Ecodesign - Why Is This Important And How Do We Put It Into Practice?

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AR 12.03
Fredrikstad, November 2003
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Why Are Environmental Aspects Important?

Society has become more and more interested in environmental issues. The reasons for this lie in the growing awareness of the fact that our quality of life is affected by our impacts on the environment and also the quality of life for future generations is very dependant on how these issues are handled by current generations. A well known concept in environmental circles is ‘Factor 10’. This is the realisation that the world’s population is expected to increase from 6 to 12 billion people by 2040 and the standard of living in South America, Asia and Eastern Europe is expected to increase by a factor of 2.5 by this time. It is also acknowledged that the total environmental impacts on the earth from human activities must be reduced by 50% in order to be sustainable. The combination of these factors means that we must fulfil our requirements 10 times more effectively than we do today (thus ‘Factor 10’).

As described above, the Factor 10 concept means that in order to achieve sustainable development we must fulfil the same functions by using our resources 10 times more efficiently than today’s technology and production processes allow. So there are a many challenges ahead in order to achieve sustainable development.

Politicians are developing more and more policies and regulations in order to control progress. This means that environmental efficiency and environmental performance are aspects developers and investors must consider, otherwise they will be forced to do so by authorities, customers and finance institutions.

The UNEP ecodesign manual [UNEP 1997] gives a good example of the environmental costs for a company with a proactive attitude to environmental issues (‘trendsetter’) compared to the costs for a company that only follows legal requirements, see Figure 4.1.

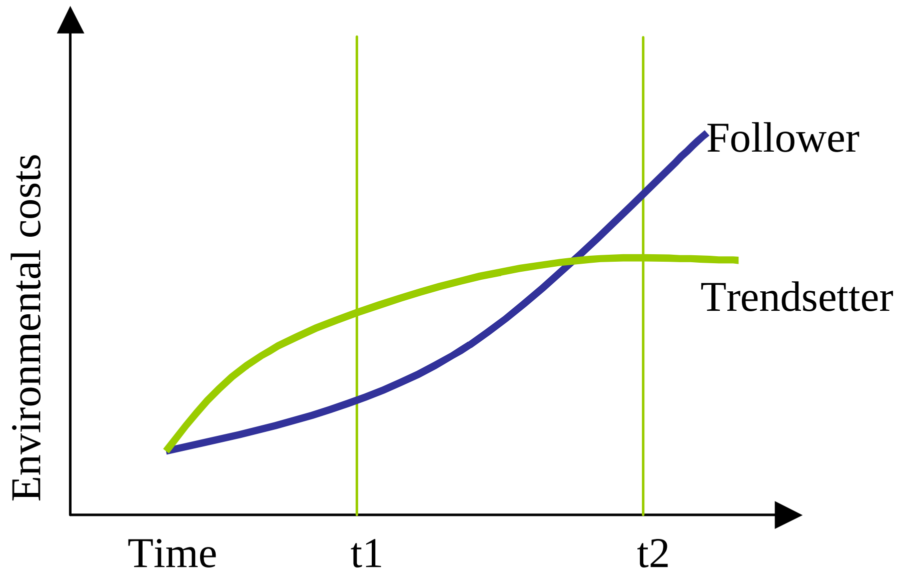


Figure 1: How environmental costs develop for trendsetters and followers [UNEP 1997]

Good examples of the environmental focus for authorities are:

EU

The EU has defined Thematic Priority Areas, including Sustainable Development, Global Change and Ecosystems [EU work programme 1.6.2].

Norway

The Norwegian State Pollution Control Authority's report on the state of the environment in Norway [SFT 2000] describes important environmental aspects for Norway for transport, energy and emissions.

Oslo

Climate Change Strategy for the Greater Oslo Area the goal for mobile sources of greenhouse gas emissions is defined as:

Emissions of greenhouse gases from mobile sources shall not increase from the 1997 level.

If the trend continues as today, there will be an increase of 23% by 2010.

Why are environmental aspects important for product development?

⇨Political focus and requirements (authorities, customers and finance institutions)

⇨The environmental aspects of many traditional products create environmental problems. These are extremely important issues that can be turned into good business opportunities.

Life Cycle Thinking, A Holistic View

Traditionally the approach to environmental aspects has been to focus on individual processes, using end-of-pipe solutions to treat pollution and waste to acceptable levels. This approach was flawed, as one often ended up only moving the problem, rather than solving it (e.g. from the air to solid, or aqueous emissions). The realisation of these limitations has lead to an acknowledgement that source reduction is the way forward, rather than end-of-pipe solutions. In order to achieve source reduction, the whole value chain for a given product must be considered. This is where the life cycle approach comes in.

Life Cycle Assessment (LCA) is a systematic survey and assessment of health, environmental and resource effects throughout the whole life cycle of a product, or product system, from 'cradle to grave' (from extraction of raw materials to final disposal).

Life cycle thinking gives a more holistic approach to health, environmental and resource problems than other environmental analyses. Information and data is analysed in a systematic way for the whole life cycle of a product according to the function of the product. This avoids sub-optimisation of a system by concentrating on optimising individual parts.

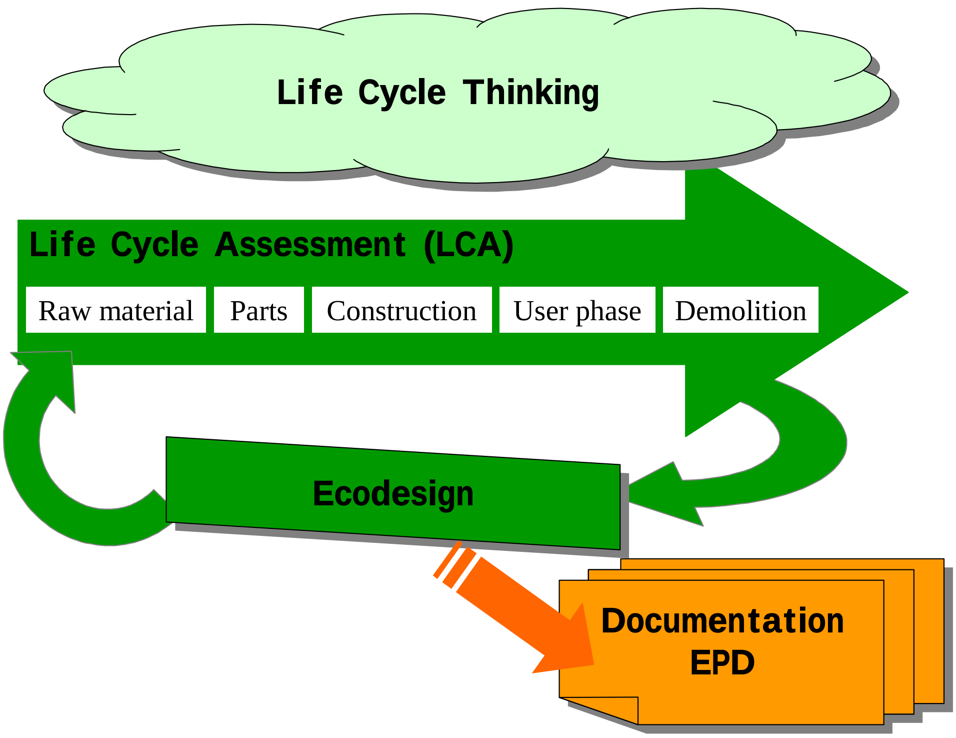


Figure 2: Life Cycle Thinking a product system: LCA, Ecodesign and Documentation in the form of an Environmental Product Declaration.

Figure 2 is a general diagram, aimed at introducing the methods and approaches proposed for further work. LCA, Ecodesign and EPD documentation will be described in more detail later in this report. However, it is useful to see how they fit together, in order to understand the roles LCA, ecodesign and EPD documentation can have in development projects. Figure 2 shows how life cycle thinking is incorporated into the project, using LCA and ecodesign and how environmental product declarations (EPDs) are linked with Life Cycle Assessment (LCA).

Including life cycle thinking in the design phase, where the degrees of freedom are greatest, provides the greatest potential for achieving the most eco-efficient design. The life cycle perspective will ensure that ecodesign principles and strategies are incorporated in the design process. This input will enable the design team to learn whether the options they can choose between will impact in a positive or negative fashion on the environmental profile of the product system. Facilitating the design of a better, more eco-effective system throughout its life cycle.

Screening LCA analyses early in the design phase of the system will be able to provide input and guidance in the following types of choices:

- choice of materials;
- choice of energy source and energy carrier[1];
- operational choices;
- function;
- efficiency of operation;
- lifetime of system and parts (e.g. trade-off between long life and more intensive production of parts)

[1] E.g. hydropower, coal, wind, gas etc.

Life cycle assessment (LCA)

A Life Cycle Assessment (LCA) of a product or product system is defined as a systematic survey and assessment of environmental and resource affects throughout the whole of the life cycle of a product/product system.

Life cycle assessment (LCA) is a process that evaluates the environmental burdens associated with a product system, or activity. This is done by identifying and quantitatively, or qualitatively, describing the energy and material uses and releases into the environment. An LCA includes the entire life cycle of the product, or activity from 'cradle to grave' (i.e. from raw material extraction and processing, through to manufacture, distribution, use, re-use, recycling and final disposal). All transportation involved in the life cycle is also considered. LCA assesses the environmental impacts of the system in the areas of ecological systems, human health and resource depletion. It does not address economic[2], or social effects [Lindfors et al., 1995, Consoli, 1993].

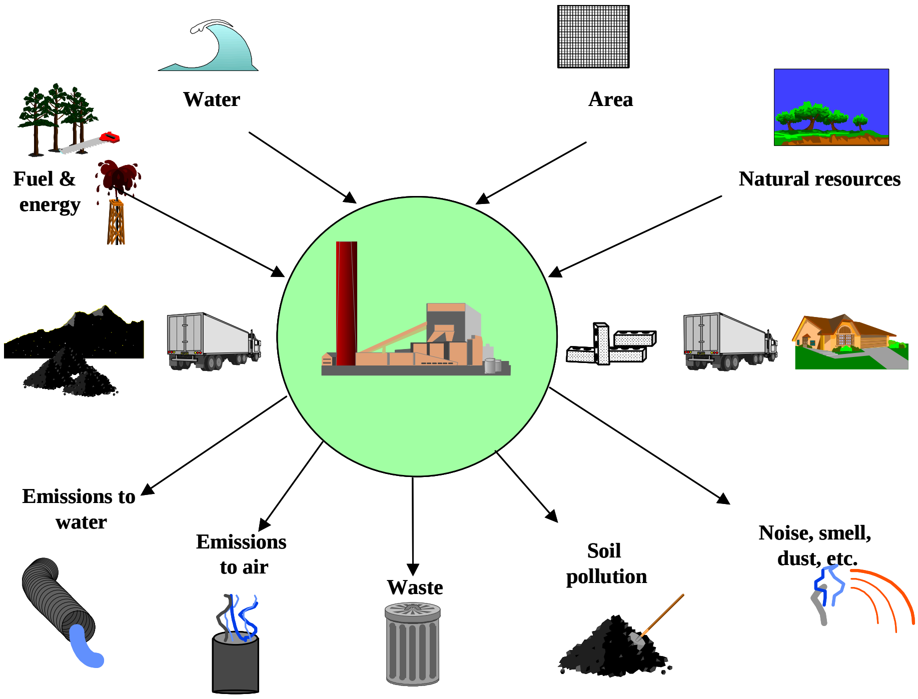


Figure 3: A life cycle for building blocks

Figure 3 shows an example of a life cycle for building blocks. The type of data that should be included for each stage in the life cycle is shown using the production process (for the blocks) as an example.

There are three central questions in a life cycle assessment:

⇨What are the most important environmental problems for a system?

⇨Where in the life cycle do the most important problems occur?

[2] Life Cycle Costs (LCC) methodology can be used to include costs in the LCA assessment. Socio-economic analysis can also be combined with LCA to obtain cost estimates for external environmental effects, so LCA can be used to address economic aspects if desired.

⇨Where is the greatest potential for environmental improvements to the product system?

The basis for estimating the reference flow of products, utility materials, energy etc. to fulfil the user requirements in a LCA will be the functional unit (FU). For end products and complex constructions, the FU shall as far as possible reflect how products, based on lifetime expectations, user efficiency, fulfilment of more than one function etc, fulfill user demands. The definition of the FU is therefore important as a basis for making relevant and fair comparisons between products in relation to how effective they fulfil one or a number of user demands.

The following aspects should be considered in determining the functional unit:

- The lifetime dimension
- The functional efficiency of the product solutions
- Multi-functionality must be covered in definition of the functional unit.

See Appendix I for a more detailed description of Life Cycle Assessment methodology.

Ecodesign

Ecodesign is defined in UNEP 1997 by the following text:
‘Ecodesign means that ‘the environment’ helps to define the direction of design decisions. In other words, the environment becomes a co-pilot in product development. In this process the environment is given the same status as more traditional industrial values such as profit, functionality, aesthetics, ergonomics, image and overall quality. In some cases the environment can even enhance traditional business values.’

The central principles of ecodesign and ecodesign strategy are shown in Figure 5.2.1.

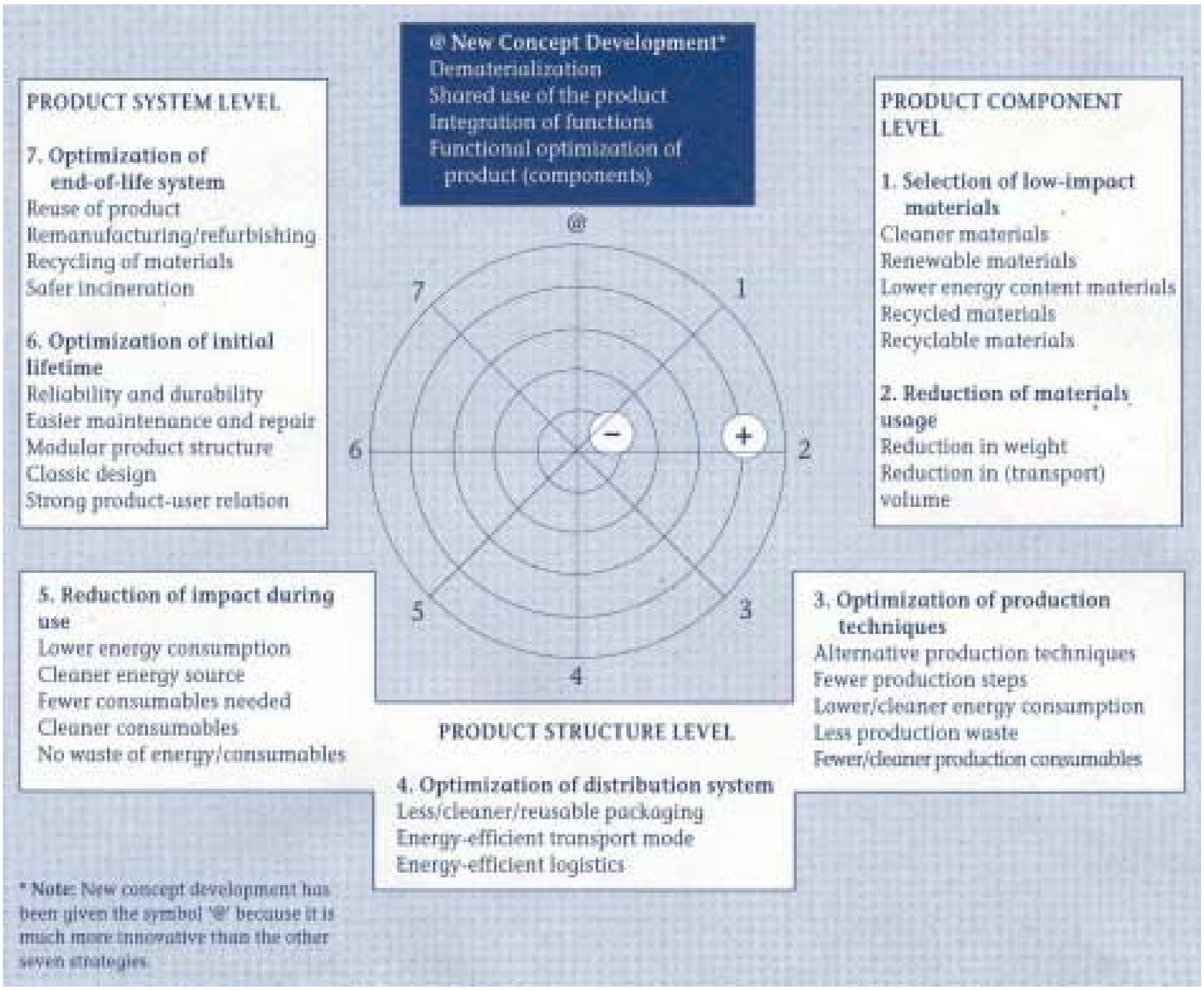


Figure 4: Ecodesign strategy wheel [UNEP 1997].

These principles are central to achieving the most environmentally friendly design. It is essential that there is good communication between designers, the safety team and environmental advisors to ensure these principles are followed when choices are made. There are many degrees of freedom in the design stage, but all choices made reduce these and have implications for the environmental profile of the final design.

It is important to remember in the design process that the following aspects normally have a positive effect of the life cycle environmental performance of a given system:

- Increased energy efficiency / flexibility
- Increased life of facility / product
- Design for potential expansion / flexibility
- Design for disassembly
- Correct use and maintenance of the facility / product (also prolongs life)
- Correct disposal (see also waste management hierarchy)

Ecodesign principles are important in order to minimise impacts on the environment and LCA ensures optimisation over a life cycle perspective. This can avoid sub-optimisation of a system by concentrating on optimising individual parts. A good example of this can be re-using old electric light fittings to ensure re-use and recycling principles are adhered to in the design and construction phase, but failing to see that a less energy efficient fitting, means more energy and resource use over the lifetime of the light fitting.

Ecodesign and LCA thinking are beneficial, also in economic terms. Minimisation of life cycle costs means finding the most cost effective solutions also.

What aspects can be important for ecodesign of products?
⇨Maximum energy efficiency
⇨Minimum wind resistance (aerodynamic design)
⇨Weight
⇨Flexiblility (new product developments can easily be incorporated, modular design, to enable easy maintenance/replacement of parts)
⇨Classic design
⇨Design for re-use/recycling (easy disassembly)
⇨Maximum lifetime
⇨Minimum maintenance and consumables requirements
⇨Raw materials with minimum life cycle environmental impacts

In order to ensure the minimisation of environmental impacts from the materials used in the product system one must also be aware of the importance of the energy used in the manufacture of raw materials. For example if a raw material manufacturer in location A uses coal as the energy source for production, while another supplier in location B uses hydropower to produce the same product, from an environmental perspective, supplier B will be preferred (given that there are no other significant differences in the production process of course).

Environmental Product Declarations (EPDs)

LCA reports can be large and detailed; they are often unsuitable for general distribution of life cycle information. Such reports will be of interest to LCA practitioners and be very valuable for documentation and verification of the technical details of the LCA performed. However, an Environmental Product Declaration (EPD) can be used to document the life cycle impacts of a given product, or product system, in summary form (in a standardised fashion). This is very useful in sales and marketing applications where this documentation of environmental aspects, which can be a strong sales argument for products, can be given to interested parties. EPDs are easily put onto websites in PDF form and can therefore make LCA data for these systems readily available.

Figure 4 shows what an EPD for a product can look like.

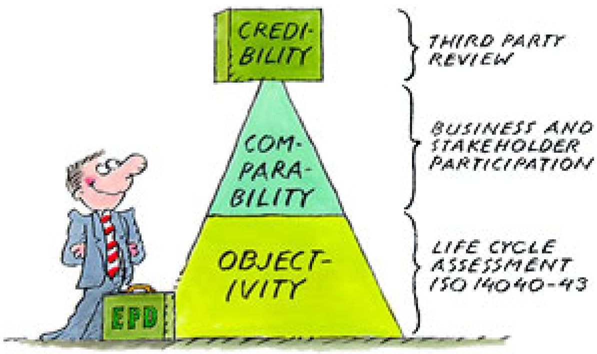
Figure 4: EPD for a product.

The outline of the EPD, showing the type of information required, is given in Appendix III.

Environmental Product Declarations (EPDs) are developed to fulfil the increasing market demand for LCA-based, quantified information about the environmental performance of products and services. Such information is needed in several markets, e.g. in the raw material supply-chain, within the framework of an environmental management system, for green purchasing and procurement and larger constructions.

An EPD is based on science-based, verified and comparable environmental information open for all products and services to support continuous improvements based on flexible in-company product development processes.

EPD is primarily intended for use by industrial consumers in commerce and industry as well as public sectors as source of information to meet market requirements for fact-based and comparable environmental information about products and services.
EPDs are designed to meet high demands of reliable and comprehensive environmental information regarding products and services.



Ecodesign criteria for product design: Examples

This chapter attempts to apply the ecodesign principles to product design processes and provide some ideas of how these principles (shown in Figure 4) and strategies for ecodesign can be put into practice.

When considering which materials should be used, recycled materials can give a better environmental profile, as you avoid processing of virgin raw materials (such as iron ore, or crude oil), but obtain raw materials in a more refined form.

Figure 6 is taken from UNEP 1997 and shows the potential reductions in environmental impacts when recycled materials are preferred to virgin materials.

100% recycled glass has an impact which is	≈ 0.8 ×that of completely new glass
100% recycled iron	≈ 0.4 ×that of completely new iron
100% recycled plastic/paper/cardboard	≈ 0.4 ×that of completely new material
100% recycled glass has an impact which is	≈ 0.8 ×that of completely new copper
100% recycled aluminium has an impact which is	≈ 0.8 ×that of completely new aluminium

Figure 6: Reduction in environmental impact when recycled materials are preferred to virgin materials [UNEP 1997].

In order to put this ecodesign theory into practice, a more concrete set of environmental design criteria can be desirable. These types of criteria can be developed for each product system considered. In order to give some examples of such sustainable design criteria the authors have developed Tables 1 and 2, below.

Sustainable Design Criteria

A common mistake is to compare material with material on a basis of mass, so 1kg steel with 1 kg concrete. This comparison would be wrong from an environmental perspective. The function of the materials and the design of the different types of solutions (e.g. steel or concrete) must be brought into consideration if comparisons between different materials are to be made.

The type of comparison described above is impossible to perform in detail at this stage of the design process. Different amounts of the different materials will be required to fulfil the same function. A good example in the case of a transport system is the materials required for the load bearing construction for carrying the load of the vehicles. It is unfair and impossible to compare 1 tonne of steel with 1 tonne of concrete in this case. If one wants to compare materials one has to calculate the amounts based on given designs for the different materials. Experience shows that heavy construction materials, with a high use of energy and polluting emissions in production, often require less maintenance during the lifetime of a construction.

The whole life span of the product should therefore to be considered in the construction phase. Some well known environmental design criteria can, however, be expressed. Table 1 lists some important issues to take into consideration when designing a complex construction.

Table 1: Important considerations for constructions, example.

		Steel	Concrete	Wood
General	Density	7.8 tonne/m^3	2.4 tonne/m^3	0.5 tonne/m^3 (Norwegian pine)
	Type of resource	Non renewable	Non renewable	Renewable
Raw material production pr weight	Energy use	High	Low (since conrete is x% crushed stone)	Low
	CO_2	Medium	High	Low
	Others to be considered			Sustainable and local forestry are important. Heavy metals and toxic elements in impregnation and glues
	Recycled material	High degree possible	As aggregate in new concrete	No
		High environmental benefit	Some environmental benefit	Little environmental benefit
Construction	On site production	From elements	From elements or casting on site	From elements
	Transport	Mode of transportation and distances has to be considered	Short distances in Norway	Larger elements to be transported
User phase	Life time	As construction	As construction	Sensitive to environment
	Surface treatment	Painting needed	No significant maintenance	Treatment needed (impregnation/ painting)
	Visual impression	Slim constructions	More massive impression	"Natural look"
	Noise			
	Vibration			
Demolition	Recycling / recovery	Material recycling	As aggregate in new concrete and in road fillings (limited use today – but under methods development)	Energy recovery – "CO_2 free"
		Toxic elements in surface treatment	PCB if synthetic rubber is used as hardener	Toxic elements from painting, glue and impregnation

Table 2: Important considerations for vehicles, example.

		Aluminium	Plastic (PE)
General	Density	2.55-2.80 tonne/m^3	0.94-0.96 tonne/m^3
	Type of resource	Non renewable	Non renewable
Raw material production pr weight unit	Energy use	Very high	High
	CO_2	Medium	Medium
	Others to be considered		Raw material is a fossil energy source
	Recycled material	Yes	Yes
	Energy savings in production when recycling	Very high	Medium
Construction	On site production	Not possible	Possible
User phase	Life time		
	Surface treatment	Painting/treatment needed	No maintenance
	Visual impression	Slim constructions	
	Noise		
Demolition	Recycling / recovery	Material recycling	Material recycling (highest benefit), or Energy recovery – with CO2 emissions

Some general points that give additional tips for ecodesign are the following:

- The energy sources used in the production of raw materials can have a large effect on their environmental impacts (e.g. Norwegian hydroelectricity vs. coal power)
- In general, design for re-use/recycling means avoiding complex composite materials
- It should be easy to separate components when the vehicles/system components come to the end of their useful life (design for recycling).
- Where possible:
    - Increase operational energy efficiency
    - Minimise emissions in the life cycle perspective
    - Minimise impacts from material production
    - Minimise visual impacts
    - Minimise noise (wind, wheels, vibration, motor)

Waste management hierarchy

General experience from life cycle assessment work and waste management systems has lead the authors to recommend the following waste management hierarchy where practicable:

1. Re-use
2. Recycling (with replacement of ‘virgin’ raw materials)
3. Energy Recovery with direct replacement of ‘dirty’ energy carriers in industry.

In general, the more energy and resource intensive the material used, the more important it is to re-use or recycle the material.

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