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Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development **23-Feb-2005**

English - Or. English

ENVIRONMENT DIRECTORATE
ENVIRONMENT POLICY COMMITTEE

ENV/EPOC/SE(2004)3/FINAL/ADD
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Working Group on Environmental Information and Outlooks

MATERIAL FLOWS AND RELATED INDICATORS

INVENTORY OF COUNTRY ACTIVITIES

This document was prepared by the OECD Secretariat to support the implementation of the OECD Council Recommendation on Material Flows and Resource Productivity (adopted in April 2004) and is part of the OECD's environment programme and horizontal project on sustainable development.

It takes stock of activities related to the measurement and analysis of resource and material flows carried out or planned in OECD countries and in selected non members. It describes the main features that characterise such activities and the extent to which information on material resources is used in environmental reporting and decision making.

It has benefited from country and expert contributions and from comments by country delegates received by end of January 2005. It will be complemented and updated as work on material flow analysis progresses.

It accompanies document ENV/EPOC/SE(2004)3/FINAL "Material flows and related indicators - OECD approach and work plan for 2005-2006".

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JT00179163

English - Or. English

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TABLE OF CONTENTS

[1] Consultant: Ms Aya Yoshida, Japan. The financial support of Japan is gratefully acknowledged.

MATERIAL FLOWS AND RELATED INDICATORS
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I. INTRODUCTION

1. Background

1. Material flow analysis (MFA) is a rapidly developing field of research with increasing policy relevance. Over the past decade, MFA has raised increasing interest as a tool that can provide a more holistic and integrated view of resource and material flows through the economy and that enables the derivation of economy-wide material flow indicators, including new indicators reflecting resource productivity or resource use efficiency that could parallel those describing labour productivity.

2. Much progress has been made in developing, refining and harmonising methodologies for various types of MFA, including accounts and indicators. Progress has been stimulated through joint research efforts by Austria, Germany, Japan, the Netherlands and the United States involving governmental and non-governmental institutions[2], and collaborative work in Europe carried out by Eurostat on methodologies for economy-wide material flows[3] and by the European Environment Agency and its Topic Centre on Waste and Material Flows. It has further been supported with international work on Integrated Environmental and Economic Accounting (commonly referred to as SEEA)[4], and with OECD work on environmental indicators (terminology, framework, selection criteria, guidance for use)[5] and on environmental accounting and material flows[6].

3. Interest in MFA as a policy making tool across OECD countries has also risen significantly and practical applications have progressed. Most OECD countries that have developed a national set of environmental or sustainable development indicators include in their set one or several indicators derived from MFA. In some countries, this has led to a move towards integrating MFA work in the national system of official statistics. To date almost all OECD countries carry out some activities on resource and material flows and related indicators.

4. Despite these advances, MFA remains a "young" tool. Countries are at a variety of stages in developing and using MFA. The status of their work, its characteristics and scope, purpose and policy use vary considerably. Some of this diversity is expected, for example in the coverage of resources or materials that reflects the varying economic and environmental importance of a given resource or material flow for different countries. Other differences, such as those concerning the concepts and methodologies applied,

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2 *The weight of nations: Material outflows from industrial economies*, Matthews, Emily, C. Amann, S. Bringezu, M. Fischer-Kowalski, W. Hüttler, R. Kleijn, Y. Moriguchi, C. Ottke, E. Rodenburg, D. Rogich, H. Schandl, H. Schütz, E. van der Voet, H. Weisz , WRI, Washington D.C., 2000.

Resource Flows: The Material Basis of Industrial Economies ; Adriaanse, Albert, S. Bringezu, A. Hammond, Y. Moriguchi, E. Rodenburg, D. Rogich, and H. Schuetz,(1997), WRI, Washington D.C., 1997.

3 *Economy-wide material flow accounts and derived indicators – A methodological guide*, Eurostat, 2000

4 *Integrated Environmental and Economic Accounting 2003- Handbook on national accounting*, United Nations, European Commission, IMF, OECD, World Bank, 2003.

5 *OECD Environmental Indicators – Development, Measurement and Use*, OECD reference paper.

6 *Special Session on Material Flow Accounting: Papers and Presentations*, WGEIO, OECD, 2003.

point to the need for additional clarification and convergence. More work is also needed to review and explain the added value of MFA compared to other monitoring and measurement tools and to appropriately position MFA within a broader architecture of environmental and economic accounts and indicators.

5. The implementation of the OECD Council Recommendation[7] on material flows and resource productivity, adopted on 21 April 2004, is expected to help addressing some of the current shortfalls in MF information, to contribute to achieve greater convergence of already existing initiatives in OECD countries and to facilitate wider dissemination and uptake of existing experience and guidance. It will also help to further broaden the geographic scope of MF work and to expand it to other interested OECD countries so as to support the sharing of lessons and related international work.

2. Purpose and scope of this document

6. This document supports the implementation of the OECD Council Recommendation on Material Flows and Resource Productivity, by taking stock of activities related to the measurement and analysis of resource and material flows carried out or planned in OECD countries and in selected non members. It describes the main features that characterise such activities and the extent to which information on material resources is used in environmental reporting and decision making. It is designed to provide a factual basis for the further exchange of experience and information and for sharing lessons at international level.

7. The document builds on information compiled from various sources, among which:

- Country and expert contributions to the OECD Helsinki Workshop on Material Flows and Related Indicators (17-18 June 2004) and to earlier OECD meetings, including the Special Session on Material Flow Accounting of the WGEIO (October 2000).
- Country and expert contributions to the International Expert Meeting on Material Flow Accounts and Resource productivity organised by the Ministry of the Environment of Japan (Tokyo, 25-26 November 2003).
- Country contributions to the annual Round Table on Environmental Information held by the Working Group on Environmental Information and Outlooks (WGEIO).
- Information available from national and international web sites, publications and documents.
- Replies by countries and research institutes to a global survey of MF activities carried out jointly with the European Environment Agency (EEA). The survey was carried out between June and August 2004. Recipients of the survey included (i) OECD countries and partners, through national delegates to the Working Group on Environmental Information and Outlooks (WGEIO) and participants to the Helsinki workshop, and (ii) countries and experts participating in the EEA's work on material flows. More than 60 replies have been received covering 40 countries, including 27 OECD countries, the European Commission (Eurostat) and the Business and Industry Advisory Committee to the OECD (BIAC) as well as 13 non members. It should however be noted that replies to the global survey often were the respondent's views, and may not reflect the countries' official position.

8. Since material flow studies cover various approaches and measurement tools, the description of countries' activities has not been limited to material flow accounts and indicators per se, but covers also other closely related work in the field of environmental accounting. It should be noted that the information contained in this document is neither exhaustive nor final. It will be complemented and updated as work on material flow analysis progresses, and as new information becomes available.

[7] For further details on the OECD approach and work see document ENV/EPOC/SE(2004)3/FINAL.

II. MEASURING AND ANALYSING RESOURCE AND MATERIAL FLOWS IN OECD COUNTRIES

2. Characteristics and scope of material flow related activities

9. MFA includes a variety of approaches and measurement tools at different levels of ambition, detail and completeness. Work carried out so far has been covering different resource and material flows at different levels of detail for different entities and with different system boundaries. Among the different approaches and measurement tools are:

- economy-wide material flow accounts (EW-MFA) and material flow balances.
- individual flow accounts focusing on resources or materials of particular environmental and/or economic importance.
- more detailed accounts and approaches including physical input-output tables (PIOTs) and substance flow analysis (SFA).
- as well as various types of indicators that can be derived from these tools.

2.1 Economy-wide MF accounts (EW-MFA)

10. More than half of OECD member countries have developed or are developing EW-MFA (Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Japan, Korea, the Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom, the United States). In nine out of these 19 countries EW-MF work is a regular activity with annual updates. In 7 countries (Denmark, Hungary, the Netherlands, Poland, Portugal, Sweden, the United States) EW-MF work has been carried out on a stand-alone or pilot basis. In three countries (Korea, Slovak Republic, Switzerland) work was initiated recently to explore the feasibility of EW-MFA.

11. A few countries did not report about plans to develop EW-MFA (Australia, Canada, Greece, Iceland, Luxembourg, Mexico, New Zealand). In Mexico, some work is planned at academic level as part of a project proposal by the University of Barcelona, IFF-Vienna and other European and Latin American universities. In Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has done some work on domestic and international direct and indirect material flows, even though full material flow analysis at the macro-level is not a priority.

12. Concerning frameworks and conceptual approaches, the System of Integrated Environmental and Economic Accounting (SEEA) and the methodological guide prepared by Eurostat (2000) appear to be instrumental in structuring work on natural resource accounts and EW-MFA in countries. In Europe, most EW-MF work is based on the Eurostat guide. Other references mentioned include documents published by the World Resources Institute (WRI) and the Wuppertal Institut for Climate, Environment, Energy, and training material from the IFF Vienna.

2.2 Individual resource and material flow accounts

13. A number of countries, including those that have not yet developed or do not plan to develop economy-wide MFAs, carry out closely related work as part of their environmental accounting activities. Such work often focuses on the development of individual flow accounts in areas of particular relevance to the country and its economy (e.g. Australia, Canada, Iceland, Ireland, France, Norway, Slovak Republic) and covers natural resources or residuals such as: energy, water, forests, fisheries, minerals, greenhouse gases. Most of these accounts are part of the countries' natural resource accounts (NRA) and build on related international work and frameworks.

14. Individual flow accounts are also prepared as part of more detailed MFA work, and focus for example on flows of raw materials, water, waste, energy and/or on flows of specific substances or materials (see also below).

2.3 More detailed MF approaches and accounts

15. The Input-Output framework is used in Australia, Austria, Canada, the Czech Republic, Denmark, Finland, Germany, Italy, Japan, Sweden and the United Kingdom in order to develop specific flow accounts distinguishing not only categories of materials but also branches of production. In some countries, hybrid flow accounts have been established by linking information from physical flow accounts to economic data from Monetary Input-Output tables. In some countries, input-output analysis supplements work on economy-wide flows. Efforts are also being made for developing simplified PIOTs that could usefully be linked to EW-MFA.

16. In Europe, many countries have established National Accounting Matrices including Environmental Accounts (NAMEAs) mainly in the field of air emissions and waste, following recommendations by Eurostat and pioneering work by the Netherlands. Such accounts, and in particular their sectoral breakdown and their links to economic accounts, are often seen as useful complementary tools and some countries have applied the NAMEA approach to material flow accounts.

17. Among the most developed MF activities is the German Material and Energy Flow Information System (MEFIS) that uses an MFA framework. It is based on physical input-output tables (PIOTs) and uses a NAMEA-type breakdown for economic activities. Other examples are the Australian Stocks and Flows Framework (ASFF) and the Canadian Material and Energy Flow Accounts (MEFA).

18. In a number of OECD countries, research work has focussed on studying flows of specific substances or groups of substances (e.g. Austria, Belgium, Finland, the Netherlands, Norway, Sweden, Switzerland, and the United States). Such work often concentrates on heavy metals and on other substances with potential negative impacts on the environment and human health. Examples include the Toxic release inventory (TRI) of the United States, and substance flow analysis (SFA) carried out by the Norwegian Pollution Control Authority and the Swedish Chemicals Inspectorate.

2.4 Data availability and quality

19. To date, time series of aggregated economy-wide MFA data are available for about two third of OECD member countries. This includes 19 countries of the European Union for which data are available from Eurostat and/or from national MF activities, Japan and the United States. Data availability and quality is generally best for direct flows and for input and consumption variables. Output variables are less well covered. Gaps remain in the coverage of international flows of resources and materials and in the coverage of hidden or indirect flows. Little coherent information is available on flows of secondary raw materials (recycled materials). This points to the need for more work on related measurement methods and conversion factors.

20. Data on individual resource flows are available in most OECD countries, but with varying degrees of completeness and coverage. Information on physical stocks and flows of individual types of resources such as forest, freshwater or energy, is relatively advanced in many OECD countries and compiled in a more or less harmonised framework, the SEEA often serving as a reference. Physical flow information on other resources or residuals such as minerals and selected metals, fish resources, greenhouse gases, is available in several countries, but appears to be less harmonised across countries.

2.5 Publication and use in reporting

21. Material flow and natural resource data are used and published in national state of the environment reports or in national environmental data publications (e.g. Australia, Belgium, Finland, Germany, Japan, Norway), or in national environmental or sustainable development indicators reports (e.g. Austria, Germany, Hungary, United Kingdom). Some countries have special publications (reports, CD-Rom, web based databases) on environmental accounting or on natural resource use (e.g. Australia, Canada, Germany, Slovak Republic, Spain, United Kingdom). The data on natural resources and material flows included in these publications stem from national MF activities or from information produced by international research institutes or by Eurostat (e.g. Hungary).

22. Material flow information used in environmental reporting often illustrates decoupling trends in areas linked to natural resource use and waste generation. Australia has used material flow information to assess the environmental impacts of human settlements in its 1996 and 2001 state of the environment reports. A more detailed analysis of the urban metabolism of three selected settlements is planned for the 2006 report.

3. Institutional arrangements and partnerships

23. Traditionally, MF work has mainly been carried out by academics or as part of research projects steered by national statistical offices, and in a few cases environment ministries and agencies. In some countries, responsibilities have progressively moved from the academic and research side to the policy side, with environment ministries being increasingly interested in indicators derived from MF studies.

24. The production of MF accounts and data is generally in the hands of national statistical offices (NSOs) as part of their environmental accounting activities or of research institutes. In a number of countries, NSOs have taken responsibility for compiling EW-MF data as part of their country's official statistics (Austria, Finland, Germany, Italy, Spain, Switzerland, and the United Kingdom)[8]. This is also the case for most work on individual natural resource accounts (e.g. Australia, Canada, Norway, Slovak Republic). In a few countries, research institutes or universities have the lead in conducting MF research on behalf of their government sometimes with government funding and/or in co-operation with government agencies (e.g. Czech Republic, Japan, Poland, Portugal, United States). In some EU countries, funding from Eurostat or the European Commission has supplemented government funding.

25. The development and publication of material flow indicators, and their use in environmental reporting is shared among NSOs and environment agencies and ministries, and sometimes research institutes. The practical arrangements depend on the stage of development and the status of the indicators work, and on already existing arrangements in the field of environmental indicators and reporting.

26. In countries where MF work is well advanced, partnerships are commonly established among various partners within the country as well as with international networks and with partners in other countries. Examples of international MF networks and partnerships are the ConAccount network managed by the Wuppertal Institut and the recently established International Society of Industrial Ecology.

27. Some countries exchange information with and provide assistance to non member countries via their research activities. Examples are bilateral partnerships established between Japan and China, and between Switzerland and Columbia, and partnerships established by the University of Vienna (IFF) with other Universities in the world to promote the application of MFA in developing countries. Major research institutes active in the field of MFA (Wuppertal Institut, IFF-Vienna) have incorporated Southeast Asian

8 See also Eurostat (1997), Materials Flow Accounting: Experience of Statistical Offices in Europe. Luxembourg.

and Latin American countries in their work, and have provided technical guidance to new-comer countries in Europe through projects partly funded by the European Commission (e.g. Amazonia21 project, SEAtrans project).

4. Outputs and results

4.1 Main uses of MF information

28. Practical applications of MFA and related information have progressed in many countries, mainly in areas where the demand for information on resource and material flows is clearly identified and linked to (i) specific policy questions and/or (ii) to associated indicator development, in line with lessons from earlier OECD work on the use of environmental account in decision making (Box 1).

Box 1. Main uses of natural resource accounts

OECD countries' experience with environmental accounting has shown that there are three uses of natural resource accounts (NRA) that are particularly relevant for decision-makers and policy analysis*. They can be used as a tool for:

- Resource management: To be suitable for this purpose, the accounts must provide extensive and detailed information; this tends to require well-developed and large statistical bases and a relatively sophisticated accounting system, often at the substance level.
- Policy analysis: This use is less information-intensive than the use for resource management. Two types of uses are distinguished:
  - Direct use of physical flow accounts: where NRA trace the flow of natural resources from the environment to the economy and within the economy, they provide information about the impacts of sectoral economic activities on the resource flows and stock and vice versa.
  - Indirect use of physical flow accounts through linking information from these accounts to economic information in the context of integrated environmental and economic accounting (hybrid flow accounts) or through introducing it into environment-economy models.
- Indicator development: the construction of selected and/or aggregated indicators of resource use and pollution intensities is the least demanding application of resource accounts in terms of information requirements.

** Seminar on Environmental Accounting for Decision Making, OECD, 1995, Paris*

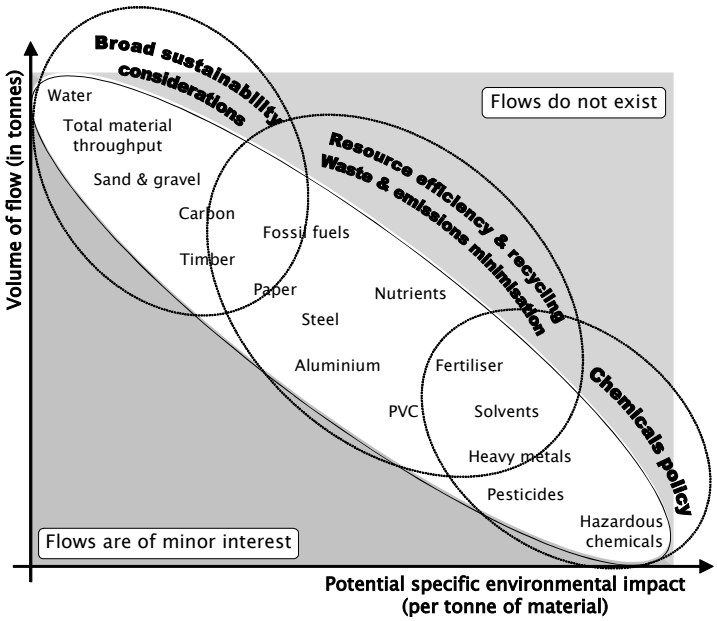
29. According to the survey replies, information from resource and material flow accounts in OECD countries is most commonly used:

- as a tool for economy-wide indicator development (18 countries).
- as a basis for policy analysis by linking environmental and economic information (18 countries) and by supporting modelling and outlook activities (8 countries).
- as a tool for monitoring the efficiency or sustainability of material resource use at various levels (14 countries), often with a link to waste management policies.

30. MF information derived from more detailed and individual flow accounts and analyses, including PIOTs and SFA, is further used as a tool for natural resource and materials management. It supports for example the implementation of policies related to integrated product management, the control of chemicals (e.g. control of hazardous substances, heavy metals) or the control of air and GHG emissions. Information derived from SFA appears to be particularly useful when applied at the micro and local levels. Information derived from PIOTs appears to be particularly useful when applied at the meso level, to track structural changes at macro-level, and as an input into modelling and outlook work.

31. It is generally recognised that, though many countries have included aggregated economy-wide MF indicators in their sets of environmental or sustainable development indicators, the actual use of MF information in national policy debates and policy making is limited. This is due among others to the fact that most MF work completed to date has shed light on the supply side (academic research, methodological and statistical work, development of MF accounts and derived indicators), and that most aggregated economy-wide indicators, that are in themselves more meaningful for communication purposes, are not always well understood. Hence, feedback on the policy relevance of the various economy-wide MF indicators in use is seen as insufficient and further insights are needed to guide their further refinement.

Figure 1. Schematic representation of material flows, environmental impacts and policy uses



Source: based on Steurer, A.(1996) as developed with Radermacher W. in 1995[9].

4.2 Links to economic aspects and environmental impacts

32. Whereas many countries point at the usefulness of MFA for linking economic and environmental information, important links, such as those between trends in material flows and trends in market prices for these materials, or trends in related resource rents remain largely unexplored. Two countries reported on related work concerning price signals to encourage efficiency in the field of water use and waste (Australia) and concerning taxes on selected natural resources and chemical compounds (Sweden).

33. Academic research continues to better understand the implications of material resource use for environmental quality and to relate material flows to environmental impacts, [10,11], and hence to well recognised environmental policy concerns. This is done by combining material flow analysis (MFA) and

[9] Steurer A., Material Flow Accounting and Analysis: Where to go at a European Level, in Statistics Sweden (ed.), Third meeting of the London Group on Natural Resource and Environmental Accounting – Proceedings, 1996

[10] *Dematerialisation: not just a matter of weight*, E. van der Voet, L. van Oers, I. Nikolic, Center of Environmental Science, Leiden University. *Measuring less, knowing more: the use of indicators in dematerialisation policy*, S. de Bruyn, J. Vroonhof, B. Potjer, A. Schwenke, JP. Van Soest, CE, Delft, 2003

[11] See also the research project by the European Commission, carried out by CML (Leiden University), CE (Delft) and the Wuppertal Institut on decoupling and resource productivity indicators, including a weighted MF indicator reflecting the highest environmental impacts. The project covers the 25 member states of the European Union and three accession countries; draft results were made available in October 2004.

life cycle analysis (LCA), by linking MF indicators to other environmental indicators or data describing pollution issues, by aggregating materials by common characteristics so as to reflect their environmental burden profile or by weighing the various material or substance flows according to their potential environmental impact or toxicity. Weighing materials for their toxicity or environmental impact requires sophisticated research (link to non-linear, multi-dimensional factors, temporal, etc.). As for other aggregated environmental indices, the use of such indicators requires a broad acceptance of the weighing methods used and a consensus about the validity of the conversion factors used[12]. Hence full empirical results for consideration at international level are not expected in the short term, but could benefit from further exchange of experience among countries active in this area of work.

4.3 Material Flow indicators

34. Eighteen OECD countries have calculated and/or use one or several economy-wide MF indicators. These indicators generally describe economy-wide material use, as well as related intensities (e.g resource productivity, eco-efficiency) and decoupling trends when linked to the relevant economic variables. Most of them are used to monitor the overall trends and to draw attention to key developments that will require further analyses.

35. Most OECD countries that have developed a national set of environmental or sustainable development indicators include in their set one or several indicators derived from natural resource or material flow accounting. In 13 OECD countries, MF indicators are part of proposed or agreed sets of environmental or sustainable development indicators (Austria, Belgium, Denmark, Finland, Germany, Hungary, Italy, Japan, Poland, Slovak Republic, Spain, Switzerland, United Kingdom).

36. Among the most common economy-wide MF indicators in use are:

- Direct material input (DMI, 16 countries).
- Domestic material consumption (DMC, 15 countries).
- Total material requirement (TMR, 13 countries).

37. Among other indicators in use or being developed are:

- Consumption indicators such as total material consumption (TMC, 5 countries), raw material consumption (RMC, 1 country).
- Physical trade balance (PTB, 5 countries), raw materials trade balance (RMTB, 1 country), physical trade balance including indirect flows (PTBIF, 1 country).
- Net additions to stock (NAS, 4 countries).
- Output indicators: domestic processed output (DPO, 5 countries); total domestic output (TDO, 3 countries); direct material output (DMO, 2 countries), total material output (TMO, 1 country).

38. Germany distinguishes between biotic and abiotic materials, and uses an indicator on abiotic raw materials productivity. It is defined as the ratio between Gross value added (at constant prices) and the sum of domestic abiotic (i.e. non-renewable) raw material extraction (used) and imports. It has similarities with indicators on labour and capital productivity, and describes the efficiency with which "non-renewable raw materials" are used in the national economy.

39. In the Netherlands, current research concentrates on developing dematerialisation indicators that reflect potential environmental impacts. In this context, the calculation of an environmentally weighted material consumption (EMC) indicator is being considered[11].

[12] *Aggregated environmental indices – Review of aggregation methodologies in use*, OECD, 2002.

40. An indicator representing a Sustainable net Benefit Measure of production (SBM) compared to Direct Material Flows (DMF) has been used in a research project "Measuring the Eco-efficiency of Welfare Generation in a National Economy" published by Statistics Finland in 2001. The aim was to test factor 4 targets, i.e. a 75% reduction in material use and maintenance of at least the current level of welfare during the next 20-30 years.

41. At international level, an indicator for material consumption is included in the 2001 UN CSD List of Sustainable Development indicators. The OECD uses several indicators related to natural resources use in its sets of core and key environmental indicators (CEI, KEI), and has considered indicators on material flows and material resource use in the development of decoupling environmental indicators (DEI) and in work on waste prevention indicators.

42. In Europe, the European Environmental Agency (EEA) publishes estimates for Total Material Requirement (TMR) in its indicator report 'Environmental Signals'. Eurostat regularly publishes material input and consumption indicators for all EU member states with time series from 1980 to the most recent year[13]. The indicators compiled include: DMC, DMI, and physical trade balance (PTB). The calculation of TMR, domestic processed output (DPO) and net additions to stock (NAS) was abandoned in the most recent update. Current efforts focus on expanding the time series to cover the ten recent member states of the European Union. The underlying data series are produced by research institutes on behalf of the European Commission (Wuppertal Institut; IFF-Vienna). The preliminary list of sustainable development indicators for the EU includes a section on production and consumption patterns with indicators on material consumption and waste generation.

4.4 Links to policy goals and objectives

43. In many OECD countries, goals and objectives concerning the efficient management and sustainable use of natural resources and materials have been embodied in national sustainable development strategies or environmental action plans. In a few countries, time-bound quantitative targets have been defined. In general, these targets are not mandatory and rather an expression of desired policy directions. Hence the publication of indicators to monitor progress towards the achievement of these targets often follows communication purposes, rather than policy purposes.

General policy goals and broad sustainability considerations

In five countries, MF indicators are associated to broad policy goals:

- decoupling natural resource use from economic growth (Belgium: Federal Plan for sustainable development; associated indicators: not yet defined);
- using resources more efficiently (Denmark: National sustainable development strategy; associated indicators: e.g. TMR/capita, total consumption of selected resources)
- improving the efficiency of natural resource use and energy through the full life-cycle (Finland: Government Programme for sustainable development; associated indicators: TMR);
- achieving non-toxic and resource efficient material cycles (Sweden: Swedish environmental quality goals);
- Improving resource efficiency (United Kingdom: UK Government framework for sustainable consumption and production; proposed associated indicators: decoupling indicators among which total material use and freshwater abstractions).

[13] "Material use in the European Union 1980-2000: Indicators and analysis", Eurostat, 2002, Luxembourg. Update forthcoming.

Quantitative objectives

In three countries MF indicators are associated to quantitative objectives of a general nature such as those aiming at:

- increasing resource productivity by a factor of 4 in the longer term (Austria: Strategy for sustainable development; associated indicators: DMI, DMC, DMC/DGP).
- achieving dematerialisation with a factor 2 to 4 by 2030 (Netherlands: 4th National Environmental Policy Programme; associated indicators: being developed, e.g. EMC).
- reducing resource consumption in industrial companies by a factor 1.5 (Portugal: National Strategy for sustainable development; associated indicators: not yet defined).

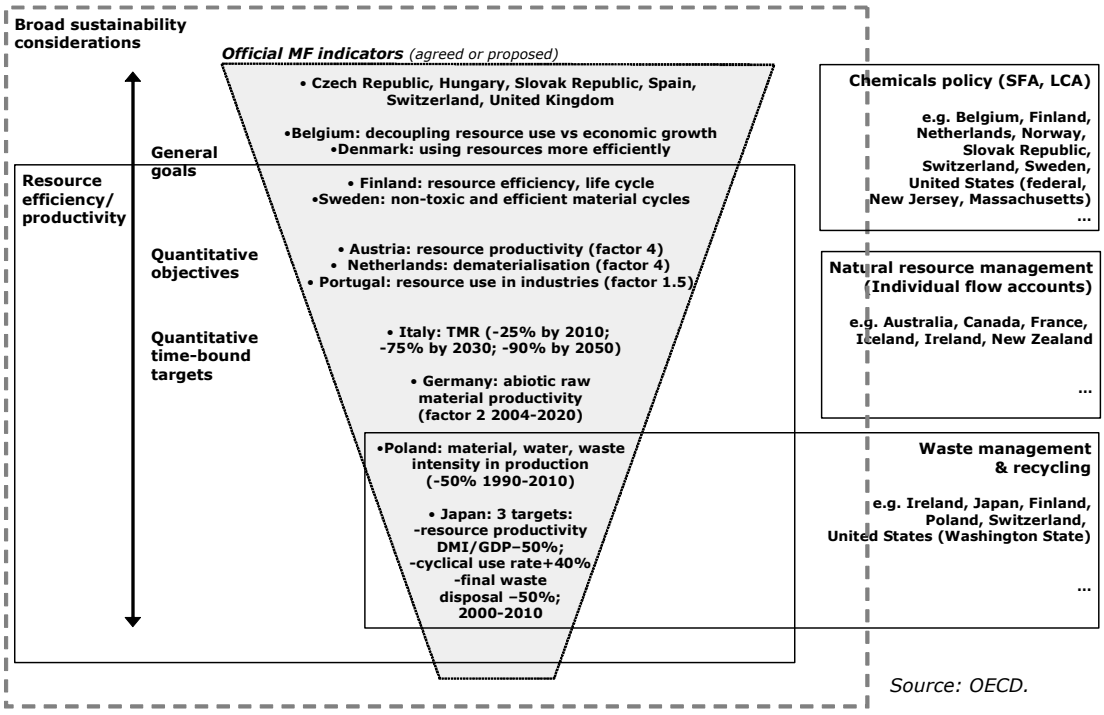
Quantitative time-bound targets

In four countries, MF indicators are associated to quantitative time-bound targets on resource productivity or material resource use intensity:

- the German target to improve the productivity of abiotic raw materials by a factor of 2 between 2004 and 2020 (National Strategy for sustainable development).
- the Italian targets to achieve a reduction of the total material requirement (TMR) of 25% by 2010, 75% by 2030 and 90% by 2050 (Environmental Action Plan for sustainable development in Italy).
- the Polish targets to reduce the water consumption, material intensity and waste generation in the production sector by 50% between 1990 and 2010 (Second National Environmental Policy).

Among the most prominent examples of policy use of MF related information and indicators is that of Japan. In 2003, the Japanese government adopted its Fundamental Plan for Establishing a Sound Material-Cycle Society. The Plan includes three quantitative time-bound targets to be achieved by the year 2010 compared to 2000: (i) improve resource productivity (GDP/DMI) by 40%, (ii) improve the cyclical use rate by 40%, and (iii) reduce the final disposal amount by 50%. The targets build on a cabinet decision, and stakeholders are asked to make efforts to contribute to their achievement.

Figure 1. Examples of uses of MF information and links to policy goals



III. OVERVIEW OF MATERIAL FLOW RELATED ACTIVITIES IN OECD COUNTRIES – SUMMARY TABLES

Table 1a. Resource and material flow accounts: main characteristics and scope

	MF related work	Type of activity (a)			Other closely related work (b)	Reference framework (c)	Comments
		EW-MFA	PIOTs	SFA			
Canada	✓	–	–	–	X NRA	Based on SEEA	Other:Material & Energy Flow Accounts - MEFA (energy, water, GHG) as part of the Canadian System of Environmental and Resource Accounts. Focus on individual accounts not full EW-MFA.
Mexico	..	..	..	..	X	..	EW-MFA: Project proposal at academic level* Other: system of Economic and Ecological Accounts of Mexico (SEEAM)
USA	☑	X ad-hoc	–	X	X	..	EW-MFA: study by World Resources Institute SFA: Yale University (4 metals) / Other: Toxic release inventory (TRI); MF studies at State level
Japan	☑	X	X	..	X	EW-MFA: Eurostat	Other: NAMEA
Korea	✓	X pilot	–	–	X	Based on SEEA	Other: NAMEA pilot
Australia	✓	–	..	..	X	Based on SEEA	--Environmental and material accounts: focus on individual resources (water, minerals, forests, fisheries, energy, GHG), not full material flow analysis. --Australian Stocks and Flows Framework (ASFF) based on input-output approach.
N.Zealand	✓	..	..	..	X NRA	Based on SEEA.	NRA: Focus on individual flow accounts.
Austria	☑	X	X	X	X e.g. NAMEA	EW-MFA: Eurostat	Many MF studies (official and academic).
Belgium	☑	X	–	X	..	EW-MFA: Eurostat & WRI	MFA: regional level, Flanders & Wallonia. SFA: ad-hoc research project incl. Al, Cr, Cd, N-compounds; & development of model for dynamic SFA (Flanders).
Czech Republic	☑	X	–	–	..	EW-MFA: Eurostat	
Denmark	☑	X pilot	X pilot	..	X NAMEA	EW-MFA: Eurostat	Other: NAMEAs for energy, water, air, waste in physical terms.
Finland	☑	X	X	X	..	EW-MFA: Eurostat, Wuppertal Inst.	PIOT: NAMEA type aggregation of industries. SFA: sectoral LCA for mining, forest, metals, packaging industries, energy, water, waste water treatment, paper, nutrients
France	–	–	–	–	X, NRA, NAMEA		NRA: water; NAMEA: air emissions by 40 branches; MFA: interest in developing project.
Germany	☑	X	X	–	..	EW-MFA: Eurostat	Full fledged Material &Energy Flow Information System (MEFIS) based on PIOTs (breakdown by 60 branches) by NSO. Plus research work by Wuppertal Institut.
Greece	–	..	..	..	..	..	
Hungary	☑	X pilot	–	–	..	EW-MFA: Eurostat	Plans to use of MFA concepts in government policy making.
Iceland	–	–	–	–	X	..	Other: Water flow accounting (link to energy) & some work on soil-erosion

	MF related work	Type of activity (a)			Other closely related work (b)	Reference framework (c)	Comments
		EW-MFA	PIOTs	SFA			
Ireland	–	_	_	_	X NRA	..	No wide application of MFA. NRA: National fossil fuel flows account; Water flows account for one region; work in progress; next steps yet to be defined.
Italy	☑	X	X pilot	_	..	EW-MFA: Eurostat	PIOT: planned; feasibility study done; expected breakdown: 60 branches as MIOTs).
Luxembg.	–	_	_	_	..	..	No plans for MFA work so far.
Netherlands	☑	X ad-hoc	–	X	X NAMEA, env. IO analysis	..	EW-MFA: joint international research project. SFA: many studies since 1990; heavy metals, nutrients, organochlorines; mainly research work. Other: NAMEA, Dematerialisation. Focus: energy content & env. impacts of MF&SF.
Norway	✓	–	–	X	X NRA	..	SFA: energy, air, hazardous substances, waste.
Poland	☑	X pilot	–	..	..	WRI	EW-MFA: preliminary study in 1998-99; WRI framework. Systematic MFA under consideration by government (cf. eco-efficiency programme in National Environmental Policy).
Portugal	☑	X pilot	–	–	..	EW-MFA: Eurostat	EW-MFA: stand-alone research study.
Slovak Republic	☑	X pilot	–	–	X NRA	EW-MFA: Eurostat	EW-MFA: project by EPA to start in 2005. Other: Individual accounts for water, mineral ores, raw materials, oil, coal, fuels, wood, construction materials etc. at national level.
Spain	☑	X	–	–	X	EW-MFA: Eurostat methodology	Other: water, forest, air emission accounts. MFA also by Basque country government.
Sweden	☑	X pilot	–	X	X	EW-MFA: WRI, ConAccount, SEEA	SFA: Air + water emissions (focus on metals) by universities & municipalities at local level; ad hoc study by Chemicals Inspectorate (appr. 200 substances). Other: energy-related materials, hazardous substances, based on NAMEA framework.
Switzerland	☑	X pilot	–	X	..	EW-MFA: Eurostat methodology	EW-MFA: feasibility study by NSO. SFA and regional or micro-level MFA: various studies by consultant firms, universities, research institutes (mostly related to waste management).
Turkey	✓	–	–	_	X pilot		Other: SEEA supply-use tables (inland water); NAMEA air; stand-alone study carried out in 1999-2002. MFA study proposed in 2006-2009 as part of capacity building (Eurostat).
UK	☑	X	X	X	X	EW-MFA: Eurostat, Wuppertal Inst.	EW-MFA based on Wuppertal Institut pilot study; plus complete UK overview mass balance. PIOT: regional, product based using PRODCOM; adhoc NGO work. SFA: studies by waste management industry as part of landfill tax credit scheme.

Notes:
Overview based on replies to the global survey of activities related to material flow analysis (by OECD and EEA) and on other country contributions. It should be noted that replies to the global survey are the respondent's views, and may not reflect the countries' official position. Further details can be found in the descriptive country sheets.

a) EW-MFA: economy-wide material flow accounts or mass balances; PIOTs: physical input-output tables; SFA: substance flow analysis.
b) Other: all other relevant activities, including individual flow accounts and other natural resource accounts (NRA), National Accounting Matrix including Environmental Accounts (NAMEAs), etc.
c) SEEA: System of Integrated Environmental and Economic Accounting.

Country notes:
MEX) The Autonomous University of Barcelona (Spain) together with the IFF-Vienna and other Universities are preparing a proposal to the EU Commission for carrying out a comparative MFA study for Mexico and some other Latin American countries.

Source: OECD.

Table 1b. Resource and material flow accounts: status of work and lead agencies

	Duration and periodicity			Status				
	Start date	**Regular activity**	**Ad-hoc project**	**Govern-mental**	**Official statistics**	**Non Govern-mental**	**Lead agency (a)**	**Comments**
Canada	early 1990s	X NRA	..	X	X	–	NSO	Refers to the Canadian System of Environmental and Resource Accounts (MEFA). Periodicity varies with projects; annual for GHG & energy accounts.
Mexico	1991	X	..	X	..	..	NSO	Refers to system of Economic and Ecological Accounts of Mexico (SEEAM)
USA	mid 1990's	..	X EW-MFA	..	..	X EW-MFA	–	EW-MFA: World Resources Institute with government funding. No formal government-wide programme yet.
Japan	1992	X EW-MFA	X	X	..	X	MIN, RES	MFA studies led by NIES with government funding. Many studies also by consultant firms, universities, research institutes (mostly related to waste management)
Korea	2004	–	X pilot	X	–	–	MIN, (RES, NSO)	07.2004: pilot compilation project of EW-MFA and of NAMEA-air initiated by Ministry of Environment in co-operation with members of the MoE, research institutes, a private consultant firm and universities, and with the active participation of the NSO.
Australia	..	X	X	X	X	X	MIN, NSO	Periodicity varies with projects (mainly NRA).
N.Zealand	2001	X NRA	..	X	..	..	NSO	Work on NRA initiated in 2001.
Austria	1991	X	–	X	X	..	NSO, RES	RES: Many academic studies by IFF-Vienna with funding by government, EU, Austrian National Bank.
Belgium	2001 Fl, 2003 W	X EW-MFA	X SFA	X	–	..	EPA	2001: Flanders, 2003: Wallonia
Czech Republic	2000	X EW-MFA: annual	–	–	–	X	RES	Charles University Environment Center: MF studies supported by government & EU funding.
Denmark	1997	–	X EW-MFA PIOTs	..	..	X	–	EW-MFA, PIOT: pilot projects by NSO. Funded by Research Foundation, EPA & EU.
Finland	1997	X annual EW-MFA		X	X	X	NSO, (RES)	Funding by government and EU.
France	–	..	–	..	–	–	–	
Germany	1993	X annual except PIOTs	..	X	X	X	NSO, (RES)	Periodicity: EW-MFA = annual; PIOTs = every 5 years. NSO: MEFIS. Research work by Wuppertal Institut partly funded by EU.
Greece	..	..	..	..	..	..	..	
Hungary	2001	–	X EW-MFA	–	–	X	MIN, NSO	EW-MFA: ad-hoc study by consultant firm.
Iceland	–	X	X	X		X	..	Refers to NRA. Periodicity varies.
Ireland	..	–	X NRA	X		X	..	Refers to NRA.
Italy	2000	X EW-MFA	X PIOTs	X	X	–	NSO	EW-MFA=annual. MF balances= every 5 years. PIOT: feasibility study done.
Luxembourg	..	..	..	..	..	..	..	
Netherlands	1997	X RES	X	X	X	X	NSO, RES	Periodicity and status varies with projects. SFA: mainly research work; many studies since 1990; some funding by NLD Science Foundation. Dematerialisation is current focus.
Norway	1970s NRA	X waste acc.	X SFA	X	X	–	NSO, EPA	Periodicity: annual for waste accounts since early 1990's / stand alone for SFA (latest 2004).

	Duration and periodicity			Status				
	Start date	**Regular activity**	**Ad-hoc project**	**Govern-mental**	**Official statistics**	**Non Govern-mental**	**Lead agency (a)**	**Comments**
Poland	1998-1999	–	X EW-MFA	–	–	X	RES	EW-MFA: preliminary MF study by Wuppertal Institut in 1998-1999. Research work also by Warsaw University.
Portugal	2000	–	X EW-MFA	–	–	X	RES, (NSO)	Stand-alone research study partly funded by government. Co-operation with NSO.
Slovak Republic	2005 EW-MFA	X NRA	X EW-MFA	X	X NRA		NSO, EPA	EW-MFA: project by EPA to start in 2005. NRA since 1993; annual updates.
Spain	2002	X	–	X	X	X	NSO	MF work in Basque country region initiated in 2001: government work by university with Wuppertal Institut.
Sweden	late 1990s	–	X EW-MFA, SFA	X	–	..	NSO	EW-MFA: ad-hoc studies only (late 1990s); no regular funding. NRA since 1993. SFA ad hoc study by Chemicals Inspectorate.
Switzerland	2003	–	X EW-MFA	X	X	X	NSO	EW-MFA: feasibility study by NSO (Aug 03-Sep 04). Studies at regional or micro level by consultant firms, universities, research institutes: some funded by trade organisations & other private institutions.
Turkey	1999	–	X	X	X		NSO	Refers to NAMEA air: stand-alone study carried out in 1999-2002; co-operation with MIN and State Planning Organisation.
UK	1999	X annual	X	X	X	X	NSO	MF pilot study by Wuppertal Institut, now NSO; plus complete UK overview mass balance completed in 2003. PIOT by NGO to be completed by end 2004.

Notes:
Overview based on replies to the global survey of activities related to material flow analysis and on other country contributions. It should be noted that replies to the global survey are the respondent's views, and may not reflect the countries' official position. Further details can be found in the descriptive country sheets.
a) MIN=ministry of the environment; NSO=national statistical office; EPA=environment agency; RES=research institute;

Country notes:
MEX) The Autonomous University of Barcelona (Spain) together with the IFF-Vienna and other Universities are preparing a proposal to the EU Commission for carrying out a comparative MFA study for Mexico and some other Latin American countries.

Source: OECD.

Table 1c. Resource and material flow accounts: use and publication

	Use of MF information to:				Official publication with MF/ NR information	Comments
	develop MF indicators	monitor resource use efficiency	link env.& econ. Inform.	support modelling & outlook work		
Canada	–	X	X	X	Yes	Publication on environmental accounting. Incl. data & indicators on MF and energy use intensities by industries, governments & households. No aggregation across flows.
Mexico	..	..	..	..	Yes	Publication on environmental accounting
USA	X	–	–	–	No	No comprehensive official publication, but EW-MF indicators published by WRI (time series) in 1997, 2000, 2004 with government funding, and MF data published by USGS.
Japan	X	X	X	-	Yes	Three MF related publications.
Korea	..	..	..	..	..	..
Australia	–	X	X	X	No	Indicators on individual resources are used and published in SoE reports.
N.Zealand	..	..	..	..	..	..
Austria	X	-	X	X	Yes	MF indicators published in SD indicators report (06.2004).
Belgium*	X	X	-	-	Yes	MF indicators published in SoE reports 2001, 2002, 2003, 2004 (Flanders); 2004 (Wallonia)
Czech Republic	X	-	X	-	No	Results of MF studies published at academic level. No official publication yet.
Denmark	X	..	X	..	No	
Finland	X	X	X	X	Yes	MF data published in "Natural resources and the environment".
France	–	..	..	..	No	
Germany	X	X	X	-	Yes	
Greece	..	..	..	..	..	
Hungary	X	..	..	..	Yes	MF indicators included in Environmental Indicators of Hungary since 2000 (Eurostat data)
Iceland	–	X	X	X	No	Refers to use of water flow data only.
Ireland	–	..	..	..	No	
Italy	X	X	X	-	Yes	
Luxembourg	..	..	..	..	..	
Netherlands	X	..	..	..	No	
Norway	–	-	X	X	Yes	Waste accounts published annually in "Natural Resources and the Environment". Special SFA report by Pollution Control Authority.
Poland	X	X	X	-	..	
Portugal	X	X	X	X	No	
Slovak Republic	X	X	X	X	Yes	Statistical Office Yearbook, Mining Office Yearbook.
Spain	X	X	X	..	Yes	Publication on env. accounting & MFA (INE).
Sweden	X	X	X	..	No	
Switzerland	X	X	X	-	No	Reports on SFA and MFA activities exist (focus: waste management). Feasibility study on EW-MFA not yet published.
Turkey	–	..	..	..	No	
UK	X	-	X	-	Yes	Publication: Environmental Accounts- Spring 2004

Notes:

Overview based on replies to the global survey of activities related to material flow analysis and on other country contributions. It should be noted that replies to the global survey are the respondent's views, and may not reflect the countries' official position Further details can be found in the detailed country sheets.

Source: OECD.

Table 2. Material flow indicators: availability and use

	Availability of EW-MF indicators				Related policy goals (b)		
	Type (a)	**in official indicator set?** *agreed or proposed*	**Years**	**Lead agency**	**Policy plans, strategies**	**Objectives & targets**	**Comments**
Canada	–	–	–	–	–	–	Indicators are available for selected resource and energy aspects.
Mexico	..	..	..	..	..	..	..
USA	DMI, DMC, TMR, Other (TDO, DPO)	–	-2000	–	–	–	EW-MF indicators published by WRI (time series).
Japan	DMI, DMC, TMR	Yes	1975-1996 1980-2001	MIN	X	X	The Fundamental Plan for Establishing a Sound Material-Cycle Society, includes time-bound targets: by FY2010, 40% increase in Resource Productivity (DMI/GDP) and cyclical use rate, and 50% reduction of final disposal amount compared to 2000.
Korea	..	..	..	..	..	..	..
Australia	–	–	–	–	–	–	Indicators have been developed on individual resources. Information from environmental and resource accounts used in support of National Strategy for Ecologically Sustainable Development.
N.Zealand	..	..	..	..	..	..	..
Austria	DMI, DMC, Other (PTB, NAS, RMTB, RMI, RMC)	Yes	-2001	NSO, MIN, RES	X	X	Long term goal in the Austrian Strategy for Sustainable Development adopted in 2002: increasing resource productivity by a factor 4. Monitoring indicators: DMI, DMC, DMC/GDP, GDP (published 06.2004).
Belgium*	DMI, DMC, TMR, Other (e.g. DPO, DMO)	Yes	2002 (F); 2001 (W)	RES, EPA	X	X	Proposed goal on decoupling use of NR from economic growth in draft Federal Plan for Sustainable Development 2004-2008. No indicators defined yet. Flanders: see footnote.
Czech Republic	DMI, DMC, TMR, Other (TMC, DPO, TDO, NAS)	Proposed	1990-2002	RES	–	..	Proposed EW-MF indicators to assess SD Strategy to be adopted soon.
Denmark	DMI, DMC, TMR	Yes	1997 TMR, 1999 DMI	EPA	X	..	No precise objective, but principle that "resources must be used more efficiently" in SD strategy.
Finland	DMI, DMC, TMR, (TMC)	Yes	-2003	NSO (RES)	..	X	The Government's SD Programme includes an objective on eco-efficiency: improve the efficient use of natural resources and energy taking into account the whole life-cycle.
France	–						
Germany	DMI, DMC, Other (abiotic raw materials productivity, DPO, PTB, NAS)	Yes	1975-2001	NSO	X	X	Objective in policy document of the Federal Government on the National SD Strategy: improving raw material productivity by a factor 2 between 2004 and 2020 (voluntary target). / Indicator to monitor progress: ratio of gross value added at constant prices and sum of domestic abiotic raw material extraction (used) and imports.
Greece	..	..	..	..	..	..	
Hungary	DMI, DMC, TMR, Other (TMC, PTB)	Yes	1992-1999	..	–	..	MF indicators included in Environmental Indicators of Hungary (Eurostat data).
Iceland	–	..	..	..	–	..	
Ireland	–	..	No	..	–	–	No targets, but recognition of need to decouple resource use from economic growth. As part of National Waste Prevention Programme, EPA plans to develop MF indicators to monitor progress (early design stage, demonstration research project nearly completed).

	Availability of EW-MF indicators				Related policy goals (b)		
	Type (a)	in official indicator set? *agreed or proposed*	Years	Lead agency	Policy plans, strategies	Objectives & targets	Comments
Italy	DMI, DMC, TMR, Other (TMC, PTB, PTBIF)	Yes	-2001	NSO	X	X	Voluntary target to reduce TMR (-25% by 2010; -75% by 2030; - 90% by 2050) in Environmental Strategy Action Plan for SD approved by inter-ministerial committee in 2002. /PTBIF: modified indirect flows balance.
Luxembourg	..	..	..	..	–	..	
Netherlands	Yes, environmentally weighted DMC, see comments	–	-2000 (Wuppertal dataset)	..	–	–	Qualitative objectives in 4th National Environmental Policy Plan: dematerialisation with a factor 2 to 4 by 2030. Development of dematerialisation indicator commissioned by the MIN; Leiden University works on environmentally weighted DMC.
Norway	–	–	–	..	No	No	Set of SD indicators being developed, incl. natural resource indicators. Action plan for SD (part of report to the Storting) includes objectives partly related to material resource use and productivity.
Poland	DMI, TMR	Yes	1992-1999	MIN, EPA	X	X	MF indicators calculated by Wuppertal Institut (research project). National Environmental Policy has targets to reduce consumption of water, material intensity & waste generation in production by 50% by 2010 compared to 1990.
Portugal	DMI, DMC, TMR	–	2000-2002	RES	X	X	The National Strategy for SD 2005-15 includes target to reduce resource consumption in industrial companies by 1.5 factor. Status of objectives and targets to be defined by the Implementation Plan of the strategy (PIENDS) (not yet published).
Slovak Republic	tbd	Proposed	..	EPA, NSO	X	..	Links to National SD Strategy; National Raw Materials Policy.
Spain	DMI, DMC, TMR, Other (DPO, TDO, DMO, NAS, TMO, TMI, TMC)	Yes	1995-2000	NSO	..	..	Link to National SD Strategy. Idem for Basque country region.
Sweden	DMI, DMC, TMR (adhoc)	–	1993-1998	NSO	X	–	Government Bill 1997/98:145. No objectives, but a strategy aiming at non-toxic & resource-efficient material cycles. Not legally binding; policy direction only. No indicators defined yet.
Switzerland	DMI, DMC, Other (PTB)	Yes	1981-2001	NSO	–	..	National system of indicators to measure SD includes "total material flow/GDP".
Turkey	–	..	..	..	–	–	
UK	DMI, DMC, TMR	Yes	-	MIN	–	..	MF indicators: included in official set, not formally adopted.

Notes:
Overview based on replies to the global survey of activities related to material flow analysis and on other country contributions. It should be noted that replies to the global survey are the respondent's views, and may not reflect the countries' official position. Further details can be found in the detailed country sheets.

a) DMI: Direct Material Input , DMC: Domestic Material Consumption ; TMR: Total Material Requirement;
DMO: Direct Material Output; DPO: Domestic Processed Output; NAS: Net Additions to Stock; PTB: Physical Trade Balance; RMTB: Raw Materials Trade Balance; TDO: Total Domestic Output; TMC: Total Material Consumption; TMI: Total Material Input; TMO: Total Material Output.

b) Indicates whether goals concerning the efficient management and sustainable use of natural resources and materials exist in national sustainable development strategies or environmental plans, and whether related objectives have been defined.

Country notes:

BEL) Flanders: voluntary goal based on pact between government, organisations of employers and employees and environmental NGOs; i.e. by 2010, Flanders should be among the top regions concerning eco-efficiency. none of the 4 indicators for follow-up of the objective relates to material resource use. However, the Flemish Environmental Policy Plan 2003-2007 includes a set of key indicators to evaluate environmental policy in the long term. TMR is one of these indicators.

Source: OECD.

IV. MATERIAL FLOW RELATED ACTIVITIES IN OECD COUNTRIES AND BEYOND - DESCRIPTIVE SHEETS

OECD AREA

CANADA

OVERVIEW

In Canada, work on material flows is part of the Canadian System of Environmental and Resource Accounts (CSERA) that builds on exploratory work in the late 1970s and early 1980s. Efforts focus on the development of individual material and energy flow accounts, rather than on economy-wide MF accounts.

The lead institution is Statistics Canada. Among other institutions playing a role is the National Round Table on the Economy and the Environment (NRTEE), and Environment Canada.

Environment Canada has developed an environmental accounts information database (2002-2003), the Environmental Valuation Reference Inventory (EVRI). EVRI was developed in collaboration with a number of international experts and organisations, between Canada, UK, France and USA.

Canada participates actively in international work and Statistics Canada acts as the Secretariat for the London Group on Environmental Accounting since 1997.

CHARACTERISTICS AND SCOPE

The first environmental and resource accounts, developed in the late 1970s - early 1980s, used the Stress-Response framework also used for organising physical data in Canada's Environmental Statistical System (Friend and Rapport, 1979; Friend, 1981)

The Canadian System of Environmental and Resource Accounts (CSERA), set-up over 1992-1997, uses the basic methods of the Canadian System of National Accounts (CSNA) to organise physical and monetary statistics. It has three components:

- the Material and Energy Flow Accounts (MEFA).
- the Natural Resource Stock Accounts.
- the Environmental Protection Expenditure Accounts (Statistics Canada, 1997).

The **Material and Energy Flow Accounts (MEFA)** record in substantial detail the annual production and consumption flows of materials and energy –in the form of resources and wastes- between the Canadian economy (industries, households, governments) and the environment The accounts are structured according to the framework and sectoral classifications of the Canadian Input-Output Accounts (Statistics Canada, 1999), thus allowing environmental data in the MEFA to be directly and easily linked with economic data (hybrid flow accounts as defined in SEEA-2003). The Input-Output Accounts provide annual estimates of the production and consumption of 476 commodities by 113 industries and 120 categories of final demand (Statistics Canada, 2004). The MEFA build on this substantial detail by incorporating physical estimates of natural resource and waste flows into the accounting framework of the Input-Output Accounts.

MEFA have so far been produced for energy use, water use and greenhouse gas (GHG) emissions. Energy and GHG emission accounts are updated annually. As these accounts are based on I/O tables, the delay with respect to the reference year is four years. Data are available for 1990-2000. Water use accounts used to be updated every five years, but related surveys have been discontinued (data available for 1981, 1986, 1991 and 1996).

Gaps remain as regards waste flows. Estimating the quantities of recycled wastes that are used in place of virgin sources is recognized as a priority, and a pilot study on scrap metals has been launched. With respect to other natural resource flows, Statistics Canada plans to collect many of the raw data required to incorporate such flows into the MEFA framework, and calls for the development of estimates for timber, metallic and non-metallic minerals and possibly land.

OUTPUTS AND USE

Publication: The accounts (MEFA) and related indicators have been published on CD-ROM in 1997 and in 2000.

Indicators: MEFA provide the basis for some important environment-economy indicators that shed additional light on the nature of economic development in Canada. These are quantative measures that define the extent to which the economy places demands on the environment as a source of raw materials and as a sink for waste materials, and provide important counterparts to the long-standing economic indicators published by Statistics Canada. Examples are:

- resource intensity and/or waste intensity of industrial output.
- resource intensity and/or waste intensity of household consumption.

A core set of material and energy flow indicators based on the MEFA is published regularly, along with other environment-economy indicators developed by Statistics Canada.

Links to policies and objectives: The development of environmental and resource accounting in Canada has been closely related to policy development. A major turning point was in 1990 when the government released Canada's Green Plan for a Healthy Environment (Government of Canada, 1990), that initiated the development of the CSERA to quantify the links between the environment and the economy, and helped to make related funding available.

Indicators derived from the MEFA appear to be most useful when applied at the micro-level, where work has focused on the eco-efficiency and material intensities in enterprises. (see case study by the National Round Table on the Economy and the Environment).

Use in research work: Some use has already been made of MEFA data in university research projects. Other researchers accustomed to using Statistics Canada's economic data and concepts, as their classifications allow easy incorporation of material and energy flow data into existing models built around these concepts particularly for the research on climate change.

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MEXICO

OVERVIEW

Mexico has not yet carried out work on material flows, but has good experience with integrated economic and environmental accounting. Environmental accounts are implemented since 1991.

The lead institution is the National Institute for Statistics, Geography and Informatics (Instituto Nacional de Estadística, Geografía e Informática - INEGI).

The System of Economic and Ecological Accounts of Mexico (SEEAM), covers environmental themes such as petroleum, forests, underground water, pollution of air and water and soil degradation. It includes indicators such as the Net Ecological Domestic Product (NEDP), a GDP adjusted for depletion and degradations costs.

Publication: Results from the SEEAM are published regularly since 1991; the latest publication includes data for the period 1997-2002.

At academic level, a proposal for carrying out a comparative MF study for Mexico and other Latin American countries is being developed by the Autonomous University of Barcelona (Spain) together with the Institute for Social Ecology-Vienna (IFF) and other European and Latin American Universities.

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- INEGI home page, http://www.inegi.gob.mx/inegi/default.asp.

UNITED STATES

OVERVIEW

The United States has no formal government-wide programme on material flows analysis, but has a long history of tracking mineral and energy flows, waste flows and toxic substances. Material flow related databases and analyses are well established in a variety of U.S. government agencies that gather material flows data relevant to their organisational missions and responsibilities.

Main institutions involved are the US Geological Survey (GS), the US Department of Energy (DOE), the US Environmental Protection Agency (EPA), and the US Department of Agriculture (DOA).

MF studies have also been carried out at State level (Massachusetts, New Jersey, Washington), and at the national level by private research institutes (World Resource Institute - WRI, economy-wide material flows) and by universities (Yale University, substance flow analysis with a focus on metals).

Together with Austria, Germany, Japan and the Netherlands, the United States has, via the World Resources Institute, actively participated in the joint international research project on material flows that led to two key publications by the World Resource Institute, et al. in 1997 and 2000.

As a result there are many sources of data on material flows in the United States, although they are not co-ordinated or integrated for analysis or public policy-making purposes. In a recent study commissioned by the DOE, the EPA, the National Science Foundation and the GS, the National Research Council recommended that a national-level effort be initiated to establish a comprehensive approach to material flows analysis building on "*a structured material flow accounting framework that can accept and integrate existing and future data*".

CHARACTERISTICS AND SCOPE

Research work carried out by the WRI in collaboration with the EPA, the GS and other government agencies has focused on **economy-wide MF studies** and has so far generated time series data from 1975 to 2000. The data are classified by life cycle phase (Inputs, Uses, Outputs, Recycling), and characterised by mode of first release (M), quality (Q), and velocity (V) of flows. Current efforts concentrate on establishing a pilot database covering approximately 200 materials at various levels of details (macro- and micro-flows) and drawing upon data available from official sources.

Examples of major material flow related studies and analysis generated by **government agencies at federal level** include the following:

- **Historical Statistics for Mineral** and **Material Commodities in the United States:** This interactive database, created and maintained by the USGS, is a compilation of historical US and world statistics on mineral and material commodities. This continuously updated database contains information on primary and secondary commodity production, imports, exports, and stock changes; reported and apparent consumption; and unit value (the real and nominal dollar value of a ton of apparent consumption) for approximately 150 commodities. For most the commodities, data are reported as far back as 1900.
- **Flow Studies for Recycling Metal Commodities in the United States**: This 2004 publication presents material flow studies for 26 metal commodities. Each study covers issues from mining, through processing and consumption, to recycling. Overall, recycling accounts for more than half of the U.S. metal supply by weight and roughly 40 percent by value.
- **The Toxics Release Inventory (TRI)**: The TRI is a publicly available EPA database with information on toxic chemical releases and waste management activities reported annually by certain industry groups as well as federal facilities. It was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. It covers 650 chemical compounds; waste and emissions are tracked, but a complete picture is not available.
- The **US life-cycle inventory (LCI) project** is a public/private research partnership aiming at creating a publicly available database on material and energy flows associated with a particular product or system. The project, sponsored by government agencies and private companies, was

initiated in May 2001 and is steered by an advisory group with 45 representatives of the government, and of industrial, academic and consulting communities. A test version of the database is available.

- The **By-Product Synergy (BPS)** project is about creating and capturing value through matching producers of under-valued waste streams with users, and working with regulators to establish support for the process. BPS promotes a shift from a waste disposal system to a reuse methodology, saving energy and cutting emissions. EPA is supporting BPS projects in New Jersey and Kansas City.

Examples of **State level initiatives** include the following:

- The states of **New Jersey** (since the mid 1990s) and **Massachusetts** (since 1990) have established inventories that track substance-specific material throughputs at the facility level (amounts of materials entering the production process, and amounts released to air water and soil). The focus is on toxic chemicals. The data are reported annually by firms that use more than a certain amount of listed toxic chemicals. New Jersey's law requires reporting of the same substances as the EPA's TRI, but with more detail regarding the flow characteristics.
- The state of **Washington** develops material flow information as part of its "Beyond Waste" project that includes long term strategic plans (30-years) for properly handling hazardous and solid wastes.

OUTPUTS AND USE

Publication: There is no comprehensive official publication on material flows, but time series with US material flows data have been published by GS and WRI.

Indicators:

- Economy-wide MF information compiled by **WRI** as part its research projects has been used to derive indicators such as Direct Material Input (DMI), Domestic Material Consumption (DMC), Total Material Requirement (TMR), Total Domestic Output (TDO), and Domestic Processed Output (DPO).
- Closely related indicators are included in other projects, e.g. **Micro Indicators of Environmental Stress** (dissipation of heavy metals into the environment, land disruption resulting from materials extraction, atmospheric releases of greenhouse gases); **Resource Efficiency Indicators** (recycling indices by economic sector, ratio of agricultural water consumption to food production, ratio of processed/raw materials).

Links to policies and objectives:

- In the states of **New Jersey** and **Massachusetts**, substance specific material flow information collected from industrial facilities is used for pollution control purposes and for encouraging industries to implement pollution prevention. It is also used for public communication purposes and can be accessed by anyone. In Massachusetts, this is done in the framework of the implementation of the Toxics Use Reduction Act (TURA) passed in 1989 to encourage a reduction in the amount of toxics used and the amount of toxic by-products generated by promoting more efficient industrial operations. It involves in-plant changes that reduce, avoid, or eliminate the use of toxic chemicals or the generation of hazardous waste, emissions (to air or land), and by-products per unit of product manufactured.
- In the state of **Washington**, MF data in the “Beyond Waste” project will be used to measure progress in achieving the goals set out in the 30-year plans as required by a State law. These goals aim at decreasing solid and hazardous wastes, properly managing wastes that remain, and reducing the use of toxic substances by moving beyond waste to resource re-use and toxic-substance reduction. The state plans will guide decision-making in the field of waste management.

The **World Resources Institute** (WRI) is an independent non-profit organisation carrying out research on environment related policy issues, including natural resource management and material flow analysis. Since the mid-1990s, the WRI has conducted 3 major studies on material flows and has published time series with material flow data for the USA in 1997, 2000 and 2004. Part of this work received financial support from the US government (e.g. EPA and GS).

The first two studies were carried out together with research partners in Austria, Germany, Japan, and the Netherlands. The aim was to develop databases and indicators that document the flow of materials through industrial economies in the late 1990's. The studies have produced two reports in 1997 and 2000. These reports, co-ordinated by the WRI, have shed light on the trends in materials throughput over the last several decades, and have contributed to the development of a standardized approach to materials flow accounting.

Current efforts initiated in late 2002, focus on refining methodologies, and developing database standards and protocols for collecting materials flow data. The aim is to compile a Materials Flow Accounts database for the United States and to advance the use of physical accounts of material throughput in the US economy as a tool for formulating national environmental policies. The project "Statistical analysis and indicators research" is carried out in cooperation with several US agencies.

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JAPAN

OVERVIEW

Japan initiated economy-wide MF studies in 1992 for a report on the quality of the environment, and has since then actively contributed to promote MF studies at international level.

The lead institutions are the National Institute for Environmental Studies (NIES) that produces annual MF data on behalf of the Ministry of Environment (MOE), and the MOE itself that is responsible for compiling MF indicators. Other bodies involved include the Japan Environmental Sanitation Center (JESC), and the Fuji Research Institute Corporation (a consultant firm). In addition, the government provides funding for academic research projects e.g. on Physical Input-Output Tables (PIOTs), Life Cycle Analysis (LCA). Some private companies (e.g. Toyota Motor Corporation) and local authorities (e.g. Aichi Prefecture) are also very active in conducting MFA related activities.

Governmental research activities on Environmental and Resource Accounting including Material Flow Accounting (MFA) have been supported financially by the Global Environmental Research Fund (GERF), managed by the MOE. The first phase of the research project on environmental accounting started in 1991. Since then, four three-year-projects have been conducted by the NIES and collaborating institutions, including the Economic and Social Research Institute (ESRI), which is responsible for the SNA. A new project has been launched for FY2004-2006 with the participation of the NIES, the National Institute for Advanced Industrial Science and Technology (AIST), the National Institute for Material Science (NIMS), and six universities.

The results of these research projects have contributed to related international activities such as those carried out by the OECD and the ConAccount network co-ordinated by the Wuppertal Institut (Germany). Together with Austria, Germany, the Netherlands and the United States, Japan has, via its research activities, actively participated in the joint international research project on material flows that led to two key publications by the World Resource Institute, et al. in 1997 and 2000.

CHARACTERISTICS AND SCOPE

The work covers economy-wide MFA, Physical Input-Output Tables (PIOTs), and National Accounting Matrices including Environmental Accounts (NAMEAs).

- **Economy-wide MFA** build on the Eurostat framework and methodology. Data are available from 1980 to FY2001 and are updated on an annual basis.
- **Physical Input-Output Tables (PIOTs)**: Japan has established PIOTs, linked to its economic input-output tables, as part of the national environmental statistical system. A trial edition of Japanese PIOTs was compiled by the NIES.
- **NAMEAs**: A Japanese NAMEA was edited by ESRI.

The current phase of the government's research projects (FY2004-2006) aims at developing indicators and methodologies to assess the performance of policy measures and technologies concerning sustainable production and consumption by using material flow models. The models are expected to be multi-scale so as to facilitate the linkages among material flow information at the macro-, meso- and micro- scales.

OUTPUTS AND USE

Publications:

Two thematic data books related to environmental accounting have been published. They are available as paper copies with CD-ROM and via internet. The first one uses input-output tables and relates to embodied energy and emission intensity data (3EID); it contains sectoral emissions of CO2 and major air pollutants. The second one relates to material flow data "World resource flows around Japan"; it describes physical international trade flows on visual maps.

A third publication on material flows with PIOTs of harvested wood is under preparation. The publication of trial versions of PIOTs for other resources is under consideration.

Indicators: Economy-wide MF information is used to derive MF indicators including Direct Material Input (DMI), Domestic Material Consumption (DMC), and Total Material Requirement (TMR).

Links to policies and objectives:

MF indicators are closely related to the Government's policy as stated in Japan's Basic Plan for Establishing a Sound Material-Cycle Society approved by Cabinet and enacted in March 2003. As part of the Basic Plan, the Japanese government adopted three numerical time-bound targets on resource efficiency. The targets were defined on the basis of results from the above-mentioned research projects and are accompanied with indicators to measure progress.

The indicators and targets are defined as follows:

- Resource Productivity (yen/tonne) = GDP / DMI
  Target: increase resource productivity to 390,000 yen/tonne by 2010 from 280,000 yen/tonne in 2000
- Cyclical Use Rate (in %) = amount of Cyclical Use / DMI + amount of Cyclical Use
  Target: increase cyclical use rate to 14% by 2010 from 10% in 2000
- Final Disposal Amount (tonnes)
  Target: decrease amount going to final disposal to 28 million tonnes by 2010 from 56 million tonnes in 2000.

The MOE measures the 3 indicators together with supplemental indicators (e.g. natural resource input broken down into several resource types; amount of import and export of waste) and releases the results every year. The Government also submits every year a white paper to the Diet which describes the MFA of Japan and the results of the indices.

At **local and enterprise level**, two examples of MFA related activities are to be mentioned:

- MFA related activity in the **Aichi Prefecture**:

  The Aichi prefecture is the centre of industrial production in Japan. MFA is used in support of the prefectural Plan for Establishing a Sound Material Cycle Society. The Plan focuses on extended producer responsibility and on the waste generator responsibility. It includes quantitative targets to be achieved by FY 2010, including general targets (40% increase in GDP; 20% increase in recycling rates; 58% decrease in waste going to final disposal), and specific targets for the government and the business sector, and for the public.

- MFA related activity by the **Toyota** Motor Corporation:

  Since 1998, Toyota has been promoting its environmental management programmes. The overall aim is to move towards "zero emissions" at all stages of car manufacturing and to encourage behavioural changes by employees. In practice, efforts focus on reducing the amounts of waste going directly to landfill by maximising recycling and reuse, optimising the effectiveness with which raw materials and energy are used in the production processes.

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KOREA

OVERVIEW

Korea plans to establish material flow accounts as part of a research project initiated by the Ministry of Environment and launched in July 2004. The work is part of a ten-year plan for the implementation of the System of Environmental and Economic Accounting (SEEA), established in 2001 by the Ministry of Environment of the Republic of Korea, and has been proceeding as follows:

- 1st stage (2001-2003): Review of experience in other countries and review of data availability and reliability. The results of this review have led to a shift in priorities moving away from the estimation of a "green GDP" towards the compilation of physical accounts. Priority is given to economy-wide material flow accounts, National Accounting Matrix including Environmental Accounts (NAMEAs) and Environmental Protection Expenditure Accounts.
- 2nd stage (2004-2007): Compilation of physical accounts.
- 3rd stage (2008-2010): Compilation of monetary accounts

Work on the compilation of physical accounts planned as of July 2004 includes:

- in 2004
  - A pilot compilation of economy-wide material flow accounts
  - A pilot compilation of a NAMEA-air (SOx, NOx, PM-10, CO, VOC, CO2, CH4, N2O)
- In 2005-2007
  - An extension of the time series for material flow accounts
  - A compilation of NAMEAs for emissions to water (BOD, Ntot, Ptot) and solid waste (domestic, industrial, construction, specified waste)
  - A feasibility study for Physical Input-Output Tables (PIOTs)
  - And work on: Environmental Protection Expenditure Accounts, land use accounts, forest accounts, water accounts

The work builds on earlier research activities on environmental accounting initiated in 1994 by the Korea Environment Institute (KEI), and is carried out in co-operation with the National Statistical Office and with the Bank of Korea (BOK) in charge of the System of National Accounts (SNA). It involves members of the Ministry of Environment, research institutes, a private consultant firm and universities.

AUSTRALIA

OVERVIEW

In Australia, work on material flows is part of the country's environmental accounting activities. Efforts focus on the production of individual material accounts in areas that are of particular relevance to the country and its economy, rather than on economy-wide material flow accounts.

This work is part of the government's environmental reporting activities and of its official statistics. Lead institutions responsible for MFA and related activities are the Department of Environment and Heritage (from a policy perspective) and the Australian Bureau of Statistics (from a statistical perspective).

Among other institutions involved is the Commonwealth Scientific and Industrial Research Organisation (CSIRO) that is in charge of the Australian Stocks and Flows Framework (ASFF).

At the academic level, MF related research work is carried out by the Griffith University.

In addition, the Australian Government has established a "Centre for Sustainable Resource Processing" as part of its Cooperative Research Centres Programme. The aim is to create a partnership of science and industry to improve the efficiency of its mineral and metals processing sector. Key areas for focus include: minimising energy consumption and greenhouse gas emissions; reducing process waste; reducing water consumption and efficiently using natural resources.

Apart from work on the ASFF, Australia is also looking to pricing signals to encourage more efficiency in areas such as water use and waste generation.

CHARACTERISTICS AND SCOPE

Australia's work on environmental and natural resource accounts are developed as satellite accounts in accordance with the System of Integrated Environmental and Economic Accounting (SEEA). In addition, the standard Australian System of National Accounts (SNA) is disaggregated in a way that reveals links to national resource use.

Environmental and material accounts produced include: Water (new account released May 2004), Minerals, Forests, Fish, Energy and Greenhouse gases. The focus is on the resource aspect, not necessarily on the full material flow analysis.

Australia's Water Account

- Australia's Water Account is compiled in accordance with the System of Integrated Environmental and Economic Accounting (SEEA). It provides information on the supply and use of water in Australia (and on water stocks, environmental flows and water trading). Data are disaggregated by industry, State and source of water used.
- Australia's Water Account has been developed because water is an important issue for Australia and its agricultural sector (less rainfall than any other continent except Antarctica; irregular supply – only 20% of Australia's total runoff can be sustainably diverted; limited supply in major agricultural and urban areas). It is used to inform policy especially in pinpointing key users and areas of inefficiency. It also informs ongoing negotiations between States and key users on water allocation.

The Australian Stocks and Flows Framework (ASFF):

- The ASFF is a highly disaggregate data base and simulation model hat keeps tracks of all physically significant stocks and flows in the Australian socio-economic system. At the centre of the framework is an input-output model for the transformation of basic materials and energy types. It covers the complete economy, including service aspects, but incorporates only the physically significant elements of each sector. It is grounded with 50 to 60 years of historical data and can be used to run scenarios for the future up to 2100.
- Results from the ASFF can assist decision making through creating and comparing scenarios. Policy analysis can suggest adjustments of chosen control variables and observe the model results. In doing this, it can provide an integrated overview of the long-term physical consequences of economic and social choices made by Australians.

OUTPUTS AND USE

Information form Australia's environmental and resource accounts is used in support of the National Strategy for Ecologically Sustainable Development and of national state of the environment reporting.

The Australian Stocks and Flows Framework (ASFF):

- The ASFF is being used in a range of policy areas including energy and greenhouse gases, oil depletion, land and water futures, long-term population policy and fisheries management.
- It has been used in the 1996 and 2001 State of the Environment reports to assess the environmental impacts of human settlements. It enables an assessment of reducing resource requirement against maintaining/improving liveability. It is expected to be used in the preparation of the 2006 State of the Environment report to describe physical stocks and flows of water, energy and wastes and other materials in the Australian economy. This will be done through a detailed study of the urban metabolism of three selected settlements in Australia. The selection of settlements was made so as to cover a range of characteristics – size (conurbation vs small town), location (coastal vs inland), pattern of growth (rapid vs slow) and climate.

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NEW ZEALAND

OVERVIEW

New Zealand does not carry out work on material flows, but has initiated work on natural resource accounts in 2001, with a focus on individual areas such as forestry, water, energy and fisheries. This is complemented with an experimental set of Environmental Protection Expenditure (EPE) accounts.

The lead institution is Statistics New Zealand.

At present there are no plans to produce a full system of environmental satellite accounts.

CHARACTERISTICS AND SCOPE

Natural Resource Accounts: The development of natural resource accounts by Statistics New Zealand builds on the System of Environmental and Economic Accounts (SEEA) and is directly linked to the System of National Accounts (SNA) used to produce NZL's national accounts. For each resource an attempt is made to produce stock and flow accounts, in physical and monetary units. The flow tables are estimated as Supply and Use tables.

Tables and reports are being produced progressively for five resources, from late 2001 to mid-2004 as follows:

- Energy (and energy minerals) accounts: physical stock account (2002; →1992-2001 data), physical and monetary flow account (2003; →1996-1999 data), monetary stock account (2004; →1987-2001 data)
- Minerals accounts: physical and monetary stock accounts (→1994-2000 data)
- Forestry accounts: physical stock and flow accounts (2002; →1995-2000 data), monetary flow account (2003; →1996-1999 data), monetary stock account (→1995-2000 data)
- Water accounts: annual water accounts (2004; →1995-2001 data; stock accounts only; data for producing flow accounts are not available in NZL)
- Fish accounts: physical stock account (2002; →1996-2000 data), physical flow account (2003; →1998-2001 data)
- Land accounts: planned.

Environmental Protection Expenditure (EPE) accounts: EPE accounts have been produced for the fiscal year 2000/01 covering environmental protection activities and natural resource management. The EPE accounts provide data that are not available from other data sources, and give an indicative measure of sustainability. The EPE accounts will be developed further to be useful for monitoring and policy purposes.

OUTPUTS AND USE

An experimental report on New Zealand Sustainable Development Indicators (SDIs), called "Monitoring Progress Towards a Sustainable New Zealand" was published by Statistics New Zealand in August 2002. The report includes a chapter on consumption and resource use. In future, information and indicators from the natural resource accounts under development are expected to be used in such reports and in the monitoring of New Zealand's Programme of Action on Sustainable Development.

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AUSTRIA

OVERVIEW

Austria initiated activities on Material Flow Accounting in 1991 as part of the country's official statistics (work on Environmental Accounting) and following a request by the Ministry of Environment in 1989. Work is also carried out by academics. It covers economy-wide material flow accounts, physical input-output tables, substance flow analysis as well as National Accounting Matrix including Environmental Accounts (NAMEAs).

Lead institutions are Statistics Austria and the IFF-Social Ecology (University of Vienna and Klagenfurt). Other institutions involved are: the Federal Ministry of Agriculture, Forestry, Environment and Water Management; the Vienna University of Technology, and Sustainable Europe Research Institute (SERI), a private consultant firm.

Academic research work receives financial support from (i) the government, (ii) the European Commission (Eurostat, DG Environment) under the 4th, 5th and 6th framework programmes, and (iii) the Jubiläumsfonds of the Austrian National Bank.

Austria also contributes to international work on MF within Europe (EEA, Eurostat) and beyond (OECD), and participates in international research networks such as the ConAccount Network co-ordinated by the Wuppertal Institut (Germany). Via SERI, it participates during the period 2002-2006, in the EU-funded research project "Modelling Opportunities and Limits for Restructuring Europe towards Sustainability" (MOSUS). Together with Germany, Japan, the Netherlands and the United States, Austria has also, via its research activities, actively participated in the second phase of the joint international research project on material flows that led to two key publications by the World Resource Institute, et al. in 1997 and 2000. Research institutes, such as the IFF-Social Ecology have further established many bilateral and multilaterial relationships (case studies, training, technical assistance), with universities in Europe, South East Asia and Latin America.

CHARACTERISTICS AND SCOPE

Economy-wide MF accounts: EW-MFA are compiled in accordance with the Eurostat methodology and updated annually. Most recent data refer to 2002.

Physical Input-Output Tables (PIOTs): Work on PIOTs is carried out by the IFF-Social Ecology. It includes the establishment of a highly aggregated PIOT for Austria, as well as conceptual and empirical work on physical input-output analyses and its applications (raw material equivalents and sectoral analysis). Some work on PIOTs has also been done by SERI as part of the EU-funded MOSUS project.

Substance Flow Analysis (SFA): SFA has been done by Statistics Austria and by the Group of Waste and Resources Management of the Vienna University of Technology.

Other related activities: NAMEAs; interlinked NAMEAs and Input-Output (IO) tables.

OUTPUTS AND USE

Publication: Data from Material Flow Accounts are regularly published by Statistics Austria in its Statistical Yearbook.

Indicators: Data from EW-MFA are used to derive selected MF indicators among which: Direct Material Input (DMI), Domestic Material Consumption (DMC), and Physical Trade Balance (PTB), Net Additions to Stock (NAS), Raw Materials Trade Balance (RMTB), Raw Materials Input (RMI), Raw Materials Consumption (RMC). DMI and DMC are part of Austria's report on indicators for the monitoring of the key objectives for sustainable development compiled jointly by Statistics Austria and the Federal Ministry of Agriculture, Forestry, Environment and Water Management.

Links to policies and objectives:

Data and indicators derived from MFA are used to link environmental and economic information and to support modelling and outlook activities. They further support the monitoring of progress under Austria's Strategy for Sustainable Development, which was formally adopted by the federal government in April 2002 by a resolution of the Council of Ministers.

The Strategy for Sustainable Development includes an official government objective for material resource use and resource productivity, under Key Objective 9 - Successful Management Through Eco-efficiency.

"… *The key objective is to increase the productivity of resources together with higher economic growth in such a way as to achieve a further decoupling**. In the short term**, **absolute resource turnover should at least be stabilised**, and **in the long term** the objective must be **to increase the productivity of resources by a factor of 4.** Thereby, the prevention of raw material and energy consumption has absolute priority wherever this is technically feasible and economically reasonable, with the ultimate goal of achieving an absolute reduction in total resource consumption*. …"

It has to be noted that the strategy and related objectives reflect the current government's views and are not binding for the next government.

Among the indicators used to measure progress are: DMI, DMC and DMC/GDP. A first indicator report on the implementation of the Austrian Sustainable Development Strategy was published in June 2004.

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BELGIUM

OVERVIEW

In Belgium, economy-wide MF work is carried out by the regional governments of Flanders (since 2001) and Wallonia (since 2003).

- In Flanders, the lead institutions are the Flemish Environment Agency and, in future, also the Public Waste Agency of Flanders. MF related data are compiled by the Centre for Sustainable Development, Ghent University.
- In Wallonia, the lead institution is the "Cellule de l'Etat de l'environnement Wallon". MF related data are compiled by the "Institut de Conseil et d'Etudes en Développement Durable" (ICEDD) an independent consultant and research institute, and the University of Liège.

Wallonia has established partnerships with the Wuppertal Institut (Germany).

At the academic level, ad hoc studies on substance flow analysis have been carried out by the Flemish institute for technological research.

CHARACTERISTICS AND SCOPE

Work on economy-wide MFA builds on the Eurostat methodology. MF data are updated on an annual basis and are used to calculate MF indicators.

- The Centre for Sustainable Development, Ghent University, under the authority of the Flemish Environment Agency, is investigating the possibilities for a sectoral breakdown of MF data and indicators and for relating MF data and indicators to environmental impacts.
- The ICEDD, under the authority of the Cellule de l'Etat de l'environnement Wallon, is calculating MFA Direct Material Input (DMI), Domestic Material Consumption (DMC) and Total Material Requirement (TMR) for specific sectors.

Work on Substance Flow Analysis by the Flemish Institute for Technological Research has focused on Al (1999), and Cr, Cd, N-compounds (1999-2002), and on the development of a model for dynamic substance flow analysis (2000-2004).

OUTPUTS AND USE

Indicators: MF data are used to calculate economy-wide MF indicators. Among these are: (i) DMI, DMC, TMR, Domestic Processed Output (DPO) and MF indicators related to GDP for the Flemish Region; and (ii) DMI, DMC and TMR for the Walloon Region. These indicators are published regularly in a special chapter of the Flemish state-of-the-environment report (2001, 2002, 2003, 2004), and in the 2004 Walloon state-of-the-environment report (dashboard).

Links to policies and objectives:

At federal level, the Federal Plan for Sustainable Development 2004-2008 includes mandatory objectives to decouple the economic growth from the use of natural resources. The selection of indicators to be used for the monitoring of progress is not yet finalised.

In Flanders, a voluntary agreement (pact) has been concluded between the government, organisations of employers and employees and environmental NGOs. The aim is to promote eco-efficiency: by 2010, Flanders is expected to be among the top-regions concerning eco-efficiency by 2010. Four indicators are used to follow-up this objective, but none of them relates to material resource use. TMR is however one of the key environmental indicators selected to evaluate environmental policy in the longer term under the third Environmental Policy Plan (2003-2007) of the Flemish Government.

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CZECH REPUBLIC

OVERVIEW

In the Czech Republic, work on economy-wide material flow (EWMF) analysis was initiated in 2000 by the Czech Ministry of the Environment as part of a research and development project*. The work was funded by the Ministry and the European Commission, and carried out by the Charles University Environment Center (CUEC) in 2000-2001.

Some MF work has also been done as part of PhD studies in the CUEC.

The Czech Republic participates, via the CUEC, in 2003-2006 in the EU-funded research project "Modelling Opportunities And Limits For Restructuring Europe Towards Sustainability" (MOSUS). The CUEC further co-operates with the IFF-Social Ecology (Austria), the Sustainable Europe Research Institute (Austria) and the Wuppertal Institut (Germany).

CHARACTERISTICS AND SCOPE

Work on **economy-wide MFA** is based on the Eurostat methodology and covers all major material balance variables. Data have so far been produced for the years 1990-2002 by the CUEC. Results, including an analysis of the relation between material productivity and economic performance, have been published in the scientific press.

Current projects by the CUEC include the following:

- Economy-wide material flow analysis –its application on regional and micro-economic level and its use in elaboration of sustainability indicators (2003-2004). This project was funded by the Czech Ministry of the Environment. The aim was to extend time series of material flow indicators in the Czech Republic up to 2002 and to develop a methodology on how to apply particular economy-wide material flow indicators or their components at sub-national and enterprise level.
- State assessment of the environment by the material and energy flow analysis (-2006). This project is funded by the Czech Grant Agency and focuses among others on analysing the indicator "net additions to stock" in the Czech Republic.

OUTPUTS AND USE

Indicators: The results of research work on MF have been used to calculated EWMF indicators among which: Direct Material Input (DMI), Domestic Material Consumption (DMC), Total Material Requirement (TMR), as well as Total Material Consumption (TMC), Domestic Processed Output (DPO), Total Domestic Output (TDO), Net Additions to Stock (NAS).

So far, results from MFA work are not yet used on regular basis in the government's policy and reporting work, and are not yet part of the country's official statistics. It is proposed to include economy-wide material flow indicators into the set of indicators that will monitor the implementation of the National Strategy for Sustainable Development of the Czech Republic (expected to be officially adopted by the Government by the end of November 2004). The suggested indicators include the following:

- Intensity of Material Consumption, defined as the ratio of domestic material consumption to GDP expressed in kg/1000 CZK GDP or in kg/ 1 USD GDP (using purchasing power parities).

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* *Methodology of state assessment and prediction of the environment by the material and energy flow, direct as well as hidden, balances.*

DENMARK

OVERVIEW

Denmark has no formal programme on material flow accounting, but has good experience with physical input-output tables in conjunction with energy use and air emissions (since the mid 1970s), and with National Accounting Matrix including Environmental Accounts (NAMEAs). Economy-wide material flow (EWMF) accounts have been compiled on an ad-hoc basis over the periods 1997-1999 and 2002-2004, with funding from the Danish Research Foundation, the Danish Environmental Protection Agency (EPA) and Eurostat.

Key institutions are Statistics Denmark (pilot work on MFAs and on Physical Input Output Tables (PIOTs), and the Danish EPA (calculation of MF indicators in connection with the national set of sustainable development indicators).

Denmark participates in international work steered by the London Group on Environmental Accounting. Contacts have also been established with the Wuppertal Institute (Germany), the IFF (Vienna, Austria) and the European Topic Centre on Waste and Material Flows (ETCWMF).

CHARACTERISTICS AND SCOPE

While there has been no development to date of an integrated framework for environmental and resource accounting in Denmark, a number of relevant projects have been undertaken in line with the SNA93 and the SEEA. Current work aims at implementing the recommendations of the SNA93 and the SEEA with respect to natural resource stock accounts and with a particular focus on crude oil, natural gas, land, forest and fish resources.

Economy-wide MFA have been compiled according to the Eurostat methodology, with basic data taken from Statistics Denmark's physical input-output tables. Economy-wide MF data are available for the years 1997 (Total Material Requirement, TMR) and 1999 (Direct Material Input, DMI).

Physical Input-Output Tables have first been used in conjunction with energy consumption and air emission data to illustrate, via a materials balance approach, the use of 23 different types of energy in 117 industries and several categories of final demand.

PIOTs have been compiled for the year 1990 for 27 industries based on physical supply-use tables with approximately 1600 products. Preliminary and very rough PIOTs have been compiled for the year 1999 for 8 industries. Separate PIOTs have also been compiled for various groups of materials.

The Danish NAMEA is a "satellite accounting system" to the national accounts and a contribution to "green" national accounts for Denmark. The purpose of the National accounting Matrix including Environmental Accounts (NAMEA) is to combine economic data with data concerning resources and pollution. NAMEAs have been compiled for energy, water, air emissions, and waste in physical terms.

OUTPUTS AND USE

Publication: Data related to material flow accounts and PIOTs for Denmark have been published on an ad-hoc basis.

Indicators:

MF data have been used by the Danish EPA to calculate MF indicators including DMI, Domestic Material Consumption (DMC), and TMR. TMR is part of the national set of sustainable development indicators that is expected to be updated annually and is accessible on internet.

Links to policies and objectives:

Denmark's National Sustainable Development Strategy: Common Future – Balanced Development published by the Government in June 2002, defines a set of objectives and principles among which "Resources must be used more efficiently". It is supported with a set of indicators that are used to monitor and report on the progress made in implementing the strategy and achieving the objectives. This includes:

- a small set of headline indicators among which indicators on resource flows for 3 factors (energy consumption, drinking water consumption, and total waste volume) in relation to GDP, and

- a detailed, specific set of 90 indicators for each of the strategy's action areas among which Total material requirement (TMR) per capita, and Denmark's total consumption of selected resources (raw and ancillary materials).

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FINLAND

OVERVIEW

Finland has good experience with natural resource accounting, and has established a programme on environmental and resource accounting in the mid-1980s. This was stimulated by interest in ensuring sustainable use of forests, the most important natural resource in the Finnish economy.

Work on material flows was initiated in 1997 and is part of the country's official statistics. It covers various types of accounts, including economy-wide material flows and physical input-output tables, and is carried out by both government authorities and academics. A first project on economy-wide material flows "*Eco-efficient Finland: Total Material Requirement and the Possibility to Reduce It in Finland*", was carried out between 1998 and 2000 as part of the Environmental Research Programme of the Finnish Ministry of the Environment.

The lead institution for MFA is Statistics Finland together with the Thule Institute of the University of Oulu. Other organisations involved include the Ministry of the Environment, the Finnish Environment Institute, and the Finnish Nature Conservation Association.

A number of academic research projects have been carried out on behalf of the government and have benefited from financial support by the government and/or by Eurostat. Examples include the project "FINPIOT: material flows and balances in the Finnish economy" that was launched in 2000 jointly by Statistics Finland and the Thule Institute of the University of Oulu and was funded by the Finnish Ministry of the Environment. Related research work has also been carried out by the Finland Futures Research Centre of the Turku School of Economics and Business Administration (Environmental Kuznets Curves (EKC), material flow indicators such as Direct Material Input (DMI) and Domestic Material Consumption (DMC).

Finland participates in related international work carried out by Eurostat, the EEA, the OECD and the UN. Co-operation has been established between the Thule Institute and the Wuppertal Institut (Germany).

CHARACTERISTICS AND SCOPE

The work covers various types of MFA at various levels of detail (economy-wide material flow (EWMF) accounts, physical input-output tables, substance flow analysis) and is complemented with other environmental accounts (timber, energy).

Economy-wide MF accounts are compiled according to the Eurostat methodology and on the basis of materials from the Wuppertal Institut. As part of the project *Eco-efficient Finland: Total Material Requirement and the Possibility to Reduce It in Finland*, comprehensive Total Material Requirements (TMR) series for Finland for the period 1970-1997 were compiled by the Thule Institute and subsequently updated every two years. In future, these data will be updated annually by Statistics Finland as part of the country's official statistics.

EW-MF accounts and balances make use of already existing basic data sources such as: industrial statistics (mining and quarrying, manufacturing industry, electricity, gas and water supply), energy statistics, agricultural statistics, forestry statistics, statistics and studies on consumption, statistics on foreign trade and statistics from industry associations.

Physical Input-Output Tables (PIOTs) have been compiled for the years 1995 and 1999 with a NAMEA-type breakdown by industrial branches. This was done a part of the research project "FINPIOT: material flows and balances in the Finnish economy". To facilitate the integration with national economic accounts, the same classifications (190 industries, 1300 products) are applied as in the monetary input-output tables (MIOTs) of Finland. The physical flows between the economy and the environment are constructed in such a way that they add up to the overall economy-wide material balance.

Substance Flow Analysis has been applied to mining, forests, metals and packaging industries, energy generation and water supply, and waste water treatment systems (sectoral life cycle assessments), and to individual flows of paper and nutrients.

Other environmental accounts include timber material accounts and physical accounts for energy:

- Timber material accounts include physical measures of the forest balance (stock, growth, natural losses and harvesting, by wood type), use of the forest, and a wood mass balance that tracks the mass of wood products through the economy from harvesting to final consumption, including associated waste materials. The detailed structure of the accounts is compatible with the System for Environmental and Economic Accounts (SEEA), but reflects primarily an interest in supporting national forest management policy tools.
- Physical accounts for energy are based on input-output accounts and show the output of energy industries as inputs to 50 industrial branches and households for 11 fuel commodities.

OUTPUTS AND USE

Publication: Time series on TMR and related indicators are reported in official publications such as:

- The annual Compendium of Environment Statistics,
- Annual report on Finland's Natural Resources and the Environment, published by Statistics Finland and the Ministry of the Environment in conjunction with the State Budget, that also serves as an instrument for the Government policy on sustainable development.

as well as in special research publications.

Indicators

Data from MFA are used to calculate MF indicators such as DMI, DMC and TMR, as well as TMR/GDP and DMI/GDP (project 'Eco-efficient Finland'), and TMC (Thule Institute). The TMR indicator is updated annually by the Thule Institute and Statistics Finland, and is part of the national set of sustainable development indicators.

An indicator representing a Sustainable net Benefit Measure of production (SBM) compared to Direct Material Flows (DMF) has been used in a research project "Measuring the Eco-efficiency of Welfare Generation in a National Economy" published by Statistics Finland in 2001. The aim was to test factor 4 targets, i.e. a 75% reduction in material use and maintenance of at least the current level of welfare during the next 20-30 years.

Data and indicators derived from MFA are used for monitoring the sustainability of material resource use, linking environmental and economic information and supporting modelling and outlook activities.

Links to policies and objectives

Strategic objectives and lines of action for material resource use are included in the Finnish Government's programme for sustainable development that focuses on eco-efficiency in its third programme period (2003-2005). The general goals include the following: "*promote changes in production and consumption patterns and minimize the exploitation of non-renewable resources; … safeguard the generative capacity of renewable resources, such as forests and land resources; …. promote economic activity that increases financial and human capital while simultaneously safeguarding natural capital*". The objective is to improve the efficient use of natural resources and energy taking into account the whole life-cycle. Material flow accounting will be developed for monitoring the use of natural resources as part of the national accounting system (2.6 Research and education, Line of action: 5).

The achievement of these objectives is not mandatory, but progress is monitored by the Finnish National Commission on Sustainable Development via a set of sustainable development indicators among which TMR.

Finland has also defined quantitative targets for promoting waste prevention and improving waste recovery rates as part of its national waste plans. The targets vary according to the type of waste concerned:

- Municipal waste, construction waste and industrial wastes: by 2005, a 15% reduction in waste generated compared to 1994, accounting for real growth in GNP, and an average recovery rate of at least 70%.
- Hazardous waste: by 2005, a 15% reduction in waste generated compared to 1992, and an average recovery rate of at least 30%.
- Contaminated sites: no quantitative target, but general goal to prevent the contamination of more sites.

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FRANCE

OVERVIEW

France has a long experience with environmental expenditure accounts (since 1975) and has been among the pioneers in the field of comprehensive natural resource accounting "Comptes du patrimoine naturel". In recent years, work has mainly concentrated on water accounts (quantity and quality aspects), on environmental expenditure accounts and on the establishment of NAMEAs (e.g. air emissions, water discharges).

Material flow studies have so far not yet been carried out. The French Environment Institute (IFEN) that acts as the statistical service of the Ministry for Ecology and Sustainable Development (MEDD), is developing a proposal for a feasibility study on MF to be carried out in co-operation with other national and international authorities and experts.

Some MF work is being done at academic level, mainly as part of PhD projects. Examples include a regional level MF study carried out by the Centre de Recherche et d'Etudes Interdisciplinaires sur le Développement Durable (CREIDD) of the Université de Technologie de Troyes (UTT). The study builds on a dynamic model for MF. It is planned to be applied to the Cape Verde Islands in co-operation with the Ministry of Industry and Energy. Partnerships have been established with the University of Barcelona (Spain) and with the Wuppertal Institut (Germany).

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GERMANY

OVERVIEW

Germany is among the most experienced countries in MFA and has developed a comprehensive Material and Energy Flow Information System (MEFIS), based on an MFA framework and on physical input-output tables. Work is carried out both by the government and by academics. Government work was initiated in 1993 as part of the country's official statistics and as part of work on Environmental Economic Accounting (EEA). Work on economy-wide material flow accounts started in 1993, mainly at the academic level.

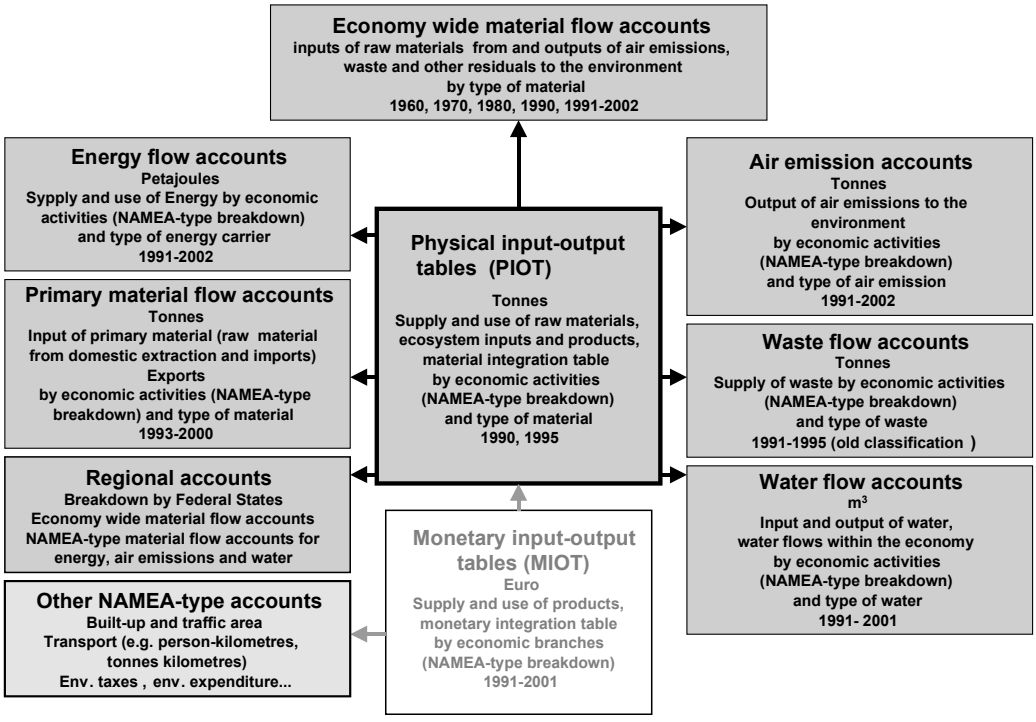
The Federal Statistical Office (DESTATIS) and its Division for Environmental Economic Accounting is the lead institution responsible for MF accounts. The work is carried out in co-operation with non-governmental research institutes, such as the Wuppertal Institute for Climate, Environment and Energy, and has benefited from financial support by Eurostat. Among other institutions involved is the Federal Environment Agency (UBA).

Germany also contributes to international work steered by the London Group on Environmental Accounting and to collaborative work in Europe steered by EUROSTAT and the European Environment Agency and its Topic Centre on Waste and material Flows. Together with Austria, Japan, the Netherlands and the USA, it has, via the Wuppertal Institut, actively participated in the joint international research project on material flows that led to two key publications by the World Resource Institute in 1997 and 2000. Bilateral co-operation in the field of Environmental Economic Accounting exists with Korea.

CHARACTERISTICS AND SCOPE

The German System of Environmental Economic Accounting (EEA) is fully compatible with the System of National Accounts (SNA) and with the System of Integrated Environmental and Economic Accounts (SEEA). The physical flow accounts, structured around physical input-output tables, are the most developed part of it.

The German system of physical flow accounts



Physical Input-Output Tables (PIOTs):

The first German PIOTs, compiled in the mid-1990s with data for 1990, were also the first PIOTs ever compiled in the world (Stahmer et al. 1997). They mirror the monetary input-output tables (MIOTs) of the national accounts and broaden their scope by adding material flows between the economy and the environment.

The PIOTs are broken down by about 60 economic production & consumption activities and by type of materials. PIOTs are compiled for selected years only (i.e. 1990 and 1995) and are supplemented with a number of sub-modules that are updated annually.

These sub-modules include economy wide material flow accounts as well as a number of NAMEA-type accounts (energy flow accounts, primary material flow accounts broken down by 72 production branches and private households and by raw materials categories distinguishing biotic and abiotic materials, water flow accounts, air emission accounts, waste flow accounts (up to 1995 only), regional physical flow accounts).

This is further supplemented by a number of other NAMEA-type accounts covering for example built-up and traffic areas, transport (person-kilometres, tonnes kilometres), environmental taxes, environmental expenditure.

Economy-wide MF accounts (EW MFA) have first been compiled in the mid-1990s for the years 1993-2000. They have recently been revised and complemented with accounts for 1960, 1970, 1980, 1990 for the former territory of the Federal Republic of Germany, and with accounts for 1991-2002 for the current territory. Annual updates are planned in future.

The accounts cover the whole physical economy and their system boundaries are fully compatible with those for PIOTs. Conceptual differences with other European MF accounts were removed thanks to a study carried out with support from Eurostat. Lessons from this study have been grouped in a "National Handbook: Material Flow Accounts" that builds on the Eurostat guide and also covers the development and calculation of MF indicators (publication forthcoming).

OUTPUTS AND USE

Publication: Data from MF accounts are regularly published by DESTATIS (various publications). MF indicators are included in "Environmental Data Germany" published jointly by the Federal Environment Agency (UBA) and the Federal Statistical Office (DESTATIS) and freely available on the web.

Indicators: Data from EW-MFA are used for compiling selected indicators among which: Direct Material Input (DMI), Domestic Material Consumption (DMC), Physical Trade Balance (PTB), Domestic processed output (DPO), Net additions to stock (NAS), and raw materials productivity (GDP/(DMI-biomass)). The indicators are calculated by the German Statistical Office and updated on an annual basis.

The indicator on "raw materials productivity" is defined as the ratio between Gross value added (at constant prices) and the sum of domestic abiotic (i.e. non-renewable) raw material extraction (used) and imports. It has similarities with indicators on labour and capital productivity, and describes the efficiency with which „non-renewable raw materials" are used in the national economy.

Links to policies and objectives

The raw materials productivity is one of the 6 indicators of the German Environment Barometer that are linked to quantitative targets and enter into the calculation of the German Environmental Index (DUX). It is also one out of 21 national key indicators for sustainable development defined in the National Strategy for Sustainable Development "Perspectives for Germany: Our Strategy for Sustainable Development" adopted by the German Federal cabinet in April 2002. The strategy outlines 21 targets or objectives to which the key indicators can be linked. The targets indicate desirable policy directions and their achievement is voluntary. One of these targets is the doubling of the raw materials productivity between 1994 and 2020.

"*By 2020, we should aim for an approximate doubling of energy- and raw materials productivity in relation to 1990 and 1994 respectively. … In the long term, the improvements in energy and raw materials productivity should be guided by the "Factor 4" vision.*"

The **Wuppertal Institute for Climate, Environment and Energy** is an interdisciplinary research institute focusing on applied sustainability research. The Wuppertal Institute develops guiding principles and concepts in areas such as: energy, transport, material flows and structural change, climate policy and eco-efficient enterprises.

The Wuppertal Institute is among the pioneers in the field of material flow analysis and of economy-wide MF indicators. The Institute has actively contributed to the international promotion of MF related studies, and has carried out MF projects for the European Commission (DG Environment, Eurostat) and the European Environment Agency (EEA) and its Topic Centre on Waste and Material Flows. Together with research partners in Austria, Japan, the Netherlands, and the United States, it has actively participated in the joint international research project on material flows that led to two key publications co-ordinated by the World Resource Institute in 1997 and 2000.

The Wuppertal Institute is the co-ordinator of ConAccount, "Coordination of Regional and National Material Flow Accounting for Environmental Sustainability", an international network of research institutions working on Material Flow Analysis (MFA). ConAccount was set up in May 1996 and supported financially by the European Commission (DG Environment) during the first phase of its existence until the end of 1997. The co-ordination of the ConAccount network is done in close co-operation with the Institute for Interdisciplinary Research and Continuing Education (IFF) in Vienna, the Centre of Environmental Science of Leiden University (CML), and Statistics Sweden.

The aim of ConAccount is to: (i) support the exchange of information between scientists and researchers developing MFA and users of MFA results, (ii) provide the basis for the development of a coherent framework of a MFA methodology, and (iii) promote the use of MFA for statistics and policy. A first R&D agenda was defined in 1997 and supported with technical workshops and conferences. Today ConAccount has about 100 participants who provide information about their activities. This is done through an interactive registration system whose current version was established (February 2000) with the support of the European Environment Agency.

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GREECE

OVERVIEW

No MFA related activities have been reported.

HUNGARY

OVERVIEW

Hungary has not yet initiated MF related activities, but has included MF indicators in its national set of Environmental Indicators, and has plans to use the MFA framework in government policy-making.

Lead institutions are the Ministry of Environment and Water (MoEW) in charge of environmental indicators and the Hungarian Central Statistical Office (HCSO).

Economy-wide MFA for Hungary were compiled for the years 1993-1997 by the Sustainable Europe Research Institute (SERI), according to the Eurostat methodology in 2001.

MF indicators (Direct Material Input, Domestic Material Consumption, Total Material Requirement, Total Material Consumption, Physical Trade Balance) are published in official publications on environmental indicators since 2000 (Environmental Indicators of Hungary 2000; Environmental Indicators of Hungary 2002; Key Environmental Indicators of Hungary 2002; Main Environmental Indicators of Hungary 2003).

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ICELAND

OVERVIEW

Iceland does not carry out work on economy-wide MFA, but has developed individual natural resource accounts in areas of particular relevance to the country's economy. This includes work on water input/output flows related to hydro-energy production, as well as research on underground water flows related to geothermal energy production. Some work has also been done on soil-erosion.

This work is closely connected to decision making in these areas, and is carried out by the Ministry of Environment, engineering bureaus, and energy agencies.

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IRELAND

OVERVIEW

Ireland has initiated a demonstration research project on MFA, focusing on the establishment of a national fossil fuel flows account and of a water flows account for a region. A first report on the results of this research project is expected be available in autumn 2004. Further work on MFA and next steps will be informed by these results.

There is no lead institution or regulatory framework for work on MFA. Current research is being carried out by the Clean Technology Centre in partnership with the Irish EPA and the Central Statistics Office.

OUTPUTS AND USE

MFA has not yet been widely applied in Ireland. National policy however recognises the need to decouple resource use from economic activities and growth. No quantitative targets have been set in this regard.

As part of the National Waste Prevention Programme, the Irish EPA intends developing material flows indicators to illustrate progress towards the objectives of national policy. This work is at the earliest design stage and will be informed by the MFA demonstration research project that is nearing completion.

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ITALY

OVERVIEW

Italy has initiated work on material flow accounting in 2000, as part of the country's official statistics and as part of its work on Environmental Accounting (EA). The work covers economy-wide MF accounts and related indicators, and Physical Input-Output Tables. Other related work is being done on NAMEAs (mainly air).

The lead institutions are the National Statistical Office (ISTAT) in charge of environmental accounting, including in physical units, and the Environmental Protection Agency (APAT) that provides basic data. Other institutions involved include the Ministry of the Environment that provides financial support to ISTAT's EA activities, including MFA. Occasionally research institutes are also involved.

Italy contributes to international work steered by the London Group on Environmental Accounting and participates in the ConAccount network co-ordinated by the Wuppertal Institut (Germany).

CHARACTERISTICS AND SCOPE

Economy-wide MFA are updated by Istat on a yearly basis for major aggregates, i.e. EW-MFA-based indicators; and every 5 years for full MF-Balances. Data for major MF aggregates (input indicators) are available for the years 1980 to 2001. A full sequence of flow accounts was compiled for 1997. The work is based on the Eurostat methodology.

Physical Input-Output Tables (PIOTs): Work on PIOTs is carried out as part of stand-alone project 2003-2005. A feasibility study has been carried out and a working group has been set up for its implementation. The foreseen level of detail is that of the Italian monetary Input/Output tables that covers approximately 60 activity branches.

OUTPUTS AND USE

Publication: The Ministry of the Environment publishes every two years a "Report on the State of the Environment", containing some aggregates derived from environmental accounting. Data and indicators are used for monitoring the sustainability of material resource use and informing related decision making.

Indicators: Indicators derived from EW-MFA include Direct Material Input (DMI), Domestic Material Consumption (DMC), and Total Material Requirement (TMR), as well as Total Material Consumption (TMC), physical trade balance (PTB), physical trade balance including indirect flows (PTBIF).

In general, information derived from environmental accounting is considered, along with sustainable development indicators, a necessary complement to economic indicators in the National Strategy for Sustainable Development. Chapter 2 "Environmental Action Tools", states that "within national statistics, environmental accounting, indicators and statistics are being developed as new strategic tools".

Links to policies and objectives:

The Environmental Action Plan for Sustainable Development in Italy, approved by the Inter-Ministerial Committee for Economic Planning (CIPE) in August 2002, includes a chapter on "Resource use and waste generation", which states that "Italy as other developed countries, has reached and maintains such levels of consumption high enough to alter any ecological balance" and that "Environmental and economic reasons urge a substantial reduction in the use of resources, as well as in the flow of materials and pollutants discharged into the environment by human activities" by more efficient use of resource in industry and shift towards sustainable consumption and eco-efficient services.

The strategy includes a sequence of time-bound objectives to reduce TMR: -25% by 2010; -75% by 2030; - 90% by 2050. Due to the strategic nature of the document, the targets reflect desirable policy directions and are not binding. TMR is used as an indicator to monitor progress.

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NETHERLANDS

OVERVIEW

The Netherlands have a long history in the field of material flow accounting, even though most work has been carried out on an ad-hoc basis. Work has been covering economy-wide material flow accounting (EW-MFA), Physical Input-Output Tables (PIOTs), environmental input-output analysis, and substance flow analysis (SFA). Other closely related work includes the Dutch NAMEA (National Accounting Matrix including Environmental Accounts). Today, priority is given to the energy content and the environmental impact of material flows and substance flows, and to the development of dematerialisation indicators.

There is no lead institution for MFA, but many government and non-government institutions are active in this field. Among these are: Statistics Netherlands, the Ministry for Housing, Spatial Planning and Environment (VROM), research institutes such as the Netherlands Energy Research Foundation (ECN), TNO and the Netherlands Environmental Assessment Agency at RIVM, and universities (e.g. Leiden University, Institute of Environmental Science; Utrecht University - Copernicus Institute - Center for Energy and Environmental Studies; University of Groningen - Institute for Environmental Studies). Work is also being done by private consultant firms mainly in the field of dematerialisation indicators. A number of these activities benefit from funding by the government and/or the Netherlands Science Foundation.

Together with Austria, Germany, Japan, and the USA, the Netherlands has, via the VROM and the Leiden University, actively participated in the joint international research project on material flows that led to two key publications by the World Resource Institute in 1997 and 2000. The Netherlands also contributes to international work steered by the London Group on Environmental Accounting. Dutch research institutes (Leiden University) participate in the ConAccount network co-ordinated by the Wuppertal Institut (Germany).

CHARACTERISTICS AND SCOPE

Economy-wide MFA: None, so far, with the exception of the contribution to the WRI led international research project. Efforts have been oriented towards developing alternative indicators reflecting environmental impacts of resource use.

Physical Input-Output Tables (PIOTs): A few efforts have been undertaken, but are now largely outdated: Iron & Steel and plastics (for 1990 and 1997); paper and paper products, cement and cement products, zinc and non-ferrous metals (for 1990).

Substance Flow Analysis (SFA): Dutch universities and research institutes (e.g. University of Leiden) have a good experience in SFA, often in connection with life cycle analysis (LCA). Since the early 1990s, many studies have been carried out at different levels. Most SFA studies have traced heavy metals (Cu, Zn, Pb, Cr, Hg, Cd) and nutrients (N, P); some have traced organochlorine compounds.

NAMEAs: The NAMEA system was developed and pioneered by the Netherlands in the early 1980s. It extends the System of National Accounts (SNA) with physical flow accounts, and is published by Statistics Netherlands every year. NAMEAs have been developed for environmental outputs (air pollutants, water pollutants, solid waste).

OUTPUTS AND USE

Publication: There is no official publication on material flows. The results of NAMEAs are published annually by Statistics Netherlands.

MF information is used in modelling and outlook activities and to link economic and environmental information. Information derived from SFA (e.g. Cadmium, Chlorine, Mercury) has proven useful when applied to chemical policy action in the Netherlands.

Indicators:

Economy-wide MF indicators were developed and published as part of the international research project steered by the WRI (1997, 2000), but were not officially adopted as part of the country's environmental or sustainable development indicator sets. Increased knowledge has resulted in an orientation towards developing alternative MF indicators i.e. dematerialisation indicators that would also reflect the environmental impact of material flows (e.g. EMC, environmentally weighted material consumption) as this more accurately fits policy needs. The work is funded by the Ministry of Housing, Spatial Planning and the Environment and carried out by a consultant firm (CE - Solutions for environment, economy and technology) and the Centre of Environmental Science (CML) of the Leiden University.

Links to policies and objectives:

Dematerialisation was put on the political agenda in 1999 after tabling a parliamentary motion to this effect. The 4th National Environmental Policy programme (NEPP4) adopted in June 2001 includes a number of proposals to promote sustainable use of biodiversity and natural resources among which a qualitative target aiming at achieving a dematerialisation of the Dutch economy by a factor 2 to 4 by 2030. The aim is to reduce the environmental impacts from resource consumption instead of resource consumption itself. The plan also asks for "a dematerialisation indicator to be created based on a material flows monitoring system that takes the degree of depletion of raw materials and energy supplies into account" as well as the environmental impacts from resource consumption. Based on the policy needs identified in NEPP4, an alternative indicator has been developed (the EMC) taking into account the environmental impacts from resource consumption based on LCAs.

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NORWAY

OVERVIEW

Norway has a long history in natural resource accounting. It carries out several activities related to material flow analysis with a focus on individual accounts such as waste accounts and flow analysis of individual substances. Economy-wide MF accounts have not been established.

Lead institutions are Statistics Norway (waste accounts) and the Norwegian Pollution Control Authority (substance flow analysis, jointly with commissioned research institutes).

CHARACTERISTICS AND SCOPE

Waste Accounts

The Norwegian waste accounts are an abbreviated form of MF since the focus is on when products enter the waste stream rather than on the whole life cycle. The objective of waste accounts is to provide a comprehensive and clear statistical framework in which waste can be quantified and presented according to different characteristics. They build on individual waste accounts that are developed as a material balance between the generation and disposal of the various wastes. The accounts record waste amounts by material, type of product, source of origin (industry/sector) and type of treatment/disposal. Materials covered include e.g. paper, glass, wet-organic waste, metals, wood, plastic, sludge, concrete and brick, textiles. Up to now it has not been possible to give an overall comprehensive picture of national waste flows, due to a lack of coherence in waste statistics and data gaps for several industry branches. Data are available for 1993-2002.

Substance Flow Analysis: Beside a few ad-hoc studies by Statistics Norway (solvents, 1995; cadmium and phtalates, 1997; wood products, 1998), SFA is mainly carried out by the Norwegian Pollution Control Authority. The work has started in the early 1990s and has since then covered many individual substances and products, from heavy metals to biocides and endocrine disruptors*.

OUTPUTS AND USE

Publication:

Main results from the waste accounts are published annually together with other environmental and natural resource information in the report "Natural Resources and the Environment" prepared by Statistics Norway. Specific reports on results from substance flow analyses are available from the Norwegian Pollution Control Authority.

Indicators: A set of sustainable development indicators for natural resources is being developed.

Links to policies and objectives:

Norway does not have objectives or targets directly related to material resource use. However, the National Action Plan for Sustainable Development in Norway (Report no. 1 to the Storting, 2003-2004, National Budget 2004, Chapter 6) includes objectives that are related to natural resource management (energy efficiency, sustainable management of fisheries, forestry, agriculture and reindeer husbandry, etc.).

* Tetra chloroethene (1991); Chlorophenols (1991); Chromium (1992); Carbon tetrachloride (1992); Lead (1992); Arsenic (1992); Zinc (1993); Nickel (1993, 2002); Trichloroethene (1993); Absorbing substances (1993); Tinorganic substances (1994); Dioxins (1994); Nonylphenol and nonylphenoletoxylates, brominated flame retardants, phtalates and chloroparaffins (1995); Environmentally hazardous substances in batteries (1995); Substances which may have endocrine effects (1996, 1998); Few chemicals with endocrine effects in consumer products in Norway (1996); Hazardous substances in toner powder for laser printers and copying machines (1997); Short chained chlorinated paraffins (1999); Brominated flame retardants (1999, 2003); Biocides and biocidal products (1999); Environmentally hazardous substances in products (1996, 1997, 1998, 1999, 2000); PCB in building materials: grouting, concrete admixture, floor covering and paint/marine coating (1998); Chemicals used in development and management of transport works (1999); Endocrine disrupters in cleaning and car maintenance products (1999); Paints and varnishes (2001); Hazardous substances in selected textiles (2004); Hazardous substances in selected building materials (2002).

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POLAND

OVERVIEW

Poland has not yet initiated systematic reporting on material flows, but such work is under consideration to respond to information needs resulting from the National Environmental Policy adopted by the Government in 2000.

An ad-hoc research project (ECOPOL) on economy-wide material flows in Poland was conducted in 1998-1999 by the Wuppertal Institute (Germany) in co-operation with the Warsaw Ecological Economic Centre of the Warsaw University and the Institute for Sustainable Development in Warsaw. Results were published in 2000.

CHARACTERISTICS AND SCOPE

Economy-wide MFA:

The Framework used in the ECOPOL project is a modified version of the approach followed in the WRI publication "Resource Flows". The project provided data on major MF variables for the years 1992-1997, as well as related MF indicators for Poland. It further included a comparison of the results with corresponding indicators calculated for some other countries: the Netherlands, Japan, Germany and the United States.

Other environmental accounts include an Air Emission Database (http://emissions.ios.edu.pl/)

OUTPUTS AND USE

Publication: Results of the research project: "ECOPOL: Ecological Economic Policy –Strategy for Poland in the 21st Century" conducted in 1998-1999 have been published in 2000 and are available on the Wuppertal Institute's website. Information on materials management is also published annually by the National Statistical Office since 2002 (Gospodarka Materialowa).

Indicators: As part of the ECOPOL project, MF indicators including Direct Material Input (DMI) and Total Material Requirement (TMR) were calculated. TMR has been included in the Polish sets of sustainable development and environmental indicators (Chief Inspectorate for Environmental Protection, Ministry of Environment).

Links to policies and objectives:

In its Second National Environmental Policy prepared by the Ministry of Environment (December 2002), the Polish Government has established a set of quantified and time-bound policy objectives related to the rational use of natural resources, in the areas of water use, material use, waste generation, and energy efficiency. The **medium-term objectives**, i.e. to be achieved by 2010, are as follows:

- to reduce **water-intensity** of production by 50% compared to 1990 levels (calculated per GDP and industrial sales value);
- to reduce the **material-intensity and waste-generation** of production by 50% compared to 1990 levels; and ensure their gradual abatement in individual production sectors so that at least average OECD levels are achieved (calculated per production unit, production value, or GDP).

The indicators used to monitor the implementation of the National Environmental Policy include among others the quantity of energy, materials and water consumed, and the volume of waste generated and pollutants emitted per GDP unit or the unit of production (expressed in physical units or by the value sold).

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PORTUGAL

OVERVIEW

Portugal has carried out work on MFA, mainly as part of case studies and pilot projects, some of them supported with government funding.

Most research work is done by two institutions: the National Institute of Engineering, Technology and Innovation (INETI) and the Centre for Sustainable Business Development, and the Technical Institute of the Technical University (IST/UTL). Other institutions involved include the National Statistical Office (INE, Instituto Nacional de Estatística) that carried out a pilot project on MFA in 2000.

INETI co-operates with the Sustainable Europe Research Institute - SERI (Vienna, Austria), and participates in the EU-funded MOSUS project ("MOSUS - Modelling opportunities and limits for restructuring Europe towards sustainability").

CHARACTERISTICS AND SCOPE

The studies have focused on **economy-wide material flow accounts** building on the Eurostat methodology. EW-MF data have been produced up to the year 2002. This includes MF indicators such as DMI, DMC, and TMR.

OUTPUTS AND USE

Links to policies and objectives

Portugal's National Strategy for Sustainable Development 2005-2015 includes an objective aiming at a **1.5 factor reduction in resource consumption in industrial companies**. The status of this objective and the indicators used to monitor progress will be defined in the implementation plan of the strategy (PI-ENDS) (not yet published).

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SLOVAK REPUBLIC

OVERVIEW

The Slovak Republic initiated MF related activities in 1993 as a part of the country's official statistics. The focus has long been on individual materials such as energy and water flows, and on substance flow analysis (SFA).

Systematic work on economy-wide material flow analysis will be carried out as of 1 January 2005 – via a project included in the Annual Work Plan of the Slovak Environmental Agency (financed by the fiscal budget of the Ministry of the Environment of the Slovak Republic). The main aim of this project is to improve information, methodologies and measurement systems on material flows at the national level. A second project, currently under preparation, will aim at collecting and analysing MF data available at the national level, in order to calculate time series of material flow indicators for the Slovak Republic.

The lead institutions are the Statistical Office of the Slovak Republic that also compiles MF indicators, and the Slovak Environmental Agency. Other institutions involved include: the Ministry of the Environment, the Ministry of Agriculture, the Ministry of Economy, and the Mining Authority/Offices.

CHARACTERISTICS AND SCOPE

Part of the MF data are updated annually by the Statistical Office. The latest data available on energy and water flows refer to 2002.

Economy-wide MFA: Work on EW-MFA initiated in 2005 will be based on the Eurostat methodology and will cover all major MF indicators. It is expected that by the end of 2005 (i) the Eurostat Guide will be accessible (in Slovak) in electronic form via internet and (ii) a first set of consolidated MF indicators will be available for the Slovak Republic. This work will also identify information gaps regarding MF indicators. Cross-sectoral and inter-institutional co-operation will be established.

OUTPUTS AND USE

Publication: Information on raw materials and other natural resources is regularly published in the country's Statistical Office Yearbook and in the Raw Materials Yearbook.

Indicators: Indicators related to material and other natural resources are compiled by the Statistical Office and other relevant government institutions, and EW-MF indicators will be included in the country's official set of environmental and sustainable development indicators.

Links to policies and objectives:

Policy objectives related to material resource use are included in Slovakia's National Sustainable Development Strategy (NSDS) adopted in 2001. Based on the NSDS and after having inserted the principles of sustainable development in individual sectoral strategies (economic, social, environmental, and information), a National Action Plan of Sustainable Development (NAPSD) has been prepared.

Work on **economy-wide MFA** and related indicators is expected to support the preparation and implementation of key strategic documents closely related to MFA and to the tracking of eco-efficiency in individual sectors of the national economy (Waste Management Programme since 2005, National Strategy of Sustainable Development, the Raw Material Policy of the SR[14]). It will further support the implementation of the EU Lisbon strategy at national level.

[14] One of the main short-term goals of the Raw Material Policy (RMP) of the SR directly relates to MF accounting – it is to create a unified statistical measurement system on the movement of raw materials in order to provide information about the quantity and type of individual commodities of raw material and related foreign trade. In this document it is possible to find out also information on:

--generation and use of mineral waste from the mining and processing of raw materials – belonging to „hidden flows" within the material flows account

--tables on export-import of raw materials needed for calculation of consolidated MFA

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--tables on mining of raw materials („Domestic Extraction“) – with complement of socio-economic indicators. It further specified the lifetime of domestic geological and industrial reserves of raw materials – based on actual estimation of reserves of individual raw material of reserved deposits and actual domestic extraction quantities of raw material.

SPAIN

OVERVIEW

Spain has initiated work on economy-wide Material Flows in 2002 as part of its activities on Environmental Accounting and as part of the country's official statistics (National Statistical Programme 2001-2004).

The lead institution is the Spanish Statistical Institute (INE).

Work has also been done at sub-national level in the Basque country region. It was initiated in 2001 by the Basque government that provided funding, and was carried out by the Institute of Public Economics of the University of the Basque Country in co-operation with the Wuppertal Institute.

CHARACTERISTICS AND SCOPE

Work on **economy-wide MFA** builds on the Eurostat methodology (and on reference material by the Wuppertal Institut and the EEA) and has generated Material Flow Accounts and Balances for the years 1996 to 2000. An effort has been made to develop, as far as data availability permits, a complete material flow analysis covering both input and output flows.

Basic data on a number of variables (domestic extraction, imports, exports, waste, emissions, dissipation of products) have been obtained through the Spanish official statistics, elaborated by INE or by the Ministry of Industry and the Ministry of Agriculture, Fisheries and Food.

Other relevant **Environmental Accounts**, include:

- Water Satellite Accounts (1997-2001).
- Air Emissions Satellite Accounts (1995-2000).
- Environmental Protection Expenditure Account (1995-2001).
- Forest Accounts (1995-2000).

Future work is expected to help improve data quality and calculation methods in line with related international work, and to disaggregate the MF Accounts by economic branches, either through Physical Input-Output Tables or through resource use tables. Since water is an essential and scarce resource in Spain, interest in water flows analysis is high, especially as regards hidden water flows. Including water in the Material Flows framework is therefore an important issue.

Basque country government: Work in the Basque country has focused on economy-wide MFA (in line with the Eurostat methodology and related documents released by the EEA) and on physical input-output tables (PIOTs). EW-MF data are updated annually and are available for 1989-2002. Efforts have concentrated on developing a Total Material Requirement (TMR) indicator building on the Eurostat methodology with however a few amendments to adapt the method to the specific characteristics of the Basque Country. The main changes made are: the use of specific coefficients in calculating erosion due to agriculture; the introduction of a new method for calculating excavation due to the construction of infrastructure and buildings; and the estimation of imports from the rest of Spain (not covered in official trade statistics).

OUTPUTS AND USE

Publication: Information on material flows and resource use is published by INE together with other information from environmental accounts. It is available on the INE's web site and as a paper publication. Results from work carried out in the Basque country were published in 2002.

Indicators: The first study on MF (1996-2000) included the calculation of a comprehensive set of MF indicators, including: input indicators (Direct Material Input (DMI), Total Material Input (TMI), Total Material Requirement (TMR), domestic TMR); consumption indicators (Domestic Material Consumption (DMC), Total Material Consumption (TMC), Net Additions to Stock (NAS)); and output indicators (Domestic Processed Output (DPO), Total Domestic Output (TDO), Domestic Material Output (DMO), Total Material Output (TMO)). All indicators have been calculated in absolute terms and in relation to economic and demographic variables (GDP, population).

Basque country government: Work on MFA has led to the calculation MF indicators including DMI and TMR, and direct material productivity (GDP/DMI). TMR per capita is included in the official set of sustainable development indicators of the Basque country.

Links to policies and objectives:

MF indicators are still under review to identify those that are most meaningful for inclusion in a set of sustainability development indicators to support the "Spanish Strategy on Sustainable Development". The preliminary list of Sustainable Development Indicators includes DMC (level III) and TMC (level I) as proposed in the "Preliminary List of SDI" prepared by Eurostat (Revision 7, 28/10/2004). Another possible development would be to use MF indicators to monitor trends of resource use policies in accordance with the EU "Strategy on the Sustainable Use of Natural Resources". The final set of indicators is planned to be approved in March 2005, according to ESS Task Force on Methodological Issues for Sustainable Development Indicators.

The Basque Environmental Strategy for Sustainable Development (2002-2020) includes a target to maintain the Total Material Requirement (TMR) per capita at 1998 levels in 2006. The target is formally adopted by the Basque government.

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SWEDEN

OVERVIEW

Sweden has been developing physical environmental accounts since 1993 giving priority to environmental accounts for energy and certain emissions. Work on national level material flow accounts (EW-MFA) was initiated in the late 1990's by the Swedish government as an ad-hoc project. So far, no decision has been taken as to the continuation of this work and related funding.

Current efforts focus on improving existing statistics that are used to populate and support material flow accounts (industrial and trade statistics, chemical products register, emission statistics), on getting a better understanding of user needs and on enhancing statistical co-ordination in the country. Further developments depend among others on developments at EU level and on future EU requirements for material flow statistics.

At the academic level, a number of research projects have dealt with substance flow analysis (SFA).

The lead institution is Statistics Sweden (MFA; environmental accounts). Other institutions involved include the Swedish EPA, the Chemicals Inspectorate, the Royal Institution of Technology, the Likoping Institute of Technology, and local municipalities.

Sweden also contributes to international work through Eurostat and the OECD, and participates in the ConAccount network co-ordinated by the Wuppertal Institut (Germany).

Apart from accounting work on material flows, the Swedish EPA has also financed a study to: (i) evaluate the effectiveness and the efficiency of taxes on selected natural resources and chemical compounds; and (ii) analyse the potential for increased implementation of natural resource and chemical taxation in Sweden*.

CHARACTERISTICS AND SCOPE

The accounting framework used for integrated environmental and economic accounting in Sweden is to a very large extent based on the National Accounting Matrix including Environmental Accounts (NAMEA) framework. Standard economic accounts are supplemented with physical data within the framework of input-output accounts. These data focus on waste flows: greenhouse gas and other air emissions, emissions of nitrogen and phosphorous and other waste flows from extraction and manufacturing industries categorised according to material, source and method of treatment.

Economy-wide MFA: The study on EW-MF, carried out by Statistics Sweden, included (i) a structure for collecting and presenting MF statistics for Sweden and (ii) a description of total material throughput building on international work available when the study was carried out (WRI and ConAccount). Variables covered include direct material inputs (DMI) in the society such as inputs from foreign trade, agriculture, forestry, mining and fuels, and outputs such as exports, waste, and air missions. The proposed structure for economy-wide MFA includes an attempt to couple MF information to environmental pressures in line with the System of Environmental and Economic Accounts (SEEA), through a monetary input-output analysis. The aim is to use the knowledge derived from this information to work towards eco-efficiency by improving the resource productivity.

EW-MF data have been compiled for the period 1987-1998 and were used to estimate the resource productivity of the Swedish economy.

Substance flow analysis (SFA): Research in the field of SFA has been focusing on metals and nutrients on a local or national level, including water and air emissions (e.g. Cu, Pb and Hg). Ad hoc studies commissioned by the Chemicals Inspectorate have so far covered approximately 200 substances.

Other MF activities include work on energy-related materials, on hazardous substances, etc

OUTPUTS AND USE

Publication: First results from the study on EW-MFA were published in 2000.

* "Extending the Environmental Tax Base: Prerequisites for Increased Taxation of Natural Resources and Chemical Compounds"

Indicators: Data from the ad-hoc study on EW-MF have been used to calculate MF indicators such as Direct Material Input (DMI), Domestic Material Consumption (DMC) and Total Material Requirement (TMR) (for the years 1987-1998). DMC was included in the first Swedish set of sustainable development indicators published in 2001 by Statistics Sweden. None of these indicators has been updated since.

Links to policies and objectives:

In 1999, the Swedish Parliament adopted 15 national environmental quality objectives that underpin the country's environmental policy up to the year 2020 ("Swedish Environmental Quality Goals: An Environmental Policy for a Sustainable Sweden", Government Bill 1997/98:145). Between 2001 and 2003, 71 interim targets (by 2010) were laid down to support the environmental quality objectives.

Resource productivity is not an explicit objective, but several of the environmental quality objectives are associated with products and necessitate the development of a strategy for an environment-oriented product policy if they are to be achieved (based on the need for: greater energy efficiency, non-toxic, resource saving ecocycles, environmentally sound products, efficient management of land and water resources). In May 2003, the Swedish Government put forward a bill "A society with non-toxic and resource-efficient ecocycles" (Government Bill 2002/03:117, not yet adopted), including objectives and measures to achieve such a society. The focus is on waste management and on producer responsibility.

In April 2004, the Government presented a national strategy for sustainable development in which all ministries participated. It includes a chapter on sustainable economic growth and competitiveness with reference to production and consumption patterns.

At national level, SFA studies commissioned by the Swedish National Chemicals Inspectorate are closely linked to policy uses. At local level, municipalities such as city of Stockholm have shown interest in SFA in order to inform chemical policies. Stockholm participated in a research project covering stocks and flows of seven heavy metals in both the rural and the urban area of the city.

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SWITZERLAND

OVERVIEW

Switzerland has good experience with material flow related work such as substance flow analysis (SFA) and MFA applied to waste management mainly at research level and at local level. Economy-wide material flows is a more recent activity and a feasibility study was carried out by the government in 2003-2004.

The lead institution for economy-wide MFA is the Statistical Office, in co-operation with research institutes (ESU services (Uster); Wertstoffbörse GMBH (Zürich)). Other MF related work is being done by local agencies for waste management (e.g. in the Cantons of Zurich, Geneva, St. Gall and Thurgau) and research institutes such as the Swiss Federal Institute for Technology (Zurich, Lausanne) that also includes MFA in the subject matters of its bachelor and master studies, and the Swiss Federal Institute for Environmental Science and Technology. Related work is also carried out by private companies (e.g. Holcim) and environmental consultant firms (e.g. Geopartner; Sieber und Cassina; Infras; Wüest und Partner).

Switzerland participates via the Swiss Federal Institute for Technology in the ConAccount Network co-ordinated by the Wuppertal Institut (Germany).

CHARACTERISTICS AND SCOPE

Economy-wide MF: The Environmental accounts based on SEEA 2003 developped by the Statistical Office include economic accounts (SERIEE), physical accounts (MFA) and integrated accounts (NAMEA). The feasibility study on EW-MF builds on the Eurostat methodology and was carried out between August 2003 and September 2004. It demonstrated the feasibility of such accounts in Switzerland and highlighted some methodological problems. The study has generated data on Direct Inputs with time series for 1981-2001. The next stages will consist in estimating hidden flows (for calculating TMR) and consolidating data on Outputs. A regular production of input indicators is considered.

Substance Flow Analysis or **MFA at regional or enterprise level** are carried out frequently (though not regularly) as part of non-governmental research projects (universities, research institutes, consultant firms) and as part of governmental activities related to waste management at federal or cantonal level (Cantons of Zurich, Geneva, St. Gall, Thurgau).

A MF study carried out for the Canton of Geneva (between September 2002 and December 2003) has assessed the metabolism of economic activities in the region. The study covered all major MF variables for the year 2000 (input and ouput flows, stocks, consumption) broken down by type of materials including energy (electricity, motor fuels, heating fuels), construction materials (concrete and bricks, sand/gravel and asphalt concrete), food (including animal feed), metals (iron, copper, aluminium), plastics, wood (timber, paper, cardboard), and water.

OUTPUTS AND USE

Publication: First results on EW-MF will be published early 2005 and parts of the feasibility study will be available on the web site of the SFSO in the 2nd quarter of 2005. A more complete report on EW-MF will be available in 2006. Numerous reports on SFA and MFA activities have been published on cantonal scale, mainly related to waste management.

Indicators: MF indicators calculated as part of the feasibility study include: Direct Material Input, Domestic Material Consumption and Physical Trade Balance.

Links to policies and objectives:

- At federal level, the proposed system of indicators to measure sustainable development (MONET) includes an indicator on the material efficiency of the economy (i.e. total material flow per GDP). The indicator is related to the postulate that "the environmental impact and risks emanating from production plants should be minimised, while energy and material flows should be optimised".

- At regional level, the Canton of Geneva uses MFA to support the implementation of the local Agenda 21 as defined in a law adopted on 23 March 2001 and revised in 2002 (loi sur l'action publique en vue d'un développement durable - Agenda 21). The Agenda 21 Law includes 9 broad policy objectives to be achieved by 2006. Objective No.5 states that the state should take into account all possible synergies among economic activities so as to minimise their impact on the environment.

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TURKEY

OVERVIEW

Turkey does not carry out work on material flows per se, but has initiated a pilot study on supply-use tables for inland waters (based on the System of Environmental and Economic Accounts (SEEA) handbook).

The lead institution is the State Institute of Statistics. Other institutions involved include: the Ministry of Environment and Forestry, the Ministry of Energy and Mineral resources and the State Planning Organization.

A proposal to launch a study on material flows in the framework of Turkey's environmental accounting activities has been included in a project "Enhancement of Environmental Statistics Capacity" submitted to Eurostat (USST-II programme 2006-2009). Co-operation is also expected to be established with the European Environment Agency's Topic Center on Waste and Material Flows.

UNITED KINGDOM

OVERVIEW

The United Kingdom has initiated work on material flows in 1999, when the UK Department for Environment, Food and Rural Affairs (DEFRA) in conjunction with the Office for National Statistics (ONS) engaged the Wuppertal Institute (Germany) to develop an economy-wide material flow account for the UK. The results of this research work, covering the period 1970 to 1999 were published in 2002 ('UK National Accounts', the ONS Blue Book).

The ONS has subsequently taken over responsibility for MF accounts on behalf of DEFRA, and MFA has become a regular activity as part of the country's official statistics. This regular work is complemented with adhoc work on Physical Input-Output Tables (PIOTs) carried out by an NGO.

MF related work is also being carried out by the UK's waste management industry that has commissioned a number of substance flow analyses under the Landfill Tax Credit Scheme.

The UK also contributes to international work steered by the London Group on Environmental Accounting.

CHARACTERISTICS AND SCOPE

Economy-wide MFA: The framework used to develop EW-MFA follows the standards set out by Eurostat. The data are updated annually by the ONS on behalf of DEFRA and are available on the National Statistics website. The most recent data available refer to 2002.

Further research by the ONS aims at refining the estimates of indirect flows (many of the factors used so far will remain based upon one-off or country-specific studies and there is scope for more coordination of research internationally), and investigates methodologies for assessing the impacts in exporting countries of domestic consumption of imports. Some efforts have also been made to develop weights relating to toxicity or environmental impact, which could be used to weight material flow output indicators.

MF Mass balance: A complete mass balance of the UK was completed in 2003.

Physical Input-Output Tables (PIOTs): Ad hoc work by a Non Governmental Organization on the development of PIOTs (Regional, product based using Prodcom) for UK and regions is expected to be completed December 2004.

OUTPUTS AND USE

Publication: MFA data are regularly published by the ONS as part of the UK's Environmental Accounts. MF data are presented alongside other data derived from natural resource accounts and other physical flow data (e.g. air and GHG emissions, waste, water).

Indicators: Indicators derived from MFA include Direct Material Input (DMI), Domestic Material Consumption (DMC), Total Material Requirement (TMR) and material productivity expressed as per capita GDP at real prices divided by per capita domestic Direct Material Consumption (DMC).

MF indicators are part of the country's official set of sustainable development indicators ('Quality of Life Counts'). MF indicators have been included as part of a proposed set of Sustainable Consumption and Production indicators for the UK, but have not yet been formally adopted.

Links to policies and objectives: In September 2003, following the commitments at the World Summit on Sustainable Development, the UK's Department for Trade and Industry and the Department for Environment, Food, and Rural Affairs published a framework document called "UK Government Framework for Sustainable Consumption and Production". This document was accompanied by a consultation document setting out the Government's initial ideas for a 'basket' of 12 "decoupling" indicators by which the effectiveness of the planned actions for sustainable consumption and production can be measured. These indicators are expected to feed in the overall review of indicators for the UK SD Strategy scheduled to be completed in 2005. Among the indicators proposed is "total material use" and "freshwater abstractions".

The UK does not have a specific target for resource use, but there is a commitment to promote continual improvements in resource efficiency, that is to make greater use of the resources extracted.

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EUROPEAN UNION – COMMISSION OF THE EUROPEAN COMMUNITIES

OVERVIEW

The European Union has been carrying out work on MFA since 1993. The works covers economy-wide material flow accounts and indicators, as well as physical input-output tables. It is complemented with MF related modelling and research work (e.g. the MOSUS project) and with work on other environmental accounts, including National Accounting Matrix including Environmental Accounts (NAMEAs) and environmental protection expenditure accounts.

The work also includes training and capacity building in the field of material flow accounts.

Lead institutions are Eurostat (methodological and statistical guidance, training, compilation of MF data); the European Environment Agency (EEA) and its Topic Centre on Waste and Material Flows (MF indicators and related guidance, policy and assessment reports), and the European Commission itself (policies and strategies, research). Other institutions involved include private and university research institutes that carry out projects on behalf of the European Union (e.g. the Wuppertal Institute, Germany and the IFF, Austria).

The European Union actively contributes to international work steered by the London Group on Environmental Accounting and participates in the work of the OECD.

CHARACTERISTICS AND SCOPE

The Statistical Office of the European Commission, **Eurostat**, initiated work material flows as of 1993 with a project called "Materials balances for selected dangerous products and substances". The project included a first feasibility study on environmentally oriented material flow accounting, and was supported with expert meetings.

Since then, Eurostat has taken significant steps to harmonise methodological approaches of material flow accounting and derived indicators and has published a methodological guide in 2001. It has also commissioned several studies to provide MF data on the European Union and its member states. The data are updated annually and are available for the period 1970-2001 for the EU as a whole and for individual member states. The underlying data series are produced by research institutes on behalf of the European Commission (Wuppertal Institut; IFF-Vienna).

Current efforts focus on further promoting the development and use of MFA in member states, refining the methodological guidelines for MFA in co-operation with research partners and with other international institutions, and developing a simplified guide on MFA in support of work on MFA carried out by the OECD.

In 2001, the **European Environment Agency (EEA)** expanded the scope of work if its Topic Center on Waste to include material flow analysis and changed its name accordingly to European Topic Centre on Waste and Material Flows (ETC/WMF). This expansion was a result of EU policy developments in the area of sustainable use of natural resources in the context of the 6th Environmental Action Programme. Concerning material flow analysis, the objectives of the ETC/WMF include (i) the provision of data and information on material flows in Europe; (ii) the inclusion of such information and related findings in reports produced by the EEA; (iii) the contribution to the further harmonisation of methodologies in the area of MF accounting and indicators; and (iv) the provision of support to policy makers in developing policy strategies and measures concerning sustainable use of natural resources.

MF data and indicators produced so far by the ETC/WMF are available on the Topic Centre's website, as well as links to selected national and international MF related activities.

In the course of the preparation of the 6th Environmental Action Programme (6EAP) and of the thematic strategy on the sustainable use of natural resources, **the European Commission** commissioned a number of studies on resource management, covering conceptual and policy issues.

- A first study, commissioned to the Wuppertal Institute via the European Topic Center on Waste and Material Flows (ETC-WMF), provided baseline data on material flows.

- A study "Public private interface" carried out in 2003 by a consortium consisting of the Danish lead organisation of the European Topic Centre on Waste and Material Flows (ETC/WMF) and the Centre for Economic Analysis (ECON) under the lead of the Danish National Environmental Research Institute (NERI), reviewed policies, objectives and targets regarding natural resource and waste at EU-level or in Member States/accession countries; and examined the impact of existing taxes and subsidies on natural resources and wastes. The aim was to make proposals for target setting, instruments and best practices based on experience so far.
- A study "Dynamic View on Resources", carried out in 2003 by Entec UK Ltd. assessed the feasibility of decoupling resource use from economic growth and developed a methodology to assess the dynamics of the use patterns of individual resources, including the relationship between the use and the environmental impacts, created at various stages of the life cycle. It reviewed the framework of resource regulation, economic structure and environmental impact related to two different resources, reviewed the impact of measures, such as material substitution, material recovery, and re-use/re-cycling, leap-frog technologies etc. and identified the best policy mixes, technological solutions, and other tools, through which the objective of de-coupling could occur.

Recently two new studies have been initiated:

- "Policy review on decoupling and development of resource productivity indicators". The aim is to identify and explain the reasons for differences in material intensities and patterns of resource use of the EU and ACC; derive a weighted indicator of material flows that reflects the highest environmental impacts; identify a limited set of mass flow and land use indicators that are manageable; and assess whether one or more indicators could be used for benchmarking exercises.
- "Material metabolisms of the physical stock". The aim is to: describe and characterise the historically accumulated physical stocks (e.g. buildings, bridges, cars, etc.) in the EU and in accession countries; identify the dissipative materials flows from the stocks due to corrosion, weathering, etc. ; forecast the energy that is required for processing and transport of goods and materials related to the stocks and estimate the environmental pressures of these material metabolisms.

In 2003, the European Commission launched a 3-year EU-wide research project called “Modelling Opportunities and limits for restructuring Europe towards Sustainability (**MOSUS**)”, funded within the Fifth framework programme of the European Union.

Twelve research institutions from 7 European countries participate in the project: the International Institute for Applied Systems Analysis (IIASA), Austria, that acts as the project co-ordinator; the Gesellschaft für wirtschaftliche Strukturforschung mbH, Germany; the Sustainable Europe Research Institute (SERI), Austria; The Charles University Prague, Environmental Center (CUEC), Czech Republic; the London School of Economics, UK; the Austrian Institute of Economic Research (WIFO), Austria; the Institute for Sustainable Development, Poland; the National Institute for Engineering and Industrial Technology (INETI), Portugal; the Research Centre on the Portuguese Economy, Portugal; the Research Centre for Sociological Studies, Portugal; the University of Lodz, Poland; the Center for International Climate and Environmental Research, University of Oslo.

The goal is to quantify the interrelations between socio-economic driving forces and the state of the environment, by illustrating the physical growth of the global economy driven by the world-wide economic integration process of the past 25 years and presenting a world-wide distribution of environmental pressures associated with material extraction.

The project uses the Eurostat guidelines for economy-wide MFA and builds on an integrated (multi-country, multi-sectoral) ecological-economic input-output simulation model, GLODYM, developed by the German Institute of Economic Structures Research. The model covers trade and financial flows between all European countries as well as flows between Europe and other parts of the world.

Expected results include a complete compilation of trends (1980-2002) in direct domestic material inputs (including domestic hidden flows), energy inputs and land use for Europe as well as all economically important regions of the world, disaggregated by economic sectors and countries. The project covers major material groups (such as fossil energy carriers, metals, industrial and construction minerals, and biomass). Most of the underlying data are derived from internationally available statistics and research reports. The physical extraction data are linked to socio-economic indicators, such as GDP and

population, in order to assess different patterns of resource productivities and inequalities in per capita resource extraction between industrialised and developing economies. The project will further develop European and global scenarios of economic performance and their interaction with resource use and environmental deterioration (decoupling), and refine MF related indicators.

OUTPUTS AND USE

Publication: MF data and indicators compiled by and on behalf of Eurostat are regularly published and can also be downloaded from the web. Aggregated MF indicators for the EU are also regularly published in the EEA's indicator reports "Environmental signals" MF data were also published in the Kiev report" Europe's environment: the third assessment" that included a chapter on material flows.

Indicators:

MF information produced so far by Eurostat for the European Union as a whole and for individual member states has been used to derive MF indicators such as: Domestic Material Consumption (DMC), Direct Material Input (DMI), and physical trade balance (PTB). The calculation of Total Material Requirements (TMR), domestic processed output (DPO) and net additions to stock (NAS) was abandoned in the most recent update.

The preliminary list of sustainable development indicators for the EU includes a section on production and consumption patterns with indicators on material consumption and waste generation.

Links to policies and objectives:

Natural resource use and resource efficiency were listed among the future key policy issues in the Review of the EU's Fifth Environmental Action Programme (Decision N 2179/98/EC), and have been included in the 6th Environmental Action Programme (6EAP) 2001-2010 of the European Union.

The 6EAP called for the development of seven thematic strategies among which one on the sustainable use of natural resources. The objectives are to: "*ensure that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment and break the linkages between economic growth and resource use*". The natural resources considered include raw materials such as minerals and biomass, environmental media such as air, water and soil, flow resources such as wind, geothermal, tidal and solar energy and space (land area). The development of the thematic strategy is accompanied with stakeholder consultations and supported with expert workshops. In 2003, the Commission published a Communication "Towards a thematic strategy on the sustainable use of natural resources". The strategy is now being finalised, after an Extended Impact Assessment, and should be adopted in the 3rd quarter of 2005.

The EU Sustainable Development Strategy includes an objective related to "breaking the link between economic growth, use of resources, and generation of waste", and asks for a system of resource productivity measurement to be operational by 2003.

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OTHER AREAS

CHINA

OVERVIEW

In China, MFA studies are not a regular government activity, but the government has funded a number of related research studies. Further regular work on MF might be considered as part of future policies and plans related to economic and environmental management and to the establishment of a policy framework for promoting a "Circular Economy" in China.

China has also recently (June 2004) initiated work on environmental accounting upon a request by President HU Jintao to study green GDP. The work is in its initial research phase and the government has commissioned research studies by various institutes.

Lead institutions are the State Environmental Protection Agency (SEPA) and its Chinese Academy of Environmental Sciences (CAEP), and the Chinese National Bureau of Statistics (NBS). Work is also carried out at province level and by academic research institutes and universities. Other institutions involved in the environmental accounting project include National Development and Reform Commission, and the Ministry of Science and Technology of China that provides part of funding for the project.

- The NBS is in charge of the compilation of the accounts. From 1998 to 2001, it has worked on the compilation of energy accounts and emission estimates for eight air pollutants as part of a co-operation project with Statistics Norway. Current work focuses on (i) the compilation of environmental-economic accounts based on environmental effects together with the State Environmental Protection Administration (SEPA), and (ii) the compilation of forest resource accounts with the State Forestry Administration and the Chinese Academy of Forestry.

  In 2002, two pilot studies on industrial pollution and forest accounts have been launched at provincial level, one by Statistics Chongqing and one by Statistics Hainan. These two research studies have been completed in 2004 and 2003 respectively.

- The CAEP is in charge of drafting frameworks and guidelines for compiling environmental accounts. To date is has drafted two frameworks: A framework of Resources and Environmental and Economic Accounting for China, and A Framework of Environment and Economic Accounting for China. The drafting of technical guidelines for environmental accounting is in progress; this is to be followed by the selection of trial provinces.

- Work to date on MFA has mainly been carried out by university research institutes (e.g. Tsinghua University, Peking University, Beijing Polytechnic University). A few universities have established contacts with research institutes in other countries, including the Wuppertal Institute (Germany), and the NIES (National Institute of Environmental Studies, Japan).

CHARACTERISTICS AND SCOPE

The development of **environmental accounts** by the government uses the SEEA 2003 as a general reference framework. Priority is given to the development of physical accounts for mineral, land, forest and water resources. The preparation of estimates of environmental protection expenditure is also considered, and the SEPA in collaboration with the World Bank sponsored a study to estimate environmental damage costs through modelling. The project is to be developed over a 3 to 5 year period.

Academic **research work on MFA** carried out to date covers many types of MF studies, most of them being supported with government funding.

- A first pilot study on MFA for China, funded by the National Development and Reform Committee (NDRC), was carried out by the Tsinghua University (Energy, Environment and Economy Institute), covering the period 1992-2000. The study covered **economy-wide MF**, **physical input-output tables** for the year 1992, and **substance flow analysis** focusing on the use of iron in the Chinese steel industry. The results of the joint international research project on MF published by the WRI et

al. in 2000 were used as a reference. The results of the study were used by the NDRC to calculate **MF indicators** such as DMI and TMR.

- Another study carried out by the Tsinghua University (Department of Environmental Science and Engineering) and funded by the government, focuses on **economy-wide MF** (building on the Eurostat guidelines) and the establishment of **physical input-output tables (PIOTs) at province level**. The work on PIOTs covers more than 40 sectors, three natural resources and three pollution discharges. **MF indicators** calculated as part of the project include DMI and TMR. The project was initiated in 2000 and finishes in 2004.
- The Peking University (College of Environmental Science) carried out a project on MFA (between August, 2001 and December 2004) focusing on **economy-wide MF** accounts and on the material-energy metabolism and environmental impacts of the **cement industry** in the Beijing area. The project received government funding and follows the Eurostat guidelines. Work by the Wuppertal Institute and WRI et al. is used as a reference. **MF indicators** for China as whole, calculated as part of the project include Direct Material Input (DMI), Total Material Requirement (TMR), as well as TMR/capita, DMI/capita, and resource productivity indicators such as GDP/TMR and GDP/DMI. Data are available for the period 1997-2002.
- The North-eastern University (Resources and Ecological Economics Research Centre) has, in January 2003, started a MF related research project, focusing on **economy-wide MFA** and using the concept of the **Ecological Rucksack**. The Eurostat methodological guide and work by the Wuppertal Institute are used as a reference. **MF indicators** calculated as part of the project include DMI, DMC and TMR as well as PBT. The most recent data available refer to 2002.

OUTPUTS AND USE

Indicators: As part of the above described research projects, EW-MF indicators such as DMI and TMR have been calculated for China as a whole. Other related indicators produced as part of the government activities include indicators on water use, energy efficiency, industrial waste recycling, etc.

Links to policies and objectives: China has many policy documents, plans and legal texts that relate to resource use, energy efficiency and sustainable development. Examples are the law on the promotion of cleaner production in China, the law on the promotion of green purchase, the law on solid waste disposal, and the policy on comprehensive utilisation of resources.

The Chinese government is working towards developing a policy framework for promoting a "Circular Economy". Plans include a revision of the Environmental Protection Law of China and of related specialised laws and regulations so as to introduce or strengthen the 3R principle (reduce, recycle, re-use) in general and in specific sectors.

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EUROPE

- BULGARIA

OVERVIEW

Bulgaria has carried out ad-hoc work on Material Flows. The work has a general scope and covers physical input-output tables (PIOTs) and Substance Flow Analysis (SFA).

The lead institution is the Bulgarian Executive Environment Agency, in co-operation with the National Statistical Institute. Some co-operation has also been established with the European Topic Center on Waste and Material Flows of the EEA whose documents were used to develop MF accounts.

MF data are available up to 1999. MF indicators have not yet been developed.

- CYPRUS

OVERVIEW

Cyprus plans to carry out a study on MFA under the lead of the Ministry of Agriculture and Natural Resources.

- LATVIA

OVERVIEW

Latvia has recently carried out a pilot study (December 2003-December 2004) on economy-wide MFA..

The lead institution for the pilot study was the Latvian Environment Agency. The Central Statistical Bureau of Latvia was also involved, along with selected sectoral and research institutions.

The Eurostat methodological guide was used as a framework when developing MF accounts. Data derived from the accounts have been used to calculate economy-wide indicators with focus on DMI and DMC. The most recent data available are from 2002.

Data and indicators derived from MFA are seen as useful tools to monitor the sustainability of material resource use and inform related decision making as well as to link environmental and economic information.

National objectives regarding material resources include "increasing the sustainable use of natural resources" and "reducing waste production". These are voluntary and are included in the Sustainable Development Strategy and the Environment Policy Plan.

- MALTA

OVERVIEW

In Malta there is currently no work being undertaken in the field of MF, but an annual or biennial study cycle is due to start in 2005 as part of Malta's official statistics.

The lead institution is the National Statistics Office.

Work is planned to focus on monitoring the sustainability of material resource use and also to link environmental and economic information. It is to be based on the Eurostat methodology.

- SLOVENIA

OVERVIEW

Slovenia has initiated a feasibility study on MFA in January 2004. Plans for carrying out regular MF activities will depend on the results of this study.

The lead institutions for the study were the Statistical Office and the Environmental Agency of the Republic of Slovenia. The Ministry for the Environment, Spatial Planning and Energy also participated.

The work is based on the Eurostat methodology. Economy-wide MF data are available for the period 1992-2002.

Data derived from material flow work will be used to calculate MF indicators including DMI. Among the indicators already in use to monitor progress and of relevance to MFA are:

- a Water Exploitation Index, Final Energy Consumption, Renewable Energy Resources, and Direct Material Input (DMI) used by the Ministry and the Environmental Agency (DMI has been included in the State of the Environment Indicator report, published late 2004 by the Environmental Agency).
- energy intensity, renewable sources and tree felling intensity used by the Institute of Macroeconomic Analysis and Development in its development report.

Data and indicators derived from MFA are planned to be used to monitor the sustainability of material resource use and inform related decision making and to link environmental and economic information.

Broad objectives for the sustainable use of natural resources are included in the National Environmental Action Programme (1999), and for the prudent use of natural resources in the Spatial Development Strategy (2004). More explicit objectives are expected to be included in the Strategy for the Development of Slovenia and in the updated National Environmental Action Programme (2004).

LATIN AMERICA

- BRAZIL

OVERVIEW

In Brazil, a detailed Material Flows Analysis of the national economy has been carried out as part of non-governmental academic research projects, first as part of a PhD thesis, and second as part of an international research project funded by the EU (Amazonia21[15]).

The lead institution for academic work on MF is the Institute of Advanced Amazonian Studies (NAEA) at the Federal University of Pará (UFPA) in Belem. Other institutions involved include the Federal University of Amazonas (UFAM) in Manaus and the UFF in Rio de Janeiro.

The NAEA further has co-operative agreements with the Universidad Autonoma Gabriel Rene Moreno, Centro de Investigacion y Manego de Recursos Naturales (UAGRM-CIMAR Bolivia), the Universidad Central de Venezuela, Centro de Estudios Integrale del Ambiente (CENAMB Venezuela), the Universidad Nacional de Colombia, Instituto Amazonico de Investigaciones (IMANI Colombia). Co-operation also exists with the IFF-Social Ecology (Vienna, Austria), the Wuppertal Institute for Climate, Environment and Energy (Germany), the Vrije Universiteit Amsterdam, Institute for Environmental Studies (IVM, Netherlands), the Lews Castle College (United Kingdom), OEAR Regional Development Consultancy (Austria).

The first MFA study was carried out between October 1998 and July 1999 and covered the period 1975-1995. Data from the study were used to calculate economy-wide indicators (DMI, DMC, TMR), and to link environmental and economic information. They were subsequently revised as part of the Amazonia21 project, building on the Eurostat methodology, supplemented by reference material from the IFF in Vienna.

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- COLOMBIA

OVERVIEW

In Colombia, most activities related to material flow analysis have been carried out at academic level as part of an international research project funded by the EU (Amazonia21[15]).

Academic work is led by the Instituto CINARA at the Universidad del Valle (Sede Melendez). Other institutions involved include at the academic level, the Universidad Nacional de Colombia, Bogotá, the Instituto de Estudios Ambientales (IDEA), Bogotá, the Corporación Autónoma Regional de Risaralda (CARDER), Pereira, and at government level the Departamento Administrativo Nacional de Estadísticas (DANE), Bogotá and the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) of the Ministry of Environment.

[15] Research project carried out by members of IFF Social Ecology (Vienna, Austria) in conjunction with researchers from Brazil, Venezuela, Colombia, and Bolivia. The project demonstrates the application of Material Flow Accounting (MFA) tools in the region of Amazonia.

Work has also been done as part of a masters and PhD thesis at the Autonomous University of Barcelona (UAB). The study covered the period 1970-2002 and MF indicators such as the Physical Trade Balance (PTB).

Data from material flow studies have been published by the IDEAM in its 2001 version of the Colombian state of the environment report "El Medio Ambiente en Colombia" (chapter "Flujo de materiales y de Energía en la economía colombiana").

MF work carried out is based on the Eurostat methodology, as well as on material from IFF-Social Ecology (Vienna, Austria) and the Austrian Ministry of Agriculture and Forestry, Environment and Water Management.

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SOUTH-EAST ASIA

- LAOS

OVERVIEW

Laos has carried out ad-hoc research work on economy-wide MF accounts, energy flow accounts, and Substance Flow Analysis (SFA) with a focus on biomass from agriculture and forestry. This work has been carried out between 2001 and 2004 in the framework of a non-governmental interdisciplinary research project "South-East Asia in Transition" (SEATrans Project) funded by the European Union [16].

The lead institution for the ad-hoc project was the National Statistics Center in co-operation with the National University of Laos, Faculty of Forestry and Faculty of Science, and the IFF in Vienna (Austria).

The results of the research project are due to be published soon.

- PHILIPPINES

OVERVIEW

The Philippines do not yet carry our regular work on MFA, but have participated in related work under the interdisciplinary research project "South-East Asia in Transition" (SEATrans Project) funded by the European Union [16].

There is no one lead institution, as sectoral material flow tables are produced at the request of the National Statistics Coordinating Board (NSCB) for a fee. Partnerships exist with academic institutions throughout Europe (Netherlands, Italy, Austria) and South-East Asia (Thailand, Vietnam, Laos), and in particular with the IFF Social Ecology (Vienna, Austria) that co-ordinated the SEATrans project. Some academic work is also being carried out at the University of the Philippines at Los Banos.

MF work has been based on methodologies and training material from the IFF, and has focused on physical input-output tables (PIOTs). Data on resource use appears in the annual Philippine Statistical Yearbook.

The Philippine Council for Sustainable Development has published sustainable development indicators, which cover some aspects of material resource use.

- VIETNAM

OVERVIEW

Work on MF in Vietnam so far has been restricted to a stand-alone study carried out between October 2000 and October 2003 under the interdisciplinary research project "South-East Asia in Transition" (SEATrans Project) funded by the European Union [16].

The work was co-ordinated by a Working Group of the University of Social Sciences and Humanities, (HCMC), with involvement by the Center for Natural Resources and Environmental Studies. The University has established close co-operation with the IFF Social Ecology (Vienna, Austria).

Information on material flows is published under the auspices of the General Statistics Organisation of Vietnam and of the Industry Ministry. MF data are used to calculate MF indicators such as DMI and DMC, but these are not included in any official set of indicators.

Information from MFA is seen as a useful tool to monitor the sustainability of material resource use, link environmental and economic information and to support modelling and outlook activities.

MF work was based on the Eurostat methodological guide and on training material from the IFF.

[16] Three-year project (2000-2003) carried out jointly by ten partners in the region and in Europe, including the IFF-Vienna (Austria) and the Leiden University (Netherlands). The project covered aspects related to social transitions, environmental impacts and policies for sustainable development.