Performing Environmental Management and Material Flow Cost Accounting (EMA & MFCA) using COMFAR

Addition to the COMFAR *III Expert* Tutorial and Reference Manuals

(Or COMFAR *III EMA* Module)

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1. Introduction

1.1 Linking COMFAR *III* with Environmental Management Accounting (EMA) and Material Flow Cost Accounting (MFCA)

Environmental protection and management have proved to be environmentally as well as economically beneficial, especially when combined with integrated prevention technologies and material flow cost accounting. A prerequisite to demonstrate these effects are company internal information systems that allow calculating and demonstrating these benefits. However, many companies do not have the accounting and management systems in place that allow such calculations. Companies all over the world therefore find it difficult to analyse the benefits of Cleaner Production (CP) properly and to obtain funding for their projects.

Environmental issues – along with the related costs, revenues and benefits – are of increasing concern to many countries around the world. There is a growing consensus that conventional accounting practices simply do not provide adequate information for environmental management purposes. To fill the gap, Environmental Management Accounting (EMA) has received international attention. For example, the Japanese Ministry of Economy, Trade and Industry is promoting Material Flow Cost Accounting (MFCA) (www.meti.go.jp/policy/eco_business). The Working Group on EMA of the United Nations Division (UN DSD EMA WG) spurred much of this interest by its publications (http://www.un.org/esa/susdev). The International Federation of Accountants (IFAC) commissioned a guidance document on EMA initiated by the first two publications by the UN DSD EMA Working Group on EMA (IFAC, 2005). UNIDO has now developed a software tool for investment appraisal – COMFAR *III* – that includes a separate project type for EMA based on the UN DSD and IFAC EMA approach.

Simply defined, environmental management accounting (EMA) is management accounting (MA) with a focus on physical information on the flow of energy, water, products and materials as well as monetary information on environmental costs and revenues and projects related to environmental protection. EMA is closely related to process costing or activity based costing as well as to environmental performance and management systems. Well-designed and implemented EMA helps to ensure better internal management and decision-making e.g. for investment appraisal, cleaner production, improving Eco-efficiency and calculating savings within organizations. EMA also serves as a basis for external accounting and reporting as well as life cycle assessments of products.

The definition of EMA adopted by the United Nations Expert Working Group on EMA distinctively highlights the physical and monetary side of EMA. According to the UN working group EMA is broadly defined to be the identification, collection, analysis and use of two types of information for internal decision-making (Jasch, 2001):

1) Physical information on the use, flows, and fates of energy, water, and materials (including wastes) and
2) Monetary information on environmentally related costs, earnings, and savings.

Once the total annual environmental and material flow costs have been assessed, the **EMA excel template** (a template in Microsoft Excel format) provides the option to distribute them to different cost centers, which should be equivalent to production processes and therefore provide good quality data for investment appraisal of specific processes. For material flow cost account (MFCA) the system boundary for the mass balances can focus on more detailed processes within a cost centre. While the EMA pre-assessment of the mass balances and annual environmental costs is done in separate Microsoft Excel templates, the subsequent investment appraisal applies the standard COMFAR *III* procedure.

The focus of the COMFAR *III* EMA module is to allow data assessment of material flows and fates and related costs for the previous business year based on the UN DSD and IFAC EMA methodology. Once the data has been assessed on a company level, it can be distributed to cost centers, reflecting production processes, and thereby providing a much better basis for the application of the already existing investment appraisal tool COMFAR *III*.

COMFAR *III* Expert is a computer program that supports project pre-investment studies. It facilitates data organization, computations and the production of pro-forma reports on financial and economic performance. The first generation of the Computer Model for Feasibility Analysis and Reporting (COMFAR), a computation tool for financial analysis of investments, was released in 1983. Since then this UNIDO software has been further developed to support the economic appraisal of projects. The main module of the program accepts financial and economic data, produces financial and economic statements and graphical displays and calculates performance indicators. Cost-benefit and value-added methods of economic analysis developed by UNIDO are included in the program and the methods of major international development institutions are accommodated. The COMFAR *III* CDM Module facilitates the demonstration of additionality for CDM projects as required under the financial analysis test of the "Tool for the demonstration and assessment of additionality (Version 3)" published by the UNFCCC CDM Executive Board.

The **COMFAR *III* EMA module** requires the application of a step-wise approach. It calls for:

1. Assessment of **materials inputs and outputs** following the IFAC EMA guideline (done in the Microsoft Excel EMA template)
2. Assessment of total **annual environmental costs** following the IFAC EMA guideline (done in the Microsoft Excel EMA template)
3. Distribution of the annual costs to **cost centers** or more specific processes (optional, depending on project needs and done in the Microsoft Excel EMA template)
4. Application for **simple investment options**, comparing cleaner technologies and end-of-pipe solutions between each other and to the last business year or existing technologies. This calculation does normally not relate to turnover and finance and is done in a **COMFAR *III* project type for EMA**. Please note, that in order to enter the financial data for comparing CP options for investment appraisal, the mass balances and the total annual environmental costs of the previous business year need to first be assessed by working with the Microsoft Excel EMA template, as indicated above. This EMA template is provided together with COMFAR *III* Expert.
5. Application for more **comprehensive projects, comprising the whole production facility and planned turnover**. It is recommended to therefore apply the traditional COMFAR *III* procedures, as described in the COMFAR *III* Expert Reference and Tutorial Manuals.

The **main difference** between the comprehensive COMFAR *III* modules and the COMFAR *III* EMA project type is that COMFAR *III* normally includes **the whole profit and loss accounts** and data for finance and working capital. The EMA project type **focuses on material flows and environmental costs only** and does not include the whole profit and loss accounts as the focus of EMA is not assessment of total costs but on the environmental and material flow costs. Also when applied for comparing CP options for investment appraisal, it normally doesn't relate to aspects of product turnover and finance issues, but compares the material flow and environmental cost related aspects. Therefore the module *Incremental Analysis* of different technology options is the most significant part of the COMFAR *III* EMA project type. It shows the *Incremental Cash flow for Financial Planning* as well as the *Incremental Discounted Cash flow* (described in Chapter 3.2 and is demonstrated by case studies in chapters 4.4 and 4.5).

The COMFAR *III* EMA project type as referred to in step 4 only addresses the environmental and material flow costs. It supports the determination whether a proposed project activity or technology is economically or financially more attractive than other alternatives without the revenue from the sale of product or finance issues.

The COMFAR *III* EMA project type supports all analysis methods suggested by the tool, namely:

- simple cost analysis,
- investment comparison analysis, or
- benchmark analysis

whereby the selection of the appropriate method is driven by the design of the proposed CP project:

1.2 Why bother?

Within the context of the Joint Programme on Resource Efficient and Cleaner Production, UNIDO and UNEP have defined:

Resource Efficient and Cleaner Production (RECP) is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment. It specifically works to advance the three dimensions of sustainable development in an integrated manner, by catalysing:

- Production Efficiency through optimization of the productive use of natural resources (materials, energy and water) by enterprises and other organizations;
- Environmental Management through minimization of the impact on environment and nature, by preventing the generation of waste and emissions and improving the use of chemicals in enterprises and other organizations ([1]); and
- Human Development through minimization of risks to people and communities from enterprises and other organizations and supporting their own development.

Environmental Sound Technologies (EST) protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes. EST in the context of pollution are “processes and product technologies” that generate low or no waste, for the prevention of pollution. They also cover “end-of-the-pipe” technologies for treatment of pollution after it has been generated.

The goal is to gradually replace costly end-of-pipe pollution control systems with a strategy that reduces and avoids pollution and waste throughout the entire production cycle, from efficient use of raw materials, energy and water to the final product. But, the actual costs of existing technologies, the losses of materials inputs and the benefits of CP options must be visual in the accounting system to obtain the finance necessary for investment options.

Financial analysis is usually required to make a decision on any type of investment. In most companies there is a single capital budgeting pool for all projects. This means that CP investments must compete with other projects. Even though a company may have established environmental objectives, this does not automatically result in a lower “hurdle rate” for environmental projects. Capital budgeting is the decision-making process that prioritizes alternate actions (investments) on which the company can spend its financial resources.

The financial feasibility analysis can be carried out using different methods of investment appraisal or a combination of them, such as the Discounted Cash Flow Models (i.e. the Net Present Value model (NPV) and the Internal Rate of Return (IRR) model), or conventional models (e.g. the payback period model).

It is necessary to make careful and realistic estimations of avoided costs realizable through CP in order to raise the IRRs and increase the NPVs to more competitive levels. To correctly appraise CP options in a financial feasibility analysis and influence the capital budgeting process, the management accounting tools need to be sufficiently developed and trace not only end-of-pipe monitoring costs but also the flows and losses of materials used. Environmental management accounting is the tool recommended for this purpose (IFAC, 2005). MFCA focuses on material flows and fates. Once the data is available in good quality, the COMFAR *III* tool can assist in the investment decision process.

Also other initiatives emphasize the need to promote costing and environmental management accounting (EMA) as tools to promote CP. Several institutions promoting CP were also involved in the UN-led Expert Working Group on “Improving the role of government in the promotion of EMA”. The UN-DESA published on “Environmental Management Accounting Procedures and Principles” (Jasch, 2001). There are several examples of EMA applications in developing countries and economies in transition. In the Philippines, EMA is a key instrument in promoting the CP concept among the

business community and is being actively disseminated by accountants. Huhtala/Cicozzi, 2002 report several examples in developing countries and economies in transition. The National Cleaner Production Centre in Zimbabwe used case studies with companies to illustrate the concept of EMA to the Trust Bank, as well as the economic benefits accrued by the company implementing CP. As a result, the bank's credit line for export-oriented SMEs promotes investments with an environmental management component. In 2004 Costa Rica organized an EMA public workshop, "Train the trainer" seminars and five company case studies that were followed by several publications to broadly disseminate awareness and tools (Jasch/Danse, 2005).

On the internal management side, EMA helps the organization to more effectively track and manage its physical and associated monetary resources, and to identify opportunities for cost savings. The benefits of doing EMA include efficiency improvements, better decision-making based on consistent information systems or strategic advantages (e.g. by better assessing the consequences of new regulations such as emission trading). Accountants who work within organizations can play a critical role by providing needed data and by working with non-accounting colleagues to ensure that the organization's information systems and reports are designed with these goals in mind.

On the external reporting side, EMA provides information to external stakeholders such as shareholders, financial institutions, rating agencies, environmental regulatory agencies and statistical agencies on organizational performance and risks – both environmental and financial. The reporting ranges from integrating these issues into standard financial reports to providing information for separate environmental or sustainability reports or for credit applications for CP projects and EST investments.

The fact that corporate environmental and material flow costs are not clearly defined and fully and systematically recorded often leads to distorted calculations for improvement options. Environmental protection projects, aiming at preventing or reducing emissions and wastes at source (avoidance option) by better utilizing raw and auxiliary materials and requiring less (harmful) operating materials, are not recognized and implemented; consequently the economic and ecological advantages to be derived from such measures are not used. The people in charge are often not aware that producing wastes and emissions is more expensive than disposing of them. By preventing the production of wastes and emissions through process optimization, the wastes of materials, energy and operation time can be reduced and in some cases totally eliminated. Therefore, the issue of disposing or treating wastes and emissions can be eliminated or drastically reduced at the sources.

Adding the purchase value of non-product output (material flow costs or negative product costs in MFCA) to the corporate environmental costs increases the share of environmental costs in relation to other costs. However, it is not the goal 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 projects not only have effects on nature, but also on neighbors (noise, odors, pollution) and employees (health and safety), if related to material and energy flows. In addition they result in a reduction of risks for employees, nature and neighbors in case of accidents and other occasional production events.

It is often difficult to determine the environmental portion of these costs. As with integrated cleaner technologies that are often more cost and material efficient, the environmental portion of health and safety or risk prevention activities usually cannot be determined precisely. 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 soil and then into the water). These approaches are expensive and inefficient.

The most important task is to make sure that ALL relevant and significant costs are considered when making business decisions. In other words, corporate 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 materials, energy and money flows through a corporation, and not a separate type of cost. Doing EMA and MFCA is simply doing better, more comprehensive MA, while wearing an environmental hat that opens the eyes to hidden costs. Therefore, the focus of MFCA is no longer on

assessing total environmental costs, but on a revised calculation of production costs on the basis of material flows (incl. energy and water).

Some of the general recommendations that came out of the UN's CP Financing program argue in the same direction (UNEP, 2001):

- Enterprises should establish practices to measure and reflect the cost of waste management and external environmental costs.
- There is a strong need to measure the economic benefits of CP—what can be the costs and benefits of doing things in a different way.

The results of the questionnaire of the recent UNIDO study on finance options for CP/EST available to SMEs worldwide show the broad agreement from the NCPCs worldwide on these recommendations.

Bolivia: "The experience shows that the implementation of cleaner production practices generates important savings in the operational cost and additional earnings for the companies. Usually, the return over the investment in these kinds of projects is high as well as the internal rate of return and the net present value. Then, these projects are attractive from a financial point of view. Moreover, they have a good impact on the environment since they reduce pollution at source. For these reasons, financial institutions are getting more interested in providing funds for them. But, usually SMEs don't have financial reports or they are of bad quality. Financial institutions take into account the total operations of SMEs to approve a loan, the lack of accurate accounting information makes the evaluation process difficult, even when the CP/EST project is well done."

39% of all countries reported, that the applicants have problems with submitting the information required to obtain funding as the quality of accounting systems in SMEs is very poorly developed. The COMFAR *III* EMA module aims to significantly improve the quality of data used for the investment appraisal of CP/EST projects and at the same time the quality of the information systems of SMEs. It can also be used for training in EMA and MFCA methodology, tools and application.

2. Environmental Management and Material Flow Cost Accounting

2.1 What is EMA and MFCA and what is it good for?

To assess costs correctly, an organization must collect not only monetary, but also non-monetary data on materials use, personnel hours and other cost drivers. EMA places a particular emphasis (IFAC, 2005) on materials and related costs because:

(1) the use of energy, water and materials, as well as the generation of waste and emissions, are directly related to the environmental impacts of organizations and their products, and
(2) material purchase costs and materials lost in waste and emissions are the most prominent cost drivers in many organizations.

EMA represents a combined approach that provides for the transition of data from financial and cost accounting to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection (Jasch, 2001). The main areas of application of EMA are internal calculations and decision-making, while environmental financial accounting (EFA) deals with issues related to external disclosure. However, the two are closely linked and rely on the same information system.

The general use of EMA information is for internal organizational calculation and decision-making. The metrics most useful for decision-making depend on the type of organization (e.g. manufacturing vs. service sector) and the types of decisions to be made (e.g., purchasing decisions about raw materials; investment decisions for energy efficiency; altered product design).

Application fields for the use of EMA data are:

- Assessment of annual environmental costs/expenditures
- 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

EMA can be used not only to help to assess specific investment options, but also to help to assess the environmental and related cost implications of particular types of materials and products. The assessment of a particular product line is often referred to as Life-cycle Assessment (LCA). Such initiatives may take place within a single organization or via aggregation of information from several organizations along the product (supply) chain. Aggregation of EMA-type (and other) information from an organization's suppliers and customers can also be used to contribute to better Supply Chain Environmental Management.

In conventional cost accounting, the aggregation of environmental and non-environmental costs in overhead accounts results in their being "hidden" from management. There is substantial evidence that management tends to underestimate the extent and growth of such costs. By identifying, assessing and allocating environmental costs, EMA allows management to identify opportunities for cost savings. Prime examples from the EMA literature are the savings that can result from replacement of toxic organic solvents by non-toxic substitutes, thus eliminating the high and growing costs of regulatory reporting, hazardous waste handling and other costs associated with the use of

toxic materials. Many other examples deal with more efficient material use, highlighting the fact that waste is expensive not because of disposal fees, but because of the wasted material purchase value.

Both, the EMA and MFCA approach have the underlying assumption, that all purchased materials must by physical necessity leave the company either as product or waste and emission. Waste is thus a sign of inefficient production.

MFCA includes the material flows along the value-added chain, from incoming goods, by way of various processing stages, through to product distribution to the customer. It also includes all the material losses incurred at various stages along the logistics chain (e.g., rejects, scraps, chippings, destruction of expired items or damaged goods), which then leave the company as environmentally and economically undesirable residue (solid waste, effluent, emissions). The material flow balance can start at the company level and then being divided into the various production steps, cost centers and single processes.

Accordingly the definition developed by the United Nations EMA Expert Working Group, **EMA** is the identification, collection, analysis and use of two types of information for internal decision making (Jasch, 2001):

- physical information on the use, flows and destinies of energy, water and materials (including wastes) and
- monetary information on environment-related costs, earnings and savings.

Starting point for EMA according to IFAC, 2005 is the assessment of a material flow balance, also called mass balance or input output balance in volumes and monetary terms on the system boundary of the organization for the complete previous business year, as most data is available only for this system boundary. In the first step of developing the material flow balance sheet, only a rough overview analysis may be performed, instead of a detailed data collection.

The mass balance is based on the assumption that whatever enters an organization must (at some point) also leave it. The mass balance includes all materials inputs, as well as the resulting amounts of products and waste and emissions. 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, leading to economic as well as environmental improvements. Improvement of environmental performance is based on the evaluation of material flows through an input-output analysis of the material flow in kilograms and monetary values. The system boundaries can be the organization or it can be further divided into sites, cost centres, processes, and products. This is the focus of MFCA.

Materials Inputs	**Product Outputs**
Raw and Auxiliary Materials	Products (including Packaging)
Packaging Materials	By-products (including Packaging)
Merchandise	**Non-Product Outputs (Waste and Emissions)**
Operating Materials	Solid Waste
Water	Hazardous Waste
Energy	Wastewater
	Air Emissions

Figure 1: Physical materials accounting: Input and Output Types according to IFAC

The input-output types are in line with the standard practice of mass balancing and the general structure of ISO 14031 for environmental performance indicators for operational systems. These physical categories may be adjusted as needed to suit specific sectors or individual organizations.

As noted in several case studies, much of the required physical accounting information unfortunately is not easily available to accounting personnel, as it is not systematically recorded or is not recorded in a way that reflects the real-world flow of materials. Personnel in other areas, such as production, environmental or other operations, generally have more detailed estimates and measurements of physical flows of materials, but often this information is not cross-checked with that of the accounting department. Accountants need to work more closely with personnel from other departments to accurately do the physical accounting side of EMA.

The EMA cost categories described in the IFAC EMA guidance document are shown in Figure 2. In the IFAC EMA guidance document MFCA is also the starting point of EMA.

1. Materials Costs of Product Outputs
2. Materials Costs of Non-Product Outputs
3. Waste and Emission Control Costs
4. Prevention and other Environmental Management Costs
5. Research and Development Costs
6. Less Tangible Costs

Figure 2: IFAC EMA cost categories

The Japanese Ministry of Economy, Trade and Industry states, that MFAC measures the flows and stocks of materials like raw materials, parts and components in manufacturing processes in physical and monetary units. The output of the material flow balance is divided into “positive products” and “negative products” (Waste and Emissions, called Non-Product Output in IFAC, 2005 and UN DSD, 2001).

Statistical agencies (SEEA 2003) only ask for **environmental protection expenditures** (IFAC EMA cost categories 3, 4 and 5). This 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. It mostly relates to End-of-Pipe technologies and 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, expenditures for environmental protection are only one part of the coin. The costs of waste and emissions include much more then the respective treatment facilities and disposal fees. Several EMA and MFCA case studies have shown that the costs of waste disposal and emission treatment are typically 1 – 20 % of total environmental costs, while the purchase costs of the wasted materials represent 40 to 90 % of environmental costs, depending on the business sector examined (e.g. Bouma, Wolters, 1998, Fischer et.al., 1997, Jasch, Schnitzer, 2003).

	Environmental protection expenditure (emissions treatment, control and waste prevention costs)
+	**Material flow costs** (Costs of unproductive material, capital, and personnel, NPO, costs of negative products in MFCA)
=	**Total corporate environmental costs**

Figure 3: Total corporate environmental costs

From a business perspective, it makes sense to minimize (environmental) costs, but not because of abandoning environmental protection, but because of production processes that do not produce waste and do not require emission treatment. This makes sense from a micro and well as macro economic perspective. Cleaner production and integrated technologies are the tools developed therefore.

The fact that environmental costs and material flows 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 them. Accurate measurement is a prerequisite for revealing improvement options.

Experiences from pilot projects (see e.g. the references in IFAC 2005, Jasch 2001 or www.eman-eu.net), show that environmental managers barely have access to the actual cost accounting documents of the company and only are aware of a tiny fraction of aggregated environmental costs. On the other hand, controllers do have most of the information but are not able to separate the environmental part without further guidance. In addition, those two departments tend to have a severe language/communication problem.

The EMA cost assessments typically reveal 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 organization. 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 for several years, technical improvement options may also become obvious. What is made visible, mostly for the first time, are the costs related to inefficient production, wasting materials and energy. Therefore 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.

Effective cost accounting requires effective material flow accounting. Understanding material flows as they move through a production system is a prerequisite to identify and track environmental cost. Material flow balances are the most important tool for the development of a consistent corporate information system and therefore should be done precisely (Staniskis/Stasiskiene, 2004).

Experience in CP investment project development and implementation shows that environmental activities can be efficient if a company's material flows are transparent and well known. Applying EMA and MFCA before the CP project development stage, supports companies to perform capital budgeting and obtain funding for their projects from financing institutions.

2.2 Assessment of annual corporate environmental costs

For the assessment of total annual environmental costs the IFAC cost categories are further divided into cost categories that confirm to standard accounts. For more detail on the definition of the cost categories please refer to the IFAC EMA Guidance document.

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.

The assignment of environmental costs to the environmental media follows the System of Integrated Environmental and Economic Accounting (SEEA 2003) of the United Nations. National statistic agencies require the environmental costs to be split up into the environmental media impacted. 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 department (e.g. health and safety).

ENVIRONMENTAL DOMAINS ENVIRONMENT-RELATED COST CATEGORIES	Air and Climate	Waste Water	Waste	Soil, Ground- and Surface Water	Noise and Vibration	Biodiversity and Landscape	Radiation	Other	Total
1. MATERIALS COSTS OF PRODUCT OUTPUTS									
➢ Raw and Auxiliary Materials									
➢ Packaging Materials									
➢ Water									
2. MATERIALS COSTS OF NON-PRODUCT OUTPUTS									
➢ Raw and Auxiliary Materials									
➢ Packaging Materials									
➢ Operating Materials									
➢ Water									
➢ Energy									
➢ Processing Costs									
3. WASTE AND EMISSION CONTROL COSTS									
➢ Equipment Depreciation									
➢ Operating Materials									
➢ Water and Energy									
➢ Internal Personnel									
➢ External Services									
➢ Fees, Taxes and Permits									
➢ Fines									
➢ Insurance									
➢ Remediation and Compensation									
4. PREVENTIVE AND OTHER ENVIRONMENTAL MANAGEMENT COSTS									
➢ Equipment Depreciation									
➢ Operating Materials, Water, Energy									
➢ Internal Personnel									
➢ External Services									
➢ Other									
5. RESEARCH AND DEVELOPMENT COSTS									
6. LESS TANGIBLE COSTS									

Figure 4: Distribution of environmental costs by environmental domain (IFAC, 2005)

2.2.1 Materials costs of product outputs

Most organizations purchase energy, water and other materials to support their activities. In manufacturing companies most of the purchased material is converted into final products that are delivered to customers. But manufacturing companies also produce waste – materials that were intended to go into final product but became waste instead because of product design issues, operating inefficiencies, quality issues, etc. Manufacturing operations also use energy, water and materials that are never intended to go into the final product but are necessary to manufacture the product (such as chemicals needed for the operation of the waste water treatment plant or fuel used for transport operations). All of these materials eventually become waste streams that must be managed.

The physical accounting side of EMA provides the needed information on the amounts and flows of energy, water, materials and resulting wastes and emissions. To effectively manage and reduce the potential environmental impacts of waste and emissions, as well as of any physical products, an organization must have accurate data on the amounts and destinies of all the energy, water and materials used to support its activities. It needs to know which and how much energy, water and materials are inputs for the physical products and which turn into waste and emissions. The physical accounting information collected under EMA is, therefore, key to the assessment of many environment-related costs and provides the basis for the application of investment appraisal tools. The physical accounting and monetary accounting sides of EMA are integrally linked in many ways.

There is a growing consensus that conventional accounting practices simply do not provide adequate information for environmental management purposes. To fill this gap, Environmental Management Accounting **(EMA**) and Material Flow Cost Accounting (**MFCA**) have been developed. The EMA and MFCA approach assume that all purchased materials leave the company either as a product or as emissions and waste (unless stored), called “negative product” in MFAC and NON-Product Output in EMA.

Whenever possible, costs should be allocated directly to the activity that causes the costs as well as to the respective cost centres and cost drivers. Consequently, the costs of treating, for example, the toxic waste arising from a product should directly and exclusively be allocated to that product.

Under the physical accounting side of EMA, an organization should try to track all physical inputs and outputs and ensure that no significant amounts of energy, water or other materials are unaccounted for. The accounting of all energy, water, materials and wastes flowing into and out of an organization is called “materials balance,” sometimes also referred to as “input-output balance,” “mass balance” or “eco-balance” (UNEP and UNIDO, 1991, German EPA 1995, Pojasek, 1997, EPA Baden-Würthemberg, 1999, METI 2007). Many organizations perform energy balances and water balances separately from other materials balances. As this terminology implies, the underlying assumption is that all physical inputs must eventually become outputs – either physical products or waste and emissions –and the inputs and outputs must balance.

In order to compile an Input-Output Analysis of material flows, it is best to start with the accounts in the list of balances (also called list of accounts) of conventional bookkeeping of the previous business year. Only this list provides a complete overview (in monetary terms) of purchased raw materials, auxiliary and operating materials in a given month or year as well as the cost of disposal, repair, insurance, transportation etc. Each account of the profit and loss statement should be examined to determine whether any environmentally relevant movements or material flows are recorded there. Personnel costs are not considered in a material flow balance but in later steps as part of the EMA assessment.

Clear definitions as to which elements of the Input/Output analysis are recorded in which accounts, which material numbers are assigned to which accounts and which materials are also recorded in stock management are essential. The objective is to obtain as complete as possible a listing of all material inputs by main material categories. This will help avoid having to break down accounts at a later date to show quantities used. Another area with optimization potential is the

distribution of individual elements in cost accounting categories (direct costs, overhead costs, distribution to cost centers and cost carriers).

Figure 1 showed the structure of the material balance. First the raw-, auxiliary-, and operating materials consumed in the previous business year are added in detail. Then the quantities (e.g. kg) and monetary values (e.g. in €) are added to the input side. On the output side the products produced and the volumes of waste and emissions are added and checked for consistency with the input side. Nevertheless, in most organizations the Input/Output analysis does not balance in the first years of data assessment.

The material purchase cost of wasted materials is the most important environmental cost category, depending on the value of raw materials and the labor intensity of the sector. In companies with stock management, not the value for materials **purchased**, but **consumed for production** is used respectively.

In some enterprises the entire material purchase is booked on one account only and it is only possible to evaluate manually 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 can be multiplied with the assigned quantities with average prices, in order to at least be able to indicate orders of magnitude. It is unfortunately obvious that such a system cannot strengthen cost consciousness in handling raw, auxiliary and operating materials.

2.2.2. Materials costs of Non-Product Output

Once the total material input has been recorded in physical and monetary term, the next step is to estimate loss percentages. The losses for each material input category (non-product output, NPO) need to be traced or estimated. Advice on the calculation of NPO is provided as follows:

Raw materials

Non-product raw material output will mostly be disposed of as solid waste. Only if the products are gaseous (e.g.: industrial gases, perfume) it will be emitted to the atmosphere. More common are liquid products (e.g.: beer, milk). The Non-product raw material output is then disposed as 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 to 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.

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 not known to the environmental and financial departments.

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.

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 organizations, their consumption is not recorded on the production cost centers, making it 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.

Administrative operating materials are not regarded in the first assessment. All other operating materials (especially chemicals, maintenance materials, etc) are assigned in NPO by definition.

Merchandise

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

Energy input

All energy input causes environmental impacts, escapes as heated water, air, and radiation and unless the company involved is a utility, energy is not the product. Energy input in most organizations is therefore 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.

Some companies however prefer to record 100 % energy input in the mass balance, but to consider only the energy use of environmentally relevant equipment defined in the later cost categories (e.g. compressors, waste water plants, after burners, etc.), just as the other operating costs of such equipment, for the annual total EMA compilation.

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 material input. 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.

Processing costs

The non-product output not only carries material purchase values, but has also undergone processing in the company before leaving it again. Thus, wasted labor and capital costs may be added.

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

The easiest estimate for the production costs of NPO are provided by the quality department, which should have records on the products that are not sold due to bad quality and the products returned by customers for the same reason. They end up in waste or are sold at a cheaper price. If the later is the case, this income should be recorded in the section for “other earnings” (e.g. food products no longer sold to people but for animals).

2.2.3. Waste and emission control costs

This cost category comprises **conventional waste disposal and emission treatment costs** including related equipment labor and maintenance materials. Insurance and provisions for environmental liabilities and clean up also reflect the spirit of treatment instead of prevention. It comprises all treatment, disposal and clean-up costs of existing waste and emissions and can often be directly traced from cost centers like waste water treatment or waste management.

An important step for the EMA cost assessment is to identify existing environmentally relevant equipment. The term “equipment” may comprise a single machine or an entire production hall. It is recommended to investigate it by the list of cost centers.

Environmentally relevant equipment in the category for treatment comprise (Jasch 2001):

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. ***NPO-equipment***: proportion of equipment that produces significant emissions and waste (e.g. old boilers, enamelling lines that paint products that have to be painted again, steam supply with heat losses, etc.)

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, dust removal equipment, waste disposal dumps or sound insulation walls. To help in determining if the equipment was purchased for production or for environmental protection, it is recommended to imagine the equipment in an area where there are no environmental laws or no people living and working.

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 on separate cost centers, from which the related personnel-, and operating costs can be assessed.

NPO-equipment: proportion of equipment that produces relevant amounts of 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 significant amounts of waste, require additional cleaning or a fleet of cars that uses too much fuel. The environmentally relevant portion of this equipment can be estimated by the portion of waste or emissions loss of heat, too high water use in cleaning, etc.

It should be noted that this equipment does not relate to environmental protection and is therefore not to be disclosed as environmental protection investment. But, for investment appraisal for better integrated pollution prevention technologies, it is essential to know the inefficiencies and costs of existing production equipment.

Depreciation for related equipment

This cost category contains the depreciation for EoP and NPO equipment. Depreciation spreads the investment costs over the expected life time for the equipment. Depreciation can be based on financial or cost accounting procedures depending on the accounting preferences of the organization.

Maintenance and operating materials

EoP and partly also NPO equipment are mostly found on separate cost centres out of which the annual operating costs can be taken. Only maintenance costs and operating materials for the above

defined equipment should be listed in this cost category. Care must be taken to avoid double counting with the material purchase values (these must be adjusted there, if materials can be directly attributed to the above defined equipment).

Related Personnel

Labor time related to waste and emission relevant equipment is recorded here as well as 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.

Taxes, Fees, Charges, Permits

Disposal fees, wastewater fees, packaging-license charge, energy taxes, emission permits and other eco-taxes are to be recorded.

Fines and Penalties

The fines for surpassing pollution restrictions are to be recorded.

Insurance for environmental liability, damage and risks

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

Clean up costs, remediation, etc.

In some sectors costs for clean up, remediation and landscaping may be required, especially in the mining and oil industry, for gas stations, power plants, etc.

2.2.2 Prevention and environmental management costs

This cost category is termed **prevention and environmental management** and records the labor costs and external services for good housekeeping as well as the "environmental" share of cleaner integrated technologies, 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 this category is on annual costs for prevention of waste and emissions, but without calculated cost savings. Also this cost category starts with identifying prevention related equipment and estimates its “environmental share”.

Integrated technologies include the proportion of 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.). 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 may be estimated. The portion of depreciation is recorded in this cost category. The operating costs may be recorded in addition; the operating materials are mostly recorded under the cost category for NPO.

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 trainings, reports and other dissemination materials are to be recorded.

Internal personnel for general environmental management activities

In this cost category the time for 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.

Research and development

Any environmentally relevant research projects should be recorded.

Other environmental management costs

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

3. Step by Step Instructions

Please note that in order to enter the financial data for investment appraisal, the total annual environmental and material flow costs of the previous business year should be assessed initially.

3.1 EMA for total annual environmental costs

This chapter contains a description on how to work with the **EMA excel templates**. A detailed assessment aid in an Excel template that follows Figure 1 + 4 is available on the COMFAR *III* CD-ROM, version 3.2 or higher.

The EMA Excel-template consists of four sheets – *Mass balance, Detail, Sum, and Structure*. Information is only added into the *Mass balance* and the *Detail* sheet.

The *Mass balance* records the physical and monetary values of material inputs and product outputs in one work step, as these amounts should be consistent. The excel template contains two columns for the source of information for both values. The enterprise resource planning system and the accounts for materials used for production should provide this information in a consistent and detailed manner.

For product output only the volumes, but no monetary values are collected, as these costs are assessed later in the cost category waste and emission treatment fees.

The mass balance is not automatically calculated, as in most organizations the data necessary is not available for the first assessment and depending on the production process adjustments may be needed. Companies may find it useful to separately calculate the mass, the energy and the water balance with the help of their process technician.

The actual cost assessment is performed in the *Detail* sheet only.

All the cost categories are already set but the several different cost items related to cost accounts or taken from cost centre reports should be listed with indicating the reference. The environmental media can be modified if necessary. If columns are added or deleted, then the same has to be done for the other two sheets.

The program automatically aggregates the costs of each cost category, but when adding lines to fill in more details a last cross check is recommended to make sure all aggregates are complete.

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

It is recommended for costs that are incurred by defined equipment to simultaneously collect the data on maintenance, external services, personnel, and material costs, especially if this information is available from cost centre reports. Care needs to be taken to avoid double counting, if e.g. operating materials are collected from cost centre reports under cost category 3 und 4 and from accounts under cost category 2 or if external services are taken from expenditure accounts and costs centers as well.

All collected data should be assigned to the correct environmental medium (media) or to general environmental management. Some companies have also added columns, e.g. for health and safety or for product oriented prevention activities.

The column *Account* is to keep record of the cost centers 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.

The sheet includes a control function, which ensures that the value in column *Costs in €* is identical to that of *Sum*. If not, an error is displayed. The values are only identical if all costs in the *Costs in €* are assigned to a medium.

3.2 Start COMFAR *III* EMA project type

Originally COMFAR *III* has offered the following 5 project types:

- Industrial
- Agriculture
- Infrastructure
- Tourism
- Mining

As of COMFAR *III*, version 3.2 the additional project type 'Environmental accounting' has been added to all three COMFAR products (COMFAR *III Expert*, COMFAR *III Business Planner* and COMFAR *III Mini Expert*). This additional project type intends to support the users of COMFAR *III* in the following two ways:

- Complete financial and economic appraisal of investment projects, and
- Analysis of core environmental components of an investment project.

The first option (Complete financial and economic appraisal of investment projects) represents the traditional (standard) methodology of analyzing and appraising investment opportunities. It allows the user to define ALL financial flows (environmental as well as non-environmental) relevant for a given project and thus gives a complete (financial and economic) picture of an investment project. This option is already described in detail in the COMFAR III manuals (Reference and Tutorial), in the relevant UNIDO publications (Manual for the Preparation of Industrial Feasibility Studies) as well as in the teaching materials (IPPA – Investment Project Preparation and Appraisal, Volume 1 – 7). Therefore this manual does not cover this option.

The second option (Analysis of core environmental components) enables the user to analyze the environmental aspects of an investment project only. Even it is not reflecting the financial and economic performance of the complete investment opportunity it supports entrepreneurs in their decision if the investment into an environmental more friendly technology also leverages the financial performance of the project. This kind of analysis is done similar to the methodology used for expansion/rehabilitation projects:

- In a first step the environmental part of the project is analyzed by specifying the 'as-is' situation, namely the present technology causing the environmental damage and its related operating costs.
- In a second step the present technology is replaced by a new (more environmental friendly) technology (= new investments) and the new operating costs related to it. Furthermore the financing of this new technology (e.g. equity capital and/or debt financing) has to be specified.
- In a third, comparative step, the two above-mentioned steps are analyzed using COMFAR's incremental analysis module. Should the incremental analysis (difference between the 'as-is' situation and the 'new option') be positive (positive NPV/IRR, acceptable payback period) then the new option leverages the financial performance of the project.

The procedure for starting COMFAR is described in chapter III of the Reference Manual. When COMFAR is started, the browser and browser overview panels are displayed with the menu-bar at the top of the window. To select the project type 'Environmental accounting' and the level of analysis the following steps are necessary:

1. Choose New project in the File Menu. The New Project modal window is displayed.
2. Select 'Environmental accounting' in the Project type list box.
3. Select the appropriate Radio button (Opportunity study, Feasibility study).
4. Press Ok.

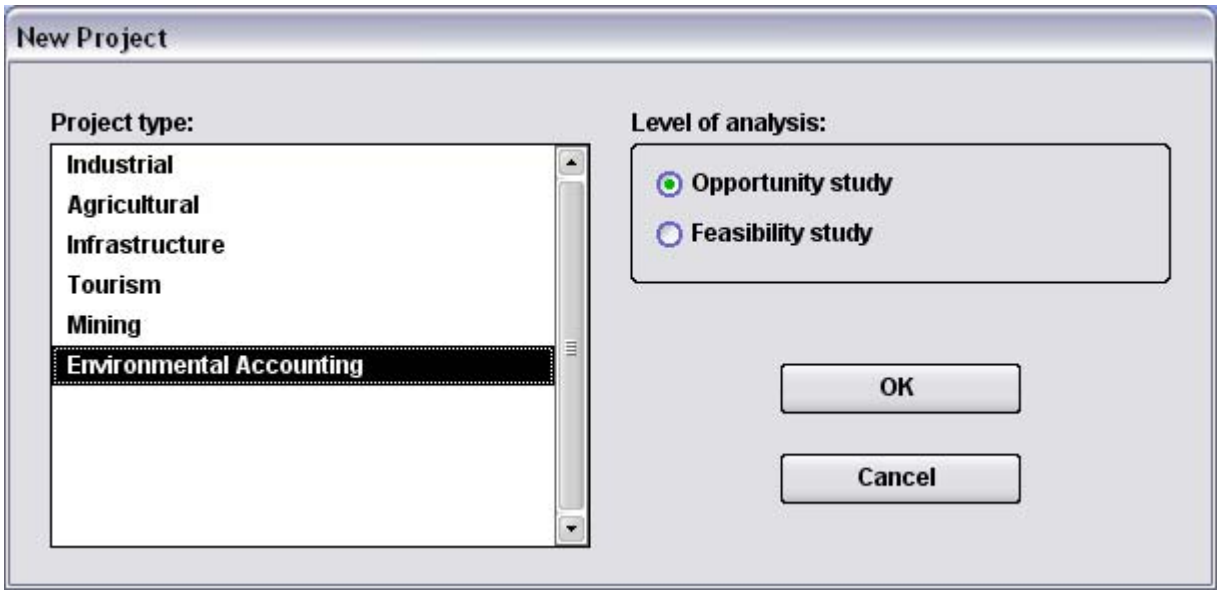


Figure 5: New project modal window

5. Unlike with the other 5 project types, an information window is displayed, indicating that prior to the use of COMFAR III the Microsoft Excel template 'EMA.xls' should be applied in order to structure the relevant environmental data.
6. Press Ok.

Figure 6: Environmental accounting note modal window

3.3 EMA for investment appraisal of CP technology options

The procedures how to apply COMFAR III Environmental Management Account (EMA) project type for the financial appraisal of Cleaner Production (CP) Technology Options does not differ significantly from the methodology applied for the other five project types. As already described in the previous chapter, EMA concentrates on the assessment of the environmental components and their direct (financial) consequences of the investment project only. This will be demonstrated later through two examples (see chapter 4). The user has to specify ALL those components of the complete investment project that are influenced by investment(s) in CP technologies. This could apply in principle to every aspect of the project. If the investment into a technology implies certain changes in the operating costs, such as lower energy costs, consumption of raw materials, etc., those components have to be financially quantified, both in the 'as-is' scenario (reflecting the current technological situation) as well as in the new scenario. The comparison of the two scenarios will demonstrate the financial effect of a proposed CP technology option. For that purpose the 'Environmental accounting' project type differs from e.g. the 'Industrial' project type in the breakdown of investment costs and production (operating) costs.

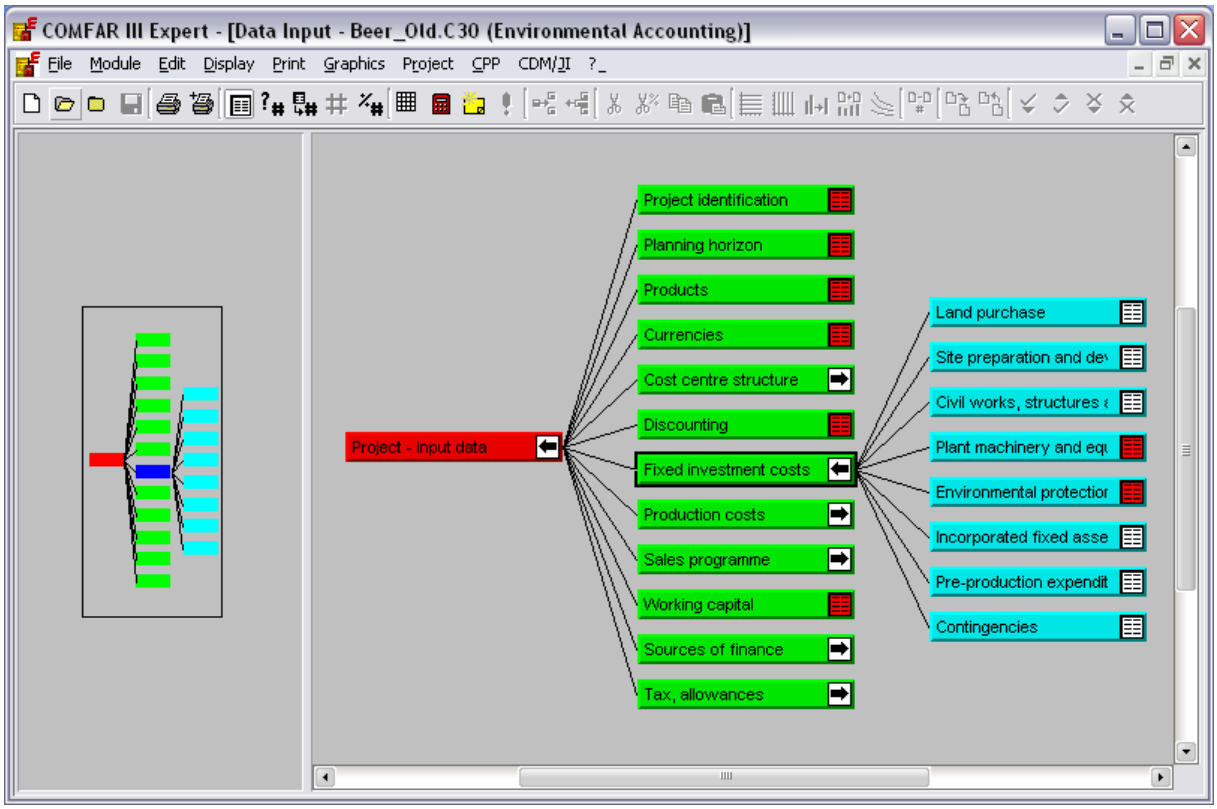


Figure 7: EMA Fixed investment costs

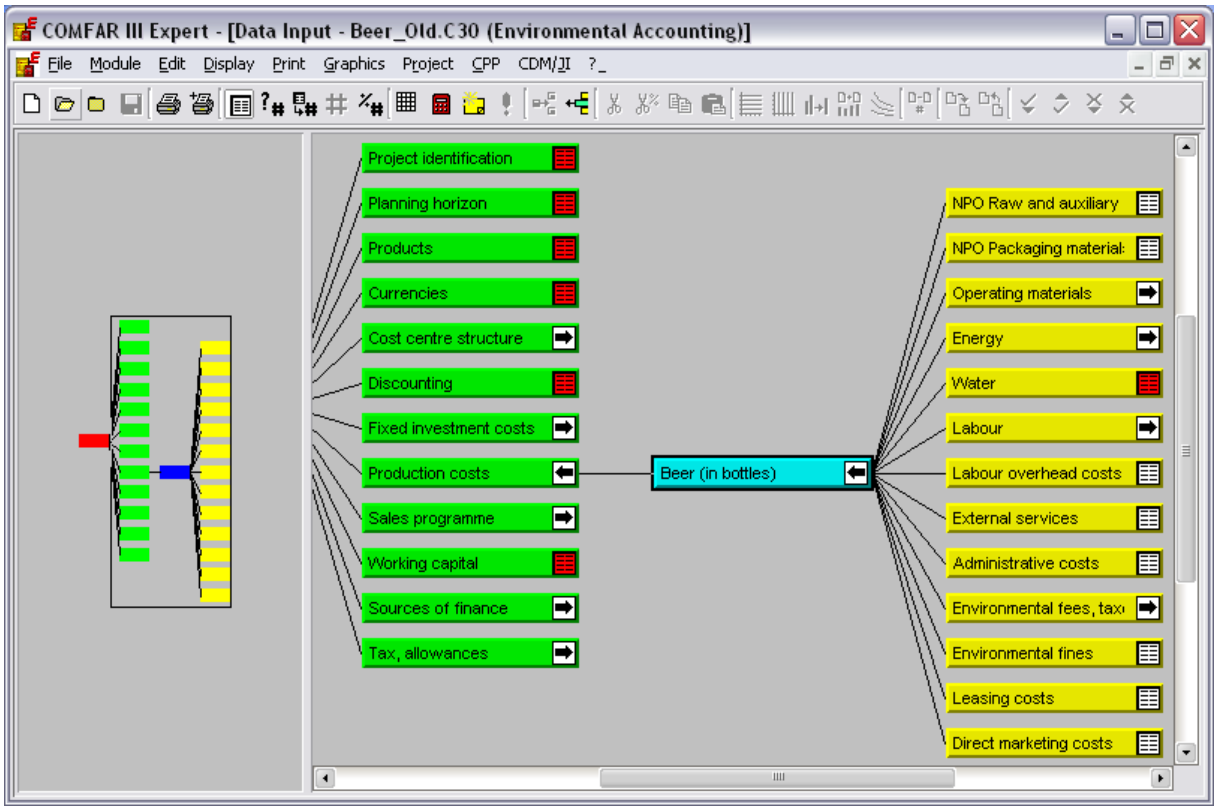


Figure 8: EMA Production costs

All other components, such as Sales programme, Working capital or Sources of Finance of the EMA project type do not differ from the 'Industrial' project type.

Warning:	As already mentioned in the previous chapters, COMFAR *III* EMA project type does not concentrate on the complete investment project, but only on the environmental components. Since COMFAR *III* has been originally designed to analyze complete financial and economic appraisal the calculation of an EMA project may produce a number of error messages and warnings. The user would have to analyze whether those warnings are relevant for that particular EMA project. If e.g. the sales price of a product produced does not differ in the new scenario from the 'as-is' scenario it is not being accounted for according to EMA methodology. COMFAR *III* will therefore not be in the position to calculate certain results and would warn the user during the calculation process. For an example on such an error/warning modal window please refer to Fig. 9 below.

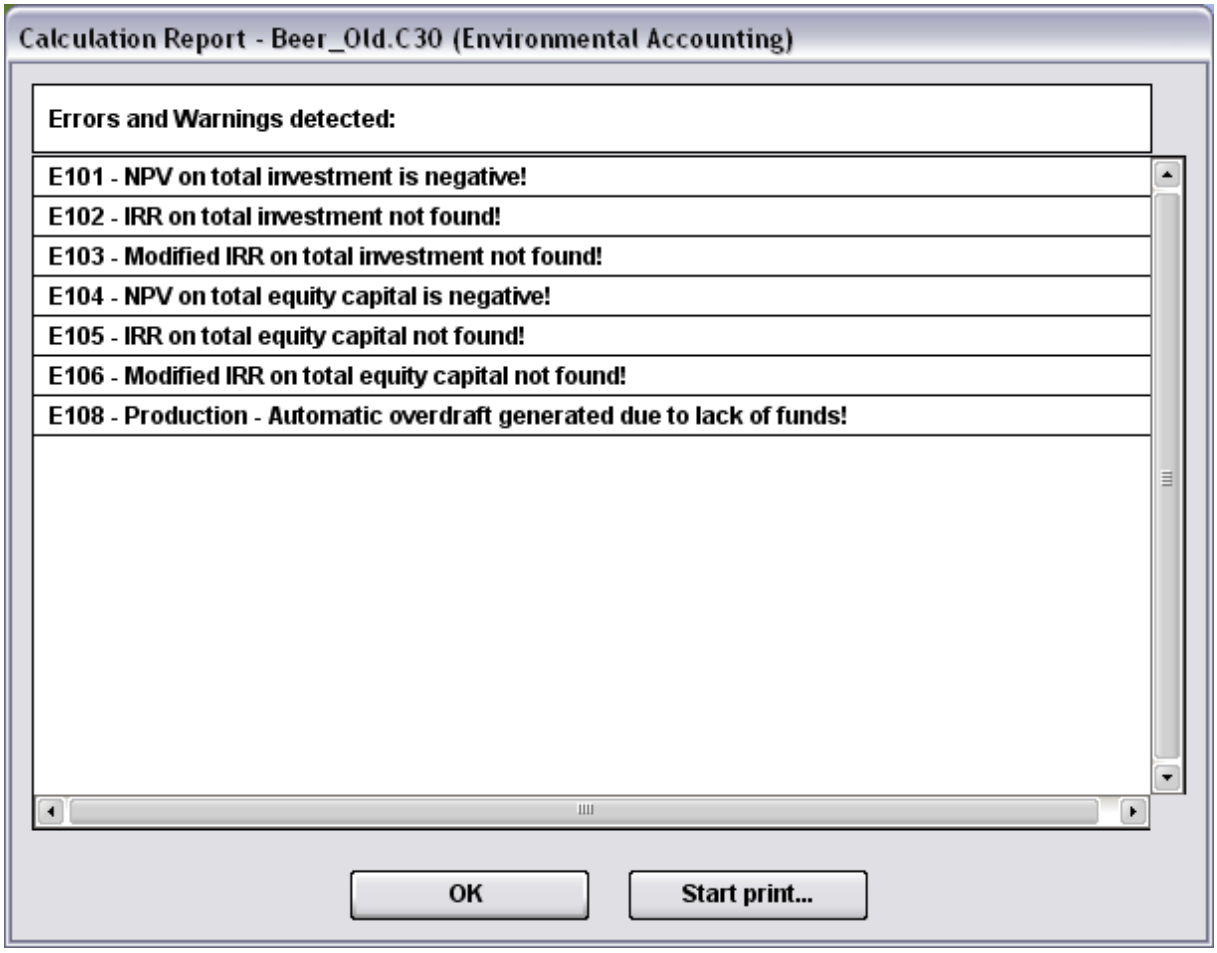


Figure 9: Calculation report modal window

The below paragraph gives a short description how to work with COMFAR *III EMA* project type, respectively which project components have to be specified:

- **Investment costs**
  - Plant machinery and equipment:
    within this node (and possible sub-nodes) the equipment relevant for production including integrated preventions is accounted for, divided by cost centres, if applicable
  - Environmental protection equipment
    within this node (and possible sub-nodes) the end-of-pipe equipment is accounted for

- **Production costs (all the subcategories can be divided by cost centers (CC), at least a CC for environmental management needs to be installed)**
  - NPO Raw and auxiliary materials
  - NPO Packaging materials
  - Operating materials
  - Water
  - Energy
  - Labor and labor overhead costs
  - External services, preferably distinguished by:
    Services for production equipment by cost centres
    Services for EOP equipment
    Services for clean up and remediation
    Services for preventive environmental management
    Services for research and development
  - Administrative costs
    Including Environmental Risk Insurance, if applicable
  - Environmental Fees, Taxes and Permits
  - Environmental Fines

4. Case study of a brewery

In order to demonstrate the application of the COMFAR *III EMA* module a case study for a fictitious brewery has been developed based on a real pilot project in Austria.

This chapter initially outlines the project idea, the assessment of the relevant environmental data, both from the investment as well as operating point of view and finally the financial assessment of those data within COMFAR *III EMA* project type.

The chapter starts with a detailed description of the brewery and production processes (Chapter 4.1.), which will later be reflected in the distribution of cost centres (Figure 13) and also allow a better understanding of the different postings in the detailed environmental cost assessment (Figure 12). Starting point of an EMA assessment is the recording of materials flows (Chapter 4.2.). It is followed by the detailed EMA cost assessment, applying the EMA Excel template. In order to make use of the total annual environmental cost for investment appraisal, it might be useful to record the environmental costs by cost centres (Chapter 4.3.).

Chapter 4.4. shows how the detailed EMA cost assessment is automatically aggregated into a one page spreadsheet and a percentage distribution of costs. These Excel templates are most useful of interpretation of results and monitoring of changes during subsequent years.

Chapter 4.5. shows how to apply COMFAR for investment appraisal in the brewery example. It starts with a general introduction into the set up of COMFAR for a case study and describes two investment appraisal examples in depth, a combined block heat production and a bottle cleaning equipment.

4.1 The brewery, its production flow and cost centres

The described brewery is a small country side brewery with about 150 people. It has implemented 14001 and EMAS for 12 years and was actually the first Austrian site to be EMAS verified. It carries the Austrian Ecolabel for returnable beer bottles. It has also participated in pilot studies to develop the UNDSD and IFAC EMA approach. The following data is based on the extensive environmental report for 2005 and pilot studies, where also other breweries were involved (Jasch, Schnitzer, 2002). The data does not directly relate to the actual figures of the brewery.

The total annual environmental costs are assessed together with an extensive performance indicator system on an annual and partly monthly basis. The environmental costs are traced from the list of accounts, the cost centre reports and performance indicator reports from production statistics (e.g. materials input per beer produced, loss percentages and production volume) and environmental management (e.g. waste volumes).

The EMA excel template for the data assessment shows

- the aggregated input output balance in values and volumes,
- the material flows by cost centers and
- the detailed environmental cost assessment,
- which is aggregated to an overview and
- a percentage distribution of costs.
- The costs are also distributed by cost centre, which provides a good basis for investment appraisal.

The brewery uses the following production cost centers:

- Brewing malt and mills
- Brew House, Wort production
- Fermentation and Storage Cellar
- Filtration
- Bottling and barrel filling

In addition, the following supportive cost centers/sub cost centers are used:

- Storage facilities for Brewing and Operating Materials
- Maintenance
- Steam/Heat production
- Refrigeration
- Waste Water Treatment
- Logistics
- Health Safety Environment and Quality Management System
- Administration

Input	Production CC	Supportive CC	Output
		Storage facillities for Brewing and Operating Materials including CIP plants	
Malt, Brewing Water, Cleaning agents, Energy	Brewing malt and mills (Grinding, Mashing and Purification)		Spent grains, Dust, Heat, Waste Water
Hop, Water, Cleaning agents, Detergents, Energy, Refrigerant	Brew House, Wort Production (Stammwürze)		Hops waste, Brewing residue, Heat, Waste water
Yeast, Sterile Air, Refrigerant, Water, Energy	Fermentation and Storage Cellar (Fermentation of the malt sugar with yeast)		Yeast, Wasted beer, Carbon dioxide, Waste Water
Water, Energy, Carbonic Acid, Cleaning agents, Disinfectants, Refrigerant,Auxiliary materials	Filtration (Separation of yeast and proteins)		Waste water, Filtrate, Auxiliary materials, Carbon dioxide
Water, Energy, Carbonic Acid, Cleaning agents, Disinfectants, Packaging materials	Botteling and barrel filling		Waste Water, Sludge, Solid Waste, Heat, Residue, bottled wasted beer
Operating materials, Energy		Maintenance	Operating materials
Energy, Refrigerant		Steam/Heat production	Heat, Air emissions
Refrigerants, Energy		Refrigeration	Air Emissions
Operating materials, Energy		Waste water treatement	Waste Water, Waste
Petrol		Logistics	Air Emissions
Operating materials, Energy		HSEQ MS	Operating materials
Operating materials, Energy		Administration	Operating materials
Total cost centres	5	8	

Figure 10: Process flow chart and cost centres of the brewery

The production process and the related cost centers are described as such:

Brewing malt and mills

The brewing malt and the hop products undergo special inspection on delivery and are stored in malt silos and coolers (hops) next to the brewing room. The malt is taken from the malt silos by elevator and screw-type conveyors, passing via the pre-cleaning machine on its way to the automatic scales and malt mill. From there the crushed malt is taken to the crushed malt box. Due to the increased levels of dust formation, there are special monitoring instructions for this area.

Brewing room –Wort production

The brewery operates a 4-vat brewing room with connected heat recovery and an automatic CIP plant and wort cooling system. A two-mash procedure is used. After combining the two mashes and when the various saccharification temperatures have been reached, the whole mash is pumped into the straining vat and the lautering of the first wort begins. The cake of draff is broken up and transported via the draff conveyor system to the draff silo. The first wort and the last runnings are pumped into the brew kettle and brought to the boil via an external heat source. The whole wort is cooked using the vapour compression system. The finished hot wort remains in the copper and after removal of the hot sediment the wort cooling begins. The wort is pumped over the vaned cooler and is cooled to fermentation temperature using spring water and mixed with yeast and oxygen. The entire brewing room facilities and the wort cooling system and flotation tanks are cleaned using an automatic CIP system. The measurement, control and monitoring device allows fully-automated mashing, lautering, wort boiling and wort cooling and cleaning of the entire system.

Fermentation and Storage Cellar

The brewery's fermentation and storage cellar has a capacity of 38,100 hectolitres. All the fermentation and storage tanks are equipped with cooling jackets, in which glycol circulates at -4 degrees Celsius helping to maintain the desired temperature. All the cylindroconical fermenting tanks can be used as fermentation and storage tanks, whilst the storage tanks are only used for storage.

Main and secondary fermentation

The yeast-enriched wort is transported from the preparation tanks to the cylindroconical fermenting tanks, where the main fermentation takes place. The yeast collects in the conical part of the containers at the end of the main fermentation and is re-collected. After the main fermentation the green beer is pumped into cylindroconical fermenting tanks or storage tanks. The final fermentation and storage of the beer lasts at least 4 weeks. The beer becomes clear over this time. The carbon dioxide created by final fermentation combines with the beer. The excess fermentation carbon dioxide, depending on the level of purity, is channeled off to the separate CO2 recovery systems for reuse. The beer stored here is now ready for filtration.

Yeast culturing and yeast cellar

The pure culture yeast is cultivated in the laboratory and is multiplied in the yeast culture device and added to the beer wort. If a strain exhibits outstanding properties, then it is kept to be used to create further pure cultures.

Filtration

The beer for filtration flows from the storage tank via the blending apparatus to the diatomite filter and on through the sheet filter, filtering the beer. The filtered beer is stored temporarily in pressure tanks or channeled straight to the bottling or barrel filling device.

Pressure tank cellar

The pressure tank cellar is used as a buffer (intermediate storage) between the filtration and bottling and barrel filling. Here the beer settles before bottling or barrel filling. This is the last stage of product clearance for bottling or barrel filling.

Bottling and barrel-filling

Bottling

The brewery production plant boasts one of Europe's most modern bottling plants. The bottled beer is taken from the pressure tanks to the fully automatic bottling machine. All the clean bottles coming from the modern double-ended bottle washing machine are inspected once again in the bottle inspector, filled in the bottling machine and then sealed with crown tops or screw-top caps. The filled bottles are taken via the level measurer to the labeling machine, where they are fitted with labels. After labeling the bottles are packed into freshly washed crates using the packing robot and stacked onto pallets. A total of 4 robots ensure optimal operation during loading up and moving the final pallet. Transportation to the outgoing goods store is performed using electric lift trucks.

Bottle cleaning machine

Bottle-cleaning water generally constitutes a significant proportion of the total pollution from breweries. This pollution is caused by different gluing methods, glue types and paper types, packaging and the standing times of the lye. One of the problems is posed by the often luxurious printwork of the labels and the other accoutrements of the beer bottle (metal foil) which can lead to heavy metal pollution in the waste water. The brewery only uses printing colors on its labels which are free of all heavy metals and it no longer uses any metal foils. The frequent problem of scale or deposits of calcium salts and magnesium salts in bottle washing machines is prevented by adding chelating agents and softeners to the rinsing solutions.

Keg filling:

The beer for keg filling comes from the pressure tanks and is filled into the pre-cleaned kegs under CO2 atmosphere. The entire cleaning and filling plant is fully automated. Maintenance- free conveyors and 2 robots are used for handling the sheathed, low-noise, stainless- steel kegs.

Storage

The storage facilities are arranged so as to allow practical access for the individual departments, whilst ensuring that the products are stored under protection, in accordance with regulations and in an environmentally friendly way. The storage guidelines are also devised to prevent any negative impact on the environment. Daily inspections and spot checks are performed to ensure compliance with storage guidelines and therefore guarantee storage safety.

Chemicals store

The brewery stores two weeks' worth of stock of the cleaning agents, disinfectants and neutralisers required in drain pans in the central chemicals store. The liquid caustic soda lye is stored temporarily in a storage tank with a capacity of 16 m3 and is pumped from there straight to the bottle washing machine, the cleaning unit in the keg-filling plant, the neutralisation station at the waste water pre-treatment plant and all the CIP cleaning units. The chemicals store is sealed and protected with a fire door to prevent unauthorized access. From here all the agents are automatically distributed to the intake points by meters and pumps. The intake points are marked with product sheets. Generally-speaking only reusable packaging is used. Great strides have been made in terms of occupational health and safety in the chemicals store through direct integration of the individual fully automatic CIP systems and their chemical intake points.

CIP systems

All the CIP systems (CIP= Cleaning In Place) are fully automated. The systems allow settings down to the nearest second and therefore enable precise dosage, efficiency co-ordination, reduced fresh water consumption and minimal use of cleaning agents. The lyes and acids used are stored and reused. Removal from storage is performed via direct pipes from the where the agents are kept in the chemicals store.

Maintenance

An internal workshop has been set up for the electronic and mechanical maintenance and repairs to equipment, machinery and vehicles. The bar service and construction of bar equipment is also carried out here. The maintenance of plants, machinery and vehicles is regulated by means of a legal safety program, laying down inspection obligations. Maintenance work is performed for the most part by the company's own employees. Vehicle maintenance is contracted out. It has been estimated that 15 % of the services performed by this cost center are related to environmental protection.

Steam/heat production

Air-compressors

The brewery has oil-free compressors for producing sterile air and compressed air. The main consumers of compressed air are the large number of pneumatic valves in the brewing room and bottling plants. The sterile air is used for wort aeration and to aid in bottling. Compressed air leakage inspections and a new buffer tank have allowed reduction of the working pressure and consumption has been brought down by 40% in comparison with the figures for 1999.

Heating boiler

This boiler with its combined fuel burner (extra-light heating oil and biogas) is used for supplying heat for room heating and the heating requirements of the bioreactors of the operational waste water pre-treatment system. Since 1999 the plant has been operating on extra-light heating oil and the biogas accumulating from the bioreactors.

Steam boiler unit

The plant's steam boiler unit is used for the production of process steam (8 bar) and is operated by light low-sulphur heating oil “Schwechat 20002”. Process steam is used above all for steaming product pipes and bottling plants, for the bottle washing machine, for the container washer, for the hot water tank, for the CIP systems, in the brewing room and for the short-time heater. The unit is monitored using a system operated without constant supervision and is inspected every day. Emissions testing are performed constantly in accordance with the inspection findings.

The steam boiler unit is fully automated. The main savings in heating oil have been recorded through the insulation of the steam pipes. This has allowed a reduction in steam consumption or in the heating oil used of almost 15% in comparison with 1995. The conversion of the combined fuel burner to extra-light heating oil has brought about a reduction in the already low emissions. Since the biogas accumulating from the biogenic waste water treatment plant can be burned in the combined fuel burner, 76% less extra-light heating oil was consumed in comparison with 1995 and virtually no biogas has to be burned off.

There have been significant reductions in emissions into the air (CO, CO2, dust and SO2) in recent years through the major savings in heating oil in terms of superheated steam. The steam boiler unit is checked every year by accredited testing and maintenance authorities and emission tests are performed every three years as stipulated in the decree, whereby the readings are far below the prescribed limits. Through the implementation of the biogas project and through the conversion from light heating oil to methane gas (biogas) or extra-light heating oil with a combined fuel burner for room and reactor heat, it has been possible to achieve reductions in emissions here as well. As an additional safety factor the accumulating biogas can be flared on demand. Also with the heat boiler the pollutants are determined every year through emissions testing and there come under the prescribed limits.

Refrigeration

The fully-automated refrigeration plants work using direct vapor. Glycol, which is used for cooling the cylindroconical fermenting tanks and storage tanks, is cooled using ammonia or dichlorodifluoromethane to minus 4 degrees and is pumped through the cooling jackets of the cylindroconical fermentation and storage tanks. The requirements of both cooling systems are co-ordinated using a heat exchanger. The quantities of ammonia used are below 500 kg and therefore fall

within the limits permitted under the Austrian Statuary Order on Hazardous Incidents (Störfallverordnung).

Ongoing background processes, such as the refrigeration plant condensers for example, can if required be withdrawn from the network in the short term. There are also facilities for idle current compensation. The greatest savings in comparison with 1999 have been achieved through the new state-of-the-art refrigeration plant (-33.4%, electricity consumption)

Waste water treatment

The brewery channels its waste water indirectly into the waste water network administered by the local Munacipality Water Pollution Control Association and consequently it uses its own waste water pre-treatment plant to reduce pollution and neutralize the waste water. The anaerobic waste water pre-treatment plant with its four bioreactors cleans the brewery's production waste water by organic means using an anaerobic procedure, whereby the methane bacteria create usable biogas from the contents of the waste water. The aim of treatment and the task of this plant is to maintain the limits set in terms of pH-value, COD, temperature and quantity and the drastic reduction of the waste water pollution into the public drainage system from currently over 66% of the total output of the brewery's waste water. Solids (e.g. draff residue) are removed from the waste water by means of a filter station before the bioreactors. In order to meet the pH-values (alkaline waste water), a neutralization plant is used, with preliminary acidification performed in the two large collection tanks. The pre-treated waste water flowing into the public drainage system is constantly inspected and logged by means of an automatic measurement section, to ensure that it complies with the limits set.

The biogas accumulating in the anaerobic bioreactors is converted in the boiler to generate room heat. In the combined fuel burner, extra-light heating oil is only burned as an alternative when there is no biogas. This has enabled savings of some 236,000 kg of extralight heating oil since 1999. A heat exchanger has also been installed in the waste water, to be able to reuse the waste heat at times for the reactor heat requirements.

Logistics

The Cost Centre is in charge of distributing drinks for the brewery. To meet customer requirements, not only the brewery's own products are being distributed, but also a large number of top-class drinks (mineral water, wheat beer, fruit juices, Coca-Cola, etc.) made by other manufacturers (merchandise). The aim is to meet all customer requirements as a single supplier, thereby also offering logistical advantages.

The company's vehicle fleet

One of the brewery's major concerns is to provide the best possible levels of customer care and on-site delivery. Deliveries to depots and customers are carried out using the company's vehicle fleet, from the production site to the Logistics Centre or to the depots and distributors. The company fleet consists of a total of 44 trucks and articulated vehicles. Deliveries to the customer from the individual warehouses are performed by the company's own drivers, with the help of an electronic clearing system. In order to minimize noise pollution only low-noise trucks are purchased.

HSEQ Management System

As mentioned, the brewery was the first Austrian site to be EMAS and ISO 14001 verified in 1995. The two company managers are responsible for external communication. The environmental team is in charge of operational environmental protection and consists of 12 people from all areas of the company's operations. The purpose of the monthly Environment Team Meeting is to look into all the environment-related issues in the brewery. The Environmental Team inspects and coordinates environmental work, ensures the exchange of information required and is responsible in particular for devising and implementing environmental projects and training. The team is also responsible for strategic environmental planning and inspection of environmental work using a ratings system and audits. Every six months the Environment Team holds an enlarged meeting of the operational health and safety committee with workers' representatives and safety experts.

4.2 Input- Output Material Flows

Figure 11 shows the Material Flow Balance of the brewery. The physical mass balance doesn't balance off to zero, as not all volumes are recorded yet (e.g. packaging volumes, tools and maintenance supply). As water is part of the product, the mass balance is rather tricky, having to include the energy and water balance as well. Care should also be taken not to aggregate different measurement units (Tons, m², m³, pieces, etc.) But even without balancing the input output analysis provides a very good controlling instrument and figures are monitored for each relevant material group on a separate account.

The monetary value of non-product output is traced in the subsequent assessment of financial data, but not in the mass balance. Turnover needs not be accounted for EMA purposes.

The focus in recent years has been to record also operating materials in the enterprise resource planning system and record their consumption volumes also on a cost centre level in order to be able to better monitor material flows.

MATERIAL Flow Balance/ INPUT / OUTPUT	**EUR**	**tonnes(unless otherwise indicated)**	**Source of information for EUR**	**Source of information for tonnes**
1. Materials Inputs			Account number	
1.1. Raw and Auxiliary Materials				entreprise resource planning system
Malt	1.000.000	4.000	5100	
Hop	120.000	500	5101	
Burst rice	120.200	200	5102	
Auxiliary materials	12.150	100	5110	
CO2 Purchase	100.000		5111	
Subtotal	**1.352.350**	**4.800**		
1.2. Packaging Materials				not yet recorded in volumes
Bottle caps lemonades	17.000		5301	
Bottle caps beer	80.000		5302	
Labels Beer	100.000		5310	
Beer cases 100% of new purchase to the closed loop system	30.000		5320	
Label glue	15.000		5330	
6 bottle-trays	160.000		5340	
Beer bottles	45.000		5341	
Pallets	14.200		5350	
Subtotal	**461.200**	**0**		
1.3. Merchandise				
not to be recorded				
Subtotal	**0**	**0**		
1.4. Operating Materials				
Cleaning agents	190.000	210	5400	entreprise ressource planning system
Refrigerants	40.000	50	5401	

Neutralisation agent	35.000	250	5402	
Filtering agents	20.000	30	5403	
Laboratory material	20.000	1	5404	
Lubricants	11.000	1	5405	
Tools and maintence supply	5.000		5500	not yet recorded
Subtotal	**321.000**	**542**		
1.5. Water				
Ground water consumption in hl	0	0		not in use
Water from own wells in HL	0	1.300.000		metering system
Water consumption from public supply (hl)	50.000	1.000.000	5650	invoice
Subtotal	**50.000**	**2.300.000**		
1.6. Energy				
Electricity (kWh)	275.000	2.700.000	5600	invoice
Heating oil extra light (Liter)	200.000	700	5601	invoice
Fuels (Liter)	21.300	300	5602	invoice
Diesel vehicle fleet (Liter)	200.000	370.000	5603	invoice
Subtotal	**696.300**			
TOTAL MATERIALS COSTS / INPUT	**2.880.850**			
2. Product Output			Account number	
2.1. Products				
beer (in hl), bottled or in KEGs	1.000.000	260.000	total production costs from financial statistics and calculation sheet for production costs	production statistics
Subtotal	**1.000.000**	**260.000**		
2.2. Byproducts				
brewing residue for agricultural composting	-3.500	280	4101	production statistics
semi-solid Kieselgur mineral silt for agricultural composting	0	240	delivered free of charge	production statistics
wet Draff for agricultural composting	-35.000	5.500	4100	production statistics
Subtotal	**-38.500**	**6.020**		
TOTAL TURNOVER / PRODUCT OUTPUT	**961.500**	**266.020**		
3. Non-Product Output				
3.1. Solid Waste				
Total non hazardous waste		20		waste recording system
Waste for Recycling		430		waste recording system

Subtotal		**450**		
3.2. Hazardous Waste				
Hazardous Waste		7		waste recording system
Waste oil		0		waste recording system
Subtotal		**7**		
3.3. Waste Water				
Qantity of waste water in m³		96.200		metering system
COD		153		calculated from laboratory results
Subtotal				
3.4. Air Emissions				
CO^2 emissions heating plant		2.500		calculated from energy input
CO^2 emissions vehicle fleet		1.000		calculated from energy input
Subtotal		**1.000**		
TOTAL NON-PRODUCT OUTPUT				

Figure 11: Input-Output Material Flows of the Brewery

4.3 Detailed Cost Assessment and Division by Cost Centers

The template in Figure 12 shows a detailed practical example of how environmental costs are recorded in the Excel template following the UN DSD and IFAC EMA Guideline. For the EMA cost assessment all postings are entered into this spreadsheet which automatically aggregates to the results presented in Figure 14 and 15.

The assessment normally doesn't take more than half a day to a day, working in a team consisting of the environmental manager, the accountant with direct access to the cost accounting system and the production manager. It is essential to record the source of information and the procedures for estimates in order to be able to repeat the cost assessment in a comparable way with less effort next year.

Figure 13 shows how the environmental costs are related with the cost centres of the brewery.

For the EMA assessment much of the data will be taken directly from cost centre reports of defined environmentally relevant end-of-pipe or pollution prevention equipment. It may be useful to monitor these cost centres in separate columns in addition to the distribution by environmental media effected.

When filling out the templates, it is not a prerequisite to completely distribute the costs by cost centres. Especially for large organization it may be rather impossible to perform this in the Excel template. But for the brewery as there are only 5 production cost centres and 8 supportive cost centres it can be done.

For investment appraisal it may be sufficient to first record the total annual environmental and material flow related costs and than separate only those costs centres, for which investment appraisal will be performed.

		Operating Costs (current expenditures)							
ENVIRONMENTAL DOMAIN **ENVIRONMENT-RELATED COST CATEGORIES**	**Data Source**	**Air and Climate**	**Water + Waste Water**	**Waste**	**Soil, Surface and Groundwater**	**Noise, Vibration and Odor and Fire**	**Nature protection**	**General Environm. MS**	**Total**
1. MATERIALS COSTS OF NON-PRODUCT OUTPUTS									
1.1. Raw and Auxiliary Materials									
Malt, 20% loss of € 1.000.000,-	5100			200,000					200,000
Hop, 20% loss of € 120.000,-	5101		10,000	10,000					20,000
Burst rice, 15% loss of € 120.200,-	5102			18,030					18,030
Auxiliary materials beer 2% loss of € 12.150,-	5110		243						243
CO2 Purchase 100%	5111	100,000							100,000
Subtotal		**100,000**	**10,243**	**228,030**	**0**	**0**	**0**	**0**	**338,273**
1.2. Packaging Materials									
Bottle caps lemonades 5 % loss	5301			850					850
Bottle caps beer 5 % loss	5302			4,000					4,000
Labels Beer 7%	5310			7,000					7,000
Beer cases 100% of new purchase to the closed loop system	5320			30,000					30,000
Label glue 7%	5330			1,050					1,050
6 bottle-trays 95 % loss of € 160.000,-	5340			152,000					152,000
Beer bottles 100% of new purchase to the closed loop system	5341			45,000					45,000
Pallets 2% loss of € 14.200,-	5350			284					284
Subtotal		**0**	**0**	**240,184**	**0**	**0**	**0**	**0**	**240,184**
1.4. Operating Materials									
Cleaning agents 100 %	5400	0	190,000						190,000
Neutralisation agent 100%	5401	0	35,000						35,000
Refrigerants 100 %	5402		40,000						40,000

Filtering agents 100%	5403		10,000	10,000					20,000
Laboratory material 100%	5404	0		20,000					20,000
Lubricants 100%	5405	0		11,000					11,000
Tools and maintenance supply	5500			5,000					5,000
Subtotal		**0**	**275,000**	**46,000**	**0**	**0**	**0**	**0**	**321,000**
1.5. Water									
Water from own well (only depreciation and operating materials)			0						0
Water consumption from public supply (hl)	5650		50,000						50,000
Subtotal		**0**	**50,000**	**0**	**0**	**0**	**0**	**0**	**50,000**
1.6. Energy									
Electricity	5600	275,000							275,000
Heating oil 100%	5601	200,000							200,000
Natural gas electricity production, 33% loss of energy efficiency of € 21.300,-	5602	7,100							7,100
Diesel vehicle fleet 100%	5603	200,000							200,000
Subtotal		**682,100**	**0**	**0**	**0**	**0**	**0**	**0**	**682,100**
1.7. Processing Costs									
5% loss of beer production	financial statistics and calculation sheet for production costs		50,000						50,000
Subtotal		**0**	**50,000**	**0**	**0**	**0**	**0**	**0**	**50,000**
Total Category 1		**782,100**	**385,243**	**514,214**	**0**	**0**	**0**	**0**	**1,681,557**
2. END-OF-PIPE									
2.1. Equipment Depreciation									
CC Waste Water treatment									
Waste water treatement plant	depreciation according to cost center		22,000						22,000
Separating waste water system	depreciation according to cost center		50,000						50,000
Brewhouse:									0

Dust filter	estimated depreciation		4,300						4,300
Vapor compaction and control system, 100%	depreciation according to cost center		7,000						7,000
Hot water recovery, condiment cooling	depreciation according to cost center		1,000						1,000
CC Fermentation- & storing cellar:									0
Chemical store, 100%	newly renovated, depreciation estimated on the basis of renovation costs				1,030				1,030
Yeast disposal equipment, also used for recovery of residual beer	depreciation estimated			30,000					30,000
Pendular gas pipeline	depreciation estimated		4,800						4,800
CC Carbonic acid system									0
CO2 recovery and alert system	depreciation according to cost center	1240		0					1,240
Subtotal		**1,240**	**89,100**	**30,000**	**1,030**	**0**	**0**	**0**	**121,370**
2.2. Operating Materials									
For the equipment defined in section 2.1. and available on separate cost centre reports, operating materials can be taken from there and deducted from section 1.4.									0
Operating materials waste water treatment plant	CC 500 (without 5401)		54,500						54,500
Maintenance waste water treatment plant	CC 500		13,700						13,700
Isolation of steam and water pipes	external services according to cost center	7,000							7,000
Subtotal		**7,000**	**68,200**	**0**	**0**	**0**	**0**	**0**	**75,200**
2.3. Water and Energy									

For the equipment defined in section 2.1. and available on separate cost centre reports, water and energy can be taken from there and deducted from section 1.5. And 1.6.									0
Energy Waste water treatment plant	CC 500	5,000							5,000
Subtotal		**5,000**	**0**	**0**	**0**	**0**	**0**	**0**	**5,000**
2.4. Internal Personnel									
For the equipment defined in section 2.1. and available on separate cost centre reports, internal personal can be taken from there.									0
Personnel waste water treatment plant	CC 500	27,300							27,300
15 % of CC Maintenance	CC Maintenance							40,000	40,000
Personnel for waste management	Estimate: 5 people with an average annual person cost of 50.000 Euros. 50 % of their time			125,000					125,000
Subtotal		**27,300**	**0**	**125,000**	**0**	**0**	**0**	**40,000**	**192,300**
2.5. External Services									
External service for waste disposal	7220 CC HSEQ			10,000	0				10,000
External services for spill management	7220 CC HSEQ				3,000				3,000
External services from lawyers and attorneys for environmental permits	7750 CC HSEQ							500	500
External services for analytical laboratory services	7230 CC HSEQ		500						500
15 % of CC Maintenance	CC Maintenance							20,000	20,000
etc., need to be posted to cost center Environmental Managment (EM) or defined by environmental manager, so that the costs can be recorded									0
Subtotal		**0**	**500**	**10,000**	**3,000**	**0**	**0**	**20,500**	**34,000**
2.6. Fees, Taxes and Permits									
License fee for packaging materials	7100			20,000				0	20,000
Environmental permits	7102		5,000					0	5,000

Waste disposal fees	7105			44,000					44,000
Waste water treatment fees	7106		100,000						100,000
CO2 allowances bought (EUA, ERU, CER)	7108	0							0
Fee for remediation of disposal dumps	7103			0					0
Other environmental fees and taxes, if applicable								0	0
Subtotal		**0**	**105,000**	**64,000**	**0**	**0**	**0**	**0**	**169,000**
2.7. Insurance									
Environmental part of liability and risk insurance, e.g. for transport of hazardous goods	7700			0	0				0
Subtotal		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2.8. Remediation and Compensation									
Environmental cost related with remediation and abandonment	7220				0				0
Environmental cost related with compensation to third parties, e.g. farmers and fisheries	7240 CC HSEQ				700		0		700
Biodiversity and landscaping	7670 CC HSEQ				1,000		0		1,000
Subtotal		**0**	**0**	**0**	**1,700**	**0**	**0**	**0**	**1,700**
Total Category 2		**40,540**	**262,800**	**229,000**	**5,730**	**0**	**0**	**60,500**	**598,570**
3. INTEGRATED PREVENTION									
3.1. Equipment Depreciation									
Electricity production (block heat with own organic material and power plant), 33% conversion loss, 33 % of depreciation of € 110.400,-	depreciation of fixed asstes register	36,800							36,800
Rainwater collection system	depreciation of fixed asstes register		500						500
Bicyle stand and company bicycle	depreciation of fixed asstes register	500							500
Subtotal		**37,300**	**500**	**0**	**0**	**0**	**0**	**0**	**37,800**
3.2. Operating Materials, Water, Energy									
For the equipment defined in section 3.1. and available on separate cost centre reports, operating materials, water and energy can be									0

taken from there and deducted from section 1.4.									
									0
Subtotal		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3.3. Internal Personnel									
Time to prepare Environmental Impact Assessments and other environment related negotiations and communications of the management board	Estimate: 2 people with annual average personal cost of 200.000 Euros. 5 % of their time							20,000	20,000
Time of the environmental manager	Estimate: environmental manager (70 %) plus substitute (30 %), average annual personal cost 100.000,-							100,000	100,000
Time of the environmental team	Estimate: 10 people 10 % of their time, average annual personal cost 100.000,-							100,000	100,000
Other internal personal attending environmental trainings and meetings.	Estimate. 100 person hours at average costs of 250 Euro							2,500	2,500
For the equipment defined in section 3.1. and available on separate cost centre reports, internal personnel be taken from there.									
Subtotal		**0**	**0**	**0**	**0**	**0**	**0**	**222,500**	**222,500**
3.4. External Services									
Services for Environmental impact assessments and other environmental studies	7760 CC HSEQ							5,000	5,000
External consultants for environmental trainings	7770 CC HSEQ							2,000	2,000
External audit of Environmental Management System	7750 CC HSEQ							3,000	3,000

Ecolabel for returnable bottle	7110 CCBottling							300	300
Subtotal		**0**	**0**	**0**	**0**	**0**	**0**	**10,300**	**10,300**
3.5. Other									
Creation, layout and printing of the environmental report	7650 CC HSEQ							5,000	5,000
Subtotal		**0**	**0**	**0**	**0**	**0**	**0**	**5,000**	**5,000**
Total Category 3		**37,300**	**500**	**0**	**0**	**0**	**0**	**237,800**	**275,600**
4. RESEARCH and DEVELOPMENT COSTS									
Pilotproject on biodiesel	7760	10,000							10,000
Total Category 4		**10,000**	**0**	**0**	**0**	**0**	**0**	**0**	**10,000**
5. FINES									
Environmental fines	7120				0			0	0
Total Category 5		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6. LESS TANGIBLE COSTS									
not accounted for									0
Total Category 6		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL ENVIRONMENT-RELATED COSTS (1. + 2. + 3. + 4. + 5. + 6.)		**869,940**	**648,543**	**743,214**	**5,730**	**0**	**0**	**298,300**	**2,565,727**
7. ENVIRONMENT-RELATED EARNINGS									
7.1. Other Earnings									
Malt dust	4101	0		-500					-500
Yeast sludge	4101	0		-3,000					-3,000
Sale of draff	4100			-35,000					-35,000
Subtotal		**0**	**0**	**-38,500**	**0**	**0**	**0**	**0**	**-38,500**
7.2. Subsidies									
Subsidy for research project on biodiesel	4305	-5,000							-5,000
Investment grant for combined block heat combustion, offset of annual depreciation	4400	-3,000							-3,000
Subtotal		**-3,000**	**0**	**0**	**0**	**0**	**0**	**0**	**-8,000**
TOTAL ENVIRONMENT-RELATED EARNINGS		**-3,000**	**0**	**-38,500**	**0**	**0**	**0**	**0**	**-46,500**
TOTAL ENVIRONMENT-RELATED COSTS & EARNINGS		**866,940**	**648,543**	**704,714**	**5,730**	**0**	**0**	**298,300**	**2,519,227**

Figure 12: Detailed cost assessment

ENVIRONMENTAL DOMAIN ENVIRONMENT-RELATED COST CATEGORIES	Total	Malt mills	Brew house	Fermentation	Filtration	Botteling	Store	Maintenance	Steam/Heat	Refrigeration	Wastewater CC 500	Logistics	HSEQ	Administration
1. MATERIALS COSTS OF NON-PRODUCT OUTPUTS														
1.1. Raw and Auxiliary Materials														
Malt, 20% loss of € 1.000.000,-	200,000	100,000	100,000											
Hop, 20% loss of € 120.000,-	20,000		20,000											
Burst rice, 15% loss of € 120.200,-	18,030		18,030											
Auxiliary materials beer 2% loss of € 12.150,-	243		243											
CO2 Purchase 100%	100,000					100,000								
Subtotal	**338,273**													
1.2. Packaging Materials														
Bottle caps lemonades 5 % loss	850					850								
Bottle caps beer 5 % loss	4,000					4,000								
Labels Beer 7%	7,000					7,000								
Beer cases 100% of new purchase to the closed loop system	30,000					30,000								
Label glue 7%	1,050					1,050								
6 bottle-trays 95 % loss of € 160.000,-	152,000					152,000								
Beer bottles 100% of new purchase to the closed loop system	45,000					45,000								

Pallets 2% loss of € 14.200,-	284					284								
Subtotal	**240,184**													
1.4. Operating Materials														
Cleaning agents 100 %	190,000	20,000	54,900		47,500	67,600								
Neutralisation agent 100%	35,000										35,000			
Refrigerants 100 %	40,000		8,000	8,000	8,000				8,000	8,000				
Filtering agents 100%	20,000				20,000									
Laboratory material 100%	20,000												20,000	
Lubricants 100%	11,000				2,200	2,200		2,200	2,200	2,200				
Tools and maintenance supply	5,000							5,000						
Subtotal	**321,000**													
1.5. Water														
Water from own well (only depreciation and operating materials)	0													
Water consumption from public supply (hl)	50,000													50,000
Subtotal	**50,000**													
1.6. Energy														
Electricity	275,000	27,500	41,250	41,250	27,500	41,250	27,500		27,500	41,250				
Heating oil 100%	200,000								200,000					
Natural gas electricity production, 33% loss of energy efficiency of € 21.300,-	7,100								7,100					
Diesel vehicle fleet 100%	200,000											200,000		
Subtotal	**682,100**													
1.7. Processing Costs														
5% loss of beer production	50,000					50,000								
Subtotal	**50,000**													
Total Category 1	**1,681,557**													
2. END-OF-PIPE														
2.1. Equipment Depreciation														
CC Waste Water treatment														
Waste water treatement plant	22,000										22,000			
Separating waste water system	50,000										50,000			

Brewhouse:	0													
Dust filter	4,300		4,300											
Vapor compaction and control system, 100%	7,000		7,000											
Hot water recovery, condiment cooling	1,000		1,000											
CC Fermentation- & storing cellar:	0													
Chemical store, 100%	1,030						1,030							
Yeast disposal equipment, also used for recovery of residual beer	30,000						30,000							
Pendular gas pipeline	4,800						4,800							
CC Carbonic acid system	0													
CO2 recovery and alert system	1,240				1,240									
Subtotal	**121,370**													
2.2. Operating Materials														
For the equipment defined in section 2.1. and available on separate cost centre reports, operating materials can be taken from there and deducted from section 1.4.	0													
Operating materials waste water treatment plant	54,500										54,500			
Maintenance waste water treatment plant	13,700										13,700			
Isolation of steam and water pipes	7,000								7,000					
Subtotal	**75,200**													
2.3. Water and Energy														
For the equipment defined in section 2.1. and available on separate cost centre reports, water and energy can be taken from there and deducted from	0													

section 1.5. And 1.6.														
Energy Waste water treatment plant	5,000										5,000			
Subtotal	**5,000**													
2.4. Internal Personnel														
For the equipment defined in section 2.1. and available on separate cost centre reports, internal personal can be taken from there.	0													
Personnel waste water treatment plant	27,300										27,300			
15 % of CC Maintenance	40,000							40,000						
Personnel for waste management	125,000						125,000							
Subtotal	**192,300**													
2.5. External Services														
External service for waste disposal	10,000												10,000	
External services for spill management	3,000												3,000	
External services from lawyers and attorneys for environmental permits	500												500	
External services for analytical laboratory services	500												500	
15 % of CC Maintenance	20,000							20,000						
etc., need to be posted to cost center Environmental Managment (EM) or defined by environmental manager, so that the costs can be recorded	0													
Subtotal	**34,000**													
2.6. Fees, Taxes and Permits														
License fee for packaging materials	20,000					20,000								

Environmental permits	5,000										5,000			
Waste disposal fees	44,000												44,000	
Waste water treatment fees	100,000										100,000			
CO2 allowances bought (EUA, ERU, CER)	0													
Fee for remediation of disposal dumps	0													
Other environmental fees and taxes, if applicable	0													
Subtotal	**169,000**													
2.7. Insurance														
Environmental part of liability and risk insurance, e.g. for transport of hazardous goods	0													
Subtotal	**0**													
2.8. Remediation and Compensation														
Environmental cost related with remediation and abandonment	0													
Environmental cost related with compensation to third parties, e.g. farmers and fisheries	700												700	
Biodiversity and landscaping	1,000												1,000	
Subtotal	**1,700**													
Total Category 2	**598,570**													
3. INTEGRATED PREVENTION														
3.1. Equipment Depreciation														
Electricity production (block heat with own organic material and power plant), 33% conversion loss, 33 % of depreciation of € 110.400,-	36,800								36,800					
Rainwater collection system	500												500	
Bicyle stand and company bicycle	500												500	
Subtotal	**37,800**													

3.2. Operating Materials, Water, Energy														
For the equipment defined in section 3.1. and available on separate cost centre reports, operating materials, water and energy can be taken from there and deducted from section 1.4.	0													
	0													
Subtotal	**0**													
3.3. Internal Personnel														
Time to prepare Environmental Impact Assessments and other environment related negotiations and communications of the management board	20,000												20,000	
Time of the environmental manager	100,000												100,000	
Time of the environmental team	100,000												100,000	
Other internal personal attending environmental trainings and meetings.	2,500												2,500	
For the equipment defined in section 3.1. and available on separate cost centre reports, internal personnel be taken from there.													0	
Subtotal	**222,500**													
3.4. External Services													0	
Services for Environmental impact assessments and other environmental studies	5,000												5,000	
External consultants for environmental trainings	2,000												2,000	
External audit of Environmental Management System	3,000												3,000	

Ecolabel for returnable bottle	300					300								
Subtotal	**10,300**													
3.5. Other													0	
Creation, layout and printing of the environmental report	5,000												5,000	
Subtotal	**5,000**													
Total Category 3	**275,600**													
4. RESEARCH and DEVELOPMENT COSTS														
Pilotproject on biodiesel	10,000											10,000		
Total Category 4	**10,000**													
5. FINES														
Environmental fines	0													
Total Category 5	**0**													
6. LESS TANGIBLE COSTS														
not accounted for	0													
Total Category 6	**0**													
TOTAL ENVIRONMENT-RELATED COSTS (1. + 2. + 3. + 4. + 5. + 6.)	**2,565,727**													
7. ENVIRONMENT-RELATED EARNINGS														
7.1. Other Earnings														
Malt dust	-500	-500												
Yeast sludge	-3,000				-3,000									
Sale of draff	-35,000				-35,000									
Subtotal	**-38,500**													
7.2. Subsidies														
Subsidy for research project on biodiesel	-5,000											-5,000		
Investment grant for combined block heat combustion, offset of annual depreciation	-3,000								-3,000					
Subtotal	**-8,000**													

TOTAL ENVIRONMENT-RELATED EARNINGS	**-46,500**													
TOTAL ENVIRONMENT-RELATED COSTS & EARNINGS	**2,519,227**	147,000	254,723	49,250	68,440	521,534	188,330	67,200	285,600	51,450	312,500	205,000	318,200	50,000

Figure 13: Cost division by cost centers

4.4 Total annual environmental costs

The detailed cost assessment is automatically aggregated into a one page display of the totals of the sub-cost categories. In many companies the columns requested for reporting to statistical agencies for

- Soil, surface and ground water
- Noise, vibration, odor and fire, as well as
- Nature protection

remain empty. The interpretation of results is simplified by referring to the automatically converted excel template of the percentage distribution of the total annual environmental costs.

The percentage distribution of total annual environmental costs clearly shows, that emission control costs are comparatively expensive in relation to prevention activities. But even in a company that has practiced environmental management and integrated prevention for 20 years, the most significant cost category are the materials costs of non product output with 67 % of total costs. This is where one still finds saving potentials.

On the other it must be said, that price changes also influence these figures. In the light of rising resource prices many companies are horrified by the thought of what they would have to pay today had they not invested into efficiency improvements in the last years. It must also be said that total energy input already constitutes 27 % of environmental total costs.

Several companies don't publish their actual cost but do disclose the percentage distribution. The figure for energy provides a good estimate of the total relation of the cost structure. Energy related impact on air and climate is also the most important cost category by environmental media.

The next two significant cost items are the losses of raw materials and operating materials. Together they are in the range of total energy input. While raw materials are more commonly monitored by organizations, the recording of operating materials by production processes and cost centers is not so common.

Only 2,7 % of the total costs relate to the operating materials directly attributed to the waste water treatment pant (line 2.2.) but another 11 % of total costs relate to operating materials that go down the drain (cleaning materials, lubricants, detergents, etc.).

When analyzing the cost distribution by environmental domains it is interesting to note that for the brewery in Austria in recent years the most prominent category shifted from waste to waste water and now stands at air and climate. This clearly relates to priorities of environmental politics and related price changes. Much of the solid waste is recycled and some is even sold which shows in line 7.1. other earnings.

ENVIRONMENTAL DOMAIN / ENVIRONMENT-RELATED COST CATEGORIES	Air and Climate	Water + Waste Water	Waste	Soil, Surface and Groundwater	Noise, Vibration and Odor and Fire	Nature protection	General Environm. MS	Total
1. MATERIALS COSTS OF NON-PRODUCT OUTPUTS	**782.100**	**385.243**	**514.214**					**1.681.557**
1.1. Raw and Auxiliary Materials	100.000	10.243	228.030					338.273
1.2. Packaging Materials			240.184					240.184
1.4. Operating Materials		275.000	46.000					321.000
1.5. Water		50.000						50.000
1.6. Energy	682.100							682.100
1.7. Processing Costs		50.000						50.000
2. END-OF-PIPE	**40.540**	**262.800**	**229.000**	**5.730**			**60.500**	**598.570**
2.1. Equipment Depreciation	1.240	89.100	30.000	1.030				121.370
2.2. Operating Materials	7.000	68.200						75.200
2.3. Water and Energy	5.000							5.000
2.4. Internal Personnel	27.300		125.000				40.000	192.300
2.5. External Services		500	10.000	3.000			20.500	34.000
2.6. Fees, Taxes and Permits		105.000	64.000					169.000
2.7. Insurance								
2.8. Remediation and Compensation				1.700				1.700
3. INTEGRATED PREVENTION	**37.300**	**500**					**237.800**	**275.600**
3.1. Equipment Depreciation	37.300	500						37.800
3.2. Operating Materials, Water, Energy								
3.3. Internal Personnel							222.500	222.500
3.4. External Services							10.300	10.300
3.5. Other							5.000	5.000
4. RESEARCH and DEVELOPMENT COSTS	**10.000**							**10.000**
5. FINES								
TOTAL ENVIRONMENT-RELATED COSTS (1. + 2. + 3. + 4. + 5. + 6.)	**869.940**	**648.543**	**743.214**	**5.730**			**298.300**	**2.565.727**
7. ENVIRONMENT-RELATED EARNINGS								
7.1. Other Earnings			-38.500					-38.500
7.2. Subsidies	-3.000							-8.000
TOTAL ENVIRONMENT-RELATED EARNINGS	**-3.000**		**-38.500**					**-46.500**
TOTAL ENVIRONMENT-RELATED COSTS & EARNINGS	**866.940**	**648.543**	**704.714**	**5.730**			**298.300**	**2.519.227**

Figure 14: Total annual environmental costs of the brewery

ENVIRONMENTAL DOMAIN / ENVIRONMENT-RELATED COST CATEGORIES	Air and Climate	Water + Waste Water	Waste	Soil, Surface and Groundwater	Noise, Vibration and Odor and Fire	Nature protection	General Environm. MS	Total
1. MATERIALS COSTS OF NON-PRODUCT OUTPUTS	**31,0%**	**15,3%**	**20,4%**					**66,7%**
1.1. Raw and Auxiliary Materials	4,0%	0,4%	9,1%					13,4%
1.2. Packaging Materials			9,5%					9,5%
1.4. Operating Materials		10,9%	1,8%					12,7%
1.5. Water		2,0%						2,0%
1.6. Energy	27,1%							27,1%
1.7. Processing Costs		2,0%						2,0%
2. END-OF-PIPE	**1,6%**	**10,4%**	**9,1%**	**0,2%**			**2,4%**	**23,8%**
2.1. Equipment Depreciation	0,0%	3,5%	1,2%	0,0%				4,8%
2.2. Operating Materials	0,3%	2,7%						3,0%
2.3. Water and Energy	0,2%							0,2%
2.4. Internal Personnel	1,1%		5,0%				1,6%	7,6%
2.5. External Services		0,0%	0,4%	0,1%			0,8%	1,3%
2.6. Fees, Taxes and Permits		4,2%	2,5%					6,7%
2.7. Insurance								
2.8. Remediation and Compensation				0,1%				0,1%
3. INTEGRATED PREVENTION	**1,5%**	**0,0%**					**9,4%**	**10,9%**
3.1. Equipment Depreciation	1,5%	0,0%						1,5%
3.2. Operating Materials, Water, Energy								
3.3. Internal Personnel							8,8%	8,8%
3.4. External Services							0,4%	0,4%
3.5. Other							0,2%	0,2%
4. RESEARCH and DEVELOPMENT COSTS	**0,4%**							**0,4%**
5. FINES								
TOTAL ENVIRONMENT-RELATED COSTS (1. + 2. + 3. + 4. + 5. + 6.)	**34,5%**	**25,7%**	**29,5%**	**0,2%**			**11,8%**	**101,8%**
7. ENVIRONMENT-RELATED EARNINGS								
7.1. Other Earnings			-1,5%					-1,5%
7.2. Subsidies	-0,1%							-0,3%
TOTAL ENVIRONMENT-RELATED EARNINGS	**-0,1%**		**-1,5%**					**-1,8%**
TOTAL ENVIRONMENT-RELATED COSTS & EARNINGS	**34,4%**	**25,7%**	**28,0%**	**0,2%**			**11,8%**	**100,0%**

Figure 15: Percentage distribution of total environmental costs

4.5 Applying COMFAR for the brewery case study

This exercise is intended to introduce a new user to the basic concepts and procedures of COMFAR *III Expert* in particular with the new project type *Environmental accounting*.. Only financial analysis is performed. Data are kept to a minimum to concentrate on the main features of the program. The program features, which are not used in this case study are not explained here. Please refer to the *Reference Manual*.

The objective of the exercise is to produce the following pro-forma financial statements and performance indicators:

- Cash flow for financial planning
- Discounted cash flow, total capital invested, NPV, NPVR, IRR
- Discounted cash flow, total equity invested, NPV, IRR, Short NPV
- Break-even point
- Incremental analysis

Data concerning all aspects of the project including currency exchange rates, initial fixed investment, production costs, sales programme, working capital requirements and financial conditions are provided in the appropriate sections below.

Note:	Every save operation (**Save Project as** in the FILE Menu) in this manual is described using names equal to the project files delivered with COMFAR *III Expert*. If you do not want to overwrite these original project files, please use other filenames as described in this manual.

Examples for investment appraisal contain:

- Combined heat and power production
- Bottling machine and reduced costs for waste water treatment

Both examples highlight the importance of a good data basis and profound thinking about the parameters to be considered for investment options. The quality of investment appraisal techniques is directly related to the quality of the information inputted into the system. Experiences from case studies show that the benefits of integrated pollution prevention are often underestimated, as the data on materials inputs, emission outputs and related costs is not transparent and the benefits of the improvement can not be made visible.

4.5.1. Investment appraisal of combined block heat production

The example of the combined heat and power production is from another brewery (Jasch/Schnitzer, 2001). It has technical as well as financial aspects and is an easy example that calculates the investment parameters based on the saved operating costs.

The combined heat and power plant (cogeneration) is an option to save energy costs. Breweries need heat for wort cooking, space heating and production of warm water. The waste heat of the cogeneration plant is enough to substitute a hot water boiler. In addition, cogeneration produces electricity that can be used directly in the brewery.

A cogeneration plant is based on a diesel engine that runs on gas. The engine power of the motor shaft produces electricity via a generator. Waste heat can be used from the cooling circuit and the exhaust gas. A cogeneration plan thus is a combined heat and power generation based on a combustion engine. The technical benefits compared to a steam boiler are the good controllability and the start-up conditions. The disadvantage is the low temperature of waste heat, which is below 100°C and can therefore not be used as steam. The overall efficiency of such a unit is about 90 %, while the electrical efficiency can be up to 40 %.

From the financial point of view cogeneration can be very interesting as electricity consumption at peak load time can be reduced and the cost savings can be even more significant, depending on the structure of the tariff.

The cogeneration unit shall be installed fort he following capacity:

Electrical performance	722 kW (production of electricity)
Thermal performance	945 kW (production of waste heat)

Total needed performance is thus 1667 kW. But, the overall efficiency (electrical and thermal performance) is only 89%. The efficiency ratio relates the actual performance to the input needed.

$$\eta = \frac{actualperformance[kW]}{inputneeded[kW]}$$

An efficiency ratio of 89 % means, that 100 kW inputted performance only have a service output of 89 kW. The efficiency ratio for waste heat is normally around 80 %. Electricity production from gas, coal or oil is significantly less efficient, the efficiency ratio is at the maximum about 40 %. An efficiency ratio of 40 % implies that in order to be able to produce 722 kW electricity, 1805 kW of energy input (e.g. natural gas) have to be inputted.

$$\eta = \frac{722[kW]}{inputneeded[kW]} = 40\%$$

$$input.needed = 722[kW] / 0{,}4 = 1805[kW]$$

The cogeneration unit will run about 6000 hours/year. The total energy input needed (e.g. from natural gas) is thus calculated as 1667 kW needed, divided by an efficiency ratio of 89 % results in 1873 kW. This performance of 1873 kW is multiplied with the operating hours of 6.000 h and thus calculates the total gas input needed as 11.238.000 kWh/a.

This will generate:

Electrical energy	4.332.000 kWh/a (= 722 * 6000)
Thermal energy	5.670.000 kWh/a (= 945 * 6000)

The cogeneration unit has external investment costs of 1.200.000 Euro and internal construction work of 70.000 Euro. It will be depreciated over 10 years. The substituted hot water boiler would have to undergo maintenance of 75.000 € in the second year. Annual maintenance costs are 5.000 Euro. Interest rate is 6 %.

Energy prices:

Electricity	0,15 Euro/kWh
Natural Gas	0,06 Euro/kWh
Waste heat old boiler	0,052 Euro/kWh

Energy prices rise in the 4th year by 8 %.

The Excel template compares the investment and expenses to the annual savings and has functions to directly calculate the net present value and internal rate of return.

The costs for gas are calculated as 11.238.000 kWh * 0,06 Euro = 674.280 Euro. The price increase of 8 % has to be considered.

The cogeneration produces heat and electricity and thus saves costs for external supply. Also maintenance of the old boiler is saved.

Electricity: 4.332.000kWh * 0,15 = 649.800 Euro. The 8 % price increase is considered again.
Thermal energy: 5.670.000 kWh * 0,052 = 294.840 Euro. The 8% price increase is considered again.

Year		Expenses			Savings		Net present value and internal rate of return			
	Investment volume	Gas	Main-tenance	Heat	Electricity	Main-tenance	Total expenses	Total annual savings	NPV	IRR
0	-1.270.000									
1		-292.193,26	-25.000,00	187.110,00	298.908,00		-317.193,26	486.018,00	-1.101.175,26	
2		-292.193,26	-25.000,00	187.110,00	298.908,00	75.000,00	-317.193,26	561.018,00	-857.350,52	51%
3		-292.193,26	-25.000,00	187.110,00	298.908,00		-317.193,26	486.018,00	-688.525,78	40%
4		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	-508.071,55	33%
5		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	-327.617,32	29%
6		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	-147.163,10	26%
7		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	33.291,13	23%
8		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	213.745,36	22%
9		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	394.199,58	20%
10		-309.724,85	-25.000,00	198.336,60	316.842,48		-334.724,85	515.179,08	574.653,81	19%

After calculating the above described project, the total investment of 1.270.000 Euro will be recovered after 6 years (static payback) respectively 7 years (dynamic payback). The project produces a a NPV of 851.198 Euro and an IRR of 18.59% which is significantly higher than the applicable discounting rate of 6%.

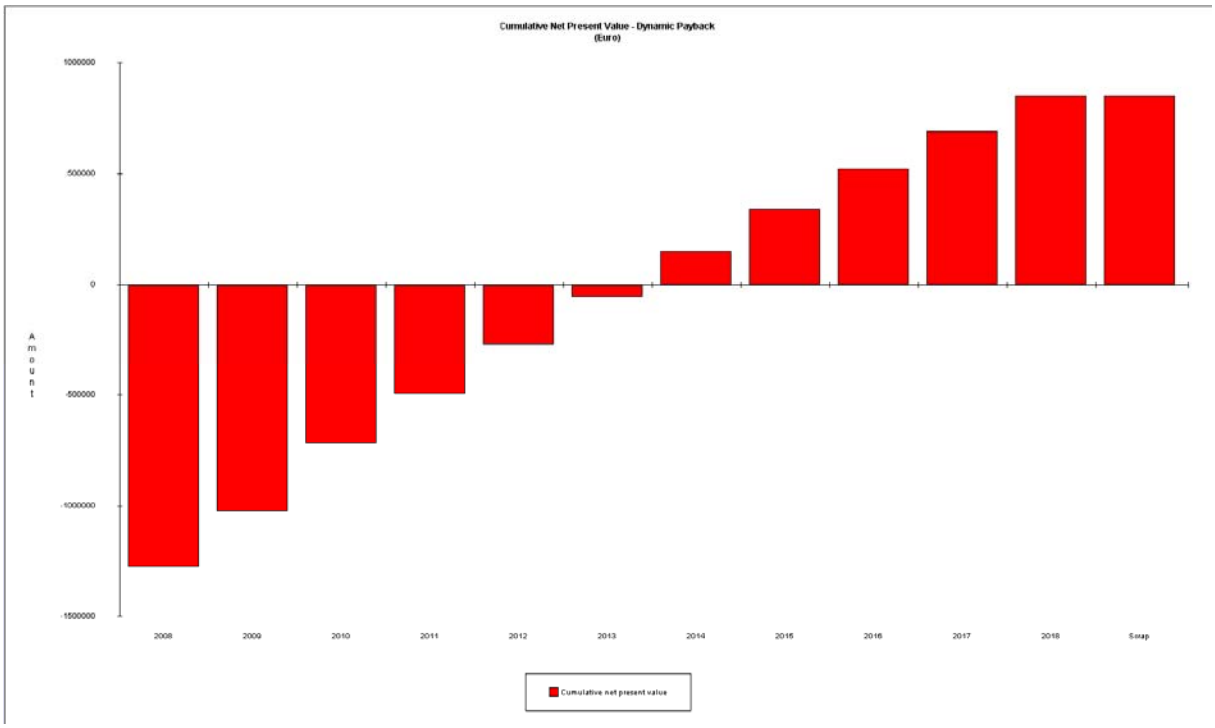


Figure 16: Cumulative NPV - Dynamic Payback

4.5.2. Investment appraisal of bottle cleaning equipment

Bottle-cleaning water generally constitutes a significant proportion of the total pollution from breweries. In addition, water input is high, it may be scarce and significant amounts of leach have to be added. The population equivalent for sewage is capped in the emission permit and with rising production waste-water can constitute a limiting factor for increase in turnover.

In the case study existing bottle-cleaning equipment is compared to new equipment.

The current production is 260.000 hl of beer. 200.000 hl are filled in bottles passing the bottle-cleaning machine. The production of bottled beer is forecasted to increase by 10.000 hl each year.

The new equipment costs 700.000 Euro and is depreciated over 10 years linear to zero. The old equipment has a remaining depreciation of 50.000 Euro per year for three years but can be sold at any time for the residual book value.

Comparison of old and new equipment:

Performance indicators by hl bottled beer	Old Equipment	New Equipment	Costs
Water input	1 hl	0,5 hl	Water is taken from the brewery wells and has no direct costs, but has to be considered scarce. The costs can be calculated by the costs for the alternative water input, which is public supply at 0,5 Euro per m3
Lye	0,26 kg	0,13 kg	0,5 Euro per Kg
Steam	150.000 l fuel oil	- 20 %	Steam is produced with fuel oil. The price for fuel oil will probably increase 5 % per year. Currently the costs are 0,5 Euro per Litre.
Waste water		-50%	30 % of the costs of the waste-water treatment plant can be attributed to the bottle cleaning machine.

The cost centre report of the waste-water treatment plant (wwtp) reflects the following data.

Type of Cost	**Euro**	**Fixed/Variable**
Depreciation	72.000	fix
Personnel	27.300	fix
Neutralization means	35.000	variable
Operating Materials	54.500	variable
Maintenance (external service)	13.700	variable
Electricity	13.750	variable
Production permit for the equipment	5.000	fix
Sewage fee	80.000	variable
Total	**307.500**	
Fixed Costs	104.300	
Variable Costs	203.200	

The costs for the waste treatment plant have to be calculated separately. 200.000 hl beer produce 400.000 hl waste-water at a sewage fee of 0,2 Euro. The new equipment reduces the total waste-water of the brewery by 50 % as the washing water is circulated in a cascading system. The waste-water treatment fee has to be related to the increase in production as well.

The waste-water treatment plant has a remaining depreciation (operational) period of 5 years.

In order to be able to add the data into the COMFAR tool, some calculations have to be done:

Performance indicators by hl bottled beer	**Old Equipment**	**New Equipment**	**Costs**
Water input	1 hl * 0,05 Euro * 200.000 hl= 10.000 Euro	0,5 hl*0,05 Euro*200.000 hl= 5.000 Euro	0,5 Euro per m3 = 0,5 Euro per 10 hl
Lye	0,26 kg*200.000 hL*0,5 Euro = 26.000 Euro	0,13 kg	0,5 Euro per Kg
Steam	150.000 l fuel oil * 0,5 Euro = 75.000 Euro	120.000 l * 0,5 = 60.000 Euro 5% annual price increase	
Waste water		-50%	30 % of the costs of the variable waste water treatment plant can be attributed to the bottle cleaning machine.

Waste Water treatment	**Euro**	**30 % bottle washing**	**- 50 %**	**Fixed/Variable**
Depreciation	72.000			fix
Personnel	27.300			fix
Neutralization means	35.000	10.500	5.250	variable
Operating Materials	54.500	16.350	8.175	variable
Maintenance	13.700	4.110	2.055	variable
Electricity	13.750	4.125	2.063	variable
Production permit for the equipment (facility fee)	5.000			fix
Sewage fee	80.000		40.000	variable
Total	**307.500**			
Fixed Costs	104.300			
Variable Costs	203.200			

Calculating the sewage fee in relation to rising production volumes:

Production	**Waste water old**	**Waste Water new**	**Sewage fee old**	**Sewage fee new**
200.000	400.000	200.000	400.000*0,2 = 80.000	200.000*0,2= 40.000
210.000	420.000	210.000	84.000	42.000
220.000	440.000	220.000	88.000	44.000
230.000	460.000	230.000	92.000	46.000
240.000	480.000	240.000	96.000	48.000
250.000	500.000	250.000	100.000	50.000
260.000	520.000	260.000	104.000	52.000
270.000	540.000	270.000	108.000	54.000
280.000	560.000	280.000	112.000	56.000
290.000	580.000	290.000	116.000	58.000

The following data is entered into COMFAR:

COMFAR terminology	Data from the case study
Production equipment	Old Bottle washing machine with a residual book value of 150.000 Euro, remaining depreciation period = 3 years
	New bottle washing machine with investment costs of 700.000 Euro, depreciation period = 10 years
	Sale of the old equipment at 150.000 Euro
Environmental equipment	Waste Water treatment plant, residual book value of 360.000 Euro and a remaining depreciation period of 5 years (calculated from the annual depreciation of 72.000 Euro * 5 years)
Product	200.000 hl in Bottles, annual increase 10.000 hl
Operating Materials	Old: Leach 0,26 Euro * 0,5 kg = 0,13 Euro per hl beer
	New: Leach: 0,065 Euro per hl beer
	Old: Neutralisation agent: 10.500 Euro
	New: Neutralisation agent: 5.250 Euro
	Old: Operating materials waste water treatment: 16.350 Euro
	New: Operating materials waste water treatment: 8.175 Euro
Energy	Old: Fuel Oil: 75.000 Euro, 5 % annual price increase
	New: Fuel Oil: 60.000 Euro, 5 % price increase
	Old: Electricity: 4.125 Euro
	New: Electricity: 2.065 Euro
Water Input	Old: 0,05 Euro per hl bottled beer
	New: 0,025 Euro per hl bottled beer
Labour	Old and new: 27.300 Euro
External Services	Old: Maintenance: 6.850 Euro
	New: Maintenance: 3.425 Euro
Taxes, Fees	Old and new: Production permit: 5.000
	Old: Sewage fee: 400.000 hl * 0,2 Euro = 80.000, but relating it to production volumes
	New: Sewage fee: 200.000 hl * 0,2 Euro = 40.000, but relating it to production volumes

After the operational steps, similar to those described above, the Incremental analysis for the DISCOUNTED CASH FLOW ON TOTAL INVESTMENT – TOTAL is displayed. The schedule shows the IRR (23.68%), NPV (€ 291,940.88) and Payback periods (static: 5.02 years; dynamic: 6.24 years at 10% discounting) of the effect from the technological change from the 'as-is' to the new scenario

In addition the new equipment allows more flexibility in the increase in turnover as the company does no longer operate close to its capped emission permit for waste water. The security for operating within the boundaries of legal compliance thus also increased. The environmental impact is significantly reduced as well.

4.5.3. Investment appraisal for a whole company

As already indicated in previous chapters, the complete investment appraisal for the complete project follows the methodology outlined in the following UNIDO publications:

- Manual for the Preparation of Industrial Feasibility Studies,
- COMFAR III manuals (Reference and Tutorial), and
- IPPA – Investment Project Preparation and Appraisal, Volume 1 – 7.

Therefore this compendium manual is not further describing the related methodology as well as its application within COMFAR *III*.

5. Beer BREWING PROJECT

This exercise is intended to introduce a new user to the basic concepts and procedures of COMFAR *III Expert* in particular with the new project type *Environmental accounting*.. Only financial analysis is performed. Data are kept to a minimum to concentrate on the main features of the program. The program features, which are not used in this case study are not explained here. Please refer to the *Reference Manual*.

The objective of the exercise is to produce the following pro-forma financial statements and performance indicators:

- Cash flow for financial planning
- Discounted cash flow, total capital invested, NPV, NPVR, IRR
- Discounted cash flow, total equity invested, NPV, IRR, Short NPV
- Break-even point
- Incremental analysis

Data concerning all aspects of the project including currency exchange rates, initial fixed investment, production costs, sales programme, working capital requirements and financial conditions are provided in the appropriate sections below.

> Note: Every save operation (**Save Project as** in the FILE Menu) in this manual is described using names equal to the project files delivered with COMFAR *III Expert*. If you do not want to overwrite these original project files, please use other filenames as described in this manual.

5.1 START COMFAR

The procedure for starting COMFAR is described in chapter III in the *Reference Manual*. When COMFAR is started, the browser and browser overview panels are displayed with the menu bar at the top of the window.

5.2 SELECT PROJECT TYPE AND LEVEL OF ANALYSIS

1. Choose **New Project** in the FILE menu. The NEW PROJECT modal window is displayed.
2. Select **Industrial** in the PROJECT TYPE list box.
3. Select the **Opportunity study** radio button.
4. Choose the **OK** pushbutton.

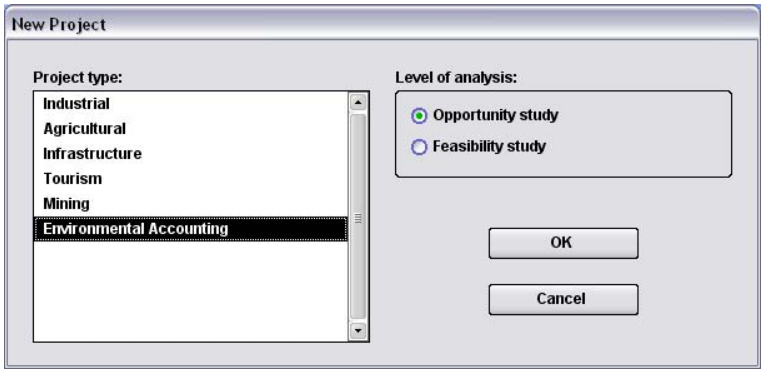


Figure 17: New project modal window

The PROJECT INPUT DATA node is displayed with the Compress Icon at the right, indicating that the node is extended. The initial data entry sequence starts with the PROJECT IDENTIFICATION node, which is also displayed. This sequence involves from five to eight nodes depending upon the complexity of

the analysis, each of which is displayed only after data in the previous node are accepted (with **OK**). The specific number of nodes in the sequence is determined by the project features selected in the PROJECT IDENTIFICATION window.

5.3 FINANCIAL DATA ENTRY

The first version of the data file does not include the plan for financing the project. The program is used to assist in determining an appropriate plan.

5.3.1. Project identification

1. Move the mouse cursor inside the browser overview frame. The cursor changes to the move cursor. Drag the frame so that the PROJECT INPUT DATA node and PROJECT IDENTIFICATION node are displayed in the browser.

   The purpose of this step is to become familiar with the use of the browser overview frame for viewing segments of the browser. Alternatively, the browser position can be altered by placing the cursor within the browser, clicking and holding the left mouse button. When the hand cursor appears, the viewing position in the browser is changed by moving the mouse. When in an acceptable position, release the mouse button.
2. Choose the Table Icon for the PROJECT IDENTIFICATION node. The PROJECT IDENTIFICATION window is displayed.

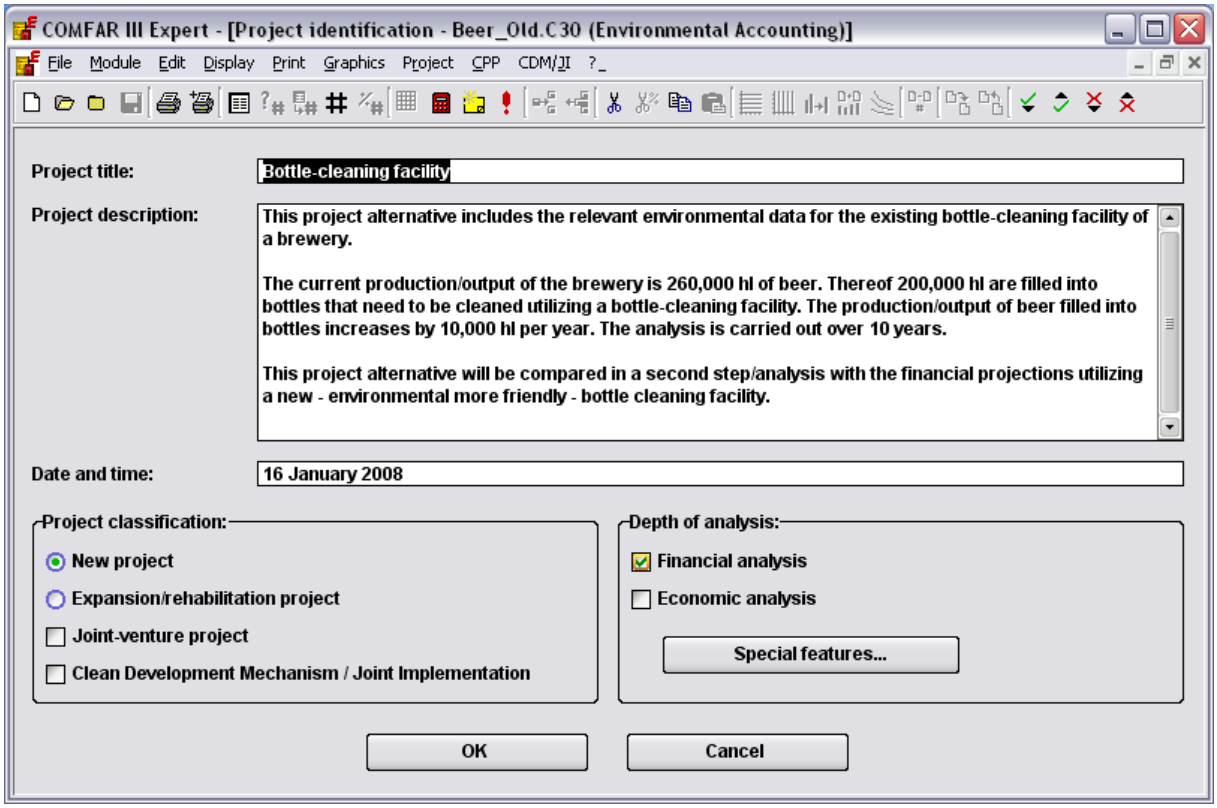


Figure 18: Project identification window

3. Select the PROJECT TITLE entry field and enter the name of the project, **Bottle cleaning facility**.
4. Select the PROJECT DESCRIPTION multiple-line entry field and enter descriptive text for the project, for example as indicated on the screen dump above.
5. Select the DATE AND TIME entry field and enter the date and time as text.

6. The **New project** radio button is selected by default.
7. The FINANCIAL ANALYSIS check box is selected by default. Economic analysis and special features are not used in this case study.
8. Choose the **Special features** pushbutton. The SPECIAL FEATURES modal window is displayed.
9. Accept the defaults in the SPECIAL FEATURES modal window with the **OK** pushbutton. Control returns to the PROJECT IDENTIFICATION window.

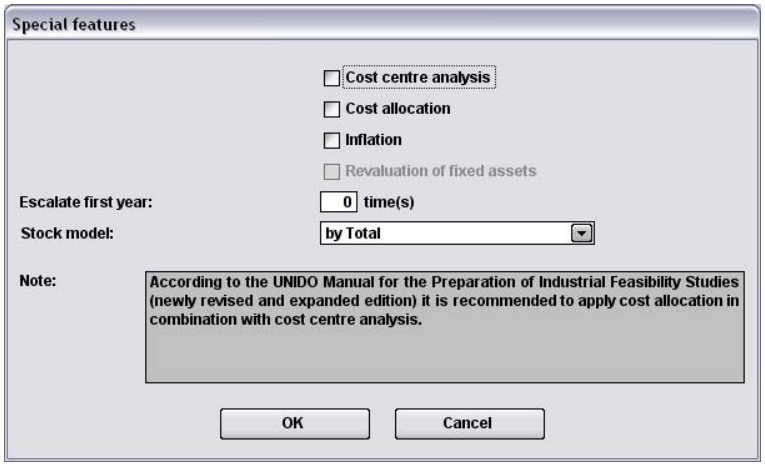


Figure 19: Special features modal window

5.3.2. Planning horizon

The planning horizon comprises one year of construction and 10 years of production. Planning during construction is yearly.

1. Choose the Table Icon for the PLANNING HORIZON node. The PLANNING HORIZON window is displayed. The insertion point is located by default in the BEGIN field of the CONSTRUCTION PHASE panel.

   Fields are most easily traversed using [**TAB**] but can also be selected with the mouse. Data entries in fields are most readily accepted with [**ENTER**] or by selecting another field with the mouse.
2. Select **12** in the MONTH OF BALANCE drop-down list box (12 is the default value).
3. Enter the beginning date, **1/2008,** in the BEGIN field of the CONSTRUCTION PHASE panel.
4. Enter **1** in the LENGTH-YEARS field.
5. Leave the value **0** in the MONTHS field.

   The END field in the CONSTRUCTION PHASE panel automatically displays the end date **12/2008,** (the last day of December, year 1). The BEGIN field in the PRODUCTION PHASE panel automatically displays the beginning date of the production phase, **1/2009** (first day).
6. Enter **10** in the LENGTH-PERIODS field of the PRODUCTION PHASE panel. The project **End** date is automatically displayed (**12/2018**). A **Reference date** can be selected as the last day of any production phase period. The reference date is significant for calculating representative results, such as break-even. In this case, the date **12/2009** is selected.
7. Choose **12/2009** in the REFERENCE YEAR drop-down list box.
8. Choose **OK** in the PLANNING HORIZON window. Control returns to the browser. The PRODUCTS node is displayed.

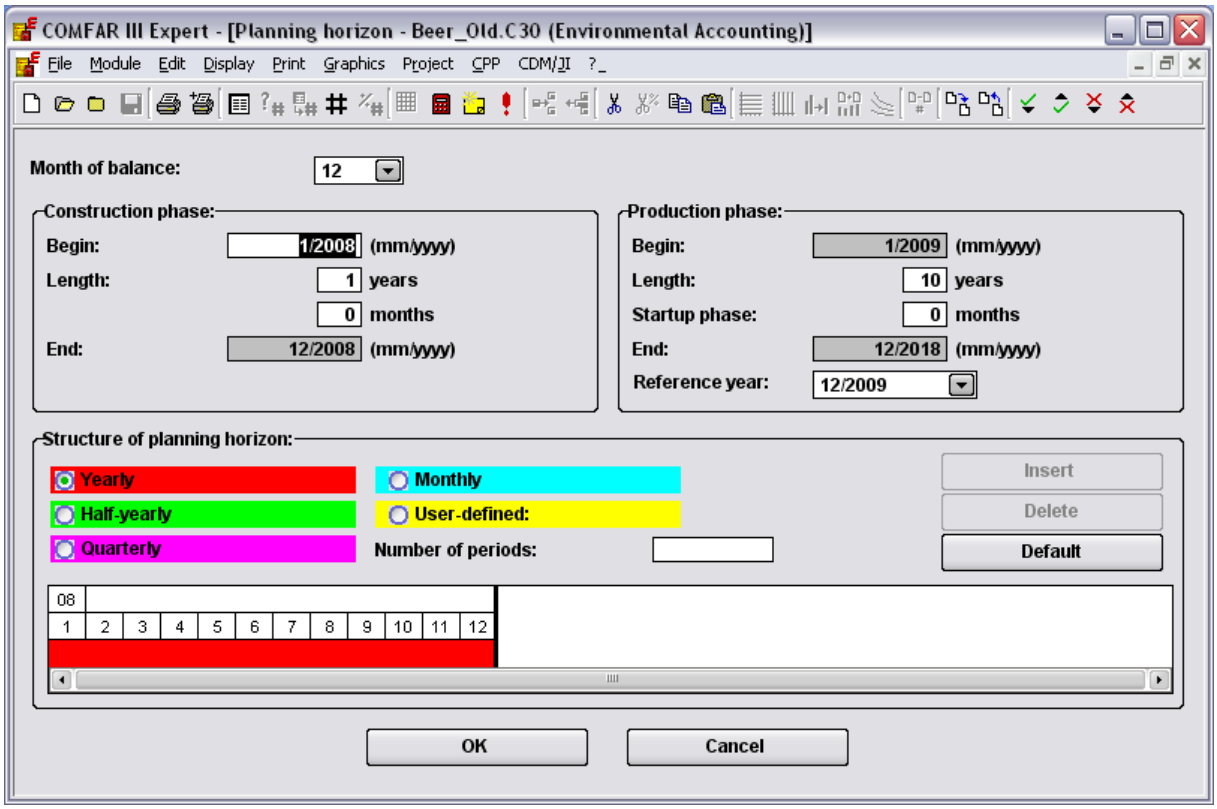


Figure 20: Planning horizon window

5.3.3. Products

The planned product is Beer (in bottles). The initial nominal capacity is 200,000hl per annum, increasing by 10,000hl every year of operation.

1. Choose the Table Icon for the PRODUCTS node. The PRODUCTS window is displayed. For a new project, COMFAR offers one product named "Product #".
2. Choose the **Edit** pushbutton to sequentially enter in the EDIT panel the **Name**, **Actual start of production** (**1/2009**), **Actual end of production** (**12/2018**) and **Nominal capacity** as specified above.
3. Choose the **Accept Edit** pushbutton to transfer the entries to the PRODUCTS list box.
4. Choose **OK** in the PRODUCTS window. Control returns to the browser. The CURRENCIES node is displayed.

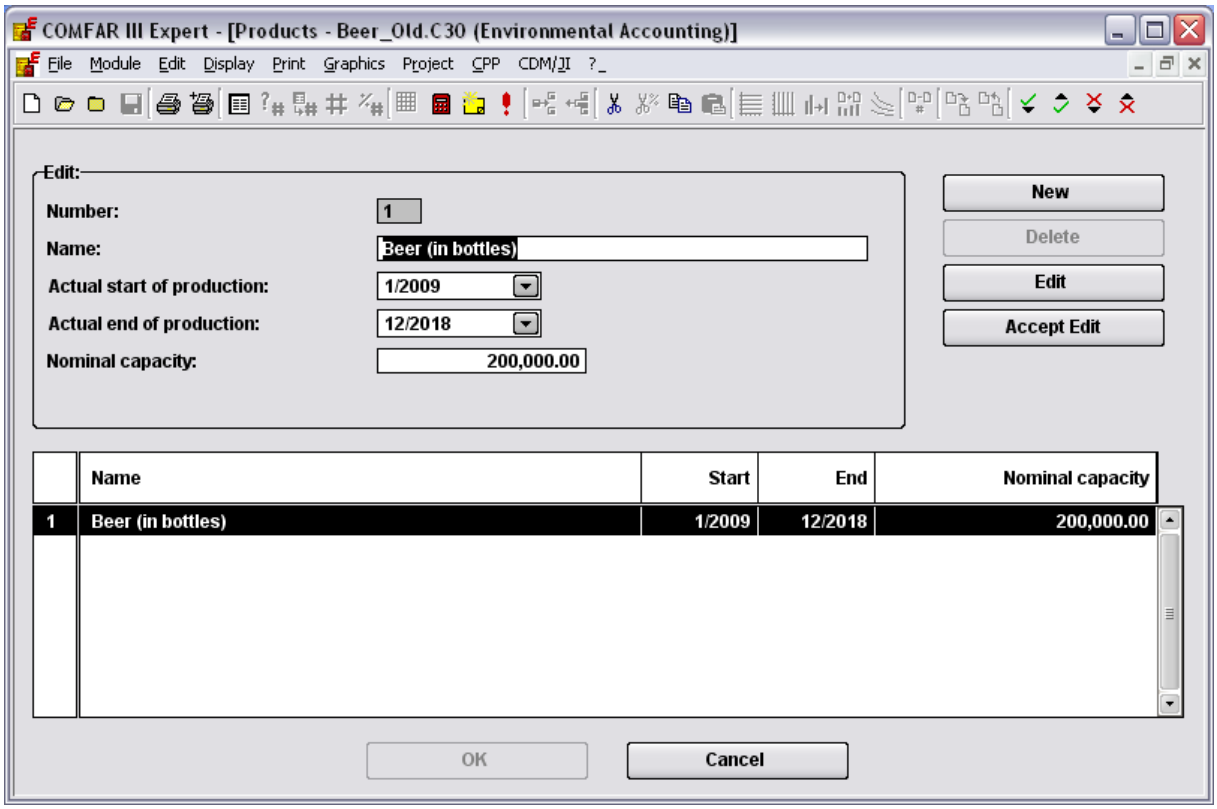


Figure 21: Products window

5.3.4. Currencies

The local currency is Euro. No other export currency is defined. All reports are expressed in the accounting currency, Euro.

1. Choose the Table Icon for the CURRENCIES node. The CURRENCIES window is displayed. For a new project, COMFAR offers the local currency as defined in the DEFAULTS modal window (*Reference Manual,* chapter V.C).
2. Choose the **Edit** pushbutton to sequentially enter in the EDIT panel the **Name** (Euro) and the **Abbreviation** (€) of the local currency. In this case EXCHANGE RATE field is inactive. TYPE is a display field only (local or foreign).
3. Choose the **Accept Edit** pushbutton to transfer the entries to the CURRENCIES list box.
4. Accept the selections with the **OK** pushbutton in the CURRENCY window. Control returns to the browser. The DISCOUNTING node is displayed.

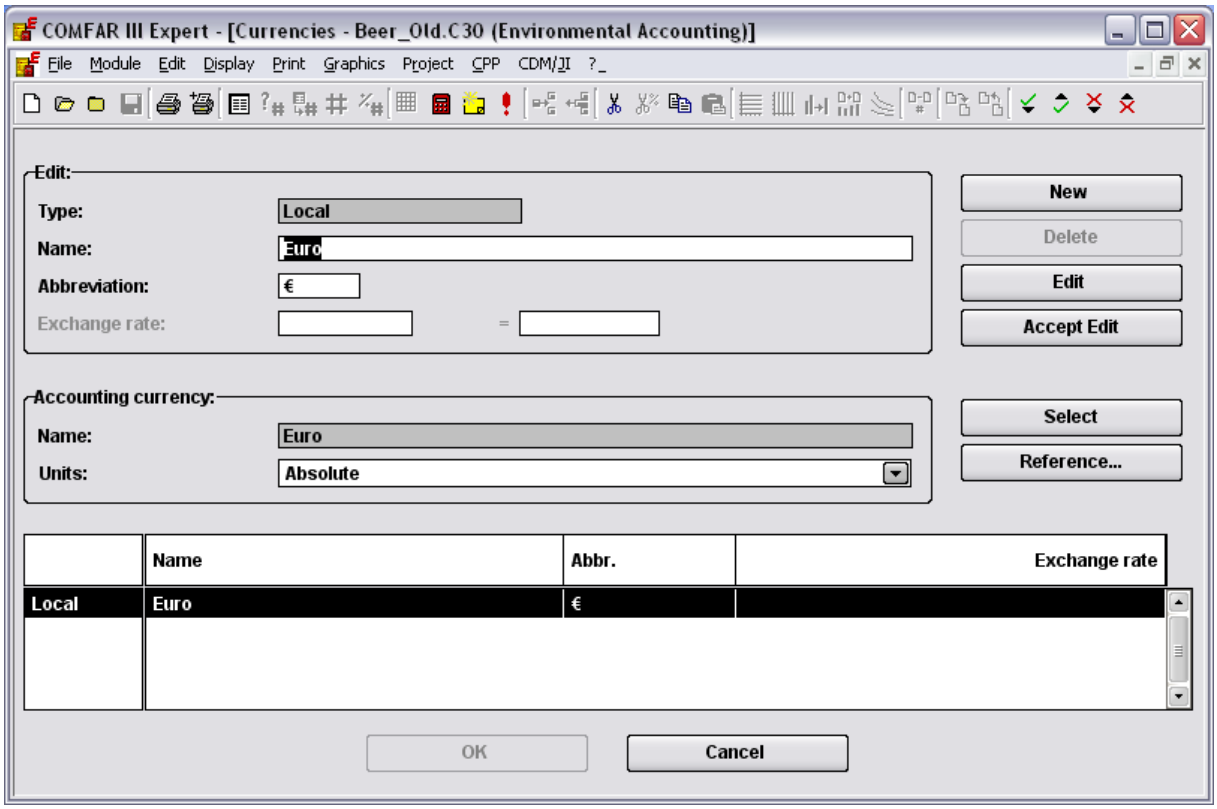


Figure 22: Currencies window

5.3.5. Discounting

The opportunity cost of capital for the total investment and for the equity is 10%. The MIRRs is not taken into account for this project.. The number of years for the Short NPV on equity is 10.

1. Choose the Table Icon for the DISCOUNTING node. The DISCOUNTING window is displayed.
2. Select the **Discounting** tab (it should already be selected by default). The DISCOUNTING list box appears in the window.
3. Enter for TOTAL INVESTMENT **10**% for the **Rate** and for TOTAL EQUITY CAPITAL **10**% and **10** (years) for **Rate** and **Length**. (*see Reference Manual,* chapter IV.3).
4. Select the **Net present values discounted to** drop-down list box. All values are to be discounted to **12/2008**.
7. Accept the selections with the **OK** pushbutton. The nodes for the remaining standard structure are displayed in the browser.

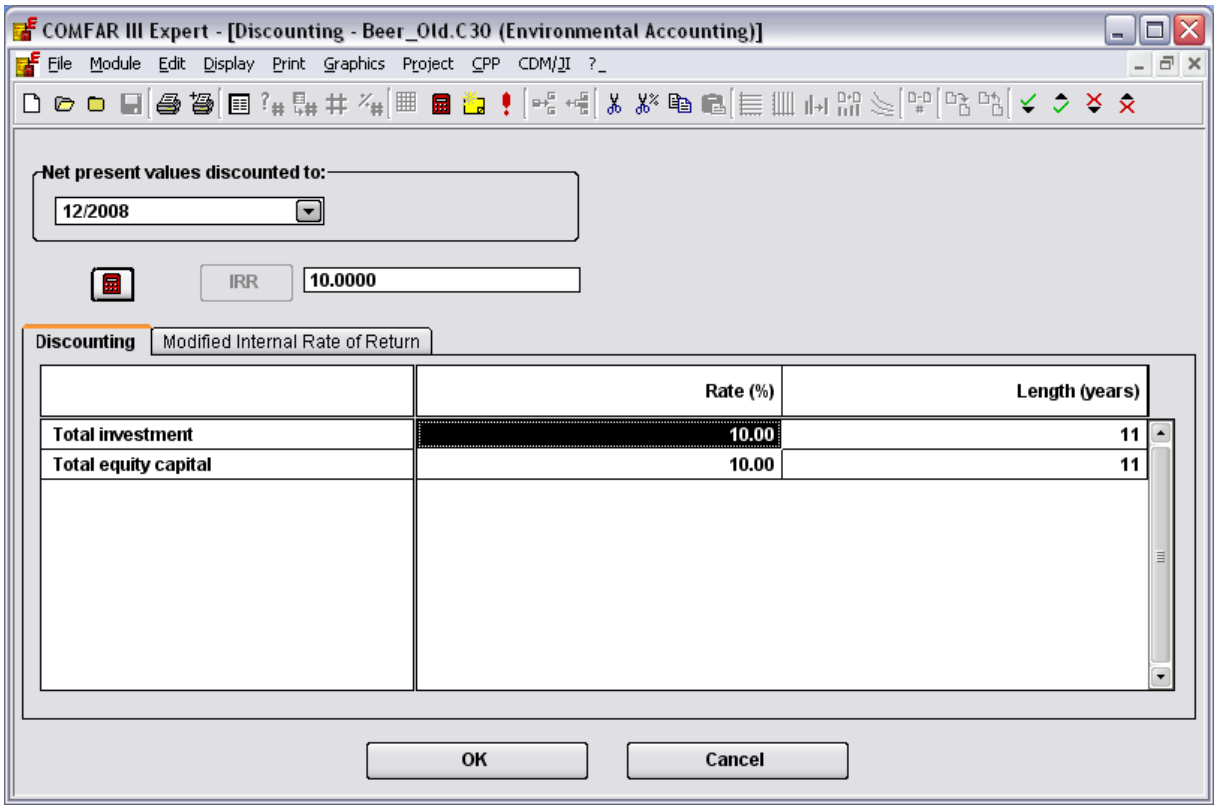


Figure 23: Discounting window

5.3.6. Fixed investment costs

Fixed investment costs are defined in the windows corresponding to subnodes of the FIXED INVESTMENT COSTS node.

- Choose the Extend Icon of the FIXED INVESTMENT COSTS node.

The structure of fixed investment costs is displayed with a node for each cost category included in the standard structure. To center those nodes on the screen, alter the position of the browser (see chapter II.C.1).

Fixed investment costs are shown in table 1 with depreciation conditions, scrap value and the investment in each of the two years of construction.

	MARKET	CURRENCY	NO. YEARS DEPRECIATION [a]	SCRAP-VALUE [a]	INVESTMENT COSTS 2008
Plant machinery and equipment	Local	€	3	0	150,000
Environmental protection equipment	Local	€	5	0	360,000

Table 1: Fixed investment costs

1. Choose the Table Icon for the PLANT MACHINERY AND EQUIPMENT node. The PLANT MACHINERY AND EQUIPMENT window is displayed.
2. Select **Euros** in the CURRENCY drop-down list box.
3. Select the **Local** radio button to designate the origin of the item.

[a] Depreciation type: linear to scrap, all items.

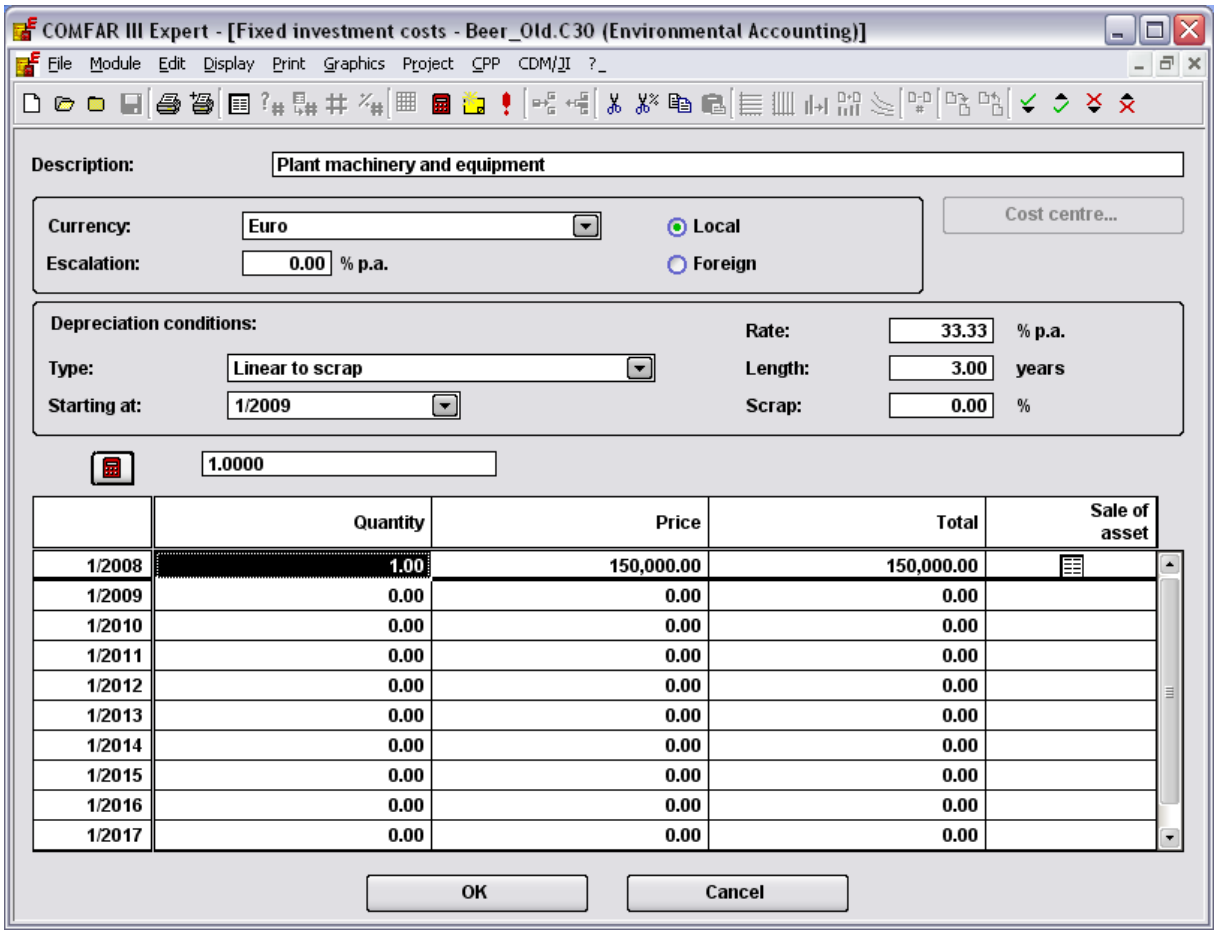


Figure 24: Plant machinery window

4. Select **Linear to scrap** from the TYPE drop-down list box in the DEPRECIATION CONDITIONS panel (unless displayed as the default value).
5. Use the STARTING AT drop-down list box to select the starting date of depreciation as the start of production (**1/2009**), which should be displayed as the default value.
6. Select the LENGTH entry field and enter the value **3**. The RATE entry field automatically displays the corresponding rate of the depreciation, **33.33 %**, when the length is accepted by pressing either [**ENTER**] or [**TAB**]. Alternatively, enter the number of rate and the corresponding length is automatically displayed.
7. Select the SCRAP entry field and enter **0** (scrap value as % of the original asset value).
8. Use the iconic buttons and list box to enter the data in table 1 for PLANT MACHINERY (all values are expressed in Euro).
9. Accept the data with the **OK** pushbutton.
10. Enter all other cost items shown in table 1.
11. Choose the Compress Icon of the FIXED INVESTMENT COSTS node.

5.3.7. Production costs

All production costs are entered as STANDARD PRODUCTION COSTS. Initial stocks of raw materials and factory supplies (initial working capital) which are purchased in the second construction year are entered as ANNUAL ADJUSTMENTS (see below).

Production costs are defined in the windows corresponding to subnodes of the PRODUCTION COSTS node.

- Choose the Extend Icon for the PRODUCTION COSTS node by clicking the **right (!)** mouse button.

The structure of production costs is displayed with a node for each cost category included in the standard structure.

The production costs at maximum sales level of 200,000 hl and the percentage variable is shown in table 2. All values are local and are expressed in Euro.

For a detailed description how to create subnodes, as for example necessary in the case of OPERATING MATERIALS, please refer to the COMFAR III Reference manual, or to the COMFAR III Tutorial manual.

1. Select the OPERATING MATERIALS node.
2. Choose **Insert** in the EDIT menu. The INSERT NEW ITEMS modal window is displayed.
3. Select the **User-defined** radio button.
4. Select the NUMBER OF ITEMS entry field and type **4**, then press [**ENTER**].
5. Use the iconic buttons and list box to edit the names of the four raw material subnodes as described in table 3 below.
6. Accept the data with the **OK** pushbutton. The newly created nodes appear in the browser as subnodes of the OPERATING MATERIALS node.

ITEM	INPUT MODE	ANNUAL COST (Euro)		
		QUANTITY	PRICE	VARIABLE (%)
Operating materials				
Lye	Per unit of output	0.26	0.5	n.a.
Neutralization means	At nominal capacity	0.3	35,000	100
Other operating materials	At nominal capacity	0.3	54,500	100
Maintenance (external services)	At nominal capacity	0.3	13,700	100
Energy				
Steam (bottle-cleaning facility)	At nominal capacity	150,000	0.5	100
Electricity (waste water treatment)	At nominal capacity	0.3	13,750	100
Water	Per unit of output	1.0	0.05	n.a.
Labour (Waste water unit)	At nominal capacity	1.0	27,300	0
Environmental fees				
Facility permit (waste water treatment))	At nominal capacity	1.0	5,000	0
Waste water treatment fee	At nominal capacity	400,000	0.2	100

Table 2: Production costs

Below, the procedure is described for defining the OPERATING MATERIALS - LYE costs. for these and the other production cost items, the standard costs are defined on the basis of AT NOMINAL CAPACITY or PER UNIT OF OUTPUT in a manner similar to that for LYE.

1. Choose the Table Icon for the OPERATING MATERIALS - LYE node.
2. Select **Euro** as the currency using the CURRENCY drop-down list box (default selection).
3. Select the **Local** radio button (default selection).
4. Select the **Standard production costs** panel (default selection).
5. Select the **Per unit of output** radio button (not default selection!).

6. Select the QUANTITY field and enter the value **0.26**.
7. Select the PRICE field and enter the value **0.5**.
8. For OPERATING MATERIALS - LYE no fixed/variable proportion needs to be defined. For those items that are specified AT NOMINAL CAPACITY select the VARIABLE PART field and enter the value (e.g. **100** default value).
9. Enter all other production cost items according to table 2 (standard production costs).

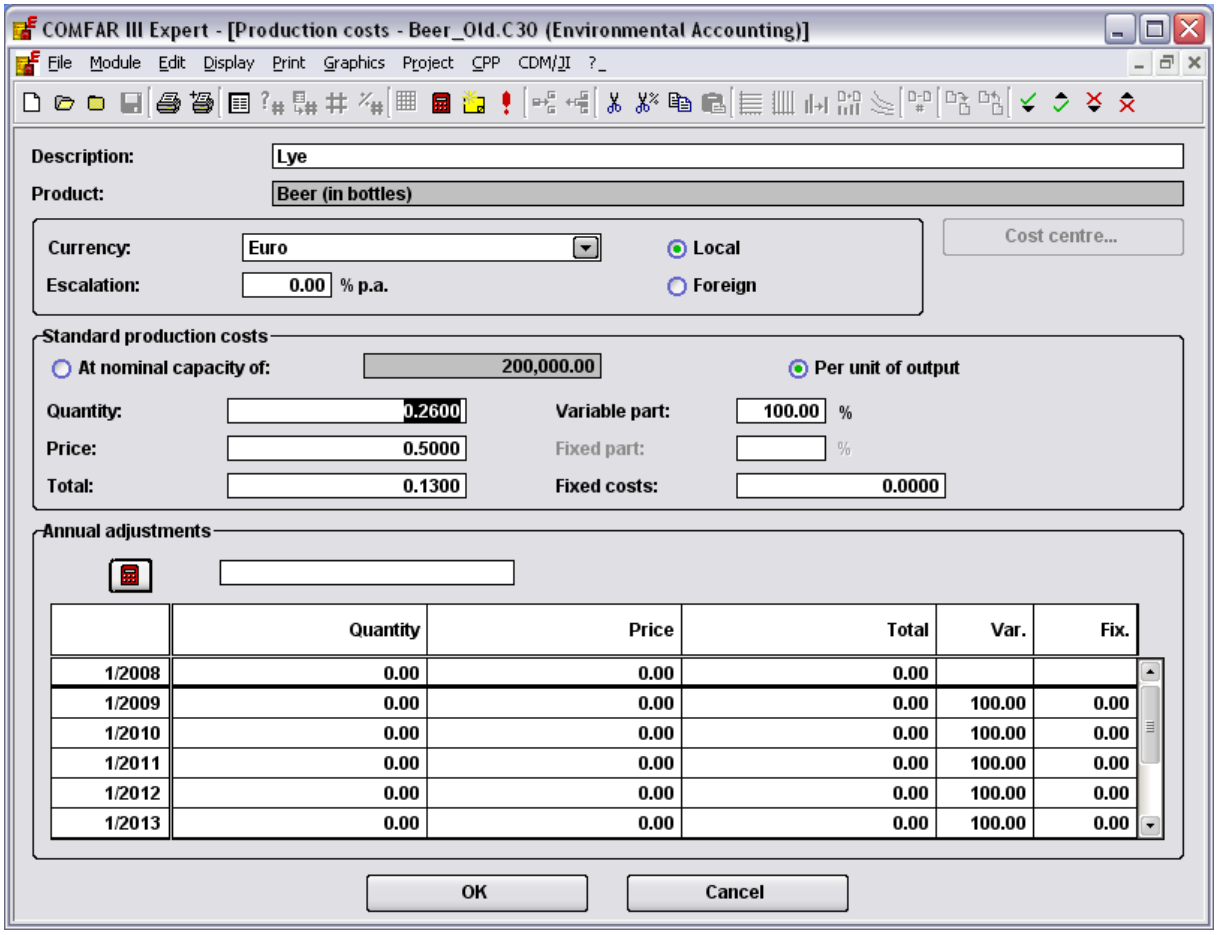


Figure 25: Tomato window - standard production costs panel

5.3.8. Sales programme

The sales programme is defined in the windows of the respective subnodes of the SALES PROGRAMME node. For this particular exercise only the quantities (initially 200,000hl with an annual increase of 10,000hl) need to be defined.

- Choose the Extend Icon of the SALES PROGRAMME node.

The structure of the sales programme is displayed with a node for each product defined before (see chapter above). The proposed sales programme is shown in table 3. All production is local.

1. Choose the Table Icon for the BEER IN BOTTLES node.
2. Select **Euro** using the CURRENCY drop-down list box.
3. Select the **Local** radio button.

4. Use the iconic buttons and list box to enter the **Quantity** for each production period (the price is neglected since it will not change in the new compared to the 'as-is' situation).

PERIOD	QUANTITY (thousands)
1/2009	200,000
1/2010	210,000
1/2011	220,000
1/2012	230,000
1/2013	240,000
1/2014	250,000
1/2015	260,000
1/2016	270,000
1/2017	280,000
1/2018	290,000

Table 3: Data for quantity

5. Accept the data with the **OK** pushbutton.
6. Choose the Compress Icon of the SALES PROGRAMME window.

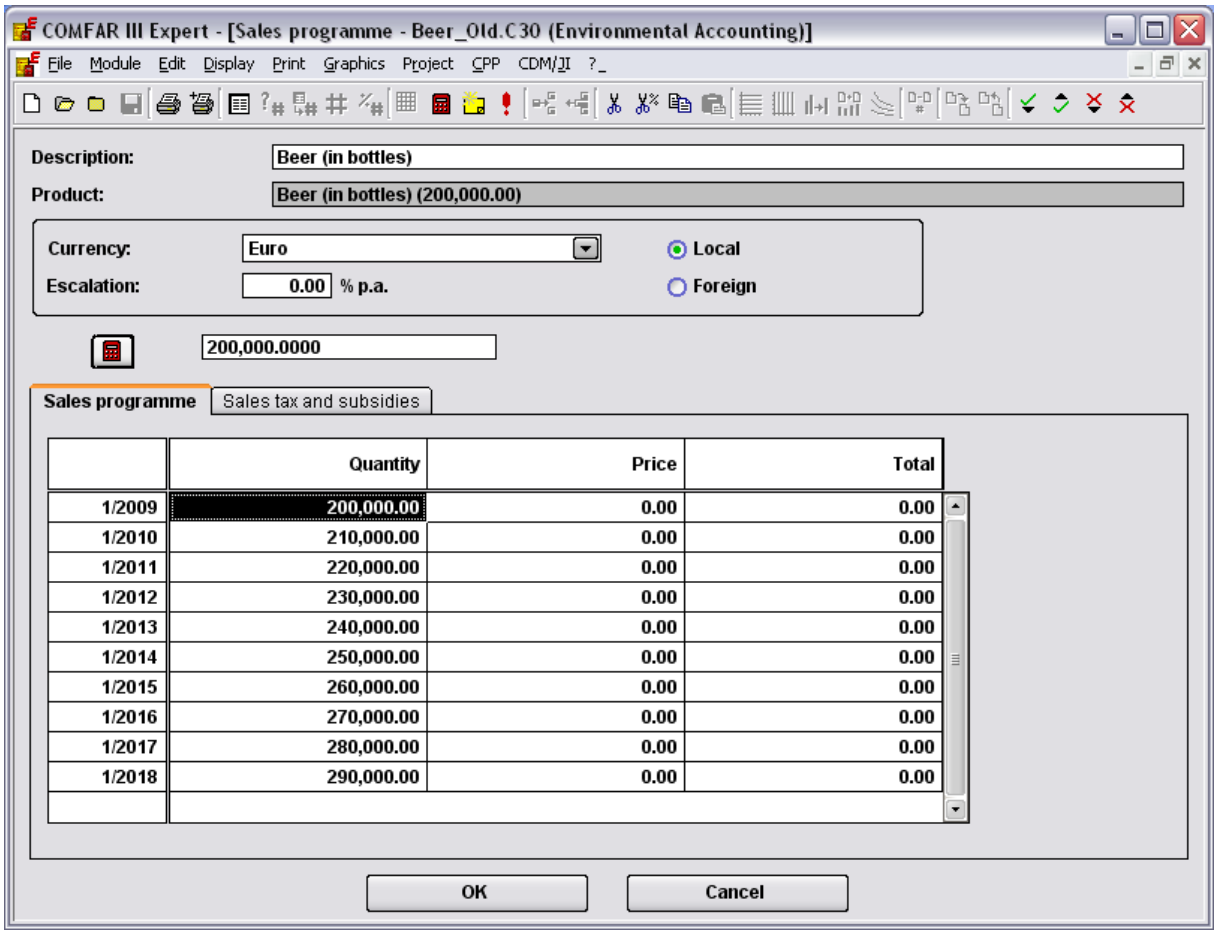


Figure 26: Sales programme window with sales programme panel

5.3.9. Working capital

Working capital requirements during the production phase are to be neglected in this example. All MINIMUM DAYS COVERAGE (Mdc) have to be set to 0

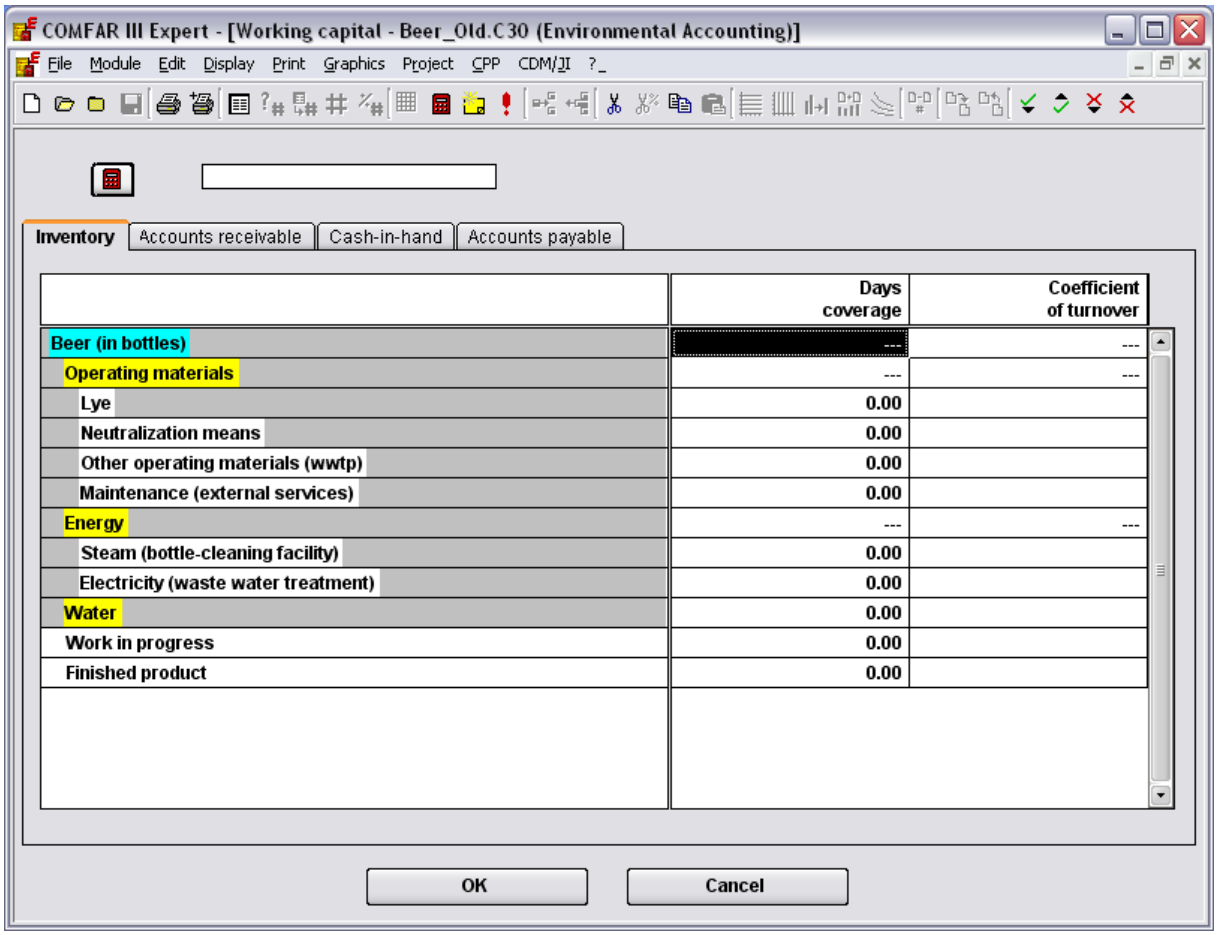


Figure 27: Working capital window

1. Choose the Table Icon for the WORKING CAPITAL node. The WORKING CAPITAL window is displayed.
2. Select the **Inventory** tab. The INVENTORY list box is displayed.
3. Use the iconic buttons to enter **0** for DAYS COVERAGE of INVENTORY
4. Select the **Accounts receivable** tab.
5. Use the iconic buttons to enter **0** for DAYS COVERAGE of ACCOUNTS RECEIVABLE.
6. Select the **Cash-in-hand** tab.
7. Use the iconic buttons to enter **0** for both DAYS COVERAGE of CASH-IN-HAND - LOCAL and CASH-IN-HAND - FOREIGN.
8. Select the **Accounts payable** tab.
9. Use the iconic buttons to enter **0** for the DAYS COVERAGE of ACCOUNTS PAYABLE.
10. Accept the selections with the **OK** pushbutton.

The project should now be saved in the original state without the definition of sources of finance, profit distribution and income tax definitions. Please note that the below figure may differ depending on the project files stored on your computer.

1. Choose **Save Project as** in the FILE menu. The SAVE PROJECT AS modal window is displayed. The FILE NAME entry field is automatically selected.
2. Enter the name of the file, **BEER_OLD,** in the FILE NAME entry field (please refer to the note given at the beginning of this chapter).
3. Save the file by choosing the **SAVE** pushbutton. Control returns to the input browser.

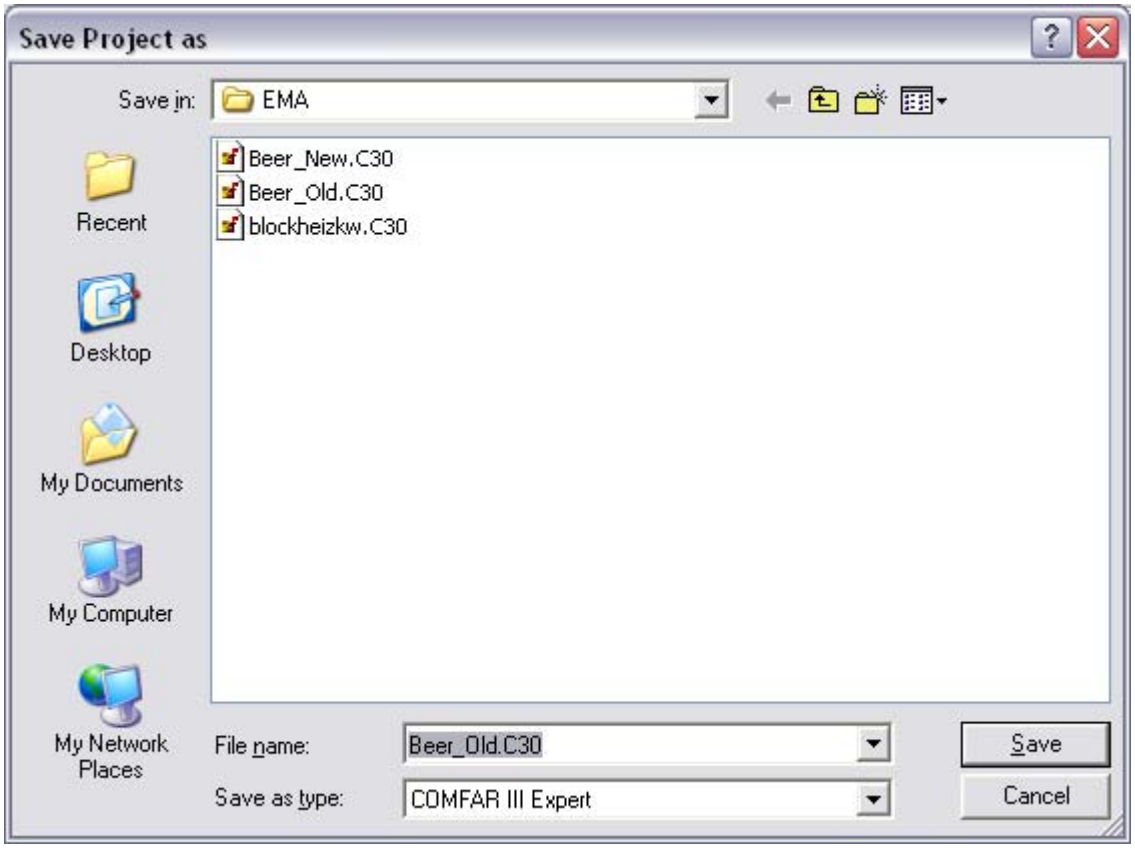


Figure 28: Save project as modal window

5.4 INITIAL CALCULATIONS

Initial calculations are performed to determine the financial requirements of the project. If no sources of finance are defined, the program increases equity automatically during the construction phase to cover cash deficits. The cash flow for financial planning reveals the magnitude, type (foreign, local) and timing of the requirements from which the financing plan can be developed.

Reports to be calculated can be selected using the **Select results** feature of the MODULE menu. However, a number of results are calculated by default and these are sufficient to provide the required output for this exercise.

1. Choose **Calculations** in the MODULE menu. The CALCULATIONS modal window is displayed showing the list of reports to be produced. A Check Icon appears in the DONE column when the calculation of the listed item is complete.
2. Choose the **Start** pushbutton. When calculations are complete the window CALCULATION REPORT is displayed, indicating that the project is underfinanced. Furthermore, other errors/warnings are displayed, as already mentioned in a previous chapter of this manual. After accepting with the **OK** pushbutton, control automatically returns to the show results browser, from which the results to be displayed or printed can be selected. At this point the result of interest is the CASH FLOW FOR FINANCIAL PLANNING in the BUSINESS RESULTS structure.

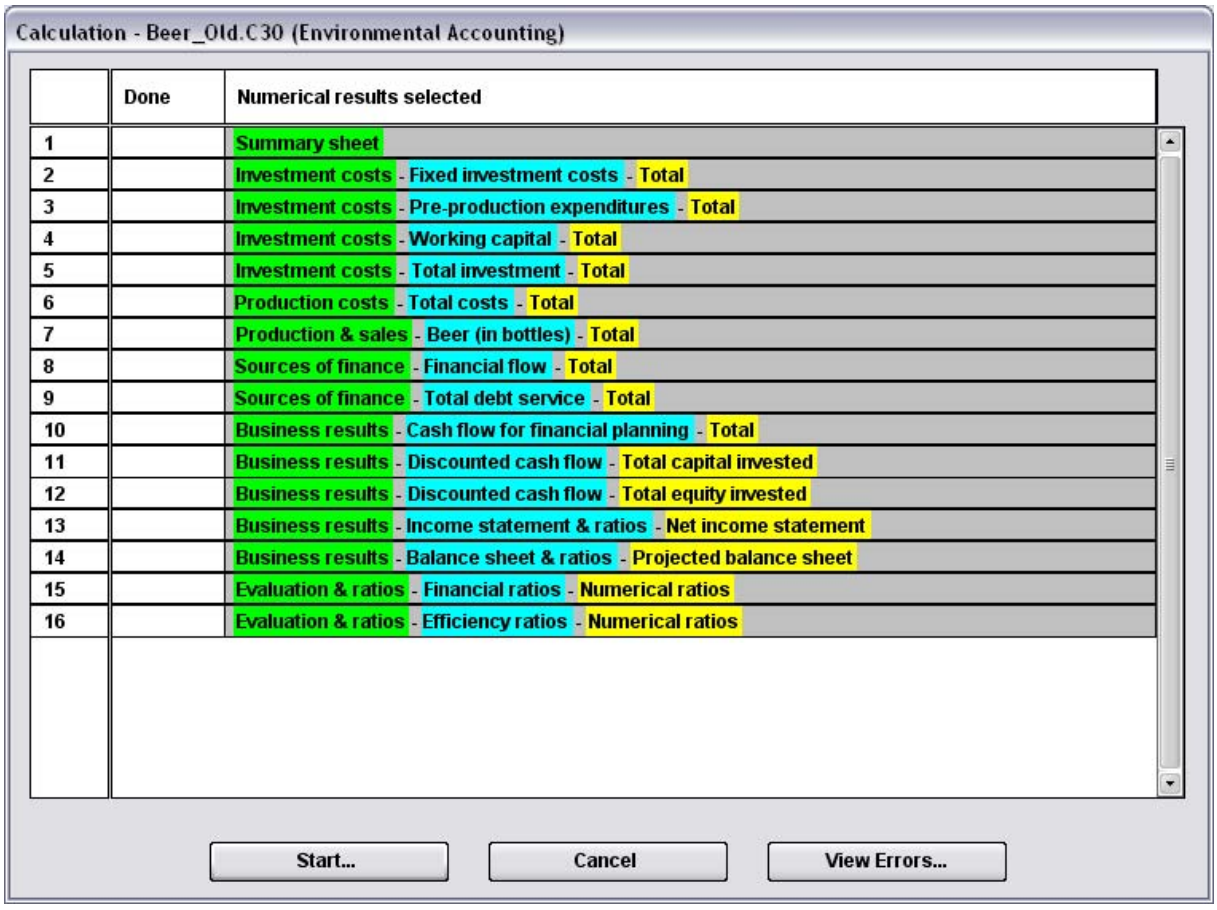
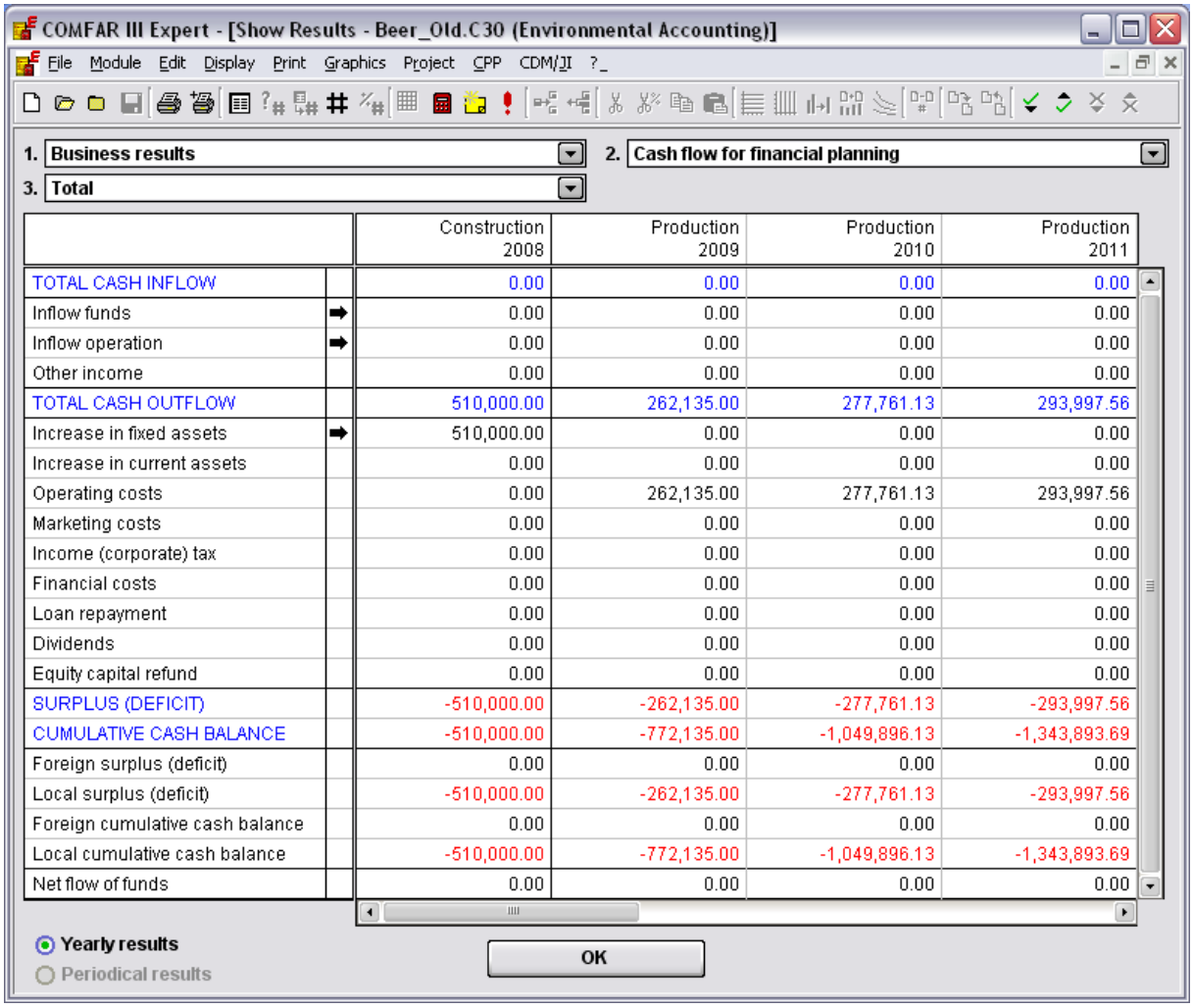


Figure 29: Calculation modal window

3. Choose the Extend Icon for the BUSINESS RESULTS node. The BUSINESS RESULTS structure is extended to reveal four nodes, the uppermost of which is the CASH FLOW FOR FINANCIAL PLANNING node, which is further extended by choosing its Extend Icon to reveal the TOTAL node (one of the default results).

4. Choose the Table Icon for the TOTAL node. The BUSINESS RESULTS/ CASH FLOW FOR FINANCIAL PLANNING/TOTAL result is displayed.



		Construction 2008	Production 2009	Production 2010	Production 2011
TOTAL CASH INFLOW		0.00	0.00	0.00	0.00
Inflow funds	➡	0.00	0.00	0.00	0.00
Inflow operation	➡	0.00	0.00	0.00	0.00
Other income		0.00	0.00	0.00	0.00
TOTAL CASH OUTFLOW		510,000.00	262,135.00	277,761.13	293,997.56
Increase in fixed assets	➡	510,000.00	0.00	0.00	0.00
Increase in current assets		0.00	0.00	0.00	0.00
Operating costs		0.00	262,135.00	277,761.13	293,997.56
Marketing costs		0.00	0.00	0.00	0.00
Income (corporate) tax		0.00	0.00	0.00	0.00
Financial costs		0.00	0.00	0.00	0.00
Loan repayment		0.00	0.00	0.00	0.00
Dividends		0.00	0.00	0.00	0.00
Equity capital refund		0.00	0.00	0.00	0.00
SURPLUS (DEFICIT)		-510,000.00	-262,135.00	-277,761.13	-293,997.56
CUMULATIVE CASH BALANCE		-510,000.00	-772,135.00	-1,049,896.13	-1,343,893.69
Foreign surplus (deficit)		0.00	0.00	0.00	0.00
Local surplus (deficit)		-510,000.00	-262,135.00	-277,761.13	-293,997.56
Foreign cumulative cash balance		0.00	0.00	0.00	0.00
Local cumulative cash balance		-510,000.00	-772,135.00	-1,049,896.13	-1,343,893.69
Net flow of funds		0.00	0.00	0.00	0.00

Figure 30: Business results - cash flow for financial planning - total result

5. Use the vertical scroll bar to move to the bottom of the table so that the SURPLUS/DEFICIT line and FOREIGN and LOCAL surplus/deficit lines are revealed for the first year of the project. The data for the first year is as follows (all expressed in the accounting currency, Eurothousand rupees):

ITEM	YEAR
	2008
Surplus/deficit (total)	-510,000

Table 7: Data for total surplus/deficit

6. Accept the result with the **OK** pushbutton. Control returns to the Show results browser.

5.5 FINANCE PLAN AND DATA ENTRY

For simplicity reasons, the complete deficit (510,000) is to be covered by equity capital For other projects a combination of debt/equity financing might be considered.

- Choose **Data Input** in the MODULE menu.

The data input browser is displayed. Data can now be entered in the SOURCES OF FINANCE structure for equity and the loan and in the TAXES, ALLOWANCES node for the corporate tax conditions.

5.5.1. Equity

1. Extend the SOURCES OF FINANCE and then the EQUITY/RISK CAPITAL node by successively clicking the Extend Icon with the left mouse button at each level.
2. Choose the Table Icon for the EQUITY SHARES node (subnode of EQUITY/RISK CAPITAL). The EQUITY SHARES window is displayed. No entries are necessary in the PREFERRED DIVIDENDS cells as all distributions are considered ordinary dividends.
3. Select **Euro** in the CURRENCIES drop-down list box (default selection).
4. Select the **Local** radio button (default selection).

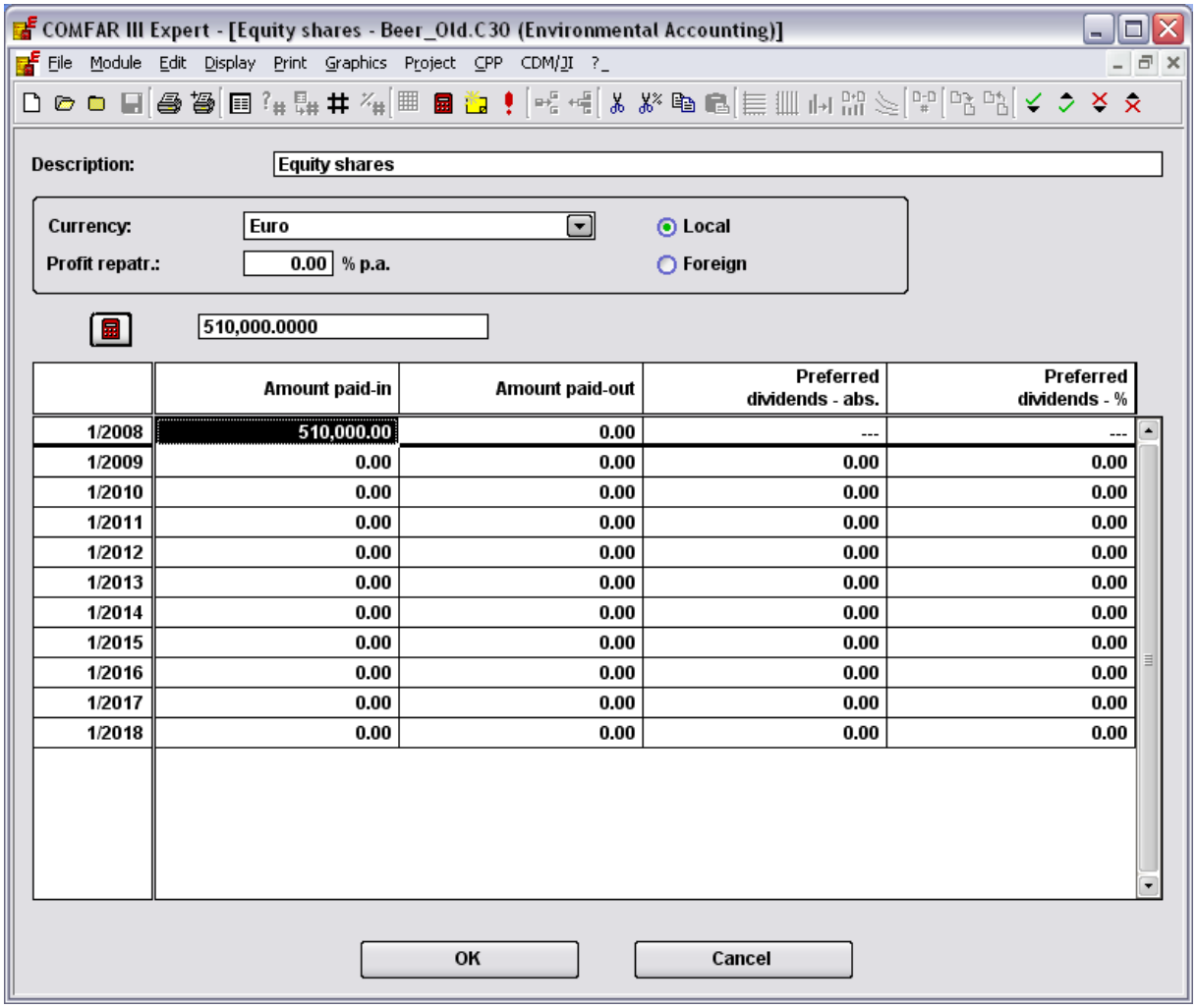


Figure 31: Equity shares window

5. Enter the equity value **510,000** for the first year of the project in the period 1/2008 using the iconic buttons and entry field.
6. Accept the data with the **OK** pushbutton. Control returns to the browser.

Prior to saving the project file the PROJECT DESCRIPTION in the PROJECT IDENTIFICATION node is changed to indicate that this version includes the initial finance plan.

1. Choose the Table Icon for the PROJECT IDENTIFICATION node.
2. Change the text in the PROJECT DESCRIPTION multiple-line entry field to indicate that this version includes the finance plan for the project.
3. Accept the new project identification with the **OK** pushbutton in the PROJECT IDENTIFICATION window.

The project is now saved as described before. The FILE NAME for this version should be **BEER_OLD**. Please note that the COMFAR *III* CD-ROM includes the project file BEER_OLD.C30 for reference. You may therefore consider to use another file name (e.g. BEER_OLD_FINAL.C30).

As described in the previous chapters, the above project file (BEER_OLD.C30) represents the technological 'as-is' scenario. Exactly the same procedures have now to be performed in order to enter the technological new situation into COMFAR *III*. The data for this new situation are given in the respective tables in this chapter. The filenames to be used should be BEER_NEW.C30 (respectively BEER_NEW_FINAL.C30 if you apply a different file name as the reference example provided on the COMFAR *III* CD-ROM).

5.6 FINANCIAL CALCULATIONS, INCREMENTAL ANALYSIS

The procedures described in the precious chapters outline how to enter into COMFAR III Expert the technological 'as-is' situation as well as the new situation from the environmental point of view. This chapter will outline how to compare the two scenarios and to evaluate the cost savings of the new situation vis-à-vis the necessary additional investment.

Initially the two scenarios prepared above have to loaded into COMFAR *III* and calculations have to be performed. The below procedure describes how to load and calculate the 'as-is' scenario (BEER_OLD.C30). For the new scenario the same procedure has to be applied, using the respective filename (BEER_NEW.C30).

1. Choose **Load Project** in the FILE menu. The LOAD PROJECT modal window is displayed.
2. Select **Beer_Old.C30** in the FILENAMES list box.
3. Accept the selection with the **OPEN** pushbutton. The original case is now displayed. The data input browser is displayed. If not, choose **Data input** in the MODULE menu.

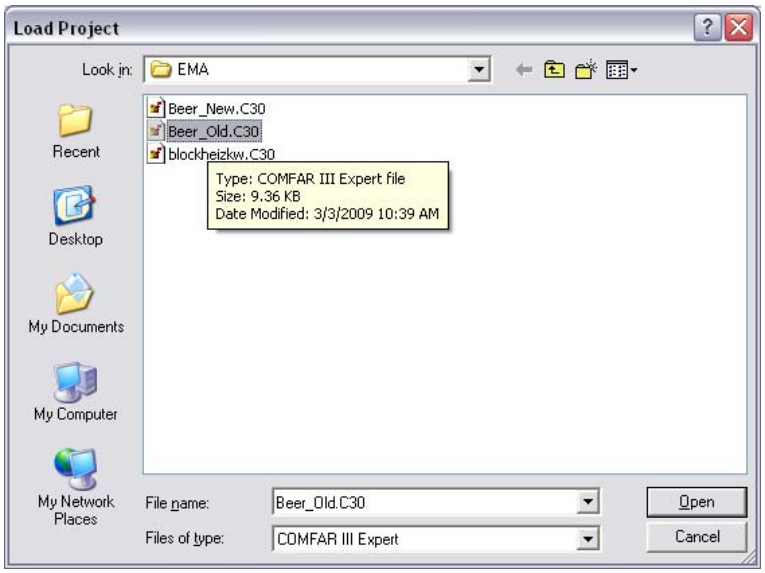


Figure 32: Load project modal window

Reports to be calculated can be selected using the **Select results** feature of the MODULE menu.

1. Choose **Select results** in the MODULE menu. The SELECT RESULTS is activated and the result tree appears.
2. Select all Business results available by clicking on the Check icon of the BUSINESS RESULTS node.

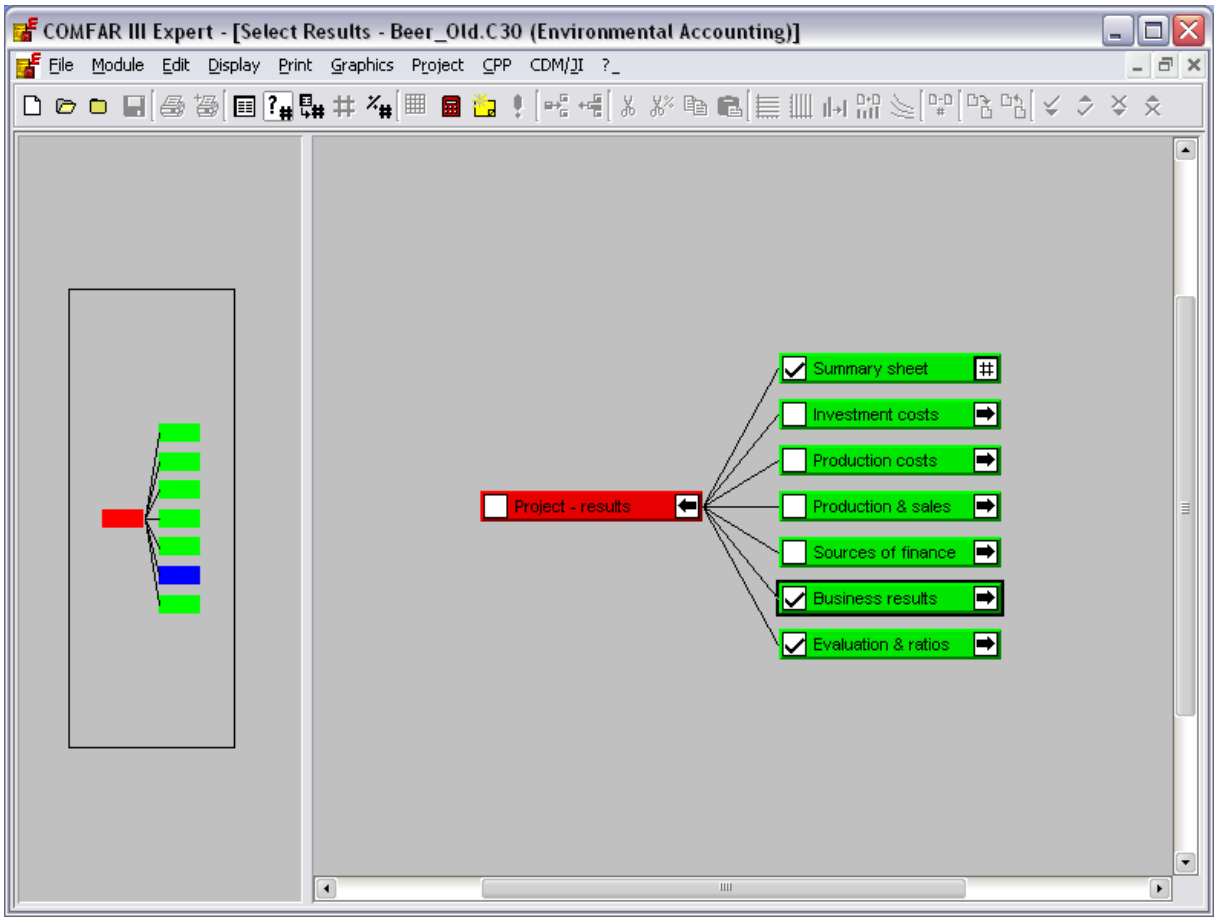


Figure 33: Select results module

Calculation is performed using the **Calculation** feature of the MODULE menu.

1. Choose **Calculations** in the MODULE menu. The CALCULATIONS modal window is displayed showing the list of reports to be produced. A Check Icon appears in the DONE column when the calculation of the listed item is complete.
2. Choose the **Start** pushbutton. When calculations are complete the window CALCULATION REPORT is displayed, indicating errors/warnings, as already mentioned in a previous chapter of this manual. After accepting with the **OK** pushbutton, control automatically returns to the show results browser, from which the results to be displayed or printed can be selected. At this point the result of interest is the CASH FLOW FOR FINANCIAL PLANNING as well as the DISCOUNTED CASH FLOWS in the BUSINESS RESULTS structure.

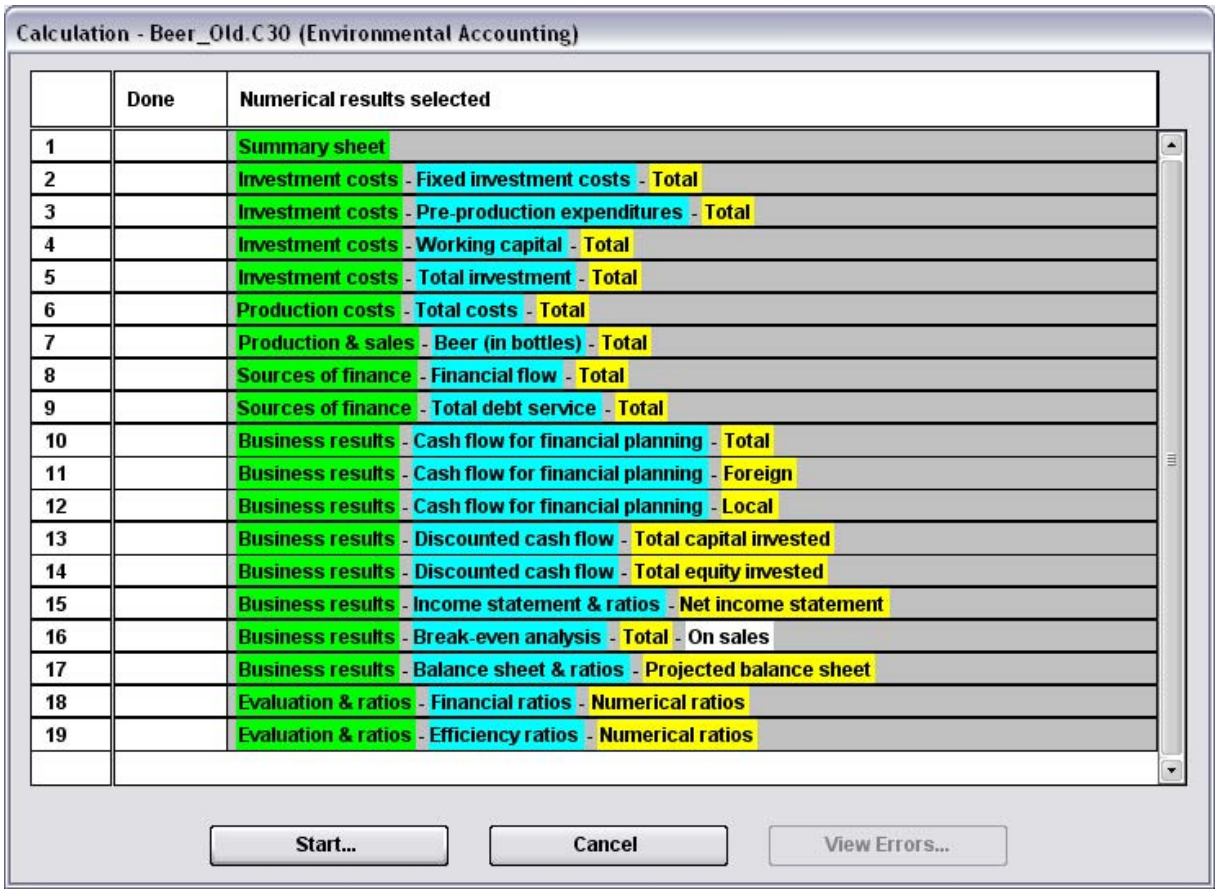


Figure 34: Calculation modal window

The same procedure for loading, selecting results and calculations has to be performed now for the new scenario (BEER_NEW.C30). Afterwards two projects (BEER_OLD.C30 and BEER_NEW.C30) are available for evaluation in COMFAR *III* (up to 5 projects could be loaded simultaneously).

To perform now 'Incremental analysis' select from the project BEER_OLD.C30 the schedule BUSINESS RESULTS - CASH FLOW FOR FINANCIAL PLANNING – TOTAL needs to be displayed.

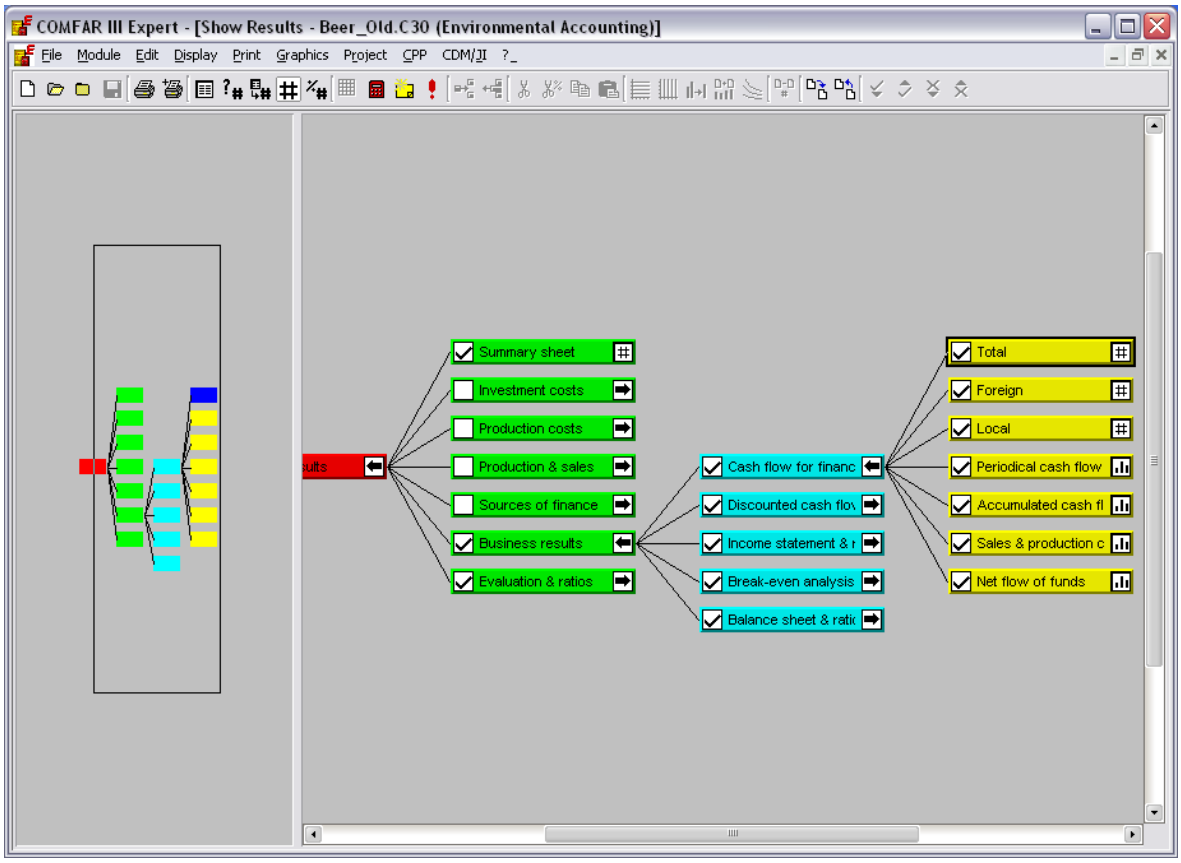
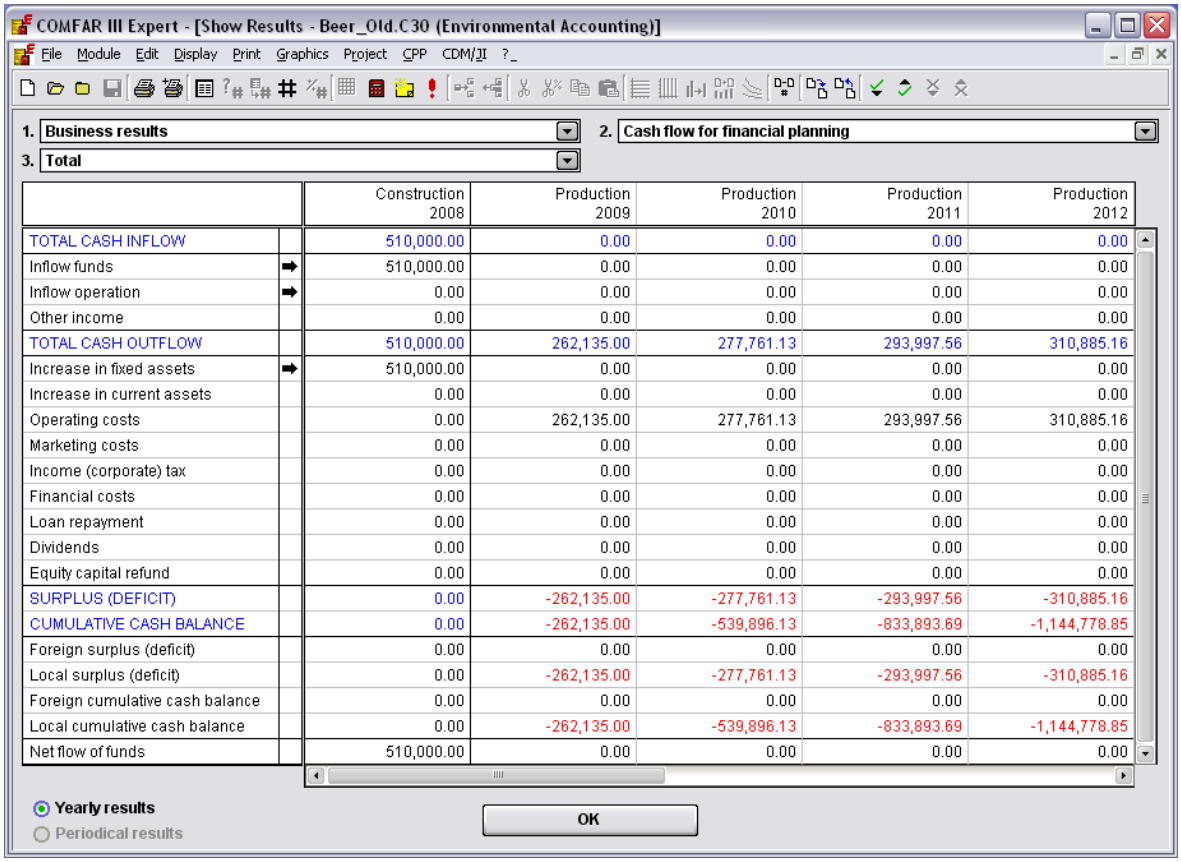


Figure 35: Show Results module



	Construction 2008	Production 2009	Production 2010	Production 2011	Production 2012
TOTAL CASH INFLOW	510,000.00	0.00	0.00	0.00	0.00
Inflow funds	510,000.00	0.00	0.00	0.00	0.00
Inflow operation	0.00	0.00	0.00	0.00	0.00
Other income	0.00	0.00	0.00	0.00	0.00
TOTAL CASH OUTFLOW	510,000.00	262,135.00	277,761.13	293,997.56	310,885.16
Increase in fixed assets	510,000.00	0.00	0.00	0.00	0.00
Increase in current assets	0.00	0.00	0.00	0.00	0.00
Operating costs	0.00	262,135.00	277,761.13	293,997.56	310,885.16
Marketing costs	0.00	0.00	0.00	0.00	0.00
Income (corporate) tax	0.00	0.00	0.00	0.00	0.00
Financial costs	0.00	0.00	0.00	0.00	0.00
Loan repayment	0.00	0.00	0.00	0.00	0.00
Dividends	0.00	0.00	0.00	0.00	0.00
Equity capital refund	0.00	0.00	0.00	0.00	0.00
SURPLUS (DEFICIT)	0.00	-262,135.00	-277,761.13	-293,997.56	-310,885.16
CUMULATIVE CASH BALANCE	0.00	-262,135.00	-539,896.13	-833,893.69	-1,144,778.85
Foreign surplus (deficit)	0.00	0.00	0.00	0.00	0.00
Local surplus (deficit)	0.00	-262,135.00	-277,761.13	-293,997.56	-310,885.16
Foreign cumulative cash balance	0.00	0.00	0.00	0.00	0.00
Local cumulative cash balance	0.00	-262,135.00	-539,896.13	-833,893.69	-1,144,778.85
Net flow of funds	510,000.00	0.00	0.00	0.00	0.00

Figure 36: Cash flow for financial planning – BEER_OLD.C30

Incremental analysis is activated by clicking on the respective icon in the COMFAR III Tool Bar. This icon is only active if at least one other project (= BEER_NEW.C30) is loaded into COMFAR III, calculation is performed and those projects can be compared (= through the same Planning horizon). After clicking on the Incremental analysis icon the incremental analysis modal window is displayed.

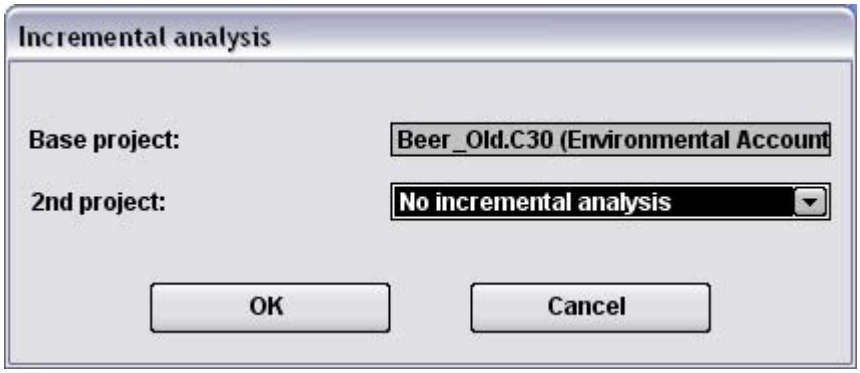
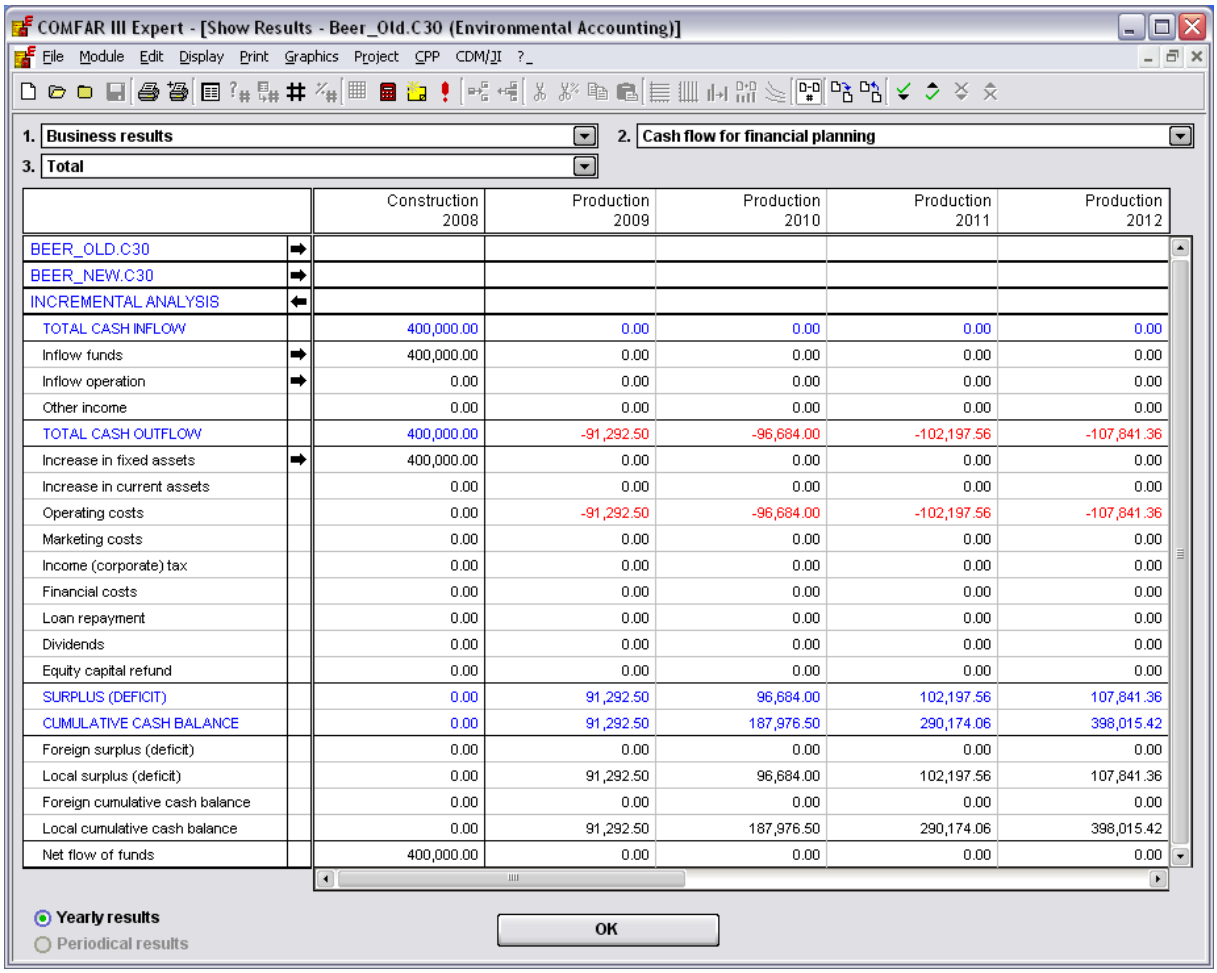


Figure 37: Incremental analysis modal window

The Base project is BEER_OLD.C30 (the 'as-is' scenario). As the second project the new scenario needs to be selected (= BEER_NEW.C30).

Figure 38: Incremental analysis modal window

After pressing OK the Incremental analysis for the CASH FLOW FOR FINANCIAL PLANNING – TOTAL is displayed. The schedule shows the additional investment (= € 400,000.-) necessary to implement the new scenario, as well as the cost savings through the implementation and operation of the new (less environmental damaging) technology.

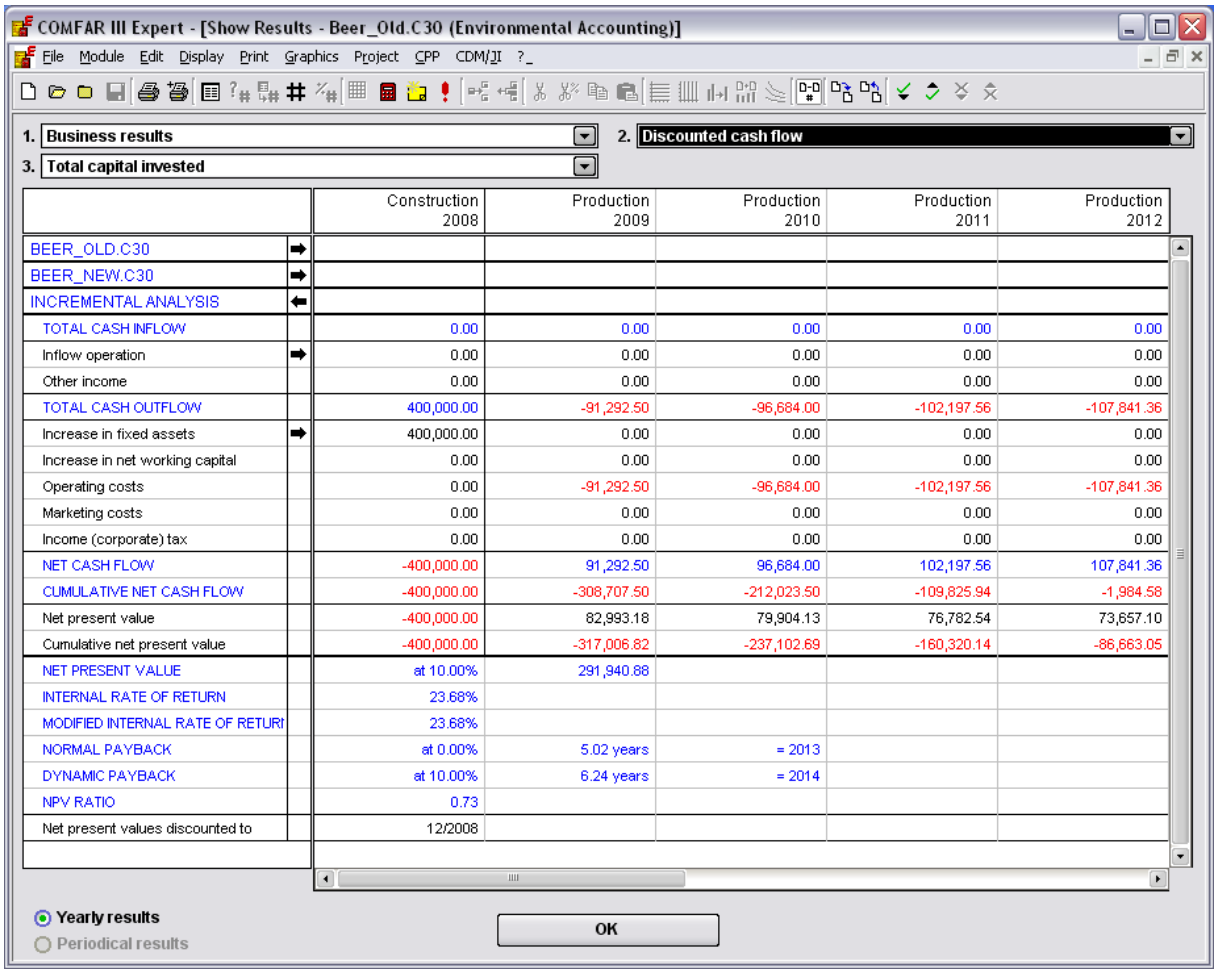


	Construction 2008	Production 2009	Production 2010	Production 2011	Production 2012
BEER_OLD.C30					
BEER_NEW.C30					
INCREMENTAL ANALYSIS					
TOTAL CASH INFLOW	400,000.00	0.00	0.00	0.00	0.00
Inflow funds	400,000.00	0.00	0.00	0.00	0.00
Inflow operation	0.00	0.00	0.00	0.00	0.00
Other income	0.00	0.00	0.00	0.00	0.00
TOTAL CASH OUTFLOW	400,000.00	-91,292.50	-96,684.00	-102,197.56	-107,841.36
Increase in fixed assets	400,000.00	0.00	0.00	0.00	0.00
Increase in current assets	0.00	0.00	0.00	0.00	0.00
Operating costs	0.00	-91,292.50	-96,684.00	-102,197.56	-107,841.36
Marketing costs	0.00	0.00	0.00	0.00	0.00
Income (corporate) tax	0.00	0.00	0.00	0.00	0.00
Financial costs	0.00	0.00	0.00	0.00	0.00
Loan repayment	0.00	0.00	0.00	0.00	0.00
Dividends	0.00	0.00	0.00	0.00	0.00
Equity capital refund	0.00	0.00	0.00	0.00	0.00
SURPLUS (DEFICIT)	0.00	91,292.50	96,684.00	102,197.56	107,841.36
CUMULATIVE CASH BALANCE	0.00	91,292.50	187,976.50	290,174.06	398,015.42
Foreign surplus (deficit)	0.00	0.00	0.00	0.00	0.00
Local surplus (deficit)	0.00	91,292.50	96,684.00	102,197.56	107,841.36
Foreign cumulative cash balance	0.00	0.00	0.00	0.00	0.00
Local cumulative cash balance	0.00	91,292.50	187,976.50	290,174.06	398,015.42
Net flow of funds	400,000.00	0.00	0.00	0.00	0.00

Figure 39: Cash flow for financial planning – Incremental analysis BEER_OLD.C30; BEER_NEW.C30

The same procedure needs to be performed in order to perform Incremental analysis for the Discounted Cash flows calculated for the two scenarios. The Discounted cash flow may be displayed either through returning to the Browser window and clicking on the respective node/icon, or by selecting discounted cash flow in the drop-down list box 2.

After the operational steps, similar to those described above, the Incremental analysis for the DISCOUNTED CASH FLOW ON TOTAL INVESTMENT – TOTAL is displayed. The schedule shows the IRR (23.68%), NPV (€ 291,940.88) and Payback periods (static: 5.02 years; dynamic: 6.24 years at 10% discounting) of the effect from the technological change from the 'as-is' to the new scenario.



	Construction 2008	Production 2009	Production 2010	Production 2011	Production 2012
BEER_OLD.C30					
BEER_NEW.C30					
INCREMENTAL ANALYSIS					
TOTAL CASH INFLOW	0.00	0.00	0.00	0.00	0.00
Inflow operation	0.00	0.00	0.00	0.00	0.00
Other income	0.00	0.00	0.00	0.00	0.00
TOTAL CASH OUTFLOW	400,000.00	-91,292.50	-96,684.00	-102,197.56	-107,841.36
Increase in fixed assets	400,000.00	0.00	0.00	0.00	0.00
Increase in net working capital	0.00	0.00	0.00	0.00	0.00
Operating costs	0.00	-91,292.50	-96,684.00	-102,197.56	-107,841.36
Marketing costs	0.00	0.00	0.00	0.00	0.00
Income (corporate) tax	0.00	0.00	0.00	0.00	0.00
NET CASH FLOW	-400,000.00	91,292.50	96,684.00	102,197.56	107,841.36
CUMULATIVE NET CASH FLOW	-400,000.00	-308,707.50	-212,023.50	-109,825.94	-1,984.58
Net present value	-400,000.00	82,993.18	79,904.13	76,782.54	73,657.10
Cumulative net present value	-400,000.00	-317,006.82	-237,102.69	-160,320.14	-86,663.05
NET PRESENT VALUE	at 10.00%	291,940.88			
INTERNAL RATE OF RETURN	23.68%				
MODIFIED INTERNAL RATE OF RETURN	23.68%				
NORMAL PAYBACK	at 0.00%	5.02 years	= 2013		
DYNAMIC PAYBACK	at 10.00%	6.24 years	= 2014		
NPV RATIO	0.73				
Net present values discounted to	12/2008				

Figure 40: Discounted Cash flow on total investment – Incremental analysis BEER_OLD.C30; BEER_NEW.C30

All other business results calculated by COMFAR *III* have no financial and/or economic meaning, since the methodology outlined in this manual concentrates only on the environmental components of the project. For the methodology for a complete feasibility study please refer to the Reference manual and Tutorial Manual for COMFAR *III*, as indicated in chapter 3 of this manual.

6. 'BLOCKHEIZKRAFTWERK' PROJECT

The COMFAR *III* CD-ROM also includes a second example to be applied with the EMA module. The similar steps as outlined in chapter 5 above have to be applied in order to exercise this example.

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