Environmental Management Accounting

How to profit from environmental protection

E M A
Environmental Management Accounting
Pilot testing

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IÖW Project report EMA pilot testing

A project within the framework of the „Factory of Tomorrow“

In 1999, the UN Commission for Sustainable Development installed a working group for Environmental Management Accounting, EMA, for which Christine Jasch wrote a strategy paper on principles and procedures for environmental management accounting. This is available for download at http://www.un.org/esa/sustdev/estema1.htm or www.ioew.at.

This preceding work was co-financed by the Austrian federal ministry of transport, innovation, and technology, and the federal ministry of agriculture and forestry, environment and water management. The goal of this project was to develop a strategy paper on definitions and principles as well as the methods and procedures of environmental management accounting, especially annual environmental costs and expenditures. A guide in form of a text book has been developed here from, translated into several languages, and used in pilot projects worldwide.

One reason for the strong interest in EMA is the increased demand for an integrated view of monetary and material aspects of environmentally relevant business activities. Sustainable development requires an integrated view of economic, social, and environmental aspects. International rating agencies and award systems for environmental and sustainability reports also place more emphasis on incorporating monetary data for environmental and social activities.

In addition to the international activities, 12 Austrian case studies were performed. This project was part of the framework “Factory of Tomorrow” and was financed by the Austrian federal ministry of transport, innovation, and technology, and the Austrian federal ministry of agriculture and forestry, environment and water management. This collection of case studies in addition to the UN EMA strategy paper should supply the foundation for a wide range of application of environmental management accounting. It should serve to increase knowledge and acceptance among businesses and also as teaching material.

The pilot projects documented below have benefited the participating businesses in the following ways:

- Estimation of the magnitude of environmental costs as defined by the UN CSD procedure
- Insight into the need for developing information systems
- Improved consistency of business wide data
- Improved decision basis for investment appraisal and for estimating the costs and benefits of projects
- Publishable results for public disclosure.

The pilot projects were carried out during workshops at the participating companies. The external project team of IÖW and Joanneum Research, as well as in the companies, always consisted of participants from accounting, process engineering, controlling, and environmental management.

The toolkit is follows the structure of company information systems and print outs in order to decrease the gap between theoretical teaching and practically available technologies for data input and resulting reports. The case studies are presented in

separate exercises so that students can solve them like preparing a balance sheet with cost accounting problems.

Out of every pilot project, a fictional and simplified exercise was created, which contains the following points:

- Description of the company and its products
- Rough description of the production process
- Description of the situation regarding waste and emissions
- Description of the separate parts of financial and cost accounting including the list of accounts, specific accounts and if necessary for the example also other evaluations (e.g. from warehouse management, production planning, cost centre reports, investment appraisal)
- Exercises to be solved
- Resolution with explanation.

The given figures and information are not identical to those of the participating organisations (due to confidentiality) but build upon these.

The project results consisting of this methodology part and the 10 case studies (available only in German) are available in print, on CD, and for download on the homepages of the Austrian federal ministry of transport, innovation, and technology (BMVIT), the federal ministry of agriculture and forestry, environment and water management (BMLFUW) and the IÖW.

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1. What is EMA - Environmental management accounting?

The main problem of environmental management accounting is that we lack a standard definition of environmental costs. Depending on various interests, they include a variety of costs, e.g. disposal costs or investment spending and, sometimes, also external costs (i.e. costs incurred outside the company, mostly to the general public). Of course, this is also true for profits of corporate environmental activities (environmental cost savings). In addition, most of these costs are usually not traced systematically and attributed to the responsible processes and products, but simply summed up in general overhead.

The fact that environmental costs are not fully recorded often leads to distorted calculations for improvement options. Environmental protection projects, aiming to prevent emissions and waste at the source (avoidance option) by better utilizing raw and auxiliary materials and requiring less (harmful) operating materials are not recognized and implemented. The economic and ecological advantages to be derived from such measures are not used. The people in charge are often not aware that producing waste and emissions is usually more expensive than disposing of them.

Experience shows that the environmental manager barely has access to the actual cost accounting documents of the company and only is aware of a tiny fraction of aggregate environmental costs. On the other hand, the controller does have most of the information but is unable to separate the environmental part without further guidance. In addition, he or she is limited to thinking within the framework of existing accounts. Also, the two departments tend to have a severe language problem.

Environmental management accounting thus represents a combined approach which provides for the transition of data from financial accounting and cost accounting to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection. The main areas of application of EMA are internal calculations and decision making.

EMA encompasses measurement in two dimensions:

- physical measurement of material- and energy input, material flows, products as well as wastes and emissions

- monetary measurement of costs, savings und earnings in relation to business activities with potential environmental effects.

It is often difficult determining the environmental portion of these costs. As with integrated clean technologies that are often more cost and material efficient, the environmental portion of health and safety or risk prevention activities can most often not be exactly determined. In general, it may be stated that assets that are allotted 100% to the environment are bad for the environment as they are often End-of-pipe technologies that do not solve the problem at the source, but rather shift it from one environmental medium to another (e.g. from the air to the ground, and then into the water). These approaches are expensive and not efficient.

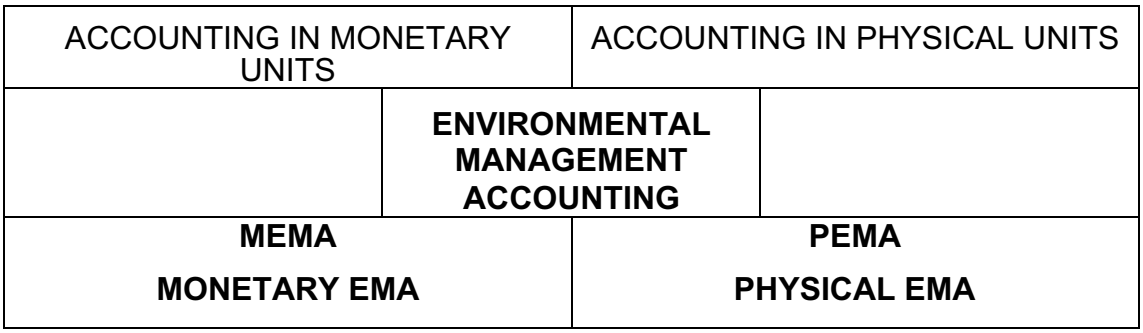

Figure 1: EMA combines monetary and physical data

Application fields for the use of EMA data are:

- Assessment of annual environmental costs/expenditure
- Definition of quantified targets for improved environmental performance
- Product pricing
- Budgeting and corporate controlling
- Investment appraisal, calculating investment options
- Calculating costs, savings and benefits of environmental projects and projects to increase material and energy efficiency
- Design and implementation of environmental management systems
- Environmental performance evaluation, indicators and benchmarking
- Cleaner production, pollution prevention, supply chain management and design for environment projects
- External disclosure of environmental expenditures, investments and liabilities
- External environmental or sustainability reporting
- Other reporting of environmental data to statistical agencies and local authorities

The approach presented in this paper has the underlying assumption that all purchased materials must by physical necessity either leave the company as a product or non-product output (waste, waste water, of emissions), or are stored, which increases the stored stock. Therefore, waste is a sign of inefficiency. In calculating the environmental costs, not only are the disposal costs examined, but also the purchasing price of „wasted“ materials, and the production costs of the waste and emissions.

When environmental costs are allocated to the overhead accounts and evenly spread over all production lines, the environmentally friendly products subsidise the environmentally harmful products. The resulting incorrect calculation of product prices reduces the profits and puts a burden on the environment.

A relatively simple application of EMA that may yield large cost savings is waste management, as the costs of handling and disposing of waste are relatively easy to define and to allocate to specific products. Other environmental costs, including costs of regulatory compliance, damage to the corporate image, environmental liabilities and risks, are more difficult to assess. But, the largest part of all environmental costs lies in the material purchase value of non-product output and can come up to 10 to 100 times the costs of disposal, depending on the business sector.

Adding the purchase value of non-product output to the environmental costs increases the share of environmental costs in relation to other costs. However, it is

not the goal of this paper to show that environmental protection is expensive, but rather to highlight the scope for savings potentials. It is also not the most important task to spend a lot of time defining exactly which costs are environmental or not, or what percentage of something is environmental or not. Environmental protection companies not only have effects on nature, but also on neighbours (noise, odours, pollution) and employees (health and safety), if related to material and energy flows. In addition it comprises reduction of risks for employees, nature and neighbours in case of accidents and other abnormal production events.

The most important task is to make sure that ALL relevant and significant costs are considered when making business decisions. In other words, environmental costs are just a subset of the bigger cost universe that is necessary for good decision making. Environmental costs are part of an integrated system of material and money flows throughout a corporation, and not a separate type of cost altogether. Doing environmental management accounting is simply doing better, more comprehensive management accounting, while wearing an environmental hat that opens the eyes for hidden costs. Therefore, the focus of material flow accounting is no longer assessing the total environmental costs, but on a revised calculation of production costs on the basis of material flows.

Advanced businesses publish their environmental investments and annual costs in their environmental reports but it is not immediately obvious if high figures are good or bad as this depends on the type of expenditure. It is necessary to specify in detail the environmental cost categories as it makes a difference if money is spent on investment or depreciation of End-of-pipe technologies and waste treatment technologies, or if the costs occur for general environmental management and donations for protecting land, or if the majority of environmental costs are the calculated production costs for non-product output. From a business perspective it is always beneficial to reduce costs, also environmental costs, even if the environmental report may give the impression that less environmental expenditure is less environmental performance.

2. What are environmental costs?

From a macroeconomic perspective, the prices for scarce raw materials, pollution and disposal do not reflect their true value and cost to society. Health hazards, repairs of contaminated sites etc. are environmental costs usually not borne by the polluter but by the general public.

Environmental costs comprise both internal and external costs and relate to all costs occurred in relation with environmental damage and protection. **Environmental protection costs** include costs for prevention, disposal, planning, control, shifting actions and damage repair that can occur at companies, governments or people (VDI 2000[1]).

This paper and EMA only deals with corporate environmental costs. External costs which result from corporate activities but are not internalised via regulations and prices are not considered. It is the role of governments to apply political instruments such as eco-taxes and emission control regulations in order to enforce the 'polluter-pays' principle and thus to integrate external costs into corporate calculations. The methods to assess these costs are summarized under the term EA (instead of EMA)

What then are corporate environmental costs? Costs incurred to deal with contaminated sites, effluent control technologies and waste disposal may first come to mind.

Measures for environmental protection comprise all activities taken for legal compliance, compliance with own commitments or voluntarily. Economic effects are no criteria, but the effect on prevention or reduction of environmental impact (VDI 2000).

Corporate environmental protection expenditure includes all expenditure for measures for environmental protection of a company or on its behalf to prevent, reduce, control and document environmental aspects, impacts and hazards, as well as disposal, treatment, sanitation and clean up expenditure. The amount of corporate environmental protection expenditure is not directly related to the environmental performance of a company (VDI 2000).

For company internal calculation of environmental costs, expenditure for environmental protection is only one part of the coin. The costs of waste and emissions include much more then the respective treatment facilities and disposal fees.

From a business perspective, it makes sense to minimise (environmental costs), but not because of abandoning environmental protection, but because of production processes which don’t produce waste and don’t require emission treatment. This makes sense from a micro and well as macro economic perspective.

[1] VDI, the German Association of Technicians, together with German Industry representatives, have developed a guidance document on the definition of environmental protection costs and other terms of pollution prevention, VDI 2000.

The concept of '**waste**' has a double meaning. Waste is a material which has been purchased and paid for, but which has not turned into a marketable product. Waste is therefore indicative of production inefficiency. For the assessment of total annual environmental expenditure as a basis for future calculations and decisions, the costs of wasted materials, capital and labour have to be added. Waste in this context is used as general term for solid waste, waste water and air emissions, and thus comprises all **non-product output**. **Materials** include water and energy.

The approach developed for the UN CSD assumes that all purchased materials leave the company either as a product or as emissions and waste (unless stored).

	Environmental protection expenditure (emissions treatment and waste prevention)
+	**Material flow costs** (Costs of unproductive material, capital, and personnel.)
=	**Total corporate environmental costs**

Figure 2: Total corporate environmental costs

A survey of several company projects, mainly in Austria and Germany, performed by the IÖW, IMU and technical University Graz, has shown that the costs of waste disposal are typically 1 – 10 % of total environmental costs, while the purchase costs of the wasted materials represent 40 to 70 % of environmental costs depending on the business sector examined.

Material flows are money flows and can therefore be partly traced by conventional accounting systems. Also, when calculating investments for environmental protection, increased material and production efficiency needs consideration.

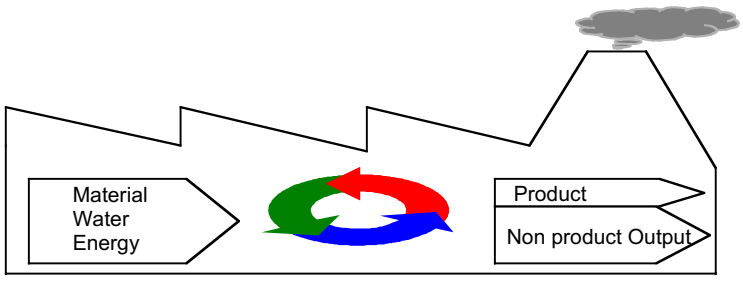

Figure 3: Material flows are money flows

The environmental cost/expenditure categories follow the historic development of awareness for environmental costs.

- The first block of the environmental cost categories comprises conventional **waste disposal and emission treatment costs** including related equipment labour and maintenance materials. Insurance and provisions for environmental liabilities and clean up also reflect the spirit of treatment instead of prevention. The first section corresponds to the conventional definition of environmental

costs comprising all treatment, disposal and clean-up costs of existing waste and emissions.

- The second block is termed **prevention and environmental management** and adds the labour costs and external services for good housekeeping as well as the "environmental" share of cleaner technologies and green purchase, if significant. Prevention activities are actually inherent to environmental management. Research and development for environmental projects is also part of pollution prevention. The main focus of the second block is on annual costs for prevention of waste and emissions, but without calculated cost savings. They include higher pro-rata costs for environment-friendly auxiliary and operating materials, IPPC technologies and the development of environmentally benign products, if significant.

Conventionally, business administration distinguishes three production factors: materials, capital (investments, related annual depreciation and financing cost) and labour. The next two blocks consider the costs of wasted material, capital and labour due to inefficient production, generating waste and emissions.

- In the third block, the **wasted material purchase value** is added. All non-product output is assessed by a material flow balance. Wasted materials are evaluated with their material purchase value or materials consumed value in case of stock management. Technical process flow balances and material flow costing helps to assess non-product output more precisely and allows distributing the related costs back to the responsible polluting cost centre or cost carrier (product).

- Lastly, the **production costs of non-product output** are calculated with the respective production cost pro rata charges, which include labour hours, depreciation of machinery and operating materials and financing costs.

- **Environmental revenues** derived from sales of waste or grants of subsidies are accounted for in a separate category.

Costs that are incurred outside the company and borne by the general public (external costs) or that are relevant to suppliers and consumers (life cycle costs) are not dealt with. Details about the individual environmental cost categories, where to find them and how to calculate them can be found on www.ioew.at/ioew/index.html under Projects, Environmental Management Accounting.

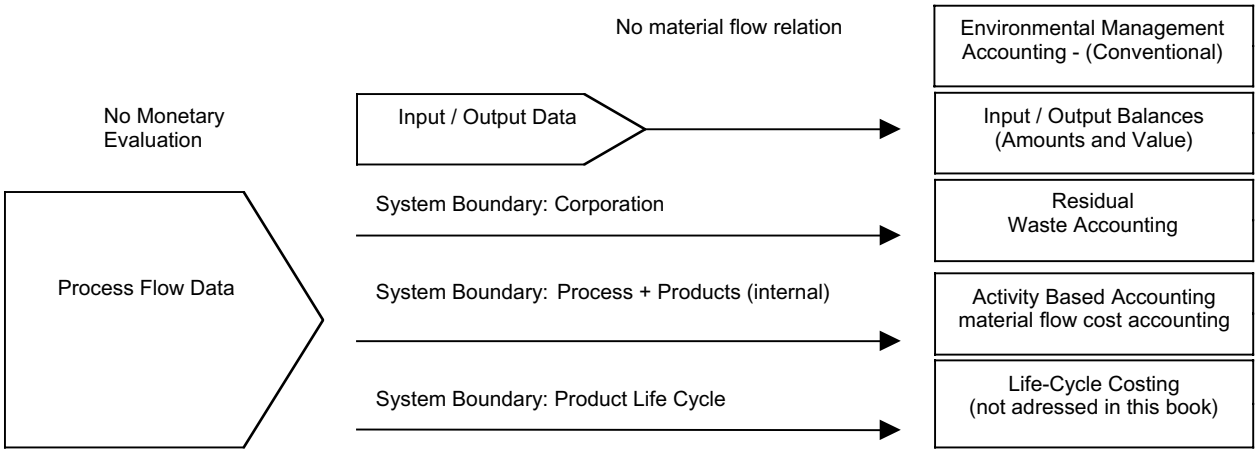

Figure 4: Different focus of environmental costs (Adopted from IMU-Augsburg)

3. Instruction for the assessment of annual corporate environmental costs

Below you will find instructions for the first assessment on site, which consists of a 1-2 day workshop and will define the environmental costs of an organisation of the previous business year. From this one can plan improvement measures and more detailed surveys, as well as calculate the potential savings and investment projects. The basis for this is always the previous year's costs.

3.1. Expenditure or cost

In financial accounting, the term expenditure is used. Cost accounting talks about costs, which have slightly different values. Which values you use depends on the organisation of accounting in your organisation. All expenditures have to be from the same business year and be derived from the profit and loss accounts. In the first project step total annual environmental expenditure assessed, which may include calculatory depreciation and interest taken from cost accounting. External costs and future changes in price are not regarded. The assessment is not for calculating investment alternatives, project costs, or potential savings. These can be calculated separately once the annual costs have been assessed.

For the assessment, it has shown to be practical to split the involved people into 2 or 3 groups after the general idea is conveyed. The involved people are: production manager, environmental officer, controller, and at least one member of the financial accounting and cost accounting department. In small organisations, these functions and the related information may be available by only two people. If this is the case, then the two or three groups refer to the timely sequence of the assessment.

Group 1 compiles the environmentally relevant business equipment using chapter 3.2 and 3.3.. Group 2 develops a first material flow balance sheet using chapter 3.4 and 3.5. Group 3 collects other cost from accounting using chapter 3.6. All three groups will have open questions that must be jointly discussed after collecting the data. The goal of the workshop is to:

- be able to present the entire environmental costs of the previous year according to figure 5 to the executive board, and
- discuss the procedure to improve the information systems and technical processes.

The assignment of environmental costs to the environmental media follows the System of Integrated Environmental and Economic Accounting (SEEA) of the United Nations.

Environmental media **Environmental cost/expenditure categories**	**Air + Climate (Energy)**	**Waste Water**	**Waste**	**Soil + Ground Water**	**Noise + Vibration**	**Biodiversity + Landscape**	**Radiation**	**Other**	**Total**
1. Waste and Emission treatment									
1.1. Depreciation for related equipment									
1.1.1. EoP - equipment									
1.1.2. Non-BAT equipment									
1.2. Maintenance and operating materials and services									
1.3. Related Personnel									
1.4. Fees, Taxes, Charges									
1.5. Fines and penalties									
1.6. Insurance for environmental liabilities									
1.7. Provisions for clean up costs, remediation									
2. Prevention and environmental management									
2.1. External services for environmental management									
2.2. Personnel for general environmental management activities									
2.3. Research and Development									
2.4. Extra expenditure for IPPC equipment									
2.5. Other environmental management costs									
3. Material Purchase Value of non-product output									
3.1. Raw materials									
3.2. Packaging									
3.3. Auxiliary materials									
3.4. Operating materials									
3.5. Energy									
3.6. Water									
4. Processing Costs of non-product output									
∑ Environmental Expenditure									
5. Environmental Revenues									
5.1. Subsidies, Awards									
5.2. Other earnings									
∑ Environmental Revenues									

Figure 5: Environmental expenditure/costs and revenue/earnings

National bureaus of statistics often want the environmental costs to be split up into environmental media (e.g. for health and safety and risk management). In case a category is not relevant, that column can be omitted, as well as others added if they are necessary or dealt with by the same departments.

A detailed survey procedure in Excel format that follows figure 5 is available for download at www.ioew.at/ioew/index.html. This program automatically aggregates the costs and shows the percentage distribution of costs. It is important always to record the method of calculating data as well as its source so it is traceable. For next years assessment, this information makes work simpler and consistent.

The goal of the workshop is to

- be able to present the entire environmental costs of the previous year according to figure 5 to the executive board, and
- discuss the procedure to improve the information systems and technical processes.

Using the explanation of Chapter 3 and the Excel worksheet you should be able to evaluate the environmental costs of the previous year in 1 to 2 days.

The cost assessment reveals improvement options in two areas:

1. What always can be found, are options and measures necessary to improve the quality and consistency of data and information flows in an organisation. This is the starting point of most projects and the focus of most follow up projects.
2. In companies, that have not done environmental management projects for several years, also technical improvement options may become obvious. What always is made visible, mostly for the first time, are the costs related to inefficient production, wasting materials and energy. So even if the technical solution might not be known at the end of the first assessment, the priority areas for deeper investigation will have been defined.

3.2. Environmentally relevant equipment

The first step in the survey is to identify the existing equipment. The term “equipment” may comprise a single machine or an entire production hall. The production steps and the output of emission and waste, as well as the equipment for emission treatment should be clearly summarised. One can find information on this in environmental reports or in the waste prevention plan.

There are three categories of environmentally relevant equipment:

1. EoP - End of Pipe equipment: equipment, machines, constructions, etc. that exist solely for environmental protection or clean up, and are not necessary for production (e.g. wastewater treatment, dust removal, waste separation, etc.)

2. IPPC - Integrated pollution control equipment: proportionate equipment, machines, constructions, etc. that may have been slightly more expensive as they produce less waste or emissions in production (enamelling line with after-burning,

boiler plant with flue gas cleaning, bottle washing line with separate discharge of glass, paper, and metal, all equipment capsuled for noise reduction, etc.)

3. Non-BAT (best available equipment): proportion of equipment that does not confirm to the best available technology and produces avoidable emissions and waste (e.g. old boilers, enamelling lines that paint products that have to be painted again, steam supply with heat losses, etc.)

To help in determining if the equipment was purchased for production or for environmental protection, imagine the equipment in an area where there are no environmental laws or no people living.

Type 1) EoP – Equipment: Equipment, machines, constructions, etc. that exist solely for emission treatment or clean up, and are not necessary for production

Traditionally, businesses have purchased "End-of-pipe" equipment to reduce environmental impact and to meet environmental legal requirements. This equipment has no effect on production. Typical examples are wastewater treatment plants (chemical, biological, or physical) dust removal equipment, flue gas scrubber, waste separation areas, or sound insulation walls.

This equipment are 100% environmentally relevant. They require investment, cause operating costs (personnel and operating materials), and need to be maintained. This equipment often are monitored as separate cost centres, from which one can see the personnel-, and continuous operating costs. These positions are sorted into the rows 1.1 to 1.3 in figure 5. If these costs centres include costs that should be assigned to another category, e.g. the disposal costs, then the cost centre report has to be further divided.

Type 2) IPPC – Equipment: Proportionate share of equipment, machines, constructions, etc. that are more expensive as they produce less waste or emissions in production

In many cases it is possible to minimise waste and emissions using equipment with integrated pollution prevention and control. Sometimes this equipment are more expensive, but often also economical. The proportion of environmentally relevant investment depends on the increase in the investment costs in comparison to state of the art technology.

Operating costs for this equipment can increase or decrease. An example of such equipment would be an (expensive) enamelling line that sprays more efficiently, which means higher depreciation costs, but also lower material use and waste due to increased efficiency.

If the additional costs were significant, their magnitude and/or the percentage of the investment costs should be estimated. The portion of depreciation is recorded in category 2.4. The operating costs are regarded using the material balance sheet under section 3, material purchase value.

Type 3) Non-BAT Equipment: proportion of equipment that does not confirm to best available technology and produces avoidable emissions and waste

Since producing emissions and waste is environmentally relevant, so is equipment, which produces them.

This equipment could be old boiler plants and non-insulated pipes that cause avoidable energy losses requiring higher energy input. Other examples are equipment that produce extra waste, require over proportionate cleaning or a fleet of cars that uses too much fuel.

The environmentally relevant portion of the equipment is calculated by the portion of avoidable waste or emissions (avoidable loss of heat, too high water use in cleaning, etc).

If the portion is significant, the portion of depreciation should be recorded in category 1.1 and the personnel costs in category 1.3, since this equipment has potential in avoiding emissions. The collected values are also important for the investment calculations. The loss of material from the material balance sheet is recorded in cost category 3. Sometimes it is also possible to trace the operating materials from the cost centre reports of the Non-BAT equipment.

3.2.1. Depreciation for related equipment

This cost category contains the depreciation for equipment of Type 1 and portions of the depreciation for equipment of Type 3. The depreciation spreads the investment costs over the expected life time for the equipment. The value for the depreciation (by financial accounting or calculatory depreciation of cost accounting) should follow principles of accounting of the organisation.

The following models exist in practice:

- The depreciation from financial accounting is used; if equipment is depreciated, there is no more annual expenditure or any more costs.
- In cost accounting, the value of depreciation by financial accounting standards (based on the original purchase value) is continued, even after the equipment is depreciated in financial accounting.
- Cost accounting calculates the depreciation on the basis of the new purchase price and adds calculatory interest.

Calculatory depreciation
The basis for calculatory depreciation is the new purchase price of the equipment. In cost accounting, the purchase prices can be translated into new purchase prices using an index.

Calculatory interest
Calculatory interest serves to integrate a required interest on owner's capital and can be calculated in addition to depreciation.

3.2.2. Maintenance and operating materials

EoP and partly also Non-BAT equipment are mostly found on separate cost centres out of which the annual operating costs can be taken.

3.2.3 Related Personnel

Labour time invested into waste and emission relevant equipment from Type 1, is assigned to category 1.2.. Labour time for inefficient production that causes waste (labour time for IPPC- and Non-BAT-equipment), is assigned to production costs or cost category 1.2.. Labour time for general environmental management activities is assigned to 2.2.. Labour time assigned to 1.2 is: personnel for waste collection and disposal and members of a wastewater treatment plant that are directly related to the existing waste and emission flow and equipment.

3.3. Assessment of energy input

The environmentally relevant portion of equipment that convert energy (boiler plants, transformations, pressure reduction plants for natural gas, air compressors, air conditioning, etc.) depends on the portion of lost energy. The part of depreciation is recorded in category 1.1 and the part of personnel costs is recorded in category 1.3.The cost of purchasing the energy is recorded in the material balance sheet.

There are four approaches to evaluating the energy use:

1. Evaluating energy as non-product output (NPO): Since energy does in most cases not enter the product, but rather escape as heated water, air, and radiation, it is considered to be 100% NPO. This allows for the best possible consistency with the input-output balance of the environmental report, and the data collection can continue without technical estimation.
2. Evaluating energy loss: Since energy is required in most processes of production, it is reasonable to only regard the transformation and transportation losses (combustion losses, pipe losses, etc). The efficiencies are known (e.g. with combustion) or have to be estimated (e.g. propulsion, conduction, etc.)
3. Evaluating avoidable losses: Since energy losses are not completely avoidable, the evaluation can regard the difference between the current system and the state of the art. If there are systems that are newer and more efficient, than the difference is environmentally relevant. For example, one can compare the current fleet of cars to the most fuel efficient vehicles available.
4. Evaluating the energy use of the environmentally relevant equipment: The energy use of environmentally relevant equipment (e.g. compressors, waste water plants, after burners, etc.) is just as the other operating costs of such equipment, 100% environmentally relevant.

Correspondingly, for simplification, most of the pilot project organisations evaluated energy use for the fleet of cars, heating, and lighting as 100% external procurement costs, while the production and use of process energy was partly evaluated as efficiency losses, and partly in relation to the state of the art (see case studies).

3.4. Material purchase value

Whatever has not left the company as a product is a sign of inefficient production and must by definition be waste and emissions. Determining the material flows for, at least, raw and auxiliary materials is therefore imperative for environmental cost assessment. The material purchase cost of wasted materials is the most important environmental cost category, accounting for 40 to 70 % of total environmental costs, depending on the value of raw materials and the labour intensity of the sector. In companies with stock management, not the value for materials **purchased**, but **consumed for production** is used respectively.

Cost savings are often feasible in the material costs category, but for this the material flows have to be made transparent and traceable. Saving costs by reducing employees can lead to negative effects such as loss of know-how, inefficiency due to time pressure, loss of work morale.

Before waste and emissions occur, the materials concerned have been
- purchased (materials purchase value)
- transported, handled and stocked (costs for stock management, handling and transport)
- processed in various production steps (equipment depreciation, work time, auxiliary and operating materials, costs for finance etc.)
- collected as scrap, waste, etc., sorted, transported, treated, transported, stocked, again transported and finally
- disposed off (disposal fees).

Corporation thus pay three times for non- product output
1. at purchase
2. during production and
3. at disposal.

Improvement of environmental performance is based on the evaluation of material flows through an input-output analysis of the material flow in kilograms. The system boundaries can be the organisation or it can be further divided into sites, cost centres, processes, and products.

The material balance sheet is based on the idea that what goes into an organisation must (at some point) come out. The material balance sheet includes all the inputted materials, as well as the resulting amounts of products and NPO. The purchased input is compared to the production volume, the sales statistics, as well as the records of waste and emissions. The goal is to improve the efficiency of material use, what leads to both economic and environmental improvements.

INPUT in kg/kWh & _	**OUTPUT in kg & _**

Raw materials	**Product**
Auxiliary materials	Core product
Packaging	By-product
Operating materials	**Waste**
Merchandise	Commercial waste
Energy	Potential recyclable waste
Gas	Hazardous waste
Coal	**Wastewater**
Heating oil	Amount in m^3
Gasoline	Heavy metals
District heating	CSB
Renewable resources (Biomass, Wood)	BSB_5
Solar, Wind, Water	**Air Emissions**
External produced electricity	CO_2
Internally produced electricity	CO
Water	NO_x
City water	SO_2
Well water	Dust
Spring water	FCKWs, NH_4
Rain/ surface water	Ozone destroying substances

Figure 6: Structure of the material balance sheet

In the first step of developing the material flow balance sheet, only a rough overview analysis is performed, instead of a detailed data collection. To find out more about how to develop the material balance sheet, see the strategy paper EMA 6a/2001 of the BMVIT (download at www.ioew.at/ieow/html.at).

Figure 6 shows the structure of the material balance sheet. First the raw-, auxiliary-, and operating materials are added in detail. Then the kg and _ of the previous year are added to the input side. Organisations with already existing material balance sheets only require the year's purchase value, respectively the material use of the input and the disposal costs.

3.4.1. Raw materials

Non-product raw material output will mostly be disposed of as solid waste. Only in those rare cases where the company's product is gaseous (industrial gases, perfume), will it be found in the air. More common is a liquid product (beer, milk) that goes down with wastewater.

For a first estimate, company internal calculation percentages for scrap can be used to estimate the non-product output of raw materials. Eventually, with more detailed material flow balances, scrap percentages may need adjustment. The reasons, why raw materials do not become products are manifold and well worth study.

Product returns, obliteration, repackaging for other countries or specified customer requests, quality control, production losses, spoilage, wastage, decay in storage,

shrinkage, etc. are some of the causes of waste generation that call for measures to increase production efficiency, which may be profitable both from an economic and ecological point of view.

3.4.2. Auxiliary materials

These materials become part of the product, but are not its main components (e.g. glue in furniture or shoes. Often, they are not monitored separately. Again, their non-product output should be estimated in a first assessment and may then be monitored in more detailed cost accounting projects. The employees at the related production lines often can provide very good estimates, which are often not known to the environmental and financial departments.

3.4.3. Packaging

Purchased packaging for products will mostly leave the company with the product, but again a certain percentage for internal losses, e.g. due to repackaging for specific destinations, should be estimated.

3.4.4. Operating materials

Operating materials are by definition not contained in the product. Some materials are built into the office building, and stationery will have left the company via mail, but the major part of chemicals, solvents, detergents, paint, glue etc. goes to non-product output. They can contain dangerous substances that need to be disposed of separately. These materials are usually not recorded in the warehouse management system, but are assigned to expenditure at the time of purchase. In most organisations, their consumption is not recorded in cost centres so that is practically impossible to trace who has used how much of them. In cost calculation, only estimates are used for the calculation of product prices, but hardly ever somebody checks if these estimates confirm to real consumption.

Operating materials (including energy) for environmentally relevant equipment, as defined in item 1.1, should be quoted separately in item 1.2 or 2.4 and can often be read directly from individual cost centre reports for this equipment. Administrative operating materials are not regarded in the first assessment. All other operating materials (especially chemicals, maintenance materials, etc) are assigned in NPO in the first estimation of the magnitude.

3.4.5. Merchandise

It is assumed that commodities do not undergo any more technical processes that might cause waste or emissions but are directly sold. They are therefore not regarded for the environmental cost survey.

3.4.6. Water

Water consists of all the fresh water from public grids, water from private wells, and surface water. The purchase cost of water is attributed to this column. Rain, ground, surface, and spring water are evaluated as costs of extraction and are assigned to the environmentally relevant equipment.

For some sectors, especially in the food industry, some water goes to the product, in which case only a percentage of water input should be quoted under purchase value of non product output.

3.5. Production costs of non-product output

The above non-product output not only has material purchase value, but has also undergone processing in the company before leaving it again. Thus, wasted labour and capital costs should be added.

Labour time lost due to inefficient production, and a share of depreciation for machinery as well as possible other costs should be accounted for under this item. For waste of raw materials and products in the various phases of production (usually solid or liquid) pro-rata production costs are calculated as a percentage based premium on the material purchase value.

3.6. Other environmental costs

After the environmentally relevant equipment including operating costs and the NPO of the material input are recorded, the final step is quickly concluded. The team checks if any of the following cost categories has caused expenditures in the last business year. The data can be found in the list of accounting.

3.6.1. Taxes, Fees, Charges

Disposal fees, wastewater fees, packaging-licence charge, energy tax and other eco-taxes are to be recorded in cost category 1.4 of figure 5.

3.6.2. Fines and Penalties

Existing fines for surpassing pollution restrictions are to be recorded in category 1.5.

3.6.3. Insurance for environmental liability, damage and risks

In certain cases, e.g. when transporting hazardous materials, the environmental portion can be estimated and recorded in category 1.6.

3.6.4. Provisions for clean up costs, remediation, etc.

In some sectors provisions for clean up are required, especially in the oil industry, for gas stations, power plants, etc. (cost category 1.7).

3.6.5. External services for environmental management

Outside help is usually required for developing an environmental management system. These costs, plus costs for environmentally relevant inspections and audits, and the costs for environmental reports and other dissemination materials are to be recorded under category 2.1.

3.6.6. Internal personnel for general environmental management activities

The portion of labour hours for environmentally relevant equipment of Type 1 and 3 should be assigned to category 1.3. In category 2.2 the additional time for the internal

personnel for general environmental management activities, not directly related to emission treatment or the production of non-product output should be recorded. Work hours for training programs including travel expenses, environmental management activities and projects, audits, compliance and communication should be estimated and evaluated with the respective work hour costs including social security and taxes.

3.6.7. Research and development

Any environmentally relevant research projects should be recorded under category 2.3.

3.6.8. Other environmental management costs

In case the business is active in environmental sponsoring, this and any other non assigned costs should be recorded under category 2.5. It is recommended that the environmental team does some brainstorming on the activities of the previous year, and that all projects of the environmental program are included.

3.7. Environmental revenues

Revenues from selling recycling materials and from subsidies and awards are recorded here.

Using the explanation of Chapter 3 and the Excel worksheet (download from www.ioew.at/ioew/index.html) you should be able to evaluate the environmental costs of the previous year in 1 to 2 days.

4. Results from the pilot projects

Following are some generally valid results and recommendations from the Austrian company projects. To be considered is that the results of 12 enterprises, in particular concerning the cost allocations, are not representative for the entire Austrian industry; however they do point out clear tendencies.

Expense distribution derived from the profit and loss accounts

The participating enterprises were evaluated separately for the production- and service sector. An analysis of the profit and loss accounts shows the following distribution: The personnel expenses in the services enterprises is approximately 40%, the material purchase only 1 to 5%. For the production enterprises the material purchase makes up 15 to 60%, also the personnel expenses has a large margin of fluctuation from 15 to 40%.

Service Sector	Min	Average	Max
Materials	1%	3%	5%
Personnel	38%	42%	44%
Depreciation	4%	9%	34%
Interest	1%	9%	23%
Other Expenses	10%	25%	48%

Figure 7: Expense distribution at service enterprises

Production Sector	Min	Average	Max
Materials	16%	44%	60%
Personnel	15%	24%	39%
Depreciation	1%	7%	16%
Interest	0%	1%	3%
Other Expenses	11%	24%	43%

Figure 8: Expense distribution in production enterprises

Structure of the environmental costs

These differences also appear in the structure of the environmental costs. The environmental cost block "material purchase value of non-product output (NPO)" is most strongly weighted in the production enterprises (with 45-85%). The NPO is by far the largest part of the environmental costs and this cost factor is generally not considered in the environmental costs inquiry.

The expenses for the waste and emission treatment follow with values between 15 and 52 percent.

The cost block “prevention and environmental management" causes between 0.5 and 14% of the environmental costs.

The fourth and last block "processing costs of the NPO", could be assessed only in some companies. It represents the production scrap evaluated by manufacturing costs of production, which is usually exposed during the stocktaking, and has a portion of approximately 3% of the environmental costs, whereby sector-specific values of up to 20% are possible.

The environmental revenues predominantly result from selling capacity of the waste water purifications -, energy production - and waste treatment plants to connected or external enterprises and are about 0 to 10%.

	Min	Average	Max
1. Waste and Emission treatment	13%	29%	52%
2 Prevention and environmental management	1%	6%	14%
3. Material purchase value of NPO	39%	64%	85%
4. Processing costs of NPO	0%	5%	17%
5. Environmental revenue	0%	-3%	-9%

Figure 9: Distribution of the cost categories by cost blocks

With the service enterprises that only use a small part of their expenditures for material (1-5%), but a high part for personnel (approximately 40%), the block "material purchase cost of the NPO" can still dominate. This is however not due to the raw or auxiliary materials, but due to the energy purchase, which often constitute the only substantial part of the environmental costs in service enterprises. There are no raw and auxiliary materials and processing costs for the NPO in the service sector.

Detailed review of the individual environmental cost categories

The following table shows the extreme and average values of the individual cost categories without the case studies from the two banks (service sector).

	Min	Average	Max
1. Waste and emission treatment			
1.1. Depreciation for related equipment	2%	9%	25%
1.2. Maintenance and operating materials and services	1%	5%	15%
1.3. Related personnel	1%	5%	20%
1.4. Taxes, Fees, Charges	4%	9%	14%
1.5. Fines and Penalties	0%	0%	0%
1.6. Insurance for environmental liabilities	0%	0%	0%

1.7. Provisions for clean up costs, remediation, etc.	0%	0%	64%
2. Prevention and environmental management			
2.1. External services for environmental management	0%	1%	4%
2.2. Personnel for general environmental management	0%	4%	10%
2.3. Research and development	0%	1%	4%
2.4. Extra expenditure for IPPC equipment	0%	1%	3%
2.5. Other environmental management costs	0,2	0,1	25%
3. Material purchase value of the NPO			
3.1. Raw materials	3%	21%	54%
3.2. Packaging	0%	3%	12%
3.3. Auxiliary materials	0%	7%	31%
3.4. Operating materials	0%	9%	37%
3.5. Energy	16%	24%	31%
3.6. Water	0%	1%	1%
4. Processing costs of the NPO	0%	5%	17%
5. Environmental revenues	0%	-3%	9%

Figure 10: Detailed distribution of the cost categories

Depreciation, maintenance and related personnel expenses

Depreciation, maintenance, and personnel expenses for environmental relevant equipment and plants, which produce proportionate scrap and efficiency losses, make up a large component of the environmental costs particularly with the breweries (up to 45%). That is also because in these enterprises the loss portion of the production plants was known very exactly and the definition of the environmental relevant equipment was very detailed. The average within this range is however only 20%. Mostly, the environmental relevant equipment can be specified from the cost centre accounts, the costs shown on a specified cost centre report can be multiplied by the related scrap or efficiency loss percentage and recorded in the excel file as environmental cost.

Fees, Taxes and Charges

In this cost category the variation is smaller than expected. With hardly more variation than 2-3% the values of all companies lie around the average value of 9%.

Fines and Penalties

This seems to be a cost category, which never occurs in pilot companies for cleaner production and environmental management, and rather corresponds to the American legal economic structure.

Prevention and environmental management

The block prevention and environmental management constitutes on the average 6% of all environmental costs, whereby the largest weight is on internal personnel expenses with nearly 4%. The remaining ranges of this block all have average values of around or less than 1%.

Material purchase value of the NPO

As mentioned above, the largest part of the environmental costs, particularly in the production sector, accrues in the third costs block "material purchase value of the NPO". The two most important points within this range are raw materials (average: 21.4% of the total costs) and energy (average: 23.8%) although there also are isolated outliers with auxiliary materials and operational materials. Water and packing material hardly lie over 1-3%, however, are not to be neglected.

Processing costs of the NPO

The next block, processing costs of NPO, records the manufacturing costs of scrap, waste and other losses revealed by the stock inventory. It has not been possible to assess these costs in all companies. It varies between 2 and 16% with an average value of around the 5%.

Environmental revenues

Environmental revenues are obtained mainly by sales of scrap materials as well as by renting of "cleaning capacities" or selling power from own production. They correspond to an average of about 3% of the environmental costs.

Distribution by environmental media

Apart from the distribution into the individual cost blocks the distribution of the costs into the environmental media can also be regarded. This also varies strongly. However no clear distinction between production- and service enterprises is to be found in this case. The costs within the categories ‘soil and groundwater', ‘noise and vibration', ‘bio diversity and radiation' are negligible and hardly or do not occur in the inquiries. The shares of the cost of the other media vary strongly. The column "other" was used whenever the costs could not be attached clearly to a medium (e.g. general environmental management).

	Min	Average	Max
Air & climate	14%	28%	41%
Waste water	0,5%	30%	56%
Waste	3%	36%	83%
Other	0,2%	7%	17%

Figure 11: Distribution of the costs by environmental media

The banks were excluded, since the extremely high portion of the energy costs would falsify the representation.

	Air & Climate	Waste Water	Waste	Other	Sum
Banks	77%	%	5%	16%	%
Galvanic shop	23%	36%	%	10%	100%
Breweries	38%	37%	%	6%	100%
Other production enterprises	24%	20%	%	6%	100%

Figure 12: Detailed distribution of the costs by sector

For evaluating by sectors, two case studies were available in each case. Looking at the galvanic shop, the largest part of the costs (36%) is attributed to the waste water, followed by waste and air & climate (power). In the breweries however the most important medium (over 38%) is air & climate (power), closely followed by waste water. With the remaining production enterprises most environmental relevant costs are attributed to waste with over 50%, followed by air & climate and waste water with approx. 20%. The banks accrue the by far highest environmental costs in the area of power, which leads to a portion of 77% for the medium air & climate and very low portions for waste water and waste.

Environmental costs per employee

The environmental costs per employee per year also move within a large margin of fluctuation. Thus in the course of the project values between _ 300, - and nearly _ 40,000, - were exposed. The services enterprises move in the centre zone with approximately _ 2,500, - to _ 4,500, - per employee and year. Thus this indicator does not seem to make sense for cross sector comparison, but probably only for the annual meeting within one organisation.

Awareness about the amount of the environmental costs

Apart from the distribution of the environmental costs their absolute amount is also of great importance. This project shows that the environmental relevant costs in most enterprises are underestimated multiple times.

At the beginning of the project the participating companies only knew the costs of the waste disposal, the energy consumption, the Austrian tax for packaging, and the total amount of the cost centre waste water treatment (if sector-specifically necessary). Enterprises that control several locations could only indicate the costs on a corporate level.

However, the costs of the waste disposal were not always consistently gathered and evaluated. Costs of the in-plant waste handling were seldom taken into account; the fact that waste also contained a material purchase value was theoretically accepted, but never had been calculated.

Energy consumption was only recorded in the profit and loss account and levied to the other cost centres not by actual consumption, but by outdated general estimates. Only equipment for energy production (if available) is recorded on a separate cost centre.

Depending on the technology applied (end of pipe or integrated technology), the plants for waste water purification are singled out as separate cost centre or included in the production cost centres. Over and over, it was difficult to impossible to estimate the environmental portion of integrated technologies, as they are mainly purchased for production purposes and confirm to state of the art.

Environmental costs such as waste handling, maintenance, energy, are sometimes all summed up in the cost centre 'building', and can only be separated from the detailed cost centre report by hand.

In practically all enterprises the environmental departments and the technical departments carry out additional recordings besides the financial accounting and cost calculation records, in order to record data on amounts as well as costs. The controllers, in particular if they have a technical background, frequently work with this information, instead of the accounting records, but the inconsistencies to the accounting figures are significant.

Only few project participants could submit a comprehensive cost statement on request for the transmittal of the environmental costs of the previous year. They frequently simply submitted print outs of separate accounts or cost centre reports.

After the method used in the project in the first workshop had been presented, the participants were asked in each case to estimate the environmental costs that would show up at the end of the day of the workshop. This also showed that the environmental managers and technical managers had insufficient information about the orders of magnitude of the operational costs. The accountants had a benefit here, yet the estimation on average was far from the actual result at the end of the day.

In summary it can be stated that the estimations differed by a currency factor Schilling to Euro (14 times) to the actual result. (7 million were estimated, and at the end of they decided that this estimation had been delivered in Euro, not in Schilling, to come closer to the actual result.)

The environmental costs lay around 7-40 times above the values admitted before the start of the project and around 3-14 times over the values estimated by the enterprises in the workshop.

Thus it becomes obvious that increased awareness for the magnitude of the environmental costs and above all the material purchase value contained in waste must be established and with it coherently also for measures for the increase of the material efficiency. It is important that environmental protection is not only regarded as a nuisance by enterprises, but that the often significant savings potential, which also means an improvement of the environmental performance do not remain concealed.

5. Recommendations

It was shown that the UN DSD method encountered large interest and that the cost assessment is feasibly conducted in 1-2 days. The project resulted in suggestions for the improvement of the accounting information system, and for the reduction of the material and loss of energy values. All enterprises want to continue the instrument.

The Verbund, Brau Union, and SCA were all interested in integrating the results of the site inquiry into a corporate-wide information and reporting system.

It however also showed that some aspects of the theory of cost accounting and investment appraisal are not calculable in the enterprises, since the internal systems do not provide the degree of necessary complexity. A monetary comprehensible investment appraisal is present only in a fraction of the participating firms. In this case, it deals only with large-scale projects such as power stations or paper-making machines, which are much too complex for didactical reasons. Also the professionalism of the cost accounting system rarely corresponds to the school theoretical requirement profile.

As most companies belong to sectors, where the production process can be regarded as a black box as well from process technological as cost centre perspective, or they anyway belong to the service sector, detailed material flow cost accounting would be a waste of effort.

Conditions for a recommendable application of detailed material flow cost accounting on a process and product level are:

- portion of material costs of the entire operational expenditures of at least 20 %, better 40%,
- production procedures, where a broad product range can go through alternatively various production steps,
- calculation of divergent product prices on basis of the cost centre accounts.

In sectors, in which one product is produced with a closed procedure (breweries, paper industry, energy industry) an intensifying allocation of the material flows to the different cost centres seems not useful.

The company projects revealed that the motivation for the companies to participate in the project was influenced by expected internal and external benefits likewise. Since nearly all participants have an environmental management system, external communication via the environmental statement or report and via the case study in the toolkit were estimated as important, as the increased transparency of the environmental costs and information systems. This estimate is still stronger with the companies listed on stock exchange, who consciously try to communicate their sustainability profile for ethical investment decisions and link ecological with economic requirements.

The suggestions during the Workshops have raised a few general recommendations for the improvement of the data collection of the environmental and material flow costs.

- Clear and written definition of corporate and site specific environmental costs as well as their distribution to cost centres

It is recommended that corporations develop written procedures which cost categories are distributed to site, subsidiary and corporation level. It is also necessary to define up to which level an allocation of the costs is meaningful (subsidiary, business field, and site). The costs of certifying the environmental management system and for environmental communication, as well as the personnel expenses of the environmental team are frequently not clearly and uniformly recorded.

- Data collection of material purchase by material groups in financial accounting

In some enterprises the entire material purchase is booked on one account only and it is only possible to evaluate by hand the extensive cost centre accounts or stocktaking lists to expose the actual material use into the material groups. As an aid, the recordings of the production manager were multiplied to the assigned quantities with average prices, in order to at least be able to indicate orders of magnitude. The fact that such a system cannot strengthen cost consciousness in handling raw, auxiliary and operating materials is obvious.

- Estimation and recalculation of material scrap percentages

The loss percentages for raw materials, packing material, auxiliary materials and the final product are often based on outdated estimated values and only are recalculated for a few material groups. The employees on-site usually have more precise estimated values than the accountants. A correct recalculation mostly raises frightening results.

- Consistency of system boundaries for material flow accounting in technical and accounting information systems and definition, which accounts, cost centres and cost categories must be consistent by amount and value

The input-output material balance disclosed in the environmental statement is hardly ever consistent with the system boundaries of the accounts and cost centre reports. As a consequence, the data can not be audited for consistency. For the recording of the costs and amounts of waste we found three different values and records on one site (record of the environmental manager without the costs for weighting, transport and rent of disposal cans, the financial account with some wrong postings and the accounts of the several suppliers with additional services.

- Losses revealed by stock inventory

The losses revealed by stock taking can be taken as estimate for the processing costs of non product output. However, the related material purchase has to be deducted for the cost category “material input”, as costs for raw and auxiliary materials and packaging are included in the processing costs.

- Projects listed in the environmental program, the environmental statement and in public journals as environmental projects should also have a recorded investment decision and traceable account posting.

Environmental projects can often not be traced in the budget foresight and in the cost centre reports, but disappear in the general overhead accounts. At least those projects, which result from the environmental program and are disclosed in the environmental statement should be marked and traceable in the cost centre reports and recorded as environmental costs.

- Separate cost category “environmental management”

The most consistent solution is to install a separate cost category or cost centre for environmental management, which a clear definition, which costs are to be attributed to this account. However, some companies try to reduce the number of cost centres. If the people involved are spread over several other cost centres and only part of their time work for environmental issues, than this solution is not adequate.

- Depreciation of projects/investments before the first year of cost assessment

During the first cost assessment, the question is often posed how to deal with missing values of the previous years. If these can be estimated or assessed easily, it should be done. But, the main goal of the first assessment is to improve the data basis for the next years and not detailed and cumbersome assessment of previous values.

- Distinction to Health and Safety and Risk management

Again, designing a system appropriate to the company involved is the most important target. Some companies have added a column for safety and risk prevention, as this duty is also part of the job description of the environmental manager. Health is mostly the duty of other departments.

6. Structure of the case studies

The environmental cost assessment scheme (Figure 5) was adapted to an Excel file that is available for download at www.ioew.at/ioew/index.html, Publications.

The Excel-file environmental costs data sheet consists of three sheets – *Detail, Sum, and Structure*. You only add information into the *Detail* sheet. All the cost categories are already set. The environmental media can be modified if necessary. Attn: If columns are added or deleted, then do the same for the other two sheets.

For costs that are incurred by equipment (1.1), it is practical to simultaneously collect the data on maintenance (1.2), personnel (1.3), and material costs (3.1-3.5). All collected data should be assigned to the correct environmental medium.

The column *Account* is to keep the same cost centres and accounts for the years to come without having to spend a lot of time finding them again. It is also practical to document the type of calculation used to acquire a certain figure. It is possible to add lines into the sheet, just beware of maintaining the automatic excel calculations.

There is a control function in the sheet, which makes sure that the value in column *Costs in* _ is identical to that of *Sum*. If this is not so, an error will show. The values are only identical if all costs in the *Costs in* _ are assigned to a medium.

The sum of the costs of all categories in the sheet *Detail* is transferred to the sheet *Sum* to have an overview and a better presentation layout. The sheet *Structure* merely calculates the costs in percentages to show the most relevant environmental costs.

All case studies are fictional and do not contain any real values from the businesses. However, they are based on the structure of the discovered processes and data collection.

The case studies vary greatly in their development to show the different aspects of accounting, cost accounting, and environmental cost accounting. The case studies, however, are available only in German.

The environmental cost collection of **SW Umwelttechnik** is based on the list of accounts. For the investment calculation, the economic feasibility of a solar plant is compared to an oil boiler plant.

In the two brewery examples of **Puntigam** and **Murau**, which due to their clearly laid out production process are in great detail, the cost calculation uses the list of assets, a part of the list of accounts, and a few detailed accounts. The purpose of the investment calculation is to see the energy saving potentials in constructing a combined block and heat power plant.

At **Roto Frank**, the inconsistencies in disposal costs, as well as the inventory differences and their evaluation possibilities are analysed.

In the example of **eloxal Heuberger** the profit and loss statement is developed using the Austrian trade law. The primary part of the environmental costs is the cost of bringing the wastewater treatment plant to state of the art.

The paper producer **SCA Laakirchen** uses the concept of calculatory depreciation for their example. Otherwise the example is similar to that of the breweries. However, an impressive difference is the use of an input-output balance sheet. A combined block heat power is regarded in the investment calculation.

The example of the ski producer **Fischer** has significant costs in the wasted material purchase and the production costs of the NPO. The investment calculation shows a printing equipment that reduces the amount of pigments.

In the example from the service sector based on two Austrian banks, **OENB**, and **Raiffeisen-Holding NÖ-Wien**, one can see that the otherwise low environmental costs are dominated by high energy costs. The investment calculation examples deal with reducing this and CO_2-emissions. Due to the confidentiality of all information, the data was not collected from accounting, but rather from the project budget and through telephone interviews.

Finally the three business areas of **Verbund-Konzern**, hydroelectric power, thermal power and grid, were analysed. Due to the sector specific structure of the Verbund, a corporate–wide assessment scheme for the environmental costs of the three business areas was developed, taking into account the different access authorisations of accountants and technicians to the corporate information system. Project budgets, parts of the profit and loss accounts, as well as various possibilities to assign costs to different production sites were incorporated into the analysis. Another focus of this example is the question of how to evaluate the loss of energy efficiency. In the thermal power plant **Dürnrohr** three possibilities are calculated. The construction of a water supply for the towns around the **Ennskraftwerk Rosenau**, and the installation of a automatic steering of air control at the **Netzgruppe Tauern West** were chosen for the investment calculations.

	Cost calculation	**Investment calculation**	**Page**
SW Umwelttechnik	List of accounts	Solar plant	56
Brauereien	List of assets, list of accounts, detailed accounts, detailed definition of environmentally relevant equipment, with and without multiple use systems	Combined block and heat power plant	71
Roto Frank	Inconsistency of disposal costs, differences in inventory		97
Heuberger	Profit and loss accounts following the Austrian trade law, provision for environmental remediation		107
SCA Laakirchen	Input / Output balance sheet, list of assets, calculatory depr., cost centre reports, detailed accounts	Combined block and heat power plant	119

Fischer Ski	Scrap percentages, Warehouse inventory	Printing equipment	136
Banks	Project proposal, energy costs	Air conditioning, flat screen monitors	160
Verbund	Corporate cost accounting, other environmental media, evaluation of the energy use and efficiency		178
Wärmekraftwerk Dürnrohr	3 variants to evaluating the loss of energy efficiency		183
Ennskraftwerke	Project budgets, assigning costs between corporation, faciliates, and sites, profit and loss accounts,	Water supply	202
Netzgruppe West	Environmental program, own demand	Automatic steering of air control	224

Figure 13: Case studies with different aspects of cost and investment calculation