

# The Development of Economy-Wide Material Flow Accounting

*Lo sviluppo della contabilità dei flussi di materia*

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**Riassunto:** La Contabilità dei Flussi di Materia a livello di intero sistema economico (EW-MFA) costituisce una rappresentazione quantitativa dei rapporti che intercorrono fra l'ambiente naturale e l'economia di un paese, utile ai fini della valutazione della sostenibilità ecologica dello sviluppo. Tale disciplina si fonda sulla misurazione in termini fisici dei flussi di materiali attivati dall'economia. Gli indicatori derivati forniscono informazioni sull'evoluzione del metabolismo economico. La EW-MFA in Europa è promossa da Eurostat con il supporto di una Task Force, della quale l'Istat fa parte, che ha predisposto nel 2000 una Guida Metodologica. L'Istituto ha predisposto il Bilancio dei Flussi di Materia per il 1997 e una sequenza completa di Conti con una serie storica di indicatori 1980 - 2001.

**Keywords:** Economy-wide MFA, material flows, material inputs-outputs, material balance, DMI, DMC, TMR, TMC, PTB, DPO, NAS, dematerialisation, sustainability.

## 1. Material Flows Accounting: the core of the question

Material Flow Accounting (MFA) is a family of decision-support tools, providing information on human-induced flows of materials and allowing overview and analysis of trends for resource and waste management and sustainability policy. Economy-Wide Material Flow Accounting (EW-MFA), in particular, is a methodology for the construction of synthetic information on the physical exchanges of an economy, based on a holistic approach. The anthropic system is looked at as a living organism - composed by buildings, streets, railways, human bodies etc. - whose activities need flows of materials that are extracted or harvested from the natural environment (inputs) and then refined, mixed, burned etc. through manufacture, use, reuse and recycling before being accumulated in stocks or returned back to the natural environment in an altered form (outputs). All the interactions between the anthroposphere and the natural system relevant for Nature are of a physical kind and whenever a physical flow is caused by human activities a pressure on the natural environment occurs. Since matter is neither created nor destroyed by any (non nuclear) process, a material balance must hold between the physical mass of all inputs and outputs of processes: all inputs are transformed in outputs that eventually will be returned to nature, so that measuring the inputs to the economic system gives an indication of all potential pressures to the natural environment. Information on the size of these flows is therefore important for the evaluation of the long term ecological sustainability. Material-flow-based indicators

provide an aggregate picture and describe the evolution of the demand for natural resources by the economic system.

## 2. EW-MFA development and policies

There is a growing awareness among policy-makers about the importance of information on the size of the material flows due to society's metabolism, and EW-MFA is perceived as a decision-support tool allowing overview and analysis of trends for resource and waste management and sustainability policy. Activities in this field have been implemented in 23 out of the 41 countries that answered to a recent OECD survey, and are planned in a number of other countries. In Europe EW-MFA is promoted by Eurostat with the support of an *ad hoc* task force (including Italy, with Istat), that in 2000 has prepared a Methodological Guide to harmonize concepts and definitions, including a set of accounts and tables; this Guide is the main reference for compilers, along with the United Nations handbook of national accounting Integrated Environmental and Economic Accounting 2003. In the last years the OECD has started a program for the promotion of MFA applications world-wide and the production of coherent and comparable accounts and indicators. Italy is one of the countries that mostly support this initiative. In this framework Eurostat's Guide has been adopted as the main methodological reference. Istat estimates on yearly basis the quantities of materials moved by the Italian economic activities, according to the European methodology, by integrating numerous and different data sources. Some EW-MFA aggregates are published in the "Report on the State of the Environment", published every second year by the Ministry of the Environment, and targets on material flows have been included in the national strategy for sustainable development.

## 3. Methodology: concepts and definitions

As compared to other holistic approaches, EW-MFA has three specific valuable features: it is meant to describe actual phenomena, without recurring in principle to "what if" evaluations; it is based on the main national accounting concepts (SNA93 and SEC95) and is a satellite account, so that its physical aggregates can be put in relation to aggregates of the core set of national accounts; the aggregation basis is very clear, i.e. only physical quantities that can be intrinsically measured in weight units are aggregated on this basis without the need of doubtful transformations. The system boundaries are defined in EW-MFA as follows: *Inputs* are all previously untouched materials that are intentionally moved by the application of labour; *Outputs to Nature* are materials on whose location and composition man loses control; other *Outputs* are directed to the economic system itself and go into the *Additions to Stocks*; intermediate and non-durable products, including recycled materials, are not accounted for, as they do not enter nor leave the system. Water and air are included into the accounts and indicators only to the extent that they are embodied in products or as memorandum items in the overall balance. Flows are classified as *used* or *unused* and as *direct* or *indirect*. *Unused* materials are the ones moved but not embodied in products (e.g. soil excavation); *indirect* has the same meaning as in I-O analysis and is referred to the material flows associated to Imp/Exp. The main indicators are: Direct Material Input

(DMI), which includes domestic extraction and harvest and imported products and is a measure of all directly used materials; Domestic Material Consumption (DMC), which equals DMI minus Exports and is a measure of the material resources that are transformed into outputs to the environment or accumulated in stocks in the country; Total Material Requirement (TMR), which is given by DMI plus unused domestic extraction and indirect flows associated to Imports and is the most comprehensive measure of resource use attributable to the country's activities; Total Material Consumption (TMC), which equals TMR minus Exports and indirect flows associated to them and is a measure of the responsibility of domestic final demand in the global use of resources; Physical Trade Balance (PTB), given by Imports minus Exports and PTB including indirect flows (PTBIF), expressing the position of a country in the international trade of material resources; Domestic Processed Output (DPO), which includes all direct outputs to nature; and finally Net Additions to Stock (NAS), which measures the physical growth of the economy, including all new construction, machinery, animals and durable goods.

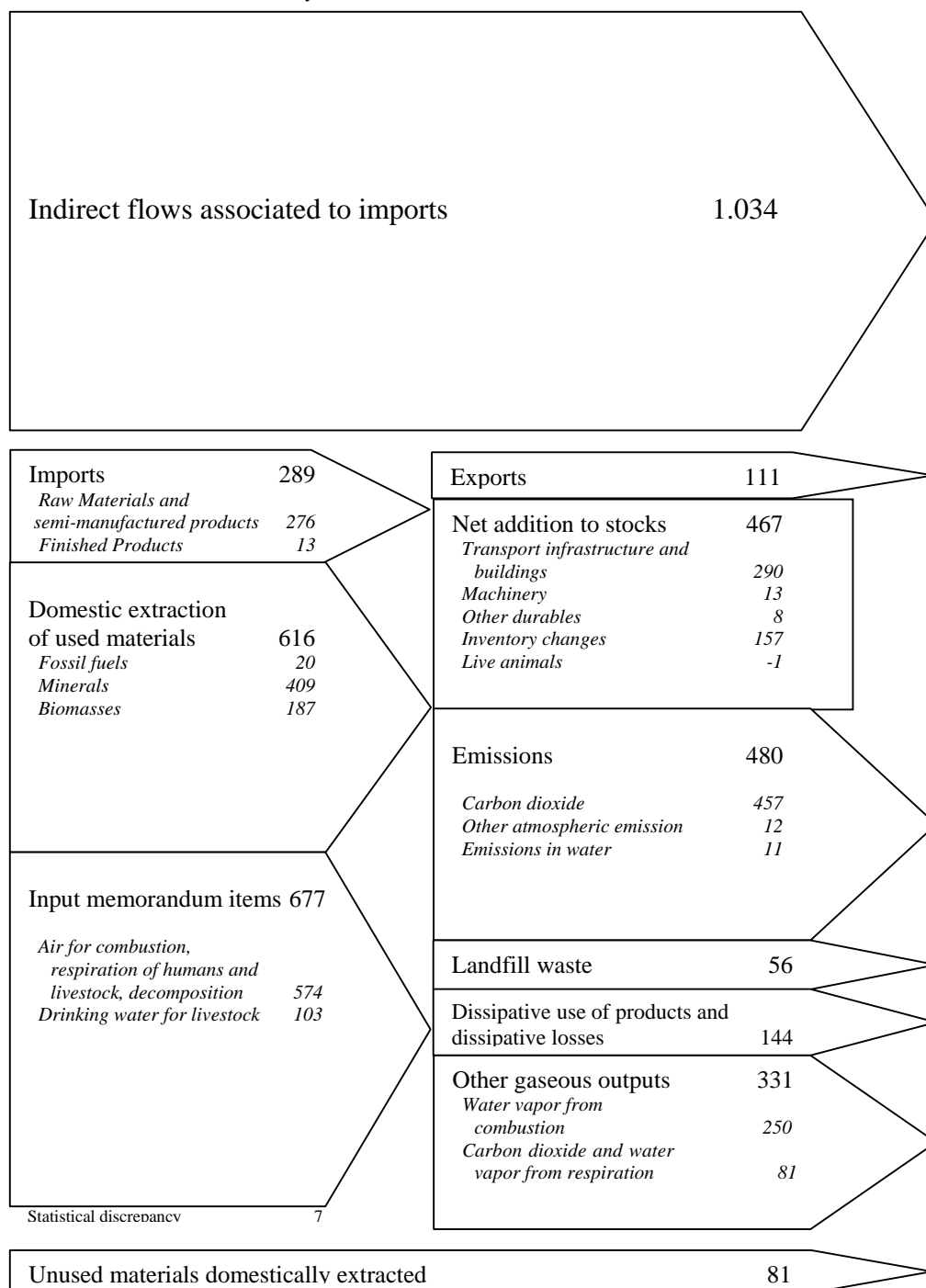
#### 4. Main results: material balance and material input-based indicators

A complete set of accounts has been calculated for Italy, including an all-encompassing balance of the material flows activated by the Italian economy for 1997 as well as a time series for some of the indicators mentioned above. The indicators' time series are long enough (1980-2001) to develop a long run analysis. It appears from this information that, while a relative decoupling of resource use and income is suggested (Table 1) by the material intensity indicators – material flows per GDP unit – no dematerialisation of in absolute terms – a necessary condition for ecological sustainability - is taking place in the Italian economy. The material balance for 1997 (Figure 1) shows that the major output of the national activities are emissions, mainly to air, which amount to 480 million tons, followed by the Additions to Stocks with 467 million tons. Each item of this balance has been estimated independently from the others by using numerous and different data sources. The statistical discrepancy between inputs and outputs is equal to only about 1% of the total used inputs, showing an overall coherence between the estimates.

**Table 1:** *Material input-based indicators, Italy 1980 and 2001, thousand tons, tons per million euro*

Indicator	1980	2001	Percentage change 1980-2001	Indicator/GDP 1980	Indicator/GDP 2001
	thousand tons	thousand tons		tons per million euro	tons per million euro
<b>DMI</b>	984.743	1.077.846	+ 9,5%	1.421	1.043
<b>DMC</b>	926.798	954.728	+ 3,0%	1.338	924
<b>TMR</b>	1.737.292	2.320.340	+ 33,6%	2.508	2.246
<b>TMC</b>	1.542.303	1.776.306	+ 15,2%	2.226	1.720
<b>PTB</b>	172.014	206.918	+ 20,3%	248	200
<b>PTBIF</b>	663.217	942.050	+ 42,0%	957	912

**Figure 1: Material Balance, Italy 1997, million tons**



## References

- Eurostat (2001), *Economy-wide material flow accounts and derived indicators, a methodological guide*, Luxembourg.
- Femia A. et al.(2003) *Update of the Economy-wide material flow indicators time series for Italy and Italian Physical Input Output Table feasibility study*, Istat, Rome
- OECD (2004), *Material flows and related indicators*, Paris.