3.5	2.3 – 5.9	0 - 4.1
Mineral wool	0.1 - 1.2	0.1 – 0.6	0.1 - 2.2
Asbestos	0	0.5	1
Special waste	0.017	0.05	0.57
Glass	0 - 0.3	0.4	0.3 - 3.3
Polluted waste	0	0	9.9
Unsorted waste	8.8 - 9.6	2.2 – 10.8	22.8 - 35.3
Asphalt	0.7	0	1
Soil, rock etc.	2	2	2

Based on information about the total floor space of new buildings in Norway in 1998 and the space of buildings being renovated or demolished, the total amount of building waste has been estimated to be about 1.5 million tons as shown in Table 2., whereof about 70 % concrete and brick tiles and 14 % wood.

Statistics Norway does not provide a similar statistics on waste from construction works (waste generated during the construction of bridges, ports, roads, railroads, airports etc.). Instead, in Table 2 the amount of such waste has been estimated by using Finnish data, correcting to Norwegian conditions by adjusting for different population sizes. This way, the total amount of construction waste (predominantly soil and rock) has been estimated to be 22 million tons. Even though the waste generated during construction works is about eight times the waste from building works, the construction related waste is not considered as a big environmental problem. Construction waste predominantly consists of non-polluted soil and rock and is more considered as a space problem than a pollution problem by the authorities. The waste is often used for road fillings and in foundations.

Table 2 Building and construction waste in Norway in 1998 by type of waste (1,000 tons). Building waste includes waste from the construction of new buildings, and renovation and demolition of existing buildings. Construction waste includes waste from works related to bridges, ports, telecommunication, roads, railroads, airports, sewage systems, hydro power plants etc. [3].

Type of waste	Building waste					Construction waste	Total waste
	Const-ruction	Reno-vation	Demo-lition	Total			
Concrete and brick	77	155	799	1,031	69%	0	1,031
Wood	41	96	76	213	14%	36	249
Paper/plastic	8	2	6	16	1%	0	16
Electric cables	0	0	0	0	0%	10	10
Metals	3	8	31	42	3%	1	43
Plaster boards	14	18	2	34	2%	0	34
Mineral wool	4	2	1	6	0%	0	6
Asbestos	0	2	4	6	0%	0	6
Special waste	0	0	1	1	0%	1	2
Glass	1	2	2	4	0%	0	4
Asphalt	5	0	2	6	0%	226	232
Polluted waste	0	0	15	15	1%	0	15
Unsorted waste	61	26	40	127	8%	14	141
Total	213	311	978	1,502	100%	287	1,790
Soil, rock etc.	13	0	3	16		22,090	22,106

The Norwegian building waste of 1.5 million tons per year correspond to about 340 kg per capita which is lower than in most other European countries. The average waste volume per capita in 1996 in the member countries of the European Union has been estimated to range from 140 kg per capita in Sweden, to as much as 6,750 kg per capita in Luxembourg as seen from Table 3. Different types of constructions and consequently different composition of the waste may be one reason for the variations in the table. Lightweight, wooden constructions are for instance very common in Norway. This contributes to a lower density of the building and construction waste in Norway than in other European countries where brick and concrete constructions are more common. A survey conducted by Statistics Norway, for example, shows that more than 90 % of all one-family and divided small houses in Norway had wood as main construction material.

Table 3 Building and construction waste in Norway and the member states of the European Community [4].

Country	Million tons	kg/capita/year
Norway	1.5	340
EU-countries		
Belgium	7.5-8.0	700-800
Denmark	2.3-5.0	460-1000
Finland	1.6	320
France	20-25	340-450
Greece	?	-
The Netherlands	13-14	870-930
Ireland	2.5	710
Italy	35-40	600-930
Luxembourg	2.7	6750
Portugal	?	-
Spain	11-22	280-560
Great Britain	50-70	880-1220
Sweden	1.2	140
Austria	52-120	840-1900
Germany	22	2860
EU, total	221-334	607-918

In addition to the effect of different constructions types used in the countries, the large variations in Table 3 are probably also caused by different definitions on what is considered as building and construction waste, and different routines concerning registration of the waste.

3.0 REUSE OF BUILDINGS AND COMPONENTS
3.1 In situ building reuse

EXAMPLES OF DECONSTRUCTION RELATED PROJECTS IN NORWAY

There is a number of deconstruction related projects ongoing in Norway. In the following, three interesting examples are shown. The first one is a large renovation project in Oslo city where reuse and recycling of materials, components and buildings are emphasised. The second is a large project on the use of recycled aggregate in the building and construction industry. The third is a system for reusing building components developed by the GAIA architects.

Pilestredet Park
A new State Hospital will open just outside Oslo in July 2000. The old State Hospital is located in the centre of Oslo. A project called Pilestredet Park has been established to convert the old hospital area into a small town with about 900 apartments, the Oslo University College and it's 3,000 students, and a number of offices and shops.

It is a goal that Pilestredet Park shall be a leading example on sustainable urban development. An urban ecology program has been established, providing requirements and

recommendations for different environmental issues. Pilestredet Park is expected to be completed in year 2004 or 2005.

Today, the hospital buildings comprise approximately 110,000 square metres above ground, whereof about 50,000 square metres will be demolished. When completed, Pilestredet Park will include 63,000 square metres of renovated buildings, and 72,000 square metres new buildings [10]. One important reason for demolishing such a large share of the existing buildings, and not to renovate them, is the need for private car parking. The new buildings will be constructed with parking in the basement.

The old hospital was owned by the state, but most of the site has now been sold to private developers. The contracts include strict requirements with regard to reuse and recycling of the demolition materials. It is a general goal to recycle at least 90 % of the waste materials generated during the building and construction works, and maximum 10 % of the total demolition waste is allowed to be deposited. It has been estimated that the development of the Pilestredet Park projects will generate about 85,000 tons of building and construction waste, not included soil and rock from the digging works. The waste from digging works is estimated to be between 300,000 and 400,000 tons. Since Pilestredet Park is located in the centre of Oslo, it will be aimed at reducing the transport of waste as much as possible. Most of the waste will therefore be seeked reused or recycled on the site. A large share of the concrete and brick waste, for instance, will be used as aggregate in new concrete.

The state has kept some part of the site for public buildings. One of the existing buildings (The Pathology Building) will be converted into the head office of the National Insurance Administration with 560 employees, another will be the new National Medical-Historical Museum. A pilot project has also been started called “The Reused House”, where the goal is to construct a house on the Pilestredet Park area using recycled and reused materials and components. The house will contain apartments for members of the Norwegian Parliament (Storting), and it will hopefully contribute to increase the members’ awareness about deconstruction related issues and the need for increased reuse and recycling.

4.0 ENHANCING MATERIALS RECYCLABILITY

Deconstruction initiatives

The general environmental awareness in the building and construction trade is increasing, and several initiatives have been taken by the trade and by the authorities to reduce the waste volumes and increase the recycling rate.

NORSAS is a national competence centre for waste and recycling. NORSAS shall promote waste reductions, increased recycling and safe handling and final treatment of waste. Furthermore, the centre shall support local councils, the industry and the authorities in the work for reduced waste volumes and increased recycling rates. NORSAS shall collect, treat and disseminate information and knowledge about waste handling. One important task for NORSAS is to operate a national register on waste handling, where all enterprises involved in waste handling are registered. The enterprises are instructed to report annually the volume, type, origin, transport and handling of waste. This information will contribute to increase the knowledge about the waste streams in Norwegian.

EcoBuild (Økobygg) is an initiative from the building and real property trade to contribute to environmental improvements and the achievement of national, environmental goals. The programme, which runs over five years (1998 - 2002), shall engage the whole trade in a co-ordinated and comprehensive effort on environmental improvements. The total budget is around 50 million NOK per year (close to 7 million USD) The financing comes from both governmental and private funds. Four ministries are involved; Ministry of Local Government and Regional Affairs, Ministry of the Environment, Ministry of Trade and Industry, and Ministry of Petroleum and Energy. A board of representatives from the building and real property trade directs the programme. Eight main areas of work are defined for EcoBuild. One of these is building and construction waste. The goal is to reduce the building and construction waste by more than 70 % by establishing a commercial market system for recycling of waste. Improved waste handling in the industry and improved practise on waste minimisation, sorting of waste and controlled handling of toxic waste in connection with building projects will be important factors to reach the waste reduction goal.

Two trade organisations, BNL and TELFO, are developing a national action plan for building and construction waste. Phase I of this work, a state of the art report on building and construction waste, was completed in December 1999 [3]. In Phase 2, specific goals for waste reductions and recycling will be established together with measures to reach these goals. The work is partly financed by EcoBuild.

4.2 Recycling issues for specific materials (concrete, metals, plastics, glass, etc.)

Norsk betongforening (The Norwegian Concrete Association) has developed national guidelines for classification of the use of recycled aggregate in the production of new concrete. Depending on the classification of the aggregate and the quality of the concrete, up to 30 weight-% of recycled aggregate is allowed.

RESIBA

RESIBA (Recycled Aggregate in Building and Construction) is a three-year research project carried out by a number of manufacturers, enterprises and organisations in the Norwegian building and construction trade. The project is financed by the involved industrial partners and the EcoBuild programme. The aim of RESIBA is to make recycled aggregate to a competitive product, and to bring Norway up to the same level as rest of Europe with regard to the use of recycle based building materials [9].

The background for RESIBA is the fact that concrete, brick and rock represent the dominating part of the total waste produced by the building and construction industry. The benefits of recycling heavy building and construction waste should be large. Crushed concrete, brick and rocks can be recycled in unbound form (as filling material in foundations etc.) as well as in bound form (as aggregate in concrete).

RESIBA consists of three sub-projects. The first sub-project is titled “Declaration and quality control”. The aim of this project is to provide basis information about the most important technical properties of recycled products, and to estimate possible environmental burdens. The development of routines for quality control of recycled product is also an important. The project is linked to the European research programme “Use of Recycled Aggregate in the Construction Industry”.

The aim of the second sub-project, “Demonstration projects”, is to evaluate the use of recycled aggregate in full-scale constructions and initiate pilot projects. The use of recycled aggregate in roads, ditches and different types of concrete shall be investigated through these pilot projects. One interesting pilot project that already has been carried is the use of recycled aggregate in sprayed concrete. The sprayed concrete was used to cover EPS insulation used in the foundation of a tramcar line in Oslo. The project is claimed to be the first in the world where recycled aggregate has been used in sprayed concrete. Totally 720 square metres of EPS were covered with four different types of sprayed concrete: without recycled aggregate, and with 7 %, 14 % and 20 % recycled aggregate. The project showed promising results with regard to mixing, spraying and mechanical properties of the concrete.

The aim of the third sub-programme, “Information dissemination”, is to spread knowledge and results from the project to the building and construction trade, as well as to the politicians and the authorities.

7.0 DESIGN OF BUILDING AND COMPONENTS FOR DECONSTRUCTION

7.2 Design of components for disassembly

GAIA architects

The GAIA group is a small group of idealists promoting ecological construction in Norway. Professional architects sharing an interest in ecological issues in house building and area planning established the group in 1983. The members of the GAIA group promote the use of traditional, locally produced building materials and well-known and simple technology. Many of their constructions are also rather labour intensive, which make the GAIA solutions rather controversial, and often difficult to implement in modern, industrialised building production.

The GAIA architects early saw the need for developing building systems that were adapted for future replacement, reuse and recycling of materials and components. But, they did not succeed in obtaining the required financing to do this until the mid 1990s when the project “Building System for Reuse” was carried out [6]. In this project, a building system called BfO was tested out. The system was based on three main principles:

- separation of the different layers of the building (with reference to Brand’s principle of “Shearing layers of change” [7])
- easily dismantling and replacement of components within each layer (extensive use of screws, weak mortar in brick works, and avoidance of glue),
- the use of mono-materials (no composites).

The BfO system included 88 specially designed wood and concrete components that could be assembled with standard components into a large number of different constructions. The specially designed components were meant to be locally produced. It was aimed at utilising wood from small-sized timber. It was further a goal to use mono-materials that could easily be dismantled for replacement or reuse in another building. A main idea behind the BfO system was that easily dismantling would make it easy to change the size and the shape of the building according to the occupant’s needs.

In the project, the BfO system and the reusability of the BfO components were tested out by first erecting a pavilion using such components. Thereafter, the pavilion was dismantled, and

the components used in the construction of a prototype BfO house with gross floor space of 130 square metres. In the project, the dismantling and reuse of the BfO components were successful. It was however also learned that the number of special components should be reduced to simplify the system, as well as it was a need for more standardised wood components, even though this would mean larger pieces of wood and not the same potential for utilising small-sized timber.

Based on the idea of the BfO system, and the experience from the BfO pilot project, the ADISA principle was developed. ADISA (Assemble for DIS-Assembly) consists of 45 standardised components (as compared to 88 for BfO) [8]. Space plans are flexible within a module of 600 mm. This ADISA principle has not been fully tested in a pilot project yet. But, some of the ideas and principles are currently used in the design of Prestheia eco-village outside Kristiansand. At Prestheia, several row houses consisting of totally 19 dwellings will be constructed during 2000 and 2001. In the design of the houses, it is aimed at using dismantleable solutions, and to obtain flexible space plans.

The original intention behind the ADISA principles was to establish a market based system where the used components could be returned to the local manufacturer for quality control, and thereafter used in a new building project within the region. But, in practise, it has been difficult to establish a market based system based on the ADISA principles.

8.0 POLICY, REGULATIONS, STANDARDS, LIABILITY

The authorities involvement in deconstruction
The involvement of the authorities is important for what is happening in the building and construction industry with regard to deconstruction related activities. The main strategy of the authorities within the field of waste handling is:

- first of all to prevent waste from being produced and to reduce the amount of harmful substances,
- secondly to promote reuse, recycling and energy utilisation of the waste,
- and finally to ensure an environmental sound treatment of the remaining waste being disposed of.

8.1 Government policy supporting deconstruction

Laws and regulations
The Pollution Law from 1981 is one important law regulating the handling of building waste. This law is based on two principles; the first principle is that waste should be handled in a way that minimise damage and inconvenience, and recycled where this is environmentally beneficial, resource efficient and economic acceptable. The second principle is that the polluters should pay the full costs of the environmental damage they are causing (Polluter Pays Principle).

According to the law, building and construction waste is defined as production waste, and the same requirements therefore apply as for other types of waste. Stricter control of the waste handling according to the Pollution Law has contributed to significantly reduce illegal dumping which was considered as a problem before. The Ministry of Environment has delegated some local councils the power to develop local regulations on building and

construction waste. The councils can require that the builder shall produce an overview of the waste amounts that will be generated during the building and construction works, and to develop a plan on how this waste shall be handled. Oslo is one of the councils having developed such local regulations on waste, and the results have been promising with regard to reuse and recycling of heavy building waste. The Ministry of Environment therefore plan to delegate this power to develop local waste regulations to all local councils in Norway.

8.3 Creating standards for deconstruction and materials reuse

The Planning and Building Act shall ensure that building and construction works are executed correctly and technically safe. Supplementary to the act, there are technical regulations that regulate building and construction works and the products used in buildings. A main goal of the act and the regulations has been to improve the quality of the building process. All building and construction projects, including demolition projects, should be executed by approved enterprises. There are strict requirement on the skills and qualifications of the persons involved in the process, and the requirements for documentation have been significantly enhanced.

The need for long-term perspectives and environmental concerns are emphasised. In the technical regulations, for instance, it is stated that:

> *"The life of works shall in all phases, i.e. execution, usage and demolition, be managed with a reasonable load on resources and environment, and without worsening quality of life and living conditions. Materials and products for use in construction works shall be manufactured with justifiable use of energy and with the aim of preventing unnecessary pollution. Construction works shall be so designed and executed that little energy is consumed and little pollution is caused during the life of the works, including demolition." (§ 8.1)*

The Working Conditions Law from 1977 shall ensure the safety, health and welfare of the employees. There are several regulations under this law. One regulation (Byggherreforskriften) instructs that the builder shall ensure that safety, health and working conditions are taken care of in all stages of the building project. The builder is responsible for the handling of materials on the building site, the storing and removing of waste [5]. Another regulation instructs works involving contact with asbestos. This regulation directs that only specially trained employees are allowed to handle asbestos or products containing asbestos.

8.4 Legal issues

Charges and taxes

There are local charges for delivering waste on disposal sites. These charges are levied to cover the full costs of establishing and running sites. The charges may therefore vary between the different local councils in the country.

A national tax on depositing waste was enforced in 1999. The tax is 300 NOK (35 USD) per ton of organic or unsorted waste. If the waste is incinerated, a basic tax of 75 NOK per ton and a supplementary tax of 225 NOK per ton applies. The supplementary tax is reduced according to the degree of energy recovery. If the waste is incinerated without energy recovery, the tax will be 300 NOK per ton, which is similar to the tax for depositing unsorted

waste. The national tax is intended to stimulate waste reductions, increased material recovery and utilisation of the energy content of the waste.

9.0 BARRIERS AND OPPORTUNITIES FOR DECONSTRUCTION

DISCUSSION

Behind the concept of deconstruction lies the need for reducing the overall resource consumption in the society. Deconstruction promotes resource efficiency by focusing on reuse and recycling of materials and components. Deconstruction includes several issues, such as:

- the reuse and recycling of the waste materials currently being generated,
- the use of reused and recycled products in the construction of buildings,
- the design of buildings for future dismantling and optimum reuse and recycling of the materials and products used.

The primary focus in Norway with regard to deconstruction efforts is short-termed on reducing the total amount of waste being disposed of. Reuse and recycling are promoted since it contributes to reduce the amount of waste being disposed of, and not because it contributes to reduce the overall resource consumption in the society.

Statistics show that Norway in many ways lies behind many other European countries with regard to reuse and recycling of building and construction materials. Only a small share of the total building and construction waste is being reused or recycled in Norway. There might be several reasons for why recycling and reuse are less practised in Norway than in other European countries. Lack of market for reused and recycled products is probably one important reason.

To be cost-efficient, recycling plants must treat a certain volume of building waste. Such a volume may be difficult to achieve many places in Norway since the country is sparsely populated. The population of 4.45 million people is spread over a total land area of 324,000 square kilometres. The corresponding population density of 13 persons per square kilometre is close to 20 times lower than in for instance Germany and United Kingdom [11]. Long transportation distances in Norway also contribute to increase the costs of reusing and recycling building and construction waste.

Land is expensive in central parts of Europe. This gives an important economic incentive for reusing and recycling waste instead of using land for waste disposal sites. In Norway, in contrast, the costs of establishing waste disposal sites may be taken to be lower since there is still much available space left. This contributes to make waste disposing more economic attractive than reuse and recycling.

Norway has good supply of natural resources like gravel, rock and timber, in contrast to many other countries where the supply is more limited. The good supply may have contributed to reduce the attention around resource efficient handling of building and construction waste in Norway.

By introducing the national tax on waste disposal in 1999, the authorities are now trying to promote reuse and recycling of waste instead of disposing. With regard to buildings, however,

and the measures taken to reduce future waste volumes, this tax will have limited influence due to the effect of discounting. Most buildings have long services lives. The present value of waste disposal costs occurring 50 or 100 years into the future is close to zero for ordinary interest rates. This way, there are almost no economic incentives in designing and constructing buildings that are suited for future reuse and recycling. It is consequently a fundamental problem that discounting in cost-benefit analyses does not favour design for disassembly and future reuse and recycling of buildings. Other than economic instruments should therefore be applied to promote long-termed reuse and recycling in the building sector.

Many promising deconstruction initiatives are taken in the building and construction trade, and there are signs indicating that the general awareness about deconstruction related issues is increasing in the population. The demolishing of a 15-storey office block in the centre of Oslo in April 2000 can for instance be used as an example of the public's interest in deconstruction. The building that was demolished was the first high-rise building erected in Norway (in 1960), and it was the highest building ever demolished in Scandinavia. Using 75 kg of dynamite, it took 4.5 seconds to take the building down. More than 10,000 people had appeared on the scene to see the building go down, and the demolishing was headline news in most media.

Information technology and internet solutions opens for easily organisation of the trading of used (and new) components. If a system for reusing building materials and components was widespread implemented in the building and construction market, it would significantly contribute to reduce the overall resource consumption and waste volumes. In the work towards such a system, the ADISA principles developed by GAIA architects may serve as an inspiration and example on how the building and construction industry could be organised in a more sustainable way.

CONCLUSIONS

The share of the building and construction waste that is being recycled or reused in Norway is currently rather low, and Norway is far from being an international leader with regard to deconstruction related issues.

The annual production of building waste has been estimated to be about 1.5 million tons, whereof about 70 % concrete and brick tiles and 14 % wood. The waste from the construction of bridges, ports, roads, railroads, airports etc. has been estimated to be 22 million tons, or eight times the building waste. The construction related waste is however not considered as a large environmental problem since it predominantly consists of non-polluted soil and rock and more represents a space problem than a pollution problem.

The handling of building waste is regulated through several laws and regulations. In compliance with the Pollution Law, some local councils have been delegated the power to develop local regulations on building and construction waste. Oslo has been one of the councils, and results so far are promising. The Planning and Building Act with the corresponding Technical Regulations put strict requirements on the skills and qualifications of the persons involved in the building process, and the requirements for documentation have been enhanced.

There are local charges for delivering waste on disposal sites. These charges are levied to cover the full costs of establishing and running sites. A national tax of 300 NOK per ton for depositing waste was enforced in 1999. The tax is intended to stimulate waste reductions, increased material recovery and utilisation of the energy content of the waste.

Several initiatives have been taken by the trade and the authorities to promote reuse and recycling of building materials. Amongst these are NORSAS - a national competence centre for waste and recycling, and EcoBuild – a five year action programme which aims to contribute to environmental improvements in the building and real property trade, and the achievement of national, environmental goals. Furthermore, two trade organisations (BNL and TELFO), are developing a national action plan for building and construction waste.

Several projects with focus on reuse and recycling have been initiated. The GAIA architects have developed the ADISA principles which is a building system adapted for future replacement, reuse and recycling of materials and components. Some of the ideas and principles behind ADISA are now being used in the design of an eco-village outside Kristiansand.

RESIBA is another interesting project. The aim of this project is to make recycled aggregate to a competitive product, and to bring Norway up to the same level as rest of Europe with regard to the use of recycle based building materials.

Pilestredet Park is a project established to convert an old hospital area in Oslo city into a small town with nearly 1,000 apartments, a college with many students, and a number of offices and shops. Pilestredet Park shall be a leading example on sustainable urban development. There are strict requirements with regard to reuse and recycling of the demolition materials. At least 90 % of the waste materials generated during the building and construction works shall be recycled, and maximum 10 % of the total demolition waste is allowed to be deposited as waste. The construction of a “Reused House” will be a show-case project at Pilestredet Park.

The primary focus in Norway with regard to deconstruction efforts is short-termed on reducing the total amount of waste being disposed of. Reuse and recycling are promoted since it contributes to reduce the amount of waste being disposed of, and not because it contributes to reduce the overall resource consumption in the society.

Statistics show that Norway in many ways lies behind many other European countries with regard to reuse and recycling of building and construction materials. But, many promising deconstruction initiatives are currently taken in the building and construction trade, and there are signs indicating that the general awareness about deconstruction related issues is increasing in the population. Hopefully, the deconstruction examples referred to above can serve as an inspiration and contribute to increase the reuse and recycling of materials and components in the building and construction trade.

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