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Environmental issues in LCC

BENGT STEEN

CPM Centre for Environmental Assessment of Products and Material Systems and Environmental Systems Analysis
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Bengt Steen, Chalmers University of Technology, bengt.steen@esa.chalmers.se

Abstract

From a methodological aspect, Life Cycle Costing, LCC, is well developed with respect to conventional costs. However, when it comes to costs related to environmental issues, neither the items, nor their estimation is well developed.

In the EU project DANTES (Eco-Efficiency evaluation of new and existing products), supported by the EU Life Environment Program, an attempt is made to use LCA information to identify and estimate environmentally related costs and benefits in an LCC. Case studies will be performed at ABB and Akzo Nobel. The methodology presented here is being developed at Chalmers. The aim of this report is to identify and define relevant external environmental costs as input to the LCC tool used in DANTES.

Some of the items of an LCC have to do with increased/decreased sales, others with goodwill. Both are difficult to estimate, but LCA or LCA-like investigations may be used for benchmarking and trend analysis.

Future costs to the product system may also be estimated, e.g. with a distance-to-target type of weighting, like in the DESC model.

LCA may be used to estimate risks, especially together with those LCA impact assessment methods that model damage. Such an item in the LCC can be dealt with as an insurance fee or in case the risk is too high, as a way to include necessary preventive actions.

In today's cost accounting it is often difficult to find environmental related costs. An LCA helps in identifying many of these costs.

LCA data may be difficult to make public and LCC data are even worse. Therefore a procedural methodology for the use of LCA as input to LCC is developed as a first step.

1 Introduction

LCA (Life Cycle Assessments) and LCC (Life Cycle Costing) both are methods that emerged from the energy crisis in the mid 70ies. LCC was developed by economists, LCA by engineers.

LCC developed quickly as there already was a methodological framework ready: economy. The main problem was to find the items to include and estimate its values. The first teaching books in LCC appear in early 1980 (e.g. Dell'Isola and Kirk, 1981).

LCA developed not so fast. Initially various mass balances was added to the energy balances. Product and waste streams were included. Later, when environmental concern grew, the mass and energy balances became environmental assessments and the framework developed gradually.

Since the early 1990s LCA has developed significantly, both in terms of techniques and tools and in environmental management applications. In other words, there has been an improved understanding of the underlying methods and applications.

The development of LCA methodology has followed several lines:

- Software - making the work easier and faster
- Harmonisation (ISO standards 14040-48), which improved communication
- Databases - making the work easier and faster

The application routines in environmental management has developed along the following lines:

- At company level: many companies have routines that determine at the commencement of a project when LCA is required. (Is a new technique or new materials involved, is any environmentally "hot" substances are involved…etc) LCC is often requested, but the full benefit of co-ordinating LCA and LCC is not yet fully achieved. Baumann found (Baumann, 1998) that a main benefit of LCA to companies is learning.
- At national level: LCA is used to back up certification and labelling rules. Some policy decisions are based on LCA studies. Environmental product declarations based on LCA are made available in some countries. (EPD, 2003)
- At EU level: The EU commission has published a Green Paper on the Contribution of Product-Related Environmental Policy to Sustainable Development – A Strategy for an Integrated Product Policy Approach in the European Union, (IPP)

LCC is a much older tool. Economists use it as a decision method for supporting investments. It considers the costs associated to the whole lifecycle of a product from the manufacture to its use and subsequent disposal.
During the 1990's discussions started to include externalities in the LCC method, e.g cost of environmental impacts caused by the product. The rational for this was to make available LCA for governments in the PPP (Polluter Pays Principle) to impose emission taxes.

LCA is used today by many companies in other sectors to learn more about their products, for design purposes and for marketing reasons. It is seldom used on a routine basis, but a few companies have a management practice that tells them when to use LCA. (e.g. ABB and Volvo Cars). EEA has made an overview over the development and use of LCA, table 1 (EEA, 1997)

	Level of detail in LCA			
Application	Conceptual	Simplified	Detailed	Comments
Design for Environment	x	x		No formal links to LCA
Product development	x	x	x	Large variation in sophistication
Product improvement		x		Often based on already existing products
Environmental claims (ISO type II-labelling)	x			Seldom based on LCA
Ecolabelling (ISO type I-labelling)	x			Only criteria development requires an LCA
Environmental declaration (ISO type III-labelling)			x	Inventory and/or impact assessment
Organisation marketing		x	x	Inclusion of LCA in environmental reporting
Strategic planning	x	x		Gradual development of LCA knowledge
Green procurement	x	x		LCA not as detailed as in ecolabelling
Deposit/refund schemes		x		Reduced number of parameters in the LCA is often sufficient
Environmental ("green") taxes		x		Reduced number of parameters in the LCA is often sufficient
Choice between packaging systems	x		x	Detailed inventory, Scope disputed LCA results not the only information

Table 1 LCA applications

A consequence of the different application of LCA and LCC is that it has different system borders (Baumann, 2003)

A weak point in the use of LCA by companies is the understanding of what its results means to their economy. A lot of interesting results are brought forward by the LCA,

but it is difficult to interpret what it means to the necessity of any company: to earn money.

This study aims at increasing the possibilities to interpret LCA results in terms of economical consequences for a company. This is done from a LCC perspective in order to focus on the economically relevant information in an LCA.

There are at least two situations, when environmental costs are of interest in LCC: one is when estimating the full life cycle cost of a project or decision. Another is when identifying cost elements related to the environment. In the first case only downstream costs are of interest. In the second case all costs related to environmental issues are of interest.

The report presented here is a part of the efforts to integrate LCA and LCC in two networks, the EU project DANTES (2003) and the SETAC working group on LCC.

2 Driving forces

When developing any methodology it is important to know the driving forces for the use of it. The ambition level of the method has to be in harmony with the ambition level of its users and it should satisfy the needs defined by it.

The basic driving force is often expressed as PPP, the “Polluter Pays Principle” or the more updated and positive version of it: “Get the prices right”(EU, 2002). Damage or benefits to third parties shall be carried by he or she who causes it.

There is however several things hindering this principle to be applied in practice:

- Lack of knowledge of who cause what damages to whom
- Lack of enforcement capacity
- Lack of global and regional consensus

These obstacles are however gradually decreasing due to

- The growth of the information society
- Increased institutionalisation
- Globalisation

The whole process may be seen through the IPP-activities (EU 2002). In the development of an IPP (Integrated Product Policy) in EU, a number of instruments and actions are identified.

As the development and integration of a methodology normally require several years, it seems reasonable to develop a methodology, which ambition level is somewhat higher than what is requested today.

3 Identification of environmentally related costs to a company

3.1 Identification of external costs

In an LCA, the environmental consequences of an activity are assessed. The outcome depends basically on three things:

- What is included?
- How is trade-offs handled?
- How is uncertainty addressed?

When deciding upon *what to include in the study*, there are many dimensions to keep in mind. One is the **qualitative** dimension. In general terms one may think of things to include as belonging to 'safeguard subjects' or 'areas of protection', e.g. human health or natural resources. In LCA the concept of impact categories exists, which is more focused but still not a quantitative indicator. The quantitative indicators, called 'category indicators' in LCA and 'impact indicators' in many other methodologies, define the qualitative system borders of the 'environment' we study.
Another dimension where system borders need to be set is **time**. The consequences of an emission or impact may never end even if our possibilities to follow and model them decrease as time elapses after the intervention. The depreciation of future impacts by narrowing system borders or (as economists do), by discounting, is particularly important to recognize when dealing with global warming effects or depletion of natural resources (Azar 1996). Yet another dimension is **space**. There are many examples on how local environmental issues have been `solved' by shifting the impact to another scale or a wider region.

If we choose to use global system borders, we must face the problem of *tradeoffs* between local and global impacts. In impact evaluation trade-off problems are ubiquitous, even if they are not always explicitly identified. For instance when deciding to include an impact indicator into the study, there has to be some kind of weighting of its significance compared to other indicators or compared to some reference. In impact evaluation, as in many other types of evaluations, there are two ways of handling tradeoffs. One is to try to minimize or maximize an objective function of some sort. This may be called a 'utilitarian' approach. (In contemporary politics it is often associated with the right wing.) Another is to try to achieve some type of justice, i.e. to deal with each indicator separately and try to reach an acceptable compromise. This notion is close to Herbert Simon's ideas of `satisficing' in contrast to `optimizing'. (In contemporary politics this worldview is mainly associated with the left wing.) In LCIA used for design purposes the utilitarian approach is often used (i.e. the overall best option is sought) while in RA and EIA the latter approach is more often used. Of course, in practice, combinations of the two tradeoff types are common.
The way of *handling uncertainty* depends on the study context, but also on the practitioner's general attitudes. A common way is to let the degree of uncertainty decide whether an issue or figure should be included or not in the evaluation. Another sometimes more fruitful way would be to accept uncertainty as a part of reality and

try to describe its consequences. Instead of focusing on what is `correct', or not, one may ask what our present knowledge, in terms of data and models, tells us. The 'precautionary principle' is often used in impact evaluation and it works well with the 'justice' type of trade-off approach, but for a utilitarian approach, safety margins in one impact type tend to decrease the appreciation of other impacts.
Because normative aspects, such as choice of system borders, are of such an importance, these must be identified, handled in a systematic way, and reported to the reader/ decision-maker.

3.2 Identification of internal costs

The WBCSD (World Business Council for Sustainable Development) formulates the business case as follows:

"Pursuing a mission of sustainable development can make our firms more competitive, more resilient to shocks, nimbler in a fast-changing world and more likely to attract and hold customers and the best employees. It can also make them more at ease with regulators, banks, insurers and financial markets."

WBCSD gives and overview of the business case in the form of a "Sustainable business value matrix", (figure1).

	Ethics, value and principles	Accountability & transparancy	Triple bottom line committment	Environmental process focus	Environmental product focus	Socio-economic development	Human rights	Workplace conditions	Engaging business partners	Engaging non-business partners	Value issues
Financial performance	+	+	+	++	+	+	+	+			Shareholder value
	+		+	+	+	+	+	++	+	+	Revenue
	+	+	+	++	+	-	-	++	+		Operational efficiency
		+	+	++	+	+	+	+			Access to capital
Financial drivers	+	+	+	+	+	+	+	+		+	Customer attraction
	++	++	+	++	+	++	++	+	+	++	Brand value and reputation
	+	+	+	+	+	+	+	++		+	Human & intellectual capital
	++	+	+	++	++	+	++		+	+	Risk profile

Sustainability issues

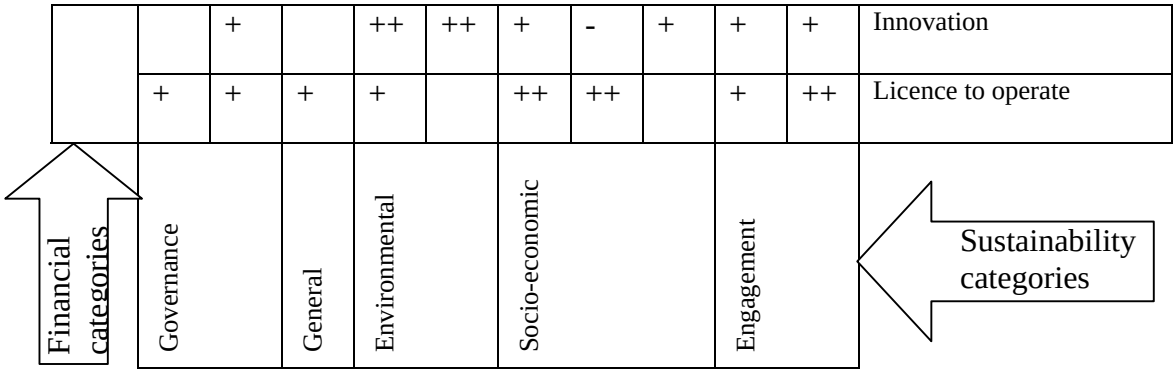

Figure 1 Type of evidence available for various relations between sustainability and value creation. – means negative, no sign means no impact, + means weak moderate positive impact and ++ means strong positive impact.

Some costs and revenues are listed below:

- Process costs
  - Control equipment
  - Environmental permit
  - Environmental monitoring
  - Certification cost
  - Labelling costs
  - Environmental management
- Sales
  - Volume
  - Price
- Accidents
- Goodwill change
  - Impact on sales
  - Impact on recruiting
  - Impact on mortgage rates
- Taxes and fees on emissions and resource consumption

To be used in an LCC, we need a clear definition of the cost so that everything of importance is included and no double counting is made.

3.2.1 Process costs

3.2.1.1 Control equipment

Process and cleaning equipment used to decrease emissions involve capital costs, operating costs and demolition costs.

3.2.1.2 Environmental permit

Costs exist for purchased services and investigations and for fees related to the permit process. Cost depends on type of industry branch and the legislation and traditions in the country where the plant is located. Local conditions can also influence the cost, like close areas of high nature conservation value, or extra sensitive ecosystems.

3.2.1.3 Environmental monitoring
Permits often come with requirements on monitoring. Monitoring can be done on process conditions, emissions and/ambient conditions.

3.2.1.4 Certification cost
A number of companies have acquired a certification according to ISO 14000. Costs are fairly well known, but there are also benefits from increased sales.

3.2.1.5 Labelling costs
Like certification costs, labelling cost are associate with the labelling process and benefit from increased sales.

3.2.1.6 Environmental management
There are costs for an environmental management, but also benefits from less insurance costs and hopefully more efficient environmental protection.

3.2.2 Sales
Sales may be influenced by company goodwill but also directly by product performance, e.g. such as communicated via labelling. This may be achieved either by increased volumes or by increased price.

3.2.3 Accidents
Insurance companies seldom offer environmental insurances. The main reason is that is impossible for them to make economic risk estimates. But the costs are there for the companies, through

- Misjudgements on environmental issues
- Rare accidents like breakdown of cleaning systems and other equipment
- Over-sizing or other extra precautions.

3.2.4 Goodwill change
3.2.4.1 Impact on sales
While labelling more or less instantaneously gives and removes benefits directly to a product, company goodwill has an impact on all products that are associated with a company. It depends not only on environmental issues.

3.2.4.2 Impact on recruiting
Costs may occur directly through increased recruiting costs and indirectly through less efficient personnel.

3.2.4.3 Impact on mortgage rates
Environmental performance is one of the parameter looked at when rating companies' creditworthiness.

3.2.5 Taxes and fees on emissions and resource consumption
Current taxes and fees are well known to, but many projects last for several years and taxes and fees may change.

4 Estimation of environmentally related costs to a company

4.1 Process costs

Statistics exist in Sweden (SCB, 2002) over process related costs, such as process external investments, process integrated investments, company internal protection work and purchases services and fees. Their relative share of the total costs for industry is shown in figure 1

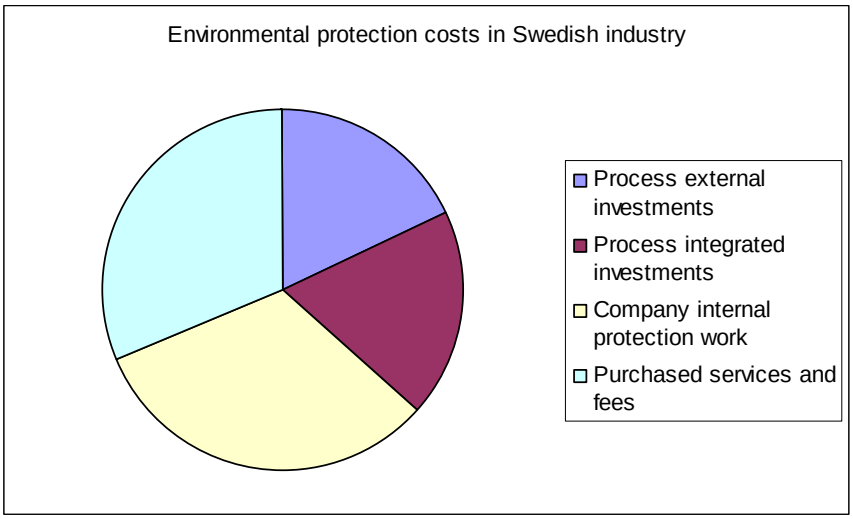

Figure 1 Environmental protection costs in Swedish industry related to process plants.

The process costs include costs for

- Control equipment
- Environmental permit
- Environmental monitoring
- Certification cost
- Environmental management

They vary between industry branches (figure 2)

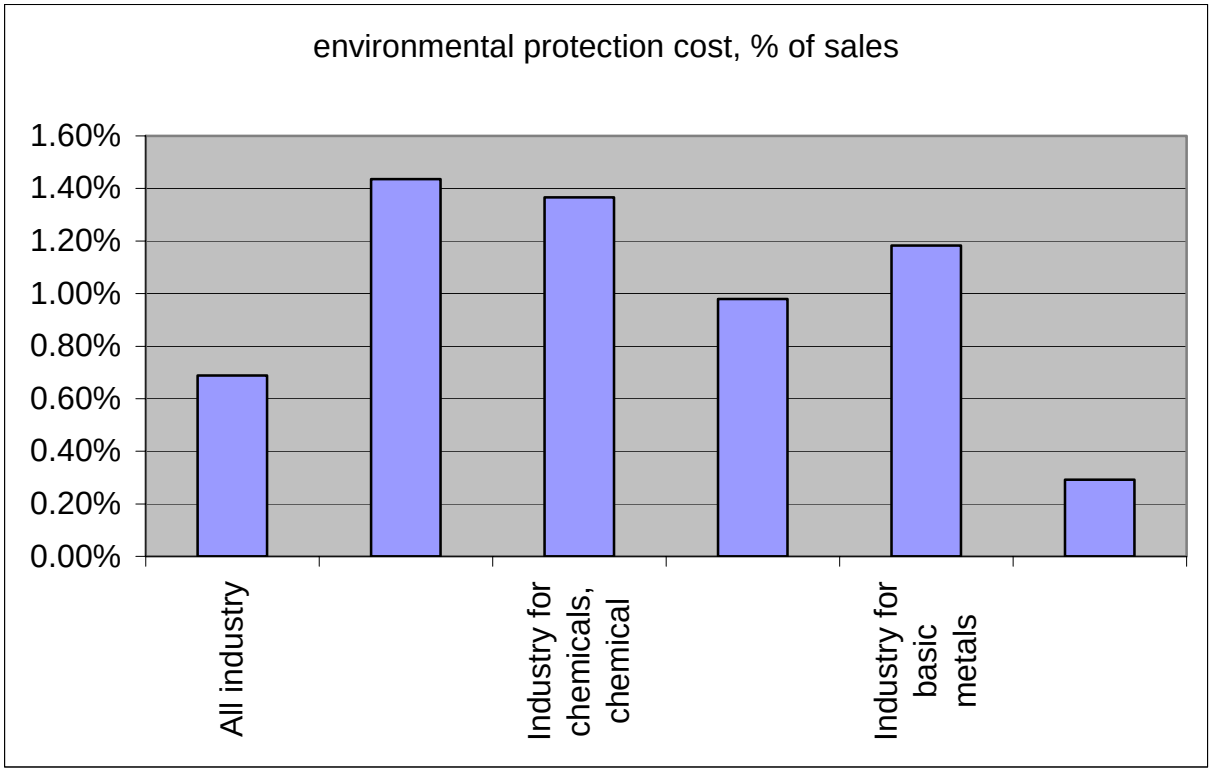

Figure 2 Environmental protection costs for various industry branches

In an LCC, environmental costs are normally included in the total costs for upstream and downstream processes, i.e. the price of delivered parts and materials and the total waste handling cost.

4.2 Sales

4.2.1 Volume

For consumer goods like washing powder, coffee-filters etc, sales statistics from producers as well as shops ought to give reasonably good information,

For capital goods like refrigerators and cars, the environmental impacts are closely linked to energy consumption at use. This makes it difficult to separate environmental aspects from economical aspects, but it is not really a problem for the LCC estimation or the environment, as long as it is included. As LCC is a steering tool for a decision, it is not so important if you achieved an environmental improvement for economical reasons or for pure environmental.

LCA data tells us about the environmental performance of a product, but not how the customers are informed. Labelling is normally the way of communicating environmental performance. Another is via media.

4.3 Price

An alternative of having increased sales volumes is an increased product price. If there is a limited customer group that appreciates environmental qualities, the volumes may not be influenced, but there may be an increased WTP.

For everyday consumer goods these are in the order of 10%.

For capital goods the increased WTP is more difficult to determine from simple price comparisons, as there seldom are two similar products in the same way as for consumer goods.

In Taiwan, the government has recommended their different organization to pay up to 10% more for sustainable alternatives.(Taiwan 2002)

4.4 Goodwill

There are at least three types of items that have to do with goodwill.

One has to do with sales volumes and prices. A company that has a “clean and honest” image attracts more customers than a company without it.

Another has to do with employment. If less people apply for a job position, the staff quality will sink, and ultimately the product and business quality. The cost for recruiting, lies in many companies on the order of 0.1 – 0.3% of the turnover. The consequences of not having the best person for a job is of course very difficult to estimate, but there are some information to be found in the variation of salaries among people doing the same job.

A third has to do with finance. The interest rates for loans may decrease and the stock value may increase. Standard&Poor use environmental criteria in rating loans with properties as security. These criteria are mostly related to things deposited on the ground or part of the building, e.g. asbestos.

LCA allow a benchmarking of companies in terms of environmental efficiency. Databases with generic (average) data may be used for comparison with type III labels. This is not yet the case, but there has been a tendency of increasing number of type III labels and easily available LCA data.

4.5 Accidents

How can the risk for accidents and unforeseen bad-will be estimated?

If looking at some of the environmental accidents from company economics point of view, what information would an LCA give on the nature and size of the accident?

4.5.1 Case 1

A damm burst in Los Frailes, a Boliden owned mining site, threatening a nature conservation area, Coto de Donana 1998. Claims come from farmers of about 7 million EUR and from Spanish Government on 45 million EUR in fines covering sanitation. The company refuses and the issue is not yet settled.

A normal LCA could have identified the process and would have had the possibility to identify the danger, but would most likely not estimate the risk.
An LCA offers a good overview over the substances and processes used.

4.5.2 Case 2

Combustion Engineering and its owner ABB are sued from 100 000 people suffering from high exposure of asbestos. CE goes bankrupt and the net cost for ABB is around 1 billion EUR. The problems relate to exposures on the 50ies and 60ies. At the end of the exposure, the risk was known, in particular when ABB bought Combustion Engineering 1990.

According to RAND, around 6000 other companies in the world are involved in asbestos-related legal conflicts and up to the year 2000, their costs have been 45 billion EUR. Another 180 billion EUR may come. According to SvD (26/2 2003) 100000 die annually from asbestos related diseases.

If a value of 1.5 million EUR/excess mortality case is used, the total value for excess mortality is 150000 million EUR/year, a figure not very far from the cost of the companies. However these seem to be set also from what is available in the companies.

In this case, externalities have become internalities of the same magnitude and could be foreseen. But the risk for companies of having to pay for externalities was probably low in the 60ies. But with the growth of the information society these risks increase and in the asbestos case here, the exact probability is not so important. The conclusion from an LCA/LCC study would still be: “unacceptable”.

A normal LCA could thus have identified the cost, but there is a risk that work environment was outside the system border, and that the problem would not show up.

4.5.3 Case 3

In southern Sweden a train tunnel is being built through the “Hallandsås”. The work started in February 1996. To prevent water from penetrating into the tunnel, cracks in the rock was sealed with “RhocaGil” a product containing acryl amid. Workers were overexposed and cattle harmed from drinking drainage water. The whole project was stopped 1997 10 07 and delayed 6 years. The costs to the companies building the tunnel were 45000 EUR as compensation to the overexposed workers, (LO-Tidningen nummer 9 12 mars 1999) and probably something to the farmers. But above all 6 years capital cost for 180 million EUR, about 50 million EUR.

Would an LCA/LCC on the tunnel project have been able to foresee this? If the people handling chemicals and materials were unaware of the risk would they have told an LCA practitioner about RhocaGil? It would have been one out of numerous chemicals used and maybe only reported as chemicals or a sealant.

But an LCA on the RhocaGil could have identified the danger and made an estimation of its consequences. This could in turn have led to improved communications with the users.

4.5.4 Case 4

Brent Spar. In 1995 Greenpeace protested against a Shell decision to dump a used-out oil platform in the North Sea. After a long debate, Shell decided to change their plans and 1998 it was demounted and partly re-used. No impact actually took place. There was only a postulation of impacts that would happen if Brent Spar were dumped.

The costs to Shell were large. In Sweden they lost market shares and their leading position was taken over by Statoil. Similar pictures may have been seen in other countries.

Could an LCA/LCC have been a support in this case? Yes and no. It may have turned the battle in to a dialog. The qualitative statements used, saying something like "heavy metals from Brent Spar will harm the bottom fauna", emissions could be quantified and compared to others, the potential destroyed area could be estimated as well as the damage cost. The alternative could have been weighed against each other.

But the Goodwill costs to the company, was probably mostly caused by Shell's attitude in the story as it developed in media. Not so much of the potential impacts.

4.5.5 Conclusions

It is extremely difficult to foresee the magnitude of cost of "accidents" of the above types. The costs for preventive measures to a certain level are easier to estimate, but may vary between different business branches.

4.6 Future costs

The damage cost for an emission may be used for estimating the potential for future taxes. The "Polluter Pays Principle" used by most governments or the modern version of it "Get the prices right" indicates that external environmental cost sooner or later may turn up as internal costs. The likely timing for introduction of the taxes is uncertain, but for a specific country and products with a short lifetime, estimations may be made looking at what treaties and environmental goals that has been set up.

For instance, the Kyoto protocol on CO_2 may influence the economy of many products.

5 Discussion and conclusions

From the above text is obvious that there is some potential for use of LCA for identifying and estimating environmentally related cost items in an LCC, but the methodology is immature.

It seems reasonable to start an improvement of the methodology by looking at future costs and benefits. Other costs exist and can be estimated without new methodology being developed.

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