

Literature and Data Survey for Generating the Basis for the Development of Closed Cycle and Waste Management Policy Towards a Sustainable Substance Flow and Resources Policy

Conclusions of the Final Report

On behalf of the Federal Ministry for the Environment,
Nature Conservation and Reactor Safety

BMU Sponsor Code: 904 31 356

Darmstadt, 2nd December 2004

*Dr. Doris Schöler, Dr. Matthias Buchert,
Dr. Wolfgang Jenseit, Dipl.-Ing. Günter Dehoust, Ass. jur. Andreas
Hermann LL.M., Ass. jur. Falk Schulze LL.M.*

2nd December 2004, Darmstadt

**Öko-Institut e.V.
Freiburg Office**
Postfach 6226
D-79038 Freiburg
Tel.: +49-(0)761-452950
Fax: +49-(0)761-475437

Öko-Institut e.V. Berlin Office
Novalisstraße 10
D-10115 Berlin
Tel.: +49-(0)30-280486-80
Fax: +49-(0)30-280486-88

Darmstadt Office
Rheinstrasse 95
D-64295 Darmstadt
Tel.: (06151) 8191-0
Fax: (06151) 8191-33

www.oeko.de

Contents

1.	Introduction.....	1
2.	Conclusion of literature and data survey.....	2
3.	Investigation requirements for development of the closed cycle and waste management policy towards a sustainable substance flow and resources policy.....	7

1. Introduction

The Öko-Institut was asked by the German Federal Ministry for the Environment, Nature Conservation and Reactor Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*) to carry out a "Literature and Data Survey for Generating the Basis for the Development of Closed Cycle and Waste Management Policy Towards a Sustainable Substance Flow and Resources Policy". The background to this work lies in the fact that the importance of a substance flow-oriented policy approach for closed cycle and waste management policy has increased in the last few years in scientific discourse and in political strategies, both at the national level in Germany and at the EU level.

The Federal Government, for example, emphasises in its current 2004 progress report titled "Perspectives for Germany – Our Strategy for Sustainable Development" (*Perspektiven für Deutschland – Unsere Strategie für eine nachhaltige Entwicklung*), in the context of a 12.3% increase in raw material productivity for the period 1999 to 2003: "...The prevention of waste and improved closed cycle and waste management policy for raw materials, as well as enhancements in the utilisation of renewable natural resources, have contributed to this increase."... Closed cycle and waste management policy successes are thus placed in the context of a higher level system (quantitatively describable here by the *raw material productivity* sustainability indicator), which can only be addressed by a substance flow-oriented concept.

The EU Commission, in turn, had already adopted waste management and the sustainable utilisation of natural resources at the beginning of 2001 as the fourth focal point of the Commission's proposal for the sixth EU Environmental Action Programme. The Commission mentions the improvement of resource efficiency and the decoupling of waste accumulation from economic growth as targets for the waste and resource management sector. These objectives require substance flow-oriented policy approaches in order to allow practical implementation when following new routes in closed cycle and waste management policy.

The objectives outlined by the Federal Ministry for the Environment, Nature Conservation and Reactor Safety address this current debate. Waste management in its current form reaches its limits as soon as mass waste or individual product groups are no longer the focus of attention, but instead individual substances that are particularly important due to their relevance as recyclable substances or pollutants. In this literature and data survey paper the Öko-Institut presents the most important facets of the scientific and political situation in the substance flow-oriented concepts sector, in order to prepare for the development of a new procedure.

This English-language report summarises the conclusions drawn from the work of the Öko-Institut. They are based on the results of literature and data survey¹. The following

¹ The results of the literature and data survey are contained in the German version of the final report.

sectors were investigated²: general material flow discussion, development of the concept of material flow management, various fields of application of material flow - analysis, material flow law, material flow management in political practice and important contributions to the material flow discussion in a waste management context.

Chapter 2 presents the Öko-Institut's conclusion to the literature and database survey. Finally, in Chapter 3, the principal investigation requirements for development of the closed cycle and waste management policy towards a sustainable substance flow and resources policy are summarised and linked to the appropriate recommendations addressed to the Federal Ministry for the Environment, Nature Conservation and Reactor Safety.

The information in the following two sections is valid for December 2004.

2. Conclusion of literature and data survey

The principal waste management tasks that need to be fulfilled, or the sustainable material flow and resources management tasks derived from them, can be allocated to two fields: the first group of tasks deals with **hazard mitigation**. Man and the environment must be protected from harmful effects originating, among other things, from waste flows. Pollutants must be diverted to effective sinks and, by the end of the material flow, only environmentally compatible emissions should be released to water, the soil and the atmosphere. The second group of tasks addresses **resource conservation**, which is constantly increasing in importance with regard to the guiding principle of sustainability. The contribution of waste management here lies only in waste prevention and in returning waste to the economic cycle by way of recovery measures. In a comprehensive material flow and resource management economy it is possible to aim for efficient and sustainable handling of resources by the targeted steering of raw materials.

Hazard mitigation and a reduction in the harmfulness of waste, or its environmentally compatible disposal, represent classical waste management tasks. Here, Europe, and not least Germany, can look back on at least three decades of successful policy. Numerous ordinances and directives have gradually resulted in a high regulation density and remarkable successes.

There are considerably less approaches and ordinances addressing resource conservation than there are addressing hazard mitigation. On the one hand, this is due to the fact that resource conservation was adopted as a political task much later than was the case for hazard mitigation. On the other hand, it is considerably more difficult to transpose resource conservation deliberations into concrete, manageable, measurable and politically achievable objectives. Outside of waste management, instruments such as tradeable certificates (e.g. emission trading) and resource taxes (e.g. mineral oil tax, eco-tax) have been introduced. The concept of manufacturer

² In the following chapters the expression "material" is usually used instead "substances" which comprises goods and substances respectively.

responsibility was introduced in a few waste management sectors (e.g. packaging, end-of-life cars, electrical scrap) in order to promote waste prevention and recovery. In addition, a few ordinances adopted the results of material flow analyses in order to promote ecologically beneficial processes and products.

With regard to the role of waste management in the material flows of the national economy, the survey demonstrated that only a minority of material flows involved in the national economy can be traced directly to waste. Within a national economy material flow management framework, waste management cannot represent the only control organ but must be seen as one component of a comprehensive material flow system. However, it still fulfils important tasks both in the hazard mitigation and the resource conservation sectors.

One pivotal result is that there is no comprehensive overall concept to date for implementing material flow management in the waste management sector. A principal reason for this is the complexity of the material, related to the numerous actors and differing perspectives involved (e.g. purely operational or industry-wide), the diversity of various material flows, displaying a range of characteristics, and the bandwidth of waste management tasks. To date, there is still no mature, convincing, overall concept for a concrete, comprehensive material flow policy that is obligatory on the operative level. Nevertheless, the indicators and objectives of the Federal Government's sustainability strategy provide an important framework for this.

The evaluated investigations unanimously demonstrate that any material flow management measures aiming to encompass all sectors should begin with material input. A large proportion of current legislation, in contrast, is output-oriented. The output orientation originates primarily in hazard mitigation and has enjoyed great success there. Substance prohibitions and threshold values were given priority in order to prevent or reduce harmful environmental impacts. This procedure will continue to be necessary, all the more so the greater the hazard to be averted. However, in addition to the hazard mitigation aspect, implementation of a sustainable economy involves anchoring material flow policy with its focus on resource conservation, and which in this context thoroughly addresses the inputs as the most effective "lever". The evaluated investigations, which approach this topic generally and do not examine any concrete material flows in detail, point out possible political instruments, beside being input-oriented. They also come to the overall conclusion that a mix of various political instruments such as regulatory law, economic incentives and duties, voluntary commitments, manufacturer's responsibility, etc. is necessary in order to properly address the complexity of material flows and achieve the objectives set out. Individual instruments such as resource taxes and the integrated product policy (IPP) continue to be discussed.

An overall concept, also defining more concrete objectives for individual material flows, has not yet been compiled. The question of which material flows should be controlled, and how, has not yet been satisfactorily addressed. There is a degree of consensus with regard to the higher level objectives such as resource conservation, dematerialisation, increased raw material productivity, etc., but a lack of substantiation of which

resource conservation potentials can be utilised and by what means. One of the main reasons for this from the point of view of the Öko-Institut is that the diverse material flows, which are relevant for both resource conservation and for hazard mitigation, vary greatly in terms of participants, environmental impacts throughout the entire life cycle, economic branches involved and technical boundary conditions.

We therefore come to the conclusion that the implementation of material flow management must be integral to a material flow policy that takes the strong differentiation of the individual material flows into due consideration. The aims of material flow policy, the potentials of resource conservation and the necessities of hazard mitigation must be separately described for each relevant material flow. Completely different concepts may also be necessary for practical implementation within the political, technical and economical framework.

The first step on the way to an effective material flow policy is the identification of the most relevant material flows. Of particularly high relevance are:

- Substances that present a hazard.
For example: Cadmium
- Substances and materials that accumulate in large quantities.
For example: Building materials
- Substances and materials for which the upstream chains are associated with resource consumption for the entire life cycle (extraction, production, etc.).
For example: Precious metals

Using the examples of cadmium, building materials and precious metals it was possible to demonstrate that completely different problems are associated with each of these material flows and that very different instruments are required to solve their specific problems. In addition, the examples mentioned make it clear that higher-level material flow concepts, operatively supported and taking the specific framework of the individual material flows into detailed consideration, are becoming strategically more important to sustainable waste management. The precious metal example also showed that less attention must be paid in future to product groups than to material flow-related waste management strategies in order to achieve the resource conservation objectives set out. The raw material and energy productivity indicators of the Federal Government's sustainability strategy can serve as higher-level pointers for this.

Research of the concepts involved in material flow law indicates that when creating a legal framework for material flow management an analysis of the existing regulatory framework, legal instruments and political strategies must be performed for every material flow in order to be in a position to properly select between the alternatives offered by current scientific discourse. One question of central importance is whether a separate material flow law is required or whether material flow regulations can be integrated in existing laws. In view of the fact that a sophisticated selection of control

instruments is already available for many material flows, complementing existing regulations with material flow components would present a practicable solution.

However, any regulations need not necessarily be located in environmental law. Because the material flow approach, being a cross-departmental task, touches upon other legal areas such as economic and tax laws, transport or building laws, material flow-related regulations can also be partially or completely dealt with in these areas. Finally, consideration should be given to whether uniform objectives are required for material flow management. The objectives could be defined in inter-departmental national regulations. The management of materials also requires development of unique instruments, because it cannot be satisfactorily achieved using regulatory instruments.

Finally, current spheres of action of national and European waste management, which form part of the current waste management discussion, were presented in the survey. The following sections indicate the spheres of action in which material flow analysis can make a contribution as a tool and those in which more comprehensive material flow management is necessary.

Waste management spheres of activity in which material flow analysis may represent an important tool:

- Recognition of future waste management material flows

A large proportion of the material input in the economic cycle initially flows into the increasing stock of capital and consumer goods. These material flows only enter waste management with varying delay times. With the help of scenarios, material flow analyses can assess the most important substances and products in order to ensure that the waste management measures necessary in future are efficient and environmentally compatible and are implemented in a timely manner.

- Evaluation of products and waste management procedures with regard to their ecological impacts throughout the entire life cycle

In combination with various evaluation models, material flow analysis is in a position to evaluate the environmental friendliness of products and processes, taking the entire life cycle into consideration. This information forms an important input for political objectives, for environmentally compatible product development and for concrete legislative implementation.

- Development of strategies for waste prevention

Precise knowledge of waste accumulation and possible alternative measures is indispensable in order to allow development of strategies for waste prevention. Here, material flow analysis may represent a suitable method.

- Expansion of the IVU Directive and extension of BREF documents

It would be a worthwhile aim for the IVU Directive to be applied to the whole waste sector, and the current emission threshold values and other standards to be

uniformly defined EU-wide in the best available technology fact sheets (BREF documents). Here, material flow analysis represents an instrument for identifying the principal processes and emissions.

Waste management spheres of activity in which material flow analysis may provide a principal component:

- High recycling costs compared to landfill/incineration often prevent recycling
Because landfill or incineration is often cheaper than recycling, many feedstock recovery measures are not realised, even if they represent the more environmentally compatible choice. The possible contribution of economic control instruments to targeted material flow management should be examined.
- Introduction of tradeable certificates in the waste and/or resource sector
Tradeable certificates are an instrument for material flow management which represent a relatively new approach in the waste sector or in manufacturing. A discussion is required on whether tradeable certificates can represent an acceptable and suitable means for the enforcement of objectives in waste prevention and recovery, and for targeted steering of material flows.
- Extension of manufacturer responsibility
One module of material flow policy is represented by the demand for manufacturer responsibility for environmentally compatible disposal and the implementation of waste prevention and recovery. It must be discussed to what extent manufacturer responsibility and the waste flows to which it can be extended makes sense, where it is already employed in the packaging, end-of-life vehicles and electrical equipment sectors, and with what other instruments it can be coupled. On the other hand, material flow analysis also allows examination of the effectiveness of manufacturer responsibility concepts.
- Association of waste management with materials instead of waste products
The existing directives for special waste flows represent only a relatively small component of total waste flows. For example, directives regulating the recycling of plastics from packaging, end-of-life vehicles and electrical equipment exist, but no direct regulations (e.g. quotas, etc.) for recycling plastics from other important applications such as building materials. Precious metals, for example, which are highly relevant during their extraction due to the high resource consumption involved, are only partly covered by directives. These gaps must be filled by targeted material flow management, with new measures oriented to accumulating materials and not to special waste products.

3. Investigation requirements for development of the closed cycle and waste management policy towards a sustainable substance flow and resources policy

The Öko-Institut literature and data survey clearly demonstrates the impressive progress the discussion on material flow concepts towards a material flow policy has made. Over almost 20 years the methods of material flow analysis and material flow management have been developed to form a convincing set of instruments. Due to the variety of work carried out in this field, the data situation for many material flows has improved, sometimes in conjunction with innovative elements such as scenario techniques (possibility of "if-then-statements" for divergent future paths (reference scenario v. sustainability scenario, etc.)). Moreover, it should not be forgotten that, thanks to technical quantum leaps in the IT sector (hardware and software), the options for efficiently recognising even complex material flows and for making them accessible to sound evaluations have expanded greatly over the last few years.

However, the literature and data survey also made it clear that the material flow discussion diverges widely, depending on research interest, the object under consideration, system boundaries, etc. (e.g. various types of material flow analysis, operational or industry-wide material flow management). This has resulted in the material flow management and resource conservation vision, which is embedded in the guiding principle of sustainable development, already leading to positive effects in various sectors (individual laws, directives, ordinances, but also economic instruments and communication activities). However, this is often implicit (the influence of the concept of material flow management is not always obvious on first view) and not part of a higher-level system. Because - as described - the material flow discussion is highly divergent, it is inevitable that a consistent material flow policy does not yet exist, let alone universal material flow laws.

Not least the planned new recycling strategy of the EU Commission, of combining the existing product-specific approach with a material-specific approach³, provides the option of developing a systematic and consistent material flow approach for the waste management sphere of action and to finally commence with concrete operationalisation.

The following investigation requirement was identified by the Öko-Institut as a short-term priority in order to formulate a new role for waste management in the framework of an active material flow policy.

As the literature and data survey has demonstrated, from a resource perspective the establishment of waste management priorities has so far been neglected. Previous - and generally successful - political activities in this sector usually had their origins in a concrete pressure to act (e.g. hazard potential of some waste groups or their constituents) or in a high degree of emotionalisation in media and the public, such as in the case of packaging, with corresponding reactions in the body politic. This does not

³ Regardless of the criticism of the future EU recycling strategy already articulated by the associations [EUWID 2004].

necessarily mean that the establishment of priorities is wrong from a resource conservation perspective. Rather, the question that needs addressing is whether other important sectors may have been neglected, because the need for action in the context of environmental protection and sustainable development was not as recognisable there.

From a material flow perspective the first step must include initial screening with regard to the relevant material flows in Germany (or, better, EU-wide). This does not primarily mean that detailed new material flow analyses must now be carried out. The object would rather be to create an overview by first evaluating the numerous available, highly detailed and high-quality material flow analyses and other data compilations (Environmental Economic Accounting, etc.). Important criteria for such an evaluation could include the resource perspective relevance criterion, flanked by further criteria such as dynamics (stagnating, falling or increasing in the past and mid- to long-term?), as well as additional important ecological criteria. The result would provide a ranking of material flows⁴ according to relevance. The respective contributions to raw material and energy productivity are recorded as far as possible during screening.

In a second step, calibration with the identified relevance of the material flows and with previous addressing by closed cycle and waste management policy is performed. Criteria here include the points raised by previous treatment through closed cycle and waste management policy (already addressed by various measures, only partially addressed or generally not addressed), the recognisable degree of effectiveness of measures already in place and the previous duration of measures, and, where necessary, future dynamisation (e.g. recycling quotas that are only obligatory as of year X).

The result is a renewed ranking of material flows in terms of the ratio of the relevance (primarily resource relevance) to the degree of previous addressing by closed cycle and waste management policy. The aim is to identify the most important material flows with relevance to resource conservation for which no, or only insufficient, measures can be identified. This makes it possible in future to counter the accusation, often raised in the affected business circles, that one branch is heavily constrained by ordinances, duties, etc., compared to others.

A recommended third step includes the detailed investigation of particularly interesting examples of material flow (*cf.* descriptions in previous sections) with the aim of making a detailed presentation of the links between resource demand, temporal dynamics and the technical, logistic, legal and political options for suitable addressing in terms of a resource-conserving material flow policy. Finally, an estimate of the possible contribution to increasing the energy and raw material productivity of the Federal Republic of Germany can be carried out up to the year 2020.

⁴ The "common denominator" for a "material flow" would need to be clarified beforehand. Pure element balances make sense and are practicable for metals; they are neither scientifically sensible nor expedient for building materials, for example. The Öko-Institut therefore proposes defining meaningful material flow groups (e.g. metals, important building material groups, bulk and other plastics, bulk chemicals, etc.), based on the demand side (quantity of final product) and then to evaluate the available material flow analyses.

Based on experience gathered in the investigation phase, the fourth and final step should include a concrete bundle of recommendations for sustainable material flow policy with resource conservation and waste prevention as the objective with regard to the selected material flows. Finally, the transferable methodical elements (which are also relevant to further material flows not yet investigated in detail) should be summarised.

The proposed steps can be partly processed in parallel, i.e. as soon as an important material flow (sector) has been identified with certainty, a concrete analysis can begin while screening is still ongoing.

Uniform objectives for material flow management should be formulated parallel to this and consistent methodical specifications for the material flow analysis (various system boundaries such as time, space, demarcation of materials, etc.) be developed as far as possible.