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DEMOLITION WASTE MANAGEMENT FOR NON-LOAD BEARING ELEMENTS OF THE BUILDING

IMPLEMENTING SUSTAINABLE DECONSTRUCTION TECHNIQUES FOR REACHING THE 70% TARGET RECYCLING, RE-USE AND MATERIAL RECOVERY TARGET OF C&D WASTE

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Executive Summary

In order to reach the In order to reach the 70% target Recycling, Re-use and Material recovery target of C&D WASTE, we need to have **a scientific, fact based, European overview of the demolition techniques** in various Member States, which for the time being is crucially lacking.

Without knowing how and what we deconstruct for which purposes, it is very difficult to implement an efficient and forward looking recycling policy at the construction product level.

In other words, the construction product manufacturers wish to push for deconstruction on the basis of realistic and achievable targets and for this purpose, we need data, facts and evidence across Europe.

1 - Rationale

1.1- Background

a. Importance of the Construction Sector - interior lining (non load-bearing elements)

The construction sector represents a strategically important sector for the European Union, providing building and infrastructure on which all sectors of the economy depend. The sector is significant in terms of employment and provides constructed assets representing 49.6% of the gross fixed capital formation (GFCF).

To reach the ambitious long-term targets of reducing CO_2 emission levels by at least 60-80% by 2050, it will require a major effort on improving building energy efficiency, particularly for existing buildings. This will necessitate a complete rethink of energy use in buildings at European level as well as of demolition techniques and disposal routes for construction and demolition waste.

In that context the Gypsum Industry together with the Insulation Industry already provides effective solutions to improve the carbon footprint of existing and new buildings, in the residential and non-residential market. The Industry is investing in eco-innovation to continue to play a ***vital role*** in the construction field as over 80% of all interior surfaces in European housing are either made from or lined with gypsum-based products. Furthermore, offices, shops, and public buildings of all kinds make substantial use of gypsum products, chosen by architects for their excellent performance in acoustic and thermal insulation, fire protection and interior design and decoration.

The potential for cutting energy consumption by improving the insulation properties of building together with plasterboards and other gypsum products is considerable. Indeed, Exane BNP Paribas estimates that around 75% of the **existing stocks** in Europe have poor energy efficiency dynamics.

Speed and ease of assembly and finishing mean that constructing with gypsum products is economical and fast and also easy and fast to dismantle. It also creates a pleasant, healthy and comfortable environment. The gypsum products' eternal recyclability, furthermore improve the overall eco-efficiency and sustainability of buildings.

b. Construction & demolition waste management at EU level

The Construction & Demolition waste in Europe is not a European market at all. It has a strong regional orientation. This regional orientation makes it difficult to obtain solid statistic, let alone to predict a solid forecast of the developments of C&D waste in Europe. Nevertheless some statistics are drawn to strive to give a view of the amount of C&D waste generated without however specifying the non-load bearing element of the building discarded.

If one excludes earth and excavated road material the amount of construction and demolition waste generated is estimated to be **roughly** 180 million tonnes per year[1].

Applying dismantling techniques instead of demolishing the building will lead to sorting and recycling of non-load bearing elements for re-use in the production process. However, as the waste characterization differs, the production processes of the manufacturers must be adapted to increase the recycled content in the product. This needs research and development.

Dismantling a building should become law if we really wish to implement a recycling society. Moreover, dismantling Gypsum based interior partitions is easy and with the indefinite recyclability of gypsum, we face a win-win situation. On one side, we close the loop and on the other side, we quarry less if the volumes recuperated are high and thus we are able to use the natural resources in a sustainable way.

1.2 - Issues at stake for non load bearing elements of a building

The Catalyst: The Waste Framework Directive

The environmental preference goes to reducing waste at source and preventing waste (article 4 of the Directive). Nevertheless, light refurbishment, major renovation and demolition of buildings are a fact of life and should be done in such a way that it improves the recyclability of all materials used in a building and more specifically of non-load bearing elements of the buildings.

The 70% recycling target for C&D waste in the new Waste Framework Directive does not include targets for individual waste type's construction and demolition waste, but does demand an overall target of 50% and 70% respectively.

Non Load bearing elements of a building and more specifically plasterboard, metal profiles, screws and insulation materials can be easily dismantled if a building is adequately deconstructed enhancing thereby their recyclability. Gypsum is indefinitely recyclable and could be classified as secondary raw material after

[1] Construction and demolition waste practices and their economic impacts, report to DG XI, Symonds, February 1999

recycling. Gypsum demolition waste would then become a resource by applying for the implementation of article 6 of the Waste Framework Directive (end-of-waste criteria) to Gypsum product enabling less recourse in the long term to gypsum in nature.

Metal scraps from profiles can also be recycled and techniques for recycling and recover insulation materials should be developed.

In any case, to enhance the recyclability of non-load bearing elements of a building, deconstruction is the main challenge and an essential element of sustainable construction, which need to be looked after by the European Commission proposing market-based incentives and regulation to make deconstruction happen in real life.

The second challenge is the decontamination of demolition scraps and reprocessing of Gypsum- and other non load bearing elements- waste to market specification in order to allow for the status of no-waste anymore.

The third challenge is to innovate in the manufacturing processes to absorb around 30% of recycled material. This is valid for gypsum and insulation materials.

2 - The key challenge of demolition waste management per se in the context of the Waste Framework Directive

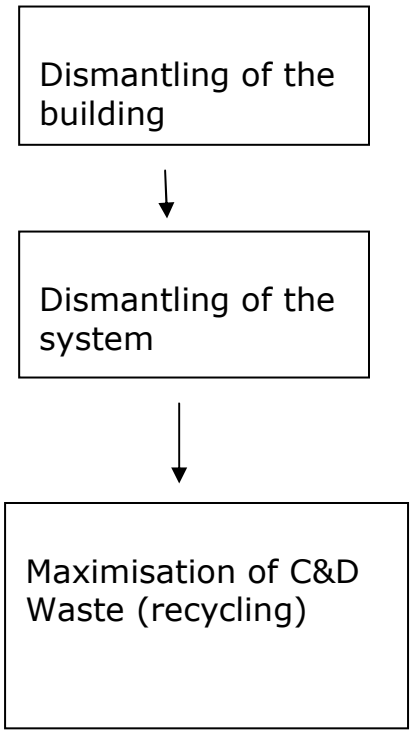
2.1- Deconstruction and the 70% Directive

Selective deconstruction enables increase of the materials quality, potential for future use and economic value.

However, for the time being in Europe, the current average demolition techniques are reducing the raw materials quality, potential for future uses, and economic value into, i.e., aggregates for road, filling material and in some case, preventing close-loop recycling (gypsum products) as the building is just crushed.

Deconstruction is an essential step in waste recycling feasibility and should become the standard if we want to reach the 70% target of the Waste Framework Directive. Deconstruction should also be applied in major renovation and light renovation of buildings. Internal partition in an office can be dismantled in case of refurbishment of that office, which is not the case currently. Education of the workforce is here essential to create a dismantling mentality when it is easy to be implemented.

A Regulation for dismantling buildings for new construction or for renovation should be considered more in depth.



2.2 - Deconstruction and public funding

Public grants are essential to trigger the momentum towards the implementation of the EC Directive since additional costs linked to de-construction are much higher than demolition costs.

But, in the context of budgetary constraints due to the economic crisis, few Member States or local authorities will have the financial means to support de-construction in the future.

However, the European community is faced with the challenge of being each year more resource efficient and recycling of C&D waste is the way to decrease the access to natural resources in the long term. The market for recycled material of non load bearing element of a building and more specifically for gypsum is there. The Gypsum manufacturers already recycle production and construction waste (clean) in their facilities. We need to increase our recycling capability with demolition waste (contaminated) by adapting the manufacturing processes and by defining the quality criteria for recovered gypsum.

Dismantling helps to enhance the producer responsibility as provided for in the Waste Framework Directive as the waste can be attributed to specific material producers. This is not the case if we crush a building.

Therefore, the question is how to reach the 70% Directive target while building an economic and sustainable model for de-construction and recycling i.e. viable in the long term without major public funding?

2.3 - Deconstruction and demolition

2.3.1- Deconstruction as an essential step towards Sustainable construction[2]

Designing a building for ease of assembly must also lead to ease of disassembly for future reuse and recycling. Principles of design for ease of assembly, or ease of construction, should be adapted to become principles of design for disassembly.

Demolition results in a non-homogenous heap of damaged materials. The recyclability of these materials is thus reduced by the demolition process itself. Direct reuse and recycling of building materials generally requires that they be recovered in good condition. Demolition frequently damages building materials to the point that their only usefulness lies in being recycled to less valuable materials. This reduction of the recyclability of the materials serves to reduce their economic value, increase their future negative effect on the waste stream, and increase the future necessity of raw materials extraction to take their place.

Deconstruction, on the other hand, serves to increase the recyclability of raw materials. Deconstruction results in numerous piles of homogenous building

[2] **Deconstruction and Material Reuse-an international overview-CIB report TG 39 Deconstruction-March 2005**

materials with minimal damage. This is because time and care are taken in recovering and sorting materials with as little negative effect on their quality as is humanly possible. The two factors unique to deconstruction that increase the recyclability of building materials are its organizational nature and the lack of damage incurred by the materials during the recovery process.[3]

Renovation of buildings for more energy efficient buildings means that we have recourse to non-load bearing elements, enhancing thus the recyclability of their refurbishment as well as its carbon footprint. We help reach the CO2 emission targets without impeding the recyclablility.

2.3.2- Benefits of Deconstruction[4]

The advantages are:

- increased diversion rate of demolition waste from landfills;
- potential reuse of building components;
- increased ease of materials recycling; and
- enhanced environmental protection, both locally and globally.

2.3.3- Challenges of Deconstruction[5]

These challenges include:

- existing buildings have not been designed for dismantling;
- building components have not been designed for disassembly;
- tools for deconstructing existing buildings often do not exist;
- disposal costs for demolition waste are frequently low;
- dismantling of buildings requires additional time;
- re-certification of used components is not often possible;
- lack of training of deconstruction workers;
- building codes often do not address the reuse of building components; and
- the economic and environmental benefits are not well-established;
- lack of adapted manufacturing processes to include more recycled materials in the final product.

2.3.4 - The Economics of Deconstruction[6]

The most important factor to be considered when assessing the economic potential of a country is its building stock. Building deconstruction, like demolition, depends on the availability of buildings that will form the feedstock for the industry. In order for deconstruction to be a favorable operation, the region must contain a large number of buildings available for removal and for deconstruction.

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[3] **Deconstruction and material reuse in the US-Abdol R. Chini and Stuart F. Bruening-the Future of sustainable construction - 2003**

[4] **Deconstruction as an essential element component of sustainable construction-Charles J. Kibert, University of Florida, Gainesville**

[5] **Same as 4**

[6] **Deconstruction and Material reuse in the US by Abdol R. Chini and Stuart F Bruening-The future of sustainable construction 2003**

In almost all scenarios, the cost of deconstruction is higher than that of demolition.

This is due to the labor intensive nature of deconstruction. However, the salvage value regained in deconstruction often makes it more cost effective than demolition. Because the labor intensive factor of deconstruction is somewhat unavoidable, it is important to focus on minimizing other factors in the cost to make it more competitive. Minimizing costs and maximizing salvage value of building materials is essential to maximizing the potential of deconstruction. Having well trained workers, as discussed before, can have a major impact on overall cost.

A study[7] compared the cost of residential building deconstruction with the cost of demolition in the Commonwealth of Massachusetts. The comparative cost analysis is developed by systematically analyzing two separate residential deconstruction projects previously reported in other studies and augmenting with up-to-date cost data for Massachusetts. The study shows that under current conditions in Massachusetts, deconstruction costs could be 17-25% higher than demolition costs. The analysis further identifies and ranks the parameters affecting these costs. These parameters, in the order of their impact on costs are: labor cost (either productivity or hourly rate), disposal cost (tipping fee and transportation), and resale value of deconstructed materials. A sensitivity analysis is used to identify the break-even points for these parameters such that deconstruction becomes economically competitive with demolition.

Regulation may serve to create a market for deconstruction with the financial help of local authorities to start the ball running.

[7] **An analysis of cost and duration for deconstruction and demolition of residential buildings in Massachusetts DANTATA Nasiru (1) ; TOURAN Ali (1) ; WANG James (1) ; Resources, conservation and recycling 2005**

3 - Towards a new approach of the construction value chain in order to bring value to deconstruction and recycling phases?

3.1 - Background

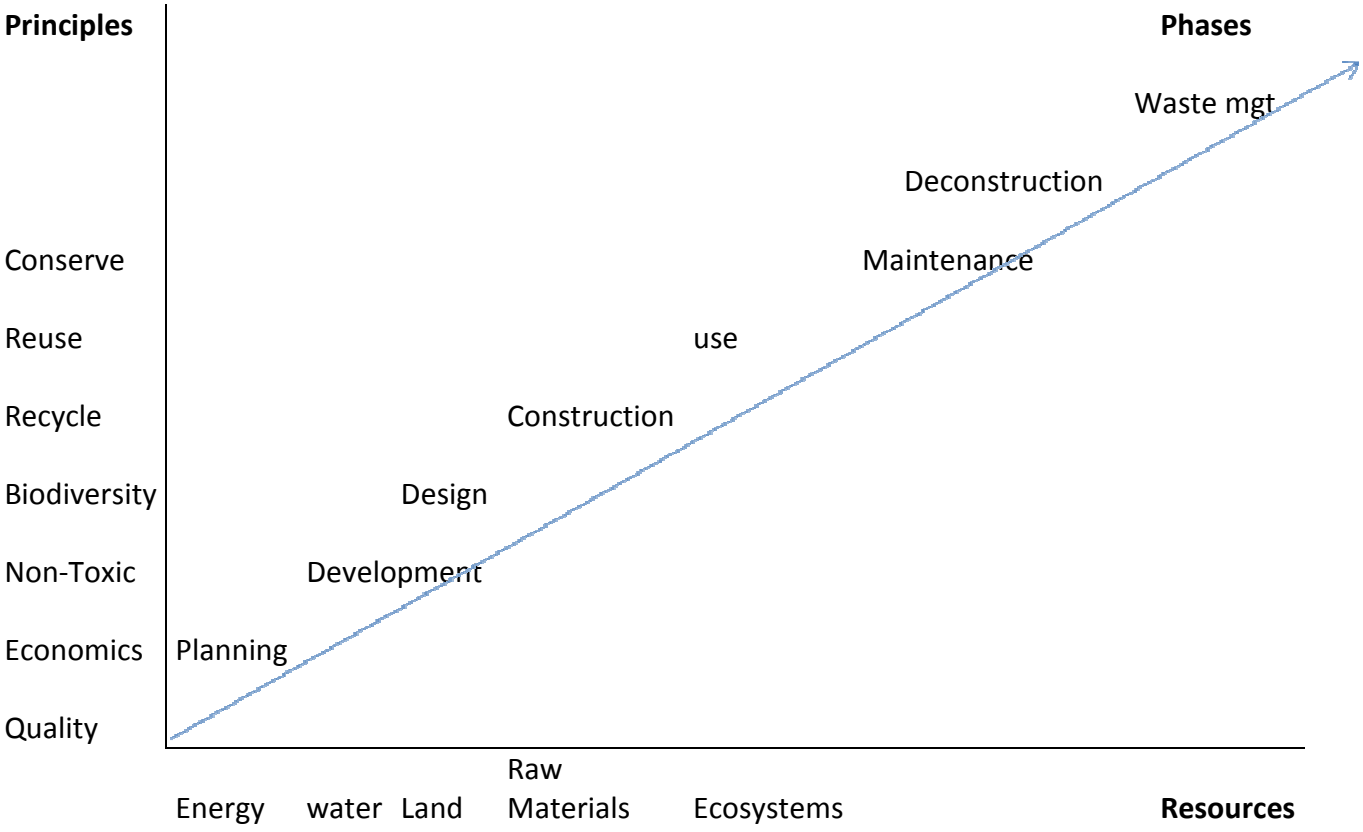
The buildings constructed 50 years ago do not reach the standard for applying entirely the modern demolition techniques. We have received from our ancestor a building stock heritage which is unfortunately not always in a good shape to be dismantled. However, we need to demolish those buildings looking wisely at the future construction. The new construction will be built eco-efficiently using innovative techniques to enable a proper dismantling at the end of its lifespan (50 years).

3.2 - Current approach of the construction industry towards the sustainable construction

The shift of the construction industry towards a path parallel to the overarching sustainable development movement is what we call sustainable construction.

This effort addresses the entire life cycle of building: their planning, design, construction, operation, modifications, renovation, retrofit, and ultimate disposal.

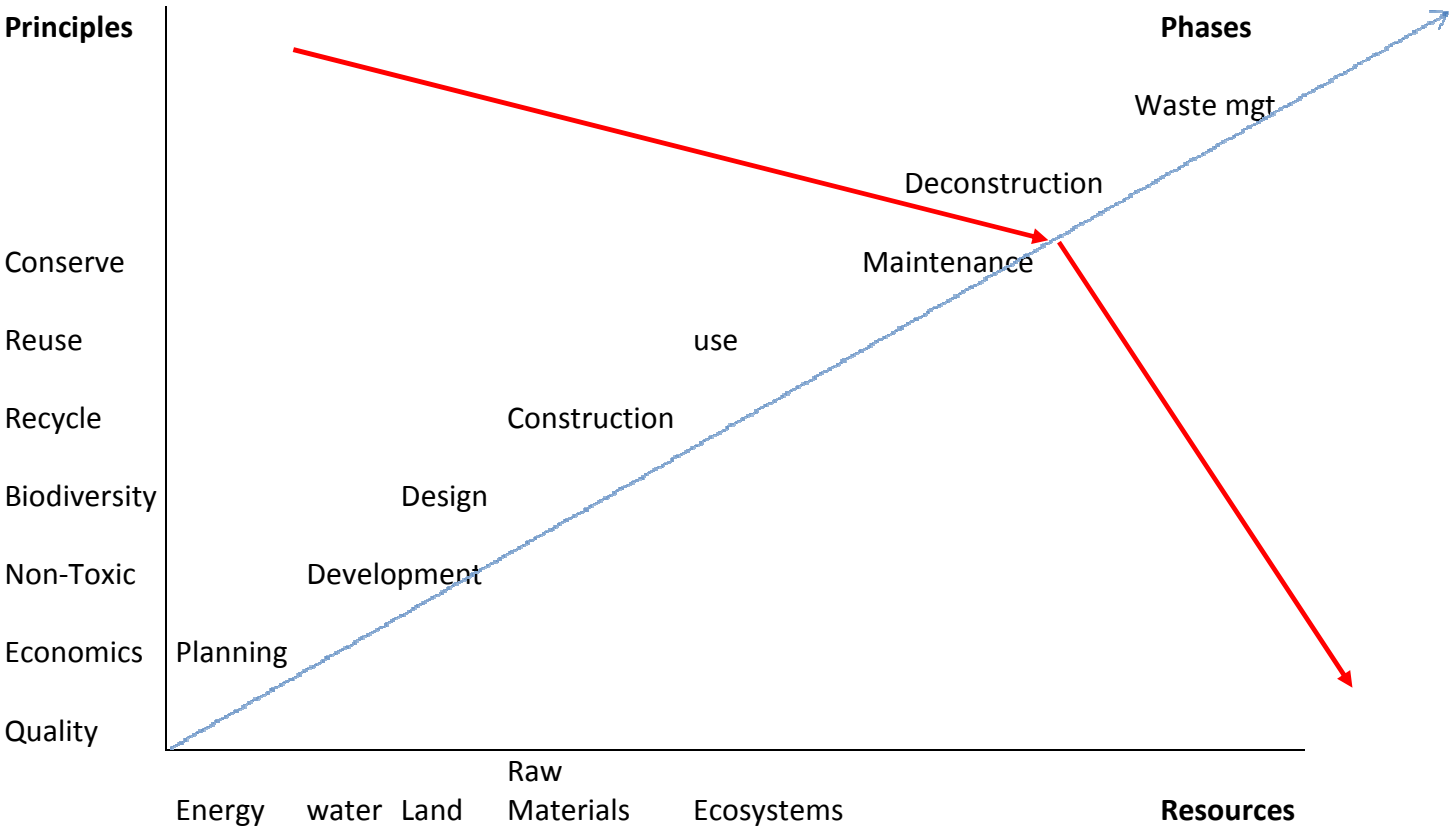
Sustainable construction: Life cycle stages



The sector is currently economically organized around the construction phase.

It seems critical to reconsider the whole value chain of the construction sector in view of bringing value to the deconstruction and recycling phases as they are not yet considered as valuable components of the chain.

Life Cycle stages



3.2- A complementary approach of the construction industry towards the sustainable deconstruction?

3.2.1 How to implement the EC Waste Framework Directive (WFD) while supporting the "Lead Market Initiative" implementation? Turning the EC obligations into a real market opportunity

The EC Directive sets targets to the EU on construction and demolition waste (70%) for 2020. The WFD will act with significant force to boost improved waste management, greater and smarter recycling, and will help foster and support underpinning markets. But the Lead market initiative for the sustainable construction sector aims to "support actions to lower barriers to bring new products or services onto the market."

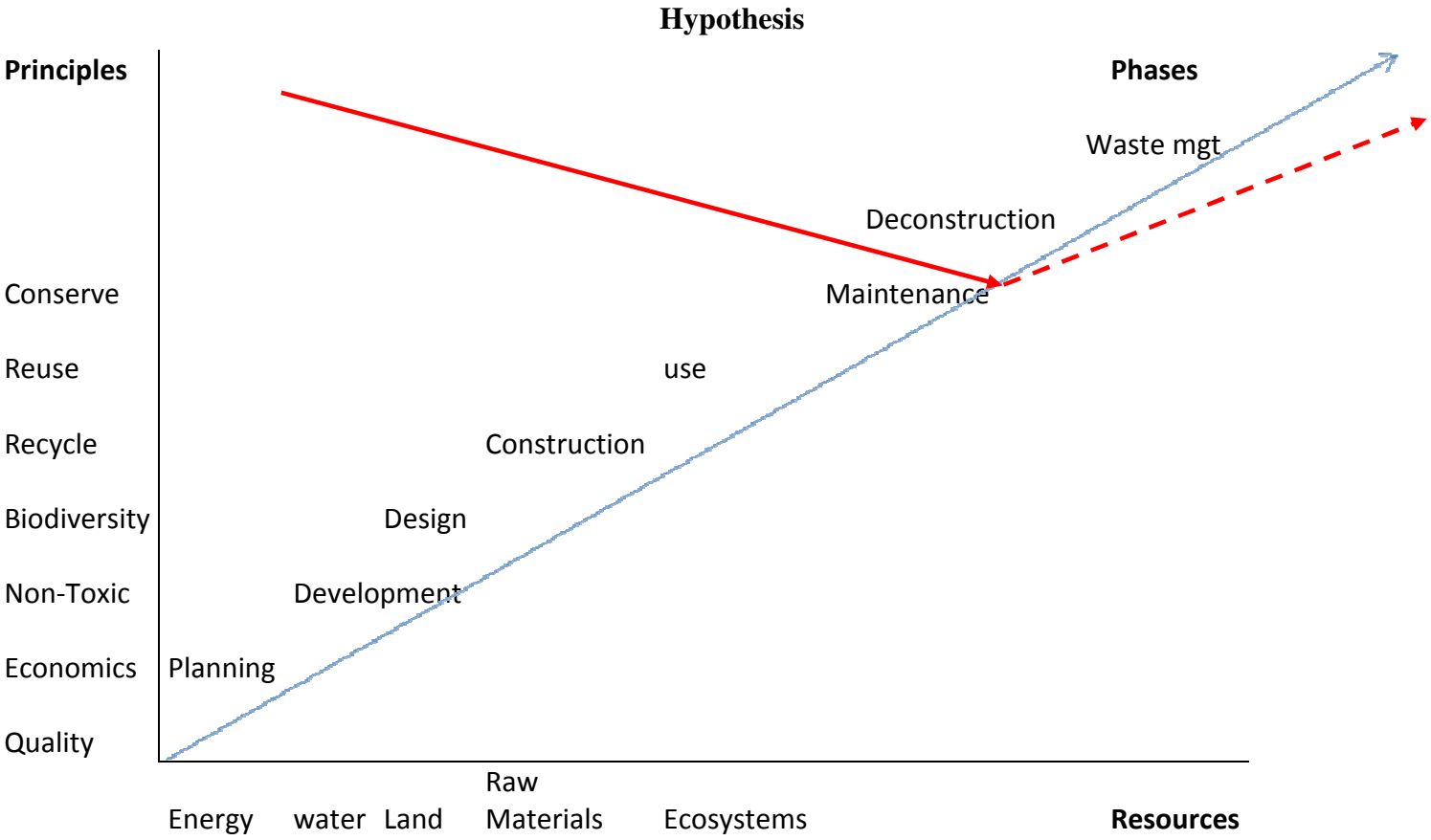
One of the key challenges to make this vision happen is therefore to turn these obligations into new market opportunities to reconcile environment objectives and economic development.

Indeed, negative impact on growth and job of these new constraints may contradict the European objective of the lead market.

Unlike other sectors like transport where huge amounts of fossil energy resources are immediately dissipated through carbon dioxide emissions, the building sector leaves huge amounts of materials after the use phase. It makes that the demolition phase is a perfect opportunity for seeking markets and applications of the waste material giving rise to both waste disposal reduction and virgin resource savings.

A new approach of the construction sector and its value chain is therefore needed to implement the EC Directive while creating new market opportunities for waste demolition.

Life Cycle stages



3.2.2 How to make it happen? Reverse Logistics for Demolition Waste[8]

The high and diversified amount of C&D waste is not only a **today's challenge** with respect to recovery of components and materials but also with respect to the **organisation of the associated logistic activities**. Therefore, the recycling organizational network and its flows and components are fundamental to C&D waste recycling feasibility. Organizational networks, flows and components involve **reverse logistics.**

The concept of reverse logistics - which has already attracted intensive research in manufacturing industry - is applied to the construction industry particularly focusing on deconstruction projects. It is shown that the main structural difference between the construction industry and the manufacturing industry, regarding take-back of products, i.e. waste, does not refer to waste treatment or recovery processes, but to the organisation of the collection and the design of logistic processes from the building site to the recovery facilities.

[8] **Organisation of reverse Logistics tasks in the Construction Industry- F. Schultmann, N. Sunke-University of Siegen, Chair of Business Administration, Construction Management and Economics, Germany-2007**

Reverse logistics encompasses the logistics activities all the way from used products no longer required by the user to products again usable in the market. It is the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin, for the purpose of recapturing value or proper disposal (Stock 1998, Jayaraman et al. 2003).

The construction industry, however, has not yet attracted much research concerning the organization of reverse logistic tasks.

The return or take-back of construction and demolition waste (C&D waste) at the end-of-life of a building or during repair and renovation processes has not been subject to reverse logistic concepts.

3.2.3 Application of Reverse Logistics in Deconstruction Projects[9]

The stages of reverse logistics can be distinguished into[10]:

- collection – **example**: bulk bag system; collection of backhaul vehicle capacity, mosquito fleet of small trucks, which collects the waste from sites et deliver them to reprocessors or waste transfer stations;
- inspection/selecting/sorting processes;
- reuse: **example** pallet reuse;
- reprocessing; **example** near plasterboard mills, mobile recycling plant;
- redistribution.

All of the activities require a certain amount of operational logistic activities, i.e. transport of Waste/product.

Discussing reverse logistics, the following aspects need to be taken into consideration (Dekker et al. 2004):

- motivation of enterprises to take action in reverse logistics as well as reasons for product return;
- processes carried out in logistics with the aim of recovering value;
- characterisation of returned products, and
- actors executing the reverse logistics activities.

[9] WRAP, Plasterbiard case study – EJ Berry –Plasterboard take-back using reverse logistics
[10] Federation of plastering and drywall contractors (FPDC): Diverting plasterboard waste from landfill in the UK-June 2006

4- European Added value

4.1- A common objective…

The Waste Framework Directive indicates that "In order to comply with the objectives of this Directive, and move towards a European recycling society with a high level of resource efficiency, Member States shall take the necessary measures designed to achieve the following targets[11]: by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste (….) shall be increased to a minimum of 70 % by weight".

4.2- … but several possible applications across Member States …

"The term "recycling" is **difficult to apply consistently to construction and demolition waste across countries** as there is a broad range of recycling and recovery activities executed. Recovery can for a minor part be incineration with energy recovery, but normally the term recovery is used as "material recovery" and indicates a lower product quality than recycling; for example backfilling operations using waste to substitute other materials.

The 70% recycling target for C&D waste in the new Waste Framework Directive includes "Preparing for re-use, recycling and other material recovery including backfilling operations…".

Further, the definition of recycling explicitly excludes "… the reprocessing into materials that are to be used as fuels or for backfilling operations"[12].

4.3- … and a highly fragmented demand …

Furthermore, accordingly to the EC itself, "The plethora and mismatch of building regulations at EU and national levels leads to considerable administrative burdens and - given that the business structure is predominantly local - to a very fragmented sustainable construction market. Many technical solutions are already available, but demand is highly fragmented"[13].

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[11] **Article 11 of the Waste Framework Directive**

[12] **EU as a recycling Society present recycling levels of municipal waste and construction and demolition waste in the EU – EEA April 2009-working paper**

[13] **European Commission: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/sustainable-construction/index_en.htm**

Within this fragmented market, we need to develop economically efficient recycling markets leading to avoid illegal transfer of waste to other EU countries or illegal shipment outside the EU.

Therefore a forthcoming key element of a sustainable construction policy is to make deconstruction compulsory all over Europe to enhance the recyclability of all construction materials and ensure a sustainable use of natural resources. The same quality standards applied to construction should also be applied to deconstruction.

4.4- … justify the need of a European common approach

In view of the above-mentioned and in order to reach the above-mentioned target, we need to have **a scientific, fact based, European overview of the demolition techniques** in various Member States, which for the time being is crucially lacking.

Without knowing how and what we deconstruct for which purposes, it is very difficult to implement an efficient and forward looking recycling policy at the construction product level.

In other words, the construction product manufacturers wish to push for deconstruction on the basis of realistic and achievable targets and for this purpose, we need data, facts and evidence across Europe.

As Pilar de la Cruz Romero, President of the European Demolition Association International Committee says in the EDA autumn 2009 newsletter, “To make demolition profitable, selective demolition must be used. Selective demolition is compatible with all methods of demolition. Initial treatment of the site and the evaluation will incur costs that should be recovered from savings made on waste management and income from recuperated materials. Local factors and criteria will determine the options available. The work carried out on-site tends to be simple and yields recycled materials of little value. Environmental criteria should be adhered to wherever economically viable. All of the above demands a substantial effort on behalf of the companies involved with regard to resources and investments, as well as requiring a high level of technical expertise and professionalism”

5- Conclusions

5.1 - A call for action at European level: a knowledge-based, sustainable and economically viable deconstruction economy

As already recognized[14], support from European Commission is therefore essential to enable the creation of a long lasting deconstruction economy and in particular to contribute answering the following key issues:

- ➔ Is there a possibility to consider demolition and recycling as key elements of the construction value chain?
- ➔ Would it be possible to think and organize a new market approach built around the value of the de-construction and recycling?
- ➔ What are the technical, economical and environmental conditions and bottlenecks to make this approach happen?
- ➔ Would regulation in the field of deconstruction enhance the C&D recycling market for non-load bearing elements of a building?

5.2 - Orientations for future actions

1. Non-load bearing elements of the building:
    a. Deconstruction issues: Cost of demolition and costs of dismantling, environment and health
    b. Issue at the plant
        i. Innovation to absorb different the recycled materials in the production chain
    c. Issues at the level of the products
        i. Define quality standards for recycled products
        ii. Contaminants
2. Organizing recycling networks, flows and component and reverse logistics. The composition of C&D waste currently hampers efficient reverse logistic activities.

[14] European Commission: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/sustainable-construction/index_en.htm : "Besides applying its better regulation policy, the Community may further **render the regulatory framework more efficient by accompanying measures and awareness campaigns**, in order to provide a common reference model on sustainability in the market area. Standardisation measures can improve the situation and introduce concepts relevant for sustainability."

5.3 - Expected deliverables

1. Improve the sustainable use of natural resources;
2. Quantitative and qualitative data with sensitivity analysis enabling the push for deconstruction rather than for demolition;
3. Increase the percentage of recycled material in the manufacturing processes via innovation;
4. Design the non-load bearing systems for better recyclability;
5. Organize optimal reverse logistics chain for recovering C&D waste;
6. Educate the workforce to dismantle in small refurbishment project and to sort in construction or major renovation.

5.4- and potential partners –

1. One Research Institute
2. European Demolition Association
3. Construction Products Manufacturers
    i. Gypsum
    ii. Insulation material
    iii. Metal scraps
4. Recyclers and reverse logistics