Stellingen

bij het proefschrift ‘Adjusting Life Cycle Assessment Methodology for Use in Public Policy Discourse’ van Remke Bras-Klapwijk

1. Levenscyclusanalyses (LCAs) negeren een aantal milieu-effecten, niet omdat deze effecten niet belangrijk zijn, maar omdat ze niet gekwantificeerd kunnen worden ( Dit proefschrift, hoofdstuk 4 en 6)

2. De LCAs over PVC zijn niet politiek neutraal omdat deze studies een impliciete keuze tegen het voorzorgsprincipe bevatten. ( Dit proefschrift, hoofdstuk 4 en 6)

3. Dat LCAs geen robuuste kennis opleveren is op zich geen probleem. Het grootste knelpunt is dat LCAs geen goede instrumenten zijn voor een discussie. ( Dit proefschrift, hoofdstuk 6)

4. Het toevoegen van een beeldvormende fase aan het huidige LCA stappenplan zal de kwaliteit van LCAs verhogen. ( Dit proefschrift, hoofdstuk 6)

5. Standaardisatie van de LCA methode komt een open en rijk debat over de milieuvervendingelijkheid van producten niet ten goede. ( Dit proefschrift, hoofdstuk 6)

6. LCAs die uitsluitend door wetenschappers zijn uitgevoerd zijn even subjectief als LCAs die door belanghebbenden worden uitgevoerd. Het voordeel van LCAs door belanghebbenden is dat deze subjectiviteit expliciet is gemaakt (Enserink en Bras 1998).


7. Het voorstel van het Ministerie van VROM om vaste doelen en weegfactoren voor het productenbeleid te ontwikkelen (Nota Produkt en Milieu) staat op gespannen voet met de eveneens door dit ministerie gewenste interactieve beleidsvorming.

8. Milieukeuren belemmeren milieuvervendingelijk innovaties.

9. Duurzame ontwikkeling wordt geremd omdat veel mensen er onbewust vanuit gaan dat ze gelukkig worden van het kopen van nieuwe producten.

11. Het postmodernisme heeft enerzijds ruimte gecreëerd voor levensbeschouwelijke en normatieve aspecten in de beleidsanalyse. Anderzijds is het door de postmoderne ineenstorting van de ‘grote verhalen’ voor veel wetenschappers moeilijk geworden om uit te gaan van een bepaalde levensbeschouwing in hun wetenschappelijke werk.

12. Spreken is zilver, luisteren is goud. Helaas is luisteren voor de meeste van ons moeilijker dan spreken. Het verplicht stellen van een cursus luisteren voor TU studenten en medewerkers verdient daarom aanbeveling.

13. Communicatieproblemen tussen mannen en vrouwen ontstaan omdat de meeste mannen denken dat vrouwen die aankloppen met een probleem, een oplossing willen. Gelukkig kan aan het oplossen van dit communicatieprobleem gewerkt worden voordat beide partijen het eens zijn over de oplossing.


15. Door de nadruk op originaliteit, gaan er helaas maar weinig stellingen over de meest essentiële zaken van het leven.
Adjusting Life Cycle Assessment Methodology for Use in Public Policy Discourse
Adjusting Life Cycle Assessment Methodology for Use in Public Policy Discourse

Proefschrift
ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof. ir. K.F. Wakker,
in het openbaar te verdedigen ten overstaan van een commissie,
door het College voor Promoties aangewezen,
op dinsdag 16 maart 1999 te 16.00 uur
door

Remke Marleen Klapwijk

ingenieur techniek en maatschappij
geboren te Wageningen
Dit proefschrift is goedgekeurd door de promotor:

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Preface and acknowledgements

Research into the use of the life cycle assessment (LCA) methodology for environmental product evaluation in public policy making is presented in this thesis. The problems of LCAs are discussed and a number of proposals to improve the discussion function of LCAs are provided. The thesis was especially written for LCA scientists. Policy makers working for governmental organizations, environmental organizations and companies may use this thesis to help them understand current LCA practices and to make better product evaluations. The thesis is also interesting for policy analysts because the discourse paradigm (Fischer and Forester 1993) is used to improve the LCA methodology.

The research was conducted as part of a project called Integral Chain Management of Plastics, being carried out at the the faculty Technology, Policy and Management, Delft University of Technology. Integral chain management is an important policy goal of the Dutch Ministry of the Environment. The Integral Chain Management project focused on the opportunities and threats for achieving sustainable production and consumption chains. The PVC issue was used to provide a case study. The following three research projects have been conducted, each approaching the issue of sustainable chains from a different angle.

- Marjolijn Knot from the Technology Assessment department focused on technology choices concerning substitution versus optimization of the PVC material by actors in the chain and looked at how these choices are influenced by characteristics of actors and processes in the PVC chain (Knot and Pauly 1998).
- The project of Silvia Pauly, of the public management department, concerns the management of policy processes in and around the PVC production and consumption chain in the Netherlands. The analysis of the PVC case provides a basis for the institutional design of decision making processes within production and consumption chains.
- The project of Remke Bras presented in this thesis, was conducted at the section of policy analysis and focused on the problems of LCA methodology and on possible solutions. The projects focus on managing substitution and optimization choices under uncertainty leading to recommendations for technological strategies, for the institutional design of decision making and for information strategies.

I have experienced encouragement, advice and love from many people: family, friends, coaches, colleagues, and peers. I want to thank you all for this. A few names should not go unmentioned. I would like to thank Wil Thissen, my supervisor, for giving me the opportunity to define my own research project and goals and for his continuous support, thinking along
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I am indebted to many people from environmental organizations, chemical industries and ministries for interviews, members of the steering group of the Integral Chain Management project, and participants of the PVC-workshop. I hope that this thesis will be useful to you.

Remke Bras-Klapwijk

Delft, January 1998
1
The Unfulfilled Promise of Life Cycle Assessment

'The fears of many LCA experts that the technique's capacity to yield unchallengeable environmental truths has been overblown have been confirmed. So, too, has been the observation by sceptics that there has been an uncanny tendency for published LCAs to reach conclusions broadly in line with the interests of the sponsors.' (Anonymous, ENDS Report 198, 1991: 26)

1.1 Introduction

Product oriented environmental policies allow immense opportunities for a sustainable society because they aim not only at a reduction of the environmental burden of products that are currently consumed but also at a transition to products with a relatively low environmental burden. The following example clarifies the benefits of a transition to alternative products. Improving 'waterbeds' that use a lot of energy to heat the water in the bed is of course beneficial for the environment but policies that stimulate people to use 'normal' beds and mattresses that do only use energy during their construction are far more beneficial.

National governments have an important role in product policies as they create a framework for the policies and decisions of other actors. Instruments such as ecotaxes, ecolabeling, levy taxes and banning orders are used to stimulate producers, distributors, consumers, and waste managers to use and produce products with relatively low environmental burdens.
Public product policies may have enormous environmental benefits, but Dutch experiences show that it is hard to realize them because there are many bottlenecks. Information provision on the environmental burden of products is one of these bottlenecks (CRMH 1992; VROM and EZ 1993). To overcome this bottleneck, a lot of effort has been put into the development of Life Cycle Assessment (LCA) methodologies that can be used to assess the environmental burden of products (Curran 1996a; Heijungs et al. 1992a and 1992b). LCA methodology is based on an integral chain philosophy and a great number of environmental effects caused by the product during its complete life cycle are calculated in an LCA. This results in quantitative ecoprofiles that show the scores for different environmental impacts, which are then used to determine the order of environmental merit of products. It is also possible to use the LCA methodology to study the environmental benefits of new production technologies and end-of-pipe technologies. The focus in this thesis is on product assessments.

LCAs that assess products can be used in different policy making situations. Companies that want to buy or produce environmentally friendly products may use them to formulate their policies or to help their designers to design environmentally friendly products. The focus in this thesis is on the use of LCAs during public policy processes in which public product policies such as ecotaxes, ecolabeling and banning orders are developed.

With the advent of LCAs, many scientists and policy makers hoped that LCAs would yield objective, conclusive results and enable policy makers to make better and better informed policies (Consoli et al. 1993; Anonymous 1991). This promise was not fulfilled in many cases. The results of LCAs are often not conclusive (Wrisberg et al. 1997) due to the complexity of the study topic and the many uncertainties that commonly exist about the product and its environmental impacts. The inconclusive nature of LCAs seems especially problematic in public product policy processes in which multiple stakeholders with competing interests are involved.

In this thesis, I will look at the reasons why current LCA methodologies do not fulfill their promises for public policy processes and develop an alternative methodology. The central research question is therefore:

*What are the main problems of LCAs in the context of public policy processes and how can these problems be explained? What kinds of methodologies for environmental product assessment are required to resolve these problems and will improve the quality of public policy processes?*

The goals of environmental product policies and the actors involved are described in section 1.2. The focus in section 1.3 is on methodologies for environmental product assessment. Section 1.4 contains a description of a number of concerns about the present LCA methodologies and studies. These concerns provide the reason to study the limitations of the LCA approach in public policy making processes and to search for options for methodological improvement. In this research insights from the discipline of policy analysis
are applied to the field of LCAs. The discipline of policy analysis is introduced in section 1.5. The central research question and the research strategy are elaborated in section 1.6.

1.2 Environmental Product Policies

Many governments in Europe and other Western countries started to develop environmental product policies in the late eighties. Products are the points of application in these policies instead of production processes. This can be illustrated by the Dutch situation. In 1987, the Dutch Parliament mandated the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM\(^1\)) to develop an environmental product policy by means of the Rijn-Vellekoop resolution. The term Ministry of the Environment will be used for the Ministry of VROM in this thesis. In reaction to this request, the Ministry of the Environment developed an environmental policy for the government that focuses on products. The Memorandum Product & Environment (VROM and EZ 1993: 8) described the aim of this policy as follows:

'To achieve a situation in which producers, distributors and consumers continuously strive for a reduction of the environmental burden of products.'

In the Memorandum, it was argued that it might also be necessary to reduce the quantity of products consumed to achieve a sustainable society (VROM and EZ 1993: 7)\(^2\).

Producers, consumers, distributors and waste processors are able to reduce the environmental burden of products in the following situations (VROM and EZ 1993: 17):

1. *Producers of raw materials, basic chemicals and materials* can develop new materials and reduce the environmental burden of the production processes of existing materials.
2. *Producers of product parts and end products* can use environmental criteria when they design new products and new production processes, and when they buy raw materials. Furthermore, they can set up systems to collect discarded products for recycling.
3. *Distributors* can provide a supply of environmentally friendly products and can set up systems to collect discarded products for recycling. Furthermore, distributors can inform consumers about the environmental aspects of the products supplied.
4. *Consumers* can take environmentally friendly decisions when they buy a product, use it and discard it.
5. *Waste processors* can set up collection, separation, recycling, and environmentally friendly waste management processes.

---

\(^1\) Ministerie van Volkshuishuisvesting, Ruimtelijke Ordening en Milieubeheer.
\(^2\) The Memorandum Product and Environment focused on a reduction of the environmental pollution per unit product without harming its functionality. The National Environmental Plan (NEP) 2 (VROM 1993a) contains a discussion of necessary changes in lifestyle and product functionality.
The above mentioned actors form a chain of actors, see figure 1.1. These actors are mutually dependent. For example, a consumer is only able to buy environmentally friendly products when these are supplied by distributors and made by producers.

Figure 1.1 Chain of actors

Policies and decisions to reduce the environmental burden of products are formulated at two levels:

- Policies of producers, distributors, consumers and waste managers
- Public policies such as ecotaxes and environmental labeling

I will focus on public policies in this thesis. The public product policies are meant to stimulate producers, consumers and distributors to produce and use different types of products, e.g. a normal bed instead of a waterbed, and to improve the products that are used, e.g. reduce the environmental burden of producing and using normal beds and water beds.

The public policies of national governments provide the framework for the decisions and policies of the chain actors\(^3\). National governments can use a variety of instruments to influence chain actors and can direct their instruments at various actors in the chain. The kind of government intervention that the Dutch Ministry of the Environment intends to use to stimulate environmental behavior of chain actors depends on the severity of the environmental damage caused by a product. The Ministry will directly regulate products with considerable environmental problems (VROM and EZ 1993: 36). In other cases, the Dutch government prefers the use of financial and communicative instruments to stimulate the actors to become self-regulatory. Instruments such as ecolabeling (see figure 1.2), ecotaxes, and information brochures are used to inform consumers and distributors on the environmental aspects of products and this will in turn stimulate producers to put environmentally friendly products on the market. Covenants containing agreements between companies and governmental actors are also used as communicative instruments.

---

\(^3\) It should be noted that chain actors are also influenced by the activities of actors such as local governments, Consumer Associations, Environmental Organisations, and Branch Associations. In addition, actors in a chain may try to steer other actors in the chain or try to co-operate with them to reduce the environmental burden of products (De Bruijn and ten Heuvelhof 1995: 133-148).
Product policies have a number of key advantages and provide a valuable addition to other environmental policies (CRMH 1992; VROM and EZ 1993). These advantages include:

- A focus on the overall burden of a product. As a result it becomes clear that it is often not enough to improve a single production or waste management process. Attention for product substitution and optimization of all the process related to a specific product increases.
- Increased attention for the role of consumers and distributors. Consumers and distributors are made responsible for using sound environmental products and become an additional lever for change.
- Chain actors are stimulated to reduce the overall burden of the product, not just to improve their part of the chain. This stimulates cooperation between different chain actors, for example producers become interested in recycling activities.

1.3 Environmental Product Assessment

The focus is on environmental product assessment in this section, one of the key elements in the formation of public environmental product policies. The value of using an integral chain approach in environmental product assessment is explained. Next, LCA methodologies and other chain methodologies that can be used for product assessment are introduced. These methodologies are often used in public policy processes.

1.3.1 Integral Chain Approach

It is generally accepted that the assessment of the environmental burden of products should be based on an integral chain approach (CRMH 1992; Consoli et al. 1993; VROM 1990; VROM and EZ 1993; Ywema and Van Overbeeke 1994).

The first aspect of an integral chain approach is that the focus is on the complete lifecycle of a product. A product comes with a chain of industrial and physical processes as shown in figure 1.3. Each physical process may have adverse environmental effects, for
example, raw materials require energy to obtain, and the physical environment may be damaged, and toxic substances may be emitted into the environment.

**Figure 1.3 Chain of processes**

```
Extractaion of raw materials

Production of basic chemicals and materials

Production of product-parts and end-products

Distribution and retail of products

Consumption of products

Collection, separation of products

Product recycling
Material recycling
Disposal and combustion
```

The second aspect of an integral chain approach is that different environmental impacts are taken into account. A product is environmentally friendly when the use of raw materials, the use of energy, and emissions of chemical agents and residues are relatively low (Cramer 1992; VROM, EZ and LV 1989). The use of raw materials and energy causes depletion of

---

4 Residues is the waste that is left over after waste-management or recycling and that is not further processed.
1992; VROM, EZ and LV 1989). The use of raw materials and energy causes depletion of resources while emissions and residues cause adverse environmental impacts such as ozone layer depletion and health effects. In many cases, environmental policies have a positive effect on some environmental impacts and a negative effect on others. These cases require a careful weighing of the pros and cons of the different effects in view of the goal to reduce the overall environmental burden.

The use of an integral chain approach in product assessment should uncover and prevent problem shifts between different parts of the chain and between different environmental impacts.

1.3.2 LCA Methodologies

An integral chain analysis requires a lot of information and the intellectual capacity to process this information. Therefore, there is a great interest in methodologies that are based on an integral chain philosophy and support the assessment of the overall burden of products (VROM and EZ 1993: 17, 18). At present, LCA methodologies are the leading methodologies for environmental product assessment and are often used in public policy processes in the Netherlands and elsewhere (VROM and EZ 1993: 18, 21, 23; Curran 1997).

LCA methodologies provide for a systematic approach, and specific techniques for product assessment from an integral chain perspective. These methodologies can be used to determine and quantify the environmental impacts of products. The quantified impacts of each product are usually presented in the form of a scorecard and called ecoprofile. Often, these quantitative environmental effects are aggregated into a report mark for the overall environmental burden of the product system. A fictive example of overall report marks for the integral environmental burden of nappies is shown in Table 1.1 to illustrate the type of results obtained. The product with the lowest mark is considered to be the most environmentally friendly product.

Table 1.1 Fictive ranking of nappies based on their integral report marks

<table>
<thead>
<tr>
<th>Type of nappy</th>
<th>Integral report mark</th>
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<tbody>
<tr>
<td>1. Cotton nappy which is washed at home/nursery</td>
<td>2.0</td>
</tr>
<tr>
<td>2. Cotton nappy provided by a napkin service system</td>
<td>3.2</td>
</tr>
<tr>
<td>3. Paper nappy produced by company X</td>
<td>3.5</td>
</tr>
<tr>
<td>4. Paper nappy produced by company Y</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Policy makers may use the quantitative ecoprofiles, overall report marks and rankings as a basis for formulating adequate product policies. A policy maker may, for example, decide to stimulate the use of cotton nappies and take measures against the use of paper nappies from
company Y. LCAs can be used also by chain actors that form their own product policies, e.g. company Y may decide to reduce the environmental burden of its nappies.

LCA methodologies have a comprehensive nature as they take the various environmental impacts of the entire product lifecycle into account. An LCA methodology organizes the analysis into four stages: goal and scope definition, inventory analysis, impact assessment, and evaluation or interpretation (Consoli et al. 1993; Heijungs et al. 1992a). Figure 1.4 visualizes these stages and gives the key activities of each stage.

**Figure 1.4 Stages in an LCA**

![Diagram of LCA stages]

There are a number of LCA handbooks to provide guidance for analysts who want to conduct an LCA, e.g. *Environmental Life Cycle Assessment of Products: Guide* and *Environmental Life Cycle Assessment of Products: Background* (Heijungs et al. 1992a and 1992b). The handbooks describe the study activities that should be carried out, contain analytical techniques and models that can be used to carry out these activities and give guidelines, and clues on how to use the methodology. This means that analysts do not have to reinvent the wheel each time they carry out an LCA.

A variety of LCA methodologies exist because handbooks and studies focus on different environmental criteria and use different models and techniques. This thesis uses the term LCA methodology for all the methodologies that are more or less based on the stage model shown in figure 1.4, that use an integral chain approach to calculate various environmental consequences, and that compare or rank products or other measures.

LCA methodologies were primarily developed for product assessment but most of their concepts, tools and models are also used to assess the environmental effects of individual measures such as recycling, product improvement and waste water treatment.
1.4 Concerns about LCAs in public policy making

LCAs are designed to enable policy makers to make better and better informed decisions. The study process and the use of LCAs in public policy processes are however not without problems. The uncertain, contestable and subjective nature of LCA rankings and ecoprofiles is a problem that is often mentioned (Cramer 1994; Herberigs 1993; Van Duin 1995; Venner 1993; Wrisberg et al. 1997). Different LCAs yield opposing judgments about the overall environmental burden of products, e.g. in the area of packaging, milk containers, nappies and margarine (Anonymous 1991; Guinée 1995). These conflicting results are caused mainly by differences in the underlying assumptions of these studies, e.g. regarding the number of disposable and reusable nappies used per child per day.

The indecisive nature of LCAs seems especially problematic in public policy processes in which the environmental viability of products and the value of product substitution are discussed. Stakeholders have specific interests in the policies to be followed. For example, product substitution may have large, negative economic consequences for the producers of a product or for the providers of the basic chemicals and materials. The possibility to organize an LCA in such a way that it leads to conclusions that comply with the interests of the clients of the study is often mentioned as problem in the literature (Herberigs 1993; Udo de Haes 1992; Udo de Haes 1993; Anonymous 1991).

Confidence in LCAs conclusions tends to be especially low when LCAs are conducted or commissioned by actors who have a specific interest in the outcomes of the study. The confidence in LCAs commissioned by Procter & Gamble, a large paper nappy producer, on disposable paper nappies against reusable cotton ones was for example very low because its conclusions were in line with the interests of study sponsors (Anonymous 1991: 24-26).

The use of LCA results seems especially problematic in public policy processes due to the involvement of multi actors with conflicting interests and ideas. The use of LCAs by a company for internal goals is considered as less problematic (Baumann 1998). Use of LCAs seems to confuse and they do not seem to be useful in adjudicating conflicts (Venner 1993; Wrisberg et al. 1997). Venner has argued that LCAs should not be used in public debates on products such as diapers and packaging since use of LCAs will hamper sound environmental decisions as they are mainly used in a defensive way (Venner 1993: 1). Others argue that the use of LCAs in multi actor situations should be avoided until a standardized methodology is available (Baumann 1998, cp. Udo de Haes 1993).
1.5 Introduction to Policy Analysis

The discipline of policy analysis focuses on the use of studies in policy processes and on methodologies used to produce information for policymakers. The policy analysis discipline can contribute to the study and development of the LCA methodology because LCAs are a type of policy analyses meant to inform policy makers.

Policy makers use scientific information

In early times, kings, emperors, pharaohs, and other policymakers were surrounded by ‘wise men’ who advised them on practical policy problems. From the 18th century onwards, policymakers have turned more and more to the sciences for information and advice. In this context, the use of applied social science, in the form of statistics, demography and scientific management, has risen in response to this challenge of political problems (Dunn 1981:12-16; De Graaf and Hoppe 1989: 28).

Since the Second World War, we have lived in a ‘knowledge society’ (De Graaf and Hoppe 1989: 28). This name emphasizes the use of organized, scientific knowledge by the government and elsewhere (Holzener and Marc 1979: 15). The use of scientific knowledge is very important and virtually ingrained in the fabric of government (delLeon 1994: 77). ‘No debate on any serious issue ...takes place without someone citing a public policy study’ (Rivlin 1984: 18-19).

Start of the policy sciences

The rise of the policy sciences, to which policy analysis belongs, fits in with the considerable growth of the use of scientific knowledge by policymakers (De Graaf and Hoppe 1989: 29). Harold D. Lasswell publications Power and Personality (1949) and Power and Society (1950) are usually seen to be the start of the policy sciences as a systematic discipline (Aquila 1988: 318; deLeon 1994: 77). The policy sciences aim at better government through the intelligent use of the sciences to deal with social problems. Lasswell formulates the main task of policy scientists as facilitation between scientific specialists and political users of scientific knowledge (De Graaf and Hoppe 1989: 30) and in this way, the policy sciences may contribute to the improvement of the policy processes and resulting governmental policies (Aquila 1988: 305).

Policy analysis is a subdivision of the policy sciences that focuses on the generation of knowledge concerning the content of problems and solutions in a specific policy area and on its use by policymakers. Methodologies for policy analyses have been developed and evaluated and descriptive and normative ideas on policymaking and analysis have been formulated. The discipline of policy analysis is closely related to disciplines that study the content of policy problems, e.g. technology assessment, town and country planning.
Similarly, it is often difficult to distinguish between policy analysis and policy administration, e.g. when authors write on the use of studies in policy making processes.

LCAs are a type of policy analyses

A number of definitions of policy analysis are discussed below to provide insight into the specific nature of policy analyses. Van Nispen and Goemans (1983:20) write:

*Policy analysis is a form of research that supports the policy formation process, in other words it is conducted for the benefit of a policymaker and has essentially a forward looking nature.*

The fact that policy analyses are usually conducted for a specific policymaker is emphasized in this definition. Some authors state that one cannot speak of a policy analysis when there is no client for whom the study is conducted (Behn 1981; Van Nispen and Goemans 1983:20). Others argue that any study that provides a particular kind of information on a specific policy problem can be characterized as policy analysis, even when the study is not conducted for a specific client. Policy analyses thus provide specific information on practical policy problems, and not general and abstract theories.

The definition of Van Nispen and Goemans emphasizes the forwardlooking nature of policy analysis. The study is designed to inform policymakers before action is taken, feasible courses of action are sought, information is generated and evidence of the benefits and other consequences is marshaled in a policy analysis (Quade 1989: 4). In contrast, policy evaluation focuses on the effects of policy measures that have already been taken.

Dunn’s definition stresses the problem oriented and multidisciplinary character of policy analysis (1981: 35):

*Policy analysis is an applied social science discipline, which uses multiple methodologies of inquiry and argument to produce and transform policy relevant information that may be utilized in policy settings to resolve policy problems.*

Typically, a policy analysis focuses on the policy problem as a whole. To understand all the aspects of the problem, policy analyses use multiple methods of inquiry and insights from different disciplines. Synthesizing insights of different disciplines and of different methods of inquiry is also an essential aspect of policy analysis (Dunn 1981: 51). A holistic, multidisciplinary, problem and action focused approach is used to mediate between scientific knowledge and policymakers.

The definitions above emphasize the intellectual, scientific character of policy analysis, but one may also regard policy analysis as the production of arguments (Dunn 1981:40):

*Policy analysis produces reasoned arguments about public policy. Policy arguments, which reflect the reasons why different segments of the community disagree about*
alternative courses of action available to governments, are the main vehicle for conducting debates about public policies.

LCAs are designed to support policy makers in a practical way and can therefore be considered to be a type of policy analyses (cp. Baumann 1998). Insights from the discipline of policy analysis are used in this thesis to reflect on current LCA practices and to contribute to the further development of the LCA methodology.

1.6 Towards a sound methodology

The purpose of this thesis is to contribute to the development of methodologies for environmental product assessment. This section describes the central research question and the policy analyses study approach.

1.6.1 Research question

Concerns about the subjective and contestable nature of LCA outcomes and the problems in using LCAs in public policy processes provided the reason to study the limitations of current LCA methodologies and to develop methodological improvements. The following question will be answered in this thesis:

What are the main problems of the current LCAs used in public policy processes and how can these problems be explained? Which kinds of methodologies for environmental product assessment are required to resolve these problems and improve the quality of public policy processes?

The focus is on LCAs because LCA methodology is an important, leading methodology for environmental product assessment and LCAs are often used in public policy processes.

The research presented in this thesis will focus on the problems of the use of LCAs in public policy processes in which a national government develops product policies. A focus on a specific type of policy processes is needed because it is assumed that the problems of LCAs and methodologies also depend on the nature of the policy making process. This assumption is thought to be valid because a methodology should fit in with both the study object and the policy making situation.

It is relevant to study LCAs problems in public policy processes because the use of LCAs in these processes seems more problematic than in other situations due to the multi-actor context. Another argument to focus on public policy processes is the fact that there has been little research undertaken in this area while the use of LCAs in companies (Baumann 1998) and the use of LCAs by product designers (Bakker 1995) has been studied in other projects.
1.6.2 Research strategy

This thesis does not contain the first attempt to improve the LCA methodologies, the research differs in a number of ways from earlier studies. Insights from the field of policy analysis and the policy sciences are applied to understand the limitations of current LCA methodologies and to adjust the methodology for use in public policy processes.

Previous studies focused mainly on the problems of the LCA study process and the LCAs. Publications on LCAs for public policy processes (Allen 1996; Allen et. al. 1997; Cowell, Hogan and Clift 1997; Curran 1996 and 1997; Goidel and McKel 1996; Postlewhaite and de Oude 1996; Schleicher 1996) contain only information on LCAs that were made for public policy processes, but do not focus on the actual use of LCAs in public policy processes. Exceptions are the recent publications of Tukker (1998) and De Bruijn and Van Duin (1998).

A broader perspective, covering the actual use of LCAs in public policy processes, is adopted because LCAs should contribute effectively to public policy processes on product-oriented environmental measures. This is illustrated in figure 1.5.

Figure 1.5 Focus of this thesis: LCA study process and use of LCAs in public policy processes

It is important to acknowledge that a study about the effectiveness of LCA methodology has, necessarily, a normative nature. To define LCAs problems and identify directions for improvement, the existing LCA practices need to be compared to an ideal or desirable situation. At present, the LCA research community has hardly reflected on the normative ideals with respect to LCA methodology.

At the same time, normative ideals influence the way the LCA community interprets LCAs problems and the development and evaluation of proposals to improve current LCA practices. For example, different evaluations of participatory modes of product assessments have been made in reaction to a contribution of the author (Bras-Klapwijk and Enserink 1997) in the Dutch scientific journal ‘Milieu’ due to diverging ideas on sound policy making and sound analysis. Abma (1998) writes:

‘Participatory assessment is an attractive proposal. It does justice to the insight that seemingly neutral, scientific issues have a political dimension’.
Wegener Sleeswijk (1998) has a different view on participatory assessment:

'The proposal of participatory assessment threatens the foundation of the environmental sciences.... It is very important that choices between different options are based on pure scientific grounds to achieve reliable LCA results. This is only guaranteed when independent experts take the final decisions'.

Therefore, I pay explicit attention to normative ideals in this thesis. Different paradigms on sound policy making and analysis have been developed in the policy sciences. A discussion of two paradigms on sound policy making and analysis, the rational and discourse paradigm, are presented in this thesis to stimulate further reflection on the normative ideals and to get more insight in the value of different problem interpretations and improvement proposals.

To answer the central research question, I use the following research strategy. First, an empirical study is made of problems met in making and using LCAs in public policy processes. The empirical study focuses on LCAs on PVC. Second, a theoretical interpretation of these problems is made. I describe the way LCAs problems are interpreted and solved on the basis of the rational paradigm on sound policy making and analysis, which is rather dominant in the international LCA community. Next, I argue that the central assumptions of the rational paradigm are not valid and introduce the discourse paradigm as an alternative for the rational paradigm. Third, the discursive paradigm is used to interpret LCAs problems and to develop proposals for adjusting LCA methodology. The option of a participatory mode of LCA is further elaborated. This research strategy is specified below.

Part 1: Making and using LCAs on PVC: current situation

The thesis starts with an empirical outline of the problems met when one compares and evaluates products using the LCA methodology. In addition, the use of LCAs in public policy processes is described. Table 1.2 shows the questions that will be answered in this part of the study.

Table 1.2 Questions on practical experiences with the LCA methodology

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do the current LCA methodologies assess the environmental aspects of products?</td>
<td>2</td>
</tr>
<tr>
<td>What problems are met during LCA study processes?</td>
<td>3</td>
</tr>
<tr>
<td>How do policy makers use LCAs in public policy processes and how does this support the policy discourse?</td>
<td>4</td>
</tr>
</tbody>
</table>

The first question is answered in chapter two on the basis of the general literature on LCAs.

The answer to the second question is based on the general LCA literature and illustrated with examples taken from LCAs on products made from the plastic polyvinyl chloride (PVC). This results, in chapter three, in an overview of the problems that one meets in conducting LCAs and the difficulties in achieving objective and decisive results.
The third question is answered in chapter four on the basis of a case study into the use of LCAs in Dutch public policy making on PVC and chlorine in the period 1989-1996. I selected the PVC case for the following reasons:

- The public policy process and social debate on PVC is an example of a policy process in which the need to replace products by ones made from other materials is discussed.
- Many LCAs on PVC have been made and have been used in the policy process.

I consider the PVC case as a revealing case study because it clearly demonstrates the problems of using LCAs in a political, polarized context where actors have huge interests in LCA outcomes.

The case study approach was selected because (cp. Yin 1994):

- The use of LCAs in public policy processes needs to be studied in its natural setting. It is impossible to construct an experimental setting.
- The focus is on the relationship between LCAs and the public policy process. A case study approach is very helpful for recognizing relationships between phenomena.
- Few previous studies have been conducted in the area of LCA and public policy making.

**Part 2: Paradigms on sound policy making and analysis**

The paradigm on the ‘ideal’ public policy making process and the ‘ideal’ study that is dominant in the LCA community is first described. These ideals are known as the rational paradigm in the policy sciences. Next, the focus is on the interpretation and evaluation of current LCA methodologies and studies that have been made by LCA scientists that were based, implicitly or explicitly, on the rational paradigm. In addition a number of other solutions proposed by LCA scientists and users are described. The questions that will be answered are shown in table 1.3. The answers are based on literature research in the field of the policy sciences and LCA.

**Table 1.3 Questions on the dominant interpretation of LCAs problems**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which paradigm of sound policy making and analysis is dominant in the literature on LCAs? What are the typical features of a sound methodology according to this rational paradigm?</td>
<td>5</td>
</tr>
<tr>
<td>What are the problems of LCA methodologies according to this paradigm and what solutions have been proposed?</td>
<td>5</td>
</tr>
</tbody>
</table>

5 A case study is an empirical inquiry, a contemporary phenomenon is investigated within its real-life context and this is especially useful when the boundaries between phenomenon and context are not clearly evident (Yin 1994: 13). The inquiry relies on multiple sources of evidence, e.g. interviews, document analysis, participatory observation. This enables the researcher to compare and contrast different sources of evidence and to create a richer and more revealing picture of the situation.
In chapter six, I argue that the central assumptions of the rational paradigm are not valid and describe an alternative view on sound policy making that has been developed in reaction to the rational paradigm of sound policy making and analysis: the discourse paradigm. Network theories are also introduced. I explain why this paradigm provides a better description of actual public policy processes on product oriented environmental measures and why it is preferred as normative framework. The questions answered in chapter six and seven are shown in Table 1.4.

**Table 1.4 Questions on the discourse paradigm**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the central assumptions of the rational paradigm valid for policy making on public environmental product policies?</td>
<td>6</td>
</tr>
<tr>
<td>Which paradigm on sound policy making and analysis provides a better framework for the development of LCA methodology for use in public policy making? Which evaluation criteria can be derived from this paradigm?</td>
<td>6</td>
</tr>
</tbody>
</table>

**Part 3: Adjusting LCA methodology**

The third part of this thesis is built on the discourse paradigm and the LCA methodology is adjusted to improve LCA’s discussion function. In chapter seven, I use the discourse paradigm to interpret the problems of LCA methodology and to develop ways to improve the current methodology. Participatory assessment is considered valuable. A stage model for participatory environmental product assessment is developed in chapter eight. Chapter eight is based on a literature study of participatory methodologies for the study of policy problems and the design of policies. Table 1.5 shows the questions that are dealt with in chapters seven and eight.

**Table 1.5 Questions on adjusting LCA methodology**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the problems of LCA methodologies according to the discourse paradigm and which solutions are valuable?</td>
<td>7</td>
</tr>
<tr>
<td>Which stage model for participatory analysis can be applied and what are the key issues in designing participatory methodologies?</td>
<td>8</td>
</tr>
</tbody>
</table>

Final conclusions, recommendations and a reflection on the research approach are presented in chapter nine.

***Positioning of the research***

In 1998, two related theses were published (Hofstetter 1998; Tukker 1998) that depart from the dominant positivistic tradition in LCA. Hofstetter, Tukker and I signal that basic frames
or worldviews influence how people perceive and manage environmental problems. We also signal that decisions are not made by a wise individual in isolation. The policy making situation is far more complex because multiple actors play a role. The consequences for the use of LCAs and for the further development of LCA methodology are assessed in the three theses.

Tukker’s thesis also contains a case study on chlorine and PVC. Tukker focuses especially on the problems in calculating robust indicators for toxicity, e.g. indicators that are accepted by holders of different frames. I focus mainly on characteristics of LCAs in relation to the discussion between actors with different frames, and use the insights gained from the case study and from theory about participatory methodologies to improve the LCA methodology qualities as a discussion vehicle. Hofstetter (1998) focuses on modeling frames and values in LCA and on developing frame-related impact assessment models.
2
Introduction to LCA methodology

The Life Cycle Assessment (LCA) methodology is introduced in this chapter for those who are not acquainted with the LCA methodology in preparation for chapter three which contains a more detailed description of the analytical activities and their problems. In section 2.1, a description of the historical development of LCA methodologies is given. The focus of section 2.2 is the practical study methodology and the four stages. A summary is provided in section 2.3.

2.1 Historical development

The first LCAs were made in the late sixties and early seventies and focused mainly on the use of energy throughout the life cycle of a product (Sundström 1971; Bousted 1974; IFIAS 1974; Guinée 1995). Interest in LCAs that also studied the emissions and use of raw materials rose in the late eighties when many governments started to set up product oriented policies, e.g. in Germany, Denmark, and the Netherlands.

From the late eighties on, governments, industries, scientific institutes and consultancy firms put a lot of effort in the development of LCA methodologies and conducted many LCAs. This was also the situation in the Netherlands, one of the countries that played a leading role in the development of the LCA methodologies. The Dutch Ministry of the Environment (VROM) and the Ministry of Economic Affairs (EZ) have stimulated the development of the LCA methodology. They sponsored and organized many research projects such as ‘Towards a method for comparative product assessment on environmental effects’ (Heijungs et al. 1992a and 1992b; Guinée 1995). The Center of Environmental Science Leiden (CML) and the Netherlands Organization for Applied Scientific Research (TNO) played a leading role in the development of the methodologies. Consultancies such as
TAUW Milieu have conducted many studies for clients and gained practical experience in LCA. Many industrial organizations such as Unilever have sponsored and conducted studies about their own products. Dutch environmental and consumer organizations are not very active in the field of LCA although environmental product policies are a focal point in their work.

Since the early nineties, the Society of Environmental Toxicology and Chemistry (SETAC) has been an important American-European LCA platform. The society organized its first LCA workshop in 1990 and started an LCA newsletter in the same year. The International Journal of LCA appeared for the first time in 1996. At present, many universities and institutes around the world are involved in the development and application of LCA methodologies.

LCA handbooks are written to support analysts. These handbooks describe the study activities that should be carried out, provide analytical techniques and models for these activities, and give guidelines and clues. The Dutch organizations CML, TNO and the Bureau Brand- & Grondstoffen (B&G) published the ‘Handbook for Environmental Life cycle Analysis of Products’¹ (Heijungs et al. 1992a and 1992b). This Dutch methodology was inspired by the work of international researchers and was discussed in the SETAC context before it was published. It became the leading handbook in the Netherlands and one of the leading handbooks in the international context. Since then many handbooks providing information about LCA methodology were written by scientists from different countries (Nordic Council 1992; Vigon et al. 1992; Keioleian and Menerey 1993; SPOLD² and BiE³ 1993; Pedersen Weidema and Kruger 1993; Lindfors et al. 1995; Van den Berg, Dutilh and Huppes 1996; Ciambrone 1997; ISO 1997).

2.2 The study approach

LCA methodologies that are described in handbooks and elsewhere follow more or less the same stage model and differ only in the specific techniques applied. For this reason it is possible to describe the LCA study procedure on the basis of the CML handbook and the ISO standards (Heijungs et al. 1992a; ISO 1997). The CML guide covers all the stages in an LCA (Pedersen Weidema and Kruger 1993) and has brought many procedures, guidelines, and models together. New methods and techniques have been developed since the appearance of the CML handbook but the general study approach has not changed. The terminology used is

¹ Milieugerichte Levenscyclusanalyse van Produkten. This publication contains of two parts ‘Achtergronden- oktober 1992’ and ‘Handleiding- oktober 1992’. The references are to the Dutch version of this publication.
² Society for the Promotion of LCA Development.
³ Business in the Environment.
based on ISO (1997) unless indicated.

2.2.1 The stage model

The goal of an LCA based product evaluation is to select, in a systematic way, the product with the lowest environmental burden from a group of products. The analysis is divided into four stages as shown in figure 2.1.

Figure 2.1 Stages in the LCA methodology

These four stages are (Consoli et al. 1993; Curran 1996b):

1. **Goal and scope definition.** Analysts determine the goal of the study and select the alternative products for analysis.
2. **Inventory analysis.** Analysts collect data about the complete life-cycle of the products, e.g. about emissions and raw materials used.
3. **Impact assessment.** Analysts calculate the environmental impacts of the emissions and raw material use for the entire product life cycle.
4. **Evaluation.** Analysts determine overall report marks for the different products and rank them from highest overall environmental burden to lowest.

The CML guide used the term classification instead of impact assessment which is still often used in the Netherlands. Recently, the name of the evaluation stage has changed into **Interpretation** (ISO 1997). This is not the only change, the valuation or weighting activities are considered as part of the impact assessment stage. I will not follow this terminology because the LCAs that I analyze in chapter three are not based on this division. The CML guide adds a fifth stage: **Improvement analysis.** In this stage, analysts generate options to improve the product chain, calculate their scores on a number of environmental impacts and rank these options.

2.2.2 Goal and scope definition

The CML handbook organizes the goal and scope definition into five mutually related activities (Heijungs et al. 1992a: 19-24 and 1992b: 19-26):

1. Defining the intended application or purpose of the study, e.g. setting criteria for ecolabeling or setting eco taxes
2. Defining the target group of the analysis
3. Defining the initiator, conductor, steering committee of the study
4. Defining the scope of the study
5. Selecting alternative products for analysis and defining the basis of comparison

The first four activities provide insight into the policy making context and the kind of insights needed and they provide direction for the actual lay-out of the analysis. Many activities in the analysis will be guided by this part of the goal definition, e.g. the selection of alternative products and the collection of data.

The fifth step of the goal definition stage, the selection of products, is a central and influential choice. It is suggested that only products that fulfill the same need of a consumer should be compared. Therefore one should first define the function of one of the products that will be analyzed. Next, products that fulfill the same function should be generated and selected for analysis. For example, a lighter and a match can both fulfill the function of lighting a cigarette, as can lit a candle.

Another activity in the fifth step is that analysts define the basis of comparison. At first sight one would think that the comparison is between the environmental burdens of units of a product. This is, however, often not sensible because the ratio in which products replace each other is often not 1:1. A lighter is not replaced by one match but by a much larger amount of matches. LCA methodologists therefore introduced the concept ‘functional unit’ of a product. This concept is used to express the number of services supplied by a product. The functional unit of a lighter and matches may be defined as lightning 1 cigarette (Van den Berg 1996: 17.7). After defining the functional unit, the number of units supplied by one product should be specified. For example, a lighter can be used to light 1000 cigarettes and a match can be used to light one cigarette. An LCA would therefore compare the environmental burden of 1 lighter with the burden of 1000 matches.

The goal definition stage gives the following results:
- Insight into the intended application of the study or policy making context
- Insight into the organization of the study
- Insight into the goal of the study and the desired scope and detail of the study
- A list of specified products to be analyzed and their basis of comparison

2.2.3 Inventory analysis
The inventory analysis stage is concerned mainly with data collection. These data are used in the impact assessment stage to calculate the product scores on a number of environmental evaluation criteria. These environmental evaluation criteria are usually called impact category or impact indicator. I will use the term environmental evaluation criteria as well which is more in line with the terminology in the field of policy analysis (Miser and Quade 1985). The inventory consists of the following activities (Heijungs et al. 1992a : 27-60 and 1992b: 27-44):
1. Drawing the product chain
2. Collecting data on emissions, energy and raw material use
3. Allocating environmental impacts when product chains are interwoven
4. Calculating the inventory table

This procedure is repeated for each product analyzed.

The inventory starts with drawing the product chain. Each product brings a chain of processes along that may affect the environment. In accordance with the overall chain approach, the LCA methodology focuses on the complete product chain. The analysts should state the boundaries between the product chain studied and the environment and also between the chain studied and other product chains. The processes within the chain have to be specified, e.g. the kind of technology used. The quality and sources of the data should be mentioned. According to the ISO standards (1997), analysts should perform an analysis of material and energy flows to determine the boundaries of the product chain analysed.

Next, analysts collect data about the chain’s emissions, use of raw material, use of energy and other environmental impacts such as noise, accidents, land use. Analysts use these data to calculate various environmental impacts such as ozone depletion in the next stage of the analysis, the impact assessment stage⁴.

Due to coproduction, combined waste management and recycling, product chains are often interwoven. In these cases, environmental impacts are related to more products and should be divided between these products. This is called allocation.

<table>
<thead>
<tr>
<th>Table 2.1 Fictional inventory table of a one liter carton milk packaging</th>
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<tbody>
<tr>
<td>Resources</td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Emissions to air</td>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Emissions to water</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Emission to soil</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>


⁴ It would be logical to attune the data collection to the activities in the impact assessment. The CML guide and other handbooks do not however advise making the environmental impacts that will be used to evaluate products explicit before the data collection takes place. As a consequence, data collection is not guided by explicitly defined environmental criteria but attuned to the standard list of environmental criteria of the CML handbook (cp. Hofstetter 1998: 32). It should be noted that the CML guide mentions the importance of attuning the data collection to the impact assessment stage (Heijungs et. al. 1992a: 44).
The last step in the inventory stage is a survey of emissions, raw material and energy use of all the chain processes. The analyst should express these inventory scores per functional unit or per product. The results of the inventory have to be listed in one or more tables. A fictional example of such an inventory list is shown in table 2.1.

The results of the inventory analysis stage are:
- Specified product chains
- Inventory tables of products or functional units

2.2.4 Impact assessment

It is according to the LCA philosophy, not enough to have insight into the quantity of emissions, raw materials and energy used since the environmental impacts of, for example, a kilo of dioxins are quite different from those of a kilo carbon dioxide. Dioxins are thought to be one of the most toxic substances around in the environment and to have adverse effects for humans and the ecosystem as a whole. Carbon dioxide is not very toxic but it causes global warming. The environmental impacts such as ecotoxicity, ozone depletion, global warming, and acidification of emissions and use of resources are therefore determined in the impact assessment stage. Figure 2.2 shows for example, that emissions such as SO₂, NOₓ and NH₃ acidify the environment, damage buildings, and reduce the vitality of woods.

**Figure 2.2 Effect chain showing relations between emissions and acidification**

Impact assessment is composed of the following activities (Heijungs et al. 1992a: 61-122, 1992b: 45-54):

1. Selecting environmental impacts to be determined
2. Selecting or designing models to calculate these impacts
3. Calculating the environmental profile of each product
4. Standardizing the environmental profile of the products

The analyst must first select the environmental impacts⁵ that will be used as evaluation criteria. The list provided by the CML handbook contains 19 environmental

---

⁵ These impacts are often referred to as environmental themes in the Netherlands.
impacts that are thought to be generally acknowledged problems\(^6\) and that can be used as point of departure, see table 2.2. The environmental impacts are categorized in three groups: resource depletion, pollution and degradation of ecosystems and landscape. Resource depletion problems are caused by the extraction of materials from the natural environment. Pollution problems are caused by emissions to the environment. Degradation problems are structural changes in the environment for example through the use of land. A short description of these environmental impacts is provided in appendix 1. In a concrete LCA, impacts can be added or removed.

### Table 2.2 List of environmental impacts proposed in CML guide

<table>
<thead>
<tr>
<th>Resource Depletion</th>
<th>Pollution</th>
<th>Degradation of Ecosystems and Landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depletion of abiotic resources</td>
<td>Global warming</td>
<td>Dehydration</td>
</tr>
<tr>
<td>Depletion of biotic resources</td>
<td>Ozone Depletion</td>
<td>Physical degradation of ecosystems</td>
</tr>
<tr>
<td></td>
<td>Human Toxicity</td>
<td>Landscape degradation</td>
</tr>
<tr>
<td></td>
<td>Ecotoxicity</td>
<td>Direct human victims</td>
</tr>
<tr>
<td></td>
<td>Photochemical Oxidant Formation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acidification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nutrification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radiation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dispersion of Heat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occupational Health</td>
<td></td>
</tr>
</tbody>
</table>


After the selection of environmental impacts that will be assessed, analysts need to select or design environmental impact assessment models that will be used to calculate the environmental impacts. Impact assessment models quantify the relationships between the emissions, extractions and actual environmental impacts. The models are based on empirical, scientific knowledge about processes in the environment. The following acidification model from the CESL methodology is an example of a quantitative impact assessment model:

\[
\text{Acidification}_X = \text{AP}_X \times \text{Emission to air}_X
\]

- **Acidification** \(_X\) : Acidification caused by emission of substance \(X\) (kg \(\text{SO}_2\))
- **AP** \(_X\) : Acidification potential of substance \(X\) (kg \(\text{SO}_2/\text{kg} \ X\))
- **Emission to air** \(_X\) : Quantity of \(X\) emitted to the air (kg \(X\))

\(^6\) Most of the listed impacts are environmental policy goals mentioned in the Dutch National Environmental Plan (VROM, EZ and LV) and in the 'Nationale Milieukennmer' (RIVM 1991).
The acidification model aggregates the effect of all the acidifying substances such as SO₂, NOₓ, and NH₃. As different substances contribute more or less to acidification, the concept of acidification potential has been introduced. This is based on the quantity of H⁺ that can be potentially formed by one kilogram of a substance in relation to the quantity potentially formed by one kilogram SO₂. The acidification potentials of SO₂, NOₓ, NH₃, HCl and HF are presented in the CML guide (Heijungs et al. 1992b: 90-91). As the inventory table tells analysts how much SO₂, NOₓ, and NH₃ have been emitted by a product, they are able to calculate the score for acidification of the product⁷. LCA handbooks often prescribe one or more impact assessment models for each environmental impact.

Next, the analyst uses the selected impact assessment models to calculate the environmental impacts. This will result in a list of scores of a product on each environmental effect called 'ecoprofile'. An ecoprofile is a scorecard that is usually much shorter than the inventory table because emissions that cause the same effect are aggregated.

It is, according to LCA scientists, difficult to interpret the ecoprofile because it is not clear if certain scores represent a small or a big environmental problem, because many of the scores are indicators for the actual impact and do not reveal actual problems, such as how many people die or become sick (Boguski et al. 1996: 2.35).

To clarify the meaning of the ecoprofile, analysts may relate an ecoprofile to a reference situation. This is called standardization or normalization of the ecoprofile. It has been proposed to relate the ecoprofile of a product to the ecoprofile of all emissions and extractions in a certain period in a certain area. For example to the ecoprofile of the Netherlands or worldwide in 1996 (Guinée 1995; Van den Berg, Dutilh, and Huuppes 1996). This specifies the relative contribution of a product to the total environmental problem of a country and will give an idea of the magnitude of the problem caused by a specific product.

Analysts may omit the impact assessment stage when a product is in every aspect of the inventory table better than the other products, however, this is usually not the case and impact assessment is required (Heijungs et al. 1992a).

2.2.5 Evaluation

The next stage of the LCA methodology is called evaluation and consists of the following activities:
1. Ranking of products or improvement measures⁸
2. Determining the reliability of the ranking and ecoprofiles

The ranking activity became part of the impact assessment stage in the recent ISO standards (ISO 1997).

---

⁷ The resulting score is in fact not an actual impact of these emissions but an indicator of the actual impact.
⁸ This activity became part of the impact assessment stage in the ISO standards (ISO 1997).
Ranking

The order of merit of the products or the improvement measures is determined in the evaluation. Analysts use the ecoprofile or the standardized ecoprofile to rank the products and in a number of cases the inventory tables. Different evaluation procedures exist. LCA handbooks prescribe the following ranking rules:

1. Use specific limitations that must be met or cannot be exceeded (Heijungs et al. 1992b; Field et al. 1994). These limitations resemble the teachers rule that the score for each of the four subjects should be at least 79.

2. Use a form of multi-criteria evaluation (Heijungs et al. 1992b):
   - Quantitative multi-criteria methods. Quantitative weightfactors are used to aggregate the ecoprofile into one numerical score for the overall environmental burden.
   - Qualitative multi-criteria methods. A panel or an analyst can compare the ecoprofiles in pairs and substantiate their choices verbally.

The CML handbook and many LCA scientists (e.g. Goedkoop et al. 1995; Sas et al. 1994) have focused on the use of weighted summation, a quantitative procedure. This procedure consists of the following steps:

1. Standardizing the impact scores
2. Directing the impact scores
3. Determining weightfactors
4. Calculating the report mark for the overall environmental burden

Standardization of the ecoprofile scores is required when an ecoprofile has not been normalized against a reference situation (Polak and Behesti 1992). Analysts direct the scores of the environmental impacts when a number of impacts are valued as positive when they are high and others as negative (Polak and Behesti 1992)10. Next, a set of weightfactors is determined or selected. A weight factor is an indicator of the relative importance of an environmental impact. This results in a formula that can be used to calculate the overall environmental burden, for example (Sas et al. 1994; Mieras 1994):

\[
\text{Overall Environmental burden} = 3,1\text{waste} + 2,8\text{nitrification} + 2,6\text{acidification} + 2,3\text{smog formation} + 1,7\text{squandering of toxic substances} + 1,1\text{climate change}
\]

The overall report marks are used to rank the products. Products with the lowest mark are considered to have the lowest environmental burden. The rankings and ecoprofiles provide simple and directive information for policy makers.

---

9 When one applies this rule, one can save time by studying first if the products meet these criteria, before one studies all the environmental aspects of the products.

10 It is assumed in the CML handbook that analysts will determine only adverse environmental impacts and does not contain the step directing impact scores. LCAs may also include positive environmental impacts, e.g. farming activities that are beneficial for bird life. In developing countries that struggle with a shortage of nutrients, eutrophication may be valued positively.
Reliability of the results

In the second part of the evaluation, analysts determine the reliability of the results. The reliability depends on the data quality and on the methodological choices made during the study, e.g. the definition of the boundaries of the product chain. Analysts may use sensitivity analyses to determine the effect of these critical choices on the ecoprofiles, overall report marks and ranking (Ayres 1995; Heijungs et al. 1992a).

Interpretation

Recently, ISO has proposed changing the name of the evaluation stage to that of interpretation (1997). Interpretation is the stage in which the findings from the inventory analysis, impact assessment and weighing are used to draw conclusions for policy makers. Analysts who make sense of the results should take the results of sensitivity analyses when these have been made and the assumptions into account. This change is proposed to take more account of uncertainties and crucial assumptions and to get more balanced conclusions.

ISO requirements

The analytical activities in each stage have been described in this section. Many techniques, tools, and formal models exist to conduct these activities. The study process may also benefit from the procedures that have been developed by LCA practitioners and users. In the ISO standards, specific requirements have been set for LCAs which are used to make claims about the environmental superiority of products (comparative assertions) and that are disclosed to the public (ISO 1997). For example, analysts who compare products should treat these products in the same way during the analysis, e.g. use the same allocation rules, impact assessment models, and system boundaries. Another ISO requirement is the review by a panel of stakeholders. Information on the social procedures that are recently used in practice or have been proposed to ensure the quality of the LCAs, can be found in chapter five. The new handbook that is in preparation for LCA studies in the Netherlands will contain a chapter on procedures for conducting LCAs (De Bruijn and Van Duin 1998; Van Drunen 1997).

2.3 Summary

An LCA methodology can be used to rank products in order of merit. Environmental impacts of the entire product life cycle are quantified, and aggregated into a report mark for the overall environmental burden of the product. The products analyzed are ranked on the basis of these report marks. The product with the lowest mark is selected as the most environmentally friendly product. The LCA methodology organizes the analysis into four stages, the activities and results are summarized in table 2.3. LCA handbooks aim at a comprehensive analysis, e.g. the complete lifecycle and approximately 19 environmental impacts are taken into account. The focus is mainly on quantitative ecoprofiles and overall
Social procedures for conducting LCAs have been developed in addition to the stage model, tools, techniques, and formal models.

**Table 2.3 Activities and results of the four stages in an LCA methodology**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activities in this stage</th>
<th>Results of this stage</th>
</tr>
</thead>
</table>
| Goal and scope definition     | • Defining intended application  
                                 | • Organizing the study                                      
                                 | • Generating and selecting product alternatives            | List of alternative products                                |
| Inventory                     | • Drawing product chain                                       | Inventory tables of each product                           |
|                               | • Identifying emissions, raw material use etc.                |
| Impact assessment             | • Determining actual environmental impacts of products       | Standardized ecoprofiles of each product                   |
|                               | • Standardizing                                               |
| Evaluation                    | • Ranking products                                           | A ranking of products or claims on their relative environmental burden\(^{11}\) |
|                               | • Determining reliability results                             |

\(^{11}\) Environmental claims on the superiority or equivalence of one product versus a competing product which performs the same function are called comparative assertions in the ISO standards (1997).
3

Limits to intellectual cogitation; difficult and subjective choices in LCAs

'Unfortunately, current quantitative LCAs often yield mutually conflicting results'

In the eighties and early nineties, many developers and users of the LCA (Life Cycle Assessment) methodology aimed at objective and decisive rankings and ecoprofiles that could be used to provide clear guidance to policy makers. The possibility of and need for objective LCAs are at present under attack. Hofstetter (1998), for example, argues that LCAs are inherently normative and proposes to include the analysis of values in LCAs.

In this chapter I analyze why it is difficult to achieve objectivity and decisive conclusions. Analysts have to make many ambiguous and subjective choices in each stage of an LCA study. This chapter and chapter four on the actual use of LCAs in public policy processes lay the foundation for the subsequent chapters that focus on strategies to deal with ambiguous and subjective choices and the problems in achieving decisive, authoritative answers.

The limits to intellectual cogitation are described in a general sense in this chapter and illustrated with examples from Dutch LCAs on polyvinyl chloride (PVC) products in separate boxes. This is structured in the following way. First, background information about PVC products and LCAs that have been made of PVC products is given in section 3.1. Next, the choices that analysts have to make in the goal and scope definition, inventory analysis, impact assessment and evaluation stage are contained in sections 3.2 till 3.5. The nature of these choices, the plausibility of different choices and their effect on the conclusions of LCAs are discussed in section 3.6.
3.1 LCAs of PVC products

3.1.1 Production and consumption of PVC products
Polyvinyl chloride (PVC) is a common plastic, used in piping, window frames, floor coverings, packaging material, wire insulation, building profiles, office materials, footwear, credit cards, toys and many other products. PVC is the only commonly used plastic that contains chlorine. Other plastics such as polyethylene (PE), polypropylene (PP) and polystyrene (PS) do not contain chlorine. An overview of the consumption of the main plastics in Western Europe is presented in table 3.1.

Table 3.1 Consumption of plastics in Western Europe (1996)

<table>
<thead>
<tr>
<th>Plastic</th>
<th>Consumption (1000 ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td>9,814</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>5,397</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>5,406</td>
</tr>
<tr>
<td>PET</td>
<td>2,093</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>2,551</td>
</tr>
</tbody>
</table>

Source: APME 1996: 4

The relative consumption of PVC in Western Europe and in the Dutch PVC compounding industry according to type of application is shown in table 3.2. A number of figures from this table are outdated because the use of PVC packaging has decreased drastically in the Netherlands and the use of PVC building profiles, especially window frames, has increased since 1990. The production and use of PVC in piping is relatively high in the Netherlands. In Germany the market shares of PE and PP piping are much larger.

Table 3.2 Application of PVC in different products in Western Europe and the Netherlands

<table>
<thead>
<tr>
<th>PVC Product</th>
<th>Consumption of PVC granulate in Western Europe in 1989 (% ton/ton)</th>
<th>Consumption of PVC granulate by the PVC compounding industry in the Netherlands in 1990 (% ton/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>28</td>
<td>46</td>
</tr>
<tr>
<td>Building profiles (e.g. window frames)</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Foil (e.g. PVC files, roofing material, bottles)</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Wire insulation</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Floor covering, wall paper</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Otherwise</td>
<td>23</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 3.1 Processes in the PVC product chain from ‘gradle to grave’
The PVC chain consists of various processes as shown in figure 3.1: salt production, chlorine production, vinylchloride production, production of PVC granules from chlorine and other basic chemicals, manufacturing of PVC products, retail activities, consumption and waste management. Different types of waste management can be applied: combustion, material recycling, chemical recycling and product recycling. In the Netherlands, a number of PVC products are recycled, e.g. piping, window frames and floor covering. Recycling is usually set up as a joint project of producers of certain PVC products.

PVC products are usually made from PVC granulate that is mixed with plasticizers which make the plastic more flexible and other additives such as stabilizers, colorants and fillers (Caesar 1992: 11). Each additive brings a complete production chain along which is not shown in detail. Many products made from PVC also contain other materials, e.g. floor covering is made from PVC and a textile pile and PVC products are used in other products, e.g. carparts. This is not shown in figure 3.1. The PVC chain is connected with other product chains through coproduction, e.g. of chlorine and sodium hydroxide. Sodium hydroxide is amongst other uses, used in wastewater treatment.

Table 3.3 Producers, traders, consumers and recyclers of PVC piping in the Netherlands

<table>
<thead>
<tr>
<th>Processes</th>
<th>Dutch actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt Production</td>
<td>AKZO Nobel, Frima Zoutwinning BV</td>
</tr>
<tr>
<td>Chlorine production</td>
<td>AKZO Nobel, General Electric Plastics, Solvay</td>
</tr>
<tr>
<td>Vinyl chloride production</td>
<td>ROVIN³</td>
</tr>
<tr>
<td>Production of PVC granulate</td>
<td>Shell, LVM⁴</td>
</tr>
<tr>
<td>Production of PVC piping</td>
<td>Alphacan Omniplast, Dyka, Martens Kunststoffen</td>
</tr>
<tr>
<td></td>
<td>PolvaPipeline, Viplex Plastics, WAVIN, etc.</td>
</tr>
<tr>
<td>Distribution of PVC piping</td>
<td>Wholesale business for the building industry and retailers, e.g. Gamma, and Praxis</td>
</tr>
<tr>
<td>Consumption of PVC piping</td>
<td>Housing associations, project developers and designers, and individual consumers</td>
</tr>
<tr>
<td>Discarding of PVC piping</td>
<td>Building companies, demolition firms, individual consumers</td>
</tr>
<tr>
<td>Collection of PVC piping</td>
<td>WAVIN/FKS⁵</td>
</tr>
<tr>
<td>Recycling of PVC piping</td>
<td>WAVIN</td>
</tr>
</tbody>
</table>

Source: Based on Caesar 1992, Anonymous 1994b, and FKS publication⁹.

¹ For example, the six largest producers of PVC piping organized in the Association of Plastic Pipe Manufacturers in the Netherlands (FKS) have set up a joint collection and recycling system for discarded pipes (Anonymous 1990. Nieuwsbrief PVC & Milieu, Vol. 1, no. 5, 1990: 6).
² Lead, tin, barium, cadmium, calcium, potassium and zinc.
⁴ Limburgse Vinyl Maatschappij. First a joint venture between DSM and Enterprise Minière et Chemique (EMC), since 1990 or 1991 owned by EMC.
⁵ The Association of Plastic Pipe Manufacturers in the Netherlands (Vereniging van Fabrikanten van Kunststofleidingsystemen, FKS) is responsible for recycling of PVC piping while WAVIN recycles the pipes.
Various actors feature in the PVC actor chain: chemical industries, compounders, producers of end products, retail stores, consumers, and waste collectors. The PVC chain is an international one. Imports and exports between the Netherlands and other countries are very important. The following products, for example, are imported: Vinylchloride (VC) from Belgium, PVC granulate and PVC end products, e.g. window frames from Germany (Caesar 1992; CBS 1993). Part of the Dutch PVC granulate and PVC end products are also exported (Caesar 1992; CBS 1993). Most of the waste management and recycling of Dutch post consumer waste takes place in the Netherlands since export of waste is not common.

A list of all the producers, traders, consumers and recyclers of PVC products in the Netherlands would become very extensive. As an example, an overview of the main producers and recyclers in the chain of PVC piping in the Netherlands is given in table 3.3.

The PVC chain is associated with harmful emissions, use of resources and other risks, especially by environmental organizations. Most of the environmental problems are related to the use of chlorine in PVC, such as the risks involved in chlorine transport, and the emissions of toxic intermediate products such as vinylchloride and dioxins. Other problems are related to the use of additives such as plasticizers and colorants. An extensive overview of the PVC chain and the environmental aspects of the production and waste management in the Netherlands is given by Berends (1989), Caesar (1992), and Faaij et al. (1991). Tötsch and Gaensslen (1992) give an overview of the German situation. How the Dutch chlorine and PVC industry, the Dutch Ministry of the Environment and the Dutch environmental organizations interpret the environmental aspects of PVC and chlorine is described in chapter 4.3. Environmental organizations have argued that a phase out of PVC is necessary to combat environmental problems while industries have stated that it is sufficient to implement a number of improvements in the production and waste management of PVC.

3.1.2 Products studied and methodology used
Many LCAs of PVC products have been carried out to determine the relative environmental pollution of PVC products and other products in the Netherlands and elsewhere7. Between 1990 and 1996, at least 14 LCAs of PVC products have been made in the Netherlands8. Other countries have also conducted PVC LCAs (Ayres 1995; EVC 1992).

I selected eight LCAs on PVC to illustrate the problems encountered when one wants to achieve objective and decisive results. Table 3.4 shows the selected LCAs, the PVC

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6 Publication of FKS on the new recycling system published in 1993 or 1994. The publication has no title. The title of the first chapter is ‘Ministerie van VROM steunt Initiatief FKS’.
7 It is not possible to provide a complete overview of LCAs made from PVC products because LCAs often belong to the ‘gray literature’ and are not always made public.
product and alternatives analyzed, and the type of LCA methodology used. Most of these LCAs use the CML methodology or one of its variants and have the following characteristics:

- Apply the stage model explained in chapter two: goal and scope definition, inventory analysis, impact assessment, evaluation.
- Analyze the environmental impacts listed in the CML guide (table 2.2) of the entire product life cycle
- Quantify the environmental impacts and present the results in the form of ecoprofiles

Five of the eight selected studies\(^9\) rank the products analyzed and provide a verdict on the relative environmental burden of PVC.

The reader should bear in mind that the examples taken from the LCAs of PVC do not always reflect the most recent LCA methods and techniques nor do most of these studies apply with recent ISO standards, e.g. a critical review by stakeholders when disclosed to the public. The examples are meant to illustrate the key choices LCA practitioners need to make. Although new methods and techniques have been developed and older ones virtually died out, the difficult points in LCA are more or less the same.

### Table 3.4 Overview of LCAs of PVC products

<table>
<thead>
<tr>
<th>Literature reference</th>
<th>Products analyzed</th>
<th>Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tukker et al. 1995a, 1995b, and 1995c.</td>
<td>PVC and other chlorine related products</td>
<td>CML methodology of 1992 (Heijungs et al. 1992a and b) and a number of recently developed procedures</td>
</tr>
</tbody>
</table>
| 2. FKS 1995. | Sewage pipes from:  
- PVC  
- Concrete  
- Glazed stoneware | Methodology based on Critical Volumes Method and Thalmann weight factors |
| 3. INTRON\(^10\) 1995a and 1995b. | Sewage pipes from:  
- PVC  
- Concrete  
- Glazed stoneware | CML methodology of 1992 |
| 4. Potting and Blok 1993, Potting 1994. | Floor covering from:  
- Linoleum  
- Cushion vinyl  
- Tufted carpet with a woolen pile  
- Tufted carpet with a polyamide pile | CML methodology of 1992 |

---


\(^10\) Instituut voor Materiaal- en Milieu-Onderzoek.
Table 3.4 Overview of LCAs of PVC products (supplement)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• PVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Carton</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Combinations of these materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Pinewood</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Aluminum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tropical hardwood</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Options to improve the PVC chain e.g. recycling of postconsumer PVC waste.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. De Baere et al. 1994a and 1994b</td>
<td>Bottles for mineral water from:</td>
<td>CML methodology 1992 and a number of other approaches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• PET</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A number of studies report extensively on the methodology used (e.g. Tukker et al. 1995a, 1995b, 1995c, De Baere et al. 1994a and 1994b, Hoefnagels et al. 1992), whereas other studies barely describe the methodology followed (e.g. FKS 1995; VNCI 1991). It should be noted that these studies do not always apply with recent ISO standards (1997). A critical peer review by stakeholders, requested by ISO for studies that compare products and are disclosed to the public, was often not made.

3.2 Goal and scope definition

This section describes the choices and estimates that have to be made in the goal and scope definition stage (see chapter 2.2.2). It is often assumed that this stage is relatively simple and without problems (Consoli et al. 1993). Analysts however encounter many difficulties in selecting products, in specifying products and in determining the basis of comparison as described in this section. The effect of the choices and estimates made on the outcomes of the studies is indicated.
3.2.1 Selection of product alternatives
Selecting product alternatives is the fifth activity in the goal and scope definition stage. According to the CML handbook, an analysis must include all the alternative products that could possibly fulfill the same product function (Heijungs et al. 1992a). Products almost always differ slightly in functionality (Udo de Haes 1992; Van Dam 1995b). Porcelain cups are more luxurious than paper cups and taste better than plastic cups. Therefore, in practice, analysts have to decide to what extent alternative products may have a different functionality.

It is not only the functionality of a product that determines if it qualifies as an alternative product. Alternative products have to fulfill certain criteria such as economic criteria, technical feasibility, commercial feasibility, and safety standards. In most cases, it does not make sense to investigate the environmental burden of alternative products that do not meet these crucial criteria. Analysts may compare a trip by bicycle with a trip by car but others may argue that a bicycle is not a valuable and feasible alternative because it can not be used for long distances.

The choice of the required functionality and other product selection criteria is, in essence, a question of normative judgment that depends heavily on the interest that one attaches to the need to reduce the environmental burden of our society. If one attaches a great interest, one will accept a decrease or change in functionality earlier and will therefore include a wider set of alternative products in the analysis.

Often it is too costly and too time consuming to include all the adequate, alternative products in the analysis. LCA analysts therefore have to select a small number of alternatives from the range of adequate alternatives. They may use one or more of the following selection principles:

1. **Promising alternatives.** Focus on promising alternatives (VNCI 1991; Walker 1988). Promising alternatives have probably a low environmental burden and are also good in other respects, e.g. low costs.

2. **Variety of alternatives.** Compare a range of different options instead of a number of rather similar options (VNCI 1991).

3. **Representative alternatives.** Include products that represent a larger group of products in order to generalize the conclusions (Ywema and Van Overbeeke 1994).

As a result of different product selection criteria and different selection procedures, different LCAs may include different alternatives. The selection of products often influences the conclusions that are drawn about the environmental benefits of the replacement of a specific product. Let us for example compare the following two situations:

- Comparison of a plastic cup to a porcelain cup and saucer
- Comparison of a plastic cup to a porcelain cup

The first comparison is made in a Dutch study commissioned for the Dutch Federation for Plastic Producers (NFK) (De Groot et al. 1993). This study results in a rather positive picture of the environmental friendliness of plastic cups and policy makers concluded that replacement was not beneficial for the environment (Herberigs 1993). A comparison of a
Box 1 Selection of products in PVC LCAs

The products that were included in an LCA of mineral water bottles are shown in table B.1. Alternative products that were not included are also listed. The table below shows also alternatives that were not included in the FKS piping study.

Table B.1 Selection of alternatives for PVC products in a study on mineral water bottles and in a study on sewage pipes

<table>
<thead>
<tr>
<th></th>
<th>Included alternatives</th>
<th>Not included alternatives (list not comprehensive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study on mineral water bottles (De Baere et al. 1994a and b)</td>
<td>bottles from:</td>
<td>• bottles from other materials</td>
</tr>
<tr>
<td></td>
<td>• PVC</td>
<td>• other packaging concepts: plastic bags, bottles</td>
</tr>
<tr>
<td></td>
<td>• glass</td>
<td>that are refilled in the store</td>
</tr>
<tr>
<td></td>
<td>• PET</td>
<td>• PET bottle which is recycled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• other variants (e.g. different weights) of glass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bottles and PVC bottles</td>
</tr>
</tbody>
</table>

| Study on sewage pipes (FKS 1995) | pipes with an inner diameter of 30 cm, made from: | pipes: |
|                                 | • virgin PVC pipe and 50% recycled PVC            | • from other materials, e.g. PE and PP |
|                                 | • concrete                                           | • from 100% recycled PVC\(^{11}\) |
|                                 | • glazed stoneware                                   | • from virgin PVC  |
|                                 |                                                     | • with other inner diameters |
|                                 |                                                     | • with different wall thickness' and thus different |
|                                 |                                                     | weights per meter |

The analysts did not include the recycled PET bottle because this bottle was not commercially available on the Belgium market (Anonymous 1994a). Apparently, commercial availability was an important criterion for the conductors of this study. Greenpeace did not agree with the exclusion of the recycled PET bottle, a promising, environmentally friendly alternative in the eyes of Greenpeace, and was of the opinion that the exclusion of the recycled PET bottle favors the PVC bottle (Anonymous 1994a).

\(^{11}\) Pipes from 100% recycled PVC may become possible in the future. At present it is technically not feasible to use more than 50 and 60% recycled PVC in new PVC pipes because the outside and inside have to be made from virgin PVC, however, recyclers expect that the percentage of recycled material will be increased.
plastic cup with a porcelain cup results in a lower environmental burden for the porcelain variant due to the absence of a saucer. Such a study would draw less positive conclusions about the environmental friendliness of plastic cups (Herberigs 1993).

Actors involved in product policies may find the choice of alternative products improper when the LCA does not include promising, environmental friendly alternatives, e.g. the porcelain variant without saucer, and compares a problematic product only with products that also have a relatively high environmental burden. Actors may also criticize the selection of products because the study focuses on variants of a product group with a relative high environmental burden. An LCA may, for example, focus on a PVC pipe with a relative high environmental burden, and ignore PVC pipes that have a relatively low environmental burden due to their low weight, long lifetime and use of recycled PVC. As a result, these LCAs may give a wrong impression of the environmental burden of PVC pipes.

3.2.2 Specification of products
Specification of products or in other words the precise definition of the properties of the product analyzed such as the materials used and product weight, is not a straightforward task. This is especially true when different product variants exist and analysts have to choose one of these or have to determine the average product features. The product specification influences the study conclusions on the ecoprofile and the ordering of merit. This effect may be considerable and change the ranking of products made from different materials completely. The time and geographical aspects of the products are also defined and used to define the product chain in the inventory stage. This choice influences the conclusions, as the environmental burden of the product chain differs between countries and time periods due to the use of different production technologies, end-of-pipe measures and recycle facilities.

| Box 2 Specification of PVC products and their alternatives |

Sewage pipes from PVC, glazed stoneware and concrete each with an inner diameter of 30 centimeter are compared in two LCAs. Pipes with different wall thickness’ and thus different weights per meter pipe exist and are used in practice for each material. The FKS study (1995) selected a heavy version of the concrete pipe (160 kg/m pipe) while the INTRON study (1995a and 1995b) selected a light version (73 kg/m pipe). The heights of the ecoprofile scores are strongly correlated with the weight of the pipe. The ecoprofile scores for the heavy version are approximately twice as high.

Two variants of PVC ringbinders are compared by Beenen and Eygelaar (1993). One is welded together and the other one is welded and glued together. The integral environmental burden of the one that is glued and welded is 35% higher than the one that is only welded when both are recycled; A considerable difference for a seemingly unimportant product variation.
3.2.3 Determination of the basis of comparison

To define a basis for comparison, one must define a functional unit and determine the number of functional units provided by the products analyzed. The quantity of functional units provided by a product is usually related to the number of times that the product is used before it is discarded.

In most cases, the lifetime of a product or the number of times used depends on the behavior of consumers, and information about the behavior of consumers is often lacking (Van Drunen 1997). Furthermore, consumers may behave in different ways and it is difficult to make general statements about the environmental burden of products (Herberigs 1991 and 1993; Miller 1997; Pedersen Weidema and Kruger 1993; Van Duin 1995b). A number of consumers may use two polystyrene cups to drink coffee, one inside the other, to prevent them burning their fingers (Portney 1993). Certain consumers keep their window frames in a good state of repair resulting in a long lifetime while others do not attend to maintenance.

Analysts have to make estimations and these have in general a large influence on the conclusions of a LCA study (Herberigs 1991 and 1993; Pedersen Weidema and Kruger 1993; Van Duin 1995). When production and waste management processes cause the main environmental burden of a product, its environmental burden is reduced by a factor two when the lifetime of a product is assumed to be twice as high.

---

**Box 3 Determining the basis of comparison**

Analysts lack information about the lifetime of PVC products and of the alternatives, e.g. of window frames, building materials and floor covering (FKS 1995; Lindeijer et al. 1990). This is, amongst other things, because PVC pipes and frames have only been used since the fifties and are still in use (Lindeijer et al. 1990). The PVC studies try to make a reasonable estimate but the differences between studies are often considerable. The FKS study puts the lifetime of certain sewage pipes at 80 years, while the INTRON study uses 40 years for the same pipes. The uncertainty is also clear from the sensitivity analyses that are made. Potting (1994) uses an average lifetime of eight years for cushion vinyl, tufted carpet and 15 years for linoleum. The study determines the change in the order of merit of these floor coverings when the lifetime of linoleum is set at eight years.
3.3 Inventory analysis

The inventory analysis stage contains four activities:
1. Drawing the product chain
2. Collecting data on emissions, energy and raw material use
3. Allocating environmental impacts when product chains are interwoven
4. Calculating of the inventory table

The problems with the choices to be made are discussed below.

3.3.1 Drawing product chains and collecting data

The inventory stage will typically start with defining the product chain of the product studied. Boundaries between the product chain and the environment and between the product chain and other chains have to be specified. It is however, not always possible to determine unambiguously where the environmental system stops and where the product chain starts. Is forestry an activity of the product chain of wooden products or is it still a part of the environmental system? (Guinée 1995: 24). It is also difficult to distinguish between the end of the product chain and the environmental system. Are landfills part of the product chain or are they part of the environment? (Guinée 1995: 24; Tillman et al. 1994: 22). Different interpretations of reality are possible because these boundaries are not given by nature. The same is true for the decision whether or not to include the environmental impacts of capital goods that are used in the product chain.

<table>
<thead>
<tr>
<th>Box 4 Drawing the PVC chain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boundaries between the PVC chain and the environment</strong>: a number of LCAs view waste of discarded PVC products that is not recycled as an output to the environment (e.g. FKS 1995: 7) while other studies view garbage dumps as part of the PVC chain.</td>
</tr>
<tr>
<td><strong>Boundaries between the PVC chain and other product chains</strong>: PVC products are usually made from PVC granulate and a number of additives. Most LCAs on PVC do not include the production of these additives in the chain. The exclusion of the production of additives, results in a position of PVC in the order of merit that is, in fact, too high, when PVC products use more additives than products from other materials and the environmental burden of these additives is considerable.</td>
</tr>
<tr>
<td><strong>Included processes</strong>: Not all the processes within the PVC chain are taken into account. For example, transport and storage of substances and their effects are neglected in most LCAs on PVC. If PVC causes more problems in this respect than its alternatives, PVC’s position in the order of merit is too high. If these processes are less harmful, PVC’s position is too low.</td>
</tr>
</tbody>
</table>
Specifying processes

After the demarcation of the boundaries of the chain, analysts need to specify the processes in the chain. This is difficult for the following three reasons. First, different production and waste management techniques exist in the same geographical area and during the same time period. It is possible to select the most modern ones (Guinée 1995: 35) but there are also good reasons to select those that disrupt the environment most. Another option is to use the average emissions of the processes that are used in a certain area. Information about the share of different techniques such as incineration, back-to-feed stock recycling or mechanical recycling is, however, often incomplete.

Box 5 Specifying processes in the PVC chain

- Production processes: Dutch producers of chlorine, ethylene, VC and PVC make use of different types of production technologies and have taken different environmental measures. For example, three different process types are used for the production of chlorine which differ considerably in environmental impacts. The diaphragm process emits asbestos, the amalgam process emits mercury compounds, while the membrane process does not yield this kind of emissions. Furthermore, emissions from different Dutch PVC plants that use more or less the same process vary considerably.

The choices on where and how the chlorine, ethylene, VC, and PVC is produced, remain however implicit in most LCAs on PVC. Seven of the Dutch LCAs on PVC products have not specified the time and geographical aspects of the PVC chains. These LCAs use indicators from general studies (Boustead 1994; Faaij 1991; Habersatter and Widmer 1991). The indicators from Habersatter/Widmer and Boustead do not refer to the Dutch situation but to respectively Germany/Switzerland and Europe. The data from Faaij do not take into account the effects of the measures that have been taken since 1990 (AKZO 1996; VNCI 1991). The study ‘Chlorine Balance’ was transparent with respect to the time and geographical aspects. It focused on the Dutch PVC chain in 1990 and used data that referred directly to this situation.

- Waste management: Explicit scenarios for future waste management and arguments for the selected waste management technologies are missing in the Dutch LCAs. Most studies base their analysis on the existing situation or on the situation in the near future. A number of studies assume that PVC piping and PVC window frames will be recycled (FKS 1995; INTRON 1995a and 1995b; VNCI 1991) while others assume that these will be incinerated (Lindeijer et al. 1990). The assumptions about the waste management of PVC influence the outcomes considerably. Beenen and Eygelaar (1993) conclude that a PVC ringbinder that is not recycled pollutes the environment 50% more than a PVC ringbinder that is recycled once.
Second, chains change continuously. These changes may occur in the physical processes, e.g. new production techniques may be improved or a monitor system might be added to reduce the quantity of emissions. The chain may also change as a consequence of changes in the relations between the social actors. A producer may decide to buy his raw materials from another raw material supplier who uses another production technique. As a result it is difficult to specify processes. It is especially difficult to define waste management processes of products that will be discarded in the far future because these processes will often change considerably as a result of technological and social dynamics. As different expectations may exist, LCAs of the same product may be based on different forecasts of future developments.

Third, available information is often not directly relevant because it applies to other geographical areas and different time periods (Ayres 1995; Guinée 1995: 35; Venner, 1993: 7-8; Vigon and Jensen 1995). Estimates are often not reliable, see for an illustrative example box 6.

**Box 6 Reliability of data on mercury emissions**

Mercury is emitted when mercury cells are used for the electrolysis of NaCl. Estimates in recent publications (1989-1995) vary between 0.5-3.0 g mercury/MT chlorine (Ayres 1997). Habersatter and Widmer (1991) estimated that 0.5g mercury/MT chlorine is emitted and many Dutch LCAs on PVC have been based on this assumption.

Ayres (1997) used mass balances to check these estimates. Ayres found that approximately 2 MMT chlorine was produced using mercury cells in the United States in 1988. If mercury emissions had been 3.0g/MT, then makeup requirements for mercury would have been a mere 6 MT, but mercury consumed in the chlorine production in 1988 was 445 MT. The actual use of mercury was nearly 75 times the 'theoretical' loss rate. On the basis of this example and similar ones, Ayres concludes that producers have either underestimated chlorine emissions, or that the mercury accumulated in waste water sludge ponds and tanks. In the latter case, mercury may gradually leak into water or air over a period of years. In both cases, mercury emissions are underestimated. Euro Chlor however asserted that the mercury in waste water sludge ponds is held in safe deposit after plant closure.

### 3.3.2 Allocation between product chains

The LCA methodology advises the analysts to allocate the environmental burden in the following situations\(^\text{12}\) (Guinée et al. 1995: 24; Tillman et al. 1994: 23; Udo de Haes 1992):

---

\(^{12}\) Instead of allocation, one could also compare the situation as is and the situation after product substitution.
1. **Coproduct**: multiple products are formed in one process.

2. **Waste treatment processes**: the waste input consists often of many different products, for example incineration of household waste.

3. **Cascade recycling**: waste of a product is used as raw material for another product. Window frames are, for example, made from plastic waste.¹³

The following allocation dilemma's exist. In case of coproduction, it is not always clear to which products one should allocate. Analysts need to distinguish between valuable coproducts and waste products because it is thought that only valuable products are responsible for the environmental burden of the production since production is not driven by a demand for waste products. There is, however, a gray area in which it is not clear if a certain coproduct should be seen as a waste product or as a product with value. An example can be found in the production of stone chips during diamond extraction. Are stone chips a waste product and should a study allocate the environmental burden only to the diamonds or are stone chips a valuable product? Does it make any difference if the stone chips are used as filling material in road construction or dumped in a mine? Furthermore, analysts need to choose between a number of allocation principles. Allocation can be done on the basis of (Boguski et al. 1996: 2.19-2.26; Guinée et al. 1993: 24-27; Heijungs et al. 1992a: 22-36):

- Mass (in kilograms or moles)
- Heat of the reaction or on other physical units
- Physical causality, e.g. emissions containing chlorine are allocated to the coproduct which contains chlorine and not to the chlorine free one
- Economic value of the products

Each allocation principle has its own rationality. A number of LCA analysts prefer allocation on the basis of physical units because the emissions are also given in physical parameters (Boguski et al. 1996), while others prefer to use a method based on the economic or social value of the products as this reflects social-economic causality (Huppes 1993). Similar dilemma's come up in allocating the emissions of combined waste management processes and case cascade recycling (Boguski 1996: 2.22-2.26, Heijungs et al. 1992: 28-36).

In LCAs of PVC products, allocation procedures need to be selected for:

1. chlorine/caustic soda production from salt, see box 7
2. ethene/propene/benzene production from oil
3. incineration of PVC products in combination with other waste
4. cascade-recycling of PVC

---

¹³ Allocation is required because the collection and recycling processes are part of the life cycle of a virgin product and part of the life cycle of the product that is made from recycled material. The environmental costs and benefits of recycling have to be divided between the virgin product and the one made from recycled material.
Box 7 Allocation dilemmas of the chlorine/caustic soda production

The dilemmas of allocation of the chlorine/caustic soda production will be explained. The co-products, chlorine, caustic soda and hydrogen\textsuperscript{14}, are produced during the electrolysis process from salt (sodium chloride). The energy used during the electrolysis process and emissions such as chlorine compounds, mercury\textsuperscript{15} and asbestos\textsuperscript{16} have to be divided between chlorine and its coproducts. A variety of allocation rules exist and they give different results as shown in table B2. The effect on the final scores in the ecoprofile of PVC products are in general small (Gui\'ee 1995). Results of allocation on the basis of economic value are very dynamic because prices for chlorine and sodium hydroxide are not stable, e.g. for caustic soda 30 dollars/ton in 1986 and up to 600 dollars/ton in 1988 (T\'otsch and Gaensslen 1992).

<table>
<thead>
<tr>
<th>Allocation rule</th>
<th>Allocation results for chlorine (% of emissions and energy use of electrolysis process)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (kg's)</td>
<td>47% of total emissions and energy use</td>
</tr>
<tr>
<td>Mass (moles)</td>
<td>25% of total emissions and energy use</td>
</tr>
<tr>
<td>Economic value of the products in 1974</td>
<td>36% of total emissions and energy use</td>
</tr>
<tr>
<td>Physical causality: which product caused the emissions or the use of resources?</td>
<td>100% of the emissions that contain chlorine</td>
</tr>
</tbody>
</table>

Source: partly based on Gui\'ee 1993: 25

3.4 Impact assessment

Impact assessment consists of the following activities (see 2.2.4):
1. Selecting environmental impacts that will be analyzed
2. Selecting or designing models to calculate these impacts
3. Calculating the environmental profile of each product
4. Standardizing the environmental profile of the products
The difficulties met during the first three activities are described in this section. Standardization is discussed in section 3.5 because standardization is part of a multi criteria evaluation.

\textsuperscript{14} Chlorine, caustic soda and hydrogen are produced in the ratio 1,000: 1,120: 28 on mass basis.

\textsuperscript{15} Mercury is emitted only by the amalgam process.

\textsuperscript{16} Asbestos is emitted only by the diaphragm process.
3.4.1 Selection of environmental evaluation criteria

LCA handbooks and studies focus on a variety of environmental impacts. The standard list of the CML contains 19 global environmental impacts, see table 2.2. This list does not include local and regional environmental impacts such as death of fish in the neighborhood of industries nor does it include impacts that were hard to quantify, such as fragmentation of wildlife areas. Other handbooks contain different lists of environmental criteria, e.g. the eco-indicator project (Goedkoop et al. 1995) or the critical volume approach (Guinée 1995: 7). Analysts often follow the handbooks but the LCA framework allows them to add environmental impacts to the ones proposed by the handbooks or limit the analysis to a smaller number of impacts.

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Subdivided environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>Ozone depletion, Greenhouse effect, Acidification, Smog, Smell</td>
</tr>
<tr>
<td>Squandering of resources</td>
<td>Abiotic depletion, Biotic depletion</td>
</tr>
<tr>
<td>Climate change</td>
<td>Ozone depletion, Greenhouse effect</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Human toxicity, Aquatic(^{17}) and Terrestrial(^{18}) ecotoxicity</td>
</tr>
</tbody>
</table>


LCAs that take different environmental impacts into account, use in fact different evaluation criteria and this leads to different and sometimes even contradicting conclusions. The standard CML list focuses on global, quantifiable impacts and ignores local impacts. As a result, studies based on this list consider products with many local impacts and only a few global impacts as relatively environmental friendly. Inclusion of previously ignored impacts, may change rankings considerable.

The same environmental impacts can be aggregated in different ways. A few examples are shown in table 3.5. The impact ‘Air pollution’ can be split up into five or even more impacts. The impact ‘climate change’ into ‘greenhouse effect’ and ‘ozone depletion’ (Adriaanse 1993; VROM, EZ and LV 1989). At first sight, one does not expect that differences in level of aggregation affect conclusions about the integral burden of products and the order of merit.

Environmental impacts that are divided into a number of subimpacts get more attention and are given a higher weight during evaluation and ranking. An ecoprofile based on the CML list and procedure contains many scores related to air pollution and only a few related to water pollution and pollution of the soil because the CML handbook subdivides impacts of emissions to air into ozone depletion, greenhouse effect, acidification, smog and smell but does not do this with emissions to water and to the earth. These emissions are

\(^{17}\) Pertaining to, living in, or growing in water.
\(^{18}\) Pertaining to, living on, or growing in the soil.
combined in a single indicator called ‘ecotoxicity’. As a result, analysts and policy makers who draw conclusions in the evaluation stage in a qualitative way, will often give more weight to the results on air pollution. They will consider products with relative high emissions to air and low ones to water and soil as very polluting. Subdivision of impacts has the same effect when the evaluation is based on a Distance To Target (DTT) method (Adriaanse 1993; Sas et al. 1994; RMB 1994). An impact will count twice when it is subdivided. It is possible to apply adjustment (correction) factors such as Tukker et al. (1995c) propose to wipe out the effects of aggregation and subdivision. The choice of the ‘reference situation’ is however arbitrary. Should analysts divide the weight factors of ozone depletion and greenhouse effects because other methodologies aggregate them into climate change or should they double the weight factor for climate change?

Concluding, ecoprofiles of the same product may vary considerably due to the focus on different impacts and different levels of aggregation.

3.4.2 Selection of impact assessment models
Analysts select or design models to calculate the environmental impacts. Different models can be used to determine the height of the same environmental impact because:

• Different proxies and indicators can be used for the same impact
• Indicators can be made operational in different ways

The following points in the effect chain can be used as indicators for actual environmental impact:


2. Inventory data: quantity and harmfulness of emissions, use of scarce raw materials, energy use and disposal of waste.

3. Effects that occur just after the emission or use of raw material: e.g. formation of acids is an early effect in the acidification chain.

4. Effects that occur at the effect chain: the actual health and environmental impacts, e.g. skin cancer, infertility. The end effects in the chain of acidification (shown in figure 2.2) are damage to buildings and decrease in vitality of woods.

Different indicators have been used for the same environmental impacts. For example, the eco-indicator project uses the quantity of toxic emissions to indicate the toxicity effect of a product while the CML handbook uses the toxic effects as an indicator.

---

19 The DTT method determines weight factors in the following way for the Netherlands (Sas et al. 1994):
Weight factor Effect X = Actual effect X in the Netherlands / Target for effect X in the Netherlands. The relative importance of an environmental impact is based on the ‘distance’ between the target and the actual situation. The target is either politically determined or based on a no-effect level, in other words a sustainability level.
Indicators can be made operational in different ways. Four different formulas for abiotic depletion are shown in table 3.6.

**Table 3.6 Formula for abiotic depletion**

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abiotic depletion = Use of raw materials that will be depleted within 100 years (kg)</td>
<td></td>
</tr>
<tr>
<td>2. Abiotic depletion = Use of raw materials (kg)</td>
<td></td>
</tr>
<tr>
<td>3. Abiotic depletion = Use of raw materials (kg) / Recoverable supply (kg)</td>
<td></td>
</tr>
<tr>
<td>4. Abiotic depletion = Use of raw materials (kg) * (Annual use worldwide (kg/year) / Recoverable supply (kg))</td>
<td></td>
</tr>
</tbody>
</table>


The first formula includes only raw materials that will be completely depleted within 100 years whereas the second one includes all the raw materials whether they are depleted in 100 years or not. The third formula relates the abiotic depletion score to the recoverable supply of the material because the use of materials that are very scarce is less desirable than the use of materials that are less scarce. The fourth formula takes the rate in which the supply diminishes into account because one might find it important to use only a little of a certain material when it has many applications and the supply diminishes quickly.

The selected indicator and practical operationalization will influence the height of the score on the environmental impact and the magnitude of the differences between different products, see for example box 8 on the next page.

### 3.5 Evaluation

Analysts may use a qualitative, argumentative procedure to rank products. This will surely result in different rankings because analysts will interpret ecoprofiles differently. It is explained that quantitative, formal evaluations will not result in objective and decisive conclusions either in this section. The focus is on weighted summation because this formal evaluation procedure is often used in LCA practices. Weighted summation consists of four steps (see 2.2.5):

1. **Standardizing**\(^{20}\) the impact scores
2. Directing the impact scores
3. Determining weight factors
4. Calculating the integral report mark and ranking

These evaluation activities became part of the impact assessment stage in recent ISO documents (ISO 1997). The different procedures for standardizing impact scores are discussed in section 3.5.1 and determining weight factors is discussed in section 3.5.2.

\(^{20}\) Usually called normalization in LCA methodology. The term standardization is a more general term used in the policy analysis sciences.
Box 8 Waste in kilo’s versus cubic centimeters

The FKS piping study uses ‘disposal of waste’ as evaluation criterion and determines the volume of the disposed waste. The study could have used a different practical realization of the indicator ‘disposal of waste’, namely the weight of the disposed waste. This would have given a different perspective on the comparison of the waste of PVC and the other products because PVC waste has a relative low density. The waste volume of the PVC pipe is twice as low as the glazed stoneware pipe and four times lower than the concrete pipe, see table B.3. When we look at the weight of the waste, the differences between the scores becomes larger.

Table B.3 Volume and Weight of disposed waste of PVC and concrete pipes

<table>
<thead>
<tr>
<th>Type of pipe</th>
<th>Volume of the disposed waste (1000 cm³/m pipe)</th>
<th>Weight of the disposed waste (kg/m pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC 50% recycled</td>
<td>4.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Concrete</td>
<td>18.8</td>
<td>45.2</td>
</tr>
</tbody>
</table>

Source: FKS 1995 and calculated. Density of PVC was set at 1390 kg/m³ and the density of concrete waste was set at 2400 kg/m³ (cp. Leijendeckers et al. 1997)

The use of the volume measure decreases the magnitude of the difference between the PVC pipe and the ones made from glazed stone ware and concrete. As a result, the use of volume measures may result in a relative larger integral environmental burden for glazed stoneware and concrete pipes in comparison with the PVC pipe.

3.5.1 Standardization of ecoprofiles

Procedures for standardization that can be used in LCAs differ with respect to the reference for standardization (FKS 1995; Guinée 1995; Van den Berg, Dutill and Huppes 1996). Analysts may use the worldwide or nationwide environmental impacts\(^{21}\) as a reference base and express the scores of a product as a percentage of the annual worldwide or nationwide impact:

\[
\text{Standardized abiotic depletion}_{\text{product x}} \text{ (%)} = \frac{\text{Abiotic depletion}_{\text{product x}}}{\text{Abiotic depletion}_{\text{total Netherlands 1997}}} \times 100\%
\]

Another possibility is to use impacts of alternative products as reference basis (FKS 1995; Guinée 1995). Analysts may use different strategies to standardize the scores in relation to alternative products (FKS 1995; Guinée 1995:142; Polak and Behesti 1992: 176):

\(^{21}\) A variation is mentioned by Guinée 1995: the average environmental impacts per world citizen per year.
1. Divide all the outcomes by the maximum outcome on that evaluation criterion: scores vary from 0.0 to 1.0\textsuperscript{22}.
2. Equate the highest score with 1.0, the lowest with 0.0 and put the other scores on the scale in between.
3. Divide all the outcomes with the score of a specific product on that criterion: the scores vary from 0.0 to infinite\textsuperscript{23}.

The selected reference basis and the standardization strategy influence the normalized ecoprofile and often the order of merit of the products because it influences outcomes on all the environmental criteria. The effect of the selected reference and standardization strategy on the ranking is hardly mentioned in the LCA literature. See box 9 for a PVC example.

3.5.2 Weighting of ecoprofiles

Determination of weight factors is necessary to calculate the total score of a product and to prioritize the products. The CML guide describes different practices to determine weight factors in a formal way:
1. Weighing based on the monetary costs of the impacts, e.g. weight factors can be based on the costs of preventing environmental impacts.
2. Weighing based on the political or social preferences with respect to the different goals, e.g. the targets of the national environmental policy can be used to determine weight factors.
3. Weighing based on no-effect level or sustainability standards.

Multiple methods exist within each category\textsuperscript{24} and as a result different sets of weight factors exist that may be used to rank products. The same method may yield more than one set of factors because analysts determine the factors for a specific area and time period and may use different information sources. The weight given to environmental impacts varies considerable and the selected set of factors has a considerable influence on the rankings as the PVC examples show, see box 10 (Bezem 1992; Mieres 1994).

\textsuperscript{22} Used in a study by Lindeijer et al., 1990.

\textsuperscript{23} This procedure was used in the FKS study (1995) but is not an accepted procedure in quantitative multi-criteria analysis. The main reason is that one environmental impact will become very dominant in the evaluation when the score of the reference product is almost 0 and standardized scores of alternative products become therefore more than 1000.

\textsuperscript{24} Examples are the Ecoindicator 95 project (Goedkoop et al. 1995), Distance To Target method (Adriaanse 1993; Sas 1994), NSAEI method (Kortman et al. 1994), EPS method (Steen and Ryding 1993) and other monetary methods (Graedel 1994; Guinée 1995: 136; Powell et al. 1995). Udo de Haes et al. (1994) describes various approaches.
Box 9 Standardization in PVC LCAs

The FKS study determined the following ecoprofiles of pipes made from PVC, glazed stoneware and concrete, see table B.4.

Table B.4 Ecoprofiles of four pipes

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>GS (62 kg)</th>
<th>GS (94 kg)</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>340</td>
<td>670</td>
<td>1020</td>
<td>410</td>
</tr>
<tr>
<td>Critical air volume (1000 m³)</td>
<td>6300</td>
<td>10650</td>
<td>16150</td>
<td>8100</td>
</tr>
<tr>
<td>Critical water volume (dm³)</td>
<td>2036</td>
<td>167</td>
<td>254</td>
<td>176</td>
</tr>
<tr>
<td>Waste volume (cm³)</td>
<td>4480</td>
<td>9630</td>
<td>14600</td>
<td>18830</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>3.0</td>
<td>0.47</td>
<td>0.71</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Source: FKS 1995:7. GS= Glazed Stoneware

The following four methods to standardize these ecoprofiles were applied to show the effect of the standardization procedure:
1. Divide all the outcomes by the maximum outcome on that evaluation criterion.
2. Equate the highest score with 1.0, the lowest with 0.0 and put the other scores on the scale in between.
3. Divide all the outcomes with the score of the PVC product on that criterion
4. Divide all the outcomes with the score of the glazed stoneware pipe of 62 kg on that criterion.

The third procedure was used in the FKS study. The resulting normalized ecoprofiles are shown in appendix 2. Here we present only the order of merit determined by the four methods, see table B.5. The weight factors for all the environmental impacts were set at 1.

Table B.5 Rankings determined by the four standardization methods

<table>
<thead>
<tr>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
<th>Method 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS. 62 kg</td>
<td>GS. 62 kg</td>
<td>GS. 62 kg</td>
<td>GS. 62 kg</td>
</tr>
<tr>
<td>Concrete</td>
<td>Concrete</td>
<td>PVC</td>
<td>Concrete</td>
</tr>
<tr>
<td>PVC</td>
<td>PVC</td>
<td>Concrete</td>
<td>PVC</td>
</tr>
<tr>
<td>GS. 94 kg</td>
<td>GS. 94 kg</td>
<td>GS. 94 kg</td>
<td>PVC</td>
</tr>
</tbody>
</table>

Note: Rankings from lowest environmental burden to the highest burden.
Box 10 Weight factors used in LCAs on PVC

The weight factors used in the study ‘Chlorine Balance’ (Tukker et al. 1995c) and the ones used in the FKS study are shown in table B.6 and B.7. The study Chlorine Balance used the DTT method and thus applied weighing on political or social preferences. The FKS study used the Thalmann and Kohlert weight factors. These factors are related to the relative scarcity of clean water, air and energy sources.

Table B.6 Weight factors based on the DTT method

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Weight factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming</td>
<td>0.025</td>
</tr>
<tr>
<td>Ozone Depletion</td>
<td>0.732</td>
</tr>
<tr>
<td>Human Toxicity</td>
<td>0.018</td>
</tr>
<tr>
<td>Ecotoxicity (aquatic)</td>
<td>0.018</td>
</tr>
<tr>
<td>Smog</td>
<td>0.048</td>
</tr>
<tr>
<td>Acidification</td>
<td>0.054</td>
</tr>
<tr>
<td>Smell</td>
<td>0.041</td>
</tr>
<tr>
<td>Waste volume</td>
<td>0.041</td>
</tr>
</tbody>
</table>

Source: Adapted from Tukker et al. 1995c. The total sum of weight factors used in the Chlorine Balance is set at 1.

Table B.7 Thalmann weight factors

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Weight factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use</td>
<td>0.35</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0.20</td>
</tr>
<tr>
<td>Water pollution</td>
<td>0.15</td>
</tr>
<tr>
<td>Disposed waste</td>
<td>0.20</td>
</tr>
<tr>
<td>Depletion of materials</td>
<td>0.05</td>
</tr>
</tbody>
</table>

FKS 1995.

The DTT and Thalmann weight factors give a different priority to environmental impacts. The DTT method gives great weight to ozone depletion because the ozone depletion caused by the Dutch is 35 times higher than the Dutch policy goals. Thallman and Kohlert gave great weight to the use of energy because they established a large energy scarcity.

Application of Thalmann weight factors and unweighted summation on the standardized ecoprofiles of PVC, glazed stone ware and concrete pipes has a large effect on the final ranking. The PVC pipe has the lowest burden when the Thalmann procedure is applied, but is only third best when unweighted summation is applied, see appendix 3.
3.6 Discussion on choices

Many choices have to be made in LCAs. The nature of these choices and their effect on the outcomes of LCAs are clarified in this section.

3.6.1 Nature of the choices

Although some choices are better than other choices, it is clear that many study activities contain choices that cannot be made in a decisive and objective way since analysts have to:

1. Make estimations because the information is incomplete
2. Select elements for analysis because a comprehensive, complete analysis is not possible
3. Use value judgments
4. Choose between different interpretations of situations

Incomplete information

Information is often incomplete. For example on the following topics:

- available alternative products and their characteristics
- processes in product chains, their characteristics and emissions
- consumer behavior and life time of products
- adverse environmental and health effects of emissions
- information about reference situations
- information needed to derive weight factors, e.g. social environmental preferences in the Netherlands

Estimations are not only about the height of certain factors but also about the structural relationships between factors. For example, the ‘conceptual’ picture of the migration of substances in nature is incomplete. Often, it is not known if and how substances accumulate in food chains and how combinations of substances affect the health of animals and human beings.

Boundaries of the analysis

It is too costly and time consuming and even impossible to include every potentially relevant element. Analysts have to decide which elements they want to include in the analysis. Key choices are:

- Which products should be included?
- Which production processes and other processes of each product should be studied?
- Which inventory data should be searched for?
- Which environmental impacts should be determined?

Again, different choices are defendable. These choices depend also on ideas about the need to achieve a sustainable society and other fundamental ideas. For example, one may accept radical changes in production and consumption patterns when one is convinced that
environmental improvement is really needed whereas one will accept only changes that do not affect the standard of living when one is not convinced of this need. The choice of environmental impacts depends also on an evaluation of the severity of these impacts. The choice which elements to include in the analysis is highly normative.

Value judgements

LCA scientists often state that an LCA is an objective activity except for the evaluation stage (Ayres 1995; Böhm and Walz 1996; VNCI 1991). It can be argued, however, that each stage contains choices in which normative considerations play a dominant role (Heijungs 1997; cp. Hofstetter 1998). Defining the required functionality and other criteria that alternative products should meet is part of the goal and scope definition and requires normative judgments. Choices in the inventory stage have normative aspects too because analysts will focus on the elements that are evaluated as problematic. Impact assessment is a normative activity, selecting environmental impacts that will be used to evaluate products is clearly normative but the choice of models to determine these impacts is also based on fundamental ideologies about the nature of environmental pollution. The choice of a operational model for abiotic depletion depends on normative judgment: Is only the use of materials that will be depleted within ten years problematic or is depletion of bigger, recoverable supplies also undesirable?

Interpretation

Analysts need to choose between different theories and models that can be used to describe the ‘facts’ of the situation. They need to choose between different allocation models, impact assessment models, and models to derive weight factors. These models contain a specific interpretation and/or focus on the study object. Models that use social-economic indicators to allocate emissions of coproducts are based on the idea that social-economic forces are responsible for the production of these products and thus for these emissions. The product with the highest price is thought to be more responsible than the other product. Allocating models that use physical indicators interpret the same situation in a different way and emphasize that physical forces cause the emissions. These choices are in fact choices for specific interpretations.

3.6.2 Effect on rankings and ecoprofiles

The following choices have a large effect on the ranking or ecoprofiles:

- Standardization and weighing procedures
- The lifetime of products or numbers of times used.
- Specification of product features
- List of environmental impacts included
Other choices generally affect only the scores on one environmental impact or change the scores in the ecoprofile only slightly because the choice is related to only one process in the complete chain:

- impact assessment model used
- allocation model used
- specification of the used production technology

Although not all the choices are equally valid and some will be rejected by virtually all LCA practitioners and users, there is room for difference of opinion. Convergence has grown at certain points, e.g. allocation, but in other areas, e.g. impact assessment, more methods and thus more choices became possible. The conclusions of LCAs are not very decisive and objective. The accumulation of all the influential and less influential choices gives the ranking and quantitative ecoprofile a relative nature (Cramer 1994; Van Duin 1995b; VROM and EZ 1993, Wrisberg et al. 1997; Van Drunen 1997). People who do not agree with the choices made in the study may reject them and draw different conclusions. The relative nature of rankings and ecoprofiles is confirmed by the appearance of studies with conflicting conclusions. Many LCAs with conflicting results can be found due to these ambiguous choices, for example on diapers (Anonymous 1991) and margarines (Guinée 1995: 154).

**Box 11 Contradicting conclusions about sewage pipes**

The FKS and INTRON studies compare PVC pipes with pipes made from glazed stone ware. The FKS study concludes that the pipes have an equal environmental burden (FKS 1995) where as the INTRON study considers concrete to be the most environmentally friendly alternative (INTRON 1995a and 1995b). These opposing conclusions were amongst others caused by the assumptions about the weight of the pipes.

Strategies that have been developed to deal with difficult choices are described in chapter five. The focus in chapter four is on the use of LCAs and their ambiguous results in public policy making on PVC and chlorine.
4

LCAs in public policy processes on PVC and chlorine

'The study 'Chlorine Balance' commissioned by the Ministry of the Environment is not beneficial for the environment'\(^1\) Van der Naald (1996a: 16).

4.1 Introduction

The developers of Life Cycle Analysis (LCA) methodology expected that the use of LCAs would contribute to better policy making processes and thus to better informed policy decisions being made; but to what extent is this actually the case? Many policy makers, network actors and scientists are concerned that LCAs can be used as a tool by actors to manipulate other actors involved in a policy discussion (Herberigs 1993; Marion et al. 1995; Venner 1993; Van Drunen 1997). A review of 132 publicly available LCAs made for the European Commission concluded that the results displayed an uncanny tendency to favor their sponsors' products (Anonymous 1997)\(^2\).

A number of authors have questioned the use of LCAs in public policy processes. Venner (1993), who is concerned about manipulative use, argues that LCAs should not be used to adjudicate in political controversies, e.g. those about reusable and disposable diapers, and packaging materials. Knotnerus (1995) argues that the government should not use LCAs to develop national product oriented policies unless the methodology is improved. Others

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\(^1\) 'Milieu niet gebaat bij chloorrapport van het ministerie van VROM'

\(^2\) This article in End Report cites the results of the study but exact literature references to this study are not provided.
argue that LCAs should not be used until a standardized methodology is available (cp. Baumann 1998). Other scientists remain positive about the value of using LCAs for public policy processes, in spite of the perceived problems, as they believe that the use of LCAs can improve the quality of political discussions, even when LCAs do not provide absolute answers (Guinée 1995: 175). Different ideas exist in the literature about the value of using LCAs during public policy making processes.

The following questions provide the focus of this chapter:

- How neutral are LCAs in a political context?
- How do actors use LCAs and how does this affect public policy discussion?

A case study into the use of LCAs in the Dutch public policy process regarding national, governmental policies on polyvinyl chloride (PVC) and chlorine was conducted in an attempt to answer these questions. I selected a case study strategy because literature on the use of LCAs in public policy processes is scarce and the available literature describes only how policy makers could use the results of LCA (Allen 1996; Allen et al. 1997; Curran 1997; Goidel and McKiel 1996; Postlewhaite and De Oude 1996, Schleicher 1996) but does not describe the actual use of LCAs.

How the PVC and chlorine discussion started in 1989 and its follow-up is described in section 4.2. A description of how the actors involved perceived the PVC issue is given in section 4.3. The neutrality of LCAs in the PVC discussion is discussed in section 4.4. The focus of section 4.5 is the use of LCAs of PVC products during the policy discussions on PVC. An analysis of how the use of LCAs has affected the quality of the discussion is given in this section. The focus of section 4.6 is the Dutch LCA-study ‘Chlorine Balance’ and its consequences for PVC and chlorine policy discussions. This study is not a product evaluation but is also based on the LCA methodology. Section 4.7 consists of a set of conclusions regarding the use of LCAs during discussions of PVC and its effects on these public policy discussions.

4.2 Start of the Dutch PVC discussion

The PVC packaging campaign

Discussions’ regarding the environmental effects of PVC originated in the 1970s in the Netherlands and centered on the emission of vinylchloride, a carcinogenic hazard for workers in the PVC industry (Knot and Mulder 1996). In the second half of the 1980s, the questions regarding the use and production of PVC intensified (Mol 1995: 262)³, especially when in

³ Articles on the PVC issue were published in the magazine ‘Natuur en Milieu’ of the Netherlands Society for Nature and Environment (Stichting Natuur en Milieu, SNM) in 1987 and 1988. The National Institute for Public Health and the Environment (RIVM) commissioned studies (Bruggemann et al. 1985; Bouws et al.
1988 more than 40% of the seal population died in the Wadden Sea and the North Sea as a result of a virus-infection\(^4\). The environmental organizations assumed that the seals were very vulnerable to the viruses due to raised levels of organochlorines in these areas as the mortality rate was lower along the less polluted shores of Scotland (Colburn et al. 1997: 7).

In 1989, eight consumer and environmental organizations\(^5\) decided to organize a joint campaign to restrict, and eventually make illegal, the use of PVC packaging (Bras and Mulder 1997). The campaign was focused on foodstuff producers, retailers and consumers. The organizers hoped that this campaign would result in the use of PVC free packaging and that it would place PVC and chlorine on the political agenda. The campaign organizers considered the latter necessary because PVC and other chlorine related products had been shown to cause many environmental problems. They were convinced that a switch to a chlorine free industry was required to achieve a more sustainable society.

Just before the environmentalists' campaign started, the Dutch were alarmed by the discovery of dioxins in the food chain. Dioxins are a class of chlorinated, tricyclic aromatic ethers. The number of chlorine atoms in dioxins varies between 1 and 8. Dioxins were considered to be one of the most toxic substances. An agricultural area, close to a large garbage incinerator was found to be heavily polluted with dioxins, and dioxins were found in the milk of cows in concentrations that exceeded official safety levels. Drinking of milk produced in this area was banned and the milk was burned, ironically, in the same incinerator causing the dioxin pollution. The incineration of PVC that contains chlorine atoms was viewed as the major cause of the dioxin pollution (Schrijer 1992).

The PVC campaign started in September 1989 and consisted of consultation with foodstuff producers and retailers. In addition, stickers to warn consumers were put on products packed in PVC. The campaign immediately drew the attention of the media, and consumers became very concerned (Reeuwijk 1990). The large Dutch supermarket chain Albert Heijn responded immediately and declared its willingness to reduce its use of PVC packaging\(^6\). Many retailers and foodstuff producers\(^7\) followed Albert Heijn's example and declared their willingness to restrict the use of PVC packaging (Bras and Mulder 1997). Alternative materials replaced eighty percent of PVC packaging for food products within one year, in the Netherlands (Fromm and Van de Vusse 1990: 5).

\(^{1998; Groot et al. 1987}\) into the environmental aspects of PVC production and consumption with the intent to use them to support a public debate.

\(^{4}\) Verbal communication Association for the Protection of the Wadden Sea.

\(^{5}\) Konsumenten Kontakt, De Consumentenbond, Alternatieve Konsumentenbond, Nederlandse Vereniging voor Huissvrouwen, Vereniging Milieudefensie, Stichting Natuur en Milieu, IUCN-ledencontact en Aktie Strohaln.

\(^{6}\) Albert Heijn's quick response can be explained by the fact that Albert Heijn had already prepared an environmental marketing strategy and had developed plans to diminish the use of PVC in packaging before the campaign started (Kuin 1990).

\(^{7}\) E.g. Unilever, Vroom en Dreesman and Central Bureau of the Provision Trade (CBL, Centraal Bureau voor de Levensmiddelenhandel).
**Reaction of the PVC-industry**

The turnover of PVC film used for PVC packaging reduced drastically. Hoechst Holland, one of the main Dutch PVC film producers, was strongly hit and approximately 120 jobs were lost (Anonymous 1994c). The reaction of Hoechst and other PVC producers was defensive. They stated that the banishment of PVC packaging could not be justified by sound arguments and called the actions against PVC and chlorine a smear campaign and a witch-hunt (Raaijmakers 1992).

After the first shock, the PVC related industries established a steering committee, The Steering Committee PVC & the Environment⁸ (SPM) in 1989. Its members consisted of Dutch producers of chlorine, PVC, and PVC products. The Committee was mandated to consult with the Ministry of the Environment and to disseminate information on PVC products throughout Dutch society, e.g. to the users of PVC pipes (Boons 1995:143; Moerman 1993; Van den Bossche 1994: 16). The SPM has published a newsletter since 1989. Informative publications on the PVC chain in the Netherlands were published that describe and evaluate the production, consumption and waste management of PVC products (Caesar 1990 and 1992). The reports describe measures due to be implemented by the industry, e.g. recycling programs for PVC piping. The PVC industry disseminated this information because it felt that it was not enough to improve the environmental aspects of the PVC industry; the industry also had to let the public know to: ‘be good, and talk about it’ (Anonymous 1993a: 51).

**Reaction of the government**

Members of the Dutch parliament posed many questions on PVC and chlorine to the Minister of the Environment. For example, in December 1990 a motion to forbid the use of PVC packaging and other PVC products intended for short use was introduced⁹.

The Ministry of the Environment developed an official viewpoint on the replacement of PVC packaging in reaction to the questions posed by the Dutch Parliament and the anti PVC campaign. The Minister agreed to PVC packaging being replaced and viewed ‘market forces’ as an excellent instrument for banishing the use of PVC packaging (Mot 1990). A covenant on packaging between the packaging sector¹⁰ and the Ministry of the Environment was signed to reduce the environmental burden of the use of packaging waste in 1991 (In’t Veld et al. 1992). The appendix of the convenant lists all the actions that should be implemented within one year. Action B2 reads ‘To replace further PVC packaging material by alternatives that have a lower environmental burden’¹¹.

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⁸ Stuurgroep PVC en Milieu.
⁹ Motion proposed by Schimmel, member of the Dutch Parliament, d.d. 6 december 1990, Kamerstukken no. 21.137/59.
¹⁰ Represented by the Foundation for Packaging and the Environment (SVM, Stichting Verpakking en Milieu).
¹¹ Het verder terugdringen van PVC als verpakkingsmateriaal door alternatieven die minder milieubelastend zijn.
The Ministry developed the following general policy on PVC:

- PVC products with a short use life, such as packaging and office supplies, should be replaced
- PVC products with a long use life, such as piping and window frames, should be recycled

The provisional text of the ‘National Environmental Policy Plan plus’ proposed an ecotax for PVC products with a short use life and that deposits should be paid in cash for PVC products with a long use life (Boons 1995: 149). The SPM and the Ministry of Economic Affairs (EZ) pressed the Ministry of the Environment to change this provisional text. The final ‘NMP plus’ proposed only that experiments would be carried out regarding ecotaxes and deposit monies for PVC products (Boons 1995: 149; VROM 1990: actions 106d and 106e).

4.3 Conflicting Perceptions on PVC: To Switch or not to Switch

4.3.1 Actor network

The PVC packaging campaign in combination with the dioxin scare induced a discussion on PVC and the need to replace PVC in packaging and other PVC applications with other materials. A policy, or issue, network came into existence. A policy network is a relatively stable pattern of relations between actors that interact on policy problems or policy schemes (De Bruijn et al. 1993: 11). Interaction took place in the framework of the ‘Packaging Covenant’, as a result of the PVC free town campaign orchestrated by Greenpeace and in other, similar contexts.

The key-actors that are frequently involved in PVC discussions in the Dutch PVC network were:

- Environmental organizations
- Consumer organizations
- PVC related industry and their organizations
- The Ministry of Economic Affairs
- The Ministry of the Environment

The environmental organizations, the PVC related industry and the Ministry of the Environment were especially active in the discussions on PVC and its environmental aspects. At times, other actors were involved in the policy network. Albert Heijn and other retailers

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12 Nationaal Milieubeleidsplan plus.
13 Ministerie van Economische Zaken.
14 Other frameworks for interaction are for example the Campaign against PVC piping by SNM and VMD, Strategic discussions ‘Plastic Waste’ (Kunststofafval) and ‘Packaging Waste’, Consultations with target groups ‘The building sector and the environment’ (Bouw en Milieu) and ‘sustainable development chemical sector’ (Duurzame Ontwikkeling Chemische Industrie), Ecolabeling programs related to PVC.
were part of the network during the campaigns against PVC packaging. In other cases, producers of alternative products or waste managers were involved.

The actors in the policy network discussed intensively the environmental aspects of PVC products and the viability of PVC. They described and substantiated their own perceptions of the problem, and rebutted opposing ideas using the press and various meetings. The following sections provide an overview of the perceptions of the key actors for the period 1989 to 1996. Important developments in these perceptions of the key actors are noted.

4.3.2 Perception of the environmental organizations
The following environmental organizations were involved in the Dutch PVC discussion:
- The Netherlands Society for Nature and Environment15 (SNM)
- Friends of the Earth Netherlands16 (VMD)
- Greenpeace Netherlands
- Association for the Protection of the Wadden Sea (Waddenvereniging)
- Environmental Federation of South Holland17 (ZHМ)

Toxicity of chlorine substances
The environmental organizations aimed at substituting alternative products for PVC products (Berends and Stoppelenburg 1990; SNM 1993a and 1993b). The emission of organochlorines18 during the production, consumption and waste management of PVC products provided the main rationale behind the argument to switch to PVC free products.

The environmental organization’s argument is as follows: many organochlorines such as DDT19, PCBs20, CFCs21 and dioxins have been shown to be very toxic (Greenpeace 1993, 1994, and 1995b: Smeitink 1995; Van der Naald 1994b and 1996b; Van de Ven 1994c). They cause cancers, chronic skin diseases, muscular dysfunction, birth defects, nervous disorders, have a detrimental effect on the immune system, and reduce the fertility of humans and animals. Environmental organizations quoted laboratory experiments and field studies to prove this claim, for example a study that shows that accidental consumption of rice oil

15 Stichting Natuur en Milieu.
16 Vereniging Milieufedensie.
17 Zuid-Hollandse Milieufederatie.
18 Hydrocarbon compounds containing chlorine, also known as chlorinated hydrocarbons.
19 Dichlorodiphenyltrichloroethane. DDT is an insecticide that was, in the past, used widely to combat malaria and agricultural pests.
20 Polychlorinated biphenyls. A group of highly stable organic compounds resulting from the reaction of chlorine with biphenyl. PCBs have been used as lubricants, as heat-transfer fluids in transformers and capacitors, and they have also been used in paints, paper coatings, and packaging materials.
21 Chlorofluorocarbons. Aliphatic carbon compounds with both chlorine and fluorine atoms. The CFCs were most commonly used as aerosol propellents, as refrigerants and in the manufacture of plastic foam products.
contaminated with PCBs in Japan resulted in foetal death and off-spring with serious health problems (Greenpeace 1994).

More recently the environmental movement has emphasized the hormone related effects of organochlorines. DDT, PCBs, and dioxins mimic natural hormones, upsetting normal reproduction and development. These results in severe birth defects, sexual abnormalities, and reproductive failure, especially when children are exposed to these substances before they are born. The detrimental effects of organochlorines occur at very low concentrations. (Colburn et al. 1997: 47-67). Phthalates, used in PVC as plasticizers, are also said to produce the same hormonal mimicking effects by the environmental organizations.

**Persistence and accumulation in food chains**

The toxic effects of chlorine emissions are enhanced by their high persistence and by the effects of biomagnification. DDT, PCBs, dioxins and CFCs are persistent, i.e. they hardly decompose and remain for a long time in the environment. Organochlorines produced decades ago still circulate in the environment. In addition, they concentrate in the tissue of animals because they dissolve easily in fat. Furthermore they accumulate in the top of food chains as they move from animal to animal in a process called bio-accumulation.

**Figure 4.1 Biomagnification of PCBs**

![Diagram of biomagnification of PCBs](image)

An example of biomagnification is shown in figure 4.1. The concentration of PCBs in a top predator such as the hearing gull can be 25 million times greater than in the surrounding water. Even when the concentrations of PCBs in lakes are very low and cannot be measured, there may still be enough present to have a detrimental effect on hearing gulls and other top predators. Therefore small emissions may cause already high, detrimental concentrations at the top of the food chain. The environmental organizations call organochlorines ‘sneaking toxics’ (Greenpeace 1994).

Organochlorines transform easily during their stay in the environment due to the extreme reactivity of chlorine and it is possible that innocent emissions of organochlorines will transform in dangerous forms due to such reactions. The environmental organizations use the term ‘poisonous cocktail’ for chlorine and organochlorines to stress the reactivity and uncontrollability of chlorine22 (Berends and Stoppelenburg 1990: 1; Van der Naald 1994a).

**Precautionary principle**

The environmentalists believe that these hazards are the tip of the iceberg and they point out that little is known about the health effects of thousands of other compounds (Amato 1993). Research into each individual substance is not possible as the industry produces at least 11,000 different organochlorines (Greenpeace International 1995c: 70). Such an approach would take decades or longer and would involve high costs. Furthermore, effects of newly introduced chlorine substances may turn up only decades after use since it takes time before the persistent chemicals migrate up the foodchain and cause detrimental effects.

Environmental organizations are convinced that organochlorines are commonly the cause of problems (Amato 1993). This can be clearly seen in the European lists of black and grey substances23 that should be restricted or made illegal because of their adverse effects, 90 of the 129 substances listed contain chlorine (Berends and Stoppelenburg 1990: 29). The environmental organizations consider all the organochlorines to be toxic, persistent and biomagnifying substances until evidence to the contrary has been provided. A precautionary principle is adopted to give added protection to the environment (Alma 1990; Greenpeace 1994).

The environmentalists did not find it sufficient to combat organochlorine emissions with ‘end-of-pipe’ measures and improvements in the production process instead they aim to reduce emissions to zero, and zero means zero and not ‘almost zero’ (Allsopp 1994). ‘End-of-pipe’ technology is not suitable according to the environmentalists because it often only shifts emissions to another point in the environment. Dioxins and other toxics remain, for example, in the sludge of wastewater treatment installations (Berends and Stoppelenburg 1990: 23).

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22 The high reactivity of chlorine has made chlorine also a valuable, attractive chemical for the chemical industry.

23 The European Community adopted a list of black substances and gray substances in 1976 (76/464/EEG). Emissions of black substances into water, air or soil should become illegal. Emissions of gray substances into water must be restricted.
Even when preventive measures have an effect, this will not result in a reduction to zero emissions. Although resulting small emissions cannot be measured using standard testing methods, they are an important argument against the use of PVC for the environmental movement. These emissions are called ‘micro’s’ in the Dutch PVC discussion. In addition, incidents such as transport accidents, fires, and failure of installations may occur because man can not control the chlorine chain completely. The best solution is therefore to banish the element chlorine from industry. “If no chlorine goes in, none comes out” (Amato 1993).

The environmental organizations are not very positive about recycling PVC\textsuperscript{24} since the production of PVC will continue with all its environmental problems, and PVC will still end up as waste after a number of recycling cycles. Recycling of PVC is often not technically and economically feasible. It is especially difficult to recycle soft PVC products that contain plasticizers and products made from multiple materials.

\textit{Chlorine and PVC free society}

The environmental organizations aim at a change to a chlorine free society because this is the only way to achieve zero emission levels and to reduce the risks of chlorine completely. The environmental organizations also used the following arguments for the replacement of PVC (SNM 1993a; Van de Ven 1994c: 8-9):

- Substitution of PVC products is feasible. There are plenty of alternatives of a good quality at a good price, VMD listed the alternatives, see table 4.1.
- PVC products contain toxic, problematic additives such as heavy metals and phthalates and other plasticizers
- PVC contamination hampers the recycling of other plastics because HCl that is formed during the recycling of PVC corrodes the recycling equipment

Macro-economic effects such as effects on employment of a phase-out of PVC products are negligible or positive (Heerings and van Gelder 1996).

\textbf{Table 4.1 Overview of alternatives of PVC products}

<table>
<thead>
<tr>
<th>PVC Product</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>floor covering</td>
<td>linoleum, wood, etc.</td>
</tr>
<tr>
<td>packaging</td>
<td>polyethylene, polypropylene, PET, carton, paper paper</td>
</tr>
<tr>
<td>wall paper</td>
<td>polyethylene, polypropylene, glazed stoneware aluminum</td>
</tr>
<tr>
<td>piping</td>
<td>alternative plastics, carton</td>
</tr>
<tr>
<td>window frames</td>
<td>alternative plastics</td>
</tr>
<tr>
<td>foil (e.g. PVC files, roofing material)</td>
<td>leather</td>
</tr>
<tr>
<td>imitation leather, canvas</td>
<td>alternative plastics, stone, wood</td>
</tr>
</tbody>
</table>

Source: Adapted from Compaan 1992.

\textsuperscript{24} Based on interviews with environmental organizations.
The perceptions of the environmental organizations did not change significantly in the period 1989 to 1996. The precautionary principle was further expounded and effects of organochlorines on the hormone system were given greater prominence. The dioxin emissions produced by incinerators that were central to the argument at the beginning of the discussion in the 80’s relegated to the background in the 90’s.

4.3.3 Perception of the consumers association

The consumers association 'De Consumentenbond' (CB) serves the interests of consumers, informs consumers about products and services, and consults with governmental actors and industries\(^{25}\). The topics environment, food and health became the spearheads of the CB’s service in 1990. The association published an environmental memorandum (De Consumentenbond 1990) that contained an inventory of the main environmental concerns of its members. Consumers were very concerned about the large amount of unnecessary packaging and especially about the use of plastic packaging. These concerns form the background for the PVC campaign.

Since the PVC packaging campaign in 1989, the CB has promoted a reduction in the consumption of PVC. The description of the perception of the consumers association is based on articles published in its magazine ‘Consumentengids’ (De Consumentenbond, June 1989, January 1992, March 1994, May 1996), an article in the newsletter PVC en Milieu (Anonymous 1993b) and an interview. The CB advocates limiting the use of PVC because it has a number of adverse environmental effects:

- Use of energy sources to produce PVC
- Emission of organochlorines, mercury and asbestos during the production of chlorine
- Emission of toxic substances when PVC is dumped or incinerated
- Use of toxic additives in PVC products such as heavy metals and phthalates
- Risks of chlorine transport
- Adverse effect of PVC contamination on the recycling of other plastics

In general, good alternatives with a lower environmental burden are available according to the CB. PVC should not be used for products with a short use life, furthermore one should not use PVC products that are not recyclable.

In the middle of 1995, the CB took stock on its PVC viewpoint given that the PVC industry had implemented new environmental measures such as recycling, and decided to maintain its viewpoint that it is good to substitute PVC products from an environmental point of view (De Consumentenbond 1996: 327; Van Duin 1995a). The consumers association considered recycling of PVC to be positive for the environment, but that PVC recycling was

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\(^{25}\) The association ‘Konsumenten Kontakt’ that was involved the PVC packaging campaign, merged with ‘De Consumentenbond to form ‘De Consumentenbond’ (CB) shortly after the campaign.
less advantageous for the environment than recycling of other materials because it contributed less to energy savings.26

4.3.4 Perception of the chlorine and PVC industry

The Dutch producers of chlorine, PVC and PVC products were organized in a number of organizations:

- The Association of the Dutch Chemical Industry27 (VNCI) represented the chemical industry. Chlorine, vinyl chloride and PVC producers are affiliated to the VNCI among other chemical industries.
- The Dutch Federation for Plastic Producers28 (NFK). This branch association represents polymer producers, plastic converters and recycling companies. PVC producers of products of a hard nature such as piping, window frames are affiliated to the NFK.
- The Dutch Association of Elastomers and Plastic Converters29 (NVR). Polymer producers and plastic converters are members of this branch association. Producers of PVC products of a flexible nature such as floor covering are affiliated with this organization.
- Steering Committee for PVC and the Environment (SPM). Its members are drawn from the branch associations NFK and NVR, and from individual companies producing chlorine, PVC granulate, PVC products or recycling PVC.
- Association of Plastic Pipe Manufacturers in the Netherlands30 (FKS).
- Federation of Manufacturers of Plastic Doors and Windows31 (VKG).

These organizations and the individual companies involved in the PVC discussion have rather similar viewpoints on the PVC issue. The VNCI and the Steering Committee PVC & Environment are the main ‘speakers’ in the PVC discussion.

Perception of the chlorine and PVC industry

The description of the perceptions of the chlorine and PVC industry is based on publications put out by SPM, VNCI and individual chlorine-related companies in the magazine Nederlandse Chemische Industrie (NCI), the newsletter PVC en Milieu and elsewhere (Beerman and Nieuwenhuijsen 1994a and 1994b; Blanken 1995: Caesar 1992, Wesseldijk 1994: Nieuwenhuijsen 1995; VNCI 1993b; VNCI 1994a; VNCI 1994b; VNCI 1995a). The industry claims that a general phase out of PVC and most other chlorine-containing products is not necessary for environmental reasons. It based this claim on the following argument.

26 The energy savings are lower because PVC is made from oil and chlorine while PE and PP are only made from oil.
27 Vereniging van Nederlandse Chemische Industrie.
28 Nederlandse Federatie voor Kunststoffabrikanten.
29 Nederlandse Vereniging van Rubber- en Kunststoffabrikanten.
30 Vereniging van Fabrikanten van Kunststofledingsystemen.
31 Vereniging van Kunststof Gevelelementen Fabrikanten.
PVC is not wrong ‘per se’ due to the presence of a chlorine atom. Not all chlorine substances should be put in the same box. It is not justified to extrapolate the effects of certain chlorine substances to others because the chlorine family is heterogeneous (Amato 1993; Blanken 1995a). The toxic effects of DDT, a pesticide made to destroy insects, should not be generalized to PVC, a plastic. The relative large number of chlorine containing substances on the European gray and black lists do not signal the toxicity of chlorine. The large number is caused by the fact that chlorine is often used in the chemical industry. Approximately 60% of all the products produced are chlorine related: chlorine is used as a raw material or an auxiliary material.

The industry views the evidence on the environmental effects of organochlorines to be very uncertain. It calls the arguments of the environmental organizations ‘very uncertain hypotheses’ that do not form a rational basis for a change to a chlorine free industry (VNCI 1995). Greenpeace’s book ‘Our Stolen Future’ (Colburn et al. 1997) on the hormone disrupting effects of chlorine is judged to be emotional and misleading because sufficient proof to relate organochlorines to the disruption of the hormonal system is lacking (AKZO 1997b).

The industry argues that effects of organochlorines should be proved in a more conclusive, scientific way and advocates the use of separate risk assessments for each organochlorine. The industry considers the quantitative LCA methodology to be an excellent way to study PVC. According to the PVC industry, LCAs show that PVC’s environmental problems are comparable to those of PE, PP, glass and carton. Some environmental problems of PVC products are a little bit worse but PVC products are better in other aspects. PVC products usually require less energy and scarce raw materials to produce than other plastics. Substitution of PVC will not bring environmental improvement along. The environment is better served by improvement measures such as recycling, improvement of incineration, and substitution of the asbestos diaphragms used in chlorine production.

Additional arguments
The PVC and chlorine industry disputes a number of specific arguments of the environmental organizations about releases by the PVC chain. They state that the current emissions of dioxins in garbage incinerators will not decrease when PVC is no longer used. Chlorine transport is safe because no transport accidents involving chlorine have occurred in the last 45 years and severe safety measures are applied (AKZO 1992). In addition, industry often points to the economic and social value of PVC and chlorine products. The large Dutch chlorine and PVC industry provides employment for many people. PVC and other chlorine related products improve the quality of life for their consumers. A spokesman for the VNCI said ‘without chlorine, we would sit naked in the moors’ (VNCI 1993a: 4).
4.3.5 Perception of the Ministry of Economic Affairs

The Directorate General of the Industry (DGI) of the Ministry of Economic Affairs (EZ) is involved in the PVC discussion. The Ministry of EZ supports the view put forward by the Chlorine and PVC industry (Smit et al. 1994)\textsuperscript{33}. The Ministry was of the opinion that the environmental burden of PVC is not very large as LCAs have shown that the burden of PVC products is comparable to other products. Product oriented measures are therefore not justified. These will only be justified if it has been proven that PVC has considerable environmental effects.

4.3.6 Perception of the Ministry of the Environment

The Directorate General for Environmental Protection (DGM) of the Ministry of Housing, Spatial Planning and the Environment (VROM) was responsible for the Dutch national environmental policy on PVC and chlorine\textsuperscript{35}.

\textit{Perception 1989-1994}

At the outset of the PVC discussion, the Ministry of the Environment shared the concerns of the environmental organizations about dioxins and the incineration of PVC. Emissions of organochlorines in the production and consumption phase were not considered to be a problem as they remained below the official standards. The Ministry wanted to solve this dioxin and incineration problem by:

- Reducing the production and consumption of PVC products with a short use life
- Recycling PVC products with a long use life

The Ministry evaluated the phase out of PVC by “market forces” as positive (Mot 1990) and recommended that the use of PVC office supplies be avoided in its information brochures for companies.

Gradually, the Ministry replaced the distinction between PVC with a long use life and a short use life by that of recyclable and non recyclable PVC\textsuperscript{36}. In 1994, the official viewpoint of the Ministry was (Brugman 1994)\textsuperscript{37}:

- No general prohibition of PVC products
- Diminish the use of PVC packaging (in accordance with the covenant on packaging)

\textsuperscript{32} Directoraat Generaal Industrie.
\textsuperscript{33} This is also clear from the interview with the EZ representative.
\textsuperscript{34} Directoraat-Generaal Milieubeheer.
\textsuperscript{35} The following directorates of DGM were involved in the design, formulation and implementation of PVC policies: the Directorate of Waste (Directie Afvalstoffen), the Directorate of Industry, Products and Consumer Policy (Directie Industrie en Consumentenbeleid, IC), and the Directorate of Chemicals, External Safety and Radiation Protection (Directie Stoffen, Veiligheid en Straling, SVS).
\textsuperscript{36} Interview with a VROM respondent, see appendix 4.
\textsuperscript{37} Letter to city-councils who turned to the Ministry for advice during the PVC free council campaign of Greenpeace.
• Diminish the use of PVC products that can not be recycled
• Stimulate reuse and recycling of PVC products

Reconsideration and results
In 1994, the Ministry took stock of its viewpoint because the administrators of the Ministry were no longer sure if they had sufficient reasons to restrict the use of PVC products. The Advertising Code Authority38 (RCC) had judged that the Ministry should not advise the general public to avoid PVC office supplies because the environmental problems of PVC were not proven. A number of new dioxin reports were a second reason to take stock of the PVC policy.

The emissions of dioxins produced by the incineration of PVC were an important reason to restrict the use of PVC products for the administrators of the Ministry. It became clear, however, that these emissions could be also reduced by improving combustion technologies. Therefore, the administrators considered restriction of the use of PVC viable only when the costs of the additional combustion technologies used to reduce dioxin and HCl problems were high or when the dioxins that remained in the slags after combustion had an adverse effect on the environment. Restriction of the use of PVC was also thought to be necessary when the effects on health of heavy metals and phthalates that are added to PVC products were large.

As the Ministry was in doubt about the nature of these problems and needed additional arguments for its PVC policy, it commissioned research projects on the:
• Environmental effects of dioxins in slags
• Costs of additional combustion technologies to reduce the dioxin and HCl problems
• Environmental effects of additives, e.g. phthalates39

At the end of 1995, the Ministry became concerned about two other aspects of the use of PVC products: the small emissions of organochlorines with a toxic, persistent and biomagnifying nature (chlorine micro’s) and the effects of organochlorines on the hormone system (Didde 1995: 15)40.

4.3.7 Conflicts between perceptions
The key conflicts between the actor groups that have been in constant discursive struggle about the desired PVC policy in the Netherlands since 1989 are of interest. The arguments of the environmental movement, the consumers association and the Ministry of the Environment focus on the environmental problems of the PVC chain whereas the industry and the Ministry

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38 Reclame Code Commissie.
39 Interview with referents, see appendix 4.
of Economic Affairs have focused on making a comparison between PVC products and their alternatives.

The environmental organisations and the PVC- and chlorine industry did not agree on the following issues related to the environmental aspects of PVC:

- The relationships between the incineration of PVC and the emission of dioxins
- The feasibility of PVC recycling
- The risk of transport and fire accidents
- The standards that should be applied to persistent, toxic and biomagnifying chlorine’s (zero or almost zero)
- The toxic effects of organochlorine emissions
- Hormonal mimicking effects of plasticizers and organochlorines
- Availability of suitable, environmentally friendly alternative products
- The controllability of the use of chlorine

The conflict between the environmental organizations and the PVC and chlorine industry is based not only on the level of the environmental burden produced by the use of PVC but also on the kind of evidence on which actions against PVC or other products should be based. The industry argues that effects of organochlorines should be proved in a decisive way and advocates the use of separate risk assessments for each organochlorine and the use of quantitative, objective LCAs. Conversely, environmental organizations advocate the application of a precautionary principle, and generalize effects known from exemplary biological studies of specific organochlorines to other organochlorines. The two groups advocate different ways to manage uncertainty.

The Ministry of Economic Affairs has more or less the same ideas about the required evidence as the PVC and chlorine industry; conclusive evidence is required and the use of LCAs is appreciated. The policymakers of the Ministry of the Environment find it important to conduct additional scientific studies on specific issues, e.g. dioxins, phthalates. This shows that the Ministry of the Environment wants to base its policy on scientific studies, as does the PVC and chlorine industry. Yet, the Ministry of the Environment wants to reduce toxic emissions of the PVC chain as much as possible, even when effects are not fully proven.

4.4 LCAs: neutral or political?

LCAs were used extensively to support the Dutch discussion regarding the viability of PVC. The focus of this section is on the following question: ‘How neutral were LCAs in the conflict on the height of the environmental burden of PVC?’. This question is approached in the following way. The involvement of network actors in Dutch LCA projects regarding PVC products is described in section 4.4.1. A description of the conceptualization of the PVC issue used in LCAs is given in 4.4.2 and related to the conceptualizations of the environmental
organizations and the chlorine and PVC industry. Section 4.4.3 contains conclusions about the position of LCAs in the PVC discussion.

4.4.1 Involvement of network actors

Since 1989, many LCAs have been conducted that compare PVC products with alternative products in the Netherlands. A list of recent LCAs is provided in table 4.2, stating client(s), additional study sponsor(s) and members of the steering committee of LCAs on PVC. The list is not complete because LCAs often belong to the gray literature or the reports are confidential.

**Table 4.2 Organization of Dutch LCAs of PVC products**

<table>
<thead>
<tr>
<th>Commissioners</th>
<th>Product</th>
<th>Client</th>
<th>Steering Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gastec and CML</td>
<td>Gas pipes</td>
<td>Gastec, Center of Gastechnology¹</td>
<td>None</td>
</tr>
<tr>
<td>(Berg van den et al. 1996a and 1996b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. INTRON (INTRON 1995a and 1995b)</td>
<td>Sewage pipes</td>
<td>Branch association of concrete pipe producers (VPB)²</td>
<td>None</td>
</tr>
<tr>
<td>3. FKS (FKS 1995)</td>
<td>Sewage piping</td>
<td>Branch association of plastic pipe producers (FKS)</td>
<td>None</td>
</tr>
<tr>
<td>4. W/E Consultants Sustainable Building (Anink 1996, SEV 1995)³</td>
<td>Window frames, piping, and other products for the building sector</td>
<td>The Netherlands Steering Committee for Experiments in Public Housing (SEV)⁴</td>
<td>None</td>
</tr>
<tr>
<td>5. TAUW Milieu BV</td>
<td>Roof gutters</td>
<td>Governmental water institute (RIZA)⁵</td>
<td>Not known</td>
</tr>
<tr>
<td>(De Rijke and Korenromp 1994)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. W/E Consultants Sustainable Building (SEV 1993)</td>
<td>Window frames, piping, and other products for the building sector</td>
<td>SEV</td>
<td>None</td>
</tr>
<tr>
<td>7. Draka Polva</td>
<td>Ring binders</td>
<td>Producer of PVC and PVC products (Draka Polva)</td>
<td>None</td>
</tr>
<tr>
<td>(Beenen and Eygelaar, 1993)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Utrecht University, NW&amp;S⁶</td>
<td>Floor covering</td>
<td>Science shop at Utrecht University</td>
<td>None</td>
</tr>
<tr>
<td>(Potting and Blok 1993 and Potting 1994)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Additional information about the commissioners, clients, steering committee is provided in the endnotes.
| Table 4.2 Organization of Dutch LCAs of PVC products and outcomes (supplement) |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| 9. IVAM (Hoefnagels et al., 1992)\(^{xii}\) | Window frames | VROM | VROM-DGVH VROM-DGM Association of plastic window frame producers VKG\(^{xiii}\) Association of metal window frame producers VMR\(^{ix}\) Association of Wood Association of suppliers to the building industry NVTB\(^{xii}\) |
| 10. KIWA\(^{xiv}\) and CREM\(^{xv}\) (Verspeek et al. 1992) | Pipes | Association of water companies (VEWIN)\(^{xv}\) | Water companies KIWA CREM |
| 11. Engineering Consultancy Pré (Goedkoop and Volman 1991) | Sewage pipes | Government Buildings Agency (RGD)\(^{xvi}\) Local housing association | Clients and independent scientists |
| 12. McKinsey & Company, CML, RIVM and PVC and chlorine industry (VNCl 1991) | Window frames | Association of the Dutch chemical industry (VNCl), VROM and EZ | VNCl EZ VROM Chemical companies related to the PVC chain University of Amsterdam\(^{xvii}\) |
| 13. CML (Lindeijer et al.1990) | Window frames | Client: Association of plastic window frame producers VKG. Additional sponsor: VROM-DGM | VROM-DGM\(^{xviii}\) Association of plastic pipe producers NFK\(^{xx}\) Association of metal and electronic producers FME\(^{xx}\) VKG Consultancy CEA\(^{xxi}\) |
LCAs of PVC were made by universities, scientific institutes, consultancy firms, producers of PVC products and on one occasion by an organization that used PVC products or their alternatives. Most LCAs were carried out by relatively independent organizations. The LCAs carried out by the producers of PVC products, numbers three and seven in table 4.2, are an exception. The LCAs had a quantitative nature except for the studies made for the Netherlands Steering Committee for Experiments in Public Housing (SEV).

Table 4.2 shows that most LCAs were commissioned by actors involved in the public discussion on PVC or by organizations consuming products who wanted to use environmentally friendly products. The study carried out by Potting, number 8 in the list, is an exception since a university initiated it. Two additional Dutch studies contain judgments on PVC on the basis of an overview of LCAs: the study of Smit et al. (1994) on PVC packaging commissioned by the Ministry of Economic Affairs and the study of Van Duin (1995a) on PVC for the Dutch Consumers Association.

Network actors were also involved in LCA study processes as members of steering committees. The clients and/or members of steering committees can be categorized in five groups:

- Ministries: The Ministry of the Environment was involved in four studies (no. 9, 11, 12, and 13), and the Ministry of Economic Affairs in one study (no. 13), and a governmental water institute that belongs to the Ministry of Transport, Public Works and Watermanagement in one study (no. 5).
- The chlorine and PVC industry was involved in five studies (no. 3, 7, 9, 12, and 13)
- Producers of alternative materials or their branch associations were involved in three studies (no. 2, 9, 13)
- Institutional consumers of PVC products were involved in three studies\(^{42}\) (no. 1, 10, and 11)
- The Netherlands Steering Committee for Experiments in Public Housing\(^{43}\) (SEV) was involved in two study projects, many PVC products were studied in each project.

Environmental organizations were invited to take part in a number of studies but rejected these invitations, e.g. the study on PVC window frames (VNCl 1991)\(^{44}\).

Network actors were also involved as technical experts who advised and supported LCA analysts. These technical experts provided information on the production, consumption and waste management processes and gave advise on methodological choices in a number of cases. The background of these experts is a point of interest. They come mainly from

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\(^{42}\) Gastec, VEWIN, and the local housing association buy and use respectively, gas pipes, sewage pipes and building products.

\(^{43}\) Stuurgroep Experimenten Volkshuisvesting.

\(^{44}\) One might say that the environmental organizations were involved in the VNCl (1991) study on PVC window frames; however the environmental organizations did not take part in this study. A scientist affiliated with the environmental organizations took part in the steering group of this study but he did not represent the environmental organizations.
companies involved in the production of the product studied and from related branch associations. The Gastec study project on pipes of different materials is an example; Producers of raw materials, producers of pipes of different materials, Steering committee for PVC and the Environment, the KIWA institute, an energy distribution firm and a building contractor all provided data on products and production processes, evaluated the quality of the data and advised the study conductors about the LCA methodology (Van den Berg et al. 1996a: 12). The SEV project is an exception: the consultancy W/E had hardly any contact with the producers and contacted mainly organizations involved in experiments on sustainable building. LCA conductors sought advise from independent experts. In general, environmental and consumer organizations were not involved as experts in studies.

LCA conductors, clients or steering committee’s often asked actors involved in the PVC discussion for reactions to concept texts. For example, companies that produced pipes and an environmental science professor strongly affiliated with environmental organizations commented on the draft report on pipes made by CREM and KIWA (no. 10) and influenced the final report in this way.

Concluding, network actors were involved in many LCA study projects on PVC as clients, steering committee members and experts, however, they were not equally involved. Representatives of the chlorine and PVC industry were most frequently involved. The Ministry was involved in a number of ‘early’ PVC studies but not in later ones. This might be related to the lowered expectations with respect to LCAs on PVC. The Ministry of Economic Affairs and the Consumers Association were involved in a few studies. The environmental organizations did not commission LCAs and refused to take part in steering committees.

4.4.2 Effect of actor involvement on LCAs outcomes

Network actors that were involved as clients and steering committee members may have influenced the methodological choices described in chapter three that have to be made when conducting LCAs. Outcomes of LCAs may correspond to the ideas of the network actors involved.

The conclusions of studies commissioned or steered by the PVC and chlorine industry are shown in table 4.3. Two studies in which only the PVC industry was involved, were positive about the PVC alternative and considered it as a good alternative (Beenen and Eygelaar 1993; FKS 1995). Two studies on window frames that were steered by producers of frames made from different materials abstained from ranking because this would require normative judgements on the relative value of different environmental goals (Hoefnagels et al. 1992; Lindeijer et al. 1990). The VNCI study, in which participants from VROM and other organizations were involved, concluded that the use of wooden frames was better for the environment but also indicated that this conclusion was very uncertain.
Table 4.3 Conclusions on PVC products of studies commissioned or steered by the PVC and chlorine industry

<table>
<thead>
<tr>
<th>Study</th>
<th>Conclusions on PVC products</th>
<th>Presence of commissioners and steering committee members that are not from the PVC and chlorine industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beenen and Eygelaar 1993</td>
<td>A PVC ringbinder is the second best alternative. It is an acceptable alternative that had only a slightly higher environmental burden than the ‘best’ ringbinder.</td>
<td>No</td>
</tr>
<tr>
<td>FKS 1995</td>
<td>The environmental burden of PVC pipes does not differ remarkably from its alternatives.</td>
<td>No</td>
</tr>
<tr>
<td>Hoefnagels et al. 1992</td>
<td>The order of merit of frames from different materials is not determined.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lindeijer et al. 1990</td>
<td>Each window frame has the highest score on at least one of the environmental criteria. It is not possible to draw conclusions about the order of merit of the frames analyzed.</td>
<td>Yes</td>
</tr>
<tr>
<td>VNCI 1991</td>
<td>The use of wooden frames is environmentally more attractive than the use of PVC frames. This conclusion was qualified as uncertain.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Producers of alternative products that may replace PVC were involved in three LCAs. As mentioned before, the studies steered by producers of window types of different materials did not rank the products (Hoefnagels et al. 1992; Lindeijer et al. 1990). The INTRON study commissioned by a branch association for concrete producers is a reaction on the FKS study and concluded that concrete pipes were environmentally more attractive than PVC and glazed stoneware ones.

The general conclusion is that when producers of products commission or steer an LCA study project, the resulting reports either:

- abstain from ranking
- conclude that all products have more or less the same environmental burden
- state that the environmental burden of the product of the client or steering committee member is relatively low
- qualify conclusions that are negative for the client or steering committee member as uncertain

LCAs were also commissioned and steered by actors that did not have a direct interest in the study outcomes. These are the LCAs commissioned by the Ministry of the Environment, RIZA, Science shop, institutional consumers, and the SEV that advises institutional
consumers (no. 1, 4, 5, 6, 8, 10, and 11). The Ministry of the Environment did not have an interest in specific outcomes nor did it have a specific opinion on the environmental viability of PVC beforehand as it wanted to judge PVC products on a case-by-case basis. The other organizations did not have an interest in positive outcomes for a specific product.

The conclusions drawn in the 7 LCAs did not point systematically in a certain direction:

- Three studies were rather negative about PVC (Goedkoop and Volman 1991, SEV al. 1993; 1995)
- The Gastec study considered PVC to be an environmentally acceptable alternative (Van den Berg et al. 1996a)
- The study commissioned by the association of water companies did not rank the products (Verspeek et al. 1992)
- The study commissioned by a governmental institute for waste water treatment and watermanagement did not rank products and only drew negative conclusions about zinc pipes (De Rijke and Korenromp 1994)
- The study of the Science shop concluded that linoleum had a lower environmental burden than PVC and two other alternatives (Potting and Blok 1993)

At first sight, these studies seem to be neutral adjudications in the discussion between the PVC and chlorine industry and the environmental organizations. The SEV studies that concluded that PVC products had in general a high burden however used more or less the same arguments as the environmental organizations. Producers of PVC and chlorine were able to influence the results of the Gastec and VEWIN study because they functioned as technical experts.

4.4.3 Conceptualization in LCAs in relation to the conflict on PVC

The LCAs on PVC determined scores on a number of environmental criteria. The way the ecotoxicity score has been determined is especially interesting because differences in views on the toxicity effects of the PVC chain are central in the PVC discussion. The different evaluations of toxicity are caused by the different opinions on the following topics:

- The risk of transport and fire accidents
- The validity of the generalization of toxic effects of dioxins etc. to the complete class of organochlorines
- The standards that should be applied to persistent, toxic and biomagnifying organochlorines (zero or almost zero)
- Adverse effects of phthalates and organochlorines on hormonal systems

45 The policymakers of VROM did not make general claims on the environmental burden of PVC and were not sure about the need to replace PVC as they did not have a clear insight into the environmental burden of PVC, see section 4.3.
46 English version: Anink 1996.
The value of a precautionary principle
The controllability of chlorine

The toxicity scores and other results of LCAs are not neutral because they are based on a specific conceptualization of the environmental issues of PVC. This conceptualization differs remarkably from the environmentalist's conceptualization. These differences concern: dealing with uncertainty, transformation, persistence, additives, transport and other risks, and evaluation of toxicity scores. These differences are shown in Table 4.4. Only the SEV studies where a more qualitative approach was followed used a conceptualization that resembled the environmentalist's perception.

<table>
<thead>
<tr>
<th>Table 4.4 Conceptualization of the environmental burden of PVC used for the LCA methodology versus the conceptualization of the environmental organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LCA methodology and PVC LCAs</strong></td>
</tr>
<tr>
<td>Does not consider uncertain toxic effects</td>
</tr>
<tr>
<td>Neglect transformations of organochlorines in the environment.</td>
</tr>
<tr>
<td>Consider all emissions to be equally persistent. In addition they assume that all the emissions are spread homogeneously over the globe and its inhabitants.</td>
</tr>
<tr>
<td>Most Dutch LCAs on PVC do not include the environmental effects of additives because it is very hard to calculate these.</td>
</tr>
<tr>
<td>Most Dutch LCAs on PVC include neither transport risks, fire hazards, and other accidents nor their effects.</td>
</tr>
<tr>
<td>Consider products with a high toxicity score acceptable when scores for other themes were low as they applied multi criteria analyses.</td>
</tr>
</tbody>
</table>

The network actors had different ideas about the kind of evidence needed on the toxicity of organochlorines emitted by the PVC chain (see section 4.3.7). The PVC and chlorine industry and other actors emphasize the need for conclusive, formal evidence whereas the environmental organizations argue that the precautionary principle should be applied. This results in a different treatment of uncertain effects. The way the LCA methodology deals with uncertain effects resembles the conceptualization of the PVC and chlorine industry. Uncertain and unquantifiable toxic effects are not considered as an argument against the use of a product:
The indicators for the toxicity of substances used in impact assessment models were based only on evidence with a certain nature (Tesh 1993). LCAs toxicity models have been based on standard western epidemiological research approaches and results. These practices all start from the assumption that the environment is healthful and the scientists task is to look for the opposite (Tesh 1993: 9). The research starts with a negative hypothesis, viz.: there is no relationship between the emission and disease (Tesh 1993: 10). To conclude for the opposite, i.e. the existence of a relation, a very high level of certainty is required. The general rule is that you must show statistically that no more than a five percent probability exists that your findings could be the results of chance. In other words, epidemiologists must be 95% sure of their data.

The toxicity indicator of a specific organochlorine was based only on studies into this organochlorine. Effects of dioxins, DDT, etc. were not generalized to other organochlorines.

LCAs tended to ignore environmental effects that could not be quantified. Ecoprofiles contained only quantifiable, hard effects and not qualitative, uncertain ones such as effects of chlorine micro’s, hormonal mimicking effects or risks of chlorine transport. Unquantifiable effects were not a reason to rank a product higher or lower but only put on a list for further research.

Uncertainties were used to abstain from ranking products or to put conclusions into perspective.

The conceptualization in LCAs differs also in other ways from the environmentalist one. LCAs neglect the transformation of organochlorines in the environment and considers all substances equally persistent. This has no other reason than the fact that quantitative models that take these aspects into account were not available and standard handbooks contain models that ignore these aspects. The effects of additives in the production phase were not included because these are hard to calculate as PVC and other products contain often little amounts of a huge variety of additives.

Transport and other risks were not included in the LCAs because this aspect is not part of the standard LCA approach. The application of multi-criteria analyses in the LCAs on PVC leads to compensation of high ecotoxicity scores by low scores on other aspects. The environmental organizations, however, consider products that are rather toxic as unacceptable, irrespective of other aspects.

Those working on the LCAs choose to apply the standard LCA methodology and ecotoxicity models in an instrumental way. They presented scores on toxicity without a discussion on the key conflicts. Even LCAs that appeared in 1996 and 1995 did not do this while issues such as the precautionary principle and generalization had been intensively discussed for a number of years (Alma 1990; Greenpeace 1993; Amato 1993). The conceptualization used in LCAs is barely described verbally. It is only implicitly present in the chain pictures, impact assessment models and evaluation models and other aspects of the methodological framework.
4.4.4 Conclusions on LCAs neutrality

The LCA methodology and LCAs on PVC have a political nature and do not function as neutral adjudicators in the PVC discussion. It is important to realize that LCA methodology and studies took a pre-assumed position in the conflict in favor for the PVC and chlorine. The conceptualization of the PVC issue resembled the perception of the PVC and chlorine industry due to the emphasis on formal, quantitative proof of environmental burdens. LCAs were also not neutral because network actors were involved in study projects and able to influence the outcomes of LCAs as they advised analysts on choices to be made. Finally, the use of an LCA methodology honored the PVC and chlorine industry’s request to use LCAs whereas environmental organizations were not positive about the use of LCAs on PVC in public discussions (Venner 1993).

4.5 Using LCAs in the PVC discussion

The way actors used outcomes and other elements from LCAs in the PVC discussion is explored in this section. First, the use of a study into pipes is described as an example (4.5.1). The use of conclusions drawn in PVC LCAs is described in section 4.5.2. The conceptual use of PVC LCAs is described in section 4.5.3.

4.5.1 An example: the ‘Pré’ study

In 1990, the Ministry of the Environment, the Government Buildings Agency (RGD) and a local housing association commissioned the engineering consultancy Pré to compare the environmental burden of PP, PE and PVC piping (Boons 1995: 156-157). The ‘Pré’ study was published in May 1991 and concluded that PVC had a higher environmental burden than its alternatives PP and PE (Goedkoop and Volman 1991).

The Steering Committee PVC & Environment (SPM) reacted immediately to the conclusions of the ‘Pré’ report. The SPM wrote a memorandum in which it pointed to the many limitations of the used LCA methodology and the lack of availability of good information. The SPM criticized a number of statements of the Pré report on the basis of the scientific literature and argued that it was impossible to draw reliable conclusions on the ranking of the piping alternatives. Additional research was required. In October 1991, the SPM asked the Ministry of the Environment to stop the publication of the ‘Pré’ report because it was used to advocate the use of pipes from PE and PP and to abstain from using PVC pipes (Boons 1995: 157).

The report was used by the environmental organizations to support their arguments when asking the Minister to prohibit PVC piping mid 1991 (Boons 1995: 157). They also used the information from the ‘Pré’ report in the campaign against PVC piping in 1993. In this campaign, environmental organizations asked housing associations, building
cooperations, local governments and other organizations not to use PVC pipes (SNM 1993a; SNM 1993b).

4.5.2 Using rankings and ecoprofiles
Many LCAs appeared after the ‘Pré’ study and were used during the PVC discussion. A general pattern can be noticed in the behavior of network actors\textsuperscript{47}. The PVC and chlorine industry used LCAs that were positive about using PVC in the following way:

- They referred to the ranking or conclusions on the environmental burden of PVC.
- They emphasized the objective and scientific qualities of these conclusions.
- They emphasized the independent nature of the study. For example, they mentioned that the Gastec study has been conducted by an organization using piping materials that had no specific interests in the use of PVC. They also stated that the Ministry of the Environment was positive about the quality and reliability of the Gastec study.

The chlorine and PVC industry also used LCAs that did not draw final conclusions on the environmental merit of products to support their claim that the use of PVC was environmentally viable. The PVC and chlorine industry argued that the Belgium VITO\textsuperscript{48} study (De Baere et al. 1994a and 1994b) had proven that replacement of PVC with other materials was not necessary because the researchers were not able to rank the products studied and had no preference for a specific product\textsuperscript{49}.

The environmental organizations referred especially to LCAs that concluded that other products were better for the environment than PVC, e.g. they referred to the ‘Pré’ study. Reports made for the Ministry of Economic Affairs and the Dutch consumers association referred to LCAs on PVC packaging material (Smit et al. 1994; Van Duin 1995a). The Ministry of the Environment often mentioned the diverging outcomes of LCAs.

In general, actors acted as critics when references were made to LCAs that were not in line with their ideas. This can be illustrated by the following discussion between representatives of the environmental organizations and the PVC and chlorine industry observed at a workshop on PVC\textsuperscript{50}:

\textit{Actor A: There are many LCAs that indicate that alternative plastics are better for the environment.}

\textit{Actor B: We do not consider these LCAs to be evidence, they are assumptions. LCAs also provide opposite results.}

\textsuperscript{47} The description of this pattern is based on articles in magazines written by representatives, interviews and on a discussion between actors (Workshop PVC and the Environment at the TUD, see appendix 6).

\textsuperscript{48} Vlaamse Instelling voor Technologisch Onderzoek.

\textsuperscript{49} The title of an article in Chemisch Weekblad (Anonymous 1994a) runs as follows ‘Belgium researchers do not declare a preference for glass or PVC. A Belgium research project has shown that there are not environmental arguments for the choice between glass, PET or PVC as packaging for mineral water’ (Translated from the Dutch).

\textsuperscript{50} Workshop PVC, TUD, see appendix 6.
Actor A: And these opposite LCAs are regarded as authoritative?
Actor B: A change to alternatives needs to be justified and this is very difficult using LCAs.

The following arguments were used in the PVC network to reject conclusions of LCAs. The first one is that studies into the same products draw different, conflicting conclusions. A second argument is related to the methodological shortcomings and the low data quality51. A third argument is related to the social aspects of the study process. Actors say that the results are not trustworthy because commissioners or members of the steering committee have vested interests in the outcomes and may have manipulated the outcomes. Representatives of the Ministry of the Environment said that they could not accept outcomes of studies made only by producers of a specific materials, e.g. the study made by the branch association of plastic pipe manufactures (FKS 1995) and the one made for the branch association of concrete pipe manufacturers (INTRON 1995).

References to LCAs did not resolve the ‘Yes! No!’ discussion about PVC and led to new polarized discussions about the quality of the LCAs. These discussions contributed little to an increased insight into the environmental burden of PVC products and their alternatives nor did they lead to a consensus on required PVC policies. They did, however, clarify the difficulties in drawing authoritative, broadly supported conclusions on PVC.

4.5.3 Using other information from LCAs

LCAs provide more than outcomes, rankings and ecoprofiles, alone. They provide terminology, models and arguments on sub-aspects. Actors may learn from these elements and use them to get better insight into the background of the claims made by the LCA studies on the PVC issue. This ‘conceptual’ use of LCAs may in turn improve the quality of the discussion on PVC and its environmental burden.

Network actors however made little reference to insights gained from LCAs other than outcomes. They did not use information from LCAs to discuss their key conflicts on the environmental aspects of PVC and the kind of policy needed. In addition, network actors were often not able to understand the true value of the LCA results even when reports described the methodology used extensively. One needs to study the formal and quantitative methods used in detail and needs to understand the ideas underlying these methods to interpret the results. For example, a number of LCAs based their weight factors on the ‘Distance to Target’ method. It takes some time before one understands what this implies, e.g. that not achieving the political targets for climate change is just as bad as not achieving the targets dealing with acidification even when the targets for acidification are more ambitious or when acidification is a relative minor environmental problem.

51 For example, Greenpeace criticized the choices and assumptions that had been made in the Belgium VITO study (Baere et al. 1994a and b) and stated that these choices discriminated PVC (Anonymous 1994a).
4.6 The use of ‘Chlorine Balance’ in the design of chlorine policies

The study ‘A Chlorine Balance for the Netherlands’ (Tukker et al. 1995a, 1995b, 1995c, Kleijn et al. 1997a) investigates the environmental impacts of the chlorine chain. The environmental aspects of PVC are part of this investigation. The study is not a product evaluation since it focuses on a sector but it is conducted in conformation with the LCA methodology. The study was initiated by the Ministry of the Environment and used by this Ministry to formulate a new Dutch chlorine policy. The ‘Chlorine Balance’ case shows how actors may win a political discussion using LCAs results. The study process and reports are described in section 4.6.1 and 4.6.2. The policy proposal of the Minister of the Environment based on the ‘Chlorine Balance’ is clarified in 4.6.3. The discussion on this policy proposal and the ‘Chlorine Balance’ is depicted in 4.6.4 and 4.6.5. The overall conclusions are drawn in section 4.6.6.

4.6.1 Organization of the study process

Environmental organizations were concerned about the effects of organochlorines and proposed the use of chlorine related products should be phased out. These concerns reached the members of the Standing Committee of Housing, Spatial Planning and Environment of the Dutch parliament (Standing Committee of VROM)52. One of these members53 asked the Dutch Minister of the Environment, Alders, to conduct an inquiry into the problems of using chlorine (Tweede Kamer 1993). The Minister honored this request.

The directorate of Chemicals, External Safety and Radiation Protection (SVS) of the Ministry of the Environment made a proposal for the set up of the study project (VROM 1993a) and wanted to start with an inventory of the “leaks”, emissions and waste products, of the chlorine chain. This problem identification would form the basis for research into potential policy measures.

The Ministry wanted to conduct the study into the chlorine chain in cooperation with the chlorine industry and the environmental organizations in order to get broad support for the study process and its results. The industry was at first suspicious but decided to take part in the steering committee for the Chlorine study in August 1993. The environmental organizations did not accept the invitation because they did not agree with the goal and study scheme. The SNM who represented Greenpeace Netherlands, VMD, ZHM and the Waddenvereniging said that the environmentalists’ goal was to phase out chlorine related products and that they did not see this goal reflected in the study scheme54. The organization of the study project ‘Chlorine Balance’ is described in table 4.5.

52 De Vaste Commissie voor Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer van de Tweede Kamer der Staten Generaal.
53 Mrs. Van Rijn-Vellekoop (PVDA).
The LCA study does not compare different products but identifies the problems of the chlorine chain. The CML methodology was used. The three main study commissioners\(^{55}\) met frequently with the steering committee. After approximately 2 years of work, CML and TNO finished the final draft of the study. A peer review panel commented on the content of the report and the presentation of its conclusions. The peer review report (Corten 1995) was used to adapt the report which appeared in November 1995 (Tukker et al. 1995a, 1995b, 1995c).

**Table 4.5 The organization of the study project ‘Chlorine Balance’**

<table>
<thead>
<tr>
<th>Clients</th>
<th>Ministry of the Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ministry of Economic Affairs</td>
</tr>
<tr>
<td></td>
<td>Ministry of Transport, Public Works and Water Management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steering Committee</th>
<th>Ministry of the Environment (3 representatives)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ministry of Economic Affairs (1 representative)</td>
</tr>
<tr>
<td></td>
<td>Ministry of Transport, Public Works and Water Management (1 representative)</td>
</tr>
<tr>
<td></td>
<td>The chlorine and PVC related industries(^ {56}) (4 representatives)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commissioners</th>
<th>Center of Environmental Science Leiden (CML) and Netherlands Organization for Applied Scientific Research (TNO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methodology</td>
<td>CML methodology 1992 and a number of new methods(^ {57})</td>
</tr>
<tr>
<td>Peer review panel</td>
<td>universities (3 members) and a consultancy (1 member)(^ {58})</td>
</tr>
</tbody>
</table>

Source: Tukker et al. 1995a: 8, 1995c: B/41

### 4.6.2 Conclusions and presentation

The ‘Chlorine Balance’ reports presented conclusions about the environmental burden of the chlorine chain, about the most polluting parts of the chain and about a number of problematic emissions. The reports conclusions are shown in table 4.6. The researchers were not able to determine the terrestrial ecotoxicity scores because adequate quantitative models were not available. The normalized burden of the chlorine chain in 1990 and the normalized environmental burden of this chain after the implementation of new policies that had been fixed before the reference date of January 1st 1995 were calculated. It is not clear when these policies will be realized. It should be noted that the scores of the chlorine chain are in both cases normalized against the total Dutch environmental burden in 1990. The results after implementation of new chlorine policies might look less positive when the total Dutch industry also reduces its environmental burden.

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\(^{55}\) Tukker, A. (TNO), R. Kleijn (CML) and E. v.d. Voet (CML).

\(^{56}\) Shell Nederland, Solvay Chemie B.V., Akzo Nobel, and Dow Europe N.V.

\(^{57}\) For example the distance-to-target method (Tukker et al. 1995a: iv).

\(^{58}\) From the University of Amsterdam (Govers), University of Wageningen (Koeman), a retired professor public relations (Van der Meiden) and a consultant from Centre for Energy Conversation and Environmental Technology (CE).
The conductors of the study did not draw conclusions from the table but suggested the study users should compare the results with a score of 0.4% because the chlorine chain produced 0.4 weight/weight % of the total Dutch production in 1990. When a score exceeds 0.4%, the chlorine chain pollutes more than the average Dutch product. The use of this rule would for example result in a negative evaluation of the scores for the greenhouse effect, ozone depletion and ecotoxicity, and in a positive evaluation of the scores on the other environmental impacts. During the study process, it became clear that the results on ecotoxicity and human toxicity were rather uncertain. For this reason, an additional analysis for all substances that had a relatively high contribution to the two toxicity scores was carried out and the study concluded that PER, DCM, chloroform and dioxins exceeded the governmental defined maximum permissible risk levels (MTR\textsuperscript{59}) in certain situations (Tukker et al. 1995c: 38-42).

Table 4.6 Contribution of the chlorine chain in 1990 and after implementation of the policy measures fixed per 1-1-1995

<table>
<thead>
<tr>
<th>Environmental theme</th>
<th>Contribution in 1990 (as percentage of the total environmental burden in 1990)</th>
<th>Contribution after implementation of the policy measures fixed per 1-1-1995 (as percentage of the total environmental burden in 1990)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse effect</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Ozone depletion</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td>Acidification</td>
<td>0.6</td>
<td>0.04</td>
</tr>
<tr>
<td>Human toxicity</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Ecotoxicity (aquatic)</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Waste dump</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Smog formation</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Smell</td>
<td>0.02</td>
<td>0.003</td>
</tr>
</tbody>
</table>


The study also indicated which parts of the chlorine chain caused more than 85% of the total contribution of the chlorine chain to an environmental theme, see table 4.7.

\textsuperscript{59} Substances are considered to have acceptable effects on humans when concentrations remain below the Maximum Toelaatbaar Risico (MTR) level.
Table 4.7 Products and processes causing more than 85% of the total environmental impact of the chlorine chain after implementation of the policy measures fixed per 1-1-1995

<table>
<thead>
<tr>
<th>Environmental theme</th>
<th>Products and processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse effect</td>
<td>CFCs&lt;sup&gt;60&lt;/sup&gt; emitted from consumed foam and HCFCs and CFCs from a number of other essential applications</td>
</tr>
<tr>
<td>Ozone depletion</td>
<td>CFCs emitted from consumed foam and HCFCs and CFCs from a number of other essential applications</td>
</tr>
<tr>
<td>Acidification</td>
<td>Production of 1,2-dichloroethane, PVC and waste management</td>
</tr>
<tr>
<td>Human toxicity</td>
<td>Use of a number of products, e.g. EDC in pharmaceuticals and in the production of EDC/PVC</td>
</tr>
<tr>
<td>Ecotoxicity (aquatic)</td>
<td>Use of pesticides and biocides</td>
</tr>
<tr>
<td>Waste dump</td>
<td>Waste from PVC products</td>
</tr>
<tr>
<td>Smog formation</td>
<td>Use of dichloromethane and trichloro-ethane</td>
</tr>
<tr>
<td>Smell</td>
<td>Use of PER (tetrachloroethane) and trichloro-ethane</td>
</tr>
</tbody>
</table>


The reports describe the methodological approach followed and data used extensively. An LCA expert is able to reconstruct the approach followed. The reports mention a number of uncertainties. The preface contains the remark that the study is not a sufficient basis to draw conclusions about the environmental viability of chlorine. The summary and the conclusions contain the warning that the scores for ecotoxicity were not very certain (Tukker et al. 1995a: ix). The summary and main report of ‘Chlorine Balance’ list knowledge gaps (Tukker et al. 1995a: xv, 66-67) such as:

- Formation of ‘micro’s’: persistent, toxic and biomagnifying substances that cannot be detected by the current test methods because they are formed in small quantities.
- Unreliability of the methods used to calculate human toxicity and ecotoxicity.
- The reports do not indicate the effects of methodological choices and information uncertainties on the height of the conclusions nor do they show a bandwidth of outcomes. They contain only exact, quantitative figures, see table 4.6.

4.6.3 Proposal for chlorine policy of VROM

The then Minister of the Environment, de Boer, used the ‘Chlorine Balance’ reports to formulate and defend a new national Dutch chlorine policy. She forwarded the ‘Chlorine Balance’ reports accompanied by a letter explaining the new chlorine policy to the Standing Committee of VROM on November 21st 1995 (De Boer 1995).

The letter started with an evaluation of the current chlorine policies. She said that the ‘Chlorine Balance’ reports showed that the government policies had set the right priorities to diminish the environmental effects of chlorine and chlorine substances, for example, the

<sup>60</sup> Chlorofluorocarbons.
prohibition of CFCs had resulted in a significant lower depletion of the ozone layer. The contribution of the chlorine chain to the national environmental themes would become relatively low after implementation of policies that had already been planned as shown by the quantitative ecoprofiles of the ‘Chlorine Balance’. These ecoprofiles were shown in a summary of the report that was attached as appendix to the Minster’s letter (VROM 1995b). This summary mentioned the uncertainty of the scores of the ecotoxicity scores but did not mention other uncertainties as the reports of those who had carried out the study did.

The Minister concluded that ‘risks of chlorine and chlorine substances were under control’\(^61\) and argued that a radical chlorine policy was not required. Although De Boer concluded that the problems of chlorine were relatively small, she expressed her concerns about substances exceeding the MTR levels in a number of situations. In addition the Minister was concerned about substances that would cause more than 85% of the total chlorine chain contributions to the environmental themes. She therefore proposed a number of small adaptations of the current chlorine policies\(^62\). The Minister formulated most actions in a rather prudent manner e.g. ‘more research’ and ‘consultation with industry’.

The minister expressed her concern about a number of knowledge gaps. She proposed to do further research on dioxins in the slags of incinerators and hormonal mimicking effects of organochlorines (De Boer 1995; VROM 1995c) Apparently, the Minister adopted the quantitative ecoprofiles and other outcomes at face value and used these to improve Dutch Chlorine policies. Uncertain effects that could not be determined in a quantitative way were not a reason to take measures.

4.6.4 Public hearing on chlorine policy proposal

The chlorine and PVC industry and the environmental organizations asked for the opportunity to discuss the report and the policy proposal with the Standing Committee of VROM. A public hearing with spokespeople from the Chlorine industry\(^63\) and the environmental organizations\(^64\) was held on January 31, 1996. Two sessions of half an hour were held: the first with the Chlorine Industry and the second one with the environmental movement. In both cases, a toxicologist\(^65\) from the Wageningen University, and peer reviewer of the ‘Chlorine Balance’ reports, was added to the panel of spokespeople. The following description of the hearing focuses on the reactions given to the ‘Chlorine Balance’

\(^61\) Risico's chloor en chloorverbindingen beheersbaar.

\(^62\) These actions involved reduction of PER in chemical laundries, dichloro benzene used in mothballs and toilet refreshers, dichloromethane used to remove paint and trichloroethylene used as solvent. The Minister pointed also to the need to solve the waste problem of PVC and promised a policy memorandum on PVC.

\(^63\) Mr. Meersseman (Solvay and chairman of the Steering Committee Chlorine of the VNCl), Mr. Blanken (staffmember on chlorine of the VNCl), Mr. Quick (technical director VNCl) and mr. Scheffers (AKZO).

\(^64\) Mr. E. Matser (SNM), W. van der Naald (Greenpeace) and D. Stoppeleburg (Waddenvereniging).

\(^65\) Mr. Prof. dr. J.H. Koeman.
reports and the policy proposal of Minister de Boer and is based on recorded tapes of the public hearing.

Mr. Meersseman of the VNCl presented an address which focused on the report ‘Chlorine Balance’ (Meersseman 1996). He was full of praise for the ‘Chlorine Balance’ and emphasized its scientific quality and its thoroughness. He also pointed to the existence of knowledge gaps and emphasized that the industry had already offered the Ministry of the Environment to support research on these fields, e.g. on possible hormonal disrupting effects. He also pointed to the fact that these knowledge gaps were not specific for chlorine substances. For example it was also thought that several non chlorine substances also mimic hormones. Meersseman emphasized two contributions of the ‘Chlorine Balance’ reports: they show that the effectiveness of the current Dutch chlorine policy and create a scientific foundation for future discussions on risks of the chlorine chain.

Next, the members of the Dutch parliament asked the four spokespeople of the Chlorine Industry a number of questions about:

- The chlorine industry’s evaluation of the ‘Chlorine Balance’
- The chlorine industry’s willingness to replace chlorine by chlorine free processes and products
- Their opinion on the economic consequences of a transition to a chlorine free industry

In their answers, the representatives of the chlorine industry pointed a number of times to the fact that Minister de Boer had concluded that the use of chlorine was acceptable from an environmental point of view. In addition, they argued that chlorine containing pesticides were responsible for the relative high ecotoxicity scores and that alternative chlorine free ones would have the same problems.

The consultation between the committee and the spokespeople of the environmental organizations started with a presentation by Mr. Matser from the SNM. He focused on the interpretation of the policy proposal made by the minister. Matser criticized the ministers conclusion that ‘chlorine is manageable and that a specific chlorine policy is not required’. This conclusion did not take into account the many uncertainties about chlorine and the recent concerns on the hormonal effects of chlorine substances. He stated that the minister should make a memorandum on her chlorine policy for the Dutch Parliament. The following three aspects were essential for designing chlorine policies according to Matser:

- Solving knowledge gaps: e.g. hormonal effects, chlorine micro’s
- Search for alternative products for risky chlorine products
- Search for ways to reduce the risks of the chlorine industry

For the next 20 minutes, the members of the committee asked the environmental organizations a number of questions. The environmental organizations clarified their concerns about chlorine and PVC and emphasized the need to look for chlorine free alternatives. During this discussion a representative of the environmental organizations stated:
"The Minister concludes that chlorine risks are manageable but the 'Chlorine Balance' reports did not look at these risks. There are many knowledge gaps. In international as well as national environmental policy, it has been stated that the precautionary principle is a central element. If the government wants to take this principle seriously, the minister should draw the obvious conclusion: chlorine should be replaced. It is important to take alternatives for chlorine into consideration'.

4.6.5 Environmental organizations not satisfied

The members of the Standing Committee agreed with the proposal of the minister after the hearing and the administrators got the task to implement it. The standing committee asked the Minister to put more effort into a joint research project on the hormonal effects of chlorines. A Steering Committee BITAC with representatives from the industry, environmental organizations and the Ministry of the Environment was established to guide the implementation of the proposal of the Ministry of Environment and to formulate a research proposal on chlorine micro's (AKZO 1997a; De Boer 1996).

The chlorine and PVC industry were satisfied with the Chlorine Balance and the new chlorine policy (AKZO 1995b; Scheffers 1995; VNCl 1995b and 1995c), but the environmental organizations were not satisfied and criticized the 'Chlorine Balance' reports and the proposal of the Minister. The environmental organizations argued that the 'Chlorine Balance' reports had shown that the government and industry were not able to present a picture of the risks of the chlorine chain. Information on emissions to the environment (chlorine micros) and on the effects of both known and unknown emissions was lacking. The movement pointed to a number of other limitations of the study:

- The study is based on data and the generally accepted convictions of the government and the industry
- Recent scientific insights, such as those into effects of chlorine on the hormone system resulting in birth defects, sexual abnormalities, and reproductive failures are not taken into account
- Effects of exposure to a combination of substances are ignored
- Inadequacy of the methodology used to determine the toxicity of emissions

According to the environmental organizations, the report did not support the claim that the risks of chlorine were manageable. Knowledge gaps should not only be translated into research proposals but also into actions against chlorine. The minister should base her policies on a precautionary principle: give the environment-added protection. The researchers who conducted the Chlorine Balance and a number of other researchers were not satisfied with the way the 'Chlorine Balance' was used in the policy process. They argued that actors

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66 Information from VROM.
67 Begeleidingsgroep Implementatie Akties Chloorketenstudie (Steeringgroup Implementation Actions Chlorine Balance).
used the figures in an undesirable, absolute, and unbalanced way (AKZO 1995a; Copius Peereboom 1996; Kleijn et al. 1996).

4.6.6 Conclusions about the use of the Chlorine Balance

The study ‘Chlorine Balance’ is based on the LCA methodology and resulted in quantitative ecoprofiles, an overview of problematic chlorine products and processes and a list of problematic substances. The reports did not present a bandwidth of results but clearly indicated the limitations of the quantitative figures as they described the methodology extensively and listed knowledge gaps. The methodology is extensively reported and well qualified institutes worked for two years on the study.

The Minister used the ‘Chlorine Balance’ to evaluate current chlorine policies and proposed a few additional measures. She defended this policy mainly with a reference to ecoprofiles and other outcomes of the Chlorine Balance and used these as absolute figures. Neither the Minister nor the study discussed and rebutted the arguments of the environmental organizations regarding the precautionary principle, the uncontrollability of chlorine, risks of chlorine micro’s, hormonal effects etc. She did not explicitly clarify how the ministry wanted to deal with uncertainty, but the ministries position is in practice very close to the industries position; no proof, no action but research and further discussion. The environmental organizations discussed the limitations of the ‘Chlorine Balance’ and the need for a phase out at the public hearing and in a number of articles, but had to accept the Ministers policy proposal for the time being.

4.7 Conclusions about LCAs in policy making

LCAs should not be considered to be a neutral instrument in the PVC discussion:

- The methodology used and studies took a pre-assumed position similar to that of the PVC and chlorine industry in that they emphasized formal, quantitative proof and conceptualized the PVC issue in the same way as the PVC and chlorine industry.
- Network actors were involved frequently in study projects and were able to influence the outcomes of LCAs as they advised analysts on the choices that were not prescribed beforehand by the methodology.

Actors in the PVC debate used outcomes of LCAs in a selective way to substantiate their claims on the problems of PVC and the required policies. References to ecoprofiles and rankings often led to polarized discussions on the ranking of products and the quality of LCAs. The conflicting nature of LCA results were often used to support ‘no action’ proposals. The LCAs did not contribute to an in-depth discussion on key conflicts between actors as researchers ignored key issues and did not justify the conceptualization of the toxicity problems implicit in their studies. The conflicting results of LCAs were often used to
support ‘no action’ proposals. The precautionary principle and other arguments of environmental organizations were removed from the chlorine discussion without a serious rebuttal due to references to the ‘Chlorine Balance’. Information contained in LCAs on PVC was often obscure for network actors that have little expertise in the LCA field.

Endnotes providing additional information on table 4.2

i The Gastec Centre works for energy utilities, manufacturers and supports these clients with research and development, information and consultancy, engineering, certification, and training.

ii Vereniging van Producenenten van Betonleidingssystemen.

iii Follow up of SEV 1993.

iv Stuurgroep Experimenten Volkshuisvesting. This committee is financed mainly by the Ministry of VROM and organized a program on sustainable building and published a handbook on the environmental aspects of building materials. The handbook showed the three most environmentally friendly products in a product field and which products should be avoided because they had a high environmental burden.

v Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling of the Ministry of V&W. This institute is responsible for waste water treatment and management of the water quality.

vi Department Science, Technology and Society of the Utrecht University (Rijksuniversiteit Utrecht).

vii Follow-up of the study of Lindeijer et al. 1990.

viii Federation of Manufacturers of Plastic Doors and Windows (Vereniging Kunststof Geveelelementen Fabrikanten).

ix Association of Metal Window Frame Producers (Vereniging van Metaalen-Ramen Fabrikanten).

x Centrum Hout. This foundation stimulates in a technical, economic, social and esthetic sense and wise use of wood.

xi Nationale Woningraad. Dutch umbrella organization of approximately 700 housing associations that manage a housing stock of 1.5 million accommodations.

xii Nederlandse Verbond Toelevering Bouw. This association promotes the interests of industries and traders that supply the building sector.


xiv Consultancy and Research for Environmental Management.

xv Vereniging van exploitanten van waterleidingbedrijven in Nederland (VEWIN). Almost all the dutch water companies are organized in this federation.

xvi Rijksgebouwendienst.

xvii The representative of the University of Amsterdam (Department of Environment and Toxicological Chemistry) was affiliated with the environmental organisations. The report of the VNCl calls him both an independent expert and a representative of two Dutch environmental organisations, SNM and VMD. According to these environmental organisations, this expert took part in the study on his own behalf.

xviii Directorate of Chemicals, External Safety and Radiation of VROM-DGM.

xix This representative was also member of the SPM.

xx Association FME (Federatie Metaal en Elektronica). FME is an association of companies in the metal, plastic, and electronics industry and related sectors.

xxi Communicatie en Adviesbureau voor Energie en Milieu (CEA).
5
Interpreting and solving LCA’s problems from a ‘rational’ perspective

The goal in this chapter is to explicate the fundamental ideas on sound policy making and analysis that have guided and still guide the development of the LCA methodology and to provide an overview of the problems of LCAs and solutions that have been described in the LCA literature. It will become clear that the rational paradigm of sound policymaking and analysis, in which the value of objective, easy to use indicators is emphasized, is dominant in the LCA scientific community. Many of the ideas of LCA scientists and LCA users about the objectives of the LCA methodology, the problems encountered and solutions fit into this rational frame. A number of alternative voices are also described.

The line of reasoning is as follows. The basic assumptions of the rational paradigm about policymaking and the nature of knowledge are described in 5.1 and the desired methodology in 5.2. It is shown that the ideas on the ideal product assessment of the LCA scientists have a rational nature in 5.3. Rational ideas on LCA’s problems and solutions are listed in 5.4. General conclusions are presented in 5.5.

5.1 Basic assumptions of the rational paradigm

Section 5.1.1 contains a description of the rational view on sound policy processes. The adherence to a positivistic inquiry paradigm is described in section 5.1.2 and the idea that analyses should have a neutral and instrumental character is explored in section 5.1.3.
5.1.1 Policy formation by an unitary policymaker

The rational paradigm is based on assumptions about the policy making process for which policy analyses are made. The assumptions are sometimes empirical descriptions of the way policies are actually made and sometimes normative descriptions of how policies ought to be made.

Decisions and policies are made or should be made in a centralized way by the government (Toonen and Korsten 1988). The government is at the top of society and has authority over other actors such as industries and environmental organizations. The government forms policies and will try to influence the behavior of other actors. This picture of the government is shown in figure 5.1.

The relations within the government are hierarchical or this would be the ideal situation: higher governmental actors are positioned above the lower ones as shown in figure 5.2. Furthermore the political sector controls the administrative sector; the administrative sector implements the politically determined goals.

Figure 5.1 Hierarchy model of policymaking

The top of the government provides, or should provide, unitary guidance. As a result, the different parts of the governmental organization are able to act as one, in other words as a unitary actor (Wildavsky 1992: 123). It is hardly possible that good and consistent policies can be formed without such central guidance. It is also essential that the goals of the unitary actor are clear and consistent because ‘A compromise of hundred clashing opinions can not provide guidance’\(^1\) (Boisot 1945: 48). The relative value of different goals needs to be clear as well to evaluate trade-offs between goals.

**5.1.2 Positivistic inquiry paradigm**

The rational paradigm is based on a positivistic or neopositivistic inquiry paradigm which assumes that objective analysis is possible or is at least an ideal that should be striven for. The positivistic and neopositivistic inquiry paradigms concerns three basic questions that can be characterized as the ontological, the epistemological, and the methodological question.

The ontological question is about the nature of the ‘knowable’. Or in other words about the nature of ‘reality’ (Guba 1990b: 20). The positivist position states that reality exists out there

\(^1\) "Een compromis van honderd botsende meeningen kan geen leiding geven"
and is driven by immutable natural laws and mechanisms. The business of science is to discover the ‘true’ nature of reality and how it ‘truly’ works.

The neopositivistic paradigm assumes that reality exists out there, but it is impossible for humans to truly perceive it with their imperfect sensory and intellectual mechanisms. Both paradigms share the idea that an objective world exists that forms a fixed foundation for human knowledge. The quality of generated knowledge can be tested against this objective world.

The epistemological question is about the relationship between the inquirer and the object of research. According to the positivistic position it is both possible and essential for the inquirer to adopt a distant, noninteractive posture. Values and other biasing factors should not influence the outcomes. In this way the inquirer can study reality without changing it and will receive objective knowledge.

The neopositivistic paradigm has reservations about the possibility of adopting a distant, neutral posture. Work in the natural sciences has demonstrated that ‘findings’ emerge from the interaction of the inquirer and the object inquired into, as shown by the Heisenberg Uncertainty Principle. To overcome these problems, objectivity remains a regulatory ideal, but it cannot be achieved in an absolute sense (Guba 1990b: 21). It can be achieved reasonable close, by striving to be as neutral as possible. The analysts should at least try to be free from values and other biases.

The methodological question is about the methods the inquirer should use for finding out knowledge. According to the positivistic paradigm questions and hypotheses should be subjected to empirical tests under carefully controlled conditions (Guba 1990b: 20). The methods used should be objective in the sense that the outcomes are not influenced by the inquirer. Quantitative methods are often considered to be more objective than qualitative ones.

The neopositivistic paradigm places emphasis on critical multiplism (Cook 1985). This entails that the findings of an inquiry should be based on as many sources of data, investigators, theories, and, methods as possible. Furthermore inquiry should not only be conducted in laboratories using quantitative techniques but also in more natural settings, using more qualitative techniques to generate more relevant and rich knowledge (Guba 1990b: 21-23).

Both positions aim for objectivity. The values and the other biases of the inquirer should not influence the analysis. Ideally there should be a distance between inquirer and the object of analysis.
5.1.3 Neutral and instrumental analysis

In the rational paradigm, it is assumed that the analyst should play a neutral role in the policy formation process (Aquina 1988: 350). The analyst should provide the unitary policymaker with neutral, objective information that helps the policymaker to select an effective and efficient policy.

This information should be directly relevant for policymakers. Preferably, policymakers should be able to use the conclusions of the study in an instrumental way (Abma 1995: 12; Majone 1989: 16; Leviton and Hughes 1981). Instrumental use means that policymakers adopt the conclusions of a policy study and translate these directly into policies. Instrumental use is different from conceptual use. Policymakers who use studies in a conceptual way do not necessarily use its conclusions but use other elements such as concepts, sub-conclusions, and models.

In summary, the rational paradigm contains the following assumptions:

- Policies are made or are ideally made by a unitary actor who has clear and consistent goals
- Objective analysis is possible or should be striven for
- Analyses should have a neutral, instrumental role in the policymaking process

5.2 The rational methodology

The three assumptions have led to the development of a comprehensive means-ends methodology of analysis. This methodology is considered the best way to conduct policy analyses because it is thought to lead to objective, conclusive, policy relevant, outcomes.

5.2.1 Phases

The analysis is divided into the following phases in the rational methodology (Findeisen and Quade 1985: 122-123; Rosenthal et al. 1987: 282):

1. Formulating the problem
2. Identifying, designing and screening alternatives
3. Forecasting future contexts or states of the world
4. Determining the effects of the alternatives
5. Comparing and ranking the alternatives

Iteration between the phases is often required (Findeisen and Quade 1985: 123). Different iterations are possible. For example, after analyzing a number of alternatives one may generate new alternatives and analyze these.
Figure 5.3 Phases in a rational study methodology

Source: adapted from Findeisen and Quade 1985: 123-124

The analysis starts with formulating the problem. A proper problem definition consists of the following activities (Findeisen and Quade 1985: 127):
1. Formulating the goals to be achieved
2. Defining the evaluation criteria
3. Defining constraints on alternatives
4. Clarifying the intended application of the study
5. Designing the initial plan and methodology for analysis and evaluation.

After the problem definition stage, alternative policies to achieve the goals are sought, studied and evaluated. The alternatives are generated in the second phase. These alternatives have to meet the constraints of the political actors. In the third phase, the impacts of the alternatives on the goals and other evaluation criteria are determined. If necessary, future developments are taken into account.

In the fourth phase, either policymakers or analysts evaluate the alternatives: they rank the alternatives on the basis of the given policy goals, evaluation criteria and their weights. The test of a good alternative is that it can be shown to be the most appropriate means (Lindblom 1959).

5.2.2 Means-ends analysis

Advocates of the rational paradigm propose a means-ends form of analysis (Lindblom 1959). A means-ends analysis has the following characteristics:
1. Clarification of values or objectives is distinct from and usually prerequisite to empirical analysis of alternative policies
2. Policy-formulation is therefore approached through means-ends analysis: first the ends are isolated, then the means to achieve them are sought
3. The test of a ‘good’ policy is that it can be shown to be the most appropriate means to desired ends

The means-ends approach is visualized in figure 5.4.
A means-ends analysis separates political questions from scientific questions (Lindblom 1959; Majone 1989). The political questions are about what-to-do; They are about the goals or values to be achieved, and the scientific questions are how questions. They are about the best policy means to achieve these goals.

The questions about the goals should be answered by the policymakers and not by scientists. The involvement of scientists in the definition of policy goals would violate the objectivity of the study. During problem formulation, the task of the analysts is restricted to assisting policymakers in clarifying their goals, evaluation criteria and constraints. It is desirable that the policymakers, for example the commissioner of the study and other stakeholders, clearly state their objectives and that these objectives are unambiguous. They must, if possible, clarify the relative importance or ranking of their objectives. Otherwise, scientists can not rank the alternatives in an unequivocal way.

Means-ends analyses are considered to be objective as analysts do not study political issues. They are also policy-relevant as they are used to evaluate different alternatives on the basis of the goals of the policymakers.

5.2.3 Comprehensive approach and scientific character

Rational policy analysts highly value comprehensive analyses (Lindblom 1959). Ideally, each relevant factor should be taken into account. For example the list of goals, evaluation criteria, alternative policies, and the investigation into effects should be comprehensive. It is only allowed to omit aspects that do not influence the final outcome of the analysis.

According to the rational paradigm, the analysis of alternatives must be based on scientific theory and data (Lindblom 1959). The assumption is that scientific theories are the best way to bring relevant knowledge on a specific problem. Furthermore, the rational paradigm highly values 'hard' methods that resemble the natural sciences as much as possible (Majone 1989). For example, the three handbooks for policy analysis of Miser and Quade (1985; 1989; 1995) pay a lot of attention to techniques such as cost-benefit analysis, systems modeling and multi-criteria analysis.

The emphasis on the use of scientific theory and formal, quantitative and verifiable procedures is related to the positivistic or neopositivistic wish to yield objective results.
Analysts and users regard results of formal techniques usually as authoritative; 'An alternative is the best because the procedure says so' (Dryzek 1993: 221).

5.2.4 Application

The rational paradigm and methodology were originally developed for the solution of technical, logistic and military policy-problems of the US government during the Second World War. Primarily, quantitative techniques from the field of systems analysis, operations research and economics were used. The analysts did not have to address any audience other than a single policymaker, or a small group of policymakers. Later, social problems such as public housing were studied in the same way. Institutes such as RAND and Brookings have made a great number of studies for the US government (Goemans 1988). The rational paradigm is also known as the rational-actor paradigm (Korsten and Toonen 1988), decisionism (Majone 1989), instrumental rationalism (Dryzek 1993) and analycentric approach (Dryzek 1993).

Rational methodologies have also been applied in the Netherlands. Many social costs-benefits analyses of infrastructural projects for the Ministry of Transport, Public Works and Water Management have been based on a rational means-ends approach (RAND 1977 and 1979). The Dutch Interdepartmental Committee for the development of Policy Analysis (COBA) was established in 1971. At first, COBA focused on costs-benefit analyses and the definition of a consistent set of governmental goals and tried to apply rational study methodologies (Aquila 1988: 355; Scholten 1980). COBA has been discontinued in 1983.

Rational methodologies can be found in a number of handbooks on policy analysis (MacRae and Wilde 1979; Nagel 1982; Patton and Sawicki 1986; Stokey and Zeckhauser 1978). The methodologies described in handbooks of Hoogerwerf (1992) and Miser and Quade (1985; 1989; 1995) are also related to the rational approach. These handbooks are in general more adapted to a political environment with different actors and consider policy analysis also as a political resource.

5.3 Desired LCA methodology

The ideas of a large group of LCA scientists and LCA users are similar to the rational paradigm. This section clarifies the ideas on the ideal study results, ideal study approach and their basic assumptions. The description is based on statements made by LCA scientists and users.

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2 For example the Schiphol rail (1969), the Oosterschelde Storm Surge (1974), the IJmuiden Harbor (1975), the Second National Airport (1975) and the reclamation of the Markerwaard (1984).

3 Commissie voor de ontwikkeling van de Beleidsanalyse
others on the desired study-results and study-approach in editorials, in articles, in the magazine LCA news and on verbal remarks made at conferences and workshops.

5.3.1 Study results

The LCA methodology focuses on the calculation of environmental effects of products, integral report marks and rankings. Ideally, these results should be objective, conclusive and also policy-relevant.

LCA results must be objective (Boguski et al. 1996; Guinée 1995; Consoli et al. 1993: Huppes, 1993:236). LCA scientists consider the requirement of objectivity to be natural. Posthlewaite, chairman of SETAC-Europe LCA steering committee in 1995, writes: ‘Where there can be little argument is that LCAs should be as objective as possible’ (1995: 1).

When LCA scientists use the term of objective they refer to a number of different things. Objective means among other things that the results must be based on scientific grounds (Guinée 1995; Posthlewaite 1995). Objective also means not subjective; normative or subjective valuations must be excluded from the analysis. The phrase ‘objective results’ is also used to indicate that an LCA must yield unequivocal and authoritative results. LCA results not only need to be objective, they should preferably be conclusive as well.

The goal of an LCA is therefore to give answers to real world problems and differs thus from scientific research that aims to create new knowledge. Guinée has called the LCA methodology a decision support tool (Guinée 1995: 5). Most LCA scientists have taken the stance that an LCA must only inform policymakers about the facts of the situation and must leave the final decision to the policymakers (Guinée 1995).

Many LCA scientists and users assume that objective, conclusive, quantitative rankings and ecoprofiles are considered as the best way to inform policymakers because the results are simple to use and provide clear guidance. There are a number of dissent voices that advocate a less quantitative and more pragmatic, qualitative approach to the generation of information because uncertainties are large and subjective judgements are needed (Brezet et al. 1994).

5.3.2 Study methodology

The means-ends approach can be traced in the LCA methodology. The methodology is meant to find the best products given certain environmental goals. The relationships between the phases in the means-ends model and in the LCA methodology are shown in table 5.1. It can be noted that the LCA methodology does not contain a stage ‘Forecasting future contexts’.

The LCA methodology aims at a comprehensive analysis. All the environmental effects and all the phases in the products’ life cycle should be taken into account. The developers of the CML guide state, for example, that they have tried to make a complete list of environmental problems (Heijungs et al. 1992a: 2). Other scientists have proposed to add new criteria to the CML guide (De Jonge and Beetstra 1997: 12).
Table 5.1 The relation between the phases in the means-ends model and the LCA methodology

<table>
<thead>
<tr>
<th>Means-ends model</th>
<th>LCA methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulating the problem</td>
<td>Goal and scope definition</td>
</tr>
<tr>
<td>Identifying, designing, and screening alternatives</td>
<td>Goal and scope definition</td>
</tr>
<tr>
<td>Determining the effects of the alternatives</td>
<td>Inventory analysis and Impact Assessment</td>
</tr>
<tr>
<td>Comparing and ranking the alternatives</td>
<td>Evaluation/interpretation</td>
</tr>
</tbody>
</table>

In addition, LCA scientists want to take the complete-life cycle of a product and all its emissions and extraction’s into account (Heijungs et al. 1992a). The wish for a complete analysis is also expressed by the fact that LCA developers see the environmental LCA as a part of a more extensive analysis in which aspects such as costs, employment aspects, utility value and safety of products are taken into account (Heijungs et al. 1992a: 7-11). Furthermore, LCA scientists want to base all the decisions on the same environmental goals and weight factors. This is needed to create a consistent environmental policy (Huppes and Heijungs 1995, Guinée, 1995). This signifies also the comprehensive approach of these scientists.

A comprehensive analysis is needed to obtain conclusive rankings. Rankings are not ‘true’ when a number of alternatives or effects are omitted from the analysis (Guinée 1995, Heijungs et al. 1992); however, LCA scientists have also proposed conducting less comprehensive analyses, e.g. by using screening procedures, because they noticed that comprehensive analyses cost a lot of time and manpower (Ywema and Van Overbeeke 1994).

LCA handbooks and concrete studies contain many formal, quantitative procedures. For example, classification models, normalization procedures and quantitative multi-criteria analysis. Quantitative procedures are used, even when a lot of things are very uncertain. For example, the developers of the CML methodology are of the opinion that the physical degradation of the ecosystems is hard to quantify and that only arbitrary formula’s can be formulated (Heijungs et al. 1992a: 87). Still, the methodology provides analysts with a formula. LCA scientists have also paid a lot of attention to the development of new quantitative procedures, e.g. for the determination of weight factors. LCA methodologies do not contain many qualitative methods to analyze product chains and their environmental effects. Concrete LCAs also have a highly quantitative character, although there are exceptions.

Most LCA scientists find formal, quantitative procedures very valuable. This can be derived from their statements and from the developed LCA methodologies. An exemplary statement is made by Guinée ‘Quantitative LCA’s are preferred above qualitative ones, in spite of the uncertainties of quantitative LCA’s’ (Guinée 1995). The advantage of a quantitative analysis is that choices, assumptions and considerations are explicated (Guinée 1995). The developers of the CML methodology state that they want to quantify the phases in
the LCA as much as possible (Heijungs et al. 1992a: 11). This should however not be done at the expense of environmental aspects that can not be quantified. Qualitative analysis is acceptable when quantitative analysis is not possible (Heijungs et al. 1992).

There are two reasons for this emphasis on quantitative, formal methods. Many people consider quantitative methods to be more objective and scientific than qualitative analyses. In addition, a quantitative approach is needed to obtain indicators that are simple for policy makers to use. There is, however, opposition against the further formalization and sophistication of LCA methodologies, especially by product designers and developers of company policies. They advocate pragmatic, qualitative approaches (Van Hemel 1998).

5.3.3 Basic assumptions on sound policy making and analysis

LCA scientists do not always make their ideas on sound policy processes, the adhered inquiry paradigm and the role of analysis in the policy process explicit but a number of signals can be found in their work.

Recently, Hofstetter (1998) pointed to the fact that it is often assumed by the LCA community that policies are made by one individual. Other LCA scientists assume or advocate the idea of central guidance although they are aware of the involvement of a number of actors in public policymaking. They argue that clear, consistent goals and weight factors are needed to formulate consistent product policies (Huppes and Heijungs 1995). Each evaluation should be based on the same set of weight factors (Huppes 1993: 230-233). A number of Dutch LCA scientists and governmental advisors state that the Dutch Ministry of Environment should define the environmental goals and their relative order (CRMII 1992; Huppes 1993; Huppes and Heijungs 1995; SER\textsuperscript{4} 1994). Other scientists want to use formal, quantitative methods to derive these standard weight factors. The set of fixed goals and weight factors will give central guidance to environmental product policies. In other words, environmental policies will be consistent.

Most policies in the area of LCA not made by one individual (Hofstetter 1998). It is a myth to think of a policy maker making a decision, like as a wise person in isolation. A more accurate scenario is that often of a group or a group of people influencing the policy maker. Hofstetter argues in addition that the concept of a hierarchically ordered set of values, the value function, seems more important to LCA analysts than to policy makers. I agree with Hofstetter's critique on the unitary policy maker In the next chapter, I will elaborate on this critique and claim that the network concept provides an even more accurate description of public policy processes than the group concept.

Most LCA scientists adhere to a neopositivistic inquiry paradigm. They are aware of the limitations of human knowledge but still strive for objectivity. The idea that analyses should fulfill an instrumental, neutral role is clear from the focus on simple to use rankings

\textsuperscript{4} Sociaal Economische Raad, Social and Economic Council
and integral report marks. LCA scientists view formal LCAs also as an objective basis for a discussion (Bovy 1995; Guinée 1995: 175). Recently, two theses with a divergent view have been published (Tukker 1998; Hofstetter 1998). According to these authors, modeling product chains and environmental issues is influenced by values and worldviews.

5.4 Problems and solutions

The dominant, rational ideas about the ideal methodology for environmental product evaluation prevalent in the LCA community have been described in the previous sections. The corresponding evaluation of the problems of LCA methodologies and the proposed solutions are described below:

- LCAs problems (5.4.1)
- Strategies to objectify LCAs conclusions (5.4.2)
- Strategies to stimulate a critical debate on LCA’s outcomes (5.4.3)
- Critical review procedures (5.4.4)
- Participatory analysis (5.4.5)

5.4.1 LCAs problems

Product designers and developers and scientists working for companies are in general not very satisfied with the formal and quantitative nature of current LCA methodologies and practices. The main reasons are that such an analysis takes too much time, is too complex, and that there is often a lack of data that can not be solved easily (Van Hemel 1998). The ‘rational’ LCA scientific community is, however, in general positive about the basic features of the LCA methodology. LCA scientists are satisfied with the stage model, the focus on rankings and quantitative ecoprofiles and the methodology’s comprehensive, quantitative nature. They consider the methodology as a very useful tool in the development towards a more sustainable economy (Guinée 1995). Boustead (1995: 98) views LCA as the logical approach to support policy makers: ‘When used improperly and without thinking, they are useless as are all decision making tools but when used properly and intelligently, they provide insights that are not available elsewhere’.

According to rational LCA scientists, current LCA practices have a number of limitations due to the fact that it is not possible to produce objective, conclusive rankings. They note several problems when ‘soft’ study results are used in public policy processes. Rankings and ecoprofiles may give ‘wrong’ answers to the questions of policy makers. Political actors may not accept the results of an LCA due to their ambiguous and soft nature (Wrisberg et al. 1997:9). Ambiguous choices are used to work towards conclusions that are in line with the
sponsors interests (Udo de Haes 1992; Lee et al. 1995). The strategic use of ambiguous choices decreases further the reliability and social acceptance of LCA results.

The use of LCA results in an absolute, instrumental way by policy makers is problematic because results are rather ‘soft’ and maybe not in line with reality. In addition, outcomes of LCAs can not be used adjudicate in political debates. A critical discussion on LCA results is necessary to rate them at their true value as instrumental adoption may easily lead to detrimental environmental decisions (Tukker et al. 1996).

‘Rational’ LCA scientists propose three complementary ways to solve the problems of the current LCA methodology. First it is important to achieve better and more objective results. It is believed that this will increase their social acceptance and results may adjudicate in political debates. In addition, possibilities to use LCAs in a strategic way will decrease. Second, LCA scientists realize that it will take time before LCAs will produce hard, conclusive results or that this ideal situation will never be fully achieved due to human limitations. LCA scientists advocate therefore a sound, critical scientific discussion in which LCA results are rated at their true value (Guinée 1995; Bovy 1995). Third, LCA scientists propose a number of social procedures that will increase the scientific quality and social acceptance of LCA results: critical review and participatory analysis.

5.4.2 Objectifying LCAs conclusions

Most LCA scientists assume that it is possible to describe things as they truly are. Only one description of the environmental pollution of products can be right. It is therefore possible to substantiate LCAs results. This will solve the problems mentioned above: wrong answers, lack of social embeddement, and strategic use of the LCA methodology.

The results of LCA will, in this view, become more objective and reliable when the following measures are taken:

- Increase the knowledge base
- Standardize methodological procedures
- Remove normative issues from the analysis or formalize them

*Increase the knowledge base*

Lack of knowledge is an important cause of the problematic results of LCA’s (Wrisberg 1997:5). A better information basis will increase the quality of the estimations and forecasts and thus reduce the soft nature of LCA results. Many LCA scientists advocate establishing more high quality data sets about the use of raw materials, energy sources and releases to the environment (Guinée 1995; Lee et al. 1995; Marion et al. 1995; Vigon and Jensen 1995; Wrisberg et al. 1997). Many projects have been started to establish public databases for the benefit of LCAs (Udo de Haes 1992; Van Dam 1995b) while other scientists focus on knowledge gaps on the behavior of substances in the environment (Wrisberg et al. 1997: 11). Those developing assessment methodologies for product designers have pointed to the
limitations of increasing the information basis. It costs a lot of time and money and information on products that are not yet produced is often not available or based on expert judgement.

*Standardization and formalization*

Many scientists and users of LCAs advocate (international) harmonization and standardization of methodological choices in LCA’s (Cramer 1994, Lee et al. 1995, Marion et al. 1995, Udo de Haes 1992, Wrisberg et al. 1997). Harmonization entails the use of a common methodological framework and terminology. Standardization goes beyond this as it diminishes the number of acceptable methodological choices and thus reduces the number of choices that have to be made by conductors of LCAs. Instead of prescribing certain methods, one could also prescribe a standard process for making methodological choices. A number of scientists propose developing a toolbox to provide analysts with guidance in making difficult methodological choices (Wrisberg et al. 1997: 12).

Standardization is usually proposed to decrease the possibilities of working in a way that produces outcomes in line with the interests of the sponsor (Udo de Haes 1992; Lee et al. 1995). As Lee et al. (1995: 51) wrote:

> ‘Life cycle assessment is highly qualitative and subjective, it is susceptible and open to manipulation and, as a result, only a standardized assessment methodology would be able to produce a relatively unbiased evaluation of environmental impacts’.

Standardization will increase the credibility of LCA results and decrease the problem of a lack of social embeddement and misuse. Moreover standardization facilitates comparisons between studies.

In 1993, SETAC published ‘*Guidelines for Life-Cycle Assessment: A “Code of Practice”*’. This publication should stimulate the use of a common methodological framework and terminology in LCAs. Among others, the following organizations are involved in the standardization of the LCA methodology (Rhodes 1995):

- Society of Environmental Toxicology and Chemistry (SETAC)
- International Standards Organization (ISO)

Other scientists criticize the proposed standardization. They do not want to standardize the LCA method because the methodology is still in the experimental stage and not ready for standardization (Ayres 1995; Knothenus 1995). For example, a choice for a certain method for allocation would be very arbitrary and its results too. Standardization would result in a premature closure of the scientific debate. They argue that more flexibility is needed to improve the present methodology (Anonymous 1997). Baumann (1998) also rejected standardization proposals. Flexibility is needed to adjust the methodological choices to the specific goals and study objects.

Further formalization and quantification of the methodology is considered as a way to increase the objectivity of the methodology. Many new quantitative methods are under development, especially for the evaluation phase.
Normative issues

Many LCA scientists consider the evaluation phase to be exceptionally subjective and problematic (Ayres 1995; Böhm and Walz 1996; Lee et al. 1995; Van Duin 1995b). Three different ways are proposed to increase the objectivity of the LCA:

- The government and political actors should determine standard weight factors that can be used by scientists
- Analysts should only present ecoprofiles and should not determine rankings based on subjective weight factors
- Analysts should use formal, scientific methods to determine weight factors

The first two proposals start from the assumption that scientists should abstain from defining weight factors. One public set of weight factors should be created and used according to the first proposal. The subjective evaluation of the ecoprofile should be removed from the analysis and left to the political actors according to the second proposal (De Smet 1992: 8-9). Each actor can then apply his or her own weight factors.

Others argue that the goals and weight factors should not be defined by politics but in an objective and scientific way (Ayres 1995; Powell et al. 1996). Formal methods to determine weight factors on the basis of the natural or social sciences should be used (Heijungs et al. 1992a: 115; Kortman et al. 1994).

There is also an opposite development direction focusing on more qualitative and pragmatic methodologies. An example is the manual for ecodesign (Breczet et al. 1994). This manual contains a qualitative approach to identify the environmental problems of a product that is known as the MET-matrix. The name MET matrix points to the Material cycle, Energy use, and Toxic emissions of a product (60-63). The evaluation of the environmental problems listed in the MET matrix is also organized in a pragmatic, qualitative way (63-66). In addition, the manual contains a qualitative approach to generate product alternatives and improvement measures (77-86). Other conceptual methodologies are the Integrated Substance Chain Management Methodology (VNCl 1991), The Chainbook (Moor and Hazewinkel 1992), and the Handbook Integral Chain Management for Companies (Van der Kolk et al. 1995). More information on these methodologies can be found in appendix 5.

5 Materialencyclus, Energiegebruik en Toxische emissies.
6 Udo de Haes at the LCANET meeting, Leiden, April 10 1997.
Studies should reveal the soft nature of LCA results to support critical scientific discussion. The following activities will contribute to the clarification of the current uncertainties and ‘arbitrary’ choices:

- Transparent and objective presentation of the method and data. In particular there should be a clear indication of what has and what has not been included in the study and of the uncertainties met during the study (Consoli et al. 1993: 37; Wrisberg 1997: 5; Corten 1995). The SETAC Code of practice described the requirements for sound reports (Consoli et al. 1993: 38-41). The presentation should be clear for policymakers and other non-LCA experts (Wrisberg 1997: 5, 13).

- Sensitivity analyses that show the results of different assumptions should be applied (Guinée 1995; Wrisberg 1997: 11). One should show the results of changes in assumptions with respect to the lifetime of products, different allocation methods, and different weight factors. In this way, the study shows a bandwidth of conclusions.

A transparent presentation and sensitivity analyses will make users aware of the soft nature of the quantitative LCA results. The results remain soft but are presented in a more balanced way. It is thought that this will enable scientists and political actors to hold a critical scientific debate on LCA results in which they rate the results at their true value. In addition, unbalanced use of results will be resisted because the study does not present its results as absolute. Studies that yield contradicting results are not considered to be a problem as they may contribute positively to a critical, scientific debate.

5.4.4 Critical review

The interest of the LCA scientific community for the social aspects of LCAs has increased recently.\(^7\) The use of an LCA methodology alone does not guarantee the reliability and objectivity of its results. In addition, sound social procedures are needed (Udo de Haes 1993). Many LCA scientists consider a critical review process to be a key element in the advancement of LCAs. It will enhance the scientific quality of LCAs and provide a critical screening of study conclusions (Bovy 1995; Consoli et al. 1993; Van Duin 1995b; Herberigs 1993; Udo de Haes 1992). It can help to increase the transparency of the presentation. The increased scientific quality and transparency will in turn enhance the social acceptance of LCA results (Consoli et al. 1993: 47).

A traditional review is carried out at the end of research and conducted conform publication policies of professional journals and associations. A peer review for LCAs should be more extensive. This is especially important for LCAs that are used in public policy processes\(^8\) (Consoli et al. 1993: 45). The SETAC standard proposes to use an interactive peer review process for LCAs that are used to inform public policy processes. Interactive implies

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\(^7\) E.g. the SETAC Case Study Symposium 1997 focused on decision making.

\(^8\) An extensive peer review is also required for advertising applications and all other studies aiming at target groups external to the sponsoring organisation.
that the panel reviews the study at several stages in the study process⁹. This enables the conductors of an analysis to take the comments of the review panel into account in the set up of the study. The reviewers should evaluate the choices made during the study process and the way the methodology, information and conclusions are presented in the report. The final LCA report should include the main findings of the peer review panel. The code of conduct of the SETAC (Consoli et al. 1993) has described the minimum requirements. The review panel should have experience in LCA and should, in general, be independent. When studies are used in policy processes, representatives of political actors should be added to the peer review panel. Recent ISO standards prescribe that a critical review by interested parties (stakeholders) is needed for LCAs which are disclosed to the public and that contain claims on the environmental burden of products (ISO 1997).

Reviews have been made for a number of LCAs on PVC mentioned in chapter three and four. In some cases, this was a rather informal procedure (Verspeek et al. 1992). In the case of the VITO study and the Chlorine Balance, an extensive peer review was made by scientific experts from a university and made public (Lindeijer and Reijnders 1995; Corten 1995). A number of limitations and critical choices made in the study were clarified by these reviews, which is positive when one wants to prevent that figures are accepted at face value. A formal peer review by stakeholders was not made. I expect that stakeholders in peer review procedures will focus on issues that are important from their point of view. Scientific peer reviewers may judge choices in an LCA acceptable because they are scientifically and technically valid, while a peer reviewer representing a certain stakeholder group may find them unacceptable because they continuously favor one product over the other. Involvement of stakeholders is also valuable for the parts of LCA that are value-laden, e.g. selection of environmental evaluation criteria.

5.4.5 Participatory analysis

A number of scientists consider interactive or participatory LCA is to be a valuable social procedure. Political actors and other stakeholders will be involved in a participatory analysis process. For example, representatives of Ministries, environmental organizations, consumer organizations, consumers, and industries producing or distributing products or their representative organizations might be involved in the study process. Participatory LCAs are considered to have the following advantages. The analyses become more relevant, choices fit in with the ideas of the political users and the acceptance of the results will be improved (DE Bruijn and Van Duin 1998). The approach is less technocratic (Marion et al. 1995; Wrisberg et al. 1997: 10-12).

Different forms of participatory life cycle analyses are possible. For example, a Steering Group with representatives from different backgrounds may guide the analysis. The

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⁹ The peer review panel should review the research work at the following stages of the LCA: after the goal definition in which an initial outline of the analysis is made, after data-collection and modeling and at the final report stage (Consoli et. al 1993).
involvement of this group in the analysis itself can be very intensive. They may select the products to be analyzed and make other key choices. Another task is to discuss interim results of the LCA study as well as the final report. In other words this group of representatives conducts a stakeholder peer review.

A number of LCA scientists want to limit the participation of political actors to the selection of research topics and normative choices (Wrisberg et al. 1997). The ‘factual’ choices should be left to independent scientists. Others want to include political actors in all the choices that have to be made, also the more factual ones. In this way, they argue, political actors are not only responsible for the normative choices but also for the ambiguous, factual choices.

An important point of discussion is the relationship between the solution of participatory life cycle analysis and the objectivity of the analysis. A number of scientists are afraid that a participatory approach will undermine the objectivity of the analysis (Heijungs 1998; Wegener Sleeswijk 1998). Others have evaluated the participatory approach of LCA as a solution that is complementary to substantiating the LCA methodology and a critical scientific debate (Wrisberg 1997: 11).

Recently, a number of participatory analyses have been conducted (Lundie 1998). Stakeholders were involved in the research design of LCAs in the French ecolabeling program (Marion et al. 1995). LCAs conducted in the framework of the Dutch Packaging Covenant had a participatory nature (Ywema and Van Overbeeke 1994). De Bruijn and Van Duin (1998) developed procedural guidelines for organizing stakeholder participation in LCAs.

The proposal for participatory LCAs is in conflict with the assumption of the unitary actor and hierarchically ordered environmental goals. The proposal is based on the idea that multiple actors with different goals and interests play a role in the policy making process and that authority is not solely based on scientific quality. In chapter six, I will introduce the network or interaction model of policy making and discuss the nature of environmental knowledge. This interaction model is used to continue the discussion on participatory LCAs.

5.5 Conclusions

Most LCA scientists adhere to the rational paradigm. Table 5.2 summarizes the ideas held in the rational paradigm about the role of policy analysis in policymaking processes and the nature of the desired study results.
Table 5.2 Basic assumptions of the rational paradigm

<table>
<thead>
<tr>
<th>View on the policy process</th>
<th>Unitary decision maker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry paradigm</td>
<td>Neopositivistic</td>
</tr>
<tr>
<td>Role of the analyst</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

Ideally, a study methodology should be able to achieve objective, policy-relevant, conclusive rankings and lists of consequences. The methodology should have a means-ends nature, be comprehensive and use scientific theories and formal, quantitative procedures.

Table 5.3 Rational methodology

<table>
<thead>
<tr>
<th>Desired study-results</th>
<th>Objective</th>
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<tbody>
<tr>
<td></td>
<td>Policy-relevant</td>
</tr>
<tr>
<td></td>
<td>Directive results that can be used instrumentally</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics of the study-process</th>
<th>Means-ends form</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comprehensive</td>
</tr>
<tr>
<td></td>
<td>Use of scientific theory and/or formal procedures</td>
</tr>
</tbody>
</table>

The LCA methodology is, in principle, consistent with the ideals of ‘rational’ LCA scientists. The inconclusive and subjective nature of current LCA results is, however, a serious problem. This hampers the use of LCAs in public policy processes: wrong outcomes, low social acceptance of outcomes and manipulative use of results.

Most LCA scientists do not want to change the basic features of the LCA methodology such as the emphasis on quantification, comprehensiveness and the means-ends approach. The measures to increase the objectivity and conclusiveness of the outcomes strengthen these features by:

- Increasing the knowledge base
- Standardizing methodological procedures
- Removing normative issues from the analysis or formalize them
- Developing new, formal methods

There is also a dissenting development orientation. A number of scientists and users want to develop more qualitative and pragmatic assessment methods, e.g. the MET matrix.

In general, LCA scientists want however to apply the same rational, quantitative methodology. This should be done in a more discussion-oriented way by:

- Improving the transparency of the presentation of methods, data, choices and uncertainties
- Adding sensitivity analysis

Furthermore, changes in the social organization of the study process, e.g. participatory analysis and peer reviews, are proposed to get better outcomes and to increase the social acceptance of these outcomes.
The improvement proposals actually aim at two different goals. The first goal is to make LCAs better suited to instrumental use, e.g. the conclusions of LCAs can be directly adopted and translated into policies by policy makers. The second goal is to improve the discussion function of LCAs. As a result, there are a number of tensions between the different solutions. Standardization is proposed to increase the objectivity and conclusiveness of LCA results and meant to make LCAs more useful in an instrumental sense. However, this solution may work counterproductive for a critical discussion because standardization will exclude certain viewpoints prematurely from the discussion.

I will discuss these proposals in the next chapter when I interpret the problems of LCA from another perspective, the discursive paradigm. I will discuss the regulatory ideal of objective, instrumental useful results and plead to consider LCAs primarily as discussion instruments. This has a number of consequences for the methodological development of LCA.
6
The 'discourse' perspective

'As politicians know only too well but social scientists too often forget, public policy is made of language. Whether in written or oral form, argument is central in all stages of the policy process' (Majone 1989: 1).

'The language of policy and planning analyses not only depicts but also constructs the issues at hand' (Fischer and Forester 1993b: 1).

Most attempts to improve LCA methodology and practice rest implicitly or explicitly on the rational paradigm of policy making and analysis as has been illustrated in the preceding chapters. An exception are the theses of Tukker (1998) and Hofstetter (1998). The fundamental assumptions of this rational paradigm are however problematic in the case of public environmental product policy processes. Therefore, a new framework for the interpretation of LCAs problems in the PVC case and for the development of methodological improvements is introduced in this chapter.

The assumptions made by the rational paradigm on the policy making process, objectivity of knowledge and the function of studies are criticized in sections 6.1 to 6.3. The discourse paradigm is introduced as an alternative to the rational paradigm because it provides a more realistic view of the way public product policies are made and of the role of LCAs therein. The discourse paradigm is known as 'the argumentative turn' (Fischer and Forester 1993a), 'discursive democracy' (Dryzek 1990) or as 'policy analysis as discourse' (Hajer 1989; Rein and Schön 1993: 145; White 1994: 506). According to discourse scientists, the key function of studies is to support the discourse of network actors, e.g. by informing and inspiring it. The concept of a sound discourse is explained in section 6.4.
6.1 Political interaction

In practice, policies are made during political interaction processes rather than by a unitary actor. Lindblom (1959) and Wildavsky (1992\(^1\)) were among the first policy scientists to emphasize the importance of political interaction. They argue that centralized policymaking on the basis of a standard set of policy goals and weight factors does not exist in practice. They propose an alternative model\(^2\) in which political interaction between different actors is central (Lindblom 1959; 1979; 1990; Wildavsky 1992: 122).

The assumption of political interaction is also central in the discourse paradigm. Dryzek (1982 and 1990), Majone (1989), Stone (1988), Fischer and Forester and other authors of ‘The Argumentative Turn in Policy Analysis’ (1993) elaborate on the theme of political interaction. They consider policymaking to be a ‘discourse’. The term discourse emphasizes the importance of verbal exchange about policy issues (Fischer and Forester 1993b: 1). Language is used to make sense of situations, contemplate actions and to convince other actors of the value of a specific interpretation.

**Figure 6.1 Network model of policymaking**

Source: De Bruijn and ten Heuvelhof 1991: 27.

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1 First published in 1979.
The theory of policy networks also emphasizes political interaction (De Bruijn et al. 1998; De Bruijn and Ten Heuvelhof 1993; Klijn and Koppenjan 1997; Koppenjan et al. 1993; Scharpf 1978). Policy network theories conceptualize a government as part of a network of actors that interact about policy issues. A government is seen as a fragmented organization consisting of many parts that are not always in complete harmony which each other (De Bruijn and Ten Heuvelhof 1991: 26; Lindblom 1959: 248). The same is true for other organizations. This picture of a government and its relations with other actors is shown in figure 6.1.

A governmental actor is not able to solve social problems on its own but is dependent on other actors. The same is true for other network actors. The fact that these actors are interdependent and need each other to solve their problems is a very important notion in the network theory. Interaction is required to deal with mutual dependencies and to find solutions that are broadly supported. Commitment for a solution will be achieved when a solution is better than the existing situation for each actor. Another central element of the network theory is the fact that each actor tries to maximize its own interests. Actors will often act in a strategic way to realize their interests. This is an important explanation for the interaction and cooperation problems in networks (De Bruijn et al. 1998: 23; Godfroij 1993).

The network model applies to public policy processes on environmental product-oriented policies. Public product policies are not made by a unitary actor with hierarchically ordered goals, but in a network of interdependent actors. The PVC and chlorine policy process illustrates this. Non governmental actors such as Greenpeace, and the chemical branch association VNCI were involved in the formation of PVC and chlorine policies. The governmental organization was not hierarchically ordered but consisted of a number of interdependent actors. The Ministry of the Environment and the Ministry of Economic Affairs were involved. These ministries were not guided by a central organization or by centrally defined goals. The different departments of the ministries, e.g. the three directorates of VROM involved in the formation of PVC policies, had room to formulate their own precise goals. The group model proposed by Hofstetter (1998) is a step forward compared to the model of the individual that takes decisions in isolation, but a less adequate description of public policy making processes than the network model. The phase model of rational policy making used by Hofstetter to position LCA within the policy making process, is by most policy scientist considered as an inadequate description of public policy making processes (Majone 1989).

*Political interaction as normative model*

The interaction model does not only reflect reality, it can also be argued that it is the best way to form policies because it will result in mutual adjustments, e.g. actors will adjust their policies to the concerns of other actors when they interact, bargain and make decisions. This will often accomplish an adaptation of policies to a wider range of interests than could be done by any unitary policymaker (Lindblom 1959: 28; Wildavsky 1992: 124). This is
especially true when an open and free discussion that puts no restrictions on participation and on the kinds of arguments that can be advanced is realized.

Besides the better adaptation to the variety of interests, networks of interacting actors have additional advantages compared to policymaking by a unitary actor (Lindblom 1959, 1979; Wildavsky 1992):

- A network of actors brings more, varied and broader knowledge to a policy problem and resulting policies have a higher quality and are better supported
- The policy process is more democratic

Therefore, I consider the interaction model a better starting point than the unitary actor assumption.

**Discourse and network tradition**

The discourse and the network tradition have much in common, both emphasize the involvement of multiple actors in public policy processes, both consider interaction and communication to be essential in policy making. Interaction enables actors to learn about the topic, to learn about perceptions and interests of other network actors, to design solutions to which network actors are committed, and to deal with mutual dependencies (De Bruijn et al. 1998; Van Eeten and Termeer 1994; Fischer and Forester 1993).

The two paradigms have, however, a number of differences in emphasis:

- The focus in the discourse tradition is especially on the content of interaction processes and the function of policy analyses in these processes. These elements are less central in policy network theories. The policy network tradition focuses more on the social and organizational aspects of interaction processes (Termeer 1993: 28). Furthermore, in the policy network tradition more emphasis is given to the strategic behavior of actors.
- The normative ideal of the discourse paradigm is an open, rich and reasonable communication process. All the actors should have equal opportunities to voice their ideas. The normative ideal of the policy network approach is to improve cooperation between interdependent actors that all try to maximize their own interests (De Bruijn, Kickert and Koppenjan 1993: 23).
- Prescriptions based on the discourse paradigm focus on the tasks of policy analysts and on the development of sound methodologies for policy analysis. Discourse authors discuss which changes in policy analytic practices, which have traditionally been based on the rational paradigm, are required from a post modern inquiry paradigm. Prescriptions of authors on policy networks focus mainly on restructuring networks and on management of interaction processes (Koppenjan et al. 1993). Only a few publications in the policy network tradition discuss the use of scientific information in policy networks (O'Toole 1984; De Bruijn et al. 1998).
6.2 Postmodern inquiry paradigm

The rational paradigm is based on the possibility of generating objective, reliable knowledge on policy issues. The idea of objective knowledge is however questionable. First, the postmodern inquiry paradigm is introduced in general in this section. Next, the idea of objective environmental knowledge is discussed.

Questioning objectivity
Lindblom is one of the first policy scientists who points to the fallibility and incompleteness of human understanding and the importance of values in policy analyses in his seminal article ‘The Science of “Muddling Through”’ (1959).

Later on, policy scientists questioned the idea of objective knowledge even more, and became adherents of postmodern inquiry paradigms that emphasize the influence of the observer on knowledge (Ascher 1986; Fischer 1993). Guba and Lincoln (1989) opt for a very radical paradigm: social constructivism. According to this paradigm, knowledge is formed in communication processes between people and does not refer to a reality outside these communication processes. Other authors, for example Rein and Schön (1993), also emphasize the constructed nature of human knowledge but are of the opinion that knowledge refers in some way to a reality outside the minds of human inquirers.

The postmodern understanding of human knowledge will now be described in more detail. The description is based on the work of policy scientists and policy analysts, and on the work of philosophers of science such as Hannah Arendt, Jurgen Habermas, Richard Rorty, and Richard Bernstein; authors writing on the discourse paradigm often refer to these philosophers (deLeon 1994; Fischer and Forrester 1993a, Kelly and Maynard-Moody 1993; White 1994).

Framing
Humans are actively involved in knowledge production. The human inquirer is not able to discover and understand the outside world as it is ‘out there’ because knowledge is necessarily influenced by the culturally determined frames of humans (Schön and Rein 1994: 41; Rorty 1991). A frame is a perspective that is used to make sense of an amorphous, complex situation and provides guideposts for knowing and acting (Rein and Schön 1993: 146). A frame treats some topics as more salient than others, defines environmental and other social problems in a unique fashion, commits to particular value judgments, and generally interprets the world in its own particular and partial way (Dryzek 1993). Frames exert a powerful influence on what we see and what we know. As a result, there are no objective facts because they are always theory and value laden (Guba and Lincoln 1989:63).

A frame consists of fixed, culturally determined guideposts that can be used to select, organize and interpret reality. Related terms are worldview, perspective (Allison 1971), belief
system (Sabatier 1988: 145), theory, and model. The term frame is used in this thesis for the fundamental ideas and concepts that guide the interpretation of a concrete situation. The term perception is used to refer to the ensemble of the frame and concrete ideas on a specific topic in this thesis. This is shown in figure 6.2.

**Figure 6.2 A perception consists of a frame and concrete ideas**

![Diagram of frame and concrete ideas](image)

Frames usually have an abstract or fundamental nature and often have to do with some deep aspect of ourselves, and are in general more resistant to change than specific insights (Sabatier 1988: 145; Schön and Rein 1994). People are often unaware of the role of frames in organizing their thoughts and actions because they take them for granted (Schön and Rein 1994: 34). Frames are often not explicitly present in the ideas and arguments of people but are there implicitly as they shape concrete ideas. Assigning names to a problematic terrain makes actors aware of their frame. Betty Friedan describes the feeling she had in the 1960s when she was troubled about the position of women, but did not know how to name her anxiety (Rein and Schön 1993: 153). The term ‘female subserviency’ both names the phenomenon she found so troubling and carries with it the remedy of ‘female liberation’. From this perspective, specific policy issues such as the issue of daycare take on a different meaning.

As knowledge is influenced by human frames, human knowledge does not mirror the world as it is ‘out there’ (Geertsema 1992). Truth as correspondence between human thought and reality becomes problematic because there is not an objective world that can be used to test the quality of human knowledge. Kant assumes that human thinking had a universal nature and that every human being will structure their experiences in the same way. This would give a fixed base for human knowledge. Postmodern philosophers argue that human thinking and interpreting does not have a universal nature as humans apply different frames (Geertsema 1992: 46).
Framing environmental issues

Fundamental ideas or frames also shape perceptions on environmental problems and desired solutions. Different frames or basic ideas about nature and man exist in our pluralistic societies. For example, different religions, Christianity, Judaism, and Hinduism, contain very different basic assumptions.

An important frame difference is the one between an antrophocentric perception of nature and the ecocentric one. The anthropocentric perception relates the quality of the environment to the living conditions of humans. The concept of sustainable development has an anthropocentric nature: nature should be preserved because future generations should be able to fulfill their needs. Plants, animals and ecosystems only have value when they contribute to the quality of human life. The ecocentric perception also includes the intrinsic value of plants, animals, and ecosystems. The English poet Blake wrote: ‘Everything that lives is holy’ (Korthals 1994).

Different frames exist also because human knowledge on the environment or nature is lacking (WRR 1994: 36-41). The environment consists of a system of ecosystems such as woods, river deltas, and abiotic parts such as raw material resources. Ecosystems are complex systems with unknown positive and negative feed backs. It is not known which parts of ecosystems are essential for the sustainable functioning of these systems. In addition, knowledge on the relationships between human activities and the environment is also lacking. Dose effect relationships are often uncertain, e.g. do emissions of CO2 contribute to a global warming and what effect has this on different ecosystems in different areas? Are humans able to live under other climate conditions? Is a desert with plants that are able to cope with a lack of water not a beautiful ecosystem?

An often cited example of frames is provided by the cultural theory. This theory describes fundamental different views on the fragility of nature and on human capacities to restore changes if necessary (Schwarz and Thompson 1990; Tesh 1993; Torgerson 1997). Tesh distinguishes two frames: a pre-environmentalist and environmentalist frame. Schwarz and Thompson3 distinguish four frame, they call them myths of nature, and visualize these frames as shown in figure 6.3.

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3 Originally, Schwarz and Thompson called the pre-environmentalist frame ‘Nature benign’ and the environmentalist frame ‘nature ephemeral’. They also described two other frames. ‘Nature capricious’, the world operates without rhyme or reason. And ‘Nature tolerant’, the world is one of forgiving of most events, but is vulnerable to the occasional knocking of the ball over the rim.

Pre-environmentalists view the environment as tough and resilient. Nature is relatively stable and can absorb waste products from human activities. Uncertain effects are not a reason to take action because nature is wonderfully forgiving: no matter what knocks we deliver, the ball will always return to the bottom of the basin. Therefore there is no need to act when environmental effects are not fully proven. The environmentalists’ frame is fundamentally different. Nature is fragile and there is a delicate balance between human actions and the environment. The slightest knock of the ball may cause nature’s catastrophic collapse. Policymakers and industries should treat the environment with great care and should not take any risks. Uncertain effects should be taken seriously and are a reason to take action. Advocates of the nature ephemeral or environmentalist frame use the ‘precautionary’ principle. Bras-Klapwijk (1997), Tukker (1998) and Hofstetter (1998) recently introduced the four frames or myths of the cultural theory to the LCA community.

As frames and values influence the perceptions on environmental problems, it is not possible to determine the effects of the use of a product on the quality of the environment in an objective way (CPB 1996; Korthals 1994; Verbruggen 1996; Verbruggen and Dellink 1996; Stolwijk 1996; WRR 1994). Environmental problems and evaluations of policy alternatives are thus partly human or social constructions and do not describe the situation as it ‘really’ is or will be. Different views exist, for example, on the effect of an extinction of rhinoceroses on the quality of the environment. Some evaluate this as a big environmental problem because it may cause a collapse of the entire ecosystem, while others believe that an
extinction of individual species does not hamper future generations in fulfilling their needs. It is thus not possible to study the environmental burden of products in a frame and value independent way (cp. Hofkes 1996; Pelle 1996; Stolwijk 1996; Verbruggen 1996; WRR 1994).

A number of environmental scientists, however, argue that the quality of the environment is not a subjective, social construction (Hueting and Reijnders 1996a; Hueting and Reijnders 1996b; Boerema 1997). Hueting and Reijnders (1996a) argue that the quality of the environment is good when the vital functions of the environment are available. Natural scientists can determine the existence of these vital functions and their existence in an objective way. The following arguments are given for this claim:

- The environment is in a certain shape. Changes occur before they are noticed. Future generations will be confronted with an actual environment and not with our social constructions.
- Environmental scientists are able to determine the physical state of the environment in an objective way and the effect of human activities on it, e.g. by counting the number of rhinoceroses.

These arguments point to the view that the environment exists outside human minds and that empirical study of the environment is very important. I agree with this point of view because I am not a radical social constructivist but I maintain that human knowledge is created in the interaction between humans and in this case, the environment, and is thus influenced by our culturally determined frames, see section 6.1.2. The presence of a world outside the mind of the human inquirer does not necessarily imply that humans are able to study the environment in a frame and value independent way. Activities such as counting rhinoceroses and determining the value of these rhinoceroses for the ecosystem are affected by frames and values. The arguments of Hueting and Reijnders make it clear, however, that not all social constructions of the environment are equally valid because there is a certain environment outside the human inquirer.

In the PVC case, actors use different frames to interpret the PVC and chlorine issues (cp. Tukker 1998; 294-296). The frame of the environmental organizations resembles the environmentalist frame of Tesh or the myth ‘nature ephemeral’ of the cultural theory. The idea of precautionary actions and an absolute zero level fits in with this frame. Nature perverse/tolerant is a less adequate description of the frame of the environmental organizations because there is no room to ‘experiment’ with low levels of dioxin emissions according to these organizations. The belief in the mankind’s ability to control dangerous chemicals is low which explains why the environmental organizations evaluate emission reduction measures as insufficient. The frame of the chlorine and PVC industry resembles the pre-environmentalist frame of Tesh or the myth ‘nature benign’. The risk of postponing action is considered small, it is better to wait for rather certain evidence. At the background there is
a ‘fatalistic’ sound, substitution actions are maybe not helpful because it is very likely that the new products have environmental problems. The industries perception does not fit in completely with the idea of no action at all because limited actions, emission reduction measures and recycling, that are surely beneficial for the environment and have less economic consequences, are advocated. The optimization proposals of emission reduction and recycling show that the belief in mankind’s ability to control technology and toxic chemicals is rather high. The frame used by the ministry of VROM is not very clear in the discussion. The ideas on actual policies are situated between the proposals of the environmental organizations and the chemical industry. VROM evaluates research as important but acknowledges on the other hand that full proof can not be established. A clear perception on the fragility of nature, management of uncertainty and on mankind’s ability to control technology is however lacking. This conclusion is also drawn by Van Eeten (1999: 65-86) who recently analyzed the discussion on chlorine.

**Dialogue instead of objective scientific basis**

The discourse scientists accept the fallible and frame-dependent nature of knowledge and analysis. Analysis takes place in, not outside, historical and linguistic processes. This does not necessarily need to lead to relativism⁴. Knowledge has still legitimacy and can function as a basis for acting. Inquirer dependent knowledge is valuable, exactly because of the specific perspective and involvement of the inquirer⁵. The following example will clarify this. A mother and a teacher may have knowledge about the same child. This knowledge is based on a different relationship with the child and on a different frame. As a result, their insights are not the same and might even be contradictory; however, both the knowledge of the teacher and the mother are valuable due to their specific interest in the child and the joint knowledge forms the basis for further understanding and acting.

Postmodern philosophers such as Habermas, Rorty and Arendt argue that dialogues can be used to deal with multiple perceptions and to create a shared basis of acting⁶. The

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⁴ Political scientists and policy analysts who observe the existence of different frames are afraid of an extreme relativist position (White 1994: 507; Dryzek 1993: 227). To combat relativism, the discourse scientists have sought substantive criteria to judge the value of frames. Schön and Rein (1994: 44) have suggested using March’s criteria of beauty, truth, and justice to judge different frames (March and Olsen 1975). ‘Beauty’ refers to eloquence in the formulation of an argument. ‘Truth’ has to do with the verifiability and reliability of the arguments. ‘Justice’ connotes an ethical evaluation of the judgments of the right and wrong of the actions to which the frames lead us. The difficulty with these criteria or any other evaluation criteria is that people may apply the same criteria in different ways or disagree about which frames more nearly exhibit these qualities. Frame evaluative criteria are thus not able to remove the specter of relativism (Schön and Rein 1994: 45).

⁵ This idea is presented in the novel ‘Lila’ by Pirsig (1994) in which an anthropologist explains that it makes no sense to observe Indians from a distance because in this way one cannot really understand them. Only through a relationship with Indians, e.g. friendship, one can understand them.

⁶ This dialogue has a different nature than scientific debates about facts, methods and their objective legitimacy.

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word ‘dialogue’ comes from two Greek roots, dia and logos, suggesting ‘meaning flowing through’ (Jaworsky 1996). The dialogue idea resembles Aristotle’s understanding of rationality ‘phronesis’ that can be translated as practical reasoning or prudent judgment (Hawkesworth 1988: 55; Kelly and Maynard-Moody 1993: 138). Practical reasoning aims to discern the ‘best’ course of action in any given situation by consciously considering values and cultural frames. This reasoning consists of rational and critical reflection on actions and makes use of ‘creative, deliberative judgment, and evaluative assessments’ (Hawkesworth 1988: 55; Kelly and Maynard-Moody 1993: 138).

Postmodern philosophers solved the relativist problem by identifying a new, communicative rational basis for thinking and acting, the ‘dialogue’. This dialogue replaces the old basis of objective rationality. Many policy scientists and policy analysts adopted this dialogue idea. A dialogue between holders of different frames and perceptions may provide the basis for policy decisions (Dryzek 1993: 227; Rein and Schön 1993; 1994: 43-45; Guba and Lincoln 1989). Political actors may reflect on the frames of their adversaries and on their own frames in a dialogue. This enables them to make an informed choice among conflicting frames, to synthesize elements of these frames in a new frame, or to find other ways to reach agreement (Dryzek 1993: 227; Schön and Rein 1994: 43). Korthals (1994) and the WRR (1994) argue that dialogues on environmental issues are needed to develop environmental policies.

Values and facts can be discussed ensemble

The postmodern paradigm does not follow the positivistic fact-value dichotomy where facts are considered to represent reality in an objective way and values are taken to be purely emotional or subjective expressions. Discourse authors argue that value judgments should not be reduced to emotions, expressions of fixed attitudes or arbitrary proposals and appeals, they should be considered as recommendations that can be accepted or rejected by the audience on the basis of arguments and counter arguments (Van de Graaf and Hoppe 1989: 155). In other words, values can be discussed in a practical way. Discourse scientists consider a dialectical treatment of facts and values as most fruitful because facts and values are usually interwoven, e.g. frames containing normative ideas influence what we count as facts (Van de Graaf and Hoppe 1989: 157; Hawkesworth 1988).

6.3 Discussion function of analyses

Studies are meant to support policy making process. They are used to set problems on the political agenda and to judge alternative policies. The ideas on policy making and knowledge in the discourse paradigm made it necessary to rethink the function of policy analyses and
other studies. It became clear that studies can not yield objective and absolute outcomes because they are frame and value dependent. Scientists are, in general, not able to draw up a unique, conclusive ranking or effect scores that are authoritative for all network actors because each network actor has own goals and values. Different frames can be used to make sense of complex, amorphous situations. Information is never complete and estimations have to be made, and uncertainty dealt with. This is also true for environmental product evaluations. Chapter three shows the relative nature of the conclusions of LCAs.

According to discourse authors, the key function of studies is their role as discussion instruments. This is rather different from the rational paradigm’s emphasis on the instrumental role. Discourse scientists view studies as arguments that are meant to convince other actors of a certain point of view. Policy analysis is conceptualized as a practical process of political, normative judgment and argument⁷ (Fischer and Forester 1993b: 2; Hoppe 1993: 78; Majone 1989).

Majone (1989; 7-8) and others emphasize the argumentative and persuasive nature of the task of analysts:

‘The job of analysts consists in large part of producing evidence and arguments to be used in the course of a public debate. The arguments analysts produce may be more or less technical, more or less sophisticated, but they must persuade if they are to be taken seriously in public policy processes.’

The justification of problem interpretations and evaluations of alternatives are extremely important because study results are not generally accepted on the basis of objectivity claims. Policy analysis is no longer viewed as an objective, neutral task but as a political, evaluative task. Guba and Lincoln (1989: 7-8) state:

To approach evaluation scientifically is to miss completely its fundamentally social, political and value-oriented character.

Majone (1989: 8) argues:

‘To reduce reason to logical calculation and proof about whatever does not matter enough to engage commitment is…to create a torn picture of the world, with all our values on one side and all our rational faculties on the other. Since to say anything of importance in public policy requires value judgments, this artificial separation between values and rational capacities is a threat to all notions of public deliberation and defensible policy choices.’

The key function of studies is, then, to contribute to a sound policy discourse. Not all types of studies and policy analytic methodologies are suitable for this task. Certain types of studies are vulnerable to misuse. Political actors may use these studies in a strategic, manipulative

⁷ The task division between policymakers and analysts proposed by rational scientists and the division between ‘values’ and ‘facts’ is no longer followed. This does not entail similar tasks for policymakers and scientists: analysts focus more on the ‘production’ of knowledge and policymakers are responsible for the policies to be made.

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way, which hampers a reasonable discourse (Majone 1989; Guba and Lincoln 1989). Discourse scientists therefore find it important to develop policy analytic practices and methodologies that contribute to a sound discussion.

As environmental product evaluations are in general not able to provide instrumental guidance in public policy processes, their key function should be to support a sound discussion on the environmental burden of products. From this discourse perspective, the contribution of LCAs to the discussion counts: Do political actors learn about the policy issue from the study? Does the study enable them to discuss multiple perceptions in a reasonable way? This puts the use of LCAs in the public policy process on PVC and chlorine in a new light.

Overall conclusion

The assumptions of the rational paradigm are not valid for public environmental product policies and product evaluations. The discourse paradigm will be used as an alternative framework for the evaluation of the use of LCAs in public policy processes which entails that the potentials and shortcomings of LCAs as discussion instruments are evaluated. The main differences between the fundamental assumptions of the rational and discourse paradigm are shown in Table 6.1.

Table 6.1 Main features of the rational and the discourse paradigm

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<th>Rational paradigm</th>
<th>Discourse paradigm</th>
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<tr>
<td>Policymakers</td>
<td>Unitary policymaker</td>
<td>Political interaction</td>
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<tr>
<td>Inquiry paradigm</td>
<td>Positivistic or neo-positivistic</td>
<td>Postmodern</td>
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<tr>
<td>Role of analyses</td>
<td>Objective, instrumental guidance</td>
<td>Normative, basis for discussion</td>
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The discourse paradigm is selected as an evaluation framework because it focuses on the content of the interaction process and on policy analytic study practices. Furthermore, it acknowledges the 'soft' nature of scientific knowledge and rethinks policy analytic practices from a postmodern perspective. In addition, I will use elements from the network theory as this theory provides additional insight into the social aspects of interaction processes and into strategic actor behavior. The network theory is, however, less central in this thesis, because it does not focus on policy analytic practices and policy analytic methodologies.

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8 Network scientists point also to the strategic use of studies, e.g. selective use of study outcomes. In addition, network actors may try to influence research processes to achieve their interests (Van Twist 1993; De Bruijn et al. 1998). Analysts may become puppets on a string in the policy process when they do not take action against it (Van Twist 1993).

9 Tukker, who acknowledges that multiple actors with different frames are involved in the discussion, argues that studies should yield robust knowledge. Knowledge should be scientific robust, it must suffer from relatively little uncertainty or ignorance. Furthermore it should be frame-related robust, the knowledge claim must be similarly interpreted in all relevant frames, and thus be commensurable (Tukker 1998: 64).
6.4 A sound discourse

According to the discourse authors, policy analyses should stimulate a sound discourse. This concept is further elaborated in this section. First, the goals that are ideally achieved in a discourse are explained in section 6.4.1. Next, the focus is on two process criteria. I argue that a reasonable style of communication is desirable and should be stimulated in section 6.4.2. The problems of discussions between holders of different frames and the importance of frame reflection are discussed in section 6.4.3.

6.4.1 Goals

Interaction processes can be used to achieve the following goals:
- increased insight into the perceptions and interests of other network actors
- further developed perception on the policy issue
- shared ideas on actions, in other words consensus on or commitment to certain actions

The goals or results of a successful discourse are shown in figure 6.4.

Figure 6.4 Products of a discourse

First, actors may learn about the perceptions of other actors in a discourse. This enlarges their insight into the problem issue as they become informed about more aspects and interpretations of the problem situation and of possible solutions (Geurts and Vennix 1989). This may result in mutual understanding and respect for different points of view, even when actors use conflicting frames (Abma 1995: 89).

Second, insight into other perceptions may lead to a critical reflection of one’s own perception. Actors ‘confront’ their own ideas with other perceptions. (Dryzek 1993; Guba and Lincoln 1989; Majone 1989). Reflection is not a matter of course because actors may close themselves off for reflection and react only in a defensive way to other insights (Termeer
In these cases, perceptions will not develop through reflection but only through the development of new arguments for the old position.

Third, actors may develop shared insights on the problem situation or on the desired solution (Termeer 1993; Guba and Lincoln 1989). Perceptions of the actors involved may converge as a result of confrontation with new information or new ways to interpret the problem. Other authors point to the fact that discourses may result in co-productions, mutual adjustments or integrative solutions (Lindblom 1959; Klijn and Teisman 1993). This is not exactly equal to consensus but implies that different perceptions are in some way acknowledged or accommodated in the policy plans and that the actors involved are satisfied with the proposals and have committed themselves to the plans (In’t Veld et al. 1998).

Perceptions can also diverge as a result of argument processes (Termeer 1993). In these cases, actors may reach consensus on strategies to cope with diverging and even conflicting perceptions. Solutions at this level are, for example, the definition of information requirements (Mason and Mitroff 1981; Friend 1989), formulation of proposals to elaborate future scenarios or setting up of a discussion about values, and designing compromises.

There is no agreement about the goal of consensus among discourse authors; is a discourse only satisfying when actors achieve consensus? Abma (1995) argues that the consensus goal does not do justice to the value of different perceptions and frames and the postmodern inquiry paradigm (1995). This is however not the case when one interprets consensus more broadly and includes policy plans that accommodate different perceptions. Abma proposes to evaluate discourses that do not lead to consensus as positive as long as actors communicate in a constructive way and try to understand each other.

The three goals shown in figure 6.4 are important according to the network and the discourse paradigm because actors are able to develop a solution that is acceptable to all the network actors.

6.4.2 Communication modes

What kind of communication mode is required to achieve the goals mentioned above and is feasible within a network context? The literature on discourses distinguishes two communication modes (MacRae 1993: 295; Rein and Schön 1993: 160): communicative\(^{10}\) and adversarial\(^{11}\) discussion. These two types of discussion processes are discussed and used to get insight into the kind of discussion style that should be stimulated.

**Communicative discussion**

Many discourse scientists advocate a communicative discussion that resembles the ideal speech situation described by Habermas. Actors behave in a cooperative way and want to

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\(^{10}\) Alternative terms: collaboratrive discourse (Habermas), consensual discourse (MacRae).

\(^{11}\) Alternative term: political discussion (Rein and Schön).
come to a shared understanding on the basis of reasonable arguments (Kunneman 1983: 18; Rein and Schön 1993: 160). They collectively seek the best policy alternative rather than advancing one alternative and asking for support (MacRae 1993: 295). Claims for adopting or rejecting a policy alternative are validated through a contest of arguments in which good, and defensible reasons are developed and communicated. No force except the better argument is exercised; and as a result, all motives except the cooperative search for truth are excluded (Habermas 1973: 107-108; Healey 1993: 244, Schön and Rein 1994: 48). The discussion can be characterized as a dialogue in which meaning flows through.

To let the best arguments prevail, a discussion must be sincere, honest, and free of manipulation (Perelman 1984: 191, 194; Schön and Rein 1994: 48), otherwise, a joint perception or decision might not be reached through the force of the argument alone but also by factors extraneous to the argument. Actors that try to deceive others or cover up relevant information curtail the contest nature of arguments. Actors need to argue in a communicative way to realize a communicative discussion. Pröpper and Bleijenbergh (1995) define communicative argumentation as ‘The argument should be balanced and rich, designed to convince or influence the discussion partner, to specify the points of view, and to clarify the political juxtapositions in a professional way’. It is important that each actor tries to imagine the perspective of the other actors, to try and put themselves in the other person’s shoes and be willing to be conciliatory. This communication style is open and respectful (Healey 1993: 242).

A communicative discussion requires unconstrained equality. All actors should have an equal chance of initiating, questioning, and defending assertions and have an equal chance of having an argument accepted on its own merits (Dryzek 1993: 229; Habermas 1973: 107-108; Healey 1993 242-243). There should be as few restrictions as possible on the kind of arguments that can be advanced, normative as well as empirical (Dryzek 1993: 229; Guba and Lincoln 1989; Habermas 1973: 107-108). Concerns, claims, issues of multiple stakeholders and insights from different scientific disciplines should be taken into account in the discussion.

MacRae (1993: 301-304) made the ideal of communicative discussion more concrete and has developed a set of substantive guidelines for communicative discussion. Loosely quoting MacRae, ‘actors should:

- Use a rather complete set of evaluative criteria instead of a single one
- Focus on goals and not merely advocate certain proposals
- Discuss alternative policies and not just a single policy
- Use ‘full’ information versus biased selection of information
- Use quantitative or precise information instead of vague information’.

The use of quantitative or precise information can also be used in a non-communicative way; ‘there are lies, damned lies, and statistics’.
Adversarial discussion

Majone has studied actual discourses and notes that actors try to win the discussion in terms of self interests or frames because this improves their position. This is called an adversarial discussion. Actors will advance proposals and arguments to make their own proposal prevail and they will not search cooperatively for the ‘best’ alternative. It resembles courtroom processes but there is no judge or jury to maintain a role above the struggle (Majone 1989: 10, MacRae 1993: 309).

Actors make use of self interested guidelines, in other words guidelines that enable them to win the discussion. They will try to present the case in the best way, to defend themselves from attack, and avoid aiding opponents. Actors will polarize by giving an exaggerated and simplified argument and they will omit or deny counter arguments for their position, because this would undermine their case relative to an adversary. This yields a debate, which is intended ‘to beat down’ (Jaworsky 1996).

Actors use a communication style that is called strategic argument (Pröpper and Bleijenbergh 1995). They apply for example strategies that exempt them from using arguments concerning the content of the issue. For example, an actor may mistake the man for the matter or play with supporters. MacRae describes a number of guidelines for strategic argument. These guidelines are the opposite of each of the five consensual guidelines described above.

Stimulating a reasonable discussion

Many discourse scientists advocate a communicative discussion style. They emphasize its ethical and democratic value and the possibility to find a satisfying solution, and they consider the adversarial mode to be unethical (Pröpper and Bleijenbergh 1995). MacRae (1993: 309) does not advocate his adversarial guidelines with pride and states ‘We would not knowingly use these guidelines to convince ourselves reasonably’. A communicative discussion is also preferred because of its opportunities to find shared solutions.

Another reason to advocate a communicative style is that it offers better opportunities for learning about the perceptions of other actors and for mutual understanding (Schön and Rein 1994; Snellen 1987: 21). It is a better basis for generating shared ideas about the policy issue or finding solutions that are broadly supported by the network actors. In an adversarial discussion, a certain actor may win the discussion and implement a certain policy that is not broadly supported. Many actors will have severe problems with the implemented policies and continue to attack them or will try to prevent implementation. When other actors come into power, it may lead to a pendulum swing from one extreme position to the other (Sabatier 1988: 155, Schön and Rein 1994: 8).

The arguments for a communicative discussion are put into perspective in the literature. Majone does not consider an adversarial communication mode necessarily unethical. He argues that clear lines to the kind of persuasion that is ethically acceptable need
to be established (Majone 1989: 37). Furthermore, opportunities for learning are lower when actors discuss in an adversarial way, but this does not mean that actors will not learn.

The idea of communicative discussion is furthermore criticized for its idealistic nature. It is argued that this style is only possible
- in the absence of power
- between like-minded actors
- under conditions of mutual trust and respect

Habermas, the ‘father’ of the communicative discussion mode, and Albae (1995) argue that this style is hardly feasible in political processes because laws of money and power apply in this area. MacRae (1993) states that the communicative style is only feasible when like-minded actors with common goals and values discuss policies that further given values. Actors can only communicate in a sincere, honest and vulnerable way when they trust each other and share sufficiently basic premises. One can not expect that actors will present the weak points of their proposals when this is not the case.

Others argue that actors need to trust each other to engage in a communicative discussion (Sabatier 1995: 202 and Rein and Schön 1993). Sabatier and MacRae are not optimistic about the possibilities to create these conditions in actor networks. Rein and Schön are more positive and provide a successful example in which people created these conditions, they remain, however, unclear about the way conditions of mutual trust can be created and obtained.

The fact that actors are in general not provided with equal opportunities to forward their ideas and interests due to the institutional context, argumentative practices and power differences is another hindrance to a communicative discussion. Actors with more resources, i.e. time and money, are better able to engage in a discussion. The idea of let the ‘best arguments prevail’ is also problematic because the quality of an argument depends on ones frames and values.

From the discussion above it is clear that the goal of a communicative discussion has an idealistic nature and ignores the role of power. Actors will often choose for an adversarial discussion mode for the following two reasons. First, the own policy proposal will prevail when the actor wins the discussion. Second, the use of a communicative discussion style is risky when conditions of mutual trust and respect are absent because other actors may take advantage of the presented weaknesses. The adversarial discussion mode also has disadvantages for an actor. The first is that the actor may lose the discussion. The second is that other actors are not satisfied with the solution when one wins the discussion and will continue to attack the solution. The third is that learning is undermined and that possibilities for win-win options decrease. Stimulating a reasonable style of discussion may therefore also be in the interest of network actors that try to maximize their own interests.

Although the standard of a ‘communicative discussion’ will not work in a political context, I consider it valuable to strive for a type of study that stimulate actors to discuss their
points of view in a reasonable way. With reasonable, I mean that actors present their cases in a way that makes a critical discussion on the arguments possible. Even strategically behaving actors will conform to certain communication rules. Without these rules, interaction would not be possible. At present, certain study and communication rules are already institutionalized. For example, study criteria related to the western scientific tradition of open debate such as transparent presentation of used methodology, uncertainties and study limitations. Network actors criticize each other when they do not obey these rules. It thus is possible to develop and implement study practices that stimulate reasonable communication although it will take time before new criteria and study practices are institutionalized and generally accepted.

6.4.3 Frame reflection
The literature distinguishes between (Schön and Rein 1994: 3-4; Sabatier 1988: 155):
- a discussion between holders of the same frame
- a discussion between holders of different frames

The first is relatively unproblematic. When holders of the same frame disagree and do come to different conclusions they are in principle able to adjudicate these conclusions. They share rules, assumptions, convictions, criteria and beliefs, all of which show how, a disagreement can be settled in principle (Schön and Rein 1994: 149). Actors are able to discuss and resolve their conflicts by recourse to evidence to which all of the contending actors will agree (Schön and Rein 1994: 3-4; Sabatier 1988: 155).

When frames conflict, actors tend to talk ‘at’ each other and are not able to resolve conflicts by appeal to ‘the facts’ (Sabatier 1988: 155; Schön and Rein 1994: 3-4). There is no framework within which disagreements can be arbitrated, because the different frames determine what counts as evidence and how evidence is interpreted (Schön and Rein 1994). The contending actors employ different strategies of selective attention. Depending on their views of the issue, they differ as to what facts are relevant. In addition, actors tend to give the same ‘facts’ different interpretations. Actors have a remarkable ability to dismiss the evidence adduced by their antagonists by focusing attention on different facts and by interpreting the same facts in different ways (Schön and Rein 1994: 5, 8). Discussions between holders of different frames tend to become ‘dialogues of the deaf’, which have essential disadvantages. First, learning about the issue and perceptions of other actors is undermined as political actors talk ‘at’ rather than with each other. Second, actors are not able to form integrated policies. Termeer (1993) calls this situation cognitive fixation; actors are not willing to reflect on their perceptions.

Rein and Schön argue that dialogues of the deaf can be prevented when actors pay attention to the frames implicit in the conflict. They should explicate frames and become aware of the role of frames to hold a real dialogue. This is called frame-reflection. Reframing strategies that stimulate actors to view issues from a different angle or viewpoint may be
useful (Termeer 1993). Frame-reflection and reframing enables actors to explore the potentials for resolution and to enlarge the ‘solution’ room.

6.5 Conclusions

The discourse paradigm emphasizes the network character of the policy process, and the frame, and value dependent character of product evaluations, which are ignored by the rational paradigm. I consider the discourse paradigm a better starting point to evaluate LCA’s problems because public product policies are formed in network situations and frames and values will necessarily influence the evaluation of the environmental burden of products. Tukker (1998) considers the discourse perspective\textsuperscript{12} also as an adequate model for the policy making process on chlorine.

The key function of studies is, then, to support and stimulate a sound discussion. Although communicative discussion modes in the Habermas sense do not seem realistic in a political context, studies can be used to stimulate an open, rich and reasonable communication process between actors with different perceptions and interests. Studies should contribute positively to the discussion and should not encourage strategic argumentation, and manipulation. Furthermore, studies should enable actors to learn about the issue, about other perceptions and frames, and enable actors to find shared solutions. It is from this point of view not always necessary to strive for knowledge claims that are supported by all frames.

It should be noted that sound study practices alone are not sufficient for a sound discussion because the quality of the discussion also depends on other factors, e.g. the institutional structure of the policy network, argumentative practices in the network, the attitude and behavior of network actors.

It is recommended to evaluate the current LCA methodology from this discourse perspective and to improve the LCA methodology in a way that stimulates actors to discuss perceptions in a reasonable and frame reflective way. This will be done in chapter seven.

\textsuperscript{12} Tukker calls it the argumentative/forensic mode of policy making.
Interpreting LCAs problems from a ‘discourse’ perspective

From a discourse perspective, analyses should, among other things, contribute to a discussion about multiple interpretations of environmental burdens of products. The LCA methodology and concrete LCAs on PVC have many ‘rational’ features due to their focus on an instrumental, quantitative contribution. Discourse scientists have however argued that rational studies do not form an adequate basis for a discussion and may even form a threat to a sound and open discussion (Majone 1989; Torgerson 1986). LCAs may have a number of shortcomings as discussion instruments and are maybe not the best, and certainly not the only way to contribute to an open and communicative discussion.

The following questions form the focus of this chapter:

- Do the LCAs inform and ‘enlighten’ actors on the complex issue of the environmental burden of PVC products and chlorine in an adequate way and do they contribute to an open and communicative discussion?
- Which features of the LCA methodology cause communication problems?
- Which methodological improvements are possible?

This chapter is organized in the following way. A literature overview of potential problems of rational studies is given in section 7.1. In section 7.2, I illustrate that LCAs present a number of problems on the basis of the PVC and chlorine case studies described in chapter four. New development directions for LCA methodologies are proposed in section 7.3. Concluding remarks on problems of current LCAs and possible solutions are presented in section 7.4.
7.1 Limitations of rational methodologies

Many discourse scientists are critical about the contribution of rational studies and methodologies to a sound discourse. The main points of criticism and a number of changes that advocates of the rational methodology have made in reaction to the critique are described and evaluated in this section. The main points of criticism are:

- Hidden values and frames (7.1.1)
- Emphasis on formal, quantitative methods (7.1.2)
- Standard goals and weight factors (7.1.3)

7.1.1 Hidden values and frames

The assumption that it is possible to study policy problems and alternative solutions in an objective way is not valid. Rational means-ends studies and their results are in practice subjective because analysts use specific policy goals, usually the goals of the client or of important political actors, to evaluate and rank the policy alternatives. This entails that rankings are always subjective. Furthermore, it is not possible to separate the study of normative issues completely from the study of ‘factual’ issues:

- Specific theories and analytical techniques are used to make sense of reality. As such, they frame reality and perceive the outside world in a specific way. Theories and techniques are also value laden (Guba and Lincoln 1989). Even formal, quantitative techniques contain normative starting points but this is often not realized (Dryzek 1993: 221). For example, the use of a discount rate to determine the value of environmental damage contains implicitly the idea that environmental damage is less problematic when it occurs in the future instead of today. Needs of future generations are thus considered to be less important than the needs of the present generations.

- The definition of goals and values is intertwined with more empirical study activities such as the generation of alternatives and the evaluation of alternatives, see section 7.1.3 for a more extensive explanation. As a result, analysts who are involved in the more empirical study activities become also involved in normative issues. The division of tasks between analysts and policymakers at which the rational paradigm aims is thus in general not realized in practice (Wildavsky 1992: 11; Majone 1989: 4-5).

Objective studies are in practice not possible. The fact that rational studies contain normative choices and use specific frames is in itself not problematic from the discourse point of view; but the problems of studies based on the rational paradigm are:

- Frames and values remain implicit and are not properly justified
- Studies appear objective, while they are in fact subjective
- Analysts are not free to develop policy goals in an independent way
Although analysts are not allowed to be normative, their activities are never fully objective. This is often not acknowledged by analysts and users of studies. Frames and values often remain hidden in studies due to the analyst's conviction of own objectivity and the emphasis on formal methods. Analysts, commissioners and others tend to claim that the study results are objective. This may give excessive legitimacy to the results. The implicit nature of frames and values and the apparent and claimed objectivity makes rational studies quite vulnerable for manipulative use. Policymakers that want to win a discussion may easily use rational analyses in a manipulative way to persuade others of the justifiability and wisdom of their choice: 'Doesn't the analysis point objectively toward a particular alternative?' (Torgerson 1986: 39). This may hamper a sound and open discussion about the desired policy, especially because when it is difficult to resist the authority of the analysis (Guba and Lincoln 1989: 37).

According to the rational paradigm, analysts should not develop and use their own goals and evaluation criteria in the analysis, because goal setting is not considered as a scientific task. As a result, goals and values of commissioners or other actors are often adopted in an uncritical way (Fischer and Forester 1987; Schuyt 1987). In this way, analysts easily become 'slaves' of commissioners and policymakers (Torgerson 1986). Critics of the rational methodology call analysts 'guns for hire' because policymakers can ask analysts to make analyses based on their goals and values (Torgerson 1986). As a result, policy analyses remain usually on the side of the interests of those in power (Kariel 1972: 106; Torgerson 1986: 38).

In reaction to this critique, a number of research approaches have been developed that enable policy analysts to reflect on policy goals while they remain objective (Van de Graaf en Hoppe 1989: 145-146). Analysts should analyze if the policy goals of the commissioners indeed contribute to the higher policy goals; e.g. the goal of reducing certain emissions might be realized while the desired reduction of acidification is not realized. This adaptation shows that followers of the rational paradigm can be critical towards the policy goals of commissioners. The critique of the discourse authors remains however valid because policy analysts continue to use goals of commissioners or other policymakers as starting point. In general, analysts using rational methodologies do not contribute to the policy discourse by developing their own insights on the desired policy goals and other normative issues, which is a pity from the discourse perspective.

7.1.2 Formal, quantitative methods
Most discourse scientists do not consider formal, quantitative methods to be the best way to gain information about complex policy problems that involve value conflicts and have an uncertain nature. The 'rational' emphasis on the use of quantitative methods and techniques has the following disadvantages:
• It results in a bias in favor of quantifiable information. Information and insights are excluded, not because they are not important, but rather because they are difficult or impossible to include in formal, quantitative models.

• Rankings and calculations are based on a simplified picture of reality and conclusions have a ‘misplaced concreteness and accuracy’. The simplified picture is needed to make calculations possible but does not always do justice to the actual situation.

• Formal techniques often have a 'black box' character; e.g. values and other assumptions remain implicit. This is especially true when the presentation is not transparent. This may hamper political actors in understanding the true value of the 'simple', quantitative outcomes. As a result it is easy to use formal studies to attempt to manipulate other network actors because these are not able to see through the study.

• The focus on formal techniques and scientific theories stimulates a politics of expertise (Fischer 1990; Lindblom 1990; Weiss 1991). Scientific experts have a lot of influence due to the emphasis on the use of scientific knowledge and analycentric techniques that overrule the arguments of the general public and of the specific stakeholders.

Concluding, formal studies may, by there vary nature, not inform actors in a rich and balanced way and relevant issues are often excluded because they can not be quantified. Learning from formal studies is often difficult because they contain simplified pictures of reality and the assumptions behind the conclusions are not transparent for policy makers. This is a funny paradox. Quantification is highly valued in the rational paradigm because quantitative results give clear direction and are simple to use by policy makers, however, the real value of the results is opaque and difficult to understand.

The discourse scientists are not of the opinion that policy analysts should abstain completely from theory and formal methods but they deny that quantified results are always better than qualitative results. They ask that attention should be paid to the value of local knowledge, everyday knowledge, intuition and qualitative analysis. This kind of knowledge and analysis is very valuable in many situations, for example when uncertainty is high or in value conflicts. In addition, they stress that quantitative results are just as soft as other information. Quantitative results appear to be precise but many different analytical methods can be applied and the selected method influences the results (Dryzek 1993: 222).

In reaction to the critique on formal methods and as a result of practical experiences, many analysts have extended the range of knowledge and techniques that may be used. A means-ends analysis may also be based on non-rational knowledge such as experience, and intuition (Dror 1983). Concrete means-ends analyses may be based on expert panels and

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1 This can be illustrated with an example from a Dutch discussion about the desired size of classes. Statistical analyses of the relationship between class size and learning results had more influence on the actual policies than the concerns and claims of parents and teachers on class size (Ritsema 1996).

2 First published in 1968.
workshops, especially when the level of uncertainty is very high and when future developments play a crucial role (Helmer 1988). These analyses are more qualitative and the critique formulated above is less relevant.

Another development is the stress on transparent presentation of the methodology used (Miser and Quade 1985; 1988). Many policy scientists argue that studies should not only present results but also the process by which these results have been achieved, e.g. by describing the used models. This is certainly a positive development from the discourse perspective but it does not eliminate the critique made above completely because policymakers are usually not experts in quantitative modeling and will still have great difficulties in understanding formal methods and the assumptions implicit in the models.

7.1.3 Standard goals and weight factors
The definition of goals and value trade-offs by the policy maker is a key element in rational studies. This enables an actor, or an analyst on behalf of the actor, to rank the available policy alternatives. Ideally, the same set of goals and weight factors should be used to evaluate all the policies to be consistent. For this reason, policy makers should define their goals and other evaluation criteria in general and abstract terms and indicate the relative value of different goals. This enables a policy maker to design consistent policies as it prevents goals shifting from decision to decision (Lindblom 1959: 242).

The use of a standard universal set of goals and weight factors hampers, however, a discussion on the goals to be followed. Furthermore, the use of a standardized set of goals and weight factors would not do justice to the specific context. Lindblom argues that it is not possible to define in abstract terms how much of one goal is worth sacrificing for another goal. First, policy goals do not always have the same relative values (Lindblom 1959: 242). One goal may be highly prized in one circumstance, another in another circumstance. The goal of diminishing the eutrophication of the environment is more important for the south of the Netherlands than for other parts because the problem is greater in the south due to the high density of pig farming to be found in the south. Second, goals and available alternatives influence each other (Wildavsky 1992). In general, policymakers will formulate only 'realistic' goals and standards.

Another problem with formal ranking methods is that it is often the marginal value of goals that is important. When policymakers need to choose an alternative they have to answer questions such as: is it worthwhile to sacrifice a little of the eutrophication goal to gain a little for the acidification goal. The formulation of marginal values of goals in abstract terms exceeds the human intellectual capabilities completely (Lindblom 1959: 242, Scholten

3 The example of ice creams can be used to explain the meaning of the marginal value. When you have no ice cream, the value of an additional ice cream might be very high for you. Maybe you are willing to pay more than 5 dollars for an ice cream. When you have already bought four ice creams, the value of an additional ice cream is almost zero because you will not be able to eat it.
Lindblom argues: ‘There is no practical way to state marginal objectives except by choosing directly among policies in which these objectives are combined in different ways’ (Lindblom 1959: 242).

Finally, rational analyses have often an internal orientation and do not relate the conceptualization of the policy problem to the issues discussed in the policy network. For example, studies barely confront their claims and choices with counter arguments from other network actors. Instead they follow their own problem conceptualization and apply the formal techniques automatically. As a result, rational studies do not contain convincing, rich, balanced arguments that can convince other actors or inspire a discussion on multiple claims and arguments (Checkland 1989; Guba and Lincoln 1989). The absence of justificatory arguments for other network actors can be explained by the fact that rational studies were originally intended to help unitary policymakers to select a good policy from their own point of view (Majone 1989: 11).

Concluding, discourse scientists argue that ‘rational’ methodologies are not the best way to contribute to a reasonable and frame reflective discussion in which participants learn about the issue, and about each other’s perceptions, and may achieve broadly supported solutions.

7.2 Problems of LCAs on PVC

From the discourse perspective, analyses should support an open, reasonable and rich discussion. We will now turn back to the empirical study of the use of LCAs in the PVC discussion and address the question to what extent LCAs contributed to this goal. The following limitations of the LCAs on PVC are discussed:

- LCAs ignored important key issues in the PVC debate (7.2.1)
- LCAs had often a black box nature for policy makers (7.2.2)
- The LCA methodology excluded certain perceptions beforehand (7.2.3)
- LCAs are vulnerable for polarized use (7.2.4)

An overview of LCAs problems is provided in section 7.2.5.

7.2.1 Ignoring key issues

The LCAs on PVC described in chapter three and four provide judgements on PVC in the form of rankings and ecoprofiles, however, these LCAs did not discuss almost all the key issues in the PVC debate on which the actors had conflicting opinions, such as the feasibility of PVC recycling in the near future and the precautionary principle (see chapter 4.4.3).

The following features of the LCA methodology and handbooks explain why LCAs on PVC tend to ignore these key issues:
- LCAs on PVC are based on a simplified picture of the PVC chain and its environmental impacts. This is amongst other reasons caused by the comprehensive nature of LCAs: many factors, processes and environmental impacts, need to be included. Often analysts do not take time to make a realistic picture of the PVC chain. For example, analysts hardly elaborated on recycling scenarios for PVC but just assume that recycling is possible although this is an important issue in the PVC discussion. Another reason for the simplification in LCAs is the emphasis on the use of quantitative environmental models. Analysts and the LCA methodology simplify issues to make calculation possible. Illustrative examples are the models used to calculate the toxicity of a product in the LCAs on PVC described in chapter three. These models treated all the emissions as equally persistent, and biomagnifying, because more quantitative models that take persistency and biomagnification into account were not yet available.

- The lack of attention for conceptualization of the policy issue, problem and alternative solutions, in the first stages of the LCA methodology. The methodology advises to start directly with collecting data and calculating environmental impacts and does not advise analysts to make a rough, qualitative description of the problem before one calculates in detail. As a result, analysts use the LCA methodology in an instrumental way, without adapting the research strategy to the specific context: the products analyzed and the policy making process. The LCA methodology has an inward orientation and does not stimulate analysts to take the public discussion on PVC into account by identifying and understanding the key conflicts in the discussion between the PVC network actors. This makes it difficult to respond to the public debate.

- The fact that many key choices are predefined in the methodology and handbooks also stimulated instrumental analyses. Analysts that made the LCAs on PVC described in chapter three often adopted the problem conceptualization and research strategy proposed by the handbooks, e.g. the standard evaluation criteria, classification models, and the integral chain perspective. The instrumental nature of the handbooks and uncritical adoption of standard approaches causes 'premature closure'; issues are excluded beforehand.

- Those conducting LCAs did often not justify their choices or defended them in only a formal technocratic way. The choices made were not related to conceptualizations and arguments of network actors.

This and the black box nature of LCAs explain why network actors barely referred to insights from LCAs other than ecoprofiles and rankings. LCAs contributed very little to the discussion in the PVC debate for the simple reason that they did not contain information on key issues. Consequently, LCAs were not able to convince actors who had a different opinion on PVC because LCAs did not contain arguments that could possibly convince them. In terms of Majone, justificatory arguments are virtually absent in LCAs on PVC. I did not study if LCAs
on other products also ignored key issues, but this may very well be the case because of the pitfalls inherent in the LCA methodology and because the handbooks used are the same.

An article of Finnveden (1997) on the values implicit in weighting methods is interesting in this respect. The choice for the use of a weighting method is a choice for allowing for trade-offs. This is in essence an ethical choice. People may find it unethical to allow for certain bad consequences and give certain effects absolute priority. The environmental organizations in the PVC discussion reason in this way with respect to emissions of persistent, toxic, bioaccumulating substances.

Finnveden shows that the choice of a weighting method is value-laden. Weighting methods and procedures contain implicit views on the value of democracy, the value of the market economy, on the equality of people living in different nations, on the equality of present and future generations all influence, etc. Finnveden mentions also that weighting methods need to correspond with perceptions on the tolerance of nature. When one stresses the precautionary principle, one will give probably a greater weight to impacts were larger uncertainties prevail.

7.2.2 Black box nature of formal methods

Learning from LCAs on PVC was also difficult because the process used to determine rankings and ecoprofiles remained a black box for policymakers. This was even true when the methodology and data used were well documented because it is difficult to understand the ideas implicit in formal methods. For example, the members of the Dutch parliament had difficulties in understanding the meaning of the chlorine chain’s ecotoxicity score of 0.07% of the total annual Dutch ecotoxicity. Baumann (1998) reports similar problems; managers in the Swedish industry had difficulties in understanding LCAs made on products produced by their own company.

Policy makers and analysts barely recognize that formal, technical choices have a normative nature or normative carry over as Dryzek and others have argued for studies made on other topics. The following examples clarify the normative nature of apparent objective methods and approaches used in LCAs on PVC:

- The use of multi-criteria analysis in product evaluation implies that one is willing to make trade-offs between different environmental criteria. One could also choose to use preconditions in the evaluation, e.g. a product is not acceptable when it has a high score on ecotoxicity even when it is very good in other aspects. Multi criteria analysis without adding absolute constraints contains implicitly the normative idea that trade-offs are acceptable.

- The level of aggregation of classification criteria seems to be a neutral, technical choice. In practice, criteria that are less aggregated get more attention in the evaluation and are considered to be more important.
• The choice in the ‘Chlorine Balance’ to show which products and processes caused more than 85% of the total contribution of the chlorine chain to the different environmental themes seems neutral. The seemingly neutral representation contains implicitly the idea that the products and processes causing more than 85% of the scores on the different themes have top priority. This mode of representation had a normative carry over, because the policy plan of the Dutch Ministry focuses on the problems of products and processes causing more than 85% of the scores. This entails implicitly the normative judgement that the ecotoxicity effect of the chlorine chain is just as important as the smell problem.

• The ‘Chlorine Balance’ suggests comparing the ecoprofile of the Chlorine Chain with the environmental burden of the average Dutch product. This bench marking activity suggests implicitly that the environmental burden of the average Dutch product is acceptable. From this it can be concluded that normative choices in quantitative, formal methods are often hidden for policy makers and analysts. This is a serious draw back of the use of quantitative, formal methods.

7.2.3 Excluding certain values and frames beforehand
The conclusions of LCAs on PVC are value laden and frame dependent as shown in chapter three. This is in itself not a problem from the discourse perspective because values and frames are an essential part of problem descriptions and evaluations. Facts are always related to ‘frames’ and it is not possible to separate ‘facts’ from values. From a discourse perspective, the following problems of the way LCAs on PVC and the LCA methodology deal with values and frames in the analysis are identified:

• Goals and weight factors applied are uncritically adopted and not justified by LCA analysts
• The methodology contains an implicit and not substantiated frame with respect to toxic risks

Uncritical adoption of goals and weight factors
The basic idea behind the LCA methodology is that analysts should strive to be objective and should try to abstain from normative activities. Defining environmental goals and weight factors is simply not their task and should be left to policy makers. In practice, analysts need normative starting points to conduct a product assessment, such as the environmental evaluation criteria used, and criteria to judge the adequateness of alternative products. They tend to use generally accepted governmentally defined policy goals. The list of evaluation criteria in the CML guide is based on Dutch policy documents from the national government and the Chlorine study is based on Dutch standards with respect to toxic substances (Copius Peereboom 1996; Kleijn et al. 1996). The Distance to Target method that is used to derive weight factors in the Chlorine Balance, is another example of the use of national, governmentally defined goals. Analysts do not discuss goals of different actors or formulate
their own ideas about the environmental goals of product substitution in LCAs. As a result, LCAs do not help policy makers to support learning processes and political discussions on the goals of environmental policies.

**Pre-assumed framing of toxic risks**

The LCA methodology frames the issue of determining the environmental burden of PVC, and other products, in a specific way. This may appear strange at first sight since one might interpret the LCA methodology as a flexible framework. Each actor or scientist is free to add own environmental goals or environmental models to the framework. This is true, but this possibility does not materialize because many critical choices have already been made in the handbooks and methodology and are adopted in an instrumental way by analysts.

In the PVC debate, the way society should deal with uncertain toxic effects was an important issue. Environmental organizations thought precaution necessary while chlorine related industries stated that actions against PVC and other products were only sensible when harmful effects were proven. The LCAs that were used in the PVC discussion, however, took a predetermined position because the LCA methodology contains a pre-environmentalist frame with respect to toxicity.

The pre-environmentalist frame results from apparently neutral or technical choices, namely the choice for an indicator for toxicity at the end of the effect chain and the choice for quantitative ecoprofiles. As a result, toxic effects that cannot be proven in a formal, quantitative way, such as the effects of additives and hormonal disrupting effects, are not considered in drawing up ecoprofiles and rankings of PVC products and their alternatives. In LCAs, uncertain effects are only used to qualify the formulated rankings and ecoprofiles but not to choose for actions against products that probably have serious impacts. Only the SEV studies (SEV 1993; SEV 1995; Anink 1996) that did not calculate ecoprofiles were able to include qualitative evidence on toxic effects in the ranking process. The approach taken in the LCA methodology and most LCAs on PVC thus resembled the way the chemical industries framed the issue of replacement of PVC products but did not match adequately with the environmentalists view⁴.

In the PVC case, LCA practitioners have tacitly taken side in the debate on the toxicity of PVC due to the choice for formal, quantitative methods and the use of actual toxic effects as indicator (ep. Tukker 1997: 24; Tukker 1998: 310)⁵. The pre-environmentalist frame regarding toxicity remains implicit because the choice of the indicator for the environmental

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⁴ Environmentalists have in general challenged prevailing conventions on what legitimately counts as evidence and knowledge relevant to policy processes (Tesh 1993, Torgerson 1997).

⁵ It should be noted that the choices made in concrete LCAs on PVC were sometimes 'beneficial' for environmental organizations and sometimes for the PVC and chlorine industry. The data about PVC production processes used in LCAs is outdated and ignored the effects of improvement measures taken by the Dutch PVC industry and resulted in a relative high environmental burden of PVC.
impact and the choice for quantification⁶ are presented as neutral choices that do not need to be defended. The conductors of the Chlorine Balance argue for example: ‘We can not help that this approach results in a small list of hard “priorities”’⁷ (Kleijn et al. 1996: 243).

Reasoning from a discourse perspective, the main problems that result from the way the LCA methodology frames toxicity in the PVC case are:

- **Premature closure** during the study process because certain risk perceptions are excluded beforehand. LCAs supported the pre-environmentalist view of the chemical industries on toxicity but did not equally support the environmentalist view that emphasizes precaution. Ecoprofiles and rankings were often positive on the use PVC products because many of the arguments of environmentalists against the use of PVC products did not count as argument within the LCA framework, e.g. controllability of chlorine, chlorine’s reactivity, and hormone mimicking effects.
- The frame used with respect to risk remained implicit and was not defended with arguments in the LCA methodology or the concrete studies. As a result, LCAs did not contribute to an open discussion in this respect.

7.2.4 Polarized use

The PVC and chlorine cases show that actors often used rankings and ecoprofiles of LCAs in a polarized way. They used the LCAs to win the discussion and improve power positions instead of convincing the other network actors. Of course one can accuse the actors involved of misuse of the study results and consider this as something that could happen to the results of any study (Kleijn et al. 1996). It is however plausible to conclude that a number of ‘rational’ features make LCAs powerful instruments for actors who want to win the discussion by holding a polarized and simplified argument.

The LCAs on PVC were powerful, political instruments due to their apparent objectivity and quantitative, simple conclusions. The objectivity claims of commissioners and

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⁶ At this point, it should be noted that the choice for quantification is not always a choice for a pre-environmentalist frame. It depends also on the kind of indicator used for the environmental impact criterion and especially if this indicator refers to the start of the effect chain or the end. The toxicity models use an effect at the end of the effect chain as indicator. The models for global warming use for example the emissions of CO₂ and other gases, an indicator at the start of the effect chain. A product is thus considered as problematic when it causes high CO₂ emissions.

Pre-environmentalists do not agree with this viewpoint because it is not proven that CO₂ emissions indeed have adverse effects. Does global warming really occur or is it just a normal variation, are CO₂ emissions indeed responsible for global warming, does global warming have adverse effects on ecosystems or are these systems able to cope with the changing conditions? This observation leads to the conclusion that quantification is a choice for an environmentalist frame when it is combined with the use of indicators at the end of the effect chain. The choice for an indicator at the beginning of the effect chain is often a choice for a pre-environmentalist frame.
policymakers gave the results more authority than justified. The ‘proven’, intransparent and seemingly very precise rankings and ecoprofiles are very suitable for a simplified and polarized argument. Actors often suppressed and denied qualifications when the results were in line with their view, e.g. see section 4.5.2 on the use of outcomes of LCAs on PVC, sections 4.6.2 and 4.6.3 about the use of the ‘Chlorine Balance’ by the minister of the Environment and the chlorine industry. On the other hand, actors that did not agree with the results of an LCA emphasize its qualifications.

LCAs were also vulnerable to polarized use due to the absolute figures presented in ecoprofiles; however, actors used even rankings and ecoprofiles that were presented in a balanced way, in a polarized way. The ‘Chlorine Balance’ case shows that mentioning qualifications in LCA reports does not necessarily lead to a more communicative discussion about PVC’s environmental aspects but may also lead to a polarized discussion on the quality of the study.  

The case of the ‘Chlorine Balance’ described in section 4.6 shows what happens when actors succeed in their polarizing strategy. The proposal of the Ministry of the Environment was accepted by the Dutch Parliament and will be implemented in the near future. The Ministry won the discussion by capitalizing on the apparent, objective conclusions of the ‘Chlorine Balance’. This freed her from providing arguments about her conceptualization of the PVC issue and from rebutting the argument of the environmental organizations. This entailed that the problem perception of the environmental organizations was pushed aside without a serious dialogue on the value of this perception and that the ideas about the precautionary principle were not taken into account in the design of policy measures. The ‘Chlorine Balance’ study thus allowed for a reduction of the openness of the political discussion.

7.2.5 Overview of LCAs problems

The key problems of the use of LCAs on PVC in public policymaking and the main causes are shown in table 7.1. It is plausible that LCAs on other products have the same problems when the LCA methodology is applied in the same way and used in situations with multi actors with strong value differences. Concluding, LCAs based on current LCA methodologies should not be regarded as the best and only way to support an open discussion in which actors review the issue, gain a better understanding of other actors perceptions and develop ideas to

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7 Translated from Dutch: ‘Dat het lijstje harde prioriteiten via zo’n aanpak klein blijkt te zijn kunnen wij ook niet helpen’.

8 The qualification of study results has, however, an important advantage. The PVC case shows that actors did not win the political discussion on the basis of references to LCAs because other network-actors used the uncertainties and methodological qualifications to challenge conclusions of LCAs. As a result, actors were not able to remove other perceptions from the political communication process. At least, the PVC debate continued and remained accessible for different actors and arguments.
deal with differences in insight. The focus on quantitative rankings, the emphasis on a quantitative, formal analysis, the pre-assumed conceptualization and the fact that frames and normative aspects remain implicit are LCAs key problems.

Table 7.1 Problems of LCAs in public policymaking on PVC and chlorine and their main causes

<table>
<thead>
<tr>
<th>Problem</th>
<th>Main methodological causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignoring key issues</td>
<td>• Comprehensive approach resulting in a simplified conceptualization of the PVC issue</td>
</tr>
<tr>
<td></td>
<td>• Instrumental application of the methodology</td>
</tr>
<tr>
<td></td>
<td>• Emphasis on quantitative effects, formal proof with a certain nature</td>
</tr>
<tr>
<td>Perceptions pre-excluded without justification in the study</td>
<td>• Analysts adopt goals of certain policy makers in an uncritical manner</td>
</tr>
<tr>
<td></td>
<td>• LCA methodology contains implicit frames and predefined choices</td>
</tr>
<tr>
<td>Polarized use of LCAs</td>
<td>• Apparent objectivity</td>
</tr>
<tr>
<td></td>
<td>• Precise, quantitative results</td>
</tr>
<tr>
<td></td>
<td>• Black box nature due to formal methods</td>
</tr>
</tbody>
</table>

7.3 Solving LCAs problems

Adjustment of the LCA methodology and of the way it is applied is required to stimulate a sound discussion among environmental organizations, governments, industrial organizations and other actors. Discourse scientists however, do not present a viable, coherent conception of what policy analysts should be doing (Sabatier 1995: 202). Nevertheless, their work contains many starting points to improve the LCA methodology. I will elaborate on their work and use their ideas on sound studies (Majone 1989; Fischer and Forester 1993a) and related ideas on participatory analysis (Geurts and Vennix 1989; Geurts and Kasperkovitz 1994; Guba and Lincoln 1989) to develop a proposal to improve the LCA methodology. I based these proposals also on recent LCA literature. The solutions proposed here are based on the idea that the current LCA methods and techniques are useful in many situations but that they should be used in a different way: less instrumental way and acknowledging normative choices.
First, I describe two new stages that can be added to the LCA methodology to stimulate a more open and emergent approach:

- conceptual modeling
- defining emergent research questions

In addition, I describe a number of important aspects of the LCA approach that need to be strengthened:

- explicating and studying values and frames
- maintaining and increasing the variety of research approaches
- using a transparent, verbal style of argumentation

It is often valuable to involve stakeholders in the study process. This solution is discussed in chapter eight.

7.3.1 Conceptual modeling

Current LCA methodology and practices are too instrumental and cause premature closure: important issues and perceptions are excluded beforehand. The methodology for product assessment should become more open and emergent and not prestructure the problem situation (Guba and Lincoln 1989; Torgerson 1997; Geurts and Vennix 1989). Structuring and conceptualizing the problem and possible solutions should be part of the study. When this is realized, the methodology will be able to accommodate a wide range of ideas and give each problem aspect and each interpretation a fair chance.

Premature closure in LCAs can be prevented by adding a new stage that I call ‘conceptual modeling’ or ‘mapping perceptions’. In this stage, analysts or stakeholders make a conceptual description of the problematic situation and of the alternative products and related environmental product policies (cp. Geurts and Vennix 1989; Checkland 1989; Guba and Lincoln 1989). The structure and key elements of the problem situation and alternatives should become clear. Analysts and stakeholders should be free to include any element thought to be relevant to form a product policy; In other words, the focus of the analysis is not automatically restricted to the chain of a product and all its environmental effects as in current LCA methodologies.

It is recommended to use qualitative methods that use concepts as the main means of representation in this stage. Two kinds of qualitative methods exist: verbal and schematic methods. Essays are an example of verbal methods. Schematic models combine verbal expressions with schematic ones; lines, arrows, boxes, points (Vennix 1990: 17). A goal-means diagram is an example of a schematic method. Qualitative methods are in general able to accommodate different perceptions, are more transparent, flexible and provide a quick way to get an overview of the situation. Qualitative methods will do more justice to the complexity of the problem as well. I will introduce a number of qualitative methods for conceptual modeling in chapter eight.

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The analysts may focus on the perception of one actor or on a number of perceptions. This depends on the goal of the product assessment. Do they want to develop one perception further or organize a discussion between the perceptions? When they want to develop one perception, this one will get the most attention. Attention for competing perceptions remains relevant for rebutting arguments of opponents.

The conceptual modeling stage can be added after the first three steps of the goal definition. These involve the definition of the intended application of the study, the target group, staffing the study project (see section 2.2.2) and do not need to be changed. The new stage model is shown in figure 7.1. The conceptual modeling step forms the basis for the definition of research questions, which is discussed in the next subsection.

The proposal to invest in conceptual modeling and clarifying problem definitions fits in with the emphasis that Baumann (1998), Baumann and Cowell (1998), Frischknecht (1998), and Hofstetter (1998) have put on the stage of goal and scope definition. They argue that this stage needs attention because goal, context and application of the study provide guidance for the methodological choices in the rest of the analysis.

Figure 7.1 Stages in the changed LCA methodology

7.3.2 Defining emergent research questions

Discourse authors advocate ‘emergent’ study approaches. Emergent entails that the focus of the study and the research questions and methods applied are not fixed in advance but are selected during the study (Abma 1995; Guba and Lincoln 1989). From this point of view, a standard LCA study approach is not desirable. It is necessary to adapt the approach to the specific context: the product, the network actors, and the issues in the policy discourse. The choice for the LCA methodology and the critical choices that have to be made during an LCA study, see chapter three, should be based on insight in the specific context of the study.

‘Failures’ such as the use of toxicity models in LCAs on PVC that are not able to deal with persistency, while this is a very important issue in the PVC discussion, will hopefully be prevented in this way. The addition of a stage ‘defining emergent research questions’ enables analysts and stakeholders to ask ‘right’ and policy relevant questions.

The conceptual descriptions of the problem situation made at the start of the product assessment provide the main inspiration source for developing relevant research questions.
This can be done in the following way. Analysts and stakeholders may ‘interrogate’ their own perception and perceptions of other actors and experts. Examples of questions that can be posed about the frame and about concrete ideas about the problem and alternative policy options on PVC and chlorine of the Dutch environmental organizations are presented in table 7.2. Similar questions may be posed about the perception of the chlorine and PVC industry.

One may also focus on conflicts between perceptions. In the PVC case, it would be important to ask questions at the level of the frames, see table 7.2 for questions at this level. This would enable the study team to develop middle positions between the two positions that are currently advocated in the PVC discourse and to design relevant research questions. Questions such as how should we deal with uncertainty related to the environmental effects of organochlorines (Tukker and Kleijn 1996) or who should pay the costs of uncertainty (Van Eeten 1998) are examples of research questions that are relevant to the PVC issue. Another example is the study on the validity of the generalization of toxic, persistent features of dioxins and DDT to all organochlorines (cp. Amato 1993).

It is not possible to answer all the questions that can be asked. Analysts and stakeholders have to select the most relevant ones for further study, e.g. questions that have a significant bearing on the final ranking of products and the preferred policy or questions that help to solve conflicts in the actor network. Checkland (1989) and other methodologists argue that one should focus on questions that directly support the design of policies, and especially on those that help to generate policies that are broadly supported. A focus on policies and actions ensures that the knowledge created is policy relevant.

I expect that addition of a stage of defining research questions to the current LCA stage model will increase the relevance of the research for policy makers. In this way, LCAs that neglect the real issues can be prevented. Before I discuss the research methods needed to answer the research questions, I will discuss how one can deal with values and frames in product evaluations.
Table 7.2 Questions on the environmentalist’s perception on PVC and chlorine

<table>
<thead>
<tr>
<th>Frames and basic assumptions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Is the precautionary principle only relevant for toxic effects of chlorine or also for other effects and other substances?</td>
</tr>
<tr>
<td>• How should the precautionary principle be operationalized: when are the concerns great enough to take action?</td>
</tr>
<tr>
<td>• Fundamental critique on the precautionary principle: environmental measures have large negative economic consequences and we do not know if these actions are beneficial for the environment or not due to our lack of knowledge. We should use a fatalist principle.</td>
</tr>
<tr>
<td>• Is chlorine uncontrollable? What is the value of the metaphor ‘chemical cocktail’?</td>
</tr>
<tr>
<td>• Why is toxicity the most important criterion in this case?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The problem:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Is the recent increase in infertility and related problems of hormonal systems caused by plasticizers and organochlorines? Or is it possible that these are caused by other sources such as eating meat from the bio-industry, using the pill, and wearing of tight pants by men?</td>
</tr>
<tr>
<td>• Are the currently observed health problems of top predators a heritage of releases of organochlorine emissions in the sixties? Is it possible that these health effects will not come into play at current levels of organochlorine emissions?</td>
</tr>
<tr>
<td>• Does the PVC chain emit chlorine micros?</td>
</tr>
<tr>
<td>• How much dioxin is released annually by the PVC chain? How much is this in relation to that released elsewhere? Why should we reduce the emissions of the PVC chain and not the emissions elsewhere?</td>
</tr>
<tr>
<td>• Which risks are specific for organochlorines and which not?</td>
</tr>
<tr>
<td>• Is additional research required before we take action? How much evidence is needed?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The solutions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How toxic are the emissions of chains of alternative products?</td>
</tr>
<tr>
<td>• Do other plastics contain fewer additives or less toxic ones than PVC?</td>
</tr>
<tr>
<td>• What are the disadvantages of these alternative solutions?</td>
</tr>
<tr>
<td>• When is a product better than an alternative one? When is the difference large enough to take measures such as ecolabels and banning orders?</td>
</tr>
<tr>
<td>• Who is affected by the solutions? Is it possible to adjust the plan to their interests?</td>
</tr>
<tr>
<td>• Who is against this solution? Is it possible to adjust the plan to the ideas of these antagonists?</td>
</tr>
</tbody>
</table>

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9 The fatalist principle is described in Schwarz and Thompson 1990, chapter 1. They call it nature capricious. The central idea is that institutions are not able to manage nature because they have no idea how nature will react to their actions nor are they able to learn. The world is 'random'.


11 This question was posed in an article by Tukker and Kleijn (1996).
7.3.3 Explicating and studying values and frames

A number of the questions on PVC and chlorine shown in table 7.2 are about the frames or fundamental values behind the problems and solutions. Normative and frame aspects are important throughout the product assessment. It is not possible to separate values and frames from ‘facts’ because they are intertwined. ‘Facts’ are embedded in frames and values (Hofstetter 1998: 37). Rather than suppressing them, resulting in pseudo-objectivity, they should be made transparent and further developed. I consider the study of values just as important as the study of ‘facts’. Values should not be reduced to purely emotional as is often done.

The conceptual modeling stage can be used to clarify underlying arguments and frames to get a more complete picture of the perception of the analyst and/or stakeholders. What are the reasons behind certain choices, e.g. why is acidification an important evaluation criterion, why is an integral chain perspective important, and why are certain additives considered to be very toxic? Frames that are rather implicit in perceptions will be voiced in this way, e.g. the precautionary principle and the uncontrollability of chlorine.

Defining emergent research questions is not a neutral activity as well. This stage can be used to pose critical questions on the frames, values, evaluation criteria that are applied in the conceptual modeling stage. These critical research questions can be used to *reflect on the frames and values to be applied* in product assessments (Fischer 1990; Rein and Schön 1993). Critical questions on the precautionary frame and on the use of toxicity criteria are shown as an illustration in table 7.2. Frames, values, and evaluation criteria also help to direct the more ‘factual’ questions on the problem and possible alternatives.

In the next stages of the product evaluation, analysts will try to answer the research questions. They need to study normative elements because they are an integral part of an evaluation of products and because ‘naked facts’ per se do not determine the ranking of products (cp. Majone 1989). A product assessment that contains new insights on normative issues will often offer a better basis for a discussion on environmental product policies than one that treats normative choices as given by policymakers or society. The use of standard goals and weightfactors is in general not recommended because it will hamper reflection and exclude certain perceptions beforehand.

When one wants to assess environmental impact scores, one needs to use methods that fit in with the basic frame and values that one wants to follow. As frames and values are often implicit in methods, tools and software that are currently in use, effort is needed to clarify these. Most of the evaluation methods used in LCAs do not assess in which country the adverse effect occurs or in which time period. They are thus based on the principle that all living people are equally important and the principle that the future generation is just as important as the present generation (Hofstetter 1998: 78, Finnveden 1997).

In addition, LCA scientists and environmental scientists could develop methods based on specific frames. Tukker (1998) and Hofstetter (1998) have started to develop frame-related
impact assessment methods. Tukker focuses on the environmentalist frame. He proposes to use studies that show that certain substances are present in the environment that cannot be accounted for to support claims on unknown emissions and adverse effects. The fact that the toxicity of the Rhine is about seven times higher than can be explained by known emissions into the environment indicates that emission registrations are incomplete. Hofstetter develops impact assessment methods for the three frames described by the cultural theory: egalitarians, individualists and hierarchists. Another possibility is to develop approaches that use views of allowable and not allowable risks to generate actions that guarantee for ‘safe landing’ (RIVM 1996).

A positive point of the development of impact assessment methods based on an environmentalist frame is that it enables scientists and environmental organizations to voice the environmentalist frame and strengthens the position of this frame in discourses. A warning is necessary at this place. It is important that calculations contribute to a sound discussion and frame reflection. Starting points to discuss the real issues and to reformulate them may be lacking when one uses frame-related impact assessment methods, especially when the methods used are very formal and when frames remain implicit (cp. Tukker 1998: 344). A yes-no discussion may easily occur due to the black-box nature of formal methods, seemingly precise results and because results based on one frame are easily dismissed by the holders of the other frame. To achieve a sound discussion and reflection on frames and on key conflicts this, results of frame-related impact assessment methods should be embedded in a verbal argument. This verbal argument should include a discussion on the frames and values embedded in these methods and why these are preferred above other frames and values, see section 7.3.5.

The final LCA report should describe explicitly the frames and values used in the evaluation and substantiate normative choices with arguments (Dryzek 1993; Fischer 1990; Guba and Lincoln 1989). This stimulates an open and fair discourse.

7.3.4 Variety of research methods needed
Analysts and stakeholders need to develop research methods to answer the selected questions. Research questions focus on different topics and each will need its own strategy. The new stage model shows that many research strategies may be applied. Elements taken from the current LCA methodologies will be useful for answering a number of questions. The chain model and inventory tables can be used to map emissions and use of raw materials, the impact assessment models can be used to translate these in environmental impacts etc. In other cases, completely different research strategies are needed. For example, research strategies need to be developed to deal with the following questions about chlorine:

- Do chlorine micro’s exist?
- Is chlorine inherently unsafe?
- How should we deal with uncertainties?
• Which uncertain toxic impacts are an argument to rank PVC and chlorine higher than other products?
• Which actors are against recycling of PVC and why? Is it possible to adjust the plan to the ideas of these antagonists?

It is not possible to design a standard set of research strategies for environmental product evaluation due to the broad range of questions that can be posed and the need for an open and emergent approach. Product evaluation should be conducted as an emergent and open process instead of a pre-structured research approach. The selection of the research method can be based on the results of the conceptual modeling and defining emergent research stage. Research methods from other studies and handbooks can be used for inspiration but research strategies should be adapted to the specific context. Creativity is thus important. The study process should have an iterative nature due to the complexity of the problem (Geurts and Vennix 1989; Geurts and Kasperkovitz 1994). In this way, analysts and other participants learn-step-by-step about the problem and alternatives.

A variety of research methods is needed to represent different frames because research methods to study issues in detail contain fundamental starting points, e.g. values and frames. The fact that current LCA methodologies contain already a variety of methods and techniques, e.g. different evaluation methods, is very valuable from the discourse perspective, although the frames and values behind these methods and techniques still need to be clarified to make them more useful, see the discussion in 7.3.3. The fact that current research strategies and environmental models are not well suited for assessing environmental impacts from an environmentalist frame that advocates precaution needs specific attention. Environmental models and indicators that reflect the environmentalists’ precautionary frame need to be developed to strengthen the precautionary position, see section 7.3.3.

7.3.5 Verbal, transparent argument

The results of the research can be used to test the conceptual model made at the start of the study process, to make it more sophisticated, to change it, and to draw conclusions about the nature of the problem and the advantages and disadvantages of different solutions. The final conclusions about the preferred product or product measures will not be objective but frame and value dependent. These conclusions are considered valuable for policymaking as they present how specific groups of analysts or stakeholders think about the kind of environmental product policies that should be implemented.

A report containing an argument for a certain problem conceptualization or for a desired solution should meet a number of criteria from the discourse perspective. The argument in studies needs to be directed to the other network actors: opposing perceptions and counter arguments are dealt with explicitly. Studies should be constructed as a site of contention. Rather than suppressing conflict, studies should incorporate diverse critical perspectives and confront these perspectives (Geurts en Vennix; 1989; Guba and Lincoln...
1989; Torgerson 1997). Studies that follow only the line of thought of the authors and do not relate this to the perceptions of other actors are less informative and are not able to generate and present arguments that have the capacity to convince other network actors.

Transparent presentation is needed. This is helpful during the study process as it enables study conductors to reflect on the fundamental ideas, arguments and key choices (Geurts and Vennix 1989, Vennix 1990). In addition, transparent reports are needed for an open and communicative political policy process. Policymakers, stakeholders and general public should be able to understand the study. It is not enough that the conclusions of the study are clear to experts. The use of simple, quantitative integral report marks to rank policy alternatives is not recommended because these are not transparent due to the accumulation of assumptions. In addition, quantitative figures should be part of a verbal argument for or against certain policy alternatives and not the only element. In this way policy makers will be able to understand the argument and studies become less vulnerable to manipulative use. Furthermore, a verbal argument or story will do more justice to the complexity of the problem, and information that can not be quantified will not be ignored.

The study commissioners should acknowledge the political normative nature of the analysis and evaluation of products and should not claim objectivity. Objectivity claims give too much authority to the studies conclusions, which will hamper an open debate on diverging perceptions.

The recent proposal of ISO (1997) to change the name of the evaluation stage to interpretation acknowledges that ranking products and making claims on environmental burdens is not something mechanically. I expect that this ISO proposal will stimulate analysts to take better account of uncertain environmental impacts and critical assumptions, which will in the end lead to a more balanced and richer argument for their claims.

7.4 Summary and conclusions

Problems
Discourse scientists argue that rational study characteristics such as formal methods, the separation of normative issues and factual issues, and a focus on quantitative, integral report marks often hamper a sound discussion about policies. The PVC case shows that:

- LCAs apparent objectivity, simple results and the black box nature of the calculations make LCAs vulnerable to misuse
- LCAs do not inform policymakers in a rich way due to the simplified and unclear conceptualization of the PVC issue, ignorance of key issues and absence of justifying arguments for choices containing normative issues
• The LCA methodology contains implicit frames and values, e.g. an implicit pre-environmentalist frame on toxicity and the goals of the Dutch national environmental policy plan (NMP)

**Adjustments**

To prevent these problems, it is proposed to improve the LCA methodology by:

1. Adding a conceptual modeling stage
2. Adding a defining research questions stage
3. Explicating and studying values and frames
4. Increasing the variety of research methods and techniques
5. Presenting a verbal, transparent argument

First, it is proposed to add a new stage to the current LCA methodology before the inventory stage named ‘Conceptual modeling of the problem issue’ or ‘Mapping perceptions and clarifying frames’. The analysis will become less instrumental and important issues will not be ignored as happens currently.

Second, research questions and research strategies are not fixed in the methodology but emerge during the study process. A stage ‘defining research questions” before the actual research starts is helpful. Choices are made during the study process, which prevents techniques being used in an instrumental way. It is useful for analysts to be familiar with a variety of research methods and the willingness to use or develop new methods.

Third, it is recommended to study values and frames in an explicit way. This proposal is in conflict with the ‘rational’ proposals to make LCA results more ‘objective’ and conclusive by removing normative issues from the analysis or by formalizing these issues. The use of standard goals and weightfactors may easily hamper reflection on normative issues.

Fourth, it is considered valuable to increase the variety of research methods because in this way it is better possible to accommodate different perceptions and to organize a discussion between them. The development of methods based on environmentalist frames is considered valuable because it will equalize the positions of pre-environmentalists and environmentalists. A variety of research methods is also needed because a variety of research questions may emerge. This proposal is the opposite of the proposal to standardize the methodology.

Fifth, the transparency and relevance of reports and arguments should be increased. Explaining the ideas implicit in the formal methods used is a positive step but it is in many cases better to use less formal methods, also because these often have a reductionistic nature. An additional advantage is that the analysis will take less time. The proposal to make more use of conceptual, qualitative approaches is closely related to the pragmatic approach of product evaluators, e.g. the industrial designers (Brezet et al. 1994; Van Hemel 1998). It differs from the ‘rational’ idea that a formal and quantitative methodology is the best one. It is
preferred to give the final evaluation not in the form of one or more absolute figures but as a rich and balanced ‘story’.

A participatory approach to the study of environmental aspects of products is discussed in the next chapter.
Participatory methodologies

Reasons to opt for participatory modes of life cycle assessment (LCA) are discussed in this chapter and I will conclude that the development of a participatory methodology for LCA is valuable from a discursive perspective. Next, the focus is on participatory methodologies in general to provide a basis for the development of a participatory methodology for LCA. The following questions are addressed:

- Which design criteria should be met by a participator methodology for life cycle assessment?
- What is a suitable and successful stage model?
- Which concrete methods and techniques can be used?

A literature study on participatory methodologies was carried out to provide answers to the questions above. Participatory methodologies have been developed for policy problems in different fields such as housing, environment, technological innovation, and social welfare. This chapter draws mainly on two participatory traditions: Soft Systems Thinking (SST) (Checkland 1981; Rosenhead 1989) and Responsive Constructivist Evaluation (RCE) (Guba and Lincoln 1989; Grin et al. 1997).

This chapter is structured in the following way. Advantages and disadvantages of a participatory mode of LCA are discussed in section 8.1. The design criteria for a participatory methodology for environmental product assessment are listed in section 8.2. An overview of different participatory traditions is given in section 8.3 and the focus on SST and RCE is explained. A stage model for participatory product evaluation is developed in section 8.4. The concrete methods and techniques that can be used in the different stages are also described in this section. A report of an experimental workshop on organochlorines is presented in section 8.5. An overview of key choices that have to be made in the organization of participatory analyses and issues for further research are described in section 8.6.
8.1 Value of a participatory LCA

LCAs can be made in an expert mode but also in a participatory way. In an expert mode, analysts conduct the analysis and develop content related ideas. Stakeholders are hardly involved in expert analyses. Experts contact their clients and possibly other stakeholders mainly at the start of the analysis to inquire into their ideas about the policy issue and their information interests. Next, the analysts will form their own ideas of the policy problem and possible solutions. At the end of the analysis, they write a report, and give presentations to inform their clients and the general public.

The term participatory policy analysis has different meanings\(^1\). In this thesis, the term is used to describe analyses in which stakeholder representatives are actively involved in the process. These representatives analyze and discuss policy problems. They develop and evaluate alternative measures. Analysts function as facilitators of participatory study processes (Guba and Lincoln 1989; Geurts and Vennix 1989). Analysts help the participating actors to reconstruct and voice their ideas and organize a discussion of ideas. They act as chair persons, and collect information and ideas. A participatory study process is a kind of mini-discourse that provides information for the larger public policy process\(^2\). In practice, there is a continuum between expert and participatory analyses.

Wegener Sleeswijk (1998) and Heijungs (1998) object to the participation of stakeholders in LCAs because they expect that the scientific quality of the studies will diminish. From the discursive perspective there is however no reason to consider life cycle analysis exclusively as a task for scientists. Normative choices have to be made anyway. A participatory analysis is not considered to be more subjective than an expert one. In many cases, the subjectivity becomes only clearer which is positive for an open debate (Bras and Enserink 1998).

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\(^1\) It is used to point to study processes in which:
- citizens participate (Mayer 1997)
- experts from different disciplines participate (de Tombe 1994)
- representatives of different stakeholders participate

\(^2\) For example, the consultancy firm Consultium organized workshops about problems and policies for chlorine in swimming pools (Martens 1994). Stakeholders such as directors of swimming pools, governmental health officials, local administrators, and technical experts on the chlorine problem or on possible solutions were invited to presentations, brainstorming sessions and discussions. The analysts from Consultium did not develop an own view on chlorine in swimming pools but only facilitated the discussion and used techniques such as brainstorming to create a good workshop.
Advantages and disadvantages of participatory modes

There are important reasons to opt for a participatory mode of analysis instead of an expert mode:

- Participants learn step by step about the issue during the analysis and not only after the analysis. They become owners of the results as they understand the results and hopefully support them (Geurts and Vennix 1989; Mayer 1997).
- Participants develop insights into normative issues and frames³.
- The interaction between stakeholders takes place during the study process and not only after the publication of study reports.
- Participants can arrive at a course of action on which most stakeholders agree through consultation and negotiation (Checkland 1989; Mason and Mitroff 1981; Guba and Lincoln 1989: 10).
- Participants possess knowledge that can not be found elsewhere: experience, values, interests, lay insights and intuition (Mason and Mitroff 1981; Mayer 1997). This is a valuable input for the analysis.
- Participants can continuously focus the analysis and discussion. This results in a policy relevant analysis (Mayer 1997; Geurts and Vennix 1989; Vennix 1990).
- Involvement of the most important stakeholders will increase the social support for the study and its results (De Bruijn and Van Duin 1998). The quality of the study will improve because different views are tested in the study process.

A number of postmodern authors seem to suggest that participatory analysis is the only option (Guba and Lincoln 1989; cp. Mayer 1997). Scientists are only allowed to function as facilitators that remain neutral with respect to the different viewpoints. I do not agree with this position. Why should analysts be deprived of their traditional task, the production of knowledge? Expert studies are valuable because the frame dependent ideas and standpoints of scientists and policy analysts can feed and stimulate public policy discussions. Expert analyses have certain advantages. They are often less time consuming, easier to organize compared to participatory analyses. Experts may study issues in more detail, and do new empirical research on specific topics. They can include the study of frames and values and reframe issues. Experts may function at ‘a distance’ from the policy process and can, in this way, develop fresh and creative ideas about the policy issue or alternatives policies. In this way, expert analyses can break through fixation and stimulate reflection among network actors, especially the catalysts ones. Expert analyses have also disadvantages, e.g. they may focus on issues that are irrelevant to the policy process because they are not steered by network actors, and participants are more often not committed to the results (De Bruijn et al. 1998).

³ Traditional expert studies do not focus on normative issues and frames. Experts that follow the discourse ideals will also focus on these aspects.
Feasibility of participatory LCAs

Participatory LCAs have a number of advantages but is possible to organize successful participatory studies (cp. Abma 1998). Conditions for a sound participatory process are relatively good when the study is made by participants with more or less the same frames and interests, e.g. representatives of different environmental organizations may make a participatory product assessment of PVC products. The following problems can be expected when participatory study processes in which actors with different perceptions and interests are organized (cp. Eeten and Termeer 1994; De Bruijn et al. 1998):

- **Actors refuse to participate** because the costs in time and energy are too high, or because actors do not expect that they will benefit from a participatory study process.
- **Actors hamper the development of broadly supported solutions.** They participate to drag their feet or behave in an opportunistic way.
- **Actors argue in a strategic way** to win the discussion or talk past each other because they do not want to reflect on their perceptions.

Flood and Jackson (1991: 134), Guba and Lincoln (1989), Rein and Schön (1993) argue considerable effort has to be put in creating mutual trust and preventing strategic behavior. A few guidelines are presented. For example, the analyst may ask for a statement of agreement of participants to adhere to certain conditions such as the willingness to communicate in a reasonable way at the start of the participatory process (Guba and Lincoln 1989: 191). Reduction of power differences is important too. Stakeholder groups who lack time, money and personnel should be supported to equalize positions (Guba and Lincoln 1989).

Additional strategies can be found in the network management literature. These strategies are based on the idea that actors will never fully trust each other. The strategies are meant to prevent strategic behavior that hampers the cooperation process. De Bruijn et al. (1998) describe design strategies for interaction processes such as postponing commitments (133-138), and loose coupling (143-148). These can be translated to the level of participatory analysis. From the network perspective, it is thus not necessary to achieve conditions of mutual trust and a respectful attitude completely because strategic behavior is controlled in a different way. An other important insight from the network literature is that a participatory analysis process with various actors requires a sense of urgency (Kotter 1997 in De Bruijn et al. 1998: 86). This entails that sufficient actors are of the opinion that they have a problem and that they can only solve it through cooperation. When these two conditions are not fulfilled, actors will often not be willing to take part in a participatory study process.

Based on the insights described above, it can be argued that a participatory LCA is feasible when:

- **Participants trust each other and are willing to communicate in a reasonable way** (Rein and Schön 1993; Guba and Lincoln 1989). These conditions will be often present when
participants have more or less the same background but not when actors have diverging and even opposing perceptions and interests and operate in a political context.

- Participants feel a sense of urgency to cooperate and are willing to take part in a participatory study process based on design principles that control strategic behavior (cp. De Bruijn et al. 1998). This type of process can be used when conditions of mutual trust are not natural.

- The facilitator is able to create mutual trust and a sound and open communication process. A good facilitator has a helping attitude, supporting others to get the job done (Vennix 1996:147-150). He needs to be authentic and integer, the use of tricks will be counterproductive since people will either anticipate them or be irritated by them. The facilitator needs to be neutral and give every person and idea an equal chance, even when he likes some persons and ideas better than others. Finally, facilitation needs an inquiring attitude. Genuine interest in what the participants want to say is important. The facilitator can, by asking questions and using active listening skills, get participants to explain their thoughts and prevent misunderstanding (Vennix 1996: 160). Active listening is the skill of listening to people, trying to get clear what they really mean and checking if you understood them right by questions such as ‘So what you are saying is…..’ (Gordon 1991).

When these conditions are not fulfilled, it is recommended to consider the use of alternative study approaches such as expert studies. It remains however worthwhile to develop a methodology for participatory LCA for situations in which participatory analysis is feasible because of its advantages over expert analysis.

De Bruijn and Van Duin (1998) have developed guidelines for the organization of LCA study processes in which stakeholders are involved. They discuss issues such as selecting participants, creating commitment to the results and balancing process and content. They assume that analytical activities follow the structure of the LCA methodology described in chapter 2. In this chapter, I will focus on the development of a study methodology that is more flexible with respect to the way the analytical activities are organized in comparison to the current LCA methodology, I touch on only a few procedural issues.

### 8.2 Design criteria

The participatory methodology for environmental product assessment should stimulate a sound communication process and focus on the following study results (cp. Guba and Lincoln 1989):

- Participants learn about other perceptions on a policy issue
- Participants develop their own perception further
• Participants develop policies or other actions with which most actors can agree or at that at least respect different perceptions

To achieve these goals, a study approach, in which the perceptions of study participants are discussed and further developed, is needed. The current LCA methodology was not designed for this goal. The LCA methodology is based on a certain philosophy and structures the problem in a specific way. When a participatory LCA is made, participants have to follow the basic philosophy and problem structuring embedded in the methodology and present their view in LCA terms. As shown in chapter six, not all the participants will be able to do this. It is for example hard to present the precautionary view within the LCA framework. This is probably one of the reasons why environmental organizations tend to refuse to participate in LCAs.

The participatory methodology that I want to develop should meet the following design criteria (cp. Flood and Jackson 1991: 33-34; Geurts and Kasperkovitz 1994: 125; Geurts and Vennix 1989; Mayer 1997: 250):
• Be able to accommodate multiple perceptions on the policy issue and should not close out certain perceptions beforehand
• The methods and techniques used should be hybrid: they should be able to handle a multiplicity of languages and perceptions
• Focus on frames and normative aspects and stimulate reflection
• Focus on the development of concrete policy proposals and actions that are broadly supported
• Focus more on ‘rough’ conceptualizations of the problem issue and alternatives than on precise calculations
• Stimulate a dialogue and cooperative behavior between actors
• Use flexible methods and tools that are easy to use by participants

The first criteria are important since each participant should be able to include his point of view in the study process to make genuine participation possible. The importance of including normative aspects in the analysis and of a more conceptual, qualitative approach has been discussed in chapter seven already. Organizing a dialogue and the development methods that are easy to use are important. The current LCA methodology was not designed for participation and its formal methods are difficult to use. Van Duin and Bruijn (1998) mention the lack of LCA knowledge of stakeholders as an important bottleneck in conducting (participatory) LCAs. Stakeholders have often not enough LCA knowledge to formulate the study task adequately which hampers the process as a whole. This problem can be solved by educating stakeholders, but also by a study approach in which participants are allowed to define problems in their own terms and which relatively simple tools are used.

Finally, the methodology should be able to deal with the complexity of environmental product evaluation were uncertainty is large and were different frames exist. Furthermore, when the methodology is used by participants that represent different network actors with
different interests it is important that the methodology is able to cope with situations in which participants may want to ‘win’ the policy process by force and try to coerce others to accept ideas and policies.

8.3 Participatory traditions

Participatory methodologies have been developed in different scientific traditions. The traditions of Soft Systems Thinking (SST) and Responsive Constructivist Evaluation (RCE) are described in subsections 8.3.1 and 8.3.2 and the relevance of these traditions in the context of this thesis are explained. The way these traditions are used to support the design of a methodology of participatory product evaluation is explained in 8.3.3.

8.3.1 Soft Systems Thinking

Soft Systems Thinking is rooted in the field of operations research and systems analysis (Flood and Jackson 1991). At first, systems scientists thought that quantitative computer models could be used to determine the best solution for complex policy problems. Soon, it became clear that quantitative computer models that could be used for simple problems with one problem owner were not suited for complex, social problems. The models were neither able to deal with the ambiguity and uncertainty of the problem situation nor could they manage the existence of multiple stakeholders with different frames⁴, goals and values.

As ‘hard’ systems methodologies failed, systems scientists developed ‘Soft System’(SS) methodologies ⁵ to study and solve social problems. A number of these methodologies are listed in table 8.1. In these methodologies, it is advised to use a specific stage model and provide analysts and participants with techniques and models that can be used during the study process. Soft Systems methodologies have a number of features in common. They focus on the conceptualization and structure of the problem situation and have a participatory nature. Participating stakeholders develop either a shared conceptual model of the situation or develop more conceptual models and compare these. Analysts usually have the role of facilitator. They organize the discussion and provide instruments to analyze the problem and to structure the discussion (Vennix 1996). Soft Systems methodologies often use visual models to map and discuss different perceptions of the policy problem.

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⁴ Weltanschauung or worldview in terms of SST.
⁵ This term refers to all the methodologies based on SST and not only to the methodology developed by Checkland.

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Table 8.1 Soft Systems Methodologies

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Options Development and Analysis (SODA)</td>
<td>Eden 1989</td>
</tr>
<tr>
<td>Strategic Choice</td>
<td>Friend 1989, Hickling 1989</td>
</tr>
<tr>
<td>Total Systems Intervention (TSI)</td>
<td>Jackson 1991</td>
</tr>
<tr>
<td>Strategic Assumption Surfacing and Testing (SAST)</td>
<td>Mason and Mitroff 1981</td>
</tr>
<tr>
<td>Participatory Systems Modeling</td>
<td>Vennix 1990, 1996</td>
</tr>
</tbody>
</table>

The SSM methodology (Checkland 1989) and the SAST methodology (Mason and Mitroff 1981), Interactive Planning (Ackoff 1981) are based on postmodern inquiry paradigms following Churchman’s philosophy (Flood and Jackson 1991: 121). The developers assume that different worldviews exist that greatly influence what people see and prefer. Participatory Systems Modeling developed by Vennix (1990) and SODA by Eden (1989) appear to start from a neo positivistic paradigm. These methodologies do not focus explicitly on worldviews or frames and assume that integration of ideas of participants is rather uncomplicated. All the Soft Systems methodologies are based on the assumption that involvement of representatives of different stakeholder groups in the policy process and study processes is essential for the design of policies.

The SSM discipline contains practical ideas about participatory methodologies that are relevant for product evaluation because these methodologies meet the design criteria more or less and start from the same assumptions as the discourse paradigm. The Soft Systems methodologies have been used with success in many situations (Flood and Jackson 1991; Rosenhead 1989; Vennix 1996). The only disadvantage of the SSM tradition is that SSM methodologies were hardly used for situations with participants from different organizations. The Soft Systems methodologies were mainly applied to study policy problems of companies and organizations and only in a few cases to design governmental policies (Hickling 1989).

8.3.2 Responsive Constructivist Evaluation

The Responsive Constructivist Evaluation (RCE) tradition was developed by evaluators of school policies, and adopted by scientists from other disciplines such as constructive technology assessment focused on evaluation of technology policies. Guba and Lincoln (1981; 1989) developed the RCE methodology because they were dissatisfied with existing methodologies for evaluation that focused on objective results and overemphasized formal, quantitative methods. Guba and Lincoln developed a new methodology that acknowledges the
social constructivist nature of knowledge, the political and normative nature of policy analysis, and the need to involve different stakeholders in policy making processes.

The RCE methodology starts with the investigation of ideas of different stakeholder groups. Analysts reconstruct the perception of each group. Next, they confront participants with ideas from other stakeholder groups which will result in consensus on a number of points. A negotiation process is used to deal with remaining differences.

At first sight, the RCE methodology meets the design criteria and starts from the same assumptions as the discourse paradigm. I expect that the RCE tradition contains practical ideas about participatory methodologies relevant for participatory product evaluation. Guba and Lincoln have applied the RCE methodology to design local school policies in a process in which teachers, parents, probation officers etc. were involved. Abma (1995), Grin et al. (1997) and many others have developed the RCE methodology further and applied it in other areas such as organizational policies and technology assessment.

There are many other traditions of participatory analysis. These are often related to specific topics, e.g. constructive technology assessment (Fonk 1994; Rip et al. 1995), urban planning (Healey 1993), ecology, military decision making, agriculture (Pretty 1994), corporate decision making (De Geus 1988). Other participatory traditions are related to specific disciplines e.g. group psychology (McGrath 1994), organizational learning, forecasting, group computer technology (De Vreede 1995). A relatively broad overview of participatory methodologies can be found in Geurts and Vennix (1989), Mayer (1997: 81-118), and series on futures research methodology (e.g. Glenn 1994).

8.3.3 Developing a conceptual model

A whole range of participatory methodologies have been developed by the different traditions of participatory analysis that meet the goals and other design criteria described in section 8.2 to a certain extent. Each methodology conducts the analysis in a specific way, has a unique stage model and uses specific tools and techniques. Each methodology has its own strengths.

The development of a participatory methodology for product evaluation will benefit from a general stage model, an overview of methods and techniques that can be used and information over key choices to be made. In this chapter, I will develop such a general stage model for participatory analysis and identify key variations in the stages on the basis of the existing participatory methodologies. The concrete methods and the techniques used in the different stages are listed and supplemented with ideas from the general literature on policy analysis.

I will try to indicate the advantages and disadvantages of a number of key choices. It is however hard to get a complete overview of the advantages and disadvantages of the different methodologies and choices. Authors and consultants often have intimate knowledge of one methodology and advocate it while they are ignorant of the power of other methods or are persistent in regarding the superiority of their method (Lane and Oliva 1998). Little
attempt has been made to clarify why methodologies yield success and to systematically evaluate and compare methodologies, with the exception of McCartt and Rohrbaugh (1989) and Vennix et al. (1993). In addition, a number of authors describe for which problems a methodology or tool is suitable (cp. Vennix 1996; Oliver and Lane 1998).

I used only methodologies from the Soft Systems and Responsive Constructivist Evaluation traditions to make a general stage model. These methodologies meet the design criteria and start from the same assumptions as the discourse paradigm. It is a conscious choice to use two traditions. A restriction to one participatory tradition is not advisable as methodologies within one tradition are rather similar and key choices might be overlooked. Including methodologies from more than two participatory traditions will easily result in a superficial and therefore not useful overview.

The goal in this chapter is to sketch a conceptual model of participatory study processes and methodologies. As a result, differences between different soft systems methodologies do not get a lot of attention. In practice there are many differences. For example, methods for building system dynamic models make participants aware of feedback relations and are especially suitable for long term problems that are dynamically complex (Vennix 1996: 104). The strategic choice method has a different nature and facilitates participants focusing on interactions between decisions and enables participants to design packages of decisions (Friend 1989). This method is especially suitable for problems that are difficult to solve because they are interwoven with other problems.

8.4 Outline of a participatory methodology

8.4.1 Stage model

The SS and RCE methodologies are based on the stage model visualized in figure 8.1 (Checkland 1989; Eden 1989; Grin et al. 1997: 60-61; Guba and Lincoln 1989: 184-187). Although we sketch the process here in a linear way, it has in practice an iterative character.

Figure 8.1 Steps in the participatory process

![Diagram](image)

Note: Iteration between the stages is often required

During the start up, analysts and clients identify the problem area and relevant stakeholders, determine the kind of study methodology that will be applied and invite stakeholder
representatives to join the study process. Next, analysts map or reconstruct different stakeholders' perceptions of the policy issue and analyze these further in a number of participatory processes. They add critical comments, their own perception or integrate the different perceptions into a joint perception. The analysts present the reconstructed perceptions and other information to the participants. The participants are asked to react on their own perception but also on other perceptions. The results of these discussions or interaction processes are used in subsequent interaction processes as usually a series of interaction processes are held. The final interaction processes focus on the development of consensus on concrete courses of action that are supported by as much participants as possible.

The heart of the study process is the interaction between stakeholders who hold different perceptions. The activities of the participatory process shown in figure 8.1 can be extended with the following side activities as participants can also learn in other ways (Guba and Lincoln 1989; Kelly and Maynard-Moody 1993):

- Defining information requests, collecting information and using the new information
- Organizing interaction processes between experts with specific knowledge and stakeholder representatives

Participatory methodologies can be distinguished on the basis of their communication mode:

- **Adversarial mode**: Participants are asked to uncover weaknesses in the perceptions of other participants in a critical debate. In this critical debate, participants will, in general, not imagine themselves in the perception of other participants because their main aim is to criticize other perceptions. They will defend their own perception as well as possible. The results of the critical debate -the perceptions, the critique and the defense- are used by the participants to develop a new, shared perception or solution. An example of this approach is the SAST methodology (Mason and Mitroff 1981).

- **Communicative mode**: Participants are stimulated to walk in each other shoes and attempt to arrive at a deep understanding of other perceptions. Participants are stimulated to translate their perceptions into a language understood by other participants and other perceptions into their own 'language'. Participants are open to the value of other perceptions and frames and do not repudiate these in advance. The questions of other participants and the increased, and deep insight into other perceptions will stimulate reflection on own perceptions. The insight in the different perceptions and the results of the reflection are the basis to develop links between perceptions and shared solutions. An example of this approach is the RCE approach, see for example the reports of Abma on an RCE process on activities for handicapped people (Abma 1995).

The adversarial style stimulates the development of a variety of ideas and policy plans and raises the level of cognitive conflict. This can be useful when conflict is absent and
participants tend to converge without an in-depth examination of the different possibilities (Vennix 1996). The communicative processes are meant to increase understanding of other perceptions and to use this knowledge to bridge the different perceptions. The communicative style seems most suitable when participants have different ideas and tend to dismiss ideas of others easily. They are encouraged to listen to each other without directly evaluating and dismissing the ideas of the other participants. The stage models of adversarial and communicative methodologies are quite similar: reconstructing perceptions and discussing them, but the concrete methods and techniques used are rather different. This will become clear when the different stages are discussed.

8.4.2 Starting up

A participatory policy analysis process starts with the following activities:
- Concluding a contract with the study sponsor
- Organizing the research work, e.g. forming a team of analysts and selecting the facilitator
- Identifying the problem area, nature of the conflict or uncertainties and stakeholders
- Evaluating the feasibility of a participatory analysis process

The first four steps have been described in handbooks for participatory methodologies (Grin et al. 1997: 62-65; Guba and Lincoln 1989: 188-204) and in general handbooks on policy analysis and project management (e.g. Hupe and Stanmeyre 1993). In a team of analysts, one can distinguish between a facilitator who is responsible for the process and content-related analysts such as LCA-experts and toxicologists (Vennix 1996; De Bruijn and Van Duin 1998). The choice of a facilitator is essential. He has a major influence on the success of the participatory process (McCatt and Rohrenbaugh 1989; Vennix et al. 1993; Vennix 1996). Mitroff (1983: 33) lists seven methods to identify stakeholders6. Evaluating the feasibility of a participatory analysis process is important, e.g. is there a sense of urgency and are actors sufficiently committed to such a process (De Bruijn et al. 1998). The feasibility is not a static feature. Analysts and stakeholders may improve the conditions for a participatory process.

The insights gathered during the starting up will help analysts and others involved in the study process to conduct the subsequent starting up activities. These consist of:
- Defining the goals of the participatory study process
- Selecting or designing the study methodology
- Selecting and inviting stakeholders to join the participatory process

Most handbooks do not mention the first two activities because they assume that the study conductors will automatically use the methodology that they have designed. As a range of methodologies exist, a rough idea about the goals and the methodology should be developed. One should also choose between a participatory and non participatory methodology.

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6 The seven methods are imperative, positional, reputational, social participation, opinion leadership, demographic and organizational.
The participants should be selected and invited for the study process. These participants should represent the network actors involved in the political discourse and other actors whose interests are at stake. It would be valuable to make a checklist of different types of stakeholders in product evaluations: governmental organizations, producers of raw materials and end materials, consumers and consumer associations, environmental organizations etc. In addition, experts with specific knowledge may be invited. It is also possible to let stakeholder participants select the methodology and invite the experts. This strategy increases the control of stakeholders over the process.

De Bruijn and Van Duin (1998) emphasize the importance of clear role definitions of the team of analysts, facilitator and participants in LCA processes and of clear goals.

8.4.3 Mapping stakeholder perceptions

A policy problem is often defined as the difference between the existing situation and a desired situation. Policy measures may help to bridge the gap between the two situations as shown in figure 8.2. Mapping the policy problem and the possible solutions is essential at the start of any policy analysis whether it is an expert or participatory one.

The value of the problem formulation and the design of alternative measures are often underestimated. Quade (1980: 23-43) notes that many policy analysts are often in such a hurry to get started on the ‘real work’ of the analysis, the data gathering and modeling, that they pay insufficient attention to formulating the problem. This can easily lead to analyses of the ‘wrong’ problem and alternatives. In addition, choices during the analysis are not clearly guided by a problem formulation.

Figure 8.2 The policy problem and alternative measures.

A number of key decisions have to made:

- Whose perceptions will be mapped?
- Which elements of perceptions will be mapped?

In a true participatory study process, perceptions of all the relevant stakeholders should be mapped. According to the discourse paradigm all the elements of the perception should be mapped: the concrete part and the frames, the ‘facts’ and the normative evaluations, the
current situation and the alternative measures. In some cases, a study process may focus on frames only or on the current situation only.

**Texts, interviews and workshops**

Methodologies used texts, interviews and/or workshops to map perceptions of stakeholders. Texts written by stakeholders are often used (Grin et al. 1997; Huff 1990). The best insight is derived when one analyses texts from different stakeholder representatives that are written for a variety of audiences because the texts used will always be linked to an actor’s agenda and the specific audience (Huff 1990:21). One should be aware that the texts may not completely reflect the mental image of an actor due to rhetorical strategies, e.g. by incorporating arguments about benefits of a certain action for others where the actor does not really expect these benefits to accrue. Information about fundamental ideas is often found in general documents of organizations.

Interviewers should focus on elements that they could not find in the texts analyzed or elements that remained unclear. Interviews are especially needed to get insight into the frames of stakeholders as frames often remain implicit in texts. Hardly any developers of participatory methodologies have proposed to use questionnaires or standardized interviews. These methods pre structure the process too much, are not able to accommodate different perceptions and do not create rich, conceptual pictures.

Interviewing stakeholder representatives can be organized in two different ways. In the first way, an analyst interviews a participant and reconstructs the participants perception. Subsequently, the analyst confronts the participant with the perception of other participants and asks for feedback. In this way, the interviewer not only maps perceptions but also organizes a first interaction process between different participants. This way of interviewing has been proposed by Guba and Lincoln (1989). In the second way, an analyst interviews participants but does not confront them with other perceptions (Grin et al. 1997).

A number of participatory handbooks suggest using a workshop to map perceptions. Participants are asked to provide input to make one or more conceptual models of the situation (Checkland 1989; Friend 1989; Vennix 1990 and 1996). In some methodologies, participants are divided in subgroups on the basis of their perception or organizational background and each group develops a picture of the problem and ideas about the desired policy (Mason and Mitroff 1981).

The following key decisions should be made:

- Should analysts map perceptions or should participants map their own perception at the start of the workshop or in another way?
- Use texts, interviews, workshops or a combination of these? This choice depends on a number of factors. Interviews cost more time but are often the only way to identify and map frames. They are needed when texts are not available.
Vennix (1996:130) advises to use interviews and texts when the facilitator has a limited experience with reconstructing perceptions. Starting from scratch in a workshop may be very ineffective in terms of time investment from participants. Furthermore, the facilitator becomes acquainted with the participants and the risk of surprises during the first workshop, e.g. the topic appears to be very political sensitive, becomes lower.

**Methods**

Perceptions about a policy are often very complex. Methods have been developed to structure the elements of perceptions. These methods help to uncover all the relevant elements and to present them in a systematic way. Methods used in SS and RCE methodologies are described below and supplemented with methods from the general literature.

A number of methods are based on the distinction between *problems and solutions* (Eden 1989; Grin et al. 1997). The policy model of Schellens and Verhoeven (1988) shown in table 8.2 is a good example. The RCE methodology (1989: 40) uses *claims, concerns and issues* to structure the mapping of perceptions. Claims are positive evaluations of specific measures or of the current situation by stakeholders. Concerns are negative evaluations of specific measures or of the current situation by stakeholders. Issues are measures or situations about which reasonable persons may disagree and the stakeholder has not yet taken a position. This approach enables analysts to get insight into the evaluations or judgments of the stakeholders of the existing situation and of possible changes to this situation. Normative aspects are explicitly included and related to factual aspects.

### Table 8.2 Policy problem and possible solutions

<table>
<thead>
<tr>
<th>The problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the problem of the existing situation under the current policies?</td>
</tr>
<tr>
<td>Why is this a serious problem?</td>
</tr>
<tr>
<td>What causes this problem?</td>
</tr>
</tbody>
</table>

*Alternatives*

<table>
<thead>
<tr>
<th>Which alternatives may possibly solve this problem?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why might these alternatives solve the problem?</td>
</tr>
<tr>
<td>What are the costs of the alternatives?</td>
</tr>
<tr>
<td>What are additional advantages and disadvantages of these alternatives?</td>
</tr>
<tr>
<td>Are the alternatives feasible?</td>
</tr>
<tr>
<td>Are they juridically and morally acceptable?</td>
</tr>
</tbody>
</table>

Figure 8.3 Causal diagram of effect PVC incineration on number of cancer patients

Legend: ovals show variables that can increase and decrease, the arrows show how a variable affects other variables, + = positive effect, - = negative effect.

The SODA methodology (Eden 1989) and the participatory methodology of Vennix (1990; 1996) use visual models to structure interview processes. The result of the interview is a visual model. Eden’s model is about goals and measures and includes normative and factual aspects in an interwoven way. The causal and influence diagrams describe how the participant views the existing situation. A causal diagram of the relation between incineration of PVC waste and cancer patients is provided in figure 8.3. An evaluation of this situation in terms of bad or good is not included in this model.

Visual models are valuable tools for mapping perceptions and are also thought to be good communication tools in workshops (Vennix 1990). Visual models from non-participatory traditions of policy analysis and other sciences can also be used to conduct interviews and present perceptions. The chain model that shows the processes related to the production, consumption and waste management of a product is, for example, a relevant model in a participatory environmental product evaluation and can be used to investigate and describe different perceptions on environmental burdens of products (VNCI 1991).
The methods mentioned thus far do not focus explicitly on mapping frames and one may overlook frames as they are often only implicitly present in the perceptions of actors. The following two interview strategies can be used to grasp frames (Grin et al. 1997: 39). An analyst may ask why participants define the problem in the way they do or why a solution is desired or why a specific effect is considered important. The concrete ideas and issues are used as starting point for the inquiry into frames. An analyst may also inquire directly into the frames of the participant, e.g.: How do you perceive nature?

Elaborating on the work of Rein and Schön (1993) it is possible to add a third strategy to conduct interviews and interpret texts. Rein and Schön argue that ‘naming’ is very important in framing (1993: 153-154). Specific expressions, phrases, symbols, concepts are often the clue to the frame. The expression ‘poisonous cocktail’ for chlorine is a clue to the frame of environmental organizations. Interviewers may ask the participant to make the ideas behind these expressions explicit: ‘Where does the expression stand for?’.

A fourth strategy is to confront participants with frames that have been made explicit elsewhere⁷ and ask them for reaction. In case of environmental product evaluation an analyst may use the frames described by the cultural theory (Schwarz and Thompson 1990) to initiate a discussion about fundamental ideas about nature and its relation to humans. This can also be done for fundamental ideas about the economy and other topics.

Methods from argumentation theory and other disciplines

The methods used in current participatory methodologies can be supplemented with methods from other traditions:

- Techniques from the field of document analysis (Grin et al. 1997; Joldersma 1991) and argumentation theory (Pröpper 1993; Pröpper and Reneman 1993: Rip et al. 1994; Schellens and Verhoeven 1988; Toulmin 1958) can be used. These techniques have been used to map stakeholder perceptions to explain the quality of implemented policies (Hoogerwerf 1984).

- Techniques from literature analysis and hermeneutics that treat perceptions as stories and result in rich descriptions. The policy analyst Roe (1989; 1994) used narrative analysis to map perceptions on policy problems.

- Creative methods that stimulate associative thinking and creative expressions of respondents or workshop participants (Abma 1995; Moore 1987).

The methods for reconstructing perceptions can support the conceptual modeling stage in expert product evaluations as well, see chapter 7.3.

⁷ Fundamental ideas of stakeholders can be found in philosophical studies, basic documents of organizations, literature on frames and on fundamental ideas prevalent in societies.
**Ways to present perceptions**

In a participatory methodology or study process, one should select a specific way to present the mapped perceptions. The RCE and SST traditions emphasized that the presentation should be transparent to the participants to stimulate a good discussion. SST developed and advocates an analytical approach, the RCE tradition advocates a narrative one. The concrete ideas are described below.

Soft system scientists present reconstructed perceptions usually in the form of visual models. Visual models combine verbal expressions with schematic expressions such as lines, boxes and arrows, points etc. Vennix (1990) and Eden (1989) argue that visual models are good communication tools as these models offer comprehensive overview and reveal the structure of mental maps, e.g. by clarifying relationships between elements. Visual models have been successfully applied to design policies with groups (Geurts and Vennix 1989; Rosenhead 1989) but most of these cases are related to company policies and the conformity of the group is relative large as all participants worked for the same organization. An exception is the use of the Strategic Choice Methodology. Here, visual models are applied successfully in the design of a national, environmental policy for liquid natural gas by a group of participants representing four different ministries (Hickling 1989).

The RCE methodology presents the results of the participatory process in the form of stories or journalistic articles (Abma 1995; Grin et al. 1997: 74; Guba and Lincoln: 224). This gives the reader a vicarious experience. In other words, the story enables the readers to imagine themselves in the situation described. Analysts may use creative writing strategies based on techniques such as scene by scene construction, character through dialogue, or the third person subjective view. In addition, Grin et al. emphasized the value of concrete examples, especially for discussion on frames and fundamental ideas. Video’s, replica’s, practical experiments and technical models can also be used to present perceptions (Grin et al. 1997: 75). These methods appear promising for transitive communication in which participants put themselves in the shoes of other network actors, whereas the visual, conceptual models seem most useful for analytical purposes.

**Selecting a strategy**

The literature on mapping stakeholders perceptions provides little guidance to choose a strategy. Each methodology proposes a specific way of working but the advantages and disadvantages are not clarified nor its application area. A theoretical basis that can guide the selection of a method to map perceptions is not available. At present, one must decide on the basis of common sense insights.

The strategy will depend on the elements of the perception that one wants to map, on the skills of the analyst and on the way the mapped perceptions will be used in the rest of the study process. Other important criteria for the selection of methods are a capacity to accommodate a variety of perceptions, its flexibility, the transparency of the method and its
results for participants. In the PVC case, a method that is able to clarify frames is probably the most helpful because a discussion on these is needed. A method that focuses only on the factual or causal aspects of the situation will be less suitable. In other cases, when the factual situation is for example not clear to the different participants, one may start with developing models about the existing situation, e.g. chain models or influence diagrams.

8.4.4 Processing perceptions

A number of methodologies analyze perceptions before they ‘feed’ them to the interaction process.

Critical comments

A number of methodologies generate critical questions and comments that focus on the pivotal assumptions in the perception. These comments are meant to stimulate a critical discussion on the perceptions, in other words, this approach fits in with the adversarial mode of communication. The SAST methodology (Mason and Mitroff 1981) is based on this principle\textsuperscript{8}. Participants are asked to design a policy plan. Next, they list the pivotal assumptions that underlie the policy plan that they have designed\textsuperscript{9}. Then, each group of participants is asked to make the strongest case for its policy plan by presenting the policy plan and ten most certain and most strategic assumptions and present this to the other groups\textsuperscript{10} (Mason and Mitroff 1981: 46).

Inspired by the SAST approach, one may think of other ways to provide stimuli for a critical discussion. For example:

- Other stakeholders prepare a reaction on a mapped perception
- Analysts pose critical, reflective questions

Joint Constructions

The RCE methodology focuses on the generation of a joint construction from multiple, reconstructed perceptions. First perceptions of different participants from the same stakeholder group, e.g. the environmental movement, are joined. What emerges is a more and more inclusive perception, which takes account of the inputs of each of the participants involved. When there is no consensus, competing insights are carried forward. The joint perception of each stakeholder group is checked by the participants of this group.

\textsuperscript{8} SAST was primarily developed for the design of companies policies. SAST focuses on assumptions about the current and future behavior of an organization’s stakeholders, e.g. clients.

\textsuperscript{9} Participants are asked to go from policy plan back to assumptions rather than from assumptions to strategy as is general done in policy analysis methodologies.

\textsuperscript{10} The groups do not present important, uncertain assumptions that underlie their policy plan to other groups. As a result, they do not to present their plan in a very open and vulnerable way. Other groups have to detect these uncertain assumptions during the interaction process.
Next, perceptions of different stakeholder groups are joined. This results in a joint construction and a list of claims, concerns and issues on which there is no agreement. This construction is also checked by the participants involved. The handbooks on RCE (Guba and Lincoln's 1989; Grin et al. (1997) are however not very clear on how analysts should actually construct joint perceptions\(^{11}\). Other methodologies combine different perceptions into one model, e.g. group model building and SODA, but do not make clear how they deal with fundamentally conflicting perceptions.

8.4.5 Discussing perceptions and developing consensus

Three categories of input for the interaction process can be distinguished:

- Multiple reconstructed perceptions
- Multiple reconstructed perceptions and critical comments from analysts or participants
- Joint construction combined with a list of conflicting issues

The authors on Soft Systems methodologies and on the RCE methodology do not describe which input is needed under which conditions. It might be sufficient to feed the interaction process with reconstructed perceptions when stakeholders have barely explained their own perception or when the reconstructed perceptions contain elements that were not discussed beforehand. In other situations, additional input in the form of critical comments or a joint perception might be needed. Critical comments seem suitable when one aims at a critical discussion. When actors tend to talk past each other and discuss in a polarized way, one may prefer to present joint perceptions and insight in courses of actions that try to achieve goals of different actors because a critical discussion does not aim at bridging different perceptions.

The following communication modes can be used:

- Direct: meetings in which participants exchange their ideas directly (e.g. Soft Systems methodology of Checkland). Many techniques for workshop discussions have been developed, for example nominal group techniques (Vennix 1996), and electronic group support systems (McGrath and Hollingshead 1994).
- Indirect: processes in which the analyst functions as intermediary. The analyst informs each participant on the different perceptions and asks for reaction. This can be done through conversations with each participant or through letters\(^{12}\).

A direct exchange of ideas in workshops might be difficult when participants do not trust each other or tend to hold a dialogue of the deaf. On the other hand, decisions can in general not be made when people do not meet directly. The RCE methodology combines the two

\(^{11}\) Inspiration might be found in the field of narrative analysis. Narrative analysts develop meta-stories from two or more conflicting stories (Roe 1994). These meta-stories reformulate the conflict and increase the latitude for agreement.

\(^{12}\) This approach is known as the Delphi procedure.

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approaches, the analyst functions first as intermediary and organizes subsequently a meeting for different participants.

After an exchange of perceptions, participants should be stimulated to focus on developing consensus with respect to a set of actions. The step from different perceptions to a shared policy plan is difficult, especially in a coercive situation. The step from a critical discussion to a constructive one in which the critique is used to choose a shared policy strategy or to build new policy strategies that combine ideas from different stakeholder groups is not really supported by the SAST methodology and other Soft Systems methodologies. Other participatory methodologies contain support for this activity as they focus on:

- Formulating conflicts and gathering information that may be used to adjudicate in these conflicts (Guba and Lincoln 1989: 185)
- Developing policies and courses of action that integrate different perceptions
- Negotiating policies at the end of the process (Guba and Lincoln 1989: 185)

The participatory study process will, in general, end with a report on the policy problem and issue in which shared insights, key differences and promising courses of action are described. This report is designed to inform actors that were not involved in the participatory study process and can be used during a public policy process.

8.5 Workshop on organochlorines

The stage model, methods and techniques can be used to design a participatory study process on the environmental aspects of products. I used them to organize an experimental workshop on the environmental standards for organochlorines. This topic is very important for evaluating the environmental burden of PVC and this normative subject has not been dealt with in studies on PVC.

Actors in the Dutch PVC discussion have different opinions on the standards for organochlorines, see chapter four. Environmental organizations argue that emissions of all the organochlorines should be reduced to zero which implies that PVC needs to be substituted. The chlorine and PVC industry wants to apply an almost zero standard for organochlorines that have proven to be persistent, and toxic, and that bio-accumulate, and this standard does not necessarily lead to a low ranking of PVC products. The goal of the workshop was to learn about other perceptions, to reflect on the own perceptions, and to develop shared insights about the issue or about ways to solve the conflict. A complete report of this workshop can be found in appendix 6. Here, I will highlight a number of choices in the workshop design and their consequences. The report is based on observations, workshop tapes and on a post workshop survey among participants.
The following participants attended the one-day workshop: two participants of the Ministry of the Environment, one from the environmental organizations, two from the chlorine and PVC industry and two experts. Interviews and texts were used to reconstruct perceptions. The perceptions of the Ministry of the Environment, the environmental organizations and the chlorine industry were presented as visual argumentation models. An argumentation model shows a central claim and a number of arguments that lead to this claim. Argumentation models were selected because they present normative and factual arguments in an interwoven way.

The workshop was divided into two sessions. A morning session concentrated on the assessment framework. The afternoon session focused on the properties of organochlorines. In each session, the participants were asked to comment on the arguments in the argumentation models of the environmental organizations, the Ministry of the Environment and the chlorine and PVC industry. An electronic discussion system was used which gave each participant an equal chance to react. Next, the facilitator summarized the comments on each argument and the group discussed the issues verbally.

In the verbal part of the morning session, the arguments in the models were discussed step-by-step discussed by the participants. Participants agreed on the grounds in the models but needed more clarification on terms such as persistent and bioaccumulating. They did not agree on the final claims in the models but were able to discuss them constructively. An interesting learning results was the discovery that all the actor groups agreed that substances that were toxic, persistent and bioaccumulating needed to be reduced to a zero or almost zero level. Another interesting result was the development of proposals for the amount of evidence needed to consider a substance as being toxic, persistent and bioaccumulating and apply the zero-standard. Two new proposals of an intermediary nature were added to the existing proposal of full proof based on risk assessment (industry) and the proposal to regard all organochlorines problematic on the basis of the precautionary principle (environmentalists). The morning session was constructive and participants learned from it. A number of participants were very knowledgeable on the issue discussed and where able to stimulate the group learning process. Even the discussion on conflicting arguments was constructive. I presume that the fact that the approach and models used focused the discussion on individual topics and not on the complete issue contributed to this.

The afternoon session focused on the properties of organochlorines. The central question was: should the whole group of organochlorines be considered as toxic, bioaccumulating and persistent or only a number of organochlorines? The topic of the afternoon session appeared to overlap with the discussion in the morning session. As a result, the participants were less motivated to discuss the argumentation models step-by-step and said they had discussed this issue before. The participants started to discuss how new research could be organized to get more insight into the properties of organochlorines. The new discussion was in itself interesting and led to new insights for a number of participants, but
did not help to create solutions that were supported by all participants. The participant from the environmental organizations was more or less withdrawn from the discussion as this participant did not agree that more research was needed. This situation was partly due to the unbalanced representation of participants. Due to the sickness of the representative from the consumers organization, the representative of the environmental organization was the only person with a divergent view on a number of topics, e.g. on conducting additional toxicological research. Reflecting back, I think that the facilitator should have reacted to this unpleasant situation for the participant of the environmental organization. During this discussion, the facilitator could have checked if all the participants were satisfied with the discussion. The afternoon session was found to be not very successful because participants did not focus on developing ideas that could solve the conflict.

The speed of the workshop as a whole was experienced as low by the participants and needs improvement. This is caused by the fact that participants are acquainted with each other perceptions in the PVC case. The workshop also shows that the step from discussing different models did not automatically lead to the development of shared ideas and proposals for conflict resolution. This step needs more support. I expect that the discussion will be more effective and efficient when the analyst identifies the nature of the conflict beforehand or develops proposals to solve the conflict. A number of other factors that influenced the success of the workshop such as the use of an electronic discussion medium are discussed in appendix six.

8.6 Towards participatory product assessment

The experimental PVC workshop shows that the stage model and methods are in principle applicable for participatory studies on issues related to environmental product evaluation. Specific methods and techniques need to be selected during the design of a participatory methodology or during a study process. I have listed the choices that have to be made with respect to the different stages in table 8.3. A number of the choices listed focus on the goals and content of the process while the other choices have a methodological nature.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Key choices</th>
</tr>
</thead>
</table>
| Starting up   | • What is the policy problem and which stakeholders are involved?  
• What are the goals of the participatory analysis? Learning, frame reflection, developing shared courses of action?  
• Is a participatory process feasible?  
• What kind of communication process is aimed at? A process that stimulates participants to put themselves in the shoes of other participants or a critical discussion?  
• Who will organize the interaction process, facilitate it and conduct analytical activities?  
• Which stakeholders should participate?  
• Should experts participate in one or more phases of the participatory process?  
• Which methodology or procedure is followed? |
| Mapping perceptions | • Whose perceptions will be mapped?  
• Which elements of perceptions will be mapped?  
• Will analysts or participants reconstruct perceptions?  
• Are texts, interviews or workshops used?  
• How are the perceptions reconstructed and presented? As visual conceptual models or as stories? |
| Processing    | • Are critical comments added to the perceptions?  
• Do analysts construct a joint construction or show relationships between different perceptions? |
| Discussing    | • What input is used? Perceptions, critical comments on perceptions, or joint constructions?  
• Will participants interact directly in a workshop or will analysts organize a dialectic circle? Which tools and techniques are used?  
• Is an adversarial or communicative approach used?  
• Which strategy is followed to design policy plans on which different participants agree? |
| Reporting     | • Will the intermediate and final results be reported and by whom?  
• When will the participatory study process end? |
| Side activities | • Is it valuable to collect information from other sources and confront participants with this information?  
• Is it valuable to do additional research? |

Based on the literature review and the PVC workshop, the following issues are recommended for further research:

• Strategies for creating and maintaining trust and respect, and for management of study processes in which multiple strategic behaving actors is hardly studied in the literature on
participatory analysis. Insights from other disciplines, e.g. public management (e.g. De Bruijn et. al. 1998) are useful but need to be translated.

- The development of a step after a critical discussion about perceptions in which a shared perception is created and the way analysts may create joint constructions of different perceptions remain unclear in the SST and RCE literature and research is recommended.
- Development of specific guidelines for environmental product assessment such as a checklist of potential participants will increase the value of the stage model. Techniques and methods of the LCA methodology can be used in the stage mapping perceptions, e.g. the chain model, and for the side activity ‘further research’. In a number of cases, it may be valuable to calculate certain environmental impacts mentioned in the conceptual models to get an idea of the magnitude of these environmental impacts.
Conclusions and recommendations

'Policy analysis produces reasoned arguments about public policy. Policy arguments, which reflect why different segments of community disagree about alternative courses of action available to the governments, are the main vehicle for conducting debates about public policies.' (Dunn 1981: 40)

Life Cycle Assessment (LCA) methodologies are used to assess the environmental burden of products from an integral chain perspective. The LCA methodology and LCAs have a number of specific features, such as a focus on integral report marks, ecoprofiles and rankings. The approach is comprehensive and formal, quantitative methods are often used. LCAs are amongst others used in public policy processes about product oriented measures. Their use in public policy processes is, however, problematic. The goals of the research presented in this thesis were:

- to identify and explain the problems encountered in making and using LCAs in public policy processes
- to define development directions for methodologies for environmental product assessment and
- to design a participatory methodology for product assessment

A three step research approach was used. First, current LCA practices were studied: the nature of the LCA methodology, the theoretical and practical difficulties of achieving objective and decisive answers and the problems of using LCAs in the public policy process regarding the viability of PVC. Second, two paradigms on sound policy making and analysis, the rational paradigm and the discourse paradigm (Dryzek 1990; Fischer and Forester 1993a), were identified and compared, leading to an evaluation framework for current LCA practices and a proposal for new development directions for methodologies for environmental product assessment. Third, I developed a general outline for a participatory methodology for
environmental product assessment. The conclusions of this research are presented in section 9.1 to 9.6. I reflect on the methodological approach in section 9.7. Recommendations for policy makers and researchers are presented in sections 9.8 and 9.9.

### 9.1 Difficulties in performing LCAs

A literature study on the LCA methodology shows that difficult choices, choices that can not be made in an objective and decisive way, have to be made in all the stages of an LCA, these choices are listed in table 9.1.

**Table 9.1 Difficult choices in LCAs**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Difficult choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal and scope definition</td>
<td>• Selection of product alternatives, e.g. which criteria should the alternatives meet to be an adequate alternative?</td>
</tr>
<tr>
<td></td>
<td>• Specification of products, e.g. weight, materials used, life time</td>
</tr>
<tr>
<td></td>
<td>• Determination of the basis of comparison.</td>
</tr>
<tr>
<td>Inventory analysis</td>
<td>• Geographical and time aspects of product and product chains.</td>
</tr>
<tr>
<td></td>
<td>• Boundaries of product chains with the environment and with other product chains.</td>
</tr>
<tr>
<td></td>
<td>• Processes to be included in the analysis, should transport, and storage be included?</td>
</tr>
<tr>
<td></td>
<td>• Specification of production processes, e.g. what to do when different technologies are in use or when emission data apply to another country or time period?</td>
</tr>
<tr>
<td></td>
<td>• Specification of consumption processes, i.e. how does the consumer use the product?</td>
</tr>
<tr>
<td></td>
<td>• Specification of recycling and waste management processes, which processes will be in use when the product is discarded?</td>
</tr>
<tr>
<td></td>
<td>• Selection of allocation procedures.</td>
</tr>
<tr>
<td>Impact assessment</td>
<td>• Selection of environmental impacts to be included in the analysis.</td>
</tr>
<tr>
<td></td>
<td>• Level of aggregation of environmental impacts.</td>
</tr>
<tr>
<td></td>
<td>• Selection and operationalisation of environmental impact indicators.</td>
</tr>
<tr>
<td>Evaluation/interpretation</td>
<td>• Choice between weighted summation and other evaluation procedures.</td>
</tr>
<tr>
<td></td>
<td>• Selection of standardization procedure</td>
</tr>
<tr>
<td></td>
<td>• Selection of procedure to determine weight factors, e.g. should the weighing be based on monetary costs or social preferences?</td>
</tr>
<tr>
<td></td>
<td>• Interpretation of results and sensitivity analyses.</td>
</tr>
</tbody>
</table>
It is not possible to make these choices in a decisive and objective way, because analysts have to:

- make estimations because information is incomplete
- select elements to be included in the analysis because a fully comprehensive analysis is never possible
- use value judgements
- choose between different interpretations of the situation

As a result, LCAs conclusions are often not decisive. Product specification, determination of product lifetime, the selection of environmental impacts studied, the choice of a standardization and weighing procedure all may have a large effect on ecoprofiles and hence change the order of merit completely. Other choices such as the impact assessment or allocation model used generally affect the ecoprofile and ranking only slightly because these choices are related to only one process in the chain or only one environmental impact.

Conclusions in LCAs are value laden. Not only the evaluation stage has a normative nature, but many seemingly technical choices in other stages are commonly based on values as well. For example, when one chooses an indicator for abiotic depletion that includes only materials that will be depleted within 100 years, the depletion of materials with reserves that will last for more than 100 years is not seen to be problematic.

One may argue that conclusions of LCAs are not decisive because LCA is a young science. There is no reason to be too disappointed. Things will become better in the future, this is normal for a new methodology. I expect that a number of choices will become easier, because a number of options and methods will be generally accepted whereas others ‘die out’ because they are regarded as wrong. Many difficult choices will however remain because uncertainty remains large, especially in the area of the relationship between emissions of substances and environmental impacts. Even when our body of knowledge grows, new uncertain effects will pop up, such as the hormonal mimicking effects of dioxins and other substances recently did, and overall uncertainty remains the same. In addition, people will continue to adhere to different logics and prefer different choices.

The difficulties in achieving authoritative conclusions in LCAs are even larger than table 9.1 shows. Environmental issues are defined and structured in a certain way by the methodology. Effects that can not be quantified are easily ignored and there is a tendency in the methodology to abstain from action in case of uncertain environmental effects. Conclusions based on this approach are not authoritative for people who view nature as ephemeral and want to apply a precautionary principle.
9.2 Difficulties in using LCAs in public policy processes

A case study into the use of LCAs on PVC products in the Dutch PVC discussion was made. Actors used rankings and ecoprofiles of LCAs to substantiate their claims on the problems of PVC and the required policies. Other network actors, however, did not accept results from LCAs that were not in line with their own ideas by pointing to methodological shortcomings, results of other LCAs and the vested interests of the commissioners and sponsors of the LCA. A polarized discussion on the ranking of products and the quality of the results of the different LCAs was often the result.

Actors referred hardly to other elements or insights from LCAs. Two factors may explain this behavior:

- Information contained in LCAs on PVC was often obscure for actors who had little expertise in the LCA field and they were not able to understand the implications of the formal methods used.
- LCAs did not contain information on key issues such as the feasibility of PVC recycling, and hormonal mimicking effects of plasticizers, they contained simplified pictures of the environmental aspects of products that were not substantiated with arguments.

Clearly, the LCA methodology and results of LCAs were not a neutral instrument in the PVC discussion. The first reason is that some of the network actors were involved frequently in study projects and were able to influence the outcomes of LCAs as they advised analysts on the choices that were not prescribed beforehand by the methodology. A correspondence between the outcomes of LCAs and the position of the client and steering committee members in the PVC discussion was noted; The 13 LCAs on PVC products and the studied alternatives were never very negative regarding products of clients or steering committee members. The second reason is that LCA methodology frames issues in a specific way. The LCA methodology requires formal, quantitative proof for toxic effects. Uncertain effects, e.g. hormonic mimicking effects, were not considered to be a reason to rank PVC lower in the order of merit. Environmental organizations apply a different frame, they use a precautionary principle and consider all the organochlorines to be toxic, persistent and biomagnifying until evidence to the contrary has been provided.

9.3 Sound policy making and analysis

Practical experiences with LCAs have pointed to several problems. As mentioned before, a normative framework or theory is required to interpret current LCA practices, to identify problems of LCAs and to define methodological improvements. Insights from the policy sciences may help to get more insight in sound policy making and sound analysis for policy
makers. Fierce discussions about criteria for sound policy making and analysis have been held in the policy sciences. Different paradigms exist that have their own view on the nature of public policy processes and the function of studies.

Rational paradigm
Currently, the rational paradigm is dominant in the international LCA community and has guided and still guides the development of the LCA methodology. The rational paradigm consists of three fundamental assumptions about the policy process, about inquiry, and about the function of studies in policy processes (Fischer and Forester 1993; Majone 1989; Lindblom 1959):

- **Unitary actor model:** Public policies are formulated by a unitary policy maker or a group that acts as such who acts rationally, i.e. has consistent and hierarchically ordered policy goals and selects the policy that performs best. This is also considered to be the normative ideal. This idea is amongst others expressed in the ambition of fixed weight factors for environmental impacts.

- **Positivist or neo-positivist inquiry paradigm:** Objective analysis is possible or should be striven for. This is expressed in the idea that scientists should not be involved in the evaluation stage of LCAs and in the emphasis on formal, quantitative methods.

- **Instrumental, objective function:** Analyses should provide objective information that provides instrumental guidance to the unitary policy maker, i.e. analyses provide conclusions that can be adopted directly by policy makers that translate these conclusions into policies. This is expressed in the idea of overall report marks and rankings and the quest for decisive conclusions.

Scientists who adhere the rational paradigm support the basic features of the LCA approach, e.g. comprehensiveness, focus on integral report marks and quantitative ecoprofiles and use of scientific methods. The key problems of current LCA practices are the inconclusive and subjective nature of the conclusions. Improving the information basis, standardizing and formalizing the methodology are proposed to solve these problems. Most LCA scientists argue that a critical discussion on the quality of the conclusions is needed. Transparent presentations of results, sensitivity analyses and social procedures such as participatory analysis and peer reviews are proposed to stimulate this. Due to the problems in achieving decisive results, LCAs are increasingly being viewed as a basis for a discussion.

Discourse paradigm
The discourse paradigm acknowledges the discussion function of studies in public policy processes. The fundamental assumptions of this paradigm differ a lot from the rational assumptions. The three fundamental assumptions are (Fischer and Forester 1993; Guba and Lincoln 1989; Majone 1989):

- **Network or discourse model:** Public policies are developed during discourses in which different governmental and social actors are involved. This is also considered to be a
normative ideal, a network of actors brings more, varied and broader knowledge to a policy problem. Policies are better ‘tested’ via confrontation with different perceptions and interests and actors can develop policies that accommodate different perceptions as mutual adjustment processes are set in motion.

- **Postmodern inquiry paradigm**: Objective knowledge is not possible because culturally determined frames of humans influence interpretations. A frame is defined as a perspective that is used to make sense of situations and treats some topics as more salient than others. A frame defines problems in a unique fashion and includes particular value judgements, and in general interprets the world in its own particular and partial way. Frame dependent and value laden evaluations are a very valuable input for public policy making processes because they reflect why different actors disagree about alternative courses of action available to the governments.

- **Normative, argumentative function**: Studies on policy problems and alternatives should acknowledge their normative and frame dependent nature and make normative issues explicit to provide a sound basis for an open and rich discussion. Studies can be used to advocate certain perceptions and function as vehicles for discussion.

The assumptions of the rational and the discourse theory are summarized in table 9.2. In practice, a continuum of ideas between the extremes of the rational and the discourse paradigm exist.

### Table 9.2 Basic assumptions of the rational and the discourse paradigm

<table>
<thead>
<tr>
<th></th>
<th>Rational paradigm</th>
<th>Discourse paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode of policy making</td>
<td>Unitary policymaker</td>
<td>Network of interacting actors</td>
</tr>
<tr>
<td>Inquiry paradigm</td>
<td>Positivistic or neo-positivistic</td>
<td>Postmodern</td>
</tr>
<tr>
<td>Function of analyses</td>
<td>Objective</td>
<td>Normative, argumentative</td>
</tr>
<tr>
<td></td>
<td>Instrumental guidance</td>
<td>Basis for discussion</td>
</tr>
</tbody>
</table>

I have chosen the discourse view on sound policy making and analysis as a basis to evaluate the experiences with LCAs in public policy processes because:

- A network of actors is, in fact, involved in the development of public policies on environmental product measures such as ecolabels and banning orders. This is also considered as a normative ideal because a network of actors brings more, varied and broader knowledge to a policy problem.

- A pre-environmentalist and an environmentalist frame may be used to perceive and interpret environmental risk. In the environmentalist frame, uncertain environmental effects are a reason to take environmental measures because precaution is needed. Pre-environmentalists want to act only in case of sufficient proof. This illustrates that humans are actively involved in the ‘construction’ of knowledge on environmental problems.
• The positivistic conception of knowledge is not an ideal to be followed for policy analyses because objective, distant knowledge does not fit in with human, political responsibility (Geertsema 1992). Values and frames do not get enough attention in positivistic studies.

The discourse perspective is therefore used in this thesis to evaluate current LCA practices and to improve the methodology for product assessment. A shift from the rational concept of policy analysis to a post modern, discussion oriented concept has been made in many related disciplines, for example in the Technology Assessment discipline (Smits and Leyten 1988).

9.4 Shortcomings of LCAs as discussion agents

From the discursive perspective, it is not a problem that LCAs on PVC do not yield decisive and objective answers because the instrumental function of studies is only of secondary importance. It is much more important that the studies and the different results can be used as a vehicle for discussion. LCAs have, however, a number of limitations when one aims at a relatively open, rich and reasonable discussion on different perceptions on the environmental burden of products. These limitations are caused by a number of methodological features that are considered as ideal in the rational paradigm, see table 9.3.

Table 9.3 Problems of LCAs in public policymaking regarding PVC and chlorine and their main causes

<table>
<thead>
<tr>
<th>Problem</th>
<th>Main methodological causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulnerability for polarized use</td>
<td>• Apparent objectivity&lt;br&gt;• Precise, quantitative results&lt;br&gt;• Black box nature</td>
</tr>
<tr>
<td>Low information input</td>
<td>• Lack of attention for conceptualization at the start of the study process, and instrumental research approach&lt;br&gt;• Absence of justifying arguments, especially on normative choices&lt;br&gt;• Simplified and unclear conceptualization due to formal methods and comprehensive approach</td>
</tr>
<tr>
<td>Implicit frames and values</td>
<td>• Predefined conceptualization of the issue&lt;br&gt;• Emphasis on quantitative effects, formal proof with a certain nature</td>
</tr>
</tbody>
</table>

LCAs rankings and quantitative ecoprofiles are vulnerable to polarized use due to their claimed objectivity, the black box nature of the formal methods, and the precise, quantitative nature of LCA results. The polarized use of outcomes of LCAs has a negative effect on the reasonable nature on the discussion as the PVC case shows. Certain perceptions may be removed prematurely.
LCAs provided only low information input for the PVC policy discussion. This low information input can be explained by a number of factors. First, the LCAs tended to ignore key conflicts in the PVC discussion due to the lack of attention for conceptualization of the issue at the start of the study process and the instrumental, prestructured research approach. Second, LCAs often did not contain justifying arguments for the conceptualization of the PVC problem underlying the calculations or provided only formal, technical arguments that were neither informative nor persuasive. Third, many normative assumptions and frames underlying the conclusions remained implicit. This is a consequence of the emphasis on formal methods and of the idea that analysts are not allowed to make normative choices. Fourth, the conceptualization of the issues was rather superficial to allow calculation and a comprehensive assessment.

The third problem is that the LCA methodology frames environmental issues in a specific way. The methodology excludes perceptions and topics beforehand, this is called ‘premature closure’ (Geurts and Vennix 1989). The LCA methodology contains an implicit pre-environmentalist frame on toxicity as uncertain effects were not a reason to act. The hidden nature of this pre-environmentalist frame especially hampers a sound discourse because the environmentalist precautionary frame does not get an equal chance.

There are several reasons to expect that the same type of problems may occur when LCAs are used in public discourses on other products. LCAs on other products will in general also yield conflicting results due to the many ambiguous choices that analysts make. They have in general the same features as the LCAs regarding PVC, e.g. the bias on quantifiable effects, instrumental application of the methodology, and seemingly precise results.

Recently, Tukker (1998) also evaluated the use of LCA methodology in the chlorine and PVC discussion from a similar perspective in which he pays attention to frames and the argumentative aspect of policy making. He argues that studies should be judged on their ability to identify or generate robust knowledge. Robust knowledge is knowledge that is scientifically robust and accepted by holders of different frames. Tukker concludes that LCAs are not able to generate robust knowledge on toxicity in the chlorine case and contains even a pre-environmentalist frame. Although robust knowledge is useful, I do not use robustness as a criterion because studies that are not robust are also valuable in discussions. I prefer to consider the quality of a study as a discussion vehicle as criterion and therefore identify different limitations of LCAs: low information input, vulnerability to manipulative use and the implicit nature of frames and values.

9.5 Argumentative and value laden product assessment

Adjustments of the LCA methodology are needed. The proposals of followers of the rational paradigm focus on strengthening the objective and decisive nature of LCA results. The quest
for objectivity has however dangerous sides. Facts and values are interwoven in environmental evaluations and facts are always influenced by frames or worldviews. Proposals to remove normative issues are dangerous because they result in pseudo-objectivity (Hofstetter 1998). The idea of decisive or authoritative conclusions is very appealing because policy making would become an easy endeavor, however, I view the existence of different rankings and comparative assertions on environmental products, as something that can not be changed and should not be changed, because a variety of perceptions is valuable. We should therefore be very careful with standardization. Standardization may suppress differences of perception or give certain perceptions little chance, which is undemocratic but it is also not productive because we can learn from different perceptions. Different opinions should not be suppressed in the name of consensus.

I think that LCAs should be adjusted to enable a sound discussion between different claims instead of focusing on authoritative, objective studies. From this perspective, polarized use, lack of policy-relevant information, implicit frames and premature closure are key problems. To prevent these problems and contribute to a more open and richer discussion, it is proposed to improve the LCA methodology by:

1. Adding a conceptual modeling stage
2. Defining emergent research questions
3. Explicating and studying values and frames
4. Increasing the variety of research methods and techniques
5. Presenting a verbal, transparent argument

First, it is proposed to add a new stage to the current LCA methodology before the inventory stage named ‘Conceptual modeling of the problem issue’ or ‘Mapping perceptions and clarifying frames’. The analysis will, as a result, become less instrumental and important issues will not be ignored as happens currently.

Second, research questions and research strategies should no longer be fixed in the methodology but should be allowed to emerge during the study process. For example one may ask in a PVC product assessment: Are the recent increases in infertility and related problems of hormonal systems caused by plasticizers and organochlorines? Should we search for more evidence or take action because precaution is needed? This can be realized by adding a stage ‘defining research questions’ after the conceptual modeling stage.

Third, it is recommended to study values and frames in an explicit way. This enables users of LCAs to learn in this area and to assess the true value of LCAs conclusions.

Fourth, it is considered valuable to increase the variety of research methods because this makes it easier to accommodate different perceptions and to support a discussion between them. A broader variety is also needed because current LCA models and techniques are not able to deal with all the research questions emerging in different contexts. For example, the development of methods to determine environmental impacts and compare different products that are based on an environmentalist, precautionary frame is important to equalize the positions of the chemical industry and environmental organizations.
Fifth, the transparency and relevancy of reports and arguments should be increased. Explaining the ideas implicit in the formal methods used is a positive step but it is in many cases better to use less formal methods, as these have often a reductionistic nature. It is preferred to give the final evaluation not in the form of one or more absolute figures but as a complex and balanced ‘story’. Conclusions need to be substantiated with arguments that may possibly convince the network actors involved in policy making.

The proposals above are directed at the study methodology or approach. Social procedures may also contribute to better LCAs and a better discussion on different perceptions. Participatory analysis is discussed in the next section.

9.6 Towards a participatory methodology

Value of a participatory product assessment
Involvement of stakeholders in study processes is a hot issue in the LCA discipline. Various experiments with participatory analyses are going on (Marion et. al. 1995). De Bruijn and Van Duin (1998) describe organizational procedures for stakeholder involvement. Participation of stakeholders is however not generally accepted, because frames, values and interests will influence the results. According to scientists who reason from an objectivist or rational point of view, independent scientists should conduct LCAs (Heijungs 1998; Wegener Sleeswijk 1998). In any case, involvement of stakeholders should be limited to normative issues such as goal setting and weighing of different goals. The scientific and objective qualities of the study will deteriorate when stakeholders are also involved in other parts of the study, for example in the impact assessment stage of LCAs (Heijungs 1998; Wegener Sleeswijk 1998).

The role that scientists and stakeholders may fulfill in a product assessment changes, however, in the light of the discursive paradigm. Product assessments are necessarily frame dependent and value laden. Many seemingly technical choices, such as the choice of the level of aggregation in impact assessment, are in fact normative. There is, therefore, no reason to limit the involvement of stakeholders and consider product assessments exclusively to be a task for scientists. LCAs can be made in an expert mode or in a participatory mode.

In a participatory mode, representatives of one or more actors will conduct the product assessment. The participatory process is meant to enable participants to:
1. Elaborate on and improve their own perception of a problem and possible solutions.
2. Improve their understanding of perceptions of other participants and gain insight into the differences and points of similarity between perceptions.
3. Develop (shared) insights on coping with the remaining conflicts between perceptions of the participants involved.

Participatory analyses have a number of advantages compared to analyses made by scientific experts:

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• The interaction between network actors takes place during the study process and not only after the publication of study reports.

• Participants can arrive at a course of action on which most stakeholders agree through consultation and negotiation (Checkland 1989; Mason and Mitroff 1981; Guba and Lincoln 1989: 10).

• Each participant possesses knowledge that can not be found elsewhere, e.g. experience, values, interests, lay insights, and intuition. This knowledge is a valuable input for the analysis (Mason and Mitroff 1981; Mayer 1997).

• Participants can continuously focus the analysis and discussion. This results in a policy relevant analysis (Mayer 1997; Geurts and Vennix 1989; Vennix 1990). Expert modes have also a number of advantages, e.g. fresh insights may emerge from them.

A participatory process is not always feasible. Actors may refuse to participate or their opportunistic behavior may hamper cooperation and a sound communication process. A participatory process is feasible under the following conditions:

• Participants trust each other and are willing to communicate in a reasonable way. These conditions will be often present when participants have more or less the same background but not when actors have diverging and even opposing perceptions and interests and operate in a political context (MacRae 1993; Schön and Rein 1994)

• Participants feel a sense of urgency to cooperate and are willing to take part in a participatory study process based on design principles that prevent strategic behavior (cp. De Bruijn et al. 1998). This type of process can be used when conditions of mutual trust are absent.

Designing a participatory methodology

Current LCA methodologies have been applied in a participatory fashion but these applications still preframed the issue and did not focus on the development of broadly supported solutions. Adjustment of the methodology for participatory analysis is therefore recommended. In this thesis, a general stage model for participatory analysis has been developed that can be used to design a methodology or concrete process for environmental product assessment, see figure 9.1. Iteration is of course needed. The model is based on Soft Systems methodologies and the methodology of Responsive Constructivist evaluation.

Figure 9.1 Stage model for participatory analysis
The key choices that have to be made regarding the set up of a study process are shown in table 9.4. A number of variants thus exist. Empirical knowledge on the advantages and disadvantages of different designs and the conditions under which they can be applied is, however, hardly available.

**Table 9.4 Key choices in the design of a participatory process or methodology**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Key choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting up</td>
<td>• What is the policy problem and which stakeholders are involved? • Is a participatory process feasible? Can conditions of mutual trust be created or are actors willing to take part in a participatory study process based on design principles that prevent strategic behavior? • What are the goals of the participatory analysis? Learning, frame reflection, developing shared courses of action? • What kind of communication process is aimed at? A process that stimulates participants to put themselves in the shoes of other participants or a critical discussion? • Who will organize the interaction process and conduct analytical activities? • Which stakeholders should participate? • Should experts participate in one or more phases of the participatory process? • Which methodology or procedure is followed?</td>
</tr>
<tr>
<td>Mapping perceptions</td>
<td>• Whose perceptions will be mapped? • Which elements of perceptions will be mapped? • Will analysts or participants reconstruct perceptions? • Are texts, interviews or workshops used? • How are the perceptions reconstructed and presented? As visual conceptual models or as stories?</td>
</tr>
<tr>
<td>Processing</td>
<td>• Are critical comments added to the perceptions? • Do analysts construct a joint perception or show relationships between different perceptions?</td>
</tr>
<tr>
<td>Discussing</td>
<td>• What input is used? Perceptions, critical comments on perceptions, or joint constructions? • Will participants interact directly in a workshop or will analysts organize a dialectic circle? Which tools and techniques are used? • Which strategy is followed to design policy plans on which different participants agree?</td>
</tr>
<tr>
<td>Reporting</td>
<td>• Will the intermediate and final results be reported and by whom? • When will the participatory study process end?</td>
</tr>
<tr>
<td>Side activities</td>
<td>• Is it valuable to collect information from other sources and confront participants with this information?</td>
</tr>
</tbody>
</table>
The stage model has been used to organize an experimental workshop on standards for organochlorine emissions, an issue important in the PVC discussion. Perceptions were reconstructed and discussed. Participants with different backgrounds learned from each other and developed new ideas. A major drawback of theory and methods in the participatory field is that the step from discussing reconstructed perceptions to generating new or shared ideas is not clarified and supported. This is especially important when participants have discussed issues endlessly and are becoming caught in a dialogue of the deaf. The advice to communicate and exchange perceptions is not enough. It is therefore interesting to use the idea to define new agendas (Van Eeten 1999), to improve theory and practice of participatory methodologies. A new agenda is designed to advance a set of questions, terms or items, which in contrast to the current agenda, enables a discourse that functions as a crosswalk for stakeholders.

9.7 Reflection on the study focus and methodological approach

The focus on the actual use of LCAs in public policy making process made it possible to study the problems that occur in this context and to design a methodology that fits in with the public policy context. The vulnerability of LCAs for polarized use would not have become clear from a study that focused only on LCA studies. The use of insights from the policy sciences on sound policy making and analysis made it possible to reflect on the goal and function of LCAs or product assessments in general and resulted in a proposal for redefinition of the goal of LCAs.

The focus has also a number of limitations. I used a policy analytic approach and focused on the improvement of the methodology for product assessment to provide better conditions for a sound public discourse. From a broader policy science perspective, there are many complementory strategies to improve public policy making processes. For example, changes at the institutional level may be much more effective in improving the policy discourse. Given my area of expertise, I decided to concentrate on the development of better study methodologies.

Two paradigms, the discursive and the rational paradigm, were central in this thesis. Network theory was also applied. For practical reasons, other theories about public policy processes and the use of studies in these processes were not taken into account. The application of other theories would probably have resulted in complementory, useful suggestions. For example, the use of a theory on the different stages in a policy process might have led to the development of different methodologies for different policy stages.

The empirical research on making and using LCAs had a specific focus, namely explaining why conclusions were not objective and decisive and what problems occur as a
consequence of rational features. As a result other problems of LCAs, e.g. their time consuming nature, were not central in this thesis.

The methodological approach used has strengths and limitations. A literature study was used to describe the problems in achieving objective and decisive conclusions. I supplemented the problems previously mentioned in literature with problems observed during the study of the LCA methodology. This resulted in an overview of difficult choices in LCAs of products. A number of the problems listed were not noted before, e.g. the effect of the selected standardization procedure on rankings.

A case study on the use of LCAs regarding PVC in Dutch public policy processes was used to identify the problems of using LCAs in public policy processes. The PVC public policy process has a specific nature, e.g. the environmental viability of PVC products has been discussed for more than 10 years, the high level of conflict between the actors, and the use different frames with respect to toxicity issues. The chance that LCAs cause problems in this context is extra large. The PVC case is therefore considered to be a ‘revealing’ case study that can be used to uncover the problems of the LCA methodology. The results of the PVC case study confirmed the problems of rational studies mentioned in the literature. It is plausible that LCAs on other products are also vulnerable to polarized use, ignore key issues and contain hidden normative choices.

In this thesis, the problems of using LCAs were identified and used as an empirical basis to argue that the discursive paradigm provides a good basis to adapt the methodology. Instead of this research approach, a comparison between a public policy process in which 'rational' LCAs were used and a public policy process in which studies that meet, more or less, the criteria of the discourse theory could have been made. The insight into the actual effect of argumentative, frame reflective studies on a public policy process would have strengthened the conclusions. This approach was however not possible because this type of product assessment was, as I far as I knew, hardly used in public processes when I started the empirical research in 1994.

9.8 Recommendations for policy makers

There are important reasons for policy makers to opt for a relatively open, rich and reasonable discussion. In this way, policy makers:

- can increase the democratic nature of public policy processes because different views are respected and taken into account during the formation of policies
- may test their views through the confrontation with other ideas and adjust their ideas and proposals
- are better able to achieve a broad commitment for certain policies
Network actors may fulfill two roles in a discourse. First, they may act as process managers who aim to create conditions for a sound discourse. Second, they may act as developers and advocates of certain visions. Often, network actors will fulfill both roles at the same time, e.g. the Ministry of VROM may act as process manager and develop at the same time a content related policy for a certain product.

A number of points of attention follow from our research for policy makers who want to advocate their vision in a communicative way and want to improve the conditions for a sound discourse:

1. Study methods should fit in with the values and frames of the organization. It is important to realize that the methods and techniques used in LCAs contain implicit values and frames and may result in ‘wrong’ conclusions from the organizations point of view. Do not choose directly for the LCA standard study approach but check if it is relevant, e.g. it may ignore certain key issues.

2. Studies can be used to disseminate the organization’s perception and to convince other network actors of the value of this perception, e.g. by commenting on the arguments of other network actors. Studies can be used also to search for solutions that are supported by other network actors.

3. ‘Premature closure’ at the start of the product assessment can be prevented. It is recommended to map the problem and possible solutions in a conceptual way and to make an overview of the perceptions of the different stakeholders. Subsequently, research questions and approaches can be selected that help to get more insight into the issue or provide the organizations with more arguments for their point of view.

4. The quality of the discussion will improve when network actors are stimulated to make studies that describe the values and frames used and provide a transparent, relevant argument for their conclusions. Prevention of the use of studies that are vulnerable to manipulative use is important.

5. Participatory studies can be used to get insight into different perceptions, to identify conflicts and to design policy measures that are broadly supported.

6. Studies and claims of network actors and experts are not objective, they are value laden and frame dependent views that reflect how different stakeholders and experts think about the environmental burden of products and the need for product policies in a certain field. From a democratic viewpoint, it is important to take the claims of other network actors seriously, i.e. by reacting on these claims in a communicative way.

7. The embeddement of participatory studies in the overall public policy process and good process management is important for their success.
9.9 Recommendations for future research

In this thesis, I have further developed discourse paradigm ideas on sound policy analyses and applied them to the field of life cycle assessment. I hope to contribute to the development of the LCA discipline and the discourse paradigm in this way. A number of recommendations for further research for the LCA and the discourse approach to policy analysis are made in this section.

LCA discipline
A number of topics for further research on methodologies for environmental product assessment can be recommended. These include:

- Normative ideas about sound policy making and sound analysis create a basis for the further development of the LCA methodology. Therefore, reflection on normative ideas, culminating in the development of design criteria for methodologies and studies, needs more attention than has been given in the LCA field so far.
- The instrumental nature of current LCA handbooks can be reduced by adding a new stage between the goal and scope definition and the inventory analysis stage in which a qualitative description of the problem and solutions is made. In addition, the important choices that are presently fixed by the methodology need to be explicated to leave decisions to analysts.
- In this thesis, I sketched a new development direction for product assessment methodologies but only started to operationalize it. New study methods may be developed, applied and evaluated. For example, methods and techniques to model environmental aspects of products in a conceptual way that supports the start of the study process. Insights from the policy analysis discipline may contribute in a generic sense, while the environmental sciences are relevant to the content related aspects.
- The development of methods to determine environmental impacts of products based on different frames is recommended, e.g. methods to determine toxicity that are based on a precautionary, environmentalist frame.
- Explication of normative judgements in product evaluations to make them more useful for an open discussion.

Discourse paradigm
It is important to develop concrete research methods that fit in with the discourse ideals and learn about their advantages and disadvantages. This will enable policy analysts to take an 'argumentative turn' in their daily practices (Sabatier 1995). Promising research topics are:

- Develop concrete methods that fit in with discursive ideals, e.g. stage models, and concrete methods and techniques to conduct the different activities such as mapping perceptions, frame reflection, and organizing a discussion between participants. The
development of ways to identify conflicts, reformulate conflicts and to develop shared solutions is especially relevant.

- Further research into the value of argumentation models to map perceptions and a comparison with other methods, e.g. the narrative approaches, and the way these mapping techniques can be used in participatory study processes is recommended.

- Evaluation of the actual contribution of studies and methodologies that are based on the discourse paradigm. Do these new methods contribute to a better policy discourse, what are their limitations? This evaluation can be used to review the list of design criteria specified in this thesis and support the improvement of study methodologies.

- More insight into the conditions under which certain participatory methodologies are successful will help policy analysts to understand when they should opt for a certain type of study and may help them to improve the conditions for a successful participatory process.

- Research into the embeddement of participatory methodologies in public policy processes and on management principles for participatory processes is required to improve the instrument of participatory analysis.
Appendix 1 Environmental impacts

The Dutch, public environmental policy focuses on eight environmental impacts. These effects are often called themes. The description of these environmental impacts is based on Heijungs (1992a), Adriaanse (1993), and Glasbergen (1994).

Climate change: Global warming and depletion of the ozone layer

The climate changes due to the greenhouse effect. The temperature of the earth increases due to the rising concentrations of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, chlorofluorocarbons (CFCs) and halons. These gases decrease the radiation of by the earth. This is called greenhouse effect or global warming.

The depletion of the ozone layer is also part of the theme climate change. The concentration of ozone in the stratosphere is low but very important because ozone blocks ultraviolet rays. Ultraviolet rays cause an increase in skin cancer, eye diseases, damage to the immune system of human beings and to plankton, which is of great importance for the food chain. A number of substances decrease the ozone concentration as they deplete ozone (O3) into oxygen (O2). The most damaging substances are CFCs and halons, which that stay for a long time in the atmosphere, in some cases more than 100 year. As a result, the depletion of ozone goes on even after the emission of ozone-depleting substances has been terminated and endangers the health of man, flora and fauna.

Acidification of the environment

The air is polluted with substances that may form acids. These acids cause immediate damage to buildings, materials, plants, man and animals. Indirect damage occurs via the soil and the water and results in a decrease in vitality of woods etc. The main potentially acid forming substances are SO₂, NO₃ and NH₃. Volatile organic components and hydrochloric acid may acidify the environmental as well. Ozone is not an acid but has the same effect.

Eutrophication of the environment

Excessive supply of plant nutrients in the form of phosphates and nitrogen compounds deregulates the ecological processes in water and soil. This is called eutrophication. For example, ponds and lakes may contain large quantities of algae due to the excessive plant nutrients, and this will result in a shortage of oxygen in the water and an intolerable climate for many plant species, fish and other animal species. The principal sources of pollution are manure, fertilizer, wastewater, sewage sludge, dredge spoil and solid waste. A shortage of plant nutrients has also adverse environmental effects because plants need them to grow.
Dispersion of toxic substances
The theme dispersion of toxic substances is related to the impacts of emissions of toxic substances except for those that are included in climate change, acidification and eutrophication and of genetically modified organisms. This theme is a ‘reservoir’ of environmental impacts Adriaanse (1993).

Disposal of waste
The theme disposal involves the collection, treatment, and destruction of solid and liquid waste-streams. It concerns especially: solid waste, radioactive waste, wastewater and contaminated soil. The problems of this theme have both a quantitative and a qualitative aspect; it concerns the huge amounts of waste and the release of harmful substances in the environment, e.g. releases of waste storage.

Disturbance of the local environment
The theme disturbance of the local environment consists of environmental problems in the daily housing and living environment such as noise, odor and risky activities, local air pollution and pollution of the climate inside buildings.

Dehydration of soils
Dehydration is a direct consequence of a low ground water level that results in adverse effects for the environment and the use of land. It is amongst other things caused by the use of water for agriculture, infrastructural works, extraction of sand.

Squandering of resources
Squandering of resources concerns the problems of the run out of natural resources such as raw materials and energy sources but also of the loss of woods, and wildlife.
Appendix 2 Four methods for standardization of ecoprofiles of PVC pipes

The ecoprofiles of PVC pipes and alternative ones that have been calculated in the FKS study (FKS 1995) and that are not yet standardized are shown in table A.1.

Table A.1 Ecoprofile of pipes of different materials that are not standardized

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>Glazed stoneware, class 160</th>
<th>Glazed stoneware, class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>340</td>
<td>670</td>
<td>1020</td>
<td>410</td>
</tr>
<tr>
<td>Critical Air Volume (CAV)</td>
<td>6300</td>
<td>10650</td>
<td>16150</td>
<td>8100</td>
</tr>
<tr>
<td>Critical Volume (1000 m3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Water Volume (CWV) (dm3)</td>
<td>2036</td>
<td>167</td>
<td>254</td>
<td>176</td>
</tr>
<tr>
<td>Waste volume (cm3)</td>
<td>4480</td>
<td>9630</td>
<td>14600</td>
<td>18830</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>3.0</td>
<td>0.47</td>
<td>0.71</td>
<td>1.60</td>
</tr>
</tbody>
</table>


I applied the following four methods to standardize these ecoprofiles:

1. Divide all the outcomes by the maximum outcome on that evaluation criterion
2. Equate the highest score with 1.0, the lowest with 0.0 and put the other scores on the scale in between
3. Divide all the outcomes with the score of the PVC product on that criterion, this method was used in the FKS study
4. Divide all the outcomes with the score of the glazed stoneware pipe of 62 kg on that criterion

The normalized or standardized ecoprofiles and the unweighted summation of the standardized scores are shown in tables A.2 to A.5. The order of merit using an unweighted summation of the four standardization methods is given in table A.6. This example clarifies the impact of the standardization method used.
Table A.2 Standardized ecoprofile using method 1

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>0.33</td>
<td>0.66</td>
<td>1.00</td>
<td>0.40</td>
</tr>
<tr>
<td>CAV (1000 m3)</td>
<td>0.39</td>
<td>0.66</td>
<td>1.00</td>
<td>0.50</td>
</tr>
<tr>
<td>CWV (dm3)</td>
<td>1.00</td>
<td>0.08</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>Waste volume (cm³)</td>
<td>0.24</td>
<td>0.51</td>
<td>0.78</td>
<td>1.00</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>1.00</td>
<td>0.16</td>
<td>0.24</td>
<td>0.53</td>
</tr>
<tr>
<td>Unweighted total score</td>
<td>2.96</td>
<td>2.07</td>
<td>3.14</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Table A.3 Standardized ecoprofile of PVC and other products using method 2

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>0.0</td>
<td>0.5</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>CAV (1000 m3)</td>
<td>0.0</td>
<td>0.4</td>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>CWV (dm3)</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Waste volume (cm³)</td>
<td>0.0</td>
<td>0.4</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>1.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Unweighted total score</td>
<td>2.0</td>
<td>1.3</td>
<td>2.8</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Table A.4 Standardized ecoprofile of PVC and other products using method 3

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>1.00</td>
<td>1.97</td>
<td>3.00</td>
<td>1.21</td>
</tr>
<tr>
<td>CAV (1000 m3)</td>
<td>1.00</td>
<td>1.70</td>
<td>2.56</td>
<td>1.29</td>
</tr>
<tr>
<td>CWV (dm3)</td>
<td>1.00</td>
<td>0.08</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>Waste volume (cm³)</td>
<td>1.00</td>
<td>2.14</td>
<td>3.25</td>
<td>4.20</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>1.00</td>
<td>0.16</td>
<td>0.24</td>
<td>0.53</td>
</tr>
<tr>
<td>Total</td>
<td>5.00</td>
<td>4.07</td>
<td>9.17</td>
<td>7.32</td>
</tr>
</tbody>
</table>
Table A.5 Standardized ecoprofile of PVC and other products using method 4

<table>
<thead>
<tr>
<th></th>
<th>PVC 50% recycled</th>
<th>Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>0.51</td>
<td>1.00</td>
<td>1.52</td>
<td>0.61</td>
</tr>
<tr>
<td>CAV (1000 m³)</td>
<td>0.59</td>
<td>1.00</td>
<td>1.52</td>
<td>0.76</td>
</tr>
<tr>
<td>CWV (dm³)</td>
<td>12.19</td>
<td>1.00</td>
<td>1.52</td>
<td>1.05</td>
</tr>
<tr>
<td>Waste volume (cm³)</td>
<td>0.47</td>
<td>1.00</td>
<td>1.52</td>
<td>1.96</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>6.38</td>
<td>1.00</td>
<td>1.52</td>
<td>3.40</td>
</tr>
<tr>
<td>Total</td>
<td>20.14</td>
<td>5.00</td>
<td>7.60</td>
<td>7.78</td>
</tr>
</tbody>
</table>

Table A.6 Ranking of pipes of different materials according to the four methods based on unweighted summation

<table>
<thead>
<tr>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
<th>Method 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GS 160</td>
<td>1. GS 160</td>
<td>1. GS 160</td>
<td>1. GS 160</td>
</tr>
<tr>
<td>2. Concrete</td>
<td>2. Concrete</td>
<td>2. PVC</td>
<td>2. GS 240</td>
</tr>
<tr>
<td>3. PVC</td>
<td>3. PVC</td>
<td>3. Concrete</td>
<td>3. Concrete</td>
</tr>
</tbody>
</table>
Appendix 3 Effect of weight factors on the ranking of PVC pipes

The standardized ecoprofile determined in the FKS study about pipes is shown in table A.7.

Table A.7 Standardized ecoprofile of pipes of different materials

<table>
<thead>
<tr>
<th></th>
<th>PVC recycled</th>
<th>50% Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (MJ)</td>
<td>0.0</td>
<td>0.5</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>CAV (1000 m3)</td>
<td>0.0</td>
<td>0.4</td>
<td>1.0</td>
<td>0.2</td>
</tr>
<tr>
<td>CWV (dm3)</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Waste volume (cm3)</td>
<td>0.0</td>
<td>0.4</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Depletion (kg)</td>
<td>1.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: based on FKS study (1995)

Different set of weight factors can be used to calculate integral report marks and to determine the order of merit of these pipes. The following two weighting procedures will be applied to the ecoprofiles of pipes of the FKS study and the results compared:
1. Weighting based on Thalmann weight factors
2. Unweighted summation: each environmental effect is given the same weight

The weight factors are shown in table A.8.

Table A.8 Weight factors of Thalmann and weight factors for unweighted summation

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Thalmann weight factors</th>
<th>Weight factors for unweighted summation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Energy use</td>
<td>0.35</td>
<td>0.20</td>
</tr>
<tr>
<td>2. Critical air volume</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>3. Critical water volume</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>4. Waste volume</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>5. Depletion of resources</td>
<td>0.05</td>
<td>0.20</td>
</tr>
</tbody>
</table>

*Used in the FKS study (1995) on pipes.

The integral report marks for both procedures are shown in table 9. The use of different weighting procedures results in different rankings. The recycled PVC pipe is has the lowest environmental burden according to the Thalmann procedure but is only the third best when unweighted summation is applied.
Table A.9 Integral report marks for four different pipes

<table>
<thead>
<tr>
<th></th>
<th>PVC recycled</th>
<th>50% Glazed stoneware class 160</th>
<th>Glazed stoneware class 240</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thalmann weight factors</td>
<td>2.5</td>
<td>3.4</td>
<td>7.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Unweighted summation</td>
<td>2.0</td>
<td>1.3</td>
<td>2.8</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Appendix 4 List of interviewees on the PVC issue

The respondents that were interviewed on the PVC issue in the period May till June 1995 are listed in table A.10.

Table A.10 Respondents interviewed on the PVC issue

<table>
<thead>
<tr>
<th>Name of the referent</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. J.W. Adrian</td>
<td>NVR and SPM</td>
</tr>
<tr>
<td>Mrs. W. Berends</td>
<td>VMD</td>
</tr>
<tr>
<td>Mr. W.L. Blanken</td>
<td>VNCI</td>
</tr>
<tr>
<td>Mr. H. Blaauwgeers</td>
<td>De Consumentenbond</td>
</tr>
<tr>
<td>Mr. Bovenkerk</td>
<td>VROM/DGM/SVS</td>
</tr>
<tr>
<td>Mr. C.J.G van Halen</td>
<td>VROM/DGM/Waste</td>
</tr>
<tr>
<td>Mrs. A. van de Ven</td>
<td>Greenpeace Netherlands</td>
</tr>
<tr>
<td>Mr. H.L.J.M. Wijnen</td>
<td>VROM/DGM/IC</td>
</tr>
<tr>
<td>Mr. B. Witmond</td>
<td>EZ/DGI</td>
</tr>
</tbody>
</table>
Appendix 5 Chain methodologies for specific target groups

A number of methodologies based on the integral chain philosophy have been developed for specific target groups, see Table A.11. These methodologies apply an integral chain approach and use the LCA methodology to determine the environmental impacts.

Table A.11 Chain methodologies for specific target groups

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Target Group</th>
<th>Literature Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Substance Chain Management (ISCM)</td>
<td>Cooperating group of companies, governmental actors and social organizations</td>
<td>VNCI 1991</td>
</tr>
<tr>
<td>The Chainbook(^1)</td>
<td>Environmental Ministry</td>
<td>Moor and Hazewinkel 1992</td>
</tr>
<tr>
<td>Systematically Tackling Environmental Problem Solving (STEPS)</td>
<td>Individual companies</td>
<td>Cramer 1993</td>
</tr>
<tr>
<td>Handbook Integral Chain Management for Companies(^2) (ICMC)</td>
<td>Cooperating group of companies from the same chain</td>
<td>Van der Kolk, de Man and Six 1995</td>
</tr>
</tbody>
</table>

The following activities recur in most chain methodologies:

1. *Formulation of the problem.* Emissions, the use of raw materials, and the use of energy sources in a product chain are mapped and the key environmental problems are determined. The problem formulation in a number of methodologies only focuses on environmental technical aspects. In other cases other aspects such as the environmental image of a product are also taken into account.

2. *Generation of alternative policies.* A variety of solutions for the problem are formulated: e.g. recycling, alternative products, and then a number of them are selected for detailed analysis using criteria such as: promising from an environmental point of view, feasibility, company fit etc.

3. *Assessment of the effects of the alternative policies.* The environmental effects are determined. A few methodologies can also be used to assess non environmental effects, e.g. economic costs.

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\(^1\) Dutch title: ‘Het ‘ketenboek’’.

\(^2\) Dutch title: ‘Milieugericht ketenbeheer door bedrijven’.
4. **Evaluation and selection.** Alternative solutions are ordered on the basis of the overall environmental burden and the best one(s) are selected. A number of methodologies use additional criteria.

5. **Implementation.** Plans for the implementation of the selected alternatives are made.

The four handbooks have a broader nature than the LCA methodology as they also cover non-environmental aspects of the alternatives and provide support for the organizational aspects of the study process. The LCA methodology is integrated in the chain methodologies. The ISCM methodology, the ICMC methodology, and the ‘Chainbook’ refer to the LCA handbook of the CML for content related aspects of the determination of the environmental effects of products and environmental measures. The STEPS methodology proposes its own LCA procedure (Cramer 1993).
Appendix 6 Report on a PVC workshop

1. Introduction

This appendix contains a description of a workshop on the environmental standards for emissions of organochlorines organized by the Policy Analysis Group of the Delft University of Technology. This workshop forms an illustration of a participatory study process on a normative issue important for the comparison of the environmental burden of PVC products with alternative products. Representatives of the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), the chlorine and PVC industries and environmental organizations participated in the workshop. The workshop was intended to enable participants:

- to develop their own perceptions further
- to learn about other perceptions
- to develop shared ideas about conflict resolution

The organizers used the workshop and its results to:

- Illustrate the general outline of participatory study processes presented in chapter eight
- Evaluate the effect of the specific approach used, e.g. visual argumentation models and electronic discussion mode, on the quality of the discussion and on achieving workshop goals.

The report of the PVC workshop is structured in the following way. The workshop goals and the workshop format are explained in section 2. The evaluation framework is described in section 3. The preparation of the workshop in section 4, the course of the workshop and the experiences of participants are described consecutively in section 5. This culminates in an evaluation of the workshop format in general in section 6.

2. Workshop goals and format

The general workshop format and the use of two specific instruments, visual argumentation models and an electronic discussion mode, are described in this section.
General workshop format

The focus of the workshop was on the environmental standards for organochlorines, such as dioxins, emitted throughout the PVC chain. The environmental organizations and the PVC and chlorine industry had different views on this issue. Environmental organizations claim that an absolute zero standard should be applied to all organochlorines while the other actors suggest different standards as described in chapter four of the thesis. The topic was chosen because it involves normative questions and is important in ranking PVC products and alternatives and in designing chlorine policies. The only way to achieve an absolute zero standard is by phasing out the use of PVC and other products made from chlorine while the almost an zero standard might be achieved by improvement of the production and waste management processes of PVC. The workshop was held in February 1996, it was not organized for a specific client nor were any of the network actors actively involved in the set up of the study.

The workshop on organochlorines was deemed to be successful when holders of different perceptions communicate in a sound and respectful way and when participants learn. The following three policy oriented learning goals are important, participants should:
1. Work out and improve their own perception of a problem and possible solutions.
2. Improve their understanding of perceptions of other participants and gain insight into the differences and similarities between perceptions.
3. Develop (shared) insights on coping with the remaining conflicts of the perceptions of the participants involved.

The workshop organizers designed the following stage model for the preparation of the workshop on the basis of the general outline of participatory processes presented in chapter eight of the thesis. The format consists of the following stages:
1. Identifying network actors.
2. Reconstructing perceptions.
3. Inviting participants.
4. Discussing multiple perceptions in a workshop.

The workshop input consisted of multiple reconstructed perceptions which where discussed simultaneously. Two specific characteristics of the workshop are discussed in the next subsections:

- the use of visual argumentation models to reconstruct perceptions
- the use of electronic discussion mode in combination with a verbal mode of discussion

Visual argumentation models

The workshop format is characterized by the use of visual argumentation models to reconstruct perceptions. There are different types of models that can be used to reconstruct arguments, for example:
- Toulmin models show one claim with its grounds, warrant, qualifier, backing and, rebuttal (Toulmin 1958; Huff 1990; Mason and Mitroff 1981: Schellens and Verhoeven 1988)
- Chain models visualize a chain like argument: grounds, claims and key claims and their warrants (Rip 1994)

A Toulmin model is shown in figure A.1. A claim is the explicit appeal produced by the argument, and is always of a potentially controversially nature. The qualifier tells us the degree to which we are to accept the claim as true. Grounds are used to support a claim while warrants show the connection between claim and grounds. Warrants are supported by backings. The rebuttal indicates circumstances in which the general authority of the warrant should be set aside.

**Figure A.1 Toulmin model**

![Toulmin Model Diagram](image)

Source: Based on Schellens and Verhoeven 1988, Toulmin 1958.

A chain model shows a sequence of arguments leading to a key claim, see figure A.2. The chain model provides more of an overview than the Toulmin model. A disadvantage is that it contains less detail.

Argumentation models were thought suitable for discussions on controversial issues because argumentation models:
- are mainly about what is credible, plausible and probable, but not self evident or generally accepted (Huff 1990: 356)
• can map both normative and factual statements and their relationships (Huff 1990; Pröpper 1993)
• make assumptions behind claims about the problem situation and preferred solutions explicit (Mason and Mitroff 1981)
• are closely related to the way actors think and communicate (Huff 1990)

The workshop organizers reconstructed the perceptions of different network actors as chain argumentation models because these models provide a good overview. It was thought that reconstructed perceptions provide enough stimuli to promote discussion of the issue at hand. The argumentation models were used because visual models are good communication tools as explained in chapter 8 of the thesis (Eden 1990; Vennix 1990).

Figure A.2 A chain argumentation model

Electronic discussion
Another characteristic of the designed workshop format is the combination of an electronic group discussion with a verbal one. The participants start with an ‘electronic discussion’ and carry on with a verbal discussion.

Participants used an electronic group support system (GSS)\(^3\) and sat at a U shaped table facing a large public screen, see figure A.3. Each participant had his or her own computer that was connected to a central server. The participant was able to type in

\(^{3}\) De Vreede (1995) has described the group support system extensively and Bots and Bras (forthcoming) the specific software used to discuss visual argumentation models.

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comments, read the comments of other participants, and react to the comments, thus communicating electronically.

Group support systems are often used to discuss problems of organizations and have recent also been used for public policy problems (Herik 1998). GSS scientists report the followii advantages of the use of electronic discussion tools: anonymity, parallelism and group memo (Dennis and Gallepe 1993). The organizers chose for an electronic discussion because they expect that it would allow each participant to bring in his or her ideas into the discussion efficiently.

Figure A.3 An electronic group discussion in session at the University of Technology, Delft

Few electronic discussions on visual models have been held before. Ackerman and Eden (1997) combine visual models and an electronic discussion mode but they use the visual models only to structure the electronic comments made afterwards. The organizers of the workshop developed software designed to support the discussion of the models of different network actors simultaneously. The participants could comment on multiple models by shifting from one model to another on their computer screen. The participants could read the electronic comments of others using a pop-up discussion list window, which showed a statement from the argumentation model and the comments made so far on this statement. Models of different actors usually contain arguments on the same topic or even exactly the same arguments. To prevent separate discussions on the same topic taking place and double comments, electronic comments on arguments about the same topic were presented in one pop-up discussion list.
The facilitator asked participants:

- to react to the boxes in the argumentation models that showed the grounds and claims
- to generate ideas on strategies to tackle conflicts about the issues presented in the argumentation models
- to comment on the electronic comments made by other participants

The facilitator advised the participants to start at the left hand side of the model and end by commenting on the conclusions given on the right hand side of the model. This advice was given because the organizers had learnt, in a prior experimental session with colleagues, that participants who start by commenting on the final claim make all their statements at this point, and do not divide them among the different arguments leading to the final claim.

**Verbal discussion**

Next a verbal discussion was held to elaborate on the information generated in the electronic discussion. The facilitator summarized the viewpoints on each of the boxes shown in the visual models on overhead sheets. Participants were asked to discuss these comments. Thus making the discussion follow the structure of the argumentation models: starting with the comments made on the ‘grounds’ at the left hand side of the model and ending with the conclusions shown at the right hand side of the model. The summary of the facilitator and a paper copy of all the electronic comments made, formed the input for the verbal discussion. A verbal discussion was thought to be useful because it allowed participants to absorb the information and to get a better idea of the support for certain ideas.

**3. Evaluation framework**

The workshop on the environmental standards for organochlorines was organized to reflect on the general outline for participatory processes presented in chapter eight in the thesis and to evaluate the specific workshop format presented in section 2, e.g. the use of visual argumentation models and electronic discussion tools in combination with a verbal follow up. Before I describe the workshop process and its results, I will clarify the evaluation framework used.
A workshop is considered successful if the communication process between the different participants is constructive and when the three goals mentioned in section 2 are achieved in an efficient way: (1) development of own perception, (2) increased insight into other’s perceptions and (3) the development of proposals for conflict resolution, are achieved in an efficient way. The workshop format is considered to be successful when it contributes to a sound communication processes and to the three policy oriented learning goals.

The relationships between the workshop format, the communication process, and the policy oriented learning goals are shown in figure A.4. This conceptual model is based on the models of Pinsonneault and Kraemer (1990) and McGrath (1984; 1995). The learning results of a participatory study process are shown at the right hand side. Other possible results of these processes such as changes in social relations are not shown in the figure. The learning results are influenced by the communication process, e.g. was it open and did each of the participants voice their ideas. The characteristics of the communication process are influenced by the workshop format and also by many other factors such as the qualities of the facilitator, and the composition of the group of participants. These factors are called input factors. Insight into the input factors, the characteristics of the communication process, and the learning results must be obtained to understand the contribution of the workshop format to the success of the workshop.

The evaluation of the PVC workshop is based on a variety of information sources: electronic and other documents made during the workshop, tapes of the workshops, the logbooks of the organizers and on a post workshop survey among the participants. This case study approach was used because information about the relationships between different factors is scarce and is often of a conflicting nature (Pinsonneault and Kraemer 1990).
4 Preparation of the workshop

The network actors involved in the general discussion on PVC were identified using a snowball method. References in texts and interviews with actors were used to identify other actors. Five major actor groups were identified in the Dutch PVC debate, see chapter four of the thesis:

- environmental organizations\(^4\)
- the Consumers Association (CB)
- the Ministry of Housing, Spatial Planning and Environment (VROM)
- the PVC and chlorine industry\(^5\)
- the Ministry of Economic Affairs (EZ)

It was decided to map only the perceptions of these key actor groups. Perceptions of actors that were less prominent in the PVC discussion were not mapped, for example those of the supermarket Alber Heijn and the operators of Dutch incinerators of household waste. Albert Heijn had reduced its use of PVC packaging and the operators incinerate the PVC waste that is discarded with household waste.

Reconstructing perceptions

Texts written for the general public or for institutional consumers were collected. There were plenty of texts available written by environmental organizations, the consumers organization and the PVC and chlorine industry. Texts produced by the ministries VROM and EZ were scarce and contained only statements on the desired policy but little on the rationale behind the desired policies.

Interviews were conducted with one or more representatives of each actor group. The interview were focused on the respondents’ perception of the environmental problems of PVC, the desired solutions and their consequences. The interviewer also asked how the respondents valued solutions proposed by other network actors. The respondents were not confronted with any other aspects of the perceptions of other network actors, and the interviewers did not focus on frames and worldviews behind the concrete ideas.

Organizations may give different descriptions of the situation for different audiences. VROM and CB told the organizers that they were taking stock of their official viewpoints\(^6\). Their internal viewpoints were thus not the same as the official one, e.g. VROM officially advocated limiting the use of non recyclable PVC for environmental reasons while the

\(^4\) The following environmental organisations are involved: Greenpeace Netherlands, Friends of the Earth (VMD), The Netherlands Society for Nature and Environment (SMN), Association for the protection of the Wadden Sea (Waddenvereniging), Environmental Federation of South Holland (ZHM).

\(^5\) This actorgroup consists of the VNCI, NFK, NVR, the Steering Group PVC & Environment, a number of sectoral organisations and a number of companies related to the production of chlorine and PVC.

\(^6\) Interview with representatives of CB and VROM.
Ministry internally was not sure if this was a good policy. The administrators of VROM provided information on their reflections while the Dutch Consumers Association informed the workshop organizers only of their official point of view. The added value of the interviews with representatives from environmental organizations, the consumers association and the PVC industry was relatively low because it did not differ much from the information that was available in the form of publicly available texts.

At this point, it became clear that it was not possible to deal with the complete set of perceptions on the use of PVC in one workshop. The organizers decided to focus the workshop on environmental standards that should be set for emissions of organochlorines such as dioxins. Environmental organizations claim that an absolute zero standard should be applied to all organochlorines while the other actors suggest different standards. The topic was chosen because it involves normative questions and is important in designing chlorine policies. The topic was selected without prior deliberation with the participants.

The workshop organizers used chain models to reconstruct perceptions on environmental standards. The claims made by each actor group on the environmental standards needed for organochlorines in texts and interviews were mapped and all the arguments for these claims. Only arguments concerning the content of the issue were included. Arguments such as 'The German Council of Environmental Experts is convinced that ...' were excluded. All arguments on the content of the issue were included, even if they were made only once. 'Symbolic' statements such as 'chlorine is a toxic cocktail' were not given a place in the argumentation models.

Models were made representing the perception of VROM, Chlorine and PVC industry and the environmental organizations. The perceptions of the consumer organization are quite similar to those of the environmentalists. The organizers did not make a model for the Ministry of Economic Affairs. This Ministry did not make its its perception on environmental standards explicit in texts and during the interviews, and at that time, it was not a specific interview topic because the workshop focus had not yet been selected.

The argumentation model of each actor was subdivided in two models: one about the standards for toxic and persistent chemical agents and one in which these standards were applied to the 'facts' about chlorine emissions. Without dividing them, they contained more than 15 statements and were too big to discuss as a whole. Most people find it hard to deal with more than seven items at once according to Miller (Checkland 1989; Miller 1956). The models on the standard are shown in figures 4 and 5. The models on the features of organochlorines in figures 7, 8, and 9.

Invitation of participants
The organizers of the workshop aimed to get proportional participation of two or three representatives from each actor group, however, it appeared to be impossible to realize this goal because only a limited number of people within each actor group are involved in the
chlorine and PVC discussion, e.g. only two persons within the consumer's organization. Seven representatives committed themselves to participating in the workshop which was made up as follows: Environmental organizations (1), Consumers Association (1), VROM (2), Chlorine and PVC industry (3) and EZ (0), see appendix 7. The Ministry of EZ did not participate because it was not the right time for a workshop from their point of view. Only one representative of the environmental organizations participated because these organizations lack time and manpower. In general, organizations do not give a high priority to a workshop free of obligations.

Of these seven representatives, five actually participated in the workshop: one representative of the environmental movement, two from the chemical industry and two from VROM. The invited representative of the consumers organization had to cancel due to illness and one representative of the chemical industry due to other urgent matters. Besides these representatives, three scientists had committed themselves to the workshop of which two actually participated. One of them was a natural scientist, the other a social scientist, both experts on the chlorine issue.

A paper presenting the argumentation models of VROM, the environmental movement and the chemical industry was send to the participants one week prior to the workshop.

5. Course of the workshop

The workshop was divided into two sessions:

- A morning session on the assessment framework
- An afternoon session on properties of organochlorines

Both sessions followed the same format: the participants started with an electronic discussion and carried on with a verbal one. The course of the two workshop sessions is described below.

The morning session

In the morning session, the seven participants made electronic comments on the statements in the models on the environmental standards, see figure A.4 and 5. The workshop organizers also made a few electronic comments in which they asked for further explanation of the statements made. After 75 minutes, most participants felt they were done. During this time, the group made approximately 80 electronic comments.
The electronic discussion on box 1-5 of the model of the environmental organizations and related boxes in the models of different actor groups focused mainly on defining the terms
toxicity, persistent and biomagnification and their relevance for the determination of a standard, see figure A.7 for an example. Although participants did not always agree with each other, there were no signs of fundamental controversies.

Figure A.7 Electronic Comments on Box 1

Box 1: Persistent Chemicals Agents remain for a considerable time in the environment
1. Per definition.
2. I agree, this is the definition of persistence
3. Can we call a chemical agent persistent when it is degraded after half a year?
4. A chemical agent with a half life of, for example, more than three months will accumulate in the environment. The precise boundary between persistent and non-persistent should be selected on the basis of advise from scientists.
5. Could someone provide a definition of persistent. Taking the expression literally, persistent agents do not exist, everything degrades ultimately. The question is for each substance: how long does it take before it is degraded?
6. A first proposal for a definition of persistence: A half life of more than three months. 50% of the emitted quantity is present in the environment after three months in this situation, 25% after 6 months, and 3% after a year. This 3% adds to the new emissions of that year.
7. I do not agree with statement 5: metals do not degrade.
8. Statement 4 and 6 good attempts but they lead to a definition of accumulation: one should not call a chemical agent persistent when the substance degrades more readily than the supply to the environment.

The participants had divergent opinions on boxes 6 and 7. The comments on statement 6 showed that the participants had different ideas about the burden of proof of toxicity, persistency and biomagnifying characteristics of emissions required before the government should establish a standard of zero emissions for these substances. The comments on statement seven showed that the participants preferred different specifications of the zero standard for very toxic, persistent and biomagnifying emissions: exact zero, almost zero and a number of other variants. This difference is quite crucial. The choice for exact zero implies that many plants related to chlorine must close down, while it is possible that they can remain open when an almost zero standard is selected because it is often possible to achieve this by waste water treatment and other measures.

The electronic comments could be divided into two groups:
• comments that reacted to the statements in the visual argumentation model, loose comments, e.g. comment 1 in figure A.6

7 Translated from Dutch.

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• and comments that were a reaction to previously made electronic comments, reactions, e.g. comment 4 in figure A.6 because it reacts to comment 3

The types of comments made in the morning session are shown in Table A.12. Only 13% of the reactions refer to an electronic comment that is also a reaction. This shows that chains of comments were very rare.

**Table A.12 Types of comments made in the morning session**

<table>
<thead>
<tr>
<th>Type of comment</th>
<th>Percentage of total comments (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose comments</td>
<td>50</td>
</tr>
<tr>
<td>Reactions to loose comments</td>
<td>37</td>
</tr>
<tr>
<td>Reaction to a reaction</td>
<td>13</td>
</tr>
</tbody>
</table>

Most of the electronic comments made were short, 67% of the comments made in the morning session were equal to or shorter than 2 lines.

*Verbal discussion*

After the electronic discussion, the facilitator summarized the different viewpoints mentioned in each box or set of boxes on overhead sheets and used this as input in the subsequent verbal discussion. The verbal discussion in the morning session could be characterized as a follow up of the electronic one. The statements in the argumentation models were discussed one by one, starting with the grounds at the left hand side of the model arriving finally at the key claim.

The discussion about the first model statements focused mainly on the clarification and specification of terms. During this discussion, it became clear that the group agreed that a zero level was only justified when a substance was persistent, toxic and had biomagnifying features. The different viewpoints were specified during the discussion about the other parts of the argumentation models. It became clear that the burden of proof required about the persistence, toxicity and biomagnifying aspects of substances to decide to implement a zero standard was an important source of conflict during the discussion about statements 6 and 7. Three proposals for the required burden of proof were designed and discussed. The natural scientist proposed implementing a zero standard for emissions that are known to be persistent and that are not proven to be non-toxic because it is relatively easy to conduct persistency test on emissions. This proposal was relatively new in the chlorine discussion and a number of participants appreciated the idea. This proposal was also presented extensively in the electronic discussion (8 lines) in the middle of the electronic session but no one reacted on it electronically.

Next, the group discussed a number of standards such as the zero=zero level and an almost zero level. One participant stated that the most important thing was the agreement on
the fact that one should strive for a zero level and considered a discussion about the rate as more import than about the choice between zero and almost zero. The facilitator asked the group which factors were important in determining the rate and as an exemplary factor, he mentioned the availability of alternative products. As a result of this example, the verbal discussion that followed no longer focused on the zero standard but on the availability of adequate alternatives for PVC products. A number of participants also discussed the lack of information on emissions by the PVC production and waste management and the discussion moved away from the issues mentioned in the argumentation models or in the electronic comments.

The afternoon session
The afternoon session focused on the properties of chlorine emissions. The three models shown in figures 7, 8 and 9 were discussed. The final claim of the environmentalists’ model was that ‘all the organochlorine emissions should be regarded as potentially toxic, persistent and biomagnifying’ whereas the other models made a difference between the different chlorine emissions as they determined the properties on a case by case basis.

Figure A.8 Environmental organizations argumentation model on features of organochlorines

11a There are many signals that organochlorines are toxic, persistent and bio-accumulating and cause serious health effects.

12 Effects of organochlorines become only clear after some time and the time between measures and effects is also long.

13a There is uncertainty about the environmental impacts of organochlorines, amongst others because knowledge on the behaviour these substances is lacking.

14a There is a good chance that other organochlorines also cause these effects.

15a A precautionary principle should be used, else measures won't be taken in time.

16a All organochlorines should be considered to be very detrimental (I.P.B), unless the opposite has been proven.

17a It has not been proved that organochlorines are non toxic.

18a A zero level of emissions of organochlorines should be strived for. This standard should be used to judge chlorine related chains and environmental measures.
The participants made about 90 electronic comments on the models showed on the computer screen. The comments were short and chains of comments were rare, as in the morning session. On the whole, the motivation of the participants was lower than in the morning, one stopped way before time. Opinions diverged on almost each statement in the models: not only on the key claims but also on the intermediate ones and on the grounds. All these differences could be traced back to the fact that some participants treated all organochlorines as a homogenous group whereas other participants saw organochlorines as a heterogeneous group.
One of the workshop organizers summarized the viewpoints to feed the verbal discussion. It was troublesome for the facilitator to start the discussion because the participants did not want to discuss the properties of the chlorine emissions nor the way one should draw conclusions about this, as group or on an individual basis. They said they had discussed these issues already in the morning session.

Finally the participants started off the discussion but they did not discuss the model statements and electronic comments one by one as in the first session. The participants from the government, industry and the scientists started to discuss possibilities to measure the
properties of chlorine emissions. A new method was proposed by the natural scientist. One of
the VROM participants was quite delighted with this idea. The participant from the
environmental organization kept quiet during this discussion.

At the end of this discussion, the facilitator asked if anyone had other essential points. Here the
natural scientists noted that the group had passed over the question of whether
organochlorines should be treated as a homogenous group or not, and asked the opinion of the
representative of the environmental organization about this. The representative of the
environmental organizations said that she was of the opinion that chlorine emissions should
be treated as one group but that further discussion would not help: ‘I don’t think we are able
to solve this here. The statements are too vague to enable this’.

Next, the facilitator asked the participants for their evaluation of the workshop. The
experiences of the participants are reported in the next section.

6. Experiences of participants

The description of the experiences of the participants is based on the remarks made by
participants during the workshop, the debriefing at the end of the workshop and a survey that
was filled in at home by the participants.

Six of the seven participants filled in the survey. The survey is shown in appendix 8. The
survey contained both open and closed questions. Most of the answers to the closed
questions were based on a five points scale. There was also a possibility to fill in that one had
no opinion.

All the respondents were positive about the atmosphere of the workshop and the
quality of the facilitator. All the respondents were of the opinion that they got enough room to
bring in their own insights. They considered the speed of the workshop to be rather low. Most
of the respondents evaluated the discussion as constructive and a meaningful way of filling in
time.

The participants were asked in the survey if they learned things regarding the
following areas:
• the topic
• ideas of other participants and the correspondences and similarities with their own
perception
• strategies to resolve conflicts

Asking in general, most of the respondents indicated that they did not learn very much. When
the workshop organizers asked the participants to mention concrete learning experiences, two

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8 The survey questions were specifically made for the PVC workshop.
out of six respondents indicated that they did not learn anything while the other four described a learning experience in each area. For example, they mentioned that they learned:

- that the conflict was mainly about the burden of proof
- that all participants agreed that substances with a toxic, persistent and biomagnifying nature had to be reduced to a zero level
- that a discussion over criteria for persistent, toxic and biomagnifying substances can be used to solve conflicts
- about a new idea on required burden of proof

Four of the six respondents would like to join a similar workshop, provided that a number of changes are made in the workshop format. Follow up workshops should be shorter or consist of two topics that are not related. The participant from the environmental movement did not evaluate the workshop as constructive and meaningful and did not want to join a similar workshop. She said at the end of the workshop: 'The workshop yields less for me than the time it costs me. A workshop follow up or a new one has no priority for me'.

VROM tried to organize workshops on other topics related to the chlorine discussion but there was not enough commitment to organize a follow up. One respondent would like to use the workshop method again, three 'maybe' and one respondent did not want to use the method again.

The debriefing of the workshop and the remarks made in the free comment space in the questionnaire gave interesting information about the participants' evaluation of the workshop method used. The participants appreciated the method used, the group support system, the visual argumentation models and the procedure followed, in quite different ways:

Participant A: 'The results are useful for a project for my organization but I wonder if we need this kind of sessions. In my opinion, the use of the electronic system interfered more than that it helped. The verbal discussion yielded more than typing in lines did'.

Participant B: 'The electronic tool has the advantage that the diverging discussion goes very quickly'.

Participant C: 'I experience the argumentation models as a limitation. I would like to add new boxes'.

Participant D: 'I judge the structure as terrific. A session where thing can diverge. You get everything on paper and you're able to look what the main points are'.

These comments show that a number of participants were enthusiastic about the combination of an electronic and verbal discussion. Others experienced the use of the electronic system and argumentation models as to rigid. The participants that were positive about the use of the electronic system and argumentation models were less acquainted with the viewpoints of the

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9 One respondent did not answer this question.
other participants\textsuperscript{10} than the ones that were negative. They valued the overview of opinions created by the electronic discussion as a good basis for the verbal discussion.

7. Evaluation

The results of the two workshop sessions on organochlorines are evaluated and explained in section 7.1. Next, the focus is on the effect of argumentation models on the communication process (7.2) and on the electronic discussion (7.3). Ideas for improvement of the workshop design are presented in section 7.4.

Workshop success

A workshop is considered successful when the communication process between the different participants is constructive and the three goals mentioned in section 2. are achieved in an efficient way. The overall picture of the morning session was:

- A constructive communication process was held in which all the participants were involved and exchanged their perceptions on both normative and factual aspects of the issue.
- The first two goals, further development of own perceptions and learning about other perceptions, were achieved but the results were not overwhelming. The description of the workshop course in section 5 shows that the group specified terms and developed new ideas, e.g. a new proposal about the type of evidence needed. A number of participants indicated that they learned about the issue and about other perceptions during the workshop but others said that they did not learn anything. All the participants found the speed of the workshop too slow.
- The results, with respect to the third goal, developing insights to deal with conflicts between different perceptions, were in general poor. The idea that persistence, toxicity and biomagnifying were important for defining standards and ideas on the required level of evidence were positive results that form a basis for conflict resolution.
- The description of the course of the workshop shows that participants discussed different perceptions but did not always define explicitly the conflict between the perceptions and develop ways to deal with these conflicts. The group did not discuss what the newly developed insights, e.g. what the proposals on evidence, could possibly mean for the different actor groups and for conflict resolution.

The morning session shows that the stage model of the workshop based on the literature research in chapter eight is feasible, and could be used to hold a constructive discussion on normative and factual aspects of PVC. The discussion was constructive because the

\textsuperscript{10} This was asked in the survey shown in appendix 8, questions 6-9.
administrators of the Ministry of the Environment and the natural scientist mediated between
the extremes of the environmental organization and the industries. The attitude of the
participants, the topic itself and the use of argumentation models form other explanations.

The stage model had the following limitations in the morning session:

- The exchange of perceptions got too much attention. The participants were already
acquainted which each others perceptions due to the previous discussions held on PVC. A
basis for learning about the conflict and conflict resolution was already available.
- The exchange of perceptions did not provide enough stimuli for participants to identify
conflicts and to develop shared proposals to deal with these conflicts. Reconstructed
perceptions appear to stimulate a discussion on the problem area itself and does not
provide enough stimuli to discuss and solve conflicts between perceptions.

The overall picture of the afternoon session was:

- Not all the participants were actively involved in the verbal discussion. The participants
from the industry, representatives of VROM, and the natural scientist developed ideas
about ways to measure the properties of chlorine emissions while the representative from
the environmental organizations was not actively involved in this discussion.
Consequently, the new research proposals were not attuned to the perceptions of the
environmental organizations which are, in general, not a proponent of more research on
organochlorines because this delays decisions.
- A number of participants developed their perception further and learned about the issues
involved, see the description of the experiences of the participants in section 6. The
different perceptions on the toxicity of organochlorines were however not exchanged
during the verbal communication process and participants did not identify and discuss
similarities and differences between these perceptions.
- The third goal, developing insights to deal with conflicts between different perceptions,
was not achieved.

This session was judged to be unsatisfactory because the communication process did not
focus on exchanging perceptions and developing consensus. The following factors explain
why the communication process was not satisfactory:

- The argumentation models and the electronic discussion showed divergent opinions but
these were not discussed verbally as aimed at in the workshop format. Participants did not
want to do this because of the seeming overlap with the topic of the morning session and
probably also because the participants were exhausted from the morning discussion, e.g. a
number of participants said they would prefer shorter workshops.
- The participants did not try to develop proposals and ideas on which they could possibly
achieve consensus. The workshop organizers did not make the goal of consensus or
conflict resolution sufficiently clear nor did they focus the group enough on this goal.
when the group was no longer following the workshop format.

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The representative of the environmental organizations was the only person present who had a divergent view on the value of more research. The representative of the environmental organizations did not mention her divergent opinion early in the communication process. This can be explained by the fact that the task of explaining and defending perceptions can exhaust people and that the participant did not expect much from such a discussion, e.g. she said 'I don't think we are able to solve this (the conflict, RB) here'.

Argumentation models
Different methods exist for the reconstruction of perceptions. The perceptions were reconstructed as visual argumentation models in the PVC case. The resulting models contain both normative and factual aspects in an interwoven way. Basic ideas such as the precautionary principle could be mentioned in argumentation models. The perceptions were well reconstructed but two drawbacks should be mentioned. The basic ideas or frames were not discussed in detail because the collected texts and interviews did not contain more information. In the case of the consumers association, it was difficult to get insight into the real perception. Respondents are not always willing to show their 'doubts' on their official point of view during interviews.

The argumentation models were used to facilitate the communication processes. An argumentation model breaks the conflict into different parts and has an disentangling effect on discussions. The model in the morning session focused only on the argument for the standard for toxic, persistent and biomagnifying substances. The issue of the standard was separated from the conflict about the actual toxicity of chlorine emissions and thus from the conflict about closing down the chlorine industry. This provided more room to discuss the issue of the standard because the disconnection made the issue less 'political'. In other chlorine discussions\footnote{These discussions differ also in another aspect from the workshop situation. They are held for a public and network actors tend to use strategic arguments strategies to win the discussion in the presence of the public, leading to polarization which hampers the clarification of issues.} that do not use argumentation models, issues such as the kind of zero standards needed are often immediately connected to the closure of chlorine related industries and consequently actors will, in general, not specify and elaborate on these issues in a balanced way (NCDO 1996).

Assumptions behind the claims about the standards themselves were detached from the grounds for these standards due to the use of argumentation models. It turned out that the ideas of participants on the first five boxes of the models in the morning session were not in conflict which explains the constructive clarifying, specifying discussion on these parts. The ideas on boxes 6 and 7 were diverging and sometimes conflictive. The discussion on these conflicts was also constructive which might be explained by the fact that the discussion
focused on an isolated topic. It was relatively easy to identify and specify the different viewpoints and to develop viewpoints between the extremes of the industry and the environmental organizations, e.g. see the proposals on evidence. The disentangling effect is of course not the only factor responsible for the constructive discussion. The attitude of the participants and the presence of persons who had an intermediate opinion on the kind of evidence, who functioned as mediators, were also important. In the afternoon session, participants did not discuss the models step by step as intended and the disentangling effect can not be confirmed.

**Electronic discussion**

The focus in this section is on the value of the electronic discussion. The electronic discussions had a shallow nature in the PVC workshop:

- Reactions on comments of other participants and especially chains of comments are rare because the feedback time in the electronic discussion was much longer than in verbal discussions. The feedback time was especially long in our workshop situation because a number of parallel discussions took place as multiple statements from different models were discussed simultaneously.

- Most of the electronic comments were very short. Statements made in verbal discussions are usually much longer, more complex and also more balanced.

As a result, participants in the PVC discussion that were already acquainted with each other’s viewpoint learned little during the electronic discussion because it was not deep and rich enough; Only participants who where less acquainted with the different points of views learned because they got an overview of the different viewpoints. This observation is supported by Herik (1998) who reports that electronic media were not very successful in supporting and stimulating an in depth analysis and discussion on complex policy problems.

The electronic tools used to discuss multiple visual models gave the discussion a rigid structure\(^{12}\). Participants experienced the electronic discussion and argumentation models as restrictive as they are not free to change statements made in the models, add new boxes etc. This decreased the richness and openness of the discussion.

The electronic discussion in the morning session probably had a positive function in the start up of the discussion:

- The electronic results formed the basis for the verbal discussion. The facilitator and the group used the electronic comments to detect which things needed further clarification or

---

\(^{12}\) Eden and Ackoff (1997) combine electronic discussions with visual models but in a different way then in the PVC workshop. An electronic discussion is held and the results of this discussion are structured in models by the group. The facilitator builds and changes the computer model while the group gave instructions. This combination does not yield complex tools and rigidity is less problematic. In general, GSS are known for their pre-structuring effects and the limited room to make off-track comments (Herik 1998).
specification and to note differences in opinion. In the verbal discussion, participants got the opportunity to comprehend the ideas put forward and to elaborate on them in depth.

- The fact that each of the participants was able to ventilate all their ideas in the beginning of the workshop may have had a positive effect on the verbal discussion.

In the afternoon session, the electronic comments were not used in this way because participants viewed this session as a repetition of the first one.

Concluding, the electronic discussion probably had a positive function in the start up of the verbal discussion but it slowed down the workshop speed because it was too shallow to stimulate in depth learning processes that are required when participants are already acquainted with each other perceptions.

Proposals for improvement
The workshop on organochlorines shows the viability of a participatory workshop in which participants learn. The workshop format needs improvement because learning goals were not completely achieved and participants experienced a number of limitations. Here, I present a number of ideas to improve workshops.

Conditions for a participatory process
Not all the actors involved in the PVC discussion were willing to commit themselves to the workshop process, e.g. the representative of the Ministry of Economic Affairs said it was politically not the right time for a workshop, and the environmental and consumers organizations lacked time and resources. The fact that the workshop did not have an official status gave it a less high priority. The support for a participatory process was thus not optimal.

Process management needs much more attention than policy analysts involved in the development of participatory methodologies have, so far, given to this topic. Import aspects are timing of the workshop within the broader policy process, motivating of participants and making agreements about the goals and results of the workshop. Insights from the network literature (De Bruijn and Ten Heuvelhof 1995) can be used and translated to workshop processes.

Workshop format
The workshop format was based on the stage model described in chapter seven and the input for the workshop consisted of reconstructed perceptions. The participants learned relatively little from the exchange of perceptions as they were already acquainted with each others perceptions, experienced the workshop speed to be to slow and did not define their conflicts explicitly nor develop ideas for conflict resolution. This makes us think that the workshop format used was not completely adequate for the PVC context and probably also for other situations in which participants have discussed issues before. Furthermore, the exchange of
perceptions did not lead automatically to conflict resolution as often assumed by Soft System scientists.

Further research on workshop formats that provide more stimuli for conflict resolution is recommended. For example, a workshop format could focus on identifying conflicts and resolving them. In such a format, the conflict between the perceptions becomes central, instead of the multiple perceptions. This requires an additional step in the stage model presented in section 2: identification of key conflicts between perceptions by analysts after step 2, reconstructing of perceptions. The workshop goal is no longer to exchange perceptions but to define and discuss the conflict between perceptions and to develop shared proposals for conflict resolution. The workshop input might consist of:

- Reconstructed perceptions and identified conflicts. This focuses the discussion directly on the conflict.
- Presenting perceptions and proposals for conflict resolution. Participants discuss and supplement the proposals.

Selection of participants
A number of lessons can be drawn with respect to the selection of participants:

- It is important to prevent a situation where only one participant has a divergent view on the topic.
- It seems to be important to prevent only actors with extreme viewpoints participating by inviting participants that could possibly act as mediators (Kleijn and Teisman 1993; Termeer 1993). In the PVC workshop, stakeholders that were less active in the political discourse such as producers of alternatives for PVC or institutional consumers using PVC were not invited. These groups may have had interesting viewpoints and might have acted as mediators between the PVC industry and the environmental organizations. Experts from universities may also function as mediators as the natural scientists showed in the PVC workshop.
- It is recommended to invite a number of knowledgeable participants. In the PVC workshop, a number of stakeholder representatives were very knowledgeable on the issue discussed and the other participants could learn from them.
- Experts from universities etc., that are not directly involved in the political process, may fulfill an important role. It is recommended to invite experts that are willing to engage in the discussion and to share their knowledge. Stakeholder representatives could be involved in selecting experts, this enables them to invite experts that they trust.

Other Lessons
A number of other lessons can be drawn from the workshop on organochlorines:
• Mapping of perceptions: it is recommended to give attention to identifying and naming frames and other basic ideas of actors during the interviews to improve the reconstructed perceptions that are used to start the workshop discussions.

• Workshop goals: organizers and participants of the workshop need to define the purpose of the workshop beforehand and what they mean regarding the term achieving consensus (cp. Guba and Lincoln 1989: 189-190). This should stimulate participants to discuss what newly developed ideas signify for conflict resolution.

• Workshop length: organize shorter workshops and/or prevent overlap between sessions.

• Electronic tools: these are not always suitable for in depth discussions. Flexible tools are needed for a rich discussion.
Appendix 7 Participants and organizers of the PVC workshop

The participants of the PVC workshop held at the Technical University in Delft on February 23 1996 are listed in table A.13.

Table A.13 Participants of the PVC workshop

<table>
<thead>
<tr>
<th>Name of the participant</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. ir. W.L. Blanken</td>
<td>VNCI</td>
</tr>
<tr>
<td>Mr. drs. H. Blaauwgeers*</td>
<td>De Consumentenbond</td>
</tr>
<tr>
<td>Mr. dr. F.A.A. Boons</td>
<td>Catholic University Brabant</td>
</tr>
<tr>
<td>Mr. ir Bovenkerk</td>
<td>VROM/SVS</td>
</tr>
<tr>
<td>Mr. dr.ir. W.M. de Jong*</td>
<td>WRR</td>
</tr>
<tr>
<td>Mr. ir. H. Nieuwenhuijsen*</td>
<td>SPM</td>
</tr>
<tr>
<td>Mr. J. Oostra</td>
<td>WAVIN</td>
</tr>
<tr>
<td>Mr. drs. R. Kleijn</td>
<td>CML</td>
</tr>
<tr>
<td>Mrs. A. van de Ven</td>
<td>Greenpeace Netherlands</td>
</tr>
<tr>
<td>Mr. ir. H.L.J.M. Wijnen</td>
<td>VROM/IC</td>
</tr>
</tbody>
</table>

*These participants did not participate due to illness and other reasons.

The organizers of the workshop are listed in table A.14.

Table A.14 Organizers of the PVC workshop

<table>
<thead>
<tr>
<th>Name of organizer</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mrs. ir. R.M. Bras</td>
<td>TU Delft, Systems Engineering, Policy Analysis and Management (SEPA)</td>
</tr>
<tr>
<td>Mr. dr. ir. P.W.G. Bots</td>
<td>TU Delft, SEPA</td>
</tr>
<tr>
<td>Mrs. dr. ir. C. van Daalen</td>
<td>TU Delft, SEPA</td>
</tr>
<tr>
<td>Mr. dr. ir. B. Enserink</td>
<td>TU Delft, SEPA</td>
</tr>
<tr>
<td>Prof. dr. ir. W.A.H. Thissen</td>
<td>TU Delft, Technology and Society (WTM)</td>
</tr>
<tr>
<td>Mrs. ir. J.M.C. Knot</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 8 Survey PVC workshop

Below the survey used to investigate the experiences of participants of the workshop PVC and the Environment, 23 February 1996, is presented. The survey was held in Dutch.

### Algemene indruk workshop

1. Stellingen over de workshop

<table>
<thead>
<tr>
<th>Geheel mee oneens</th>
<th>Geheel mee eens</th>
<th>Geen mening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. De workshop was voor mij een zinvolle tijdsbesteding.
b. De tijdsverdeling over de verschillende onderdelen was slecht.
c. De sfeer tijdens de workshop was goed.
d. De discussie tussen mensen met verschillende achtergronden was constructief.
e. Het onderwerp van de workshop is belangrijk voor het nemen van beleidsmaatregelen over PVC.
f. De voorzitter heeft de workshop goed geleid.
g. De doelen van de workshop waren voor mij in het begin van de workshop duidelijk.
h. In de workshop heb ik meer dan voldoende mogelijkheden gekregen om mijn eigen inzichten in te brengen.

2. Het werktijp tijdens de workshop lag:

<table>
<thead>
<tr>
<th>Geheel mee oneens</th>
<th>Geheel mee eens</th>
<th>Geen mening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2a. Het werktijp tijdens de workshop lag:

<table>
<thead>
<tr>
<th>Te laag</th>
<th>Goed</th>
<th>Te hoog</th>
<th>Geen mening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3a. Tijdens de workshop was de verdeling van deelnemers over de verschillende organisaties:

<table>
<thead>
<tr>
<th>evenwichtig, doorgaan naar vraag 4.</th>
<th>niet evenwichtig, doorgaan naar vraag 3b.</th>
<th>geen mening, doorgaan naar vraag 4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>b.</td>
<td>c.</td>
</tr>
</tbody>
</table>

3b. Welke organisaties waren ondervertegenwoordigd?

.................................................................

3c. Welke organisaties waren oververtegenwoordigd?

.................................................................
3d. Heeft deze onevenwichtige vertegenwoordiging problemen veroorzaakt? Zo ja, welke?

4a. Zijn er bepaalde onderwerpen, die relevant zijn voor het nadenken over normen voor organo-chloor emissies, onvoldoende aan bod gekomen? Zo ja, welke onderwerpen zijn dit?

[ ] ja, met name

[ ] nee

4b. Kunt u aangeven waarom deze onderwerpen belangrijk zijn?

Leesstuk

De volgende vragen gaan over het leesstuk en over de situatie voordat de workshop gehouden werd.

5. Stellingen over het leesstuk dat hoorde bij de workshop “PVC en Milieu”.

a. Door het leesstuk heb ik mij goed op de workshop kunnen voorbereiden.

b. Het leesstuk bevatte voor mij geen nieuwe informatie over de visies op normen voor organo-chlooremisssies.

c. De visie van mijn organisatie is niet adequaat weergegeven in het leesstuk.

d. De argumentatiemodellen werkten voor mij verhelderend.

6. Heeft u de afgelopen 12 maanden nieuw uitgekomen publicaties over milieu-aspecten van chloor en/of PVC gelezen? Zo ja, welke?

( U kunt meer dan één antwoord aankruisen)

[ ] publicaties van de milieubeweging

[ ] publicaties van de Consumentenbond

[ ] publicaties van de Chemische Industrie

[ ] publicaties van VROM

[ ] publicaties van andere instellingen

[ ] geen enkele publicatie

7. Zijn er specifieke onderwerpen met betrekking tot PVC en/of milieu waar u relatief veel kennis over heeft? Zo ja, welke onderwerpen zijn dit?
8. Met welke organisaties heeft u voorafgaand aan de workshop de afgelopen 12 maanden over normen voor organo-chloor emissies gesproken?
(U kunt meer dan één antwoord aankruisen)
[ ] met vertegenwoordigers van VROM
[ ] met vertegenwoordigers van de chemische industrie
[ ] met vertegenwoordigers van de milieubeweging
[ ] met vertegenwoordigers van de Consumentenbond
[ ] met vertegenwoordigers van andere organisaties, met name
[ ] met geen enkele organisatie

9. Met hoeveel van de deelnemers aan deze workshop heeft u in de 12 maanden voorafgaand aan deze workshop over het PVC-vraagstuk gesproken?

...............deelnemers

Het gebruik van argumentatiemodellen

10. Stellingen over de in de workshop gebruikte argumentatiemodellen

<table>
<thead>
<tr>
<th>Stelling</th>
<th>Geheel mee eens</th>
<th>Geheel mee oneens</th>
<th>Geen mening</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Door het gebruik van argumentatiemodellen werd de communicatie beter.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. Door het gebruik van modellen werd dieper op de materie ingegaan.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. De weergave van de visies van de verschillende partijen was correct.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. Een model met meer dan 8 uitspraken is te complex.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. De modellen versterkten mijn inzicht in de samenhang tussen verschillende argumenten.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>f. Het gebruik van modellen leidde niet tot het expliciet maken van argumenten.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
<tr>
<td>g. Door het gebruik van modellen kreeg ik inzicht in oorzaken van meningsverschillen.</td>
<td>☐ ☐ ☐</td>
<td>☐ ☐ ☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
h. Het gelijktijdig werken met twee of meer argumentatiemodellen is af te raden.
i. Het expliciet maken van argumenten hielp niet bij het vinden van oplossingen voor meningsverschillen.

Elektronisch communiceren

De volgende vragen gaan over het elektronisch communiceren over de argumentatiemodellen. De eerste ronde ging over normen voor toxische, persistente en bio-accumulerende stoffen in het algemeen. En de tweede over organo-chloor emissies en het voorzorgsprincipe.

11. Stellingen over het elektronisch communiceren.

a. De elektronische discussie is goed verlopen.
b. De elektronische discussie was een herhaling van eerder gevoerde discussies.
c. Een aantal ingevoerde opmerkingen had ik nog niet op deze manier gehoord.
d. Ik prefereer een mondelinge discussie.
e. Het elektronische commentaar bevatte veel zinvolle opmerkingen.
f. Het gebruik van een elektronisch systeem voor dit onderwerp vond ik niet prettig.
g. Tijdens de elektronische discussie had ik geen overzicht over het ingevoerde commentaar.

Mondeling communiceren

De volgende vragen gaan over de mondelinge discussies over de argumentatiemodellen. De eerste ronde ging over normen voor toxische, persistente en bio-accumulerende stoffen in het algemeen. En de tweede over organo-chloor emissies en het voorzorgsprincipe.
12. Stellingen over de mondelinge discussie

a. De eerste discussieronde verliep beter dan de tweede.
b. De eerste ronde leverde mij nieuwe informatie op.
c. De tweede ronde leverde mij nieuwe informatie op.
d. Er was te weinig tijd uitgetrokken voor de mondelinge bespreking.
e. De argumenten van sommige deelnemers sloegen nergens op.
f. Ik vond het lastig om mondeling te communiceren aan de hand van het elektronische commentaar.
g. De argumentatiemodellen hielpen bij het structureren van de discussie.

12. Vervolg stellingen over de mondelinge discussie

h. Tijdens de mondelinge discussie werden de belangrijkste verschilpunten duidelijker voor mij.
i. Ik heb andere visies beter leren kennen.
j. Mijn kennis het vraagstuk is niet vergroot.
k. Er zijn weinig ideeën voor het omgaan met meningsverschillen ingebracht.
l. De voorzitter heeft de discussie niet goed geleid.
m. De groep had te weinig kennis over het onderwerp.
n. In de discussie met computers kwamen de verschillende opvattingen evenwichtiger aan bod.

Resultaten
De volgende vragen gaan over de resultaten van de workshop.

13. Heeft u door de workshop nieuwe informatie gekregen over normen voor chlooremissies?
   [ ] nee
   [ ] ja, 1........................................................................................................................................
   2..................................................................................................................................................
14. Heeft u door de workshop meer inzicht gekregen in de ideeën van andere deelnemers over normen voor chlooremissies?
   Zo ja, kunt u de belangrijkste twee kort noemen?
   [ ] nee
   [ ] ja, 1. ...........................................................................................................................
   2. ..............................................................................................................................

15. Heeft u door de workshop meer inzicht gekregen in de overeenkomsten en verschillen tussen partijen?
   Zo ja, kunt u de belangrijkste twee kort noemen?
   [ ] nee
   [ ] ja, 1. ...........................................................................................................................
   2. ..............................................................................................................................

16. Heeft u meer ideeën gekregen over mogelijkheden voor het oplossen van conflicten?
   Zo ja, kunt u twee mogelijkheden noemen?
   [ ] nee
   [ ] ja, 1. ...........................................................................................................................
   2. ..............................................................................................................................

17. Zijn er in de workshop inzichten ontwikkeld, waarvan u het idee heeft dat ze voor alle deelnemers (vrij) nieuw waren?
   [ ] ja, over normen voor chloor-emissies en achterliggende redenen
   [ ] ja, over oorzaken van dissensus
   [ ] ja, over omgaan met meningsverschillen
   [ ] ja, over ......................................................................................................................
   [ ] nee
   [ ] geen mening

18. Denkt u deze inzichten te gaan gebruiken? Zo ja, waarvoor?
   [ ] ja, voor ......................................................................................................................
   [ ] nee
   [ ] niet van toepassing/geen mening
19. Bent u bereid om nog eens aan een soortgelijke workshop over PVC of een ander onderwerp deel te nemen?
   [ ] ja
   [ ] ja, mits er voor een andere opzet wordt gekozen
   [ ] ja, mits ........
   [ ] nee, want de opzet is mij slecht bevallen
   [ ] nee, want ........................................

20. Zou u de methode ooit zelf willen gebruiken?
   [ ] ja
   [ ] misschien
   [ ] nee
   [ ] geen mening/niet van toepassing

Opmerkingen en aanvullingen
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
Literature References


Bousted, I., 1995. ‘Life Cycle Assessment- the logical approach to decision making’, *Europak 95: The 7th International Conference on Plastics Packaging for the Food and beverage Industry*, Dusseldorf, Germany, 3-4 October, pp. 84-98.

Bouws et al., 1987. *Inventarisatie van de consequenties van de vervanging van PVC door alternatieve grondstoffen voor enkele verpakkingsmaterialen*, TNO rapport 183/’87, Delft: TNO.


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Eeten, M. van, forthcoming. Dialogues of the Deaf; Defining New Agendas for Environmental Deadlocks, Doctoral dissertation Delft University of Technology.


EVC (European Vinlys Corporation), 1992. Ecobalances, An objective basis for assessing the environmental impact of PVC and alternative products, an inventory of published studies, Brussels: EVC.


250


Lasswell 1949, *Power and Personality*.


Rijke, J. de and R.H.J. Korenromp, Milieugerichte levenscyclusanalyse van dakgootsystemen, TAUW Milieu BV, Divisie Milieu en Technologie, Afdeling Ketenbeheer.


SPOLD and BiE, 1993c. The LCA Source Book; A European Business Guide to Life-Cycle Assessment, Brussels: SPOLD and BiE.
Sundström, G., 1971. Investigation of energy requirements from raw material to garbage treatment for four Swedish beer and packaging alternatives, Malmö.


VROM, 1995c. ‘Maatregelen ter verdere reductie van mogelijke (niet of niet-goed bekende) risico’s’, Appendix 3 to the letter of Minister de Boer, November 21.


Summary

Adjusting Life Cycle Assessment Methodology for Use in Public Policy Discourse

1. Life cycle assessment and research question

Information provision is one of the bottlenecks in the realization of public product oriented policies (CRMH 1992; VROM and EZ 1992). Life Cycle Assessment (LCA) methodologies are often used to analyze, evaluate and compare the environmental burden of products (Curran 1996a; Heijungs et al. 1992a and 1992b). The LCA methodology is based on an integral chain philosophy, and is used to calculate a great number of environmental effects caused by a product during its complete life cycle. This results in ecoprofiles that show the scores for different environmental impacts that are then used to determine the order of merit of products. The analysis is usually organized into five stages: goal definition and scoping, inventarisation, classification and evaluation and improvement analysis (Consoli 1993; Heijungs et al. 1992a). The methodology often has a formal and quantitative nature.

It was hoped that LCAs would yield objective, conclusive results that could be used in an instrumental way by policy makers. This promise has yet to be fulfilled. The inconclusive nature of LCAs seems especially problematic in the political context of public product policies. In this thesis, I analyse the reasons why current LCA methodologies do not fulfill their promises for public policy processes. In addition, I discuss alternative strategies to improve current LCA methodology. The central research question is: What are the main problems of LCAs in the context of public policy processes and how can these problems be explained? What kinds of methodologies for environmental product assessment are required to resolve these problems and improve the quality of public policy processes?

A three step research approach was used to answer these questions. One, current LCA practices were studied: the nature of the LCA methodology, the difficulties of achieving objective and conclusive answers and the use of LCAs in the public policy process on PVC. Two, to give an insight into the “ideal” study and policy process, I discuss two paradigms on sound policy making and analysis, the rational and the discourse paradigm (Dryzek 1990; Fischer and Forester 1993). Three, the discoursive paradigm is used to design a number of improvement strategies.

2. Using LCAs in the PVC debate

A discussion of the environmental viability of PVC products was started in 1989 in the Netherlands. The key actors are environmental organizations, chlorine- and PVC related branch associations, the Ministry of Housing, Spatial Planning and the Environment, the

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Ministry of Economic Affairs and a consumers association. These actors have different perceptions on the environmental viability of PVC.

LCAs that compare PVC products with their alternatives have been made. It is shown empirically that difficult ambiguous choices have to be made in all the phases of LCAs. Analysts can not make these choices in a conclusive and objective way, because they had to:

- make estimations because information is incomplete
- select elements to be included in the analysis because analyses a fully comprehensive analysis is not possible
- use value judgements
- choose between different interpretations of the situation

The choice of standardization procedures, weighing procedures, product lifetime, and environmental impacts studied may have a large effect on ecoprofiles and changed the order of merit completely. The choice of classification and allocation models also affect the ecoprofiles and rankings. The accumulation of all influential and less influential choices give the conclusions of LCAs a relative nature. LCAs on the same products yield totally different rankings and ecoprofiles. The FKS and INTRON studies on PVC pipes provide an illustrative example.

The conclusions drawn in LCA studies are not value-free. Value judgements were made in all the stages of an LCA. For example, analysts make judgements on the adequacy of alternative products in the goal definition stage. It was observed that the LCA methodology and studies implicitly take a pre-accepted position in the conflict in favor of the PVC and chlorine industry. Due to the emphasis on formal, quantitative proof of environmental effects, uncertain effects, e.g. hormonic mimicking effects, were not considered to be a reason to rank PVC lower in the order of merit. Environmental organizations, however, apply a precautionary approach and want to include uncertain effects in their evaluation of PVC products.

In general, network actors are frequently involved in study projects, and are able to influence outcomes of LCAs since many choices are not predefined by the methodology. A relation between the perceptions or interests of the involved network actors and outcomes of the LCAs on PVC studied could be noted. Concluding, and opposite to the intention of LCA scientists, LCAs are not politically neutral.

Network actors use rankings and ecoprofiles of LCAs to substantiate their claims on the problems of PVC and the required policies. However, they reject conclusions from LCAs that are not in line with their own ideas, pointing to methodological shortcomings, conclusions drawn in other LCAs and the vested interests of the commissioners and sponsors of the LCA. A polarized discussion on the ranking of products and the quality of the conclusions is a common result. The Chlorine Balance case shows that an actor, if powerful enough, may win the discussion in this way and thus cause certain policies to be implemented without a serious rebuttal of counter arguments. The use of LCAs thus decreases the openness of the discussion.
Use of LCAs did hardly inspire the discussion on PVC and chlorine in a more conceptual way. The actors rarely referred to elements or insights taken from LCAs other than the conclusions. Two factors may explain this. One, information contained in LCAs on PVC was often obscure for actors who had little expertise in the LCA field and two, certain key issues were often ignored.

3. Problems and solutions based on the rational paradigm
LCA scientists and others have interpreted the problems of LCAs and proposed a number of solutions. Most LCA scientists adhere to a specific normative view on sound policy making and analysis that is known as the rational paradigm in the policy sciences. The fundamental assumptions of the rational paradigm are:

- policies are made by an actor or group of actors with clear and consistent goals
- objective knowledge should be strived for (neopositivistic inquiry paradigm)
- analysis should play a neutral and instrumental role

LCAs should be able to be used to achieve objective, policy-relevant, conclusive rankings and lists of consequences. The methodology should determine the best alternative given certain goals (means-end approach), be comprehensive and scientific theories and formal, quantitative procedures should be used.

According to many ‘rational’ LCA scientists, LCA methodology is on the right track; basic features of LCA methodology do not need to be changed; however, they consider the indecisive and subjective nature of current LCA results to be a serious problem. This hampers the use of LCAs in public policy processes: wrong outcomes, low credibility of outcomes and manipulative use of LCAs. They want to improve the objectivity and decisiveness of the conclusions by:

- Increasing the knowledge base
- Standardizing methodological procedures and determining fixed weightfactors
- Formalizing normative choices or leaving them to policy makers
- Developing new, formal methods

In addition, they propose changes in the social organization of the study process, e.g. participatory analysis and interactive peer reviews, to get better outcomes and to increase the credibility of these outcomes.

4. Problems and solutions based on the discourse paradigm
The use of the rational paradigm to improve the methodology for product assessment is however questionable when we look closely at the PVC public policy processes. The assumptions made by those using the rational paradigm do not appear to be valid:

- Public policies on environmental product measures are made by a network of actors that have different goals and values
- Objective knowledge is not possible because interpretations are influenced by the culturally determined frames of humans

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• Studies are not able to provide instrumental guidance in network situations
• Objective, distant knowledge does not fit in with human, political responsibility (Geertsema 1992)

The discourse paradigm (Fischer and Forester 1993; Guba and Lincoln 1989; Majone 1989) is a better alternative because the network nature of public policy making and the constructivist nature of environmental knowledge is acknowledged. Discourse authors argue that public policy discourses should be open, rich, and reasonable. The prime function of studies is to support a discussion between network actors. Studies should be explicitly normative and explain the frames or interpretation frameworks used.

The discourse paradigm sheds a new light on the problems met in making and using LCAs on PVC. The fact that LCAs on PVC do not yield decisive and objective answers is no longer a problem, they simply represent the different views prevalent in society. The PVC case shows, however, that LCAs have a number of limitations as agents for discussion:

• Rankings and ecoprofles are vulnerable to polarized use due to their apparent objectivity, the black box nature of the formal methods used, and the seemingly precise nature of LCA results.
• LCAs provide only low information input. This can be explained by a number of factors. One, LCAs tend to ignore key conflicts due to a lack of attention for conceptualization of the issue at the start of the study process and the instrumental, prestructured research approach. Two, LCAs usually provide only formal, technical arguments that are neither informative nor persuasive. Three, many normative assumptions and frames underlying the conclusions remain implicit. Four, the conceptualization of the issues is rather simple to allow for calculation and a comprehensive assessment in the case of quantitative LCAs.
• LCA methodology frames environmental issues in a specific way. For example, the LCA methodology emphasizes full proof on toxicity and does not suit the precautionary principle. The methodology excludes deviating perceptions and topics beforehand, this is called “premature closure”. This is mainly caused by the prestructured or instrumental research approach. The implicit nature of frames is especially problematic.

Solutions
The following changes in the LCA methodology for product evaluation are proposed to provide a better basis for a rich, reasonable and open discussion:
• Adding a conceptual modeling stage before the inventory stage
• Adding a stage ‘defining emergent research questions’
• Explicating and studying values and frames
• Increasing the variety of research methods and techniques used
• Using a more qualitative approach

The first proposal is to add a new stage ‘Conceptual modeling’ to the current LCA methodology before the inventory stage. This will cause the analysis to become less instrumental and important issues will not be ignored. In case of a participatory assessment,
this stage can be used to map different perceptions and frames. Two, research questions and research strategies should no longer be fixed in the methodology but should emerge during the study process. It is recommended to add a stage ‘defining emergent research questions’ after the conceptual modeling stage.

Three, it is recommended to study values and frames in an explicit way. This proposal for a more normative methodology is in conflict with the proposals to make LCA results more ‘objective’ and conclusive. Four, it is considered valuable to increase the variety of research methods used to accommodate different perceptions and to promote a dialogue between holders of different perceptions. The development of methods based on a precautionary frame is valuable because it will equalize the positions of chemical industries and environmental organizations. Five, a more qualitative approach will increase the transparency and relevancy of reports and arguments. Presentation of the final evaluation in the form of a rich and balanced ‘story’ is preferred above the use of one or more absolute figures.

*Participatory product assessment*
Both participatory and expert modes of product assessment are considered valuable. Expert studies are valued for the fact that independent research may lead to the development of fresh and creative insights. The participatory mode is valuable because stakeholder values and ideas can be incorporated and stakeholders can continuously focus the analysis, which results in policy relevant research.

Adjustment of the current LCA methodology is needed to organize a discussion between the holders of different perceptions. A general stage model for participatory analysis has been developed in this thesis, see figure S.1. The model is based on Soft Systems methodologies (Rosenhead 1989) and the Responsive Constructivist Evaluation methodology (Guba and Lincoln 1989).

**Figure S.1 Stage model for participatory analysis**

The key choices that have to be made during the set up of a participatory assessment have been listed. For example, one has to choose a strategy to map perceptions and choose a discussion mode. This model and the list of key choices has been used to organize a workshop with stakeholders on standards for organochlorines, a topic relevant in the PVC discussion.
5. Recommendations for policy makers and researchers

There are important reasons for policy makers to opt for a relative open, rich and reasonable discussion, by doing this, policy makers can increase the democratic nature of public policy processes and they will be better able to achieve a broad commitment for policies.

Recommendations for policy makers are:

- Select study methods that fit in with the values and frames of the organization.
- Use studies to disseminate the perception of the own organization and to convince other network actors of the value of this perception.
- Prevent ‘premature closure’ at the start of the product assessments.
- Stimulate other network actors to clarify the values and frames used and to provide a transparent, relevant argument for their conclusions. Prevent the use of study methodologies that allow the study to be used manipulatively.
- Use participatory methodologies to find broadly supported policy measures.

Recommendations for LCA scientists are:

- Reduce the instrumental nature of current LCA handbooks by adding a new stage between goal definition and inventarisation in which a qualitative description of the problem and solutions is made. In addition, the important choices that are presently fixed by the methodology need to be explicated and left to stakeholders or analysts.
- Contribute to the development of methods to determine environmental impacts of products that fit in with specific frames, e.g. methods to determine the toxicity that are based on a precautionary, environmentalist frame.

Recommendations for policy analysts:

- Develop concrete research methods that fit in with discursive ideals, e.g. ways to identify conflicts and consensus, to reformulate conflicts and to develop shared solutions
- Clarify the conditions under which certain participatory methodologies are successful. This information will help analysts to understand when they should opt for a certain methodology and may help them to create the conditions required for an open discussion.
Summary in Dutch - Samenvatting
Adjusting Life Cycle Assessment Methodology for Use in Public Policy Discourse

1. Inleiding en onderzoeksvragen
Levenscyclus analyse (LCA) is een methode voor het inschatten van de milieubelasting van producten en processen, die sinds het eind van de jaren tachtig volop in de belangstelling staat. Deze belangstelling is gekoppeld aan de opkomst van het milieugerichte producten beleid (VROM en EZ 1992) en de doelstellingen van integraal ketenbeheer (VROM 1989). De levenscyclus analyse methode biedt een raamwerk en concrete methoden en technieken om de milieubelasting van producten en milieumaatregelen op systematische wijze in kaart te brengen. Een groot aantal milieu-effecten van de gehele keten van processen wordt meegenomen. Ecoprofielen laten zien hoeveel producten bijdragen aan verschillende milieu-effecten zoals verzuring en ecotoxiciteit. Daarnaast worden producten gerangschikt van minst naar meest milieubelastend met behulp van multicriteria evaluatie methoden. De analyse is meestal opgedeeld in vijf fasen: doelbepaling, inventarisatie, classificatie, evaluatie en verbeteranalyse (Heijungs 1992a and 1992b).

In de nota ‘Product en Milieu’ van VROM en EZ (1992) wordt aangegeven dat de LCA methode een centrale rol kan spelen in het milieugerichte productenbeleid. LCAs worden gebruikt in het kader van productgerichte overheidsmaatregelen zoals ecotax, en milieukeur. Ook individuele bedrijven en product ontwerpers maken gebruik van LCAs in hun bestissingsprocessen. Er zijn echter een aantal problemen verbonden aan het maken en gebruiken van LCAs.

Dit proefschrift richt zich specifiek op de problemen die ontstaan bij het gebruik van LCAs van producten in publieke besluitvormingsprocessen. De volgende vragen staan centraal en worden aan de hand van LCAs over PVC producten beantwoord:
- Welke problemen zijn er bij het maken van LCAs?
- Welke problemen zijn er bij het gebruik van LCAs in een publiek besluitvormingsproces?
- Wat zijn de oorzaken van deze problemen?
- Welke veranderingen in de LCA methode kunnen bijdragen aan het oplossen van deze problemen?

Bij het beantwoorden van deze vragen wordt aandacht besteed aan opvattingen over de aard van het besluitvormingsproces, de aard van kennis en de rol van studies in beleid aangezien deze visies zeer bepalend voor de interpretatie van de problemen rond het gebruiken van LCAs en voor het vinden van mogelijke oplossingen. Dit gebeurt in de vorm van een

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discussie tussen het rationele paradigma, dat vrij dominant is in de LCA discipline, en het discussieve paradigma uit de beleidswetenschappen.

2. Interpretatie en oplossingen vanuit het rationele paradigma
Sinds de tweede wereldoorlog is het gebruik van wetenschappelijke kennis door beleidsmakers wijdverbreid. Tegemoord vindt er bijna geen debat over een serieus onderwerp plaats zonder dat iemand aan een studie refereert. De discipline beleidsanalyse die zich richt op het ontwikkelen van methoden voor studies voor beleidsmakers ontwikkelde zich gelijktijdig. In eerste instantie was het rationele paradigma erg dominant.

Het rationele paradigma gaat uit van de volgende aannames:

- Beleid wordt gemaakt door een hiërarchisch georganiseerde actor die uitgaat van centrale doelen. Dit is ook de beste manier om beleid te maken omdat er zo een consistent beleid ontstaat.
- Het is mogelijk en nastrevenwaardig om beleidsmakers te ondersteunen met objectieve en integrale studies die bepalen welke beleidsalternatieven het beste zijn gegeven de doelen van de beleidsmakers. Formele, kwantitatieve methoden hebben de voorkeur.
- De uitslag van studies spelen een instrumentele rol in het beleid. Dat houdt in dat beleidsmakers de conclusies direct benutten bij het nemen van beleidsbeslissingen.

Deze ‘rationele’ aannames lagen ook ten grondslag aan de ontwikkeling van de LCA methode. De LCA methode benadert de evaluatie van producten op rationele wijze. Er wordt bepaald welke producten het beste zijn gegeven bepaalde milieudoelen (doel-middel benadering), de gehele keten en veel milieu-effecten worden meegenomen (integrale benadering) en er wordt veelvuldig gebruik gemaakt van formele, kwantitatieve methoden. Aangezien de meeste LCA wetenschappers in- of expliciet uitgaan van het rationele paradigma, zijn ze tevreden met de basis opzet van de LCA methode.

Er is echter wel een belangrijk probleem, namelijk het niet eenduidige en subjectieve karakter van de ecoprofielen en rangordes. Analisten worden in elke fase van de levenscyclus analyse geconfronteerd met keuzes die niet volledig objectief te maken zijn. Een bekend voorbeeld is de keuze van systeemgrenzen. Het gecombineerd effect van al deze keuzes is enorm groot. Ecoprofielen en de uiteindelijke rangorde van producten kunnen er tengevolge van verschillen in keuzes en aannames totaal anders uit zien. Een illustratief voorbeeld zijn de studies over PVC buizen (INTRON 1995; FKS 1995). Volgens de éne studie is de PVC buis het meest milieuvriendelijke alternatief terwijl de andere studie tot een tegengesteld oordeel komt.

In de beleidspraktijk veroorzaakt dit gebrek aan eenduidigheid een aantal problemen. Doordat verschillende keuzes plausibel zijn is het mogelijk om naar bepaalde resultaten toe te werken. Dat blijkt onder meer uit de PVC casus. De resultaten van LCAs zijn nauwelijks gezaghebbendheid in de PVC discussie. Actoren in de PVC discussie verwijzen regelmatig naar conclusies van die LCAs over PVC die overeenkomen met hun visie en belangen. Ze wijzen op de wetenschappelijke kwaliteit en objectiviteit van deze studies. Actoren die het
niet eens zijn met deze conclusies bekritiseren deze LCAs echter door te wijzen op LCAs met tegengestelde resultaten, op beperkingen van de gemaakte methodische keuzes en op het feit dat de opdrachtgevers belang hadden bij de uitkomsten van de studie.

Vaak stellen LCA wetenschappers de volgende oplossingen voor om deze problemen op te lossen:
1. De methode verder objectiveren en eenduidig maken door standaardisatie, verder formaliseren van de methode en het verwijderen van normatieve elementen.
2. Stimuleren van een kritische wetenschappelijke discussie over de uitkomsten door het uitvoeren van gevoeligheidsanalyses en een transparantere presentatie van het onderzoek.
3. Veranderen van het sociale proces om de kwaliteit en de gezaghebbendheid te verbeteren door peer reviews en participatie van belanghebbenden.

Een aantal praktisch ingestelde wetenschappers en gebruikers van productstudies zijn tegen het verder formaliseren van de methode omdat deze dan te complex wordt voor de doorsnee gebruiker en de analyse bovendien zeer tijdrovend wordt. Zij vinden het belangrijk dat er kwalitatieve, conceptuele methoden ontwikkeld worden die beeldvormend kunnen werken. Over participatie zijn de meningen verdeeld. Wetenschappers die veel waarde hechten aan objectivity vrezen dat de wetenschappelijke kwaliteit van LCAs wordt aangetast omdat belanghebbenden oneigenlijke keuzes maken en de analyses onderling niet meer consistent zijn.

3. Interpretatie vanuit het discursieve paradigma

Het rationele paradigma is sterk bekritiseerd in de beleidswetenschappen en onder beleidswetenschappers zijn er zelfs bijna geen aanhangers meer. Van de alternatieve paradigma's is het discursieve paradigma het meest relevant voor het begrijpen van de problemen van LCAs en voor het verder ontwikkelen van de LCA methode. Het discursieve paradigma stelt dat:

- Het beeld van de hierarchische actor met een set van doelen en weegfactoren is in strijd met de werkelijkheid. Beleid komt tot stand als resultaat van de interactie tussen actoren met verschillende doelen en belangen.
- Kennis is nooit objectief maar wordt beïnvloed door de kenner, die als het ware door een bepaalde 'bril' naar de werkelijkheid kijkt. Feiten en waarden zijn nauw met elkaar verweven (postmodern wetenschapsparadigma).
- De primaire functie van studies is niet het aanleveren van objectieve, gezaghebbende informatie, maar het ondersteunen van communicatie tussen aanhangers van verschillende en uiteenlopende visies. De argumentatieve functie is belangrijker dan de instrumentele functie.

De PVC casus illustreert dat beleid over productgerichte overheidsmaatregelen gevormd wordt in interactieprocessen tussen actoren met verschillende achtergronden. De ministeries van VROM en EZ, diverse brancheorganisaties van de chemische industrie en van PVC producten, milieu organisaties en de consumentenbond zijn betrokken bij de beleidsvorming.
In de PVC case zien we ook dat kennis van milieuproblemen niet objectief is maar wordt beïnvloed door frames, normen en waarden. Zo interpreteren de betrokken actoren onzekerheid verschillend. De milieuorganisaties zijn van mening dat er maatregelen genomen moeten worden als er een kans is dat er schadelijke milieu-effecten zullen optreden omdat de balans tussen milieu en menselijk handelen zeer precair is (voorzorgsprincipe). De chemische industrie vindt daarentegen dat acties niet gerechtvaardigd zijn totdat met redelijke zekerheid aangetoond is dat de schadelijke effecten zich inderdaad voordoen. In dit soort complexe situaties met een veelheid aan actoren en beperkte menselijke kennis, kunnen product evaluaties bijna nooit een instrumentele rol vervullen. Hun functie als discussie basis is dan het belangrijkste.

Een goede discussie is rijk, open voor veel participanten en argumenten. Deelnemers communiceren op een redelijke manier met elkaar en probeert elkaar te overtuigen op basis van argumenten. Deze discussie norm is belangrijk vanuit ethisch oogpunt maar ook voor het vinden van oplossingen die een breed draagvlak hebben. Volgens veel beleidswetenschappers zijn studies met rationele kenmerken niet de beste manier om een goede discussie tussen actoren tot stand te brengen. De LCAs uit de PVC casus bleken een drietal beperkingen te hebben. Ten eerste kunnen ze vrij gemakkelijk manipulatief gebruikt worden door actoren die hun eigen belang nastreven. Dit komt doordat de kwantitatieve ecoprofielen en rangordes heel gezaghebbend overkomen en het onduidelijk is hoe deze uitkomsten precies tot stand zijn gekomen door het veelvuldig gebrui van abstracte, formele methoden.

Een tweede probleem is dat de LCAs over PVC maar weinig voeding blijken te bevatten voor een goede discussie. Actoren verwezen zelden naar inzichten uit LCAs anders dan de conclusies. De LCAs over PVC bleken ook de belangrijkste issues uit het PVC debat, zoals omgaan met onzekerheid, transportrisico's, de onzekere maar mogelijk grote milieu-effecten van organochloor verbindingen en additieven, volkomen te negeren. Door het instrumentele, en kwantitatieve karakter van de LCA methode worden deze issues genegeerd. Analisten passen de standaardmethode toe zonder na te gaan of deze past bij het specifieke product en de specifieke beleidsdiscussie. Verder krijgen niet kwantificeerbare zaken nauwelijks aandacht.

Een derde probleem is dat LCAs als neutraal gepresenteerd worden maar in feite uitgaan van bepaalde frames en doelen. De milieudoelen die zijn opgenomen in het CML handboek en in de Distance-To-Targetwegingsmethode zijn de doelen zoals die door de Nederlandse overheid zijn vastgesteld. Daardoor hebben andere doelen minder kans. Verder gaat de LCA methode impliciet uit van de gedachte dat effecten bewezen moeten zijn, alvorens er maatregelen tegen producten genomen worden. Immers, alleen te kwantificeren effecten tellen mee bij het maken van rangordes van producten. Dit komt niet overeen met het voorzorgsprincipe dat door milieu organisaties wordt gehanteerd ten aanzien van PVC. Zij vinden onzeker toxische effecten ook een reden om een product als ongewenst te beschouwen. Een zelfde redenering gaat op voor de toxiciteitsmodellen uit de LCA methode. De toxiciteitsindicator voor een bepaalde organochloorverbinding die in deze modellen wordt
gebruikt, is gebaseerd op onderzoeksresultaten die betrekkend hebben op deze specifieke verbinding. Echter, vanuit het voorzorgsprincipe generaliseren milieu organisaties de effecten van dioxine en andere schadelijke chloorverbindingen naar alle organochloorverbindingen. Vanuit het idee van een open discours is vooral het impliciete karakter van de frames en normatieve keuzes, voornamelijk veroorzaakt door objectiviteitsidealen en het gebruik van formele methoden, een probleem.

4. Oplossingen vanuit discursieve paradigma
Vanuit het discursieve paradigma wordt gezocht naar ontwikkelingsrichtingen die de waarde van studies voor een open en rijke discussie vergroten. De volgende vijf veranderingen in de methode en analyse praktijk zijn wenselijk:

- Toepassen van een beeldvormende fase aan de huidige LCA methode waarin een ruw beeld wordt geschetst van de milieu-aspecten van een product en de belangrijkste issues, ook de normatieve issues. Dit voorkomt een instrumentele, niet-beleidsrelevante analyse.
- Stimuleren van een open en zich stap voor stap ontwikkelend studieproces door na de beeldvormingsfase onderzoeksvragen en bijbehorende strategieën op te stellen. Voorbeelden gericht op PVC zijn ‘Hoe gaan we om met onzekerheid?’ en ‘Verstoren chloorverbindingen de hormoonhuishouding?’ Deze aanpak bevordert een beleidsrelevante analyse en doet recht aan het specifieke product dat onderzocht wordt.
- Vergroten van de variëteit aan onderzoeksmethoden. Op deze manier kan er ruimte gecreëerd worden voor verschillende frames en interpretaties. Tevens is dit nodig om in te spelen op de veelheid aan onderzoeksvragen.
- Expliciet maken en verantwoorden van normatieve keuzes en frames in alle fasen van de analyse.
- Formele, kwantitatieve methoden minder gebruiken omdat ze vaak reductionistisch zijn en bovendien versluijerend werken. Conclusies kunnen beter als verhaal gepresenteerd worden dan als ogschijnlijk, precieze getallen.

In combinatie met de vijf genoemde oplossingen, is het waardevol om een participatieve methode te ontwikkelen als aanvulling op expert studies. In een participatief studieproces kunnen belanghebbenden hun frames, normen en overige ideeën inbrengen, en de analyse en evaluatie sturen. Participatieve studies met deelnemers die verschillende actoren representeren kunnen ook gebruikt worden om te zoeken naar breed gedragen oplossingen. Een participatieve studie is echter niet altijd haalbaar. Condities van vertrouwen en respect zijn nodig volgens auteurs die zich bezighouden met participatieve analyse (Guba and Lincoln 1989). Ook kan men een proces ontwerpen met spelregels die strategisch, opportunistisch gedrag voorkomen en samenwerking bevorderen waarbinnen een participatieve analyse mogelijk wordt. Als de behoefte aan samenwerking en vinden van een gezamenlijke oplossing groot is, zullen actoren bereid zijn om zich te committeren aan een dergelijk proces.
In een participatieve methode staat de discussie over verschillende percepties en het zoeken van een oplossing waar alle deelnemers mee tevreden zijn centraal. De huidige LCA methode is niet met dit doel ontworpen. In de literatuur over soft systems methoden (Rosenhead 1989) en Responsive Constructivist evaluation (Guba and Lincoln 1989) is het volgende stappenplan voor een participatieve analyse ontwikkeld:

- het initiëren van de analyse,
- inventariseren van de verschillende percepties,
- analyseren en bewerken van deze percepties (bijvoorbeeld zoeken naar overeenkomsten en verschillen, herformuleren van conflicten, verzinnen van win-win opties),
- organiseren van een discussie over deze percepties,
- ontwikkelen van consensus en/of commitment voor bepaalde akties.

Er kunnen verschillende methoden gebruikt worden om percepties te construeren. In dit promotie onderzoek is een workshop georganiseerd over wenselijke normen voor organochloor emissies. Hierin werd geëxperimenteerd met visuele argumentatiemodellen. Percepties van VROM, milieu organisaties en de chemische industrie werden gereconstrueerd over de norm voor organische organochloor emissies. Deze modellen dienden als communicatie middel. Door het gebruik van argumentatiemodellen werd een onderwerp opgedeeld in deel onderwerpen. Mede hierdoor kon er constructief gecommuniceerd worden over de deelonderwerpen waarover geen verschil van mening was en was het mogelijk om conflicten beter en gedetailleerder te definiëren. De stap analyseren en bewerken van percepties dient nog verder te ontwikkeld worden.

5. Aanbevelingen voor beleidsmakers en onderzoekers

Uit het onderzoek volgen de volgende aanbevelingen voor beleidsmakers die een open, rijke en redelijke discussie over de milieu aspecten van producten willen stimuleren en uit zijn op draagvlak voor oplossingen:

- Het is belangrijk om na te gaan of studiemethoden aansluiten bij het frame en de waarden van de organisatie van de beleidsmaker
- Een organisatie kan studies gebruiken om de eigen perceptie uit te dragen en om anderen te overtuigen van de waarde van deze perceptie
- Aan het begin van het studieproces kan door een open aanpak voorkomen worden dat waardevolle inzichten, relevante onderwerpen en bepaalde opvattingen bij voorbaat worden buiten gesloten
- Het is belangrijk om te stimuleren dat gebruikte frames en waarden expliciet worden vermeld in studierapporten en conclusies op transparante wijze worden onderbouwd
- Participatieve studieprocessen kunnen gebruikt worden om breed gedragen oplossingen te vinden indien deze processen haalbaar zijn
Aanbevelingen voor LCA wetenschappers:

- Reflectie op goede beleidsvorming en analyse, uitmondend in het ontwikkelen van ontwerpcriteria voor studiemethoden, verdient meer aandacht.
- Het instrumentele karakter van LCA handboeken kan verminderd worden door het toevoegen van een beeldvormende fase waarin een kwalitatieve beschrijving van probleem en oplossingen wordt gegeven. Verder verdient het aanbeveling om belangrijke keuzes die vastgelegd zijn in de methode expliciet te vermelden.
- Ontwikkelen van methoden voor het bepalen van milieu effecten die gebruikt kunnen worden om een bepaald frame verder uit te werken is zinvol, bijvoorbeeld methoden voor het bepalen van toxiciteit die uitgaan van het voorzorgsprincipe.

Aanbevelingen voor beleidsanalisten die uitgaan van een discursieve paradigm:

- Het ontwikkelen van onderzoeksmethoden om conflicten te identificeren en te herformuleren evenals het ontwikkelen van methoden voor het bedenken van gedragen oplossingen is belangrijk.
- Meer inzicht in de condities waaronder participatieve studies succesvol zijn en welke methoden en technieken het beste gebruikt kunnen worden in bepaalde situaties is zinvol omdat deze informatie een bewuste keuze voor een bepaalde studieaanpak mogelijk maakt.
### Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>B&amp;G</td>
<td>Bureau Brand- &amp; Grondstoffen</td>
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<tr>
<td>BiE</td>
<td>Business in the Environment</td>
</tr>
<tr>
<td>BITAC</td>
<td>Begeleidingsgroep Implementatie Akties Chloorketenstudie (Steering Group Implementation Actions Chlorine Balance)</td>
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<tr>
<td>CB</td>
<td>De Consumentenbond (the consumers association)</td>
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<tr>
<td>CBL</td>
<td>Central Bureau of the Provision Trade (Centraal Bureau voor de Levensmiddelenhandel)</td>
</tr>
<tr>
<td>CBS</td>
<td>Statistics Netherlands (Centraal Bureau voor de Statistiek)</td>
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<tr>
<td>CE</td>
<td>Centre for Energy Conversion and Environmental Technology (Centrum voor Energiebesparing en Schone Technologie)</td>
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<tr>
<td>CEA</td>
<td>Communicatie en Adviesbureau voor Energie en Milieu</td>
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<tr>
<td>CFC</td>
<td>Chlorofluorocarbon</td>
</tr>
<tr>
<td>CML</td>
<td>Center of Environmental Science Leiden (Centrum voor Milieukunde Leiden)</td>
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<tr>
<td>CNV</td>
<td>National Federation of Christian Trade Unions (Christelijk Nationaal Vakverbond)</td>
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<tr>
<td>COBA</td>
<td>Committee for the Development of Policy Analysis (Commissie voor de ontwikkeling van de Beleidsanalyse)</td>
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<tr>
<td>CPB</td>
<td>Netherlands Bureau for Economic Policy Analysis (Centraal Plan Bureau)</td>
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<tr>
<td>CRMH</td>
<td>Council for the Environment (Centrale Raad voor de Milieuhygiène, since 1993 or 1994 Raad voor het Milieubeheer)</td>
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<tr>
<td>DCM</td>
<td>Dichloromethane</td>
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<tr>
<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
</tr>
<tr>
<td>DGI</td>
<td>Directorate-General of the Industry, Ministry of EZ (Directoraat-Generaal Industrie)</td>
</tr>
<tr>
<td>DGM</td>
<td>Directorate-General for the Environmental Protection, Ministry of VROM (Directoraat-Generaal Milieubeheer)</td>
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<tr>
<td>DGV</td>
<td>Directorate-General of Housing, Ministry of VROM (Directoraat-Generaal Volkshuisvesting)</td>
</tr>
<tr>
<td>DTT</td>
<td>Distance To Target</td>
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<tr>
<td>ECVM</td>
<td>European Council of Vinyl Manufacturers</td>
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<tr>
<td>EDC</td>
<td>Ethylene dichloride</td>
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<tr>
<td>EMC</td>
<td>Enterprise Minière et Chimique</td>
</tr>
<tr>
<td>EZ</td>
<td>Ministry of Economic Affairs (Ministerie van Economische Zaken)</td>
</tr>
<tr>
<td>FKS</td>
<td>Association of Plastic Pipe Manufacturers in the Netherlands (Vereniging van Fabrikanten van Kunststofleidingsystemen)</td>
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<tr>
<td>FME</td>
<td>Association FME (Federatie Metaal en Elektronica)</td>
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<tr>
<td>FNV</td>
<td>The Netherlands Trade Union Confederation (Federatie Nederlandse Vakbeweging)</td>
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<tr>
<td>Gastec</td>
<td>Centre of Gas Technology (Nederlands Centrum voor Gastechnologie)</td>
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<tr>
<td>GE</td>
<td>General Electrics</td>
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<tr>
<td>GSS</td>
<td>Group Support System</td>
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<tr>
<td>H₂</td>
<td>Hydrogen</td>
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<tr>
<td>HCFC</td>
<td>Hydro-chlorofluorocarbon</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrochloric acid</td>
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</tbody>
</table>
IC  Directorate of Industry, Products and Consumer Policy, VROM/DGM (Directie Industrie en Consumentenbeleid)
ICA  Integral Chain Approach
ICMC  Integral Chain Management for Companies
INTRON  Instituut voor Materiaal- en Milieu-Onderzoek
ISCM  Integral Substance Chain Management
IVAM  Interfacultaire Vakgroep Milieukunde, Universiteit Amsterdam
KIWA  Service Institute for Quality Control and Research for the Sectors Water, Construction and Environment (Dienstverlenend Centrum voor Kwaliteitsbeheersing en Onderzoek in de sectoren Water, Bouw en Milieu)
LCA  Life-Cycle Assessment or Life-Cycle Analysis
LCI  Life-Cycle Inventory
LVM  Limburg Vinyl Company (Limburgse Vinyl Maatschappij)
MJ  Mega-Joule
MTR  Maximum Permissible Risk Level (Maximum Toelaatbaar Risico)
NCDO  National Committee for International Cooperation and Sustainable Development (Nationale Commissie voor Internationale Samenwerking en Duurzame Ontwikkeling)
NCI  Dutch Chemical Industry (Nederlandse Chemische Industrie)
NFK  Dutch Federation for Plastic Producers (Nederlandse Federatie voor Kunststoffenfabrikanten, since 1-1-1998 NRK)
NMP  National Environmental Policy Plan (Nationale Milieubeleidsplan)
NRK  Dutch Federation for Rubber and Plastic (Federatie Nederlandse Rubber- en Kunststoffenindustrie)
NVR  Dutch Association of Elastomers and Plastic Converters (Nederlandse Vereniging van Rubber- en Kunststoffenfabrikanten, since 1-1-1998 NRK)
NVTB  Nederlandse Verbond Toelevering Bouw
NW&S  Department of Science, Technology and Society, RUU (Vakgroep Natuurwetenschap en Samenleving)
NWR  National Housing Federation (Nationale Woningraad)
PCB  Polychlorinated biphenyls
PE  Polyethylene
PER  Tetrahydrofuran
PET  Polyethylene terephthalate
PP  Polypropylene
PS  Polystyrene
PVC  Polyvinyl chloride
RAAKS  Rapid Appraisal of Agricultural Knowledge Systems
RCC  Advertising Code Authority (Reclame Code Commissie)
RGD  Government Building Agency, VROM (Rijksgebouwendienst)
RIVM  National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieuradg)
RIZA  Institute for Inland Water Management and Waste Water Treatment, Ministry of V&W (Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling)
RMB  Council for the Environment (Raad voor het Milieubeheer, previously CRMH)
RMNO  Advisory Council for Research on Nature and Environment (Raad voor het Milieu en Natuuronderzoek)
RUU Utrecht University (Rijksuniversiteit Utrecht)
SAST Strategic Assumption Surfacing and Testing
SCP Social and Cultural Planning Office (Sociaal en Cultureel Plan Bureau)
SEPA Systems Engineering, Policy Analysis and Management, TUD (Technische Bestuurskunde)
SER Social and Economic Council (Sociaal Economische Raad)
SETAC Society of Environmental Toxicology and Chemistry
SEV The Netherlands Steering Committee on Experiments in Public Housing (Stuurgroep Experimenten Volkshuisvesting)
SNM The Netherlands Society for Nature and Environment (Stichting Natuur en Milieu)
SPM Steering committee PVC and the Environment (Stuurgroep PVC en Milieu; since 1995, Stuurgroep PVC en Ketensbeheer)
SPOLD Society for the Promotion of Life-Cycle Assessment Development
SST Soft Systems Thinking
STEPS Systematically Tackling Environmental Problem Solving
SVM Foundation for Packaging and the Environment (Stichting Verpakkingen en Milieu)
SVS Directorate of Chemicals, External Safety and Radiation, VROM/DGM (Directie Stoffen, Veiligheid en Straling)
TNO Netherlands Organization for Applied Scientific Research (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek)
TSI Total Systems Intervention
TUD Delft University of Technology
V&W Ministry of Transport, Public Works and Water Management (Ministerie van Verkeer en Waterstaat)
VC Vinyl chloride
VITO Flemish Institute for Technological Research (Vlaamse Instelling voor Technologisch Onderzoek)
VKG Federation of Manufacturers of Plastic Doors and Windows (Vereniging Kunststof Gevelelementen Fabrikanten)
VMD Friends of the Earth Netherlands (Vereniging Milieudefensie)
VMR Association of Metal Window Frame Producers (Vereniging van Metalen-Ramen Fabrikanten)
VNCI Association of the Dutch Chemical Industry (Vereniging van Nederlandse Chemische Industrie)
VPB Federation of Manufacturers of Concrete Pipes and Manholes (Vereniging van Producen ten van Betonleidingsystemen)
VR Negligible Risk Level (Verwaarloosbaar Risico)
VROM Ministry of Housing, Spatial Planning and the Environment (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer)
WRR Netherlands Scientific Council for Government Policy (Wetenschappelijke Raad voor het Regeringsbeleid)
WTM Technology and Society, TUD (Wijsbegeerte en Technische Maatschappijwetenschappen)
ZHM Environmental Federation of South Holland (Zuid-Hollandse Milieufederatie)
About the author

Remke Bras (1969) graduated from the Eindhoven University of Technology in 1992. Her masters project focused on the technical and financial feasibility of anaerobic waste water treatment in Thailand and was conducted at the Asian Institute of Technology, Bangkok.

Remke joined the Faculty of Systems Analysis, Policy Analysis and Management of the Delft University of Technology in 1993. She conducted her doctoral research on the use of life cycle assessment in public policy processes at the group of Policy Analysis. She presented her work at SETAC conference on LCA and decision making in 1997 and was active in the SETAC working group ‘LCA and decision making’.

In January 1999, Remke joined the group of Technology Assessment of the Delft University of Technology. She is member of the project team ‘Education Sustainable Development’ (Onderwijs Duurzame Ontwikkeling) which aims to integrate sustainability issues in the curricula of various faculties in Delft.