1. Introduction

Within the framework of a sustainable economy, environmentally-oriented information and management instruments, e.g. environmental auditing, controlling and reporting, material flow analysis and life-cycle assessment, are important tools for enterprises of all sizes and sectors. They help them to analyse, interpret and finally reduce or avoid environmental impacts stemming from their products, processes or production sites. Public administration and consumer organisations require such data as well, e.g. for issues of procurement and public information.

The main purposes of these information and management instruments are: providing an insight into the environmental consequences arising from products; processes; activities as well as certain behaviour patterns; comparing alternatives; developing improvement options and monitoring the improvement success.

One crucial aspect of any environmental analysis is the need for a sound and valid database for process data. Most enterprises have a reasonably good idea, or at least they are in the position to obtain the relevant information, about what happens on their factory sites with respect to, for example, electric power consumption of the machines or the water and air emissions from a factory. But information about the environmental performance of the pre and post-chains of the produced goods or services is often hard to come by. The existence of an easy accessible, free of charge and centralised database for process data is, however, essential for a broad implementation and dissemination of environmental management instruments.

In the absence of a national data base for this kind of information, the German Federal Environment Agency (Umweltbundesamt = UBA) has been working since 1996 – in cooperation with, among others, the Öko-Institute – to enhance the interchangeability of life-cycle data by unified data formats and to create a publicly available data server on the internet. In 2000, a database, offering free public access to environmental data, was installed at the UBA under the name of ProBas (process-oriented basic data for environmental management instruments).

Meanwhile, ProBas has evolved into a database comprising more than 7,000 unit process data sets that are useful for a diversity of life cycle management applications. These range from cost data to accurate emission data from the national CO2 emission inventory, to life cycle assessment data sets. ProBas data are freely available over the internet. The ProBas website provides extended search and data filtering options as well as fast access to the data records. Downloading data is now possible in Excel and PDF formats, and a Help facility is available.
2. Supply and demand of “Process-oriented basic data”

2.1 Relevance of ProBas

Process-oriented basic data are of vital interest in any kind of environment-related mass/energy flow analysis. These data sets are the nodes in mass/energy flow networks. They represent and characterise the so-called unit processes in which material or energy is transformed, e.g. from raw materials to products or from fuels to effective energy, transported, used or disposed of. In contrast to specific data that cannot be generalised but rather must be collected on site for each single process, basic data are universally valid with respect to specified conditions, i.e. time, space, state of the art, etc. Basic data are useful and necessary in environmental analysis instruments in all cases when process data cannot be collected directly by the respective enterprise. That is, for most processes that are not situated within the factory site, especially when no information on specific data is available. Examples are energy generation processes, transport processes or “pre-chain processes”, such as raw material extraction and treatment.

Process-oriented basic data sets, even if they have to represent very different types of unit processes, can be expressed in a uniform manner (Figure 1). Unit processes mostly generate one main economic output, i.e. the product which the process is designed for. Furthermore, on the other hand, other outputs, such as by-products and those going to post-chain processes like waste water, demand one or more economic input. Examples are semi-finished products, energy, auxiliary materials, etc., stemming from pre-chain processes. As for the environmental perspective, outputs from and inputs into the unit process occur in the form of emissions to air or water, and of resource consumption and land use, respectively.

All inputs and outputs of a unit process are mutually linked by mathematical functions. These are mostly linear. Normally, all these material and energy flows are related to the main economic output, the so-called reference flow. Reference flows describe a certain amount of the product or service, e.g. 1 t Aluminum, 1 kWh of electricity, 1 km transport service. During the past two decades, a great deal of environment-related mass/energy flow analyses, such as life-cycle assessments (LCA), have been carried out. Hence, a large amount of process-oriented basic data should be available and could, in principle, be used for future applications. As a matter of fact, much of these data was gathered for internal purposes and is therefore undisclosed. Moreover, parts of the existing data are obsolete, since they do not represent the state of the art. But suitable data still exist for future environment-related substance flow analyses published in different data sources, e.g. the GEMIS database from Öko-Institute, websites of industry associations or documentation from published studies, such as dissertations.

Fig. 4: unit process

For the definitions of the technical terms used here see ISO Standards 14040 ff - Life Cycle Assessment

GEMIS is a freeware and database for mass/energy flow analyses, see http://www.oeko.de/service/gemis/

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Searching in different data sources and the selection of the appropriate data sets are common practices for experienced practitioners, unless they do not have their own databases. However, it can be a serious barrier for inexperienced people. A particular aim of the ProBas project is to support this target group.

ProBas resembles a library rather than a data source. With this in mind, the procedures of ProBas are:

- data search and import,
- data maintenance,
- data access and export.

2.2 Data search and import

Since the access to ProBas is free of charge, the data stock is restricted to freely available data, like those from the GEMIS database, the ZSE emission database from UBA and various data sets from Plastics Europe, European Aluminium Association etc.

A unique standardised data format for process data does not exist. Hence it was a particular challenge to develop such a format that fits with all data sets in order to allow their import into a common structure within the ProBas database, i.e. without neglecting their specific characteristics.

Furthermore, data import tools were developed in order to handle - as far as possible automatically - the import of data sets from external sources. For all data bases that frequently serve as data sources for ProBas, e.g. because they are updated periodically, specifically adapted import routines were written.

Moreover, a generic interface, based on MS-Excel, was specially developed for use with imports from any other data base. To allow insertion into ProBas, all import tools formally edit the data sets by a special procedure without altering their content.

The data set format in ProBas is geared to the structural proposals of the ISO technical specification 14048, with the exception of those points that are too sophisticated for most data sets. Following this technical specification, the data sets in ProBas contain robust quantitative data on energy use, emissions, etc. In addition meta-data provide, among other things, temporal, spatial and technological information. Thereby they indicate the applicability and limitations of the data set.

Furthermore, it proved necessary to add “editorial comments” to the data sets of certain data sources. This had to be done because of source-specific methodological characteristics that are not directly linked to the single data sets and, hence, not automatically imported as meta data together with these data sets. For example, these comments are written into a preface or comprehensive documentation that supports the respective data source. The danger is that the absence of this kind of information could lead to severe misinterpretations of the data sets.

2.3 Data maintenance

The core of ProBas is a flexible and expandable data base which allows a connection to the internet and that can be operated both as a central data base with MS SQL 7.0 and as a local data base with MS Access 2000.

The aim of the ProBas project is to currently expand, adjust and update the data stock. This requires procedures for both introducing new data sets and updating the data sets already in existence.

Both new and updated data sets can be imported via the aforementioned import tools. When being imported for the first time, every data set automatically receives an unambiguous identification code (GUID, a worldwide unique 16-Byte number). This procedure is necessary to allow a faultless update of these data sets in the future.
Moreover, the data sets must be sorted to fit the branched structure of ProBas to enable a fast and easy access. For this purpose the data are assigned to a structure identification code (SID). This happens automatically to a large extent by querying the NACE code (if available in the data set) or predefined string items. Only a small share of the data sets does not meet these criteria, a situation that will, naturally, be continually improved and updated. In this case, these data sets have to be sorted manually.

A significant feature of the ProBas data base is that it not only contains discrete single process data sets but also data sets connected to process chains. Examples are the processes involved in Germany’s electricity supply, starting at the coal mine or oil well and ending at the power socket. For every process step it is possible to access both the environment-related data of the respective process and the aggregated data from the individual processes comprising the process in question.

2.4 Data access and export

ProBas provides different ways to arrive at the data sets desired (Figure 2). The option “Auswahl nach Themen” offers a branched schematic in which the data sets are structured as to their subject area, such as energy production, material production, transports, waste management, up to the point of final product. In addition, the data sets are allocated to various economic sectors following the NACE-code (National Accounts in Europe). Furthermore, the data sets can be searched by different items, e.g. data source, author, geographical references, and by full-text search.

Access to the data base and to the respective data sets is technically implemented by a dynamic web application (Figure 2), which is compatible with any of the most popular web browsers.

Fig. 5: ProBas Website

* NACE: Nomenclature générale des activités économiques (Nomenclature of economic activities)
Regarding the web technology, ISAPI\(^6\) (Internet Server Application Programming Interface), a functional expansion of IIS (Internet Information Server), is used for the generation of the dynamic web page contents. The parameterised queries to the IIS server of UBA are edited via dynamic link library (dll) and then sent as an SQL script by ADO connection to the SQL server of UBA. Moreover, the dll generates HTML pages with the results of the queries which are transferred via the IIS server to the client browser. The start page of the web access is performed as a static HTML page. All information concerning the configuration of the user interface is generated dynamically by the dll. Hence, several requests to the database are necessary to generate all information required to assemble the pages. This application is scalable which means that several requests can be managed and processed at the same time. If the number of requests increases a further run of the application will be started in order to answer them. Alterations of the database, e.g. by data import or editing, are immediately accessible via the web.

![Access structure](image)

Templates in XLS and PDF format are available for the export of the selected data sets.

3. Next steps: the future of ProBas

3.1 Data quality management

Currently, ProBas accepts – like a library - all data sets that meet certain formal and qualitative basic requirements checked by coarse screening tests. If this is the case, the data sets will be introduced into the

\(^6\) ISAPI is an application running within the IIS server. It consists in a dll (dynamic link library) which is loaded into the memory of the IIS-server. Once loaded, the dll remains in the memory of the IIS-server. That leads, compared to other techniques, to a much better time and resource performance.
data base “as they are” without any further detailed review or even editing (the aforementioned editorial comments aside). Consequently, the ProBas management takes no responsibility for the data content. This remains with the original data provider.

In order to enhance the reliability and the user’s acceptance of ProBas data sets, UBA intends to make a thorough revision of a selected part of the data stock. For this purpose, experts of the UBA will scrutinize and, where necessary, adapt particular data sets or compile new data sets. Subsequent to the review procedure, this subset of revised datasets will be labelled as “reviewed by UBA”. This procedure is going to start soon for just a few data sets. In the long term, more and more data sets of the ProBas stock will be converted into “UBA-reviewed” ones.

3.2 English language
Currently, all explanations, user information, structure, etc., as well as most data sets are in German. In the future, all relevant information will be translated into English in order to reach a wider user group. Because it is generally intended to leave the datasets in their original language, it may be worth considering providing an online thesaurus or glossary for all relevant technical terms.

3.3 Data search
Acquiring and implementing freely available data are permanent procedures within the ProBas project. It is intended to expand continuously the ProBas data stock. Potential data sources could be public sponsored research or development projects. Also publications by enterprises or industry associations might contain appropriate process data. Therefore, any information that leads to an enlargement and/or improvement of the ProBas data base is always highly appreciated.

3.4 Usability improvement
In order to enhance the usability, the handling of the website and the query handling procedures will have to be gradually improved. Therefore, a user feedback procedure will be established. On one hand, via registration, users will have access to further information like newsletters. On the other, the ProBas webmasters will learn more about the user profiles and thus have the ability to subsequently improve the website.

Bibliography

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