Federal Environment Ministry
Federal Environmental Agency

Guide to Corporate Environmental Cost Management

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Thank you!

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Publishers' Foreword

"Environmental protection can cut costs" – in 1996 those were the first words of the foreword by the Federal Environment Ministry and the Federal Environmental Agency to the "Manual of Environmental Cost Accounting". When companies make use of our natural environment, this gives rise to costs. If these can be reduced, it also reduces the burdens on the environment and at the same time helps to ensure the competitive strength of the companies in the long term.

At that time the focus was still on the costs of corporate environmental protection. The intention was to allocate these costs to the cost centres and cost units that caused them, in order to obtain a transparent picture of how environment-related costs originate. The aim was efficient design of corporate environmental protection.

The situation has moved on since then. The growing importance of integrated environmental protection measures has created a need for new rules for differentiating corporate environmental protection expenditure. There have also been considerable developments in material and energy flow related approaches such as flow cost accounting. This is focusing more attention on those costs that can be reduced not by lower-cost environmental protection measures, but by improving efficiency in the input of resources. The objective here is more cost-conscious and more environment-conscious management of the entire production chain. This is also reflected in the new title "Environmental Cost Management". Environmental relief effects result from reduced resource inputs and reduced waste outputs.

At the same time expectations – some of them unrealistic – about the size of the potential savings have been brought down to earth. No doubt there will always be examples of major savings coupled with very short payback periods for the necessary investments. As production becomes increasingly eco-efficient, however, spectacular savings will tend to become the exception. The success of environmental cost management is rather a matter of permanent optimisation of details. At the interface between corporate environmental protection and entrepreneurial profitability objectives, environmental cost accounting has proved its value many times.

From an environmental policy point of view, the significance of environmental cost management lies primarily in the way it systematically brings to light potential for environmental relief within companies. It exploits the entrepreneur's self-interest in reducing costs to maintain a high standard of environmental protection and helps give effect to the "polluter pays" principle. The publishers therefore take the view that environmental cost management can make an important contribution to achieving sustainability in economic activity.

This Guide is intended for practitioners in companies. It is intended not only for environmental experts, but above all for the responsible persons in accounting and controlling departments and for company management. The aim is to familiarise them with the methodological approaches of environmental cost management in relation to specific business tasks – investment planning, use of environmental protection technology, production control, environmental reporting – and help them with the selection of suitable approaches.

The publishers wish to thank the institutes responsible for preparing the Guide – the Institute for Ecological Economy Research (IÖW), Berlin, the Institute for Management and Environment (IMU), Augsburg, and Borderstep – Institute for Sustainability Research, Berlin – and also the members of the expert support group and all others who in the course of the project have contributed to its success. We hope the Guide to Environmental Cost Management will be widely accepted and used in the business world.

Federal Environment Ministry and Federal Environmental Agency

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1

Environmental cost management: combining cost-effectiveness and environmental protection

Since the 1970s, numerous corporate environmental cost accounting concepts have been developed for a variety of purposes and decision situations. The development of environmental cost management has gone hand in hand with shifts of emphasis on different issues in environmental policy and focuses in corporate environmental management. In the 1970s, for example, environmental policy and corporate environmental protection measures centred round emission reduction. It was against this background that in 1979 the German Engineers' Association (VDI) published VDI Guideline 3800 "Determining the cost of emission reduction systems and measures". Today, by contrast, the debate revolves around questions of eco-efficient steering of entire product life-cycle chains and strategic issues concerning sustainable business activity. To support such endeavours, a good deal has been done in recent years to develop and improve approaches to environment-oriented cost accounting. The development of key environmental policy areas and environmental cost accounting concepts is illustrated in Fig. 1.

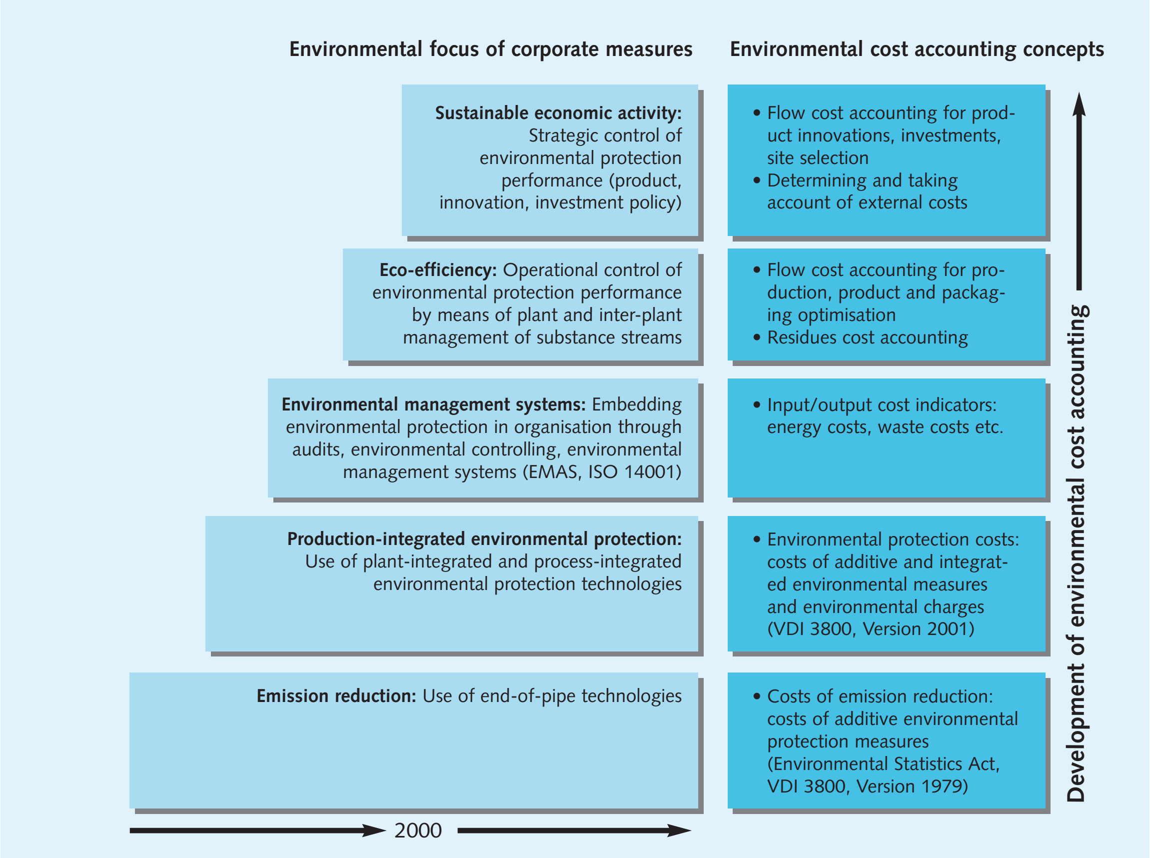


Fig. 1: Key environmental policy areas and environmental cost accounting concepts

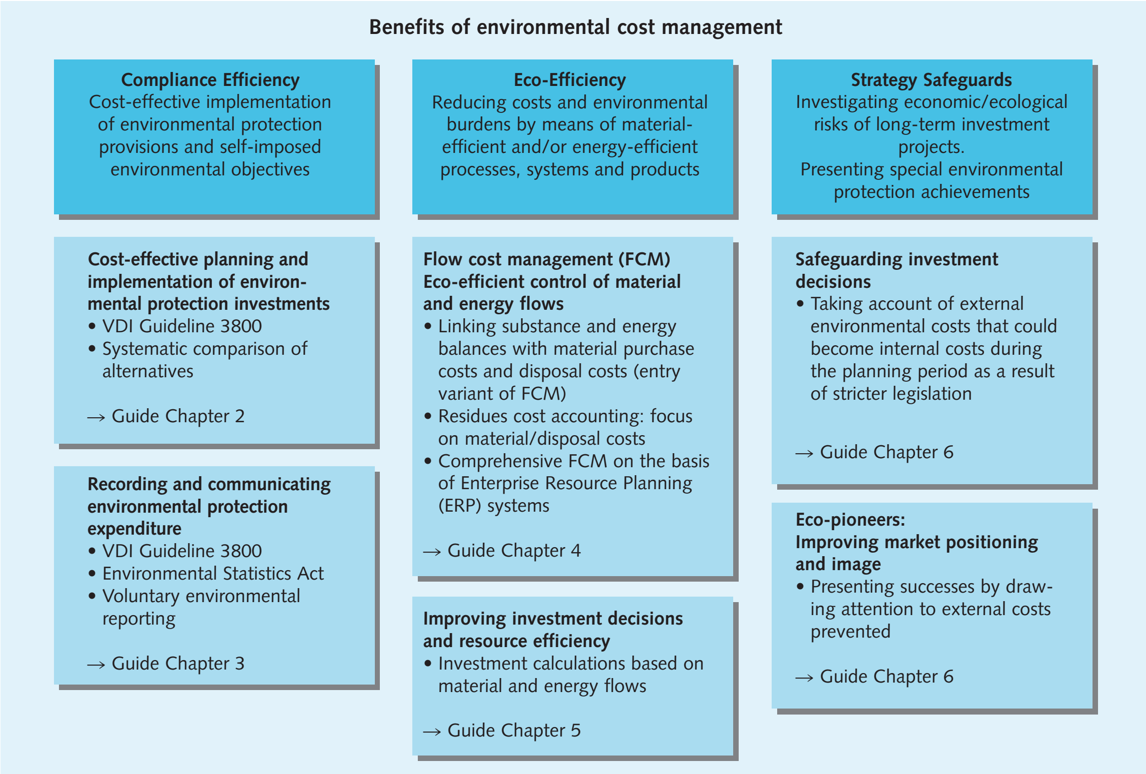


Fig. 2: Benefits of environmental cost management

Environmental cost management performs three central functions:

- It supports environmental protection by helping to ensure cost-effective implementation of environmental provisions or self-imposed environmental objectives (compliance efficiency)
- It promotes "win-win solutions" by supporting the search for eco-efficient processes and products and thereby linking cost reduction with savings in resources (eco-efficiency)
- It helps safeguard corporate strategies by helping to identify and take account of investment-relevant environmental costs and supporting the marketing of environmentally sound products

Not every cost accounting approach is equally suitable for these tasks. This brochure is intended to help company management, controllers and environmental managers to find the approach that is appropriate to their purposes and their business situation. Fig. 2 shows the uses to which the successive approaches of environmental cost management can be put.

This Guide is structured in terms of the tasks that can be supported effectively by means of environmental cost management, and provides an introductory overview of the approaches suitable for such calculations. For each method it outlines the basic idea, the procedures and the expenditure and benefits. Since the brochure is primarily intended to provide a rapid overview of the various approaches and assist in selecting a suitable strategy, it does not go into any great detail, but lists further sources of information in the individual chapters.

Table 1 supplements Fig. 2 by giving a summary of the practical business issues where environmental cost management can be of assistance and indicating the benefits that can be achieved in each case.

The environmental cost accounting approaches set out in this Guide not only differ in the business purposes for which they are used, but to some extent focus on different costs. It is basically possible to distinguish three different ways of looking at costs:

- Environmental protection costs: these are costs for environmental protection systems and for the measures designed to prevent, reduce, eliminate, monitor or document adverse environmental impacts.
- Material and energy flow costs comprise all those costs which are associated with the purchase, use and disposal of material and energy.
- External costs of business activities: these are environmental costs that are borne not by the company that causes them, but by the parties affected by them (e.g. neighbours) or by society as a whole.

Environmental protection costs, flow costs – for these and other definitions see the Glossary.

Each of these cost focuses offers different business opportunities: the focus on environmental protection costs serves to ensure cost-effective planning and

When does which approach help?

Basic questions	Which approach is most helpful here?	What is the business benefit?
1. **Environmental protection investments:** How can I find the lowest-cost investment alternative?	VDI Guideline 3800 "Determining the cost of corporate environmental protection measures" (Guide Chapter 2)	VDI 3800 offers clearly structured instructions for recording all expenditure associated with an environmental protection investment and makes it possible to compare various investment options.
2. **Environmental statistics:** How can I satisfy the reporting requirements of the Environmental Statistics Act in a way that benefits the company?	Information from Federal Statistical Office and VDI Guideline 3800. Another recommendation, for cost-relevant systems that are used solely for environmental protection purposes, is to set up a separate cost centre (Guide Chapter 3)	VDI 3800 helps with the calculation of investment expenditure and with distinguishing integrated environmental protection measures. Creating environmental protection cost centres permits better control of the costs arising there and allows cost comparisons between different systems (benchmarking).
3. **Voluntary environmental reporting:** How can I improve the company's credibility and image in the eyes of the target groups by presenting environmental protection expenditure in environmental reports or environmental statements?	Principles for voluntary reporting on environmental protection costs (Guide Chapter 3.4)	Compliance with reporting principles creates transparency, makes it easier to interpret the information and thereby enhances credibility in the eyes of the target groups.
4. **Material and energy balances:** How can I use the data from material and energy balances for cost management and cost reduction purposes?	Linking material and energy balances with material purchase and disposal costs (entry variant of flow cost accounting) (Guide Chapter 4, especially p. 27 ff.)	Short-term improvements and cost reductions can be achieved at low cost on the basis of existing data.
5. **Large quantities of waste:** How can I make further reductions in waste quantities and residues costs?	Flow cost accounting with focus on material and disposal costs (residues cost accounting (Guide Chapter 4, especially p. 27 ff.)	Creates good transparency of internal material flows and of the factors that cause and increase material losses, and usually offers a cost reduction potential in the region of 1 - 2% of production costs.
6. **Reducing material costs:** How can I reduce material costs for production locations with complex production structures and a multiplicity of internal materials movements?	Comprehensive flow cost accounting on the basis of Enterprise Resource Planning (ERP) systems (Guide Chapter 4)	Detects and deals with inconsistent material data in ERP systems. IT and organisational integration brings substantial improvements in efficiency (reductions in material losses and in quantities of materials used in products and packaging etc.).
7. **New and replacement investments:** How can I improve investment decisions and resource efficiency?	Investment calculations based on material and energy flows (Guide Chapter 5)	Systematic consideration of investment-relevant material flows improves the data and information basis for investment decisions and thereby increases profitability.
8. **New business fields:** How can I ensure even better safeguards for decisions on long-term investments in new business fields or innovative product segments?	Taking account of external environmental costs that might become internal costs during the planning period as a result of stricter legislation etc. (Guide Chapter 6)	For many sectors (energy, transport etc.) scientific studies have already yielded reliable data on external costs that can be used in an investment planning context.
9. **Eco-pioneers:** How can I make customers and the public aware of the benefits to society of the company's environmental protection efforts?	Publicising avoidance of external costs (Guide Chapter 6)	Eco-pioneers, e.g. in the construction, energy supply or food sectors, can use their marketing and PR activities to show in monetary terms the extent to which they prevent environmental damage by means of their products and production processes.

Table 1: Navigating through environmental cost management: When does which approach help?

implementation of statutory environmental protection requirements or of self-imposed environmental objectives of industrial associations and individual companies. Recording and steering of material and energy flow costs helps to reduce or avoid costs by means of material-efficient processes, systems or products. Here cost reduction and eco-efficiency are combined in a win-win strategy. In individual cases it may also make business sense to consider external costs, for example if external costs become internal costs within a planning period as a result of public charges, liability provisions or official conditions, or if a company sells environmentally sound products that make it possible to avoid external costs.

Environmental cost accounting as a player in the "orchestra" of management instruments

The special potential of environment-related cost and investment accounting methods lies in the fact that it links physical and monetary parameters. Aspects of environmental relevance can be expressed in monetary units and translated into a "business language". In this way environmental cost accounting can support the controlling functions and serve as a useful supplement to other instruments of environmental management such as audits, eco-balances or environmental indicators. Thus environmental cost accounting is not to be regarded as an isolated "tool", but as an indispensable player in the "orchestra" of the various management instruments.

The following chapters set out to indicate the purposes for which the strategies of environmental cost accounting can offer "added value" compared with other instruments, and how they can be used to combine cost-effectiveness with environmental protection.

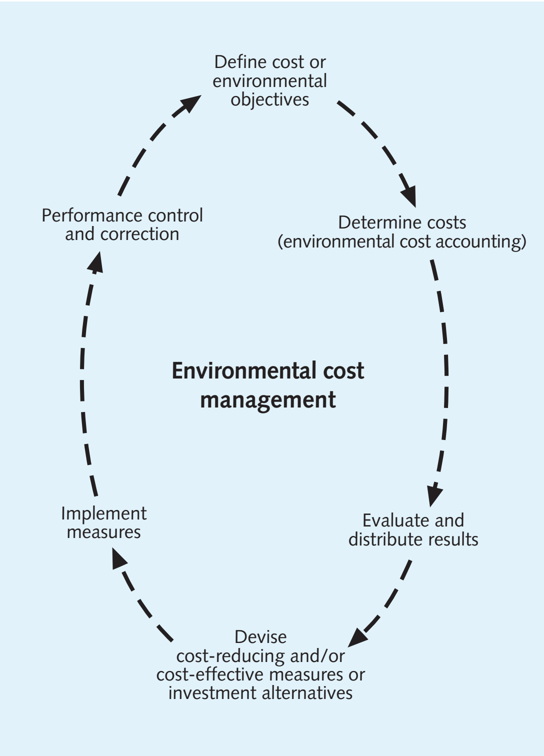


Fig. 3: Environmental cost accounting as part of the management cycle

"The introduction of flow cost accounting in Sortimo has led to a marked improvement in material flow transparency and data quality. This puts us in a position to systematically cut material costs and reduce environmental burdens. We also expect a pay-off in the form of optimised materials management and improved production planning"

Andreas Manntz, Commercial Director, Sortimo International GmbH (Zusmarshausen)

"Companies that stay successful in the long term are environmentally aware companies. Determining external costs helps the company to see the environmental burdens it causes in relation to its economic success. This enables it to identify long-term financial risks at an early stage and avoid them. External costs can also be used as a marketing argument: falling external costs are evidence of a company's environmental protection endeavours."

Prof. Andreas Troge, President, Federal Environmental Agency

Opinions from industry and the Federal Environmental Agency

"Anyone who regards statutory reporting on environmental protection expenditure as no more than a tedious duty hardly does justice to the opportunities it offers. Given appropriate preparation of the data, merely looking at the expenditure side is in itself often enough to reveal relief effects that have been achieved in the course of time thanks to integrated and more efficient environmental protection solutions. And these improvements have created scope for further measures. Analysing and monitoring environmental protection expenditure is only a first building block in the edifice of environmental cost management, however. Especially in the case of material-intensive and energy-intensive production operations, it makes sense to employ further environmental cost management techniques to take account of the cost behaviour of material flows. In most cases it is advisable to integrate this in the corporate cost accounting system in order to minimise the work involved in recording and managing the data."

Ralph Thurm, Corporate Environmental Protection Division, Siemens AG

2

Cost-effective planning and implementation of environmental protection measures

This chapter indicates ways of systematically comparing available options for investment in environmental protection systems to ensure reliable identification of the least expensive and most efficient solutions.

Now that sewage works and air quality control systems have been installed throughout Germany over the past three decades, the need for investment in such end-of-pipe environmental protection systems is a much less frequent occurrence than it used to be. Nevertheless, there will always be situations in which a new environmental protection system becomes necessary.

2.1 Special features of environmental protection investments

If there are several alternative options for an investment decision, investment calculations support the economic approach in the decision-making process. In conventional investments such as new production facilities, the investment calculation sets expenditure against expected revenue in order to compare alternatives on the basis of internal discounting rates or payback periods. Chapter 5 shows how the decision process can be improved for conventional investments of this kind.

Unlike conventional investments, however, end-of-pipe environmental protection systems do not usually generate any revenue or produce any relevant cost reductions. For measures of this kind, which result in higher costs, only the size of the investment and the regular annual expenditure is determined. On this basis it is possible to calculate the cost per environmental burden avoided, in other words the efficiency of the funds spent. This procedure is in line with the revised VDI Guideline 3800 "Determination of costs for industrial environmental protection measures". The Guideline is concerned on the one hand with identifying and distinguishing regular environmental protection expenditure, and on the other with preparing investment calculations for environmental protection measures.

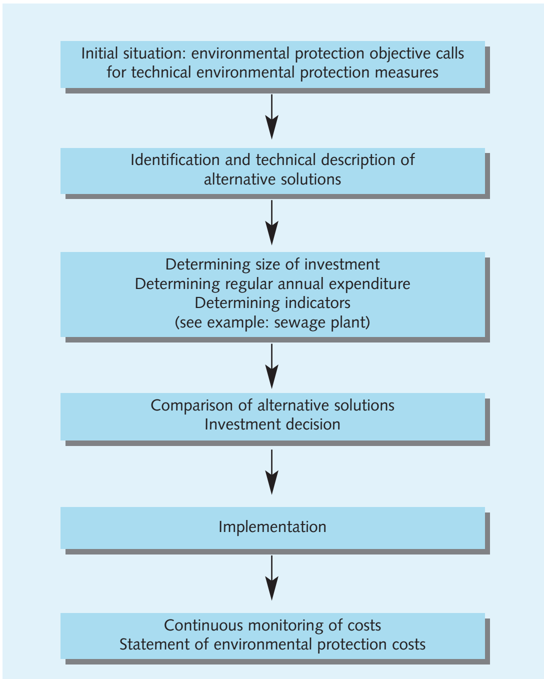


Fig. 4: Steps in selecting low-cost environmental protection measures

2.2 Procedure

The calculation described in the VDI Guideline can be used where there is a need for a technological environmental protection measure. The aim may be to comply with official environmental requirements or to meet a self-imposed environmental objective set, for example, in the context of an EMAS or ISO 14001 environmental management system. It therefore considers investment projects for sewage plants, air filter systems, catalytic converters, waste management systems, or plant-integrated environmental protection measures.

In the ideal case there are various possible solutions which are drawn up in preparation for the decision. To be able to compare them properly later, it is first necessary to describe their consumption data (operating supplies including energy) and their performance data (e.g. filter capacity).

Determining the size of the investment

The size of the investment is then determined for each alternative solution. An investment in an end-of-pipe environmental protection solution comprises all expenditure from planning to commissioning. As well as the cost of acquisition there are a number of other items to be taken into account, e.g. delivery, measuring equipment or training courses. An overview of such items can be found in the checklist "Additional costs of environmental protection systems".

Determining regular expenditure

The operation of an environmental protection system gives rise to various kinds of regular expenditure, which are determined on an annual basis. The main categories are:

- **Expenditure arising from the investment.** This kind of expenditure arises independently of the actual operation of the system. It includes depreciation, interest, insurance premiums, impersonal taxes, a share of administrative costs, expected maintenance and repair costs.
- **Operation-related expenditure.** This essentially comprises expenditure on operating supplies consumed (including energy) and on personnel. The quantities likely to be consumed can be worked out from the planned utilisation of the system.

In addition, follow-up expenditure may be incurred if the investment project gives rise to alterations in the production processes themselves (e.g. changes in efficiency). In some cases fees or services, e.g. for waste disposal and emission measurements, or even revenue from the sale of recycling materials, may be an aspect of relevance to the decision; these can be subsumed under "Other income and expenditure".

The regular expenditure is calculated by determining and totalling the expected annual figures for all the individual items.

Checklist
"Additional costs of environmental protection systems"

The following cost items may arise in addition to the actual purchase price when installing an environmental protection system:

- Site acquisition (including property transfer tax, any demolition costs,…)
- Buildings (foundations, site development, rehabilitation,...)
- Delivery (including instrumentation and control systems, freight, packing, insurance)
- Assembly (including assembly insurance and commissioning)
- Peripheral equipment (e.g. pipework, conveyor systems)
- Painting, insulation
- Energy supply and other supply facilities
- Sewers, roads, railways, amenity rooms
- Additional investments (transport facilities,building site facilities,...)
- Raw materials store (including increases in current assets, e.g. due to minimum stocks necessary for ensuring long-term operation)
- Spare parts store
- Startup costs for system or parts thereof
- Measuring equipment for emission and immission measurements (air, water, soil)
- Interest until commissioning (e.g. interest on building finance)
- Engineering and consulting (including expenditure on own planning work)
- Customs duty
- Licences
- Cost of approval procedures (including any expert opinions obtained)
- Instruction and training of personnel needed to operate the system

If environmental protection systems are subsequently installed in existing production processes, such integration may give rise to additional capital expenditure and regular expenditure. To make it possible to compare costs for identical or similar systems within the company or within the industry, such integration investments should be recorded and shown separately.

Source: VDI 3800

VDI Guideline 3800 – help with investment decisions

Indicators and selection decision

As a rule, different alternative solutions involve not only different costs, but also different benefits. The benefit of environmental protection systems usually consists in the prevention of emissions. To permit a better comparison of the relationship between costs and benefits, it is therefore necessary to compile not only the costs of the various systems, but also the sum of the emissions they prevent. These figures can be used to arrive at two indicators for each alternative solution, namely the amount of capital invested per emission unit prevented, and the level of regular costs per emission unit prevented.

Once the calculation procedure described here (see also the example of an "Industrial wastewater treatment plant" on page 13) has been carried out for each alternative solution, the figures for capital expenditure, regular expenditure, emissions avoided and the cost-benefit indicators are known. As a rule these figures constitute the essential core information for the selection decision that now has to be taken.

2.3 Benefits

The investment calculation described in the VDI Guideline has several advantages to offer. For example, the Guideline makes for the use of a standardised procedure within the company and, with its detailed checklists, ensures timely inclusion of all costs incurred. At the same time it ensures the compatibility of the investment calculation with the Environmental Statistics Act. This has the advantage that cost monitoring is based on the cost categories that have to be used for environmental statistics. The figures from cost control can thus be used directly for the purpose of Environmental Statistics.

If modifications to cost accounting are made when the system goes into service, the environmental statistics should also be taken into account. As explained in Chapter 3, it is advisable to create a separate cost center or at least a separate cost location for the new environmental protection system. This not only permits better monitoring of regular costs, but also simplifies the preparation of statistical returns.

Bibliography

Verein Deutscher Ingenieure (publ.): VDI Richtlinie 3800, Determination of costs for industrial environmental protection measures, Berlin 2001

Bundesumweltministerium, Umweltbundesamt (publ.): A guide to corporate environmental indicators, Bonn, Berlin 1997

Example: Industrial wastewater treatment plant

A new treatment plant is needed to clean the wastewater from a planned paint shop. The usual treatment stages – neutralisation, sedimentation and filtration – are to be used to remove heavy metals, in particular sizeable quantities of zinc and nickel, from the wastewater. The wastewater treatment plant, which can remove up to 10 tonnes of heavy metals a year, is assumed to have an operating life of 25 years and an average utilisation of 90%. The example shows how the relevant expenditure and indicators can be calculated in accordance with VDI 3800.

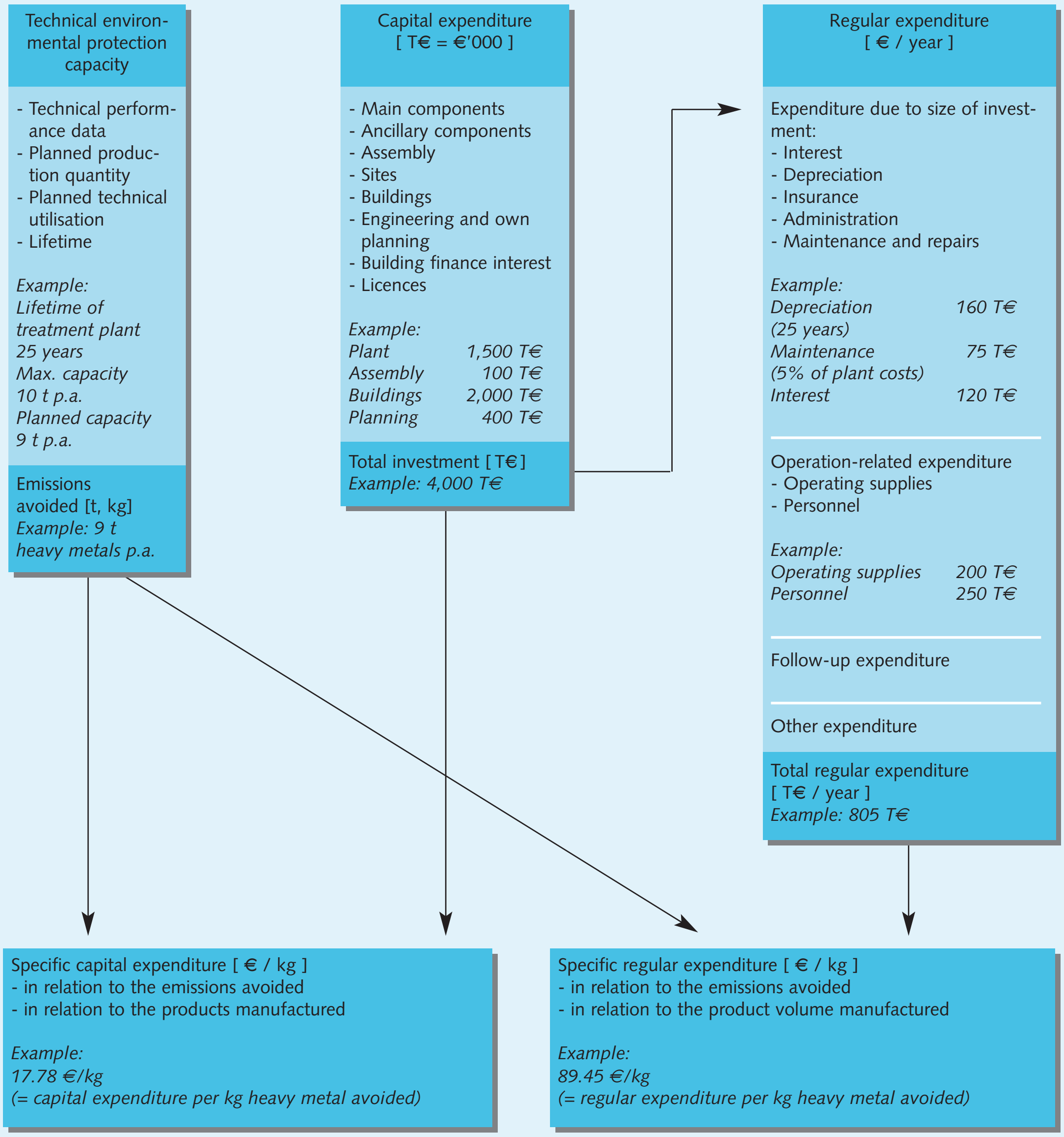


Fig. 5: Determining expenditure and indicators for environmental protection investments in accordance with VDI 3800

Model calculation in accordance with VDI Guideline 3800

In addition to the treatment plant considered above costing €1.5 million, an alternative offer, plant B, was also investigated. Plant B has a more modern process management system and various ancillary units that reduce personnel costs and consumption of operating supplies. As a result, capital expenditure increases to €2.2 million and regular annual expenditure decreases to €730,000 (see Table 2). A comparison of the figures for the two plants reveals that the higher initial expenditure is offset by the lower regular expenditure. Interest effects are taken into account by applying statistical interest when determining regular expenditure.

Plant type	**Emissions avoided p.a.**	**Purchase price [thousand €]**	**Total investment incl. ancillaries [thousand €]**	**Regular expend. p.a. [thousand €]**	**Specific investment [€ / kg]**	**Specific regular expenditure [€ / kg]**
Plant A	9,000 kg	1500	4000	805	17.78	89.44
Plant B	9,000 kg	2200	4700	730	20.89	81.11
Comparison of plants	same	+700	+700	-75	+3.11	-8.33

Table 2: Comparison of investment alternatives

3

Environmental statistics and monitoring of environmental protection costs

This chapter shows how to determine environmental protection costs for statistical returns in such a way that they can also be used for improved cost control of environmental protection systems.

In many German companies the first step towards environmental cost management begins with the requirement, frequently seen as an annoying obligation, to determine spending on environmental protection for the statistical returns. Every year information on environmental protection expenditure is obtained from up to 15,000 companies in the manufacturing industry. The statistics gathered in this way make it possible to quantify the economic significance of environmental protection in Germany. The environmental statistics also cover environmental burdens due to emissions. This creates a basis for observing the relationships between environmental protection expenditure and its results.

€13 billion for end-of-pipe environmental protection

3.1 Focus of statistics

The environmental statistics record "expenditure on measures intended exclusively or predominantly for the protection of the environment". This means they essentially focus on expenditure on end-of-pipe environmental protection measures, plus fees and premiums. At present the statistics do not take account of integrated measures, such as filter systems integrated in production installations or ecological optimisation of products.

At this point we have to consider the meaning of the term "expenditure" in the environmental statistics. In this context expenditure is taken to mean capital

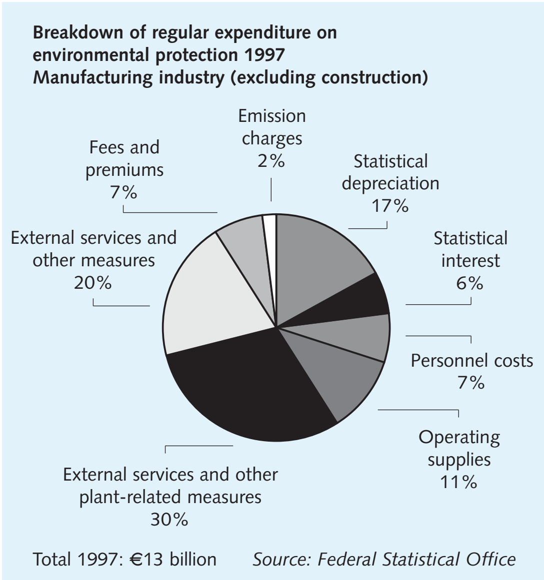


Fig. 6: Breakdown of regular expenditure on environmental protection

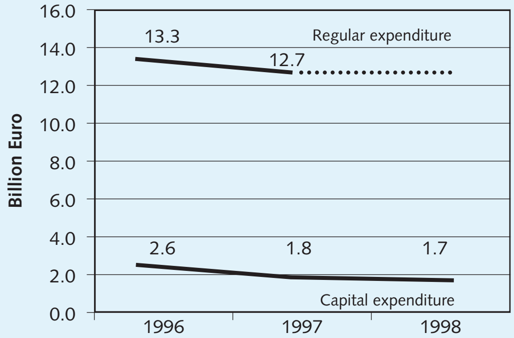
expenditure on environmental protection systems and, shown separately, regular expenditure on environmental protection systems. Regular expenditure also includes depreciation and statistical interest on the environmental protection systems. Total regular expenditure on environmental protection systems in 1997 came to €13 million, compared with a figure of €1.8 billion for capital expenditure.

Is industry doing less for the environment?

The findings of the environmental statistics show that German industry is investing less and less in environmental protection measures. Whereas DM 5.08 billion was invested in environmental protection technologies in 1996, two years later the figure stood at only DM 3.29 billion. Has environmental protection become less important? As a rule this is not the case. The reason for the decline seen here lies in the focus of the statistics. They only include expenditure on end-of-pipe environmental protection measures. In the meantime, however, there is evidence of a clear trend towards integrated environmental protection technologies, which make for reduced environmental pollution in the course of the production process. As a result, the need for additional filters or sewage plants is steadily diminishing. The statistics, however, do not take account of such investment in integrated technologies. In assessing the trend, moreover, one has to consider the large numbers of existing environmental protection systems. Whereas in the past many companies have had to invest in first-time projects for sewage plants, filters or waste management systems, today only replacement investments or upgrades are necessary.

Finally there is another indication that companies are keeping up their environmental protection efforts. The figure for regular expenditure on environmental protection measures shows only a slight drop.

Capital expenditure and regular expenditure on environmental protection (manufacturing sector), excluding emission charges



Source: Federal Statistical Office

Fig. 7: Capital expenditure and regular expenditure

3.2 Procedure

The companies in the environmental statistics reporting group have to compile information about their capital expenditure on environmental protection projects and their regular expenditure on environmental protection. Since small and medium enterprises at least do not regularly make extensive capital expenditure on environmental protection projects, the information on this category should be relatively easy to determine. The situation is different when it comes to determining regular environmental protection expenditure. The figures needed for this purpose can either be estimated or determined with the help of cost accounting.

More precise determination of the data naturally takes more time initially. This may pay off if environmental protection costs occur on a significant scale in various places, because it yields sound figures that also permit better internal cost control and transparency.

To make it as easy as possible to determine environmental protection expenditure[1] on a periodic basis, it is advisable to modify the cost centre structure. First of all, separate cost centres should be created for all cost-relevant systems that are used solely for environmental protection (e.g. sewage treatment plants or waste separation systems). The costs arising for these cost centres can then be used without difficulty for the environmental statistics.

In the case of small and medium enterprises without appreciable environmental protection systems of their own, external services (e.g. environment-related consulting, emission monitoring etc.) and fees may be charged to separate accounts and thus recorded under new cost categories. In such cases these cost categories could be evaluated when compiling details of environmental protection costs.

Procedure for less cost-relevant environmental protection systems

If the creation and administration of a separate cost centre is not considered worthwhile in the case of less cost-relevant environmental protection systems, it is advisable to use and document an allocation procedure for determining environmental protection costs. This ensures that the figures obtained are always comparable. If cost locations are distinguished within cost centres, it is also possible to use these cost locations for systematic recording of environmental protection costs.

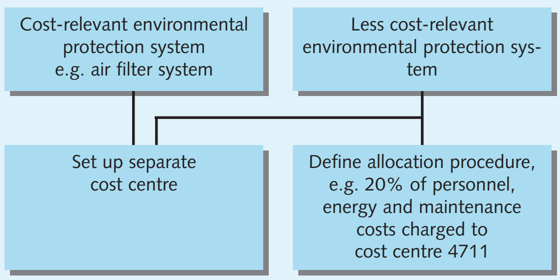


Fig. 8: EP cost centres or allocation procedures

[1] For the distinction between costs and expenditure, see the Glossary.

3.3 Benefits and limits

Regular determination of environmental protection costs does more than merely provide figures for the statistics. The newly created environmental protection cost locations can also be used to ensure better control of the costs incurred there. They permit early identification by cost accounting of problems in these end-of-pipe areas, such as excessive consumption of operating supplies or increasing maintenance costs. Where there are several comparable plants within a company it is possible to make regular cost comparisons, a kind of internal benchmarking. And finally, separate cost centres make it possible to allocate the costs of environmental protection systems to the production cost centres that use them. This helps to achieve greater cost transparency.

It is however essential to bear in mind the limits of this costs perspective. Three aspects are of special importance here:

Better cost control in end-of-pipe environmental protection makes sense, but it is not enough.

1. An exclusive focus on environmental protection costs is not a good way of systematically exploiting eco-efficiency potentials. This is because environmental protection costs account for only a small proportion of the costs caused by the materials used and by waste and emissions. As a rule the original material costs of the substances contained in the waste and wastewater are several times the cost of disposal. To systematically identify cases of cost-reduction potential in environmentally relevant material flows, it is essential to take account of the associated material and production costs. This finding has led to the development of flow cost accounting, in which ancillary calculations systematically provide information for tapping development potential. Flow cost accounting is described in Chapter 4, starting at p. 20.

2. The cost of end-of-pipe environmental protection measures as recorded in the environmental statistics presents an incomplete picture of the company's environmental protection performance. This is because companies today are increasingly taking production-integrated environmental protection measures which prevent harmful environmental impacts arising in the course of the production processes. These integrated technologies have the attractive feature that they are often more efficient and less expensive than end-of-pipe measures. At the same time, however, they are much more difficult to differentiate in cost accounting. The VDI Guideline 3800 described below takes a detailed look at this differentiation problem.

3. Information about environmental protection costs can also be used for corporate communication on environmental issues. Where such figures are published, they should specify which environmental protection costs are covered – and which are not. The last section of this chapter shows how to provide information about environmental protection costs in a way that enables experts and the interested public to interpret the figures correctly.

Further development of environmental statistics: VDI Guideline 3800

The revised edition of VDI Guideline 3800 "Determining expenditure on corporate environmental protection measures", published in 2000, takes a close look at how to differentiate expenditure on environmental protection measures. In particular, it provides assistance with systematic differentiation in the case of integrated environmental protection measures. For this purpose it distinguishes:

- Plant-integrated environmental protection measures, (e.g. built-in catalytic converters, additional combustion chambers) and
- Process-integrated environmental protection measures (e.g. converting coating technologies from solvent-based paints to powder coatings). (See Fig. 10)

The cost components for plant-integrated environmental protection measures are comparatively easy to identify. This means they can basically be allocated to environmental protection costs in accordance

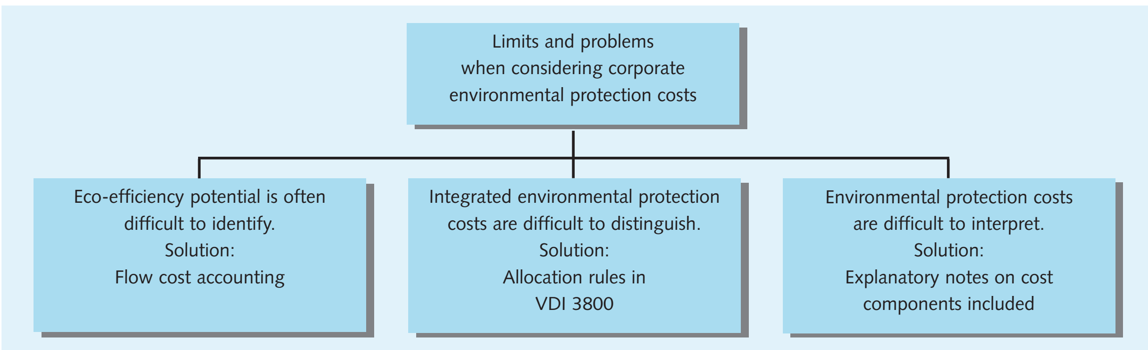


Fig. 9: Limits to consideration of environmental protection costs

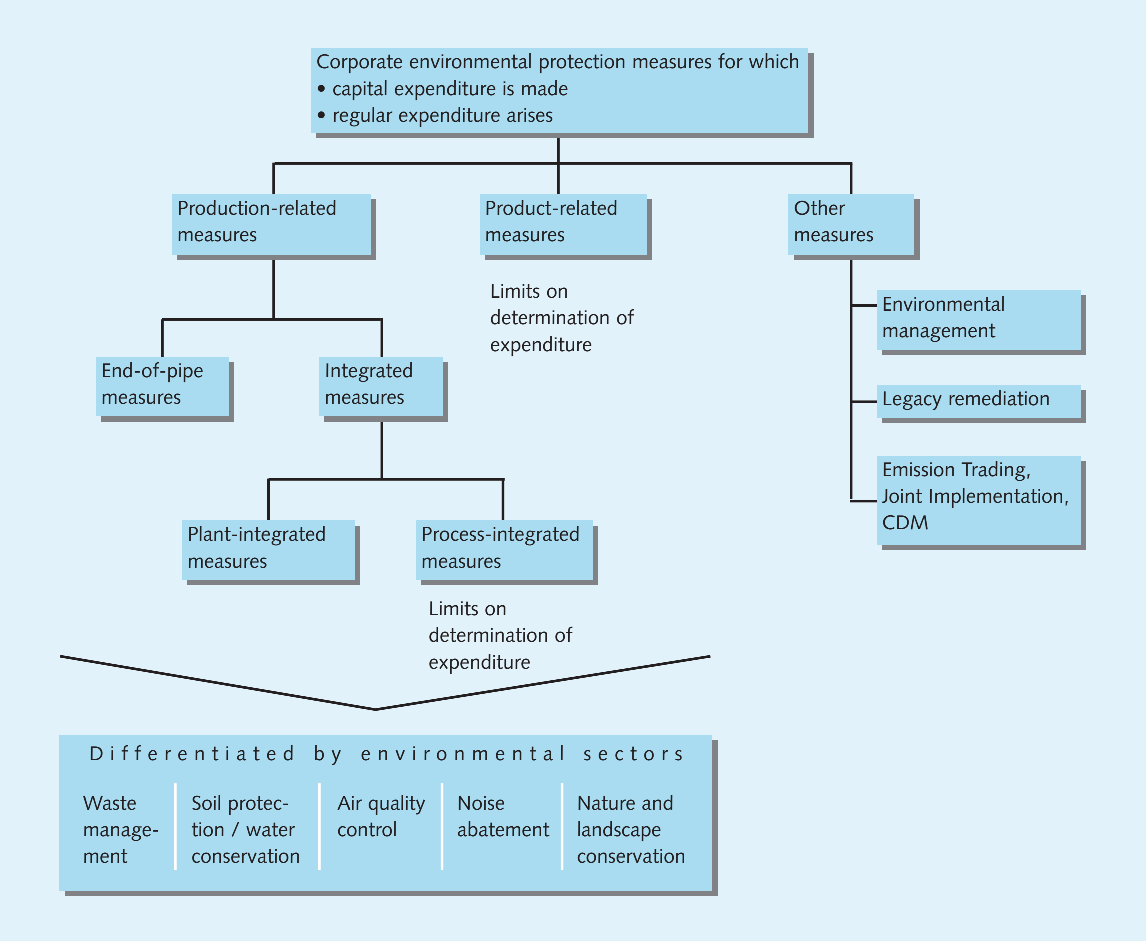


Fig. 10: Differentiation of environmental protection measures in VDI Guideline 3800

with the new VDI Guideline. It is much more difficult, however, to assess process-integrated environmental protection measures, because as a rule changes in a production process pursue not only environmental objectives, but also a variety of other objectives such as cost reductions, quality improvements etc.

In such cases, therefore, the environmental protection components can only be estimated. In order to avoid gross differences as a result of individual assessments, either industries or the typical users of the process-integrated technology under consideration are recommended to agree standard percentages for the environmental protection component of installations of this kind. If no such convention exists, no environmental protection expenditure should be shown for the process-integrated measure in question.

As already mentioned, environmental statistics in Germany do not at present take account of the costs of integrated environmental protection measures. Discussions are in progress at European level about the possibility of widening the scope of national statistics accordingly, which may possibly result in the inclusion of plant-integrated environmental protection measures. Until then companies must decide for themselves whether it is worth their while to determine their own integrated environmental protection costs. The principal benefit is seen in the improved basis of data for environmental reporting. The cost of integrated environmental protection measures can be used to show the public the significance of this block of costs by comparison with the possibly falling costs of end-of-pipe measures.

At present the statistics only take account of expenditure on end-of-pipe measures and remediation of contaminated sites.

Taking account of integrated measures in cost accounting

It does not make sense to create separate cost centres for integrated environmental protection measures, as they are components of production installations. If integrated environmental protection costs are to be determined on a regular basis, suitable cost locations can be set up. Or the costs can be determined in an ancillary calculation as a fixed percentage of the costs for the relevant cost centre.

3.4 Environmental protection costs in voluntary reporting

Even if the company has "only" complied with the Environmental Statistics Act and merely determined its expenditure on end-of-pipe environmental protection measures, it is a logical step to make use of this information in environmental reports or other forms of environmental communication as well. To enable the readers to assess and interpret this information correctly, it is advisable to bear in mind the following aspects:

- The information should make it clear what kinds of environmental protection measures (end-of-pipe, integrated) and what cost categories (depreciation, personnel costs) have been included.
- Where costs are shown for end-of-pipe environmental protection measures, the differentiation rules used as a basis for the environmental statistics should be complied with. Attention should be drawn to this procedure.
- Where costs are shown for integrated measures, the differentiation rules set out in the VDI Guideline should be complied with. Here too, drawing the attention of the interested public to such compliance with the VDI differentiation rules can help them to interpret the figures.
- Supplementary information on the savings achieved as a result of environmental protection measures is recommended in order to convey a complete picture of the costs situation. A look at the savings achieved can be used to make it clear that future-oriented solutions lie in more efficient utilisation of input materials.

Taking account of these aspects makes it considerably easier for the reader to interpret the published figures. Explanatory notes about trends over time, the significance of environmental protection costs for internal management or the findings of the environmental statistics may be used to round off the picture for the reader.

Example: Presenting environmental protection costs in an environmental report

In an environmental report the environmental protection costs disclosed could be explained as follows:

"We determine our ongoing operating expenses and our capital expenditure on environmental protection in accordance with the requirements of the German Environmental Statistics Act. In the last financial year we spent €45.8 million on operating expenses and €11.3 million on end-of-pipe environmental protection measures (e.g. filters, wastewater treatment systems etc.) and environmental management. As in the past, the largest items are waste management and water conservation. The item 'Miscellaneous' comprises all items that cannot be directly allocated to the categories of the environmental statistics. These are essentially the expenditure on our environmental management systems."

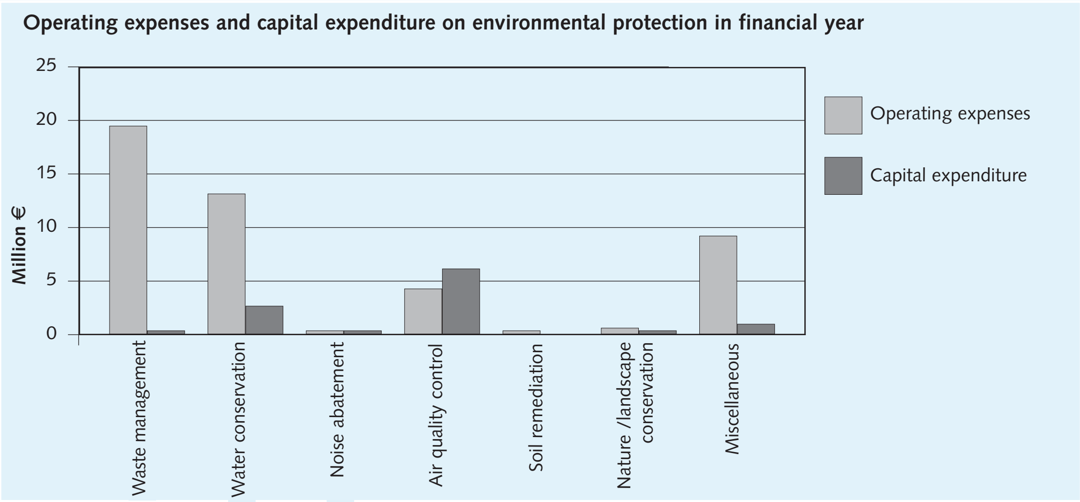


Fig. 11: Breakdown of environmental protection expenditure – Possible presentation in environmental report

Presenting environmental protection costs in an environmental report (continued)

"The costs of integrated environmental protection measures are not determined, as they cannot always be clearly identified and are not required for the official statistics. Nevertheless, integrated environmental protection measures are growing increasingly important. They avoid environmental burdens at source or prevent them occurring in the first place. As a rule, therefore, they are more efficient and less expensive than end-of-pipe environmental protection technologies. For example, we were able to switch off the central exhaust air cleaning system for a production hall because all the systems in the hall were equipped with integrated extraction facilities and filters. The costs for central exhaust air cleaning are no longer incurred and are therefore no longer recorded. However, the costs of the measures integrated in the plants are not included in the statistics either.

This example makes it clear that the decrease in environmental protection expenditure revealed by the statistics is not due to any slackening of our efforts, but is a sign of increasing efficiency in the environmental protection sector.

Falling environmental protection costs may be a sign of success.

Thanks to efficiency improvements of this kind in the past three years we are saving about €2 million a year on regular costs throughout the group and have been able to make further reductions in environmental pollution at the same time."

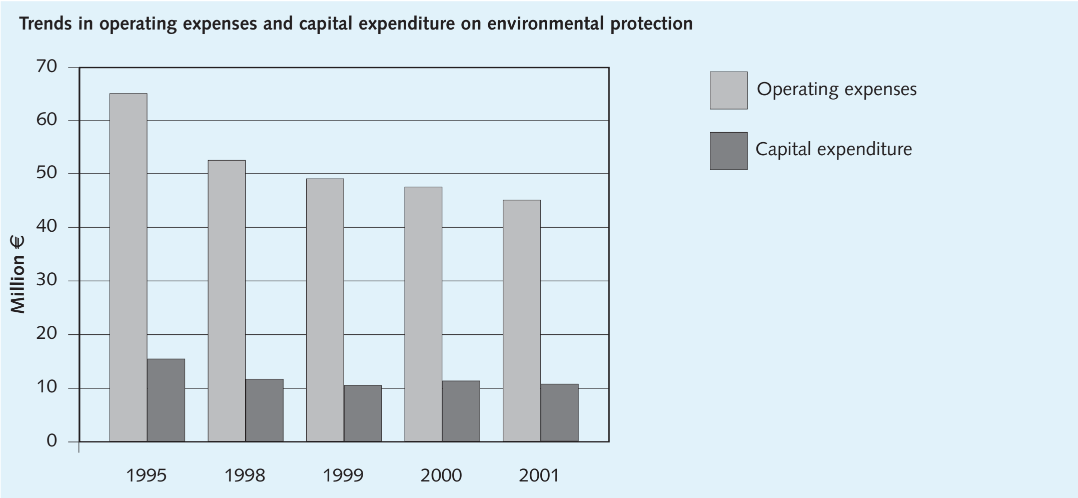


Fig. 12: Development of environmental protection expenditure – Possible presentation in environmental report

Bibliography

Verein Deutscher Ingenieure (publ.): VDI Guideline 3800, Determination of costs for industrial environmental protection measures, Berlin 2001

Fichter, K., Loew, T., Systeme der Umweltkostenrechnung, in: Handbuch Umweltcontrolling, 2nd edition, published by Federal Environment Ministry and Federal Environmental Agency, Vahlen Verlag, Munich 2001

4

Eco-efficient control of material and energy flows

This chapter shows how to identify environmental relief potentials and cost reduction potentials in the field of energy and materials management. Transparent information about material and energy flows in terms of quantities and values enables employees in a wide variety of functional areas to take systematic measures to increase efficiency.

Ever since the Rio environmental conference in 1992, people have been discussing – under the headings of "eco-efficiency" and "sustainable development" – concepts that meet with a broad measure of acceptance in industry and politics. Essentially these concepts seek to resolve the conflicts between environmental and business interests and to develop ways of acting that achieve greater harmony of business, social and ecological objectives.

The days are gone when environmental protection was regarded solely as a locational disadvantage that pushed up costs. Particularly in the past ten years a large number of examples have shown that professional, precaution-oriented environmental management can also bring about considerable reductions in costs. This is surprising when one considers that exploiting cost-reduction potential is one of the most basic functions of businesses. Accordingly, the controlling function with extensive cost accounting instruments specialises in this task. How was it nevertheless possible to discover such cost reduction potentials by means of environmental management projects?

Cost-reduction potential is closely connected with material costs.

Environmental aspects of businesses are closely connected with their flows of materials and energy. For this reason many environmental management projects have first made a close scrutiny of internal material flows. This resulted in a degree of transparency of such flows that had previously not existed in these businesses, and thus led to the now familiar cost reductions.

This revealed the basic problem that efficient start-to-finish design of material and energy flows frequently falls through the grid of functional organisation forms and static cost accounting systems.

In order to permit systematic localisation of the potential that exists for cost reductions and environmental relief (eco-efficiency), new cost accounting approaches that seek to remedy precisely this deficit have been developed in recent years, among them flow cost accounting and residues cost accounting. As an example of these approaches, this chapter describes flow cost accounting. Residues cost accounting and input/output cost indicators are outlined as the need arises, as simplified variants of flow cost accounting.

4.1 Objective of flow cost accounting

Especially in manufacturing companies, material costs are by far the biggest block and are thus of great relevance in any cost context. In the manufacturing sector in Germany, material costs average around 56%. In many industries, such as the pharmaceutical or car industries, they are actually substantially higher. In the past, most companies' cost-cutting activities have nevertheless concentrated to a large extent on personnel costs. It is generally agreed, however, that a lower limit has been reached in this field, unless cuts are to be made in production. It can therefore be assumed that in the years to come the focus of cost-reduction programmes will shift towards material costs.

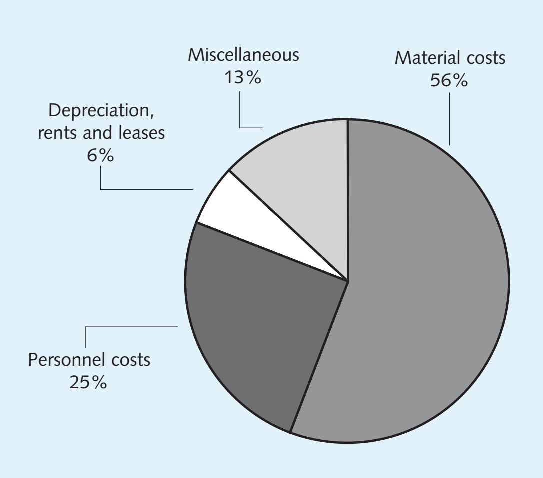


Fig. 13: Cost structure in the manufacturing sector (Source: Federal Statistical Office)

Tom Sidlik (head of purchasing at DaimlerChrysler) pointed out that about 78 percent of all Chrysler's costs were due to materials. "This means material costs are the way to cut costs quickly".

Source: Stuttgarter Zeitung, 09.12.2000

Major obstacles to systematic reduction of material costs are presented by lack of transparency of internal material flow structures and of the costs directly connected with material and energy flows. Although the corporate accounting system is able to provide overall period-specific information about the value of the materials entering the company and the materials consumed, it can hardly say anything about what use is made of the material and where it ends up. This deficit is reflected in the allocation of costs to cost centres, for example, which is an important element of internal cost transparency. Whereas most companies practise a detailed allocation of personnel costs and depreciation to cost centres, the greater part of the material costs (and especially the direct material costs) bypass the cost centres and hence also the cost-reduction pressure they exert. As a rule, conventional cost accounting is unable to represent material costs in the required structure and degree of detail.

Flow cost accounting is intended to supplement conventional cost accounting in order to increase the cost transparency of material flows. The aims of flow cost accounting are to

- bring about transparency of flow structures for all internal material flows, from the supplier (incoming materials) through internal production to the customer (products and packaging) or waste manager (material losses),
- allocate the corresponding quantities, values and costs to all internal material flows and stocks,
- provide decision makers in purchasing, production, development, sales, despatch and logistics with the information about flow quantities and costs that they need for their activities,
- initiate cost-effective measures to reduce material flows, by reducing material losses and developing material-reduced products and packagings,
- help reduce product-related and site-related environmental burdens by implementing such measures.

Flow cost accounting closes the gaps in conventional cost accounting.

Flow cost accounting is part of a comprehensive management approach – flow management – aimed at efficient design of the entire material and information flows relating to the company. Unlike process cost accounting, in which the primary focus is on reducing personnel costs, flow cost accounting concentrates on reducing material costs.

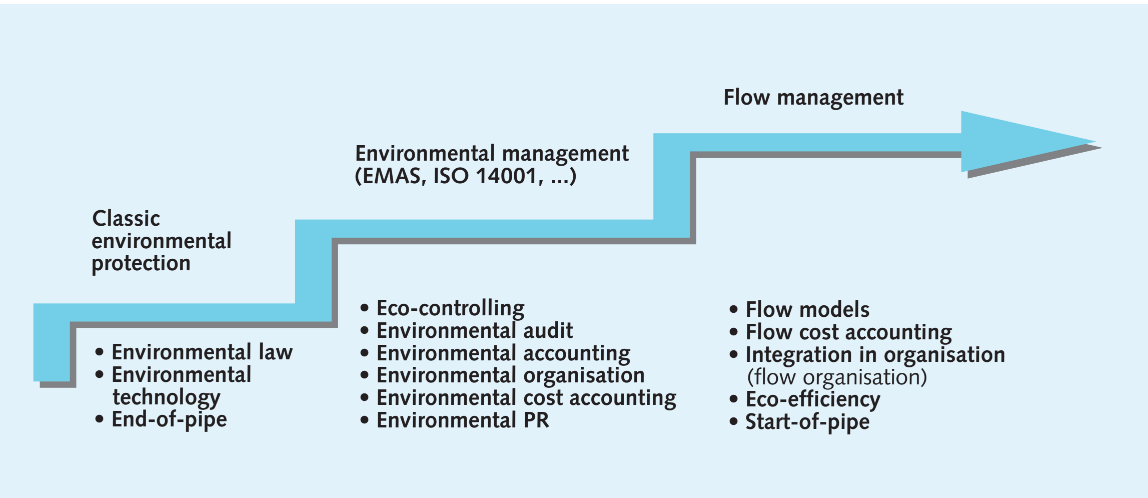


Fig. 14: From environmental protection to flow management

4.2 Concept and forms of flow cost accounting

Basic concept

Flow cost accounting regards the relevant material flows as cost collectors, and therefore allocates the costs of the company's production operations to these material flows. For this purpose it is first necessary to determine the structure of the material flows in a simplified form. A material flow model is used to describe the structure of the internal material flows and thus at the same time define the framework for flow cost accounting. The material flow model is made up of internal and external quantity locations and of material flows. Internal quantity locations are all spatial or functional units within the company where materials are stored, worked on or otherwise transformed. Thus typical quantity locations are goods reception, the raw materials store, the various production areas or despatch. In the same way as the quantity locations of the classic logistics chain, however, all environmentally relevant systems and facilities, such as residue centres, water treatment plants or filter plants, are also treated as quantity locations. External quantity locations such as suppliers and customers, and also waste disposers or municipal sewage plants, represent material flow related external interfaces of the company. Material flows link the quantity locations and thus symbolise movements of materials from one quantity location to another. Fig. 15 shows a highly simplified example of a material flow model.

Expanding the logistics chain to include material losses

In the context of flow cost accounting the costs of the company's production operations are allocated to the material flow model. The main focus here is on period-related transparency of the material values moved; on the basis of the value of materials entering the company within a given period, questions arise as to the use and whereabouts of this value. What value of materials entered production during this period? What value of materials left production as a product? What value of materials went as a product to the customer? What value of materials was lost in total? To be able to answer these questions, flow cost accounting must not, as is usual in conventional cost accounting, mix material costs and production costs for intermediate and finished products. Instead, flow cost accounting initially shows merely the value of materials moved for every material flow at purchase price.

Thus for every material entering the company, flow cost accounting shows in a high degree of detail its distribution within the company. In simplified form it must be possible to divide the incoming material value among the following reference quantities (see also Fig. 16):

- Change in material stocks
  (in the example: € 5 million)
- Material in product (example: € 112 million)
- Material lost (example: € 19 million).

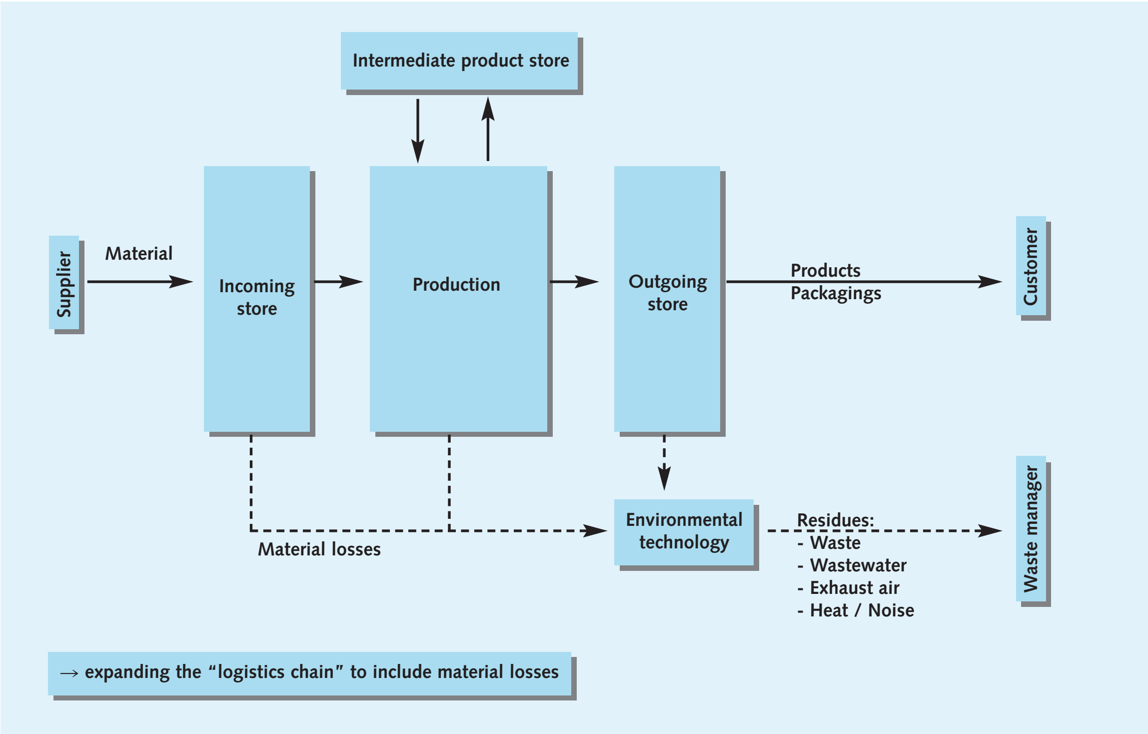


Fig. 15: Simplified material flow model

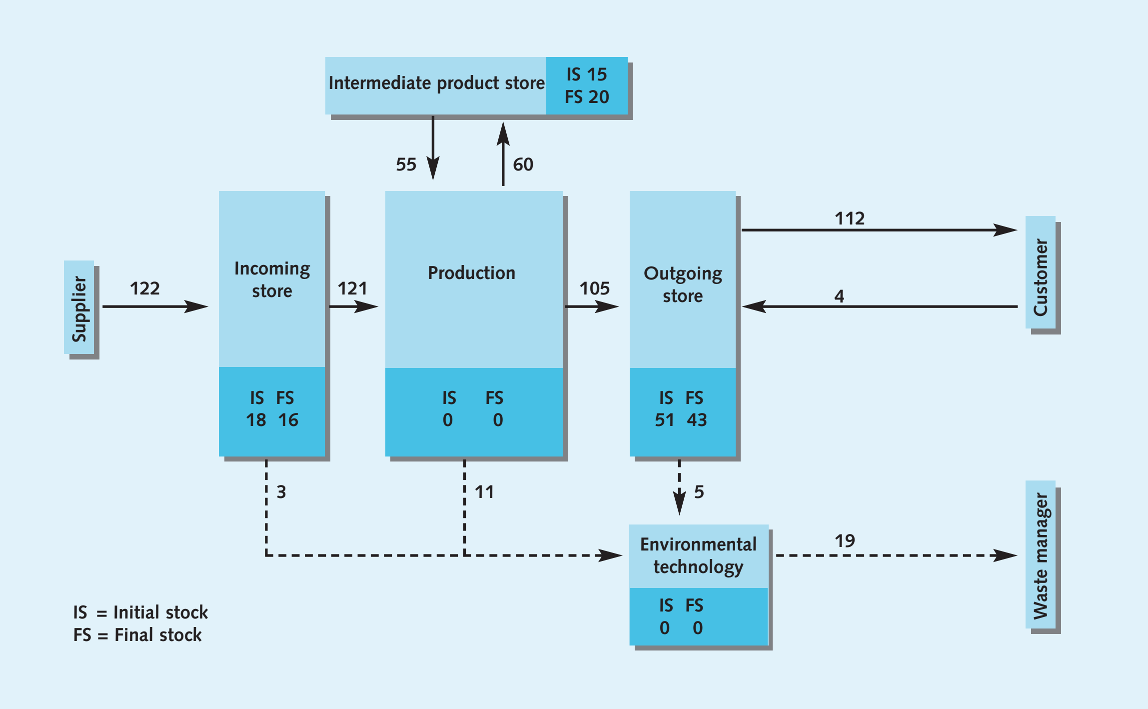


Fig. 16: Flow model with material values

As well as the pure material value, it is also possible in flow cost accounting to assign to the material flows the costs of storage, processing or administration of materials, such as personnel costs and depreciation (system costs), and the disposal costs of the materials. In particular, flow costs and other administration costs of units that are not physically involved in the material flow can be allocated to the material flows in the same way as in process cost accounting.

The flow costs matrix provides an overview of all costs associated with the material flows (Table 3). The first two rows show what costs were due to material and packaging for the products and how these costs are distributed among purchasing, internal added value and delivery. The third row shows the costs of material losses. The material costs arose from buying the material contained in the material losses. The system costs show the added value that is already contained in the material losses. The delivery and disposal costs indicate what costs are incurred for disposal of the material lost.

Implementation variants

Flow cost accounting is a comprehensive cost accounting approach and can therefore assume very substantial proportions in practical implementation within the company. It therefore makes sense to take a look at different variants of flow cost accounting, in order to find a variant that is appropriate to the company in terms of affordable expenditure and targeted benefits. The following are important parameters that determine which individual design of flow cost accounting is used:

Different practical variants permit individually tailored flow cost accounting

- the size and degree of detail of the material flow model,
- the cost categories covered (partial or full cost accounting) and
- the data taken as a basis.

Design factor: Material flow model

The decision in favour of a particular material flow model dictates important specifications for the subsequent calculation of the flow costs. It is therefore

Costs in million €	Material costs	System costs (Personnel, depreciation etc.)	Delivery, disposal costs	Total
Product	85	22	0	**107**
Packaging	27	18	2	**47**
Material losses	19	4	1	**24**
Total	**131**	**44**	**3**	**178**

Table 3: Simplified flow costs matrix

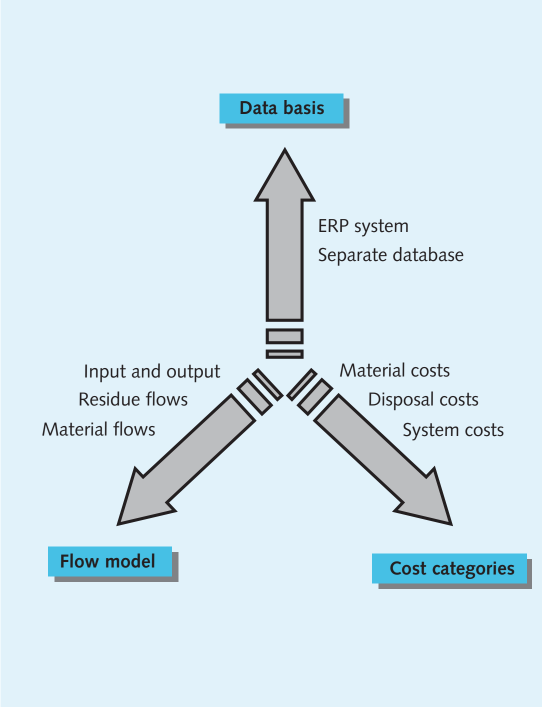


Fig. 17: Criteria for variant formation

of crucial importance to first arrive at a clear idea of the size and degree of detail of the material flow model. It is possible to distinguish a variety of material flow models that either represent only the material-related inputs and outputs (environmental balance), only the material losses flows (residues) or the entire flow of materials within the company.

Compiling the inputs and outputs in a corporate environmental balance sheet yields the simplest view of the material and energy flows. Flow cost accounting on this basis allocates flow costs to the inputs and outputs only, and thus offers a highly simplified entry version. A considerably more comprehensive version is offered by the model for flows of residues, which represents material losses and energy consumption figures. While focusing on material flows which do not add value, this keeps expenditure on flow cost accounting within limits. The development of cost-reduction measures is however confined to reducing material losses. Only a model of all internal material flows gives a complete picture of the "paths" taken by the materials through the company from arrival through all internal stages to departure. Only this kind of overall approach makes it possible to judge the consistency of the material flow data in the existing information systems and improve it if necessary. Furthermore, flow cost accounting on the basis of all material flows generates data not only on energy and residues, but also on products and packaging, thereby considerably broadening the scope for developing cost-reduction measures.

Design factor: Cost categories

Flow costs may be defined as all costs incurred as a result of the flows of material and energy through the company. To this extent flow costs are more or less identical with the costs of production of goods by the company. What is new is the flow-oriented perspective, which results in a specific subdivision of the costs. Flow cost accounting distinguishes between:

- Material costs
- System costs
- Supply and disposal costs.

Exact representation of material costs is the most important and at the same time the most difficult part of flow cost accounting from a methodological point of view. Indeed, this component could be described as the central aspect of flow cost accounting. In conventional cost accounting, a material can only be recorded as costs once. This results in a highly simplified view of the complex material flows. In order to increase the transparency of material flows, flow cost accounting first of all assigns the associated material values to all material flows considered. This is possible because these values, unlike the costs, are not added together to yield a total. It is only on the basis of a material flow model with material values that a clear definition of the material costs in view is made. Allocation of material values to material flows is a fundamental component of flow cost accounting and should therefore always be taken into account when making the company-specific selection of the practical variant to be implemented. Moreover, it is in the materials sector that the greatest eco-efficiency potential lies.

System costs are the costs that are incurred to keep the company going and put it in a position to design, control and transform the flows of materials. Essentially, therefore, system costs consist of personnel costs, depreciation and other costs (e.g. for external services). The system costs are invested in the material flows and make these more expensive after every processing stage. Thus system costs can basically be allocated to the flows of materials. Frequently, however, the work involved in exact allocation of system costs outweighs the benefits that result from the increased transparency.

Supply and disposal costs result from the fact that products are delivered to customers and residues to waste management firms. They consist primarily of costs for carrier services, special transport packaging, costs of transboundary transport, and the charges such as recycling and disposal costs involved in the disposal of residues.

Design factor: Data basis

Depending on the design of the flow cost accounting system, an extensive data basis is needed to implement it. Thus the cost-effectiveness of flow cost accounting itself depends to a large extent on the input necessary to create and evaluate this data basis. In order to contain this expenditure, it is therefore advisable to make extensive use of the data basis that already exists within the company. As a rule, extensive additional measures to collect data are not cost-effective. Basically it is possible to create a separate data basis for flow cost accounting or to use the existing ERP system – where one is available.

Separate database or integration?

Initially the simpler and more obvious step would seem to be to create a separate data basis for flow cost accounting. Numerous existing data sources can be used for this purpose, such as waste management data or production statistics. Frequently this data basis will be supplemented by estimates random sample values. This form of "data collection" has some advantages, but also crucial disadvantages. The advantages lie in the fact that first evaluations are available relatively quickly. This form is therefore particularly suitable for a one-off project calculation with subsequent development of measures. A separate data basis is less suitable for ongoing flow cost accounting, because it involves too much work for data capture.

For ongoing use of flow cost accounting it always makes sense to build on the data of an existing ERP system, as such systems contain considerable quantities of data on material flows and stocks in a high degree of detail. To date, however, ERP systems have yet to offer a clear connection with material flows. Indeed, numerous case studies have shown that the systems also provide inconsistent data which is then of limited use. If such deficits are to be identified in the context of a flow costs project, it is necessary before starting on flow cost accounting to analyse the existing ERP systems and, if necessary, improve their precision.

Selected variants

To make it easier to get started with flow cost accounting, it is advisable to set priorities with regard to its content and to divide its introduction into several phases. For example, it usually makes sense to start by concentrating on material costs. The system costs can be added in a later phase as needed. From the areas indicated in the last section (see Fig. 17) it is possible to design numerous variants of flow cost accounting. The three variants shown in the following table are particularly suitable for entry purposes.

Variant 1

Variant 1 is the simplest variant. The material value of the material entering the company is determined, and the disposal costs are used for the material leaving the company. As a rule these cost figures are available within the company and only need to be systematically organised and prepared. Using this data basis it is possible to undertake a first prioritisation of cost-relevant fields of action, which can help to focus the development of measures. As this variant does not provide any information about internal interrelationships, it is not possible to analyse weaknesses and identify deficits exactly (e.g. material numbers or machines with high wastage, products with large proportion of packaging etc.). The variant is therefore particularly suitable for companies where internal material flows are not very complex (especially service companies) or for a first estimate of costs to clarify whether a more detailed form of flow cost accounting should be used and in what sectors.

Variant	Material flow model	Cost categories	Data basis	Comments	Expenditure
1	Input-Output	Material costs, disposal costs	Separate data basis	Simple entry variant; particularly suitable for assessing cost relevance and for service companies	low
2	Residue flows	Material costs, system costs, disposal costs	Separate data basis	Useful variant in the context of a one-off cost reduction project; also suitable for small companies (residues cost accounting).	
3	Entire flow of materials	Material costs	ERP systems	Most widely used variant of flow cost accounting, as it offers a very favourable ratio of expenditure to improved transparency.	high

Table 4: Variants of flow cost accounting

Example: District hospital
District hospital with 240 staff, 180 beds and 58 500 patient days a year.

Measures:
Reduce energy consumption and its costs
Reduce laboratory material consumption and its costs
Reduce medical oxygen costs

Expenditure:
Low expenditure on data collection by administration management/financial accounting and running staff workshops (2-3 sessions of 3 hours each).

Benefits:
The measures paid for themselves during the first year of their implementation and resulted in total savings in the six-figure range. In parallel, substantial savings in resource consumption were achieved for energy/chemicals/ hazardous substances, and also in residues and exhaust air emission levels of CO_2, SO2 and NOx.

Three typical variants of flow cost accounting

Variant 2
Variant 2, which is also known as residues cost accounting, requires rather more input and is therefore to be regarded as a project in its own right. It considers all material flows that leave the company in the form of residues (exhaust air, wastewater, waste). First the disposal quantities and costs are determined. In order to determine the material costs, a relationship is established between disposal fractions and the material classes purchased. The average purchase price of the material classes is then used to assess the value of the disposal quantity. On the basis of the residues cost flows, the final step is to estimate corresponding system costs. As a rule this procedure involves numerous estimates, assumptions and averages, which leads to a certain lack of precision of the database. Compared with Variant 1, however, it is possible to draw initial conclusions about internal relationships (e.g. material class with the highest material losses, production sector with highest material losses, disposal fraction with the highest material value etc.). The imprecise data basis in this variant is an obstacle to ongoing flow cost accounting, as an analysis over several periods scarcely permits reliable conclusions. Residues cost accounting is therefore to be recommended as a one-off project calculation in cases where there is a need to identify and reduce cost-relevant material losses within a limited period. Moreover, residues cost accounting is a detailed method for examining the relevance of and priorities for a more comprehensive kind of flow cost accounting.

Variant 3
Variant 3 establishes flow cost accounting as a permanent institution within the company; it is therefore the variant that involves the most input and expenditure. Here the material costs are studied in detail. The flow of the material value entering the company is tracked in detail through all internal sectors (storage locations, production plants, environmental technology etc.) until the material leaves the company as product, packaging or residue. This variant is based entirely on the data available from existing ERP systems. The flows are tracked for each individual incoming material number such that the valuation can be made on the basis of existing average or standard prices. Thus the valuation of materials is performed on a standardised basis for material in product and packaging and for material losses. This makes it possible to determine the exact material loss per material number and allocate it to the individual machine, storage location or product. The data basis thereby generated allows conclusions to be drawn with great accuracy and considerable detail about internal relationships (machine with the highest material losses, product with the highest material losses, product with the largest proportion of packaging etc.). Although the introduction of this variant involves more time and money (especially for modifications to the ERP system), as a permanent set of instruments for an ongoing process of improvement it can make an effective contribution to reducing the amount of material input. Since this variant is entirely based on data from the existing ERP system once it has been introduced, regular expenditure is low. No manual collection of data is required. In addition, this variant makes it possible to check the data consistency of existing ERP systems and frequently brings to light considerable deficits.

Variant 3 of flow cost accounting yields the greatest effects with regard to cost reduction and environmental relief. The procedure for introducing it is therefore described briefly here. If this variant does not appear to be the right one for your company, you can skip the following description.

4.3 Procedure for integration of flow cost accounting

The procedure begins with modelling and analysis of the company's material flows. Then the relevant material entries are determined in the ERP system, and finally all relevant elements of the ERP system are modified and developed to cater for the needs of flow cost accounting.

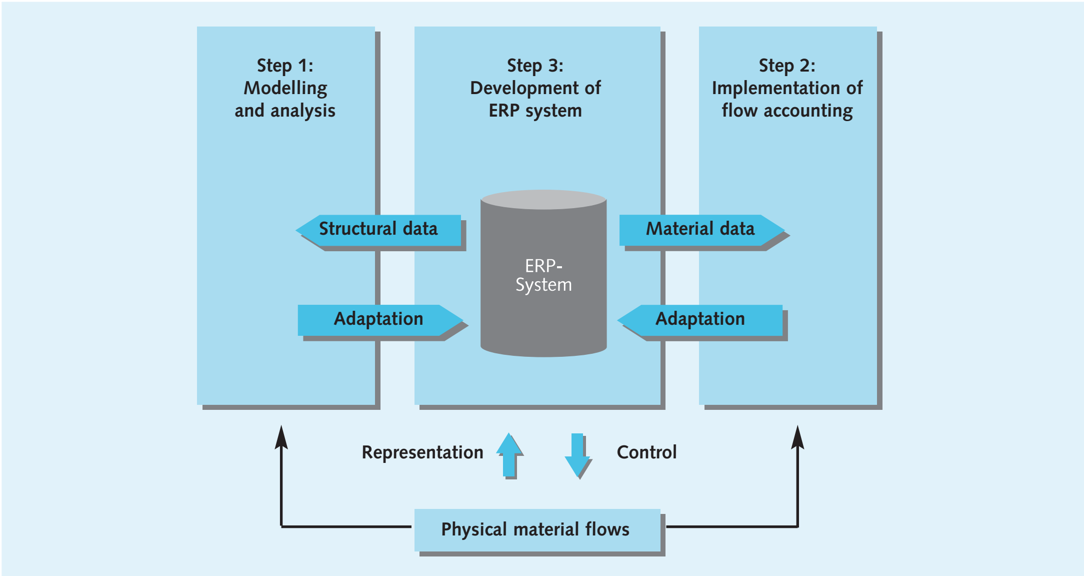


Fig. 18: Procedure

Permanent integration costs time and money, but pays in companies with high material losses.

Modelling and analysis
In the first step it is necessary to find out what material flow data of relevance to flow cost accounting is available in the ERP system. Although ERP systems represent material flows and thus generate extensive material data, such systems are geared more to steering material flows and not to flow-oriented representation of them. The aim is to clarify the relationship between the material data in the ERP system and the physical material flows. For this reason the first step involves creating two models which are then compared:

- Model of physical material flows
- Model of material-related entry structure in ERP system

Modelling the physical material flows and quantity locations involves differentiating all physical locations where material is stored, transformed and inspected, and showing the material flows between these locations. Defining the material flow model dictates important specifications and structures for the flow cost accounting system.
To model the entry structure it is first necessary to identify the ERP modules with material flow data and their interfaces (store management, procurement, production planning and control, finance, despatch etc.). The model of the ERP system then shows the structure of all material entries that are based on physical flows of materials. The model contains the following information: storage locations, production orders, work steps, cost centres, type of movement, reason for movement etc.

Following this modelling, the two models are compared. This is done by superimposing one model on the other to identify the following overlaps and discrepancies:

- Quantity locations (physical level) and entry units (ERP system)
- Material flows (physical level) and material entries (ERP system)

By means of this comparison it is possible to analyse which stock and flow data from the ERP system can be allocated to the material flow model and in what structure. This also defines the potential data basis for the flow cost accounting system. At the same time the comparison process yields information about data gaps and inconsistencies.

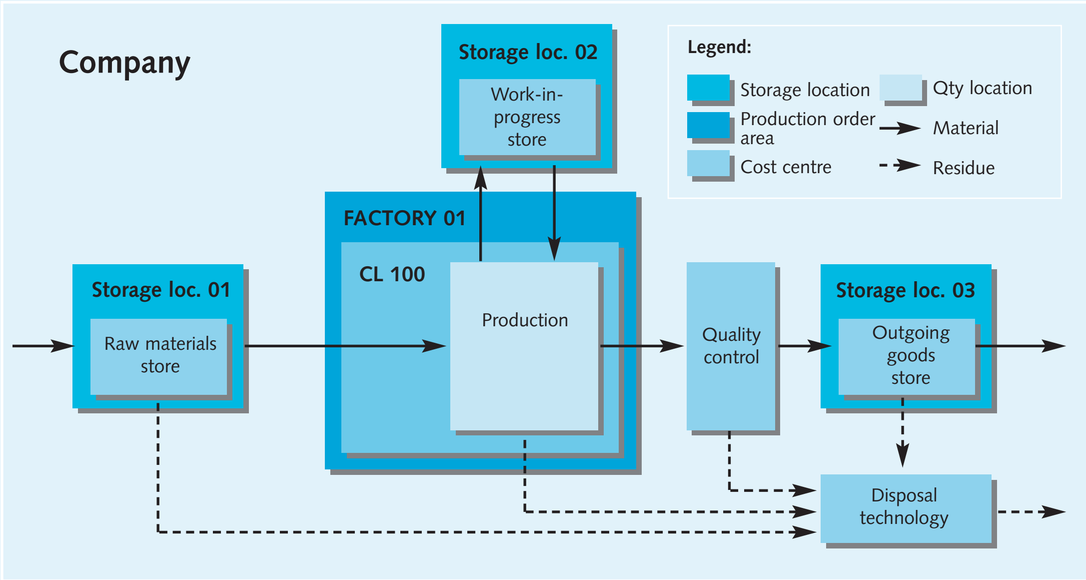


Fig. 19: Comparison of material flow model and entry structure

Implementing flow cost accounting
The forms of calculation in flow cost accounting require a defined data basis for a standardised period:

- Master data for all articles (material number, material price, weight etc.),
- Material movements (material number, movement from X to Y, reason for movement),
- Data for all material stocks (material number, initial stock, final stock),
- Bill of materials for all intermediate and final products

The data are compiled by queries or small programs in the ERP system and filed in table form as required. If flow cost accounting is not performed in the ERP system, but in an external database, the tables are imported into a different system. The calculation algorithms are based on a materials list with a breakdown right down to raw materials level. This makes it possible to specify directly the raw materials contained in every single intermediate and final product. This resolution is necessary because in view of the value added during the production jobs it is only at raw materials level that a difference calculation can be performed. The flow data are calculated separately for each entry unit considered (storage locations, production orders, work steps, cost centres etc.). The difference calculation is based on the following equation:

Initial stock + Additions – Removals – Final stock = Material losses + Entry errors

The calculation is performed at article level, then totalled across all articles for the production sectors, stores, cost centres etc. This calculation is performed in parallel for the material quantities and the material values determined on the basis of prices contained in the master data, which means that material losses can be shown both as quantities and as values in Euro.

The detailed data basis that results from flow cost accounting can then be allocated in the form of of flow data to the material flow model and the entry structure, and analysed. Measures are decided on the basis of the detailed flow data tables. There the articles and production orders with the largest losses are identified. On the basis of this information, the causes are determined in discussions with the individuals responsible. This initial flow cost accounting makes it possible to identify first action priorities for developing measures, and to clarify whether and in what form flow cost accounting should be implemented on an ongoing basis.

Development of the ERP system
If, after the first trial use of flow cost accounting, it is decided that this instrument is to be instituted on a permanent basis, then extensive use should be made of the ERP system. Important aims of this integration are:

- to improve data quality and reliability,
- to increase the degree of detail of data in consultation with the data users, and
- to reduce the input required for flow cost accounting.

The first step in integration must be to arrive at a precise definition of the representation of material flows in the ERP system in line with the requirements of flow cost accounting. In the next step the calculation algorithms for the flow cost accounting system can be finalised and implemented. In a further step, the conventional accounting system can also profit from the improved data basis in the material data and the additional analyses produced by flow cost accounting.

The implementation of flow cost accounting can be undertaken directly in the database of the ERP system, in the data warehouse or in a separate database with interfaces to the ERP system.

4.4 Cost management and organisational development

Initially, cost accounting approaches merely produce large quantities of data. If the data is not systematically analysed and taken as a basis for making changes, it remains ineffective. For flow cost accounting, this raises the question of how it can be embedded in a cost management system and what contribution it can make to the development of the organisation. This question is answered below on the basis of five important questions.

1. Which department can influence which material flow?
Cost management with flow cost accounting can be coordinated by a central controlling department. However, data analysis and the development of measures call for extensive detailed knowledge and can therefore only be undertaken by the departments concerned. First of all, therefore, it is necessary to find out which department has an influence on which material flow. Here, however, the problem may arise that certain material flows, e.g. destruction of items in stores, come about due to coordination problems between the sales, production planning and production departments and can therefore only be influenced by them jointly. Fig. 20 shows a typical example of the relationship between departments and material flows.

2. How are responsibilities and powers for material cost reduction to be distributed?
Closely related to the question of "influenceability" is that of responsibility for reducing material costs. It is necessary to lay down, in consultation with the departments affected, who bears the prime responsibility for which material and what powers are granted to the department. In many companies there is not sufficient clarity about responsibilities and powers with regard to reducing material costs. This is all the more surprising because material costs are a very sizable block of costs. Since the greater part of the material costs (direct material costs) are not charged to the operating cost centres, material costs frequently fall through the net of responsibilities and cost reduction programmes.

3. Who should receive what data and how often?
Once the questions of influence and responsibilities have been sorted out, it is possible to decide which department is to receive which data in what period. To avoid overloading the departments concerned with data, an individual material report with indicators should be defined for each department, so that the staff are only informed about material flows that they can actually influence. Once this is done, the more detailed the reports the better. In any case the data should always relate to the individual material numbers and production jobs. Where possible the flows should also be classified by the various reasons for their existence (production consumption, rejects, destruction, quality testing). For example, returns could be subdivided into "Damage in transit", "Faulty product" and "Wrong delivery address".

Organisational integration ensures lasting success.

The larger the block of costs that can be influenced, the more detailed and frequent the reports should be.

4. Is material costs reduction an integral component of the system of objectives?
Reducing material costs should not be left to chance. Indeed, this cost reduction aspect too should be and integral and coordinated component of the system of corporate objectives. Just as reductions in person-

	Material value in product	Material value in packaging	Destruction/ Store	Losses/ Production	Repacking	Returns
Product development	x	x		X		
Sales	x	x			x	x
Production planning					x	x
Purchasing			x	X		
Job preparation				X		
Production				X		
Despatch						x
Transport / Logistics						x

Fig. 20: Example of relationships between departments and material flows

nel costs or other costs are planned, cost reductions in the materials sector should be planned as well. In this process is of course important to take account of and, if possible, resolve potential conflicts of objectives (for example between the introduction of new return-intensive sales structures and reducing returns costs by 20%) before they arise. Here the Balanced Score Card, for example, can make a useful contribution to company-wide coordination of objectives within defined areas.

To emphasise the importance of the objectives, material-related objectives should also have a place in company incentive schemes (bonus system, performance-related pay, competitions etc.).

5. How are efficiency reviews to be conducted?
Finally it is necessary to clarify how performance controls by cost management are to be ensured with flow cost accounting. To this end the sequence of defining objectives, planning measures, implementing measures, and results actually achieved must be checked regularly to see that it is functioning properly. It may from time to time be necessary to make modifications to the structure of the flow cost accounting system, to the reports or the incentive schemes, in order to maintain effective cost management over a lengthy period.

Central benefits include improved cost transparency and the identification of eco-efficiency potentials

4.5 Benefits

The central benefit of flow cost accounting lies in the fact that it makes for detailed and up-to-date transparency of quantities, values and costs in connection with the flows of materials within the company. The much improved cost transparency relates to as much as 50% to 90% of the total costs of the company's production operations. If the relevant staff are integrated in a reporting system, the appropriate systems of objectives and incentives are created and adequate freedom of action is granted for developing and implementing measures, this can result in considerable improvements in efficiency and a wide-ranging innovation thrust. This, however, will depend not only on flow cost accounting, but also on its organisational integration.

The measures devised on the basis of flow cost accounting permit a reduction in the input of materials and thereby lead to cost reductions at the same time as providing environmental relief. In the development of measures, the following key areas of action can be distinguished:

- Material reductions when developing new products or modifying existing ones (e.g. thinner pack walls, elimination of packaging components);
- Organisational measures to reduce material losses (e.g. increasing batch sizes, better adjustment of machines, reduction in over-deliveries and excessive production allowances, coordination between sales and production planning, changes in material procurement, coordination with suppliers, switching to returnable packs);
- Technical optimisation of existing production lines to reduce material losses (e.g. more precise web guidance, control via photo cells, returning material losses to the plant);
- Investing in new production plants to reduce material losses.

In addition to a small number of major measures, an ongoing improvement process may over the years also result in numerous smaller measures which taken together can have quite substantial effects. In the course of numerous pilot projects the following benefit areas have proved realistic in the context of a continuous improvement process:

- Reducing material losses by 10% to 25%
- Reducing material in packaging by 3% to 10%
- Reducing material in product by 1% to 5%

Reductions in material inputs for existing products may result from modifying the materials list or reducing over-deliveries and excessive production allowances. Where new products are developed it is even possible to achieve material input reductions of 30% or more.

The following scenario is based on the lower end of the range of benefits mentioned. It illustrates the impact on profit that can result from exploiting the potentials identified.

Benefits scenario

The following benefits scenario is based on ratios that are typical of manufacturing companies. The company in the example has 1,200 employees at the production location and manufactures pharmaceutical products. The scenario uses the flow data from the example in Figs. 4 and 5 and extrapolates the potential for improvement. For the sake of simplicity, taxes are disregarded in this scenario. Flow costs and the costs of the company's production operations are identical.

Initial data
Annual turnover: €206 million
Profit: €10.3 million (return on sales approx. 5%)
Cost of production process: €196 million
- of which: €131 million material costs (material losses of 14.5% correspond to €19 million)
  - of which: €85 million in the product
  - of which: €27 million in the packaging
- of which: €44 million system costs
- of which: €3 million delivery and disposal costs

Measures
1. Reduce material losses by 10% (€1.9 million)
2. Reduce quantity of material in product by 1.0% (€0.85 million)
3. Reduce quantity of material in packaging by 3% (€0.81 million)
   These add up to annual reduction in material costs of around €3.5 million.
   These measures reduce the delivery and disposal costs by around €0.3 million

Expenditure
The capital expenditure for implementing the measures comes to €5 million

Benefits
The measures pay for themselves in one year and five months.
After that the company's profit is up by about 34%.

A **further benefit** of flow cost accounting that must not be underestimated lies in the development of the ERP system. Admittedly the introduction of flow cost accounting and the modifications to the ERP system involve a certain input of time and money. In the scenario above, for example, the capital expenditure might for example include €0.2 million for the introduction of flow cost accounting. After that, however, permanent use of flow cost accounting involves little additional expenditure. On the contrary, additional potential benefits result from the improved data quality and the greater detail in regular operation.

Bibliography

Strobel, M. / Loew, T.: Stoff- und energieflussorientierte Kostenrechnung, in: Handbuch Umweltcontrolling, 2nd ed., Bundesumweltministerium, Umweltbundesamt Berlin (publ.), Verlag Vahlen, Munich 2001, p. 523 - 536.

Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung (publ.): Leitfaden "Flusskosten-management – Kostensenkung und Öko-Effizienz durch eine Materialflussorientierung in der Kosten-rechnung", Wiesbaden 1999.

LfU Baden-Württemberg (publ.): Leitfaden "Betriebliches Material- und Energieflussmanagement – Öko-Effizienz durch nachhaltige Reorganisation", Karlsruhe 1999.

Three major research projects which will run until 2002/2003 are concerned with further development of flow cost accounting and related issues such as IT solutions or organisational adaptations. These projects will give rise to further publications. Relevant information can be found on the project websites: www.eco-effizienz.de, www.eco-rapid.de and www.bum.iao.fhg.de/intus.

5

Identifying and implementing eco-efficient investments

This chapter shows how investment calculations can be adapted to obtain a better data basis for assessing the economic and ecological impacts. This investment calculation keyed to material flows and energy flows paves the way for high resource efficiency of the new installations at an early stage.

5.1 Optimising the conventional investment calculation

In recent decades investment calculations have grown more important for businesses as production processes have been mechanised, automated and therefore become more capital-intensive. A company that wants to remain competitive has to invest in new technologies and systems. The purpose of investment calculation is to supply decision-oriented information about the advantages of the available investment alternatives. As cost pressures and environmental awareness increase, efficient use of materials and energy is constantly becoming more important. The decision in favour of a particular investment alternative is also a decision in favour of the material and energy flows associated with that system. Thus every investment decision plays a part in shaping future material and energy flows and hence in shaping the operating costs and environmental impacts of the installation. In order to cater for these aspects better, the scope of the conventional investment calculation can be widened to include a systematic consideration of future material and energy flows. The aim of this investment calculation keyed to material and energy flows is

The decision in favour of a particular production plant cements cost structure and environmental burdens for a long period.

- to create an improved data basis for investment decisions on the basis of the probable material and energy consumption figures and the material losses and emissions of the system, in order to
- permit a better assessment of the investment decision on the basis of material efficiency and environmental aspects.

This investment calculation keyed to material and energy flows can be used for all kinds of investments in fixed assets. The question of whether or to what extent the investments are for environmental protection purposes is therefore immaterial in this context.

5.2 Procedure

Basic principle of material and energy flow oriented investment calculation

Environment-orientation in investment calculations is frequently equated with differentiating between additive and integrated environmental protection investments, thereby reducing it to delimitation of the environmental protection components of an installation. Additive environmental protection investments are solely for environmental protection purposes, and for this reason the costs arising during their operation are taken over *en bloc* for environmental cost accounting. Integrated environmental protection investments have only a limited environmental component and can – depending on one's cost accounting philosophy – be included pro rata in environmental cost accounting. This environmental technology perspective does not take account of investments without an environmental protection component.

Material and energy flow oriented investment calculation dispenses with this delimitation of environmental protection components. The basic idea consists in determining the quantities and assessing the monetary value of all material and energy flows associated with the installation at the project planning stage.

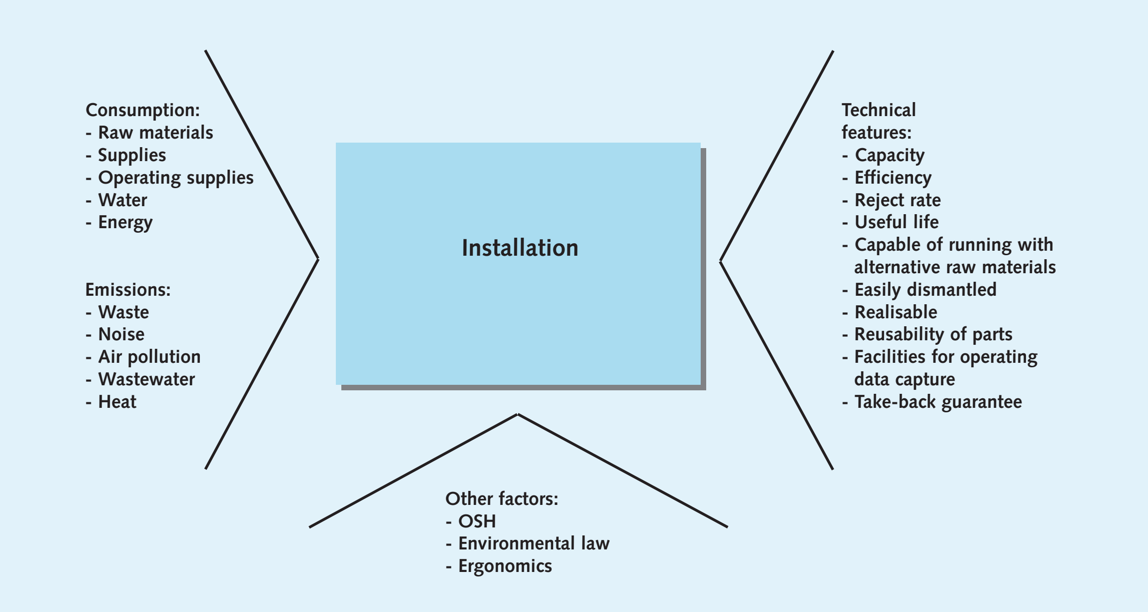


Fig. 21: Economically and ecologically relevant features of an installation

This is because all material and energy flows associated with the installation are – without exception – ecologically relevant, regardless of any environmental protection component in the installation.
Normally an investment is assessed on the basis of the payment or expenditure series triggered by the investment. The following information is necessary for an investment analysis:

- Timing of inpayments and outpayments or income and expenditure
- Amount of inpayments and outpayments or income and expenditure
- Investor's interest rate

The approach takes both quantitative and qualitative information into account. The quantitative information is based in the first place on quantity series for material and energy flows, which are valued in monetary terms so that the expected inpayments and outpayments or income and expenditure can be summarised in a series of figures. On the basis of this series of figures it is possible to make cost comparisons or determine the capital value. The qualitative information (such as on performance, operation or environmental aspects) supplements the monetary data.

Whereas conventional investment calculations, in addition to acquisition and personnel costs, merely make a rough estimate of the most important raw materials in terms of quantity, a material and energy flow oriented investment calculation attempts to take in all expected material flows in order to determine their cost relevance. To this end all expected inputs and outputs of the installation are brought together in an environmental balance sheet in order to produce the quantity series.

In principle, this wider inclusion of material flows can be used in all investment calculation methods. It is thus immaterial whether a static method such as a cost comparison calculation or a dynamic method such as a capital value calculation is used, because both employ the same calculation elements.

Systematic consideration of material flows yields a better basis for decision making

Sequence of steps in material and energy flow based investment calculations

A material and energy flow based investment calculation is performed in four steps:

- Define the individual investment alternatives and scenarios
- Collect and evaluate the data
  - Determine quantity series
  - Prepare payment series
  - Perform the actual investment calculation (e.g. determining capital value)
  - Take account of the scenarios
- Determine the qualitative factors associated with the individual investment alternatives
- Summarise all quantitative and qualitative factors to arrive at an investment recommendation

Defining the investment alternatives and scenarios

When compiling the investment alternatives, it is advisable to consider conventional installations as well as ecologically optimised installations. It is also important to consider not only the initial situation, but also the risks associated with an investment. After all, the advantages of an investment are to a large extent determined by a number of factors such as utilisation, market prices of production factors and products, or possible plant failure.

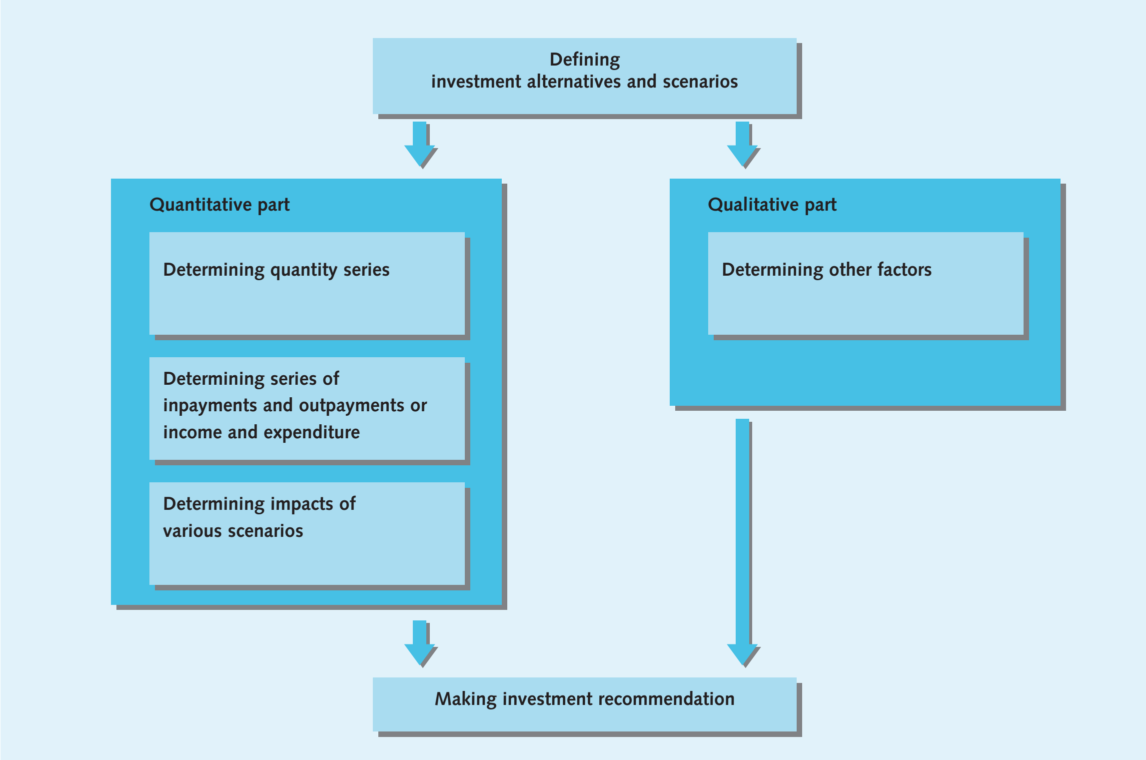


Fig. 22: Procedure for material-flow-based and energy-flow-based investment calculation

The resulting risk can be taken into account by drawing up corresponding scenarios. The ideal example distinguishes the following scenarios:

- Realistic scenario (realistic case)
- Pessimistic scenario (worst case)
- Optimistic scenario (best case)

The expected material flows are brought together in process balance sheets.

Data collection and evaluation

Data collection starts with determining the quantity series. Quantity series contain the substance and energy inputs and outputs for all types of operation of an installation. On the basis of the expected frequency of the various types of operation it is possible to prepare, for every type of operation of the installation, a material and energy balance sheet or an overview of the principal material and energy data. By totalling the individual balance sheet items, these balance sheets are aggregated to produce the material and energy balance sheet for the entire installation. If necessary, the material and energy balance sheet should be differentiated to take account of the timing of the payment series.

The items in the material and energy balance sheet can be subdivided into further sub-items according to the plant-specific consumption and emission figures (cf. Table 5 and the example of investment in a printing machine on p. 36).

To prepare the material and energy balance sheet, it is necessary to have information about the consumption of materials and energy by the plant, the efficiency and reject rate of the installation, and the probable utilisation and production and reject quantities. Furthermore, account should be taken of any interactions with other products or processes with regard to quality assurance.

If the planned investment also influences the consumption figures of upstream and downstream production units, an additional balance sheet may be prepared for these as well. This approach not only takes account of all environmental aspects directly or indirectly connected with an investment across all processes in the company, but also makes it possible to represent the associated environmental and cost effects (see Fig. 23).

Once the quantity series has been established, the next step is to determine the inpayments and outpayments or income and expenditure associated with the procurement and disposal of the plant input and output. To this end it is necessary to value the quantity series on the basis of the relevant transfer prices. Not only procurement and disposal costs must be taken into account, but also the cost of handling and logistics, the cost of obligations to take back products and the cost of plant documentation and monitoring.

This yields the figures necessary for applying the usual algorithms of conventional investment calculation methods. For example, the series of figures can be used to calculate the capital value of the investment option in view.

Another part of the task of data collection and evaluation is drawing up scenarios (see Table 8). In practice the realistic scenario is first determined for each

INPUT		OUTPUT	
Type	Quantity	Type	Quantity
Materials consumption		Output	
- Raw materials	kg, litres etc.	- Product A	number, kg, litres etc.
- Supplies	kg, litres etc.	Waste	
- Operating supplies	kg, litres etc.	- Residue X	kg, litres etc.
		- Residue Y	kg, litres etc.
Water consumption		Wastewater / loads	
- Drinking water	cu.m.	- Wastewater quantity	cu.m.
- Well water	cu.m.	- Wastewater load	kg
Energy consumption		Heat / pollutants	
- Electricity	kWh	- Waste heat	kWh
- Compressed air	kWh	- Pollutant load	kg

Table 5: Material and energy balance sheet for an installation

investment option. This scenario then serves as a basis for working out the performance, consumption and emission data for the pessimistic and optimistic scenarios. Frequently these scenarios are merely based on different assumptions about production utilisation and market prices.

Taking account of other factors

In addition to the quantitative factors – quantity and price – the investment calculation basically also takes account of qualitative factors, since it is not possible to express all aspects in terms of figures. Flow-oriented investment calculation recommends also taking account of environment-related risks as part of this qualitative assessment. Here attention should be drawn to the interests of different groups, probable positive and negative image effects, strategic requirements and synergy effects, and also any changes expected in the relevant environmental legislation.

Making the investment recommendation

Finally, on the basis of the quantitative and qualitative factors, a recommendation is made in favour of a particular investment decision. Whereas there are clear criteria for comparing the quantitative factors (minimise comparative costs, maximise capital value), the qualitative factors tend in practice to be given more or less weight in the investment decision depending on the individual management and competition situation at the time.

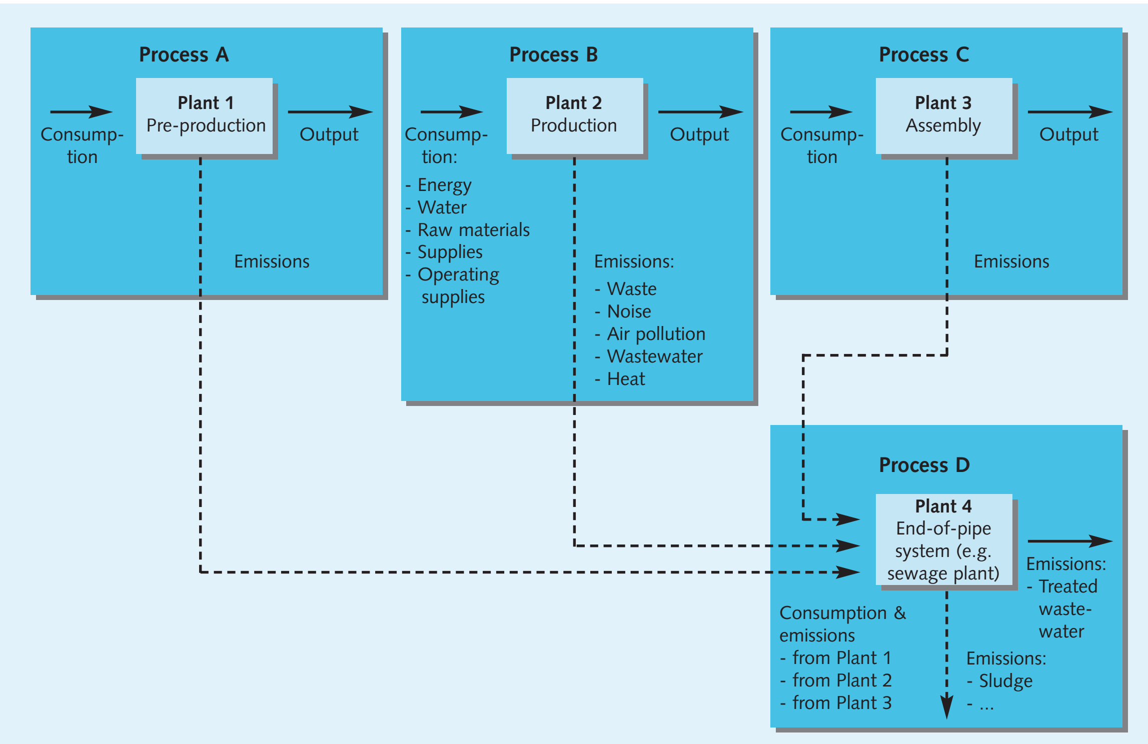


Fig. 23: Environmental implications of an installation for upstream and downstream units

Example: Investment in a printing machine

A printing works is considering acquiring an additional sheet-fed printing machine. This printing machine requires a large number of supplies and operating supplies, plus water and energy. The printing process gives rise to various kinds of waste. It also results in wastewater, heat and air pollution. The advantages of the investment are assessed using the capital value method. Since no reliable prediction of sales trends is possible, three different scenarios are catered for.

Input per thousand sheets printed		Output per thousand sheets printed	
Materials consumed		**Output**	
- Paper	163.0 kg	- Paper	151.2 kg
- Printing ink	0.6 kg		
- Varnish	0.04 kg	**Waste**	
- Additives	0.2 kg	- Domestic-type waste	0.8 kg
- Operating supplies	0.1 kg	- Waste subject to special monitoring	0.05 kg
- Hanzardous substances	1.0 kg	- Waste for recycling	10.5 kg
Water consumption	52.9 l	**Wastewater / loads**	43.0 l
Energy consumption		**Heat / Pollutants**	
- Electricity	24.0 kWh	- Carbon dioxide	22.0 kg
- Heating oil	1.4l	- Other emissions (including particulates)	0.1 kg

Table 6: Material and energy balance of a printing machine

Table 6 shows the material and energy balance for the printing machine. The balance sheet is based on a reference quantity of 1000 printed sheets. The balance sheet items are first determined and recorded in the units of quantity kg, litre and kW/h. Then the value of the quantities is assessed on the basis of transfer prices and expected revenue (cf. Table 7, where outpayments are identified by a minus sign and inpayments by a plus sign.) In addition, the associated personnel costs and *pro rata* repair and maintenance costs must be entered to permit complete determination of the surplus inpayments.

Input	Output	Transfer price	Quantity per thousand	Total per thousand
Materials consumed				
- Paper (sheets)		78.12 € / '000	1,080	-84.37 €
- Printing ink		7.5 € / kg	0.6 kg	-4.50 €
- Varnishes		25 € / kg	0.04 kg	-1.00 €
- Additives		11.10 € / kg	0.2 kg	-2.22 €
- Operating supplies		3 € / kg	0.1 kg	-0.30 €
- Hazardous subst.		13 € / kg	1.0 kg	-13.00 €
Water consumption		2 € / m3	52.9 l	-0.11 €
Energy consumption				
- Electricity		0.09 € / kWh	24 kWh	-2.16 €
- Heating oil		0.26 € / l	1.4 l	-0.36 €
	Output			
	- Printed sheets		1,000	156.00 €
	Waste			
	- Domestic-type waste	100 € / t	0.8 kg	-0.08 €
	- Special-monitoring waste	420 € / t	0.05 kg	-0.02 €
	- Waste for recycling	20 € / t	10.5 kg	-0.21 €
	Wastewater / loads	3.80 € / m3	43.0 l	-0.16 €
	Heat / Pollutants			
	- Carbon dioxide	5 € / t	22 kg	-0.11 €
	- Other emissions	0 € / t	0.1 kg	0 €
Output and external services				
- Output		36 € / h	0.4	-14.4 €
- Repairs, maintenance, modification *(pro rata)*		100 € / h	0.2	-20 €
Total				**+13.0 €**

Table 7: Valuation of balance sheet items at transfer prices and inclusion of additional cost items

Investment in a printing machine (continued)
To calculate the capital value, the following are taken into account:

- the non-recurring acquisition costs (purchase price, transport, installation etc.) totalling €1,300,000
- the balance of payments surplus over the 10-year useful life and
- the non-recurring removal and scrap disposal costs of €30,000

Moreover, the capital value is determined for all three scenarios. The management expects the machine utilisation in the years ahead to be in the region of 25 million sheets per year (realistic scenario). It is assumed that the maximum deviations from this estimate will be 15 million sheets in the worst case and 37.5 million sheets in the best case.

To illustrate the possible impact of the broader database in material flow oriented investment calculations, the following Table 8 also distinguishes between two cases. Case 1 shows the results of the calculation taking account of all raw materials and supplies, as required by material flow oriented investment calculation. Case 2, as is usual in conventional investment calculations, only includes the main raw materials and supplies (paper, ink, energy). A comparison of the capital values obtained makes it clear that disregarding supplies tends to result in an overestimate of profitability. In the example shown here the result is that the conventional calculation also shows a positive capital value for the worst-case scenario, which proves to be wrong when all costs incurred are taken into account.

This example illustrates how important it is to systematically determine all material and energy flows probably connected with an installation. Missing consumption or emission data in the payment series can result in considerable shifts in the capital value and even to different investment recommendations.

Scenario	'000 printed sheets per year	Payment series in €			Capital value (interest rate 8%)
		t = 0	t = 1 to 10	t = 10	
Case 1: Takes account of all raw materials and supplies					
Realistic (realistic case)	25,000	-1,300,000	325,000	-30,000	866,881
Pessimistic (worst case)	15,000	-1,300,000	195,000	-30,000	-5,430
Optimistic (best case)	37,500	-1,300,000	487,500	-30,000	1,957,269
Case 2: Disregards additives, operating supplies and hazardous substances					
Realistic (realistic case)	25,000	-1,300,000	724,750	-30,000	3,459,236
Pessimistic (worst case)	15,000	-1,300,000	434,850	-30,000	1,603,983
Optimistic (best case)	37,500	-1,300,000	1,087,125	-30,000	5,980,801

Table 8: Using scenarios in capital value calculation

Ensuring greater reliability in the economic perspective and broadening the environmental perspective paves the way for more resource efficiency

5.3 Benefits

The benefit of material and energy flow oriented investment calculation lies primarily in the fact that it improves the data basis for the decision process. More systematic consideration of the expected material and energy flows ensures that the economic perspective is more reliable. Moreover, the material and energy balances prepared in the course of the calculation provide a good basis of information for low-cost assessment of the environmental aspects and any environmental risks.

In this approach, the orientation to material and energy flows begins as early as the project planning phase for an installation. This paves the way at an early stage for high resource efficiency in production.

Bibliography

Wicke, L. et al.: Betriebliche Umweltökonomie – Eine praxisorientierte Einführung, 1992.

Letmathe, P.: Umweltorientierte Investitionsrechnung, in: Bundesumweltministerium, Umweltbundesamt (publ.) Handbuch Umweltcontrolling, 2nd ed., Munich 2001, p. 537-556

Rauberger, R./ Strobel, M./ Wagner, B.: Produktionsanlagen, in: Bundesumweltministerium, Umweltbundesamt (publ.): Handbuch Umweltcontrolling, 2nd ed., 2001, p. 467-478.

6

Business calculations with external costs?

This chapter shows how decisions with long-term effects can be made more reliable by taking appropriate account of external costs. It also describes how external costs can be used as a marketing argument.

6.1 Significance of external costs

Today German companies are already doing a considerable amount to protect the environment. This not only cuts costs, but also involves substantial expenditure. External costs nevertheless still arise on a large scale as a result of environmental pollution resulting from the companies' operations and their products. For example, traffic alone – i.e. a result of both business and private decisions – in Germany causes external costs totalling at least € 35 billion. These costs are borne by the general public in various forms, including damage to health and damage to buildings and forests.

Traffic costs society € 35 billion a year.

External costs, as the term suggests, are borne not by the originator of the environmental damage, but by third parties who are not involved. These costs arise as a result of adverse effects on property, health or social context. The criteria and methods used in calculating external costs are of varying degrees of severity. When determining minimum quantities, only clearly identifiable parameters such as damage to health or buildings are used. If a more complete picture is required, more complex calculations are possible, if it is desired to take account of carbon dioxide induced impairments resulting from climate change. Basically, however, the problem is that for numerous methodological reasons the size of the external costs can never be quantified exactly. For example, there are considerable difficulties involved in arriving at an objective assessment of global environmental damage or of adverse effects on human well-being.

As external costs are not borne directly by companies, it is not usual in practice to take account of such costs for accounting purposes. There is no reason to expect any change in this situation. Cases where companies include external costs in internal calculations will probably continue to be rare in the future as well. One reason is that it is the internal costs that are decisive for the long-term existence of the company and for ensuring reasonable profits. Another is that there are other methods available for assessing the environmental impacts of a company's operations and its products, and as a rule these are more suitable than external costs (see also the box below on "Ecological assessment methods"). As a result, calculation approaches that include external costs tend to play a minor role in environmental cost management.

Ecological assessment methods

During the past 25 years of environmental research, a variety of instruments have been developed for assessing environmental aspects. At a very early stage attempts were made to value the corresponding environmental damage in money terms in order to have a standard unit for calculation purposes. In the meantime, however, it has emerged that this monetarisation of environmental damage does not make sense for every problem. Moreover other assessment methods have been developed, some of which are more precise and easier to use. For example, "impact potentials" (e.g. CO_2 equivalents for the greenhouse effect) are used to compare environmental impacts of different product alternatives (in accordance with the ISO 14042 standard developed specifically for this purpose). Thus monetarisation is only one of of a number of assessment methods that vary in suitability depending on the case in question.

External costs in environmental policy

For decades now the damage that society has to pay for as a result of environmental pollution has been a subject of environmental policy. From an environmental protection point of view the costs arising from such damage ought to be borne by the polluters themselves. Then, the thinking goes, such costs would be taken into account in business calculations and would find their way into product prices, with the result that products involving high environmental burdens would be pushed off the market. In fact, however, such total internalisation of external costs is impossible for a variety of reasons, one of them being that this would have extreme repercussions for entire sectors of industry. It also has to be remembered that not only industry, through its production operations, but also households, through their use of products, make a considerable contribution to environmental burdens and hence to external costs.

Even if complete internalisation is not feasible, environmental policy has in many areas brought about an internalisation of external effects by means of official requirements, limit values and bans. Until about the mid 1970s, for example, people in the vicinity of industrial complexes had to put up with substantial air pollution and the resulting harmful effects on health. In the meantime the companies have been required to prevent such pollution by means of modern filter systems and bear the resulting expenditure.

In future, environmental policy will continue its endeavours to reduce relevant environmental burdens and the associated external costs with the aid of suitable policy instruments. For example, when drafting the EU Electronic Scrap Directive, one of the underlying aims was to apply "within the framework of this directive … [the] principle of internalisation of external costs". Here there was a special focus on the cost of disposing of end-of-life equipment, which has hitherto been borne by local authorities in the course of their waste management operations. These costs are now to be internalised in order to promote the reuse, recycling and recovery of old equipment.

There are however two contexts in which it may make sound business sense to take external costs into account:

1. External costs may be taken into account in decisions that have a long-term binding effect, such as investments in major installations, technologies to be used in future, company acquisitions or location decisions. After all, external costs may become internal costs as a result of new market situations or more stringent environmental policy.
2. Ecological pioneers, for example in the fields of building, energy supply or food, can in their marketing and PR activities publicise in money terms the amount of environmental damage that is prevented by their products and production processes.

6.2 Decisions with binding effects in the future

In spite of the oft-quoted dynamic nature and volatility of market conditions, businesses also have to take decisions that have long-term effects on their own competitiveness. Examples of such decisions with binding effects in the future include

- realignment of product portfolio,
- selection of process technologies,
- planning of major installations,
- sale and acquisition of companies,
- location decisions.

In the decision-making processes for such projects with binding long-term effects, one of the central aspects is always the question of how to cope with uncertainty. Changes in the sales situation or fluctuations in raw materials prices may have serious positive or negative effects on profitability. This problem is usually tackled with the aid of scenario analyses. Companies are recommended to take account of external costs in such analyses where appropriate.

In order to take appropriate account of external costs in decisions with binding long-term effects, the first step is to make a rough estimate of the environmental relevance of the alternative options. As a rule it will be possible to judge the environmental relevance from the input materials or emissions resulting from production or from the manufactured products themselves. In cases of high environmental relevance it is then necessary to investigate whether there is evidence to suggest that the cost of input materials or of disposal might rise appreciably in the medium term. An important factor here might be the expectation that costs which have hitherto been external may in future be internalised as a result of regulations or directly via the market. On the basis of the business principle of prudence, the company must take suitable measures (e.g. allocation of provisions) if the project is nevertheless implemented. Of course it goes without saying that as a basic principle the environmental impacts of long-term decisions should in any case be minimised regardless of any impending internalisation of external costs.

Internalisation of external costs is a constant objective of environmental policy.

6.3 Public relations work with external costs

Key questions

- What is the environmental relevance of the alternative options?
- Is there anything to suggest that there may be substantial increases in the price of especially relevant input materials or the cost of disposal?
- What indications are there of possible increases in location costs (e.g. as a result of new noise abatement regulations), tightening of liability regulations or the introduction of obligations to take back old products?
- How does the decision calculation change in response to assumptions of rising prices, rising costs or stricter liability requirements?
- Do assumptions about rising costs make it necessary to develop additional alternative options?

Example: External costs of airports

The steadily growing number of peopele travelling by air makes privatised airports a good investment from the point of view of analysts and fund managers. However, when giving consideration to investing in airport operating companies, the external costs of air transport should not be overlooked. Particularly relevant factors here are air pollution and climate-relevant emissions, and also the noise problem. At present it is not possible to predict whether, in view of the greenhouse problem, politicians will bring about an increase in the price of kerosene. Local residents, on the other hand, may have a strong lobby: the German Association for the Prevention of Aircraft Noise has made it clear that German citizens have particularly little protection against aircraft noise compared with other European countries. For example, if Dutch limits applied to German airports, Frankfurt Airport would, for its existing runway system, be faced with costs of around €2 billion for the installation of noise-reducing windows and other compensation (source: "Bundesvereinigung gegen Fluglärm"). If its capacity were increased by new runways or by lifting the ban on night flights, these external costs would be even higher. The various organisations of local residents affected will undoubtedly use all means at their disposal to prevent such expansion.

Airports are thus confronted with the basic risk that – depending on court judgements and political decisions – the profit situation could change considerably as a result of the noise problem alone. In view of this, airport shares are in the long-term probably a riskier investment than hitherto assumed.

There are a small number of cases where companies have attempted to demonstrate the ecological benefits of their products by drawing attention to the prevention of external costs. The "Neumarkter Lamsbräu" brewery tells its customers that the ecological management of the company results in the prevention of external costs amounting to €0.5 to €2.5 million a year or €0.75 to €4.00 per crate of beer. Several studies of the external costs of the agricultural and transport sectors were used to determine these savings. The range quoted is due to the differences between the findings of the studies considered.

The bakery "Märkisches Landbrot" also uses external costs to draw attention to its special environmental protection achievements. On its web site the company states that in 1997, with a turnover of around €4 million, it caused external costs of only €16,000. In terms of a loaf of bread that means external costs of only 0.75 cents. Compared with this, it spends more than 43.3 cents per loaf on internal environmental protection measures and using ecological raw materials. In this way the company makes it clear that the selling price of the bread helps finance above-average environmental protection measures and that the external costs are extremly low by comparison.
As this shows, it is possible with the aid of external costs to use a common yardstick – money units – to convey the magnitude of the environmental burdens caused and make them easier to grasp. Considerable pioneering spirit is needed for this, however, as no standardised procedure is available yet and the figures needed for monetarisation of the environmental impacts have to be compiled from a variety of studies. For serious argumentation with external costs, transparency is indispensable. A brief explanation of the method chosen should always be provided. Further information on the underlying studies and the limitations of the calculations performed should also be offered.

6.4 Typical questions

Regardless of the purpose for which external costs are to be used, the user is faced with three fundamental questions, and these are in principle easy to answer:

1. **Is it at all possible to arrive at serious figures for external costs?** Answer: Studies sometimes come up with widely differing figures for external costs of certain environmental burdens. While there is disagreement on the overall figure, it is usually possible to determine accepted minimum figures. These minimum figures are used, for example, in assessing infrastructural projects or when drafting environmental legislation. Thus it is indeed possible to perform serious calculations with external costs.

2. **How much time and money is involved in taking account of external costs?** Answer: determining external costs on one's own involves a good deal of time and money. It is however possible to fall back on existing studies in which the cost parameters are already documented.

3. **Where can one find the studies in which external costs are determined?** Answer: since its establishment the Federal Environmental Agency has repeatedly made intensive studies of external costs in connection with major environmental issues. The EU Commission and other research establishments have also published such figures. The studies, or information about them, are available from the Federal Environmental Agency, for example.

Bibliography

There are currently no guides or other publications dealing with practical aspects of how to take external costs into account from a business point of view. For this reason the following list only draws attention to a number of sources that discuss the topic in general terms.

Bundesumweltministerium, Umweltbundesamt (publ.): Handbuch Umweltcontrolling, 2nd edition, Vahlen Verlag, Munich 2001, Chapter 3.3 ("Ecological assessment methods")

Loew, T.; Fichter, K.; Müller, U., Schulz, W., Strobel, S.: Ansätze der Umweltkostenrechnung im Vergleich, Berlin 2001, Chapter 6 (Taking account of external costs).

Schaltegger, S.; Burrit, R.: Contemporary Environmental Accounting – Issues, Concepts and Practice, Sheffield 2000. Includes a brief section on life cycle costing.

7

Glossary

External costs, environmental protection costs, flow costs – the systematic diagram shows the relationships between these and other cost terms .

The definitions compiled here come from different schools of thought about environmental costs, which are essentially described in this Guide. The relationships between them are shown in Fig. 24.

The starting point for these approaches is the environmental aspects, in other words the emissions, raw materials consumption etc., that are caused by a company and its products. These environmental aspects may be prevented by means of environmental protection measures taken by the company. Such measures may be implemented by the company itself, or by third parties on its behalf, and give rise to environmental protection costs. Together with emission charges and other payments, these environmental protection costs belong to the category of environment-related internal costs. They are regularly recorded in the environmental statistics (see Chapter 3 on Environmental Statistics). These internal costs contrast with external costs, which have to be borne by the general public as a result of the environmental damage caused. Such damage includes damage to buildings and harmful effects on health, for example, and also impairment of uses, e.g. loss of recreation areas. One of the aims pursued by environmental policy is to influence the relationship between external and internal costs in such a way that the benefit to society as a whole is optimised. In the past the resulting decisions have repeatedly led to the introduction of new environmental regulations. Reason enough not to disregard external costs when it comes to strategic planning or capital expenditure decisions (see Chapter 7 on External Costs).

For reliable identification and analysis of the corporate environmental costs that result from the company's environmental protection measures, various types of environmental protection measures are distinguished (production-related, plant-integrated, process-integrated, end-of-pipe etc.). This differentiation and the relevant representation in Fig. 24 originate from VDI Guideline 3800 (see Chapter 3). And finally it is necessary to consider the inclusion of environmental protection costs in flow cost accounting (see Chapter 5). The links with the flow diagram from flow cost accounting are indicated by dashed lines.

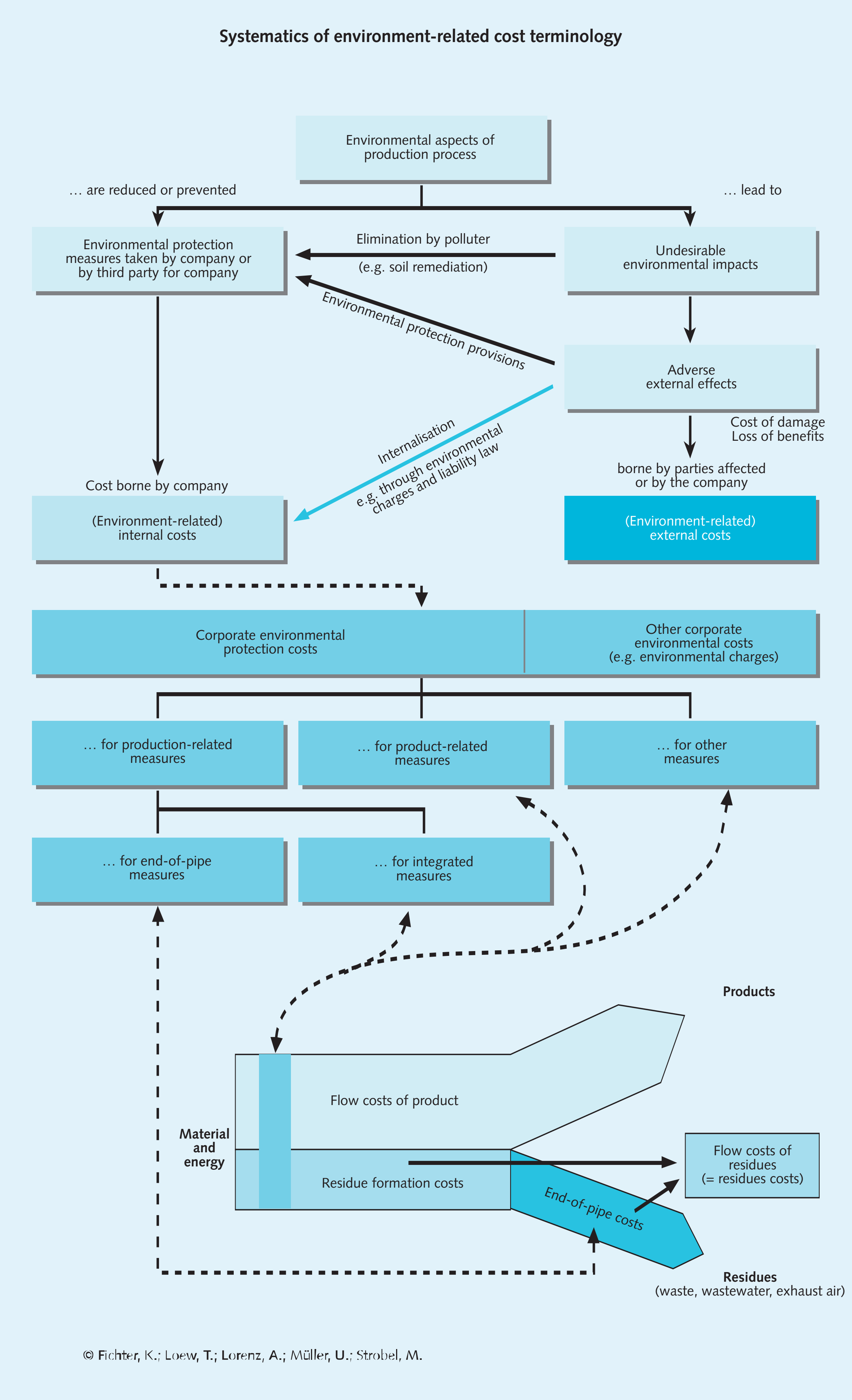


Fig. 24: Terminology of environmental cost management

Term	Definition and comments
Plant-integrated environmental protection measures	Plant-integrated measures comprise the installation and operation of system parts which (i) are connected with the production process, (ii) can be verified as technical elements of production plants and (iii) serve to reduce (minimise) environmental impacts at the point of performance. *Source: based on VDI 3800*
Expenditure	Consumption of goods, valued at acquisition cost Note: For the difference between expenditure and costs see under → Costs.
Corporate environmental protection costs	→ Costs of environmental protection measures, in other words of those measures taken by the company or by third parties on its behalf which are designed to prevent, reduce, eliminate, monitor and document the environmental impacts arising from the company's activities and the negative environmental impacts caused or to be expected. Note: corporate environmental protection costs also include depreciation on environmental protection investments. Environmental protection costs arise not only through end-of-pipe systems but also through the more cost-efficient integrated environmental protection measures.
Corporate environmental protection measures	Corporate environmental protection measures are those measures taken by the company or by third parties on its behalf which are designed to prevent, reduce, eliminate, monitor and document the environmental impacts arising from the company's activities and the negative environmental impacts caused or to be expected.
Corporate environmental protection expenditure	→ Expenditure which arises for environmental protection measures, in other words for those measures taken by the company or by third parties on its behalf which are designed to prevent, reduce, eliminate, monitor and document the environmental impacts arising from the company's activities and the negative environmental impacts caused or to be expected.
Savings through environmental protection (environmental savings)	Cost reduction, cost prevention and revenue from environmental protection measures Note: Examples of savings through environmental protection are cost reductions resulting from reductions in hazardous waste or revenue from the sale of recycling material. At present the term plays a minor role in discussions in Germany, but it could acquire greater significance both in Germany and internationally.
End-of-pipe measures	End-of-pipe measures are environmental protection systems which are technically separated from other production processes. They can be assigned uniquely and completely to environmental protection. End-of-pipe systems form the interface between the corporate processes and the company's environment. Note: end-of-pipe systems can be shown separately in the plant inventory. *Source: VDI 3800*
ERP systems	Enterprise Resource Planing Systems are integrated software systems for business applications, from manufacturers such as SAP, Oracle, Baan, SSA etc. They provide a complete or restricted range of functionalities such as order entry, procurement, production planning, despatch, financial accounting and controlling. The representation and planning of material flows is essentially by means of standardised structural elements such as materials master data, storage locations, production jobs, materials lists and work plans.
Flow costs	Flow costs are the internal costs which arise for the use, transformation and disposal of material flows. Total flow costs are to a large extent congruent with total manufacturing costs. In detail, however, flow costs display a material flow oriented cost structure. Flow costs can be differentiated into the flow costs of the product and the flow costs of the material losses (residues costs).
Capital value	The capital value is the result of an investment calculation using the the capital value method, also known as discount or present value method. To determine the capital value, all future inpayments and outpayments are discounted to a single point in time immediately before the start of the investment. The difference between the discounted inpayments and the discounted outpayments is the capital value. If the capital value is positive it represents the payment surpluses that are left after taking account of all outpayments and interest related to the project. (after Wöhe 1990)

Term	Definition and comments
Costs	Costs are valued performance-related consumption of goods. Note: In business administration, the difference between costs and → expenditure is, in simple terms, that costs relate to the performance-related consumption of goods within the company, in other words the focus is on the production of goods. Expenditure, by contrast, is concerned with consumption of value regardless of any connection with production. This includes expenditure on soil remediation, for example, which is undertaken independently of current production, since these days it can be assumed that no soil pollution takes place in the course of normal production operations. In most business transactions, costs and expenditure are largely identical. For this reason small and medium enterprises frequently make no distinction between the two categories. The environmental statistics, however, are concerned with expenditure and not costs.
Life-cycle costs	Costs of a product which arise for the various persons and institutions involved in the product's life cycle from production of raw materials through transportation, production and use to disposal. Note: in the context of product development, analysing life-cycle costs serves to identify eco-efficiency potentials in the product's life cycle. Sections of the life-cycle costs can play a decisive role in the decision to acquire durable economic goods. For example, lower maintenance and repair costs may justify a higher purchase price.
Monetarisation	The valuation of a use or damage in units of money Note: in the field of environmental politics, → monetarisation is taken to mean the valuation of environmental impacts.
Eco-efficiency	Eco-efficiency expresses the relationship of net economic gain to the associated environmental impacts. Any optimisation of a product or manufacturing process is eco-efficient if economic and ecological improvements are achieved at the same time. Note: eco-efficiency is also regarded as a corporate philosophy. Through eco-efficient management, the company is to be made more competitive and innovative and thereby contaminate the environment less and less.
Product-related environmental protection measures	Measures designed to prevent, reduce, eliminate, monitor and document the negative environmental impacts caused or to be expected from a product or service. *Source: based on VDI 3800*
Production-related environmental protection measures	Production-related environmental protection measures are measures which avoid, reduce or eliminate an impact on the environment in the company's production operations. Production-related environmental protection measures comprise → end-of-pipe measures and integrated measures. *Source: VDI 3800*
Production-integrated environmental protection measures	Unlike end-of-pipe technologies, integrated measures influence impacts on the environment directly on site or in the course of the production process. This may be achieved by means of plant-integrated measures or process-integrated measures. Note: the term "integrated environmental protection measures" is used synonymously. *Source: based on VDI 3800*
Process-integrated environmental protection measures	In the case of a process-integrated environmental protection measure, the entire process of performance is structured such that, by comparison with traditional technology, it prevents or minimises the occurrence of environmental impacts. It is not possible to identify individual components which lead to the reduction of environmental impacts. *Source: based on VDI 3800*
Environmental costs	Collective term for various costs which are determined in connection with environmental management, environmental protection measures and environmental impacts. These costs are derived from various cost concepts, areas of application and objectives.
Environmental cost management	Collective term for various types of methods, approaches and processes used to analyse, plan and control → environmental costs in order to structure corporate environmental protection efficiently, exploit ecological and economic optimisation potentials and take appropriate account of environmental cost aspects in all company decisions.
Environmental cost accounting	Collective term for various methods, approaches and processes for determining → environmental costs and showing them for internal or external company purposes.

8

Bibliography

Handbuch Umweltcontrolling
This manual of environmental controlling is a comprehensive reference work for corporate environmental management and describes all important instruments of environmental controlling. It includes a chapter on environmental cost management which provides an introduction to the subject. It gives a detailed description of environment-oriented investment calculation (→ Chapter 5). The table of contents and brief summaries of all chapters of the manual are available from www.Umweltbundesamt.de .

Bundesumweltministerium, Umweltbundesamt (publ.): Handbuch Umweltcontrolling, 2nd edition, Vahlen Verlag, Munich 2001, 710 pages, € 29.-, obtainable from booksellers.

Ansätze der Umweltkostenrechnung im Vergleich
This scientific study was prepared as part of the same research project as this Guide. It examines numerous approaches to environmental cost accounting to determine their suitability for practical business use, and thereby makes an important contribution to the further development of environmental cost accounting. At the same time the study served as a basis for the preparation of this Guide.

Loew, T.; Fichter, K.; Müller, U.; Schulz, W.; Strobel, M.: Ansätze der Umweltkostenrechnung im Vergleich, UBA-Texte, Berlin 2003, approx. 200 pages, approx. € 10 , available against prepayment from "Werbung und Vertrieb", Ahornstr., 1-2, 10787 Berlin.

Leitfaden Flusskostenmanagement, Leitfaden Betriebliches Material und Energieflussmanagement
Both guides are designed for controllers and environmental officers and serve as instructions for introducing a flow cost accounting system (→ Chapter 5).

Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung, Hessische Technologiestiftung (publ.): Leitfaden Flusskostenmanagement. Kostensenkung und Öko-Effizienz durch eine Materialflussorientierung in der Kostenrechnung, 106 pages, € 9.- , obtainable from booksellers or from Hessische Technologiestiftung, Phone: +49 611/774-60 0, Fax: +49 611/774-62 0, bracht@technologiestiftung.de .

Landesamt für Umweltschutz Baden-Württemberg (LfU), Ministerium für Umwelt und Verkehr Baden-Württemberg (publ.): Betriebliches Material- und Energieflussmanagement. Ökoeffizienz durch nachhaltige Reorganisation, Karlsruhe 1999, 76 pages, € 9.–, obtainable from the publishing service of LfU: JVA Mannheim, Druckerei, Herzogenriedstr. 111, 68169 Mannheim, Fax: +49 621/39 83 70.

Leitfaden betriebliche Umweltkennzahlen
The guide describes in practical terms the introduction and use of corporate environmental indicators.

Bundesumweltministerium, Umweltbundesamt (publ.): Leitfaden Betriebliche Umweltkennzahlen, Bonn, Berlin 1997, 47 pages, free of charge from Umweltbundesamt, ZAD, Postfach 33 00 22, 14191 Berlin, Phone: +49 30/8903-0 Fax: + 49 30/8903-29 12

Leitfaden Flusskostenrechnung als Erweiterung der betrieblichen Abfallbilanz

The guide is designed in particular for small and medium enterprises that prepare corporate waste balances. It shows how flow costs for waste can be determined at low cost in small ancillary calculations (→ Chapter 5).

Sonderabfallgesellschaft Brandenburg/Berlin mbH (publ.): Leitfaden Flusskostenrechnung als Erweiterung der betrieblichen Abfallbilanz, Potsdam 2000, 22 pages, € 17.40, from: Sonderabfallgesellschaft Brandenburg/Berlin mbH, Phone: +49 331/2793-0, Fax: +49 31/2793-20, Goesta.Jancke@SBB.Brandenburg.de

VDI Guideline 3800 – Determination of costs for industrial environmental protection measures

The VDI Guideline describes how expenditure on end-of-pipe and integrated environmental protection measures can be clearly differentiated (→ Chapter 3). It also shows an investment calculation for environmental protection systems (→ Chapter 4).

Verband Deutscher Ingenieure (publ.): VDI Guideline 3800, Determination of costs for industrial environmental protection measures, Beuth Verlag, Berlin 2001, 24 pages, € 56.65 , obtainable from Beuth Verlag, Tel.: +49 30/2601-22 60, Fax: +49 30/2601-1724, www.din.de/beuth

Contemporary Environmental Accounting - Issues, Concepts and Practice

This textbook gives a detailed introduction to various approaches to environmental cost accounting and other non-monetary instruments of corporate environmental controlling. Although the book is primarily intended for academics and students, it is very suitable for use as a work of reference for controllers and environmental managers.

Schaltegger, Stefan; Burrit, Roger: Contemporary Environmental Accounting – Issues, Concepts and Practice, Sheffield 2000. Hardback £ 40, paperback £ 19.95, from Greenleaf Publishing, Fax: +44 114/282 34 76, sales@greenleaf-publishing.com, or from booksellers.

Recent further reading

Fischer, Hartmut (Ed.): Reststoff-Controlling, Springer-Verlag, Berlin-Heidelberg 2001, 213 pages, € 75.-

Strobel, M.: Systemisches Flussmanagement – Flussorientierte Kommunikation als Perspektive für eine ökologische und ökonomische Unternehmensentwicklung; Ziel-Verlag; Augsburg 2001, 337 pages, € 24.-

Research projects

Work is currently in progress on a number of long-term research projects on environmental cost management which will give rise to further publications. Information on these is available from the web sites of the institutions that prepared this Guide.
(→ Imprint)