Scenarios and Strategies for Extended Producer Responsibility

Using Morphological Analysis to Evaluate EPR System Strategies in Sweden

Adapted from a report to the Swedish Ministry of the Environment

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April 2004

1. Introduction

On behalf of the Swedish Ministry of the Environment, the Swedish Defence Research Agency (FOI) conducted a study to evaluate an Extended Producer Responsibility (EPR) system in Sweden. The purpose of the study was to formulate a range of *contextual environmental scenarios* and, by identifying the most important parameters of an EPR system, develop alternative EPR strategies, which can be tested within the context of these scenarios. The study was aided by the employment of computer aided General Morphological Analysis (GMA), in order to develop scenario and strategy laboratories which can be used as "if-then" modelling frameworks.

Two working groups of seven persons each – a "strategic environment group" and a "strategy development group" – performed the modelling together with two morphologists. The groups were composed of researchers from the Swedish EPA, other relevant government authorities and two NGOs and two private companies involved in waste management and recycling. During a final joint meeting, the strategic environment model was merged with the strategy model.

1.1 Definitions and boundaries

1.1.1 Extended Producer Responsibility (EPR)

"Extended producer responsibility" (EPR) imposes accountability over the entire life cycle of products and packaging introduced on the market. This means that firms, which manufacture, import and/or sell products and packaging, are required to be financially or physically responsible for such products after their useful life. They must either take back spent products and manage them through reuse, recycling or in energy production, or delegate this responsibility to a third party, a so-called producer responsibility organization (PRO), which is paid by the producer for spent-product management. In this way, EPR shifts responsibility for waste from government to private industry, obliging producers, importers and/or sellers to internalise waste management costs in their product prices. (Hanisch, C., 2000. *Is Extended Producer Responsibility Effective? Environ Sci Technol*, **34** (7), pp.170 A-175 A.)

The long-term purpose of EPR is to encourage more environmentally friendly product development -- products that require fewer resources, are easier to reuse/recycle, and which contain fewer environmentally dangerous substances. The problem, then, is to develop flexible EPR-strategies for a future in which there is a good deal of uncertainty concerning, for instance, national or international directives, technological developments, shifting political ideology, market forces and ethical concerns.

1.1.2 Extended Producer Responsibility System

An EPR system is defined as those laws and regulations, plus those monitoring, information, logistic and enforcement systems, which together comprise the way in which EPR will be applied.

1.1.3 Contextual Environment, Strategy Space and Transactional Environment

The *contextual environment* is defined as those factors in the external world, which can influence how the EPR system functions, but which cannot be influenced by the EPR system.

The *strategy space* is defined as the internal world of the EPR system, comprising those factors, which the EPR system-owner can control, and mould into a strategy for coping with the contextual environment.

However, factors can be designated as "external" or "internal" only *a potiori*. In reality, there is always some degree of overlap between these contexts. Some factors, while being external to the EPR system as such, *can* be influenced by the system. For instance, people's propensity to sort their household refuse is not an internal factor within an EPR system, but may well be influenced to some degree by the chose of EPR strategy (e.g. information campaigns, rewards or sanctions).

Factors, which are external to a system as such, but which can be influenced by the system, belong to the *transactional environment*.

In this study, two morphological models are developed and linked: an (external) scenario field consisting of the contextual and transactional environments together; and a strategy field representing possible EPR-systems. The transactional factors within the scenario field can be varied in response to different strategy alternatives in the strategy field.

Also note: In this report, we use the term *scenario* to denote a "projected futures state" rather than a series of events.

1.2 Structure of the report

The report contains a description of methods (Chapter 2), a presentation of the morphological fields that describe the contextual environments and the producer-responsibility strategy space (Chapter 3), eight environment-specific scenarios (Chapter 4), ideas concerning possible PA solutions (Chapter 5) and a short conclusion summing up the modelling process (Chapter 6).

Naturally, the prerequisites for a Swedish EPR system are specific to conditions in Sweden. However, this report may be of interest to a broader, international audience, not the least because of the methodological approach that is presented.

2. General Morphological Analysis and Non-Quantified Modelling

2.1 Introduction

General morphological analysis (GMA) is a non-quantified modelling method for structuring, analysing and evaluating multidimensional social, political or technical problem complexes. It was originally developed by Fritz Zwicky – the Swiss-American astrophysicist and aerospace scientist – as a general method for structuring and investigating the total set of relationships contained in multi-dimensional, usually non-quantifiable, problem complexes.

Morphological analysis can be employed for:

- developing scenarios
- analysing risks
- relating means and objectives in complex policy spaces
- supporting decisions and developing strategy alternatives
- evaluating structures (of organizations or social-technical systems)

Morphological modelling is done in small subject specialist groups with the strong facilitation of practiced morphologists. The ideal size of the group is six to seven participants, excluding facilitation.

GMA goes through *cycles of analysis and synthesis* in the form of a number of steps or phases. The process is iterative and the steps are repeated to ensure that the group obtains deeper understanding of the problem complex being analysed. The visible result is a *morphological field*, i.e. a parameter space describing the variables of the problem complex being studied and how these variables are internally connected. With computer support, the morphological field can be used as a "what if" modelling laboratory for designating various possible underlying conditions (inputs) and examining resulting solutions (outputs). [1]

[1] For more information on General Morphological Analysis, visit www.swemorph.com.

2.2 GMA in practice

Computer supported GMA proceeds through a number of iterative steps or phases:

- **Analysis Phase 1 - Identify the variables**

Identify and define the parameters (which could also be termed dimensions or variables) that best describe the problem complex. (A – D below.)

A	B	C	D

- **Analysis Phase 2 - Define alternative values or conditions for each variable**

Each parameter is provided with a meaningful number of possible alternative values, which are called conditions. To be true variable, these conditions should be mutually exclusive.

A	B	C	D
a1	b1	c1	d1
a2	b2	c2	d2
a3		c3	d3
a4		c4	

- **Synthesis Phase 1 – Pair-wise consistency assessment**

The resultant morphological field (a parameter space) is checked for internal consistency. This is done by making pair-wise comparisons of all of the conditions in accordance with a special assessment template (below). The principle involved is to answer the question: Is it conceivable that a world including State a1 and State b1 (for example) can coexist? *Note that this is not a matter of determining causality, only internal consistency. On the other hand, arguments involving causal relationships may be used to arrive at the conditions required for coexistence.*

		A						C			
		a1	a2	a3	a4	b1	b2	c1	c2	c3	c4
B	b1										
	b2										
C	c1										
	c2										
	c3										
	c4										
D	d1										
	d2										
	d3										

- **Synthesis Phase 2 – Configurations**

Based on the assessments made in Synthesis Phase 1, internally consistent combinations of variable conditions, called configurations, are produced which consist of one condition from each parameter. The blue cells below jointly comprise one configuration.

A	B	C	D
a1	b1	c1	d1
a2	b2	c2	d2
a3		c3	d3
a4		c4	

- **Examination phase – Evaluate the configurations**

Study the matrix and configurations (the solution space). Identify and cluster groups of configurations. Search for different solutions with the help of single or multiple drivers – i.e. choose the *input data* in the form of one or several assumed conditions and obtain the remaining "consistent" conditions as *output data*.

- **Iterate the entire process (if necessary)**

2.3 Special considerations for the EPR study

In classical morphological analyses, the aim is to reduce the morphological field by excluding as many "inconsistent" internal pairs of conditions as possible. This results in a greatly reduced number of possible solutions compared with the original field of *formally* possible solutions (i.e. the total problem space). In certain cases, however, fields may have few internally inconsistent conditions. Such fields are called *hyper-coherent* – i.e. the variables are generally orthogonal, and pretty much everything is possible.

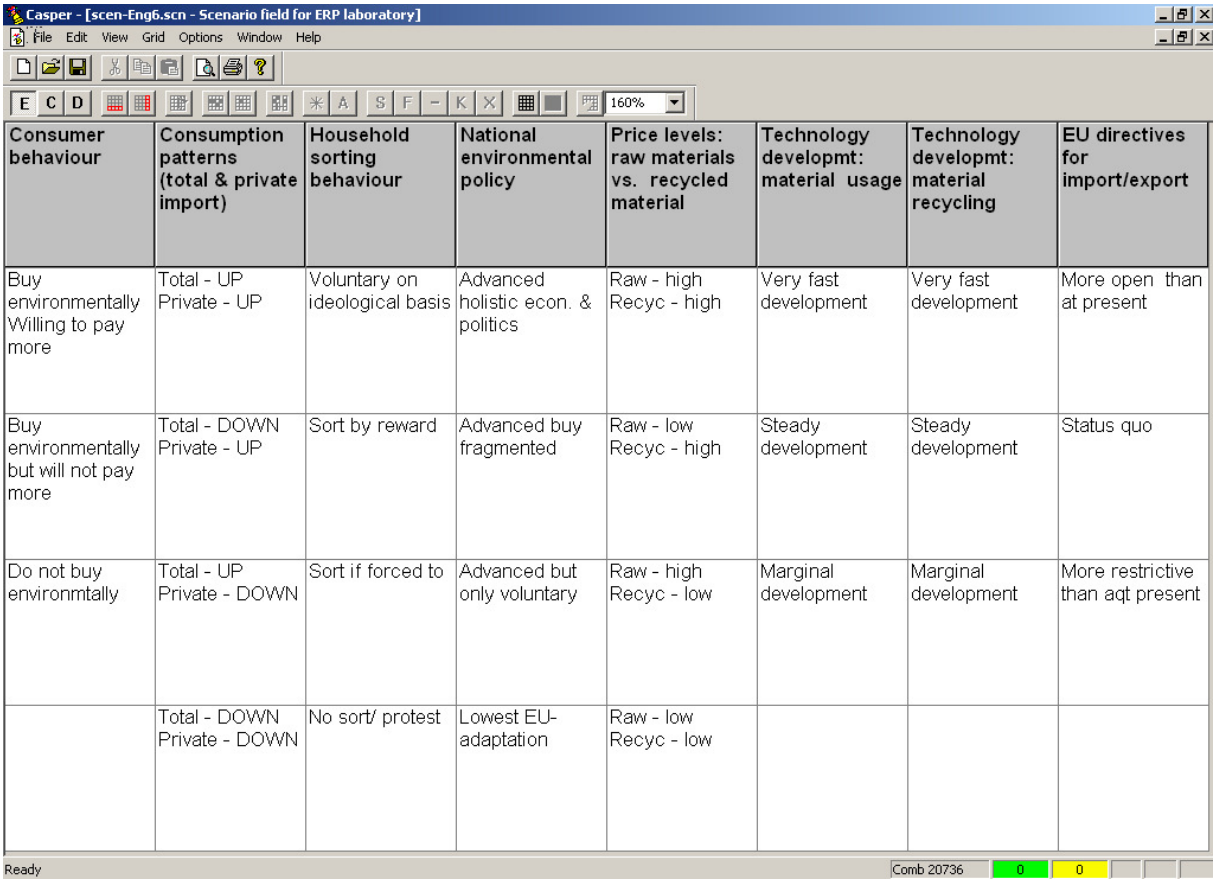
Scenarios fields frequently have this characteristic, as was the case with the EPR scenario field. Eight different scenario configurations were identified, which covered virtually the entire scenario field. Subsequently, each scenario configuration was evaluated separately for internal consistency.

During the final, joint work session, one EPR strategy solution was selected for each scenario, based on which one best fit the requirements of the particular scenario. This was done by finding the best fit for each strategy's defined conditions vis à vis each scenario as a whole.

3. Two morphological fields

3.1 The Scenario Laboratory

The working group responsible for the contextual and transactional environment developed the following scenario field (the field contains 20,736 formal configurations):



Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
Buy environmentally Willing to pay more	Total - UP Private - UP	Voluntary on ideological basis	Advanced holistic econ. & politics	Raw - high Recyc - high	Very fast development	Very fast development	More open than at present
Buy environmentally but will not pay more	Total - DOWN Private - UP	Sort by reward	Advanced buy fragmented	Raw - low Recyc - high	Steady development	Steady development	Status quo
Do not buy environmtally	Total - UP Private - DOWN	Sort if forced to	Advanced but only voluntary	Raw - high Recyc - low	Marginal development	Marginal development	More restrictive than aqt present
	Total - DOWN Private - DOWN	No sort/ protest	Lowest EU-adaptation	Raw - low Recyc - low			

The field contains the following variables:

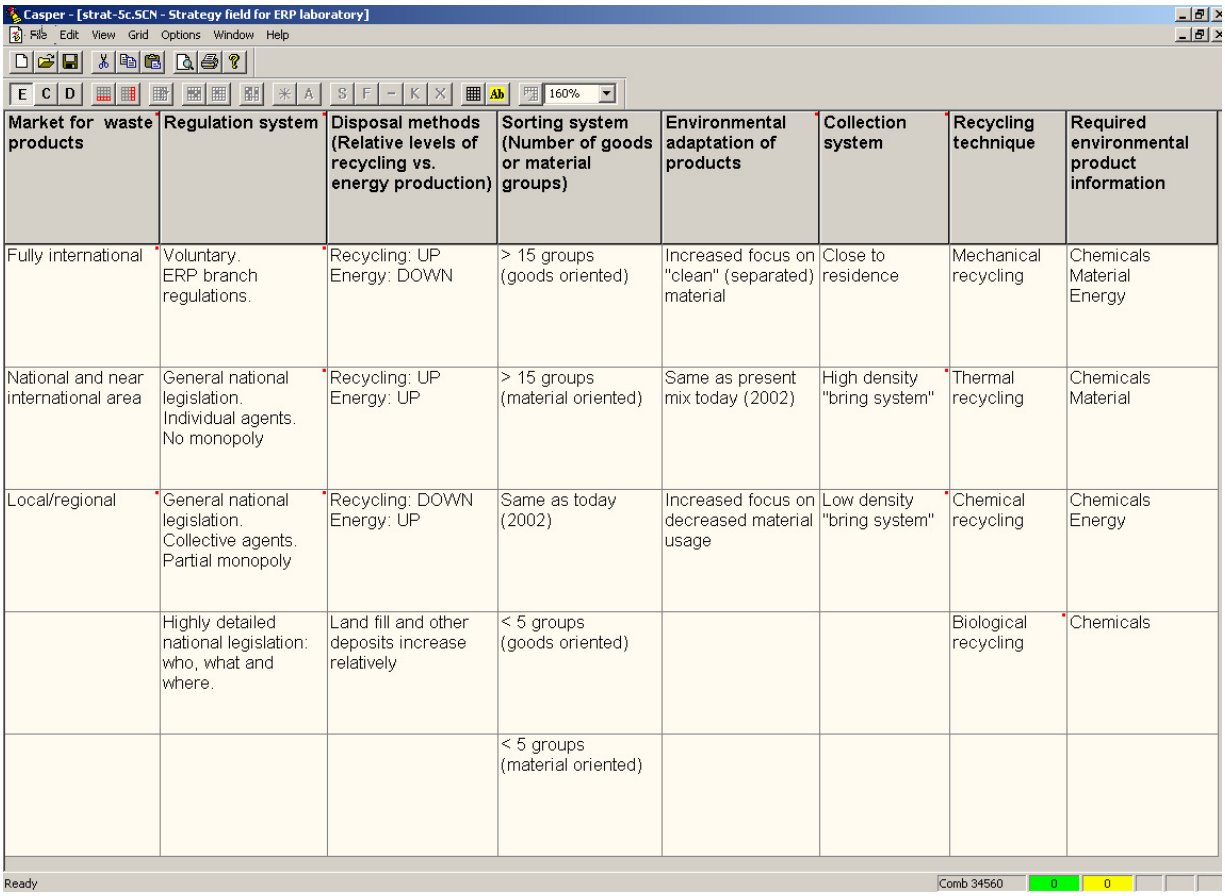
- **Purchasing behaviour**: How environmentally aware and environmentally knowledgeable are consumers in general (including both households and purchasers in private and public organizations)? More specifically, how willing are consumers to pay for environmentally compatible products?
- **Consumption**: How will consumption increase, both totally as in its proportion in private imports (for example, via the Internet)**.**
- **Consumer behaviour – sorting:** How willing will consumers be to sorting their waste products under different reward or sanction policies?
- **National environmental policy**: Is Sweden's environmental policy in phase with the EU's environmental policy or is it at the leading edge in relation to the EU? Are the control mechanisms characterized by a holistic approach, resulting in a good balance between incentives/sanctions and environmental policy? Is the policy based on voluntary commitments from various participants? If, alternatively, controls are employed, which should be prioritised?
- **Price of new basic materials vs. price of recycled materials**: The price of new raw materials, including oil, is mainly determined by the global market and by national taxes

and subsidies. The price of recycled materials in a particular area is significantly affected by technological advances.

- **Technological advances – use of materials**: What is the pace of dematerialization (meaning the development towards the use of less material in relation to utility)?
- **Technological advances – recycling**: What is the pace of technological progress in the field of materials recycling?
- **EU regulations governing the import and export of waste:** In what way will the rules governing the flows of waste over national borders change (compared with today)?

3.2 The Strategy Laboratory

The Strategy Development Group developed the following morphological field for describing various possible strategies for a Swedish EPR system (containing 34,500 formal configurations):



Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
	Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
			< 5 groups (material oriented)				

This field contains the following variables:

- **Market for waste products:** Within which regions will we trade in waste? From what origins will we allow waste to be sent to and treated in Sweden? Also, where will we allow waste collected in Sweden to be sent for processing?
- **PA regulation system**: Is Swedish producer responsibility based on voluntary commitments or legislation? Does this apply to all products or to specific products? Does the producer have the sole right to the waste?

- **Disposal methods**: How will different methods of disposal increase or decrease relative to one another? Is energy recovery from waste increasing or decreasing? Is the *proportion* of landfilled waste increasing in relation to the recovery of materials and energy? (This will be an effect of control instruments proposed in other ongoing studies.)
- **System for sorting waste at source**: Into how many fractions should the consumer sort waste, and what is the sorting principle – goods type or material type? (Each have their advantages and disadvantages.)
- **Environmental adaptation of products**: How should products be environmentally adapted? Shall product design we focus and "clean" material, or on less material or other favourable environmental characteristics?
- **Collection system**: How accessible should the collection system be?
- **Recycling techniques:** What mix should be considered?
- **Environmental product information**: What information about the product should the producer provide to the consumer?

4. Eight contextual scenarios

The scenario group defined eight scenarios, which covered virtually every condition in the scenario field. The scenarios were chosen in order to fill out the outer limits of the eight dimensional scenario field, thus covering extreme (but plausible) examples. During the final work session, the groups jointly studied the configurations, which resulted in certain adjustments and supplementary descriptions. The eight scenarios (time-frame 2015-2020) are:

1. Global crisis (Production gone wild)
2. Raw materials crisis (Oil crisis 2020)
3. Current development pessimistic (Characterized by environmental stagnation)
4. Current development optimistic (Characterized by strong environmental policy)
5. Greenhouse nightmare (Move away from combustion)
6. BATman – Best Available Technology (High-tech solutions)
7. Dematerialization (A composite world/Less yields more)
8. Green paradise (Everybody "does the right thing")

4.1 Global crisis

- Political situation: Very weak
- Market: Anarchy
- Technological development: Weak
- Environmental situation: Catastrophic

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
Global crisis	Buy environmentally Willing to pay more	Total - UP Private - UP	Voluntary on ideological basis	Advanced holistic econ. & politics	Raw - high Recyc - high	Very fast development	Very fast development	More open than at present
Raw materials crisis	Buy environmentally but will not pay more	Total - DOWN Private - UP	Sort by reward	Advanced buy fragmented	Raw - low Recyc - high	Steady development	Steady development	Status quo
Current development - pessimistic	Do not buy environmentally	Total - UP Private - DOWN	Sort if forced to	Advanced but only voluntary	Raw - high Recyc - low	Marginal development	Marginal development	More restrictive than at present
Current development - optimistic		Total - DOWN Private - DOWN	No sort/ protest	Lowest EU-adaptation	Raw - low Recyc - low			
Greenhouse nightmare								
Batman: High-tech solutions								
Dematerialization								
Green paradise								

In the scenario "global crisis" we envisage a deep worldwide recession. Europe and the United States have failed with respect to the new economy. Sluggish regions that remain in the old economy see their chance. The EU is in a process of disintegration and is politically very weak.

Swedish consumers are ignorant in terms of environmental matters and are occupied by day-to-day concerns. However, consumption in Sweden is increasing, despite the fact that consumers are short of money. This is possible because of unrestricted imports of cheap products from low-wage countries without environmental regulations. The price of raw materials on the global market is low because natural resources are being exploited – and depleted – without any consideration of tomorrow. Technological development in the environmental sector is very weak. New technologies are only being developed in cases where this is required to earn more money. Environmental issues are irrelevant.

Politicians in Sweden (and in other "industrialized countries") are weak and are being forced to loosen up environmental regulations in order to save jobs. European companies are continuously restructuring in order to tackle their financial losses. Due to continuous ownership shifts and the risk of widespread "freeloading problems," legislated producer responsibility is no longer relevant.

Comment: This scenario is a "doomsday vision" for EPR and, while not impossible, it is not regarded as especially credible for Sweden within a period of ten years. Nevertheless, it serves the purpose of functioning as a mental base line for other scenarios.

4.2 Raw materials crisis

- Political situation: Weak
- Market: Strong
- Technological development: Weak
- Environmental situation: Serious

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
Global crisis	Buy environmentally Willing to pay more	Total - UP Private - UP	Voluntary on ideological basis	Advanced holistic econ. & politics	Raw - high Recyc - high	Very fast development	Very fast development	More open than at present
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Greenhouse nightmare								
Batman: High-tech solutions								
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Green paradise								

There is a global shortage of raw materials. The price of oil is extremely high and global economic development is sluggish. It is not a total global economic crisis, but a strong setback for the new economy. Due to security policy instability, corruption and an increase in crime and mafia-like methods in many parts of the world, such activities as global trade in raw materials are severely hindered.

Swedish consumers focus on day-to-day living and are largely uninterested in environmental problems. Consumption has stagnated and increasing numbers of consumers are engaging in independent imports of cheap goods to exert pressure on prices. Consumers can only be persuaded to sort waste at source in return for rewards in the form of lower charges or other incentives.

The national environmental policy is mainly rhetorical; ambitions are high – in verbal terms – but are not backed up by effective means of control. It is assumed that market players will voluntarily comply with the ambitious objectives. In one respect, this actually works, although only because of the high price of raw materials. The development of technologies for the recycling of materials is being fuelled by these high prices, which means that the price of recycled materials is competitive with that of new raw materials. Product designs are adapted to the need to disassemble products that are then recycled from clean material fractions. One of the consequences of this is that it is not necessary to legislate for producer responsibility.

Manufacturers compete with one another for waste, which has become a attractive product, while new, improved techniques are being developed to utilize waste products as raw materials. European Union rules and regulations governing the import and export of waste have become more restrictive. Countries want to retain as much as possible of their recyclable basic materials within their own borders. Due to economic stagnation, technological development aimed at reduced material use in production (dematerialisation) is weak. There is no significant demand for luxury products made of sophisticated materials. Instead, products are reused and materials recycled. There is also a certain amount of competition between the recycling of materials and their use for energy extraction.

Comment: This scenario is somewhat reminiscent of Sweden in the 1960s, with its end-of-pipe solutions, and of the former German Democratic Republic, where a shortage of foreign currency for purchasing oil fuelled the development of technologies for the recycling of plastic. But it is mainly reminiscent of Japan today, where the focus is on recycling and not on dematerialization.

4.3 Current development – pessimistic (environmental stagnation)

- Political situation: Weak
- Market: Strong
- Technological development: Weak
- Environmental situation: Deteriorating slowly

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
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Greenhouse nightmare								
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The EU has expanded relatively quickly and now encompasses most European countries. The focus is on formulating an agricultural policy that makes sense – not an easy task! In the environmental arena, a wait-and-see approach has been adopted in order to give the new member countries a chance to catch up.

Global economic conditions are weak, which, among other things, has resulted in sluggish technological development. This applies principally to recycling technologies, mainly due to the fact that the price of raw materials is low. This, in turn, is the result of weak environmental policies that have failed to prevent the depletion of natural resources.

Technologies for the more efficient use of materials are becoming more attractive and increasing numbers of "mixed materials" are being used in new products. The rules for trading in waste within the EU are becoming more relaxed so that these mixed materials can be accommodated in large-scale recycling plants.

In Sweden, environmental awareness among consumers and politicians has cooled down somewhat but is not completely dead. However, environmental requirements frequently have to play second fiddle because consumers are sensitive to prices and would rather buy cheap than buy "environmentally". There is no public demand for cheap *and* environmentally compatible products.

Increase in consumption is sustained primarily through increases in private imports. Outside Sweden, it is possible to acquire cheap products that have poorer environmental properties than their Swedish counterparts. Consumption patterns are becoming increasingly heterogeneous and there are increasing numbers of cases of waste accumulating outside homes, thus making sorting at source impractical. Consumers only sort waste if they are forced to do so, if it is easy and if it does not require sacrifices in the form of time or money.

There is no holistic approach to Sweden's environmental policy. Political decisions about environmental matters mainly entail symbolic actions, when pressure from the media and/or lobbyists becomes excessive. In relation to the EU, however, Sweden is at the leading edge of environmental requirements, although the means of control are weak and uncoordinated. In the short term, this results in disadvantages for Swedish production in both domestic and foreign markets. In the longer term, however, demand for environmentally compatible products may give Sweden a competitive edge.

4.4 Current development – optimistic (strong environmental policy)

- Political situation: Strong
- Market: Strong
- Technological development: Medium-fast
- Environmental situation: Improving slowly

The greenhouse effect is beginning to become more widely recognized and wealthy countries are levying carbon-dioxide taxes in order to reduce the combustion of fossil fuels. As a result, the price of oil has skyrocketed, thus increasing the price of other new basic materials. This has resulted in a relatively healthy pace of technological development aimed at both a *reduced* consumption of materials and *increased* recycling.

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
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Greenhouse nightmare								
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Political support for research and development in the environmental field is robust, which manifests itself in, for example, economic stimuli to actors who invest in such R&D. Producers are increasingly investing in new materials such as laminates, composites and biodegradable plastics. The aim is to enhance key characteristics of these materials, while simultaneously reducing the use of material per utilized unit. Recycling technologies that can accommodate mixed waste materials are being developed. Other producers are choosing a different strategy, i.e. products designed to be easily disassembled and divided up into clean material fractions.

The EU has successfully expanded and the new member states have settled into the community relatively quickly. The EU now has a distinct environmental profile, characterised by a strong political will and joint action within the EU. Rules regarding trading in waste have been relaxed, since the recycling of mixed materials requires large-scale plants that do not exist, and *need* not exist, in all countries.

Due to the EU's ambitious environmental objectives, Sweden takes the chance of positioning itself at the leading edge of development. Sweden is joined in this by several other countries, mainly Germany, the Netherlands and Denmark. In these countries, environmental policy is approached holistically, whereby several control mechanisms complement one another. Environmental requirements – in the form of distinct goals and deadlines – are stringent. Market players are expected to propose solutions within a framework of incentives and sanctions. The sanctions imposed on those producers who try to shirk their obligations are stern.

However, although consumers want environmentally compatible products, they are not prepared to pay significantly more for them. Consumption is increasing steadily, as is the proportion of environmentally compatible products. For example, many consumers are choosing to independently import environmentally compatible products from other leading-edge countries, in order to exert pressure on prices. Also, consumers want to be rewarded for sorting their waste at source, and demand simple, time-saving systems.

4.5 Greenhouse nightmare – Move away from combustion

- Political situation: Very strong
- Market: Strong
- Technological development: Strong
- Environmental situation: Serious but improving

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
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Greenhouse nightmare								
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The greenhouse effect is recognised globally and has resulted in forceful regulation in many countries (particularly the affluent countries) and regions in order to achieve results as quickly as possible.

The EU has taken the global lead in the environmental arena. Other wealthy countries are still lagging slightly behind, but even they realize that something has to be done quickly. Sweden is at the leading edge of environmental development together with Germany, the Netherlands and Denmark. The EU is gradually sharpening its environmental regulations, especially those that involve the combustion of fossil fuels. Within the EU, taxes on oil and energy-intensive new raw materials are high, rfe4sulting in high prices.

The above, combined with strong stimuli for R&D, means that the pace of technological development is rapid in terms of both reducing material usage (dematerialisation) and increasing recycling. The development of composites, laminates and other light, material-efficient alternatives that have applications in the automotive and packaging sectors is being driven by high oil prices.

Consumers have become extremely aware of the threatening environmental problems and are willing to pay the higher price that environmentally compatible products cost. Since Swedish manufacturers can provide such products at acceptable prices, private imports are rising only moderately. For cost reasons, products that require considerable amounts of fossil materials are finding it increasingly difficult to compete in the market.

Technological development in the recycling field is contributing to the advent of recycling methods for both clean and mixed materials, but processes that are extremely energy intensive are finding it difficult to compete for cost reasons. EU rules governing trading in waste are relatively unchanged.

4.6 BATman – Best Available Technology

- Political situation: Strong
- Market: Strong
- Technological development: Very strong
- Environmental situation: Improving steadily

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
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A broad spectrum of consumers demands environmentally compatible products at reasonable prices. This message has hit home among politicians within the EU, who have driven development in this field, whereby the need for environmental compatibility is now taken for granted. Dialog between producers (incl. industry organizations) and politicians is lively and open.

Technological development has proceeded extremely rapidly in the field of both materials usage and recycling, stimulated by EU and national regulations. New technologies are quickly spreading all over the world.

Recovered raw materials are in great demand, since the price of new raw materials is high. Prices are being kept up with the help of taxes that are harmonized throughout the EU (and several other affluent countries). The EU's ambitious environmental policy, which Sweden is keeping pace with, is characterized by a holistic approach and a series of various control instruments. Because of this combination of factors, extended producer responsibility can be upheld largely by voluntary commitments. Dialog and consultation between governments and

the business community – frequently at the EU level – result in the formulation of rules based on the IPP concept.

Consumption is increasing, but the market is increasingly supplying environmentally compatible products. Private imports are rising only modestly because the same rules apply in all the principal import countries. New high-tech materials are being developed and along with complementary recycling technologies.

Consumers comply with the rules for waste handling as long as the systems are simple and convenient. However, since many products are changing appearance due to innovative materials, consumers are finding sorting waste at source increasingly difficult to understand. Usual packages are being converted into smart electronic products and even clothing has built-in electronics. The old rules for sorting at source are becoming invalid and consumers are beginning to tire of keeping track of excessive numbers of fractions.

4.7 Dematerialization – Less gives more

- Political situation: Weak
- Market: Strong
- Technological development: Strong – but one-sided
- Environmental situation: Improving

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
Global crisis	Buy environmentally Willing to pay more	Total - UP Private - UP	Voluntary on ideological basis	Advanced holistic econ. & politics	Raw - high Recyc - high	Very fast development	Very fast development	More open than at present
Raw materials crisis	Buy environmentally but will not pay more	Total - DOWN Private - UP	Sort by reward	Advanced buy fragmented	Raw - low Recyc - high	Steady development	Steady development	Status quo
Current development - pessimistic	Do not buy environmentally	Total - UP Private - DOWN	Sort if forced to	Advanced but only voluntary	Raw - high Recyc - low	Marginal development	Marginal development	More restrictive than at present
Current development - optimistic		Total - DOWN Private - DOWN	No sort/ protest	Lowest EU-adaptation	Raw - low Recyc - low			
Greenhouse nightmare								
Batman: High-tech solutions								
Dematerialization								
Green paradise								

Raw-material prices are very high because competition is intensifying as economic and industrial development gathers momentum in an increasing number of countries. This has fuelled the rapid development of technologies aimed at reducing the use of material in the traditional "industrialized nations." There is increased consumer pressure for more products that are functional, environmentally compatible and cheap.

Materials science explodes, and producer technology is primarily focused on "dematerialization", rather than recycling technology. New smart composites and laminates are key ingredients in significantly reducing the total usage of materials. This, in turn, has resulted in higher prices for recycled material. On the other hand, completely new materials are being developed that are biodegradable and thus do not constitute a major waste problem. In terms of environmental requirements, there is a distinct focus on reducing the usage of materials, which also results in reduced energy consumption for transportation – a must at a time when the pressure on natural resources is severe.

The Swedish environmental policy is at the leading edge in relation to the EU average, but it does not involve a holistic approach. The political controls that are meant to support the environmental compatibility lack a focus. Many of the new products in demand are manufactured outside Sweden and are imported privately. The trend is towards a situation where increasing numbers of products are difficult to recover and recycle. Market incentives, for keeping recycling systems in operation for the items that can still be recovered, are weak. Consumer interest in sorting waste at source and recycling is diminishing, as the traditional recycling techniques based on clean materials cannot handle high-tech mixed waste materials. EU rules for trading in waste are unchanged compared with the end of the 1990s.

4.8 Green paradise

- Political situation: Weak
- Market: Very strong
- Technological development: Strong
- Environmental situation: Improving significantly

SCENARIO	Consumer behaviour	Consumption patterns (total & private import)	Household sorting behaviour	National environmental policy	Price levels: raw materials vs. recycled material	Technology developmt: material usage	Technology developmt: material recycling	EU directives for import/export
Global crisis	Buy environmentally Willing to pay more	Total - UP Private - UP	Voluntary on ideological basis	Advanced holistic econ. & politics	Raw - high Recyc - high	Very fast development	Very fast development	More open than at present
Raw materials crisis	Buy environmentally but will not pay more	Total - DOWN Private - UP	Sort by reward	Advanced buy fragmented	Raw - low Recyc - high	Steady development	Steady development	Status quo
Current development - pessimistic	Do not buy environmentally	Total - UP Private - DOWN	Sort if forced to	Advanced but only voluntary	Raw - high Recyc - low	Marginal development	Marginal development	More restrictive than at present
Current development - optimistic		Total - DOWN Private - DOWN	No sort/ protest	Lowest EU-adaptation	Raw - low Recyc - low			
Greenhouse nightmare								
Batman: High-tech solutions								
Dematerialization								
Green paradise								

Consumers and producers in Sweden and a large number of other industrialized countries join forces to develop environmentally compatible products. Consumers influence the market directly by choosing the most environmentally compatible products and being prepared to pay more for them. The focus is on quality rather than quantity and services rather than a large number of goods. Politicians have dared to stick out their necks and implement a comprehensive system of tax swaps. New raw materials have become more expensive, but services cheaper.

Consumption in Sweden has increased only marginally compared with 2000. Private imports of products are only increasing moderately because Swedish producers have taken the vanguard with respect to environmental compatibility and can therefore match the requirements of Swedish consumers. Consumers are living up to society's demands for how waste should be handled. Collecting waste is profitable, since there is a good market for recovered materials.

Producers provide encouragement and support and also conduct in-house R&D aimed at developing more energy-efficient materials and state-of-the-art recycling technologies. In addition to consumer demands, the high price of raw materials – resulting in part from the system of tax swaps – is a major driving force for companies. In relative terms, the price of recovered recycled materials is lower, because of intensive technological development in the area. Strong measures are being taken to reduce the use of fossil fuels and to develop new energy technologies.

Swedish environmental policy is at the leading edge in relation to the EU average and is based on dialog and voluntary commitments from the market players. Politicians have stated a clear-cut policy in line with the IPP principle, but they largely transfer responsibility for driving development in this field to the "green" market. Since the trend in Sweden is also noticeable in several other EU countries, the US and Japan, the prerequisites for production in Sweden are favourable, despite the country's ambitious environmental objectives. EU rules for trading in waste have become more liberal. Subsidies for collecting and sorting waste have been banned in individual countries, to prevent unfair competition between countries.

Note that this voluntary "everybody does the right thing" scenario was not considered particularly plausible by the scenario group, but (like the "Global crisis" scenario) was developed as a Zwickian "boundary condition".

5. EPR system strategies: Idea generation based on the contextual scenarios

The next question is how an extended producer responsibility system can be shaped in order to suit each particular contextual/transactional scenario. In this section, we present a number of ideas in the form of configurations in the strategy field. These should be viewed as examples of strategic ideas formulated with the help of morphological analysis rather than actual, detailed solution proposals.

5.1 Global Crisis

We concluded that it was not meaningful to talk about extended producer responsibility in the global crisis scenario, because environmental concerns would hardly be the order of the day in such global circumstances. Instead, this scenario serves as a mental base line for other scenarios.

5.2 Raw Materials Crisis

The market takes care of producer responsibility with little government involvement, since waste has become a desirable and profitable raw material.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.3 Current development – pessimistic (environmental stagnation)

Producer responsibility is subject to political regulation but left in private hands. In Sweden, demand for recovered basic materials is slack and a large amount of waste is exported. Energy recovery is the most common waste-disposal method.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.4 Current development – optimistic (strong environmental policy)

Producer responsibility is based on voluntary input and general requirements that are formulated in a dialog between politicians and the business community. Demand for recovered basic materials is high. The waste market functions well based on the control instruments available within Swedish environmental policy, which is characterized by a holistic approach.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.5 Greenhouse nightmare – Move away from combustion

Producer responsibility is subject to stringent legislation in order to quickly achieve results. Materials recycling and energy recovery compete for waste, but there is a political willingness to steer demand for recovered basic materials towards materials recycling.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.6 BATman – High-tech environmental adaptation

Producer responsibility is voluntary and based on a combination of agreements between governments, market players and specific industry regulations. Demand for recovered raw materials is high and technologies for the "after-sorting" of waste are fully developed.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.7 Dematerialization: Less yields more

Producer responsibility is politically regulated by means of general provisions. The collection and treatment of waste is governed by law, but without a single party having sole rights. Politicians want to bolster materials recycling, because increasing numbers of products are becoming difficult or impossible to recover, at least in the short term. The most common way of taking care of waste, which largely consists of advanced composites, is energy recovery.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
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Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
Current development - optimistic		Highly detailed national legislation: who, what and where.	Land fill and other deposits increase relatively	< 5 groups (goods oriented)			Biological recycling	Chemicals
Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

5.8 Green paradise – Do the right thing

Producer responsibility is voluntary and based on industry regulations. Collection and treatment of waste is managed solely by the national market or internationally by neighbouring countries. The system is based on consumers and producers agreeing about the need for eco-cycle adaptation and materials recycling. This is a Zwickian boundary value configuration.

SCENARIO	Market for waste products	Regulation system	Disposal methods (Relative levels of recycling vs. energy production)	Sorting system (Number of goods or material groups)	Environmental adaptation of products	Collection system	Recycling technique	Required environmental product information
Global crisis	Fully international	Voluntary. ERP branch regulations.	Recycling: UP Energy: DOWN	> 15 groups (goods oriented)	Increased focus on "clean" (separated) material	Close to residence	Mechanical recycling	Chemicals Material Energy
Raw materials crisis	National and near international area	General national legislation. Individual agents. No monopoly	Recycling: UP Energy: UP	> 15 groups (material oriented)	Same as present mix today (2002)	High density "bring system"	Thermal recycling	Chemicals Material
Current development - pessimistic	Local/regional	General national legislation. Collective agents. Partial monopoly	Recycling: DOWN Energy: UP	Same as today (2002)	Increased focus on decreased material usage	Low density "bring system"	Chemical recycling	Chemicals Energy
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Greenhouse nightmare				< 5 groups (material oriented)				
Batman: High-tech solutions								
Dematerialization								
Green paradise								

6. Conclusions

With relatively limited time (5 workshop days), and limited subject-specialist support (two working groups of seven persons each), morphological analysis could be employed to create both a customized environmental scenario laboratory and a prototype strategy laboratory for generating and testing different EPR system solutions. A prerequisite was the formation of two subject specialist groups (one for the scenario lab and one for the strategy lab) and the ability to time the meetings of these groups so that they could monitor and influence each other's *on-going* work. The transfer of knowledge between the groups, through their respective morphological fields, proved to be highly efficient.

The joint review of the contextual/transactional scenarios, visualised as morphological fields, allowed us to create raw material for scenario texts *in situ* in a relatively large group of experts (the composite group of 14 persons). This is far more desirable than the usual case of this being performed by back-office personnel in small, consultant-dominated groups. We were also able to generate ideas for EPR solutions, based on the various scenarios, in the composite group.

The project was reported in the official Swedish Government Report: SOU 2001:102 *Resurs i retur* (*Resources in return),* 2002.