**Environmental RTDI Programme 2000–2006**

# Material Flow Accounts (MFAs) – Demonstration for Ireland (2001-EEO/DS-(1/1))

## Synthesis Report

*(Main Report available for download on www.epa.ie/EnvironmentalResearch/ReportsOutputs)*

Prepared for the Environmental Protection Agency

by

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# ACKNOWLEDGEMENTS

# DISCLAIMER

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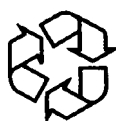
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# Table of Contents

# 1    Introduction and Background

## 1.1    Introduction and Definition

Currently, countries measure their economic growth and performance through the System of National Accounts (SNA). These financial accounts measure the total economic transactions in an economy. Indicators such as Gross Domestic Product (GDP) provide information on whether national income is growing or declining. There is no equivalent system for measuring the physical 'transactions' in an economy. Policy and other decision makers have very little idea of the material requirements of modern economies and few indicators of where, or when, physical constraints are likely to be reached.

One set of tools that can be used is material flow accounting – accounting for the physical flow of materials through our economy and society. Material flow accounts (MFAs) are **accounts in physical units** (usually in tonnes) **of the extraction, import, production, export, consumption, recycling and disposal of specific materials** (e.g. water, fossil fuels, minerals, products, etc.) **within a defined area** (e.g. a country or region).

It has been recommended by the World Resources Institute that governments set up a set of national accounts in physical terms using material flow accounting that runs parallel to the System of National Accounts. Many countries have produced MFAs for different substances and regions, and use them as indicators for policy making. To date, Ireland has not produced such national or regional accounts. This project represents a first attempt at generating MFAs for Ireland.

Ireland has undertaken a commitment to sustainable development. Appropriate monitoring tools are necessary in order to:

- Measure progress towards sustainable development., and

- Make/review policies and decisions toward sustainability.

Material flow accounting is a suitable monitoring tool that can be utilised. MFAs can be used to provide sufficient information in order to monitor the existing situation and trends, plan and control improvement measures, facilitate comparison of alternatives, and highlight/discover certain flows that may be of specific relevance in the future.

The long-term aim should be to develop national physical accounts for all major material flows in Ireland. This desk study serves as a first step in identifying available methodologies, demonstrating MFAs in an Irish situation, establishing the capability to produce flow accounts within Ireland, and identifying major data gaps for the future production of such accounts. This report also attempts a first quantification of Total Material Flows in Ireland.

## 1.2    Objectives

The main objectives of the study are:

- Review existing methodologies for MFAs and select/tailor the methodology for Ireland

- Demonstrate the methodology for two pilot cases:

   (i)    national fossil fuel flow accounts, together with derived indicators, and

   (ii)   water flow accounts for a region

- Identify data gaps for a complete set of national MFAs

- Evaluate the applicability of MFAs in Ireland and any policy implications.

## 1.3    Expected Benefits

The benefits of MFAs are based on the principle that *what is not measured cannot be controlled*. We would never dream of trying to run an economy without a comprehensive set of economic indicators and accounts. Similarly, we cannot hope to reduce the environmental footprint of our activities without clear indications of our impacts, in terms of material and energy flows.

The specific benefits of a MFAs pilot project are to test a methodology and to produce a first set of early accounts. The long-term aim should be to develop comprehensive accounts for a range of flows. These can be used to assess current environmental impacts, and, based on these, to make decisions for improvement.

# 2 Review of Existing Material Flow Accounting Methodologies

The review was carried out in two parts:

1. Examination of selected European material flow accounting methodologies

2. Examination of existing material flow accounting software.

## 2.1 European Methodologies

In total, eight methodologies were reviewed. These were at a European level and also at country-specific levels. At the European level, the following were examined:

- The Eurostat methodological guide for economy-wide material flows (Eurostat, 2001)

- The EU Total Material Requirement Study carried out by the European Environment Agency (Bringezu and Schütz, 2001).

The methodologies used by the following countries were examined:

- Germany

- Austria

- Netherlands

- United Kingdom

- Sweden

- Finland.

The review of work in other countries has shown that, for tracking resource flows at national level, it is best to use the Eurostat methodology. This will allow comparison with other countries. The majority of national-level studies that have been carried out since the publication of the Eurostat methodology utilise this method. For studies at a regional level, or for specific materials, there is more flexibility in the methods that can be used. Useful illustrative tools, such as Sankey diagrams, were also identified from the review. Countries are using material flow accounting indicators in their sustainable development strategies – for example, Sweden.

This study aims to tailor the methodology in the Eurostat guide to suit the Irish situation. This study has also demonstrated the use of the Eurostat methodology to prepare fossil fuel accounts and to make a first attempt at total material accounts for Ireland. Therefore much of the Eurostat guide has been used in developing an material flow accounting methodology for Ireland. However, individual country-level material flow accounting methodologies have been reviewed for:

- Additional guidance and implementation experiences

- Assistance in the identification of the key parameters, and

- Information on experiences with regional rather than economy-wide material flows.

## 2.2 Software Review

Nine suites of software were identified and examined. Where demonstration versions were available, these were obtained and tested.

The types of software packages that have been reviewed can be broken down into two main categories:

1. Those that perform calculations and illustrate results

2. Those that illustrate results only.

The calculation/illustration software packages are less suitable for national and regional flow accounts and more suitable to company-level material flows. They go into a level of calculation and detail that is not necessary/applicable for national or regional material flow accounting.

Illustration-only packages can be useful to illustrate the results of material flow accounting while the actual material flow accounting data are stored in a package such as Microsoft Excel. This has been borne out by the fact that MFAs for a number of other countries are compiled in Excel. One such package was chosen for the illustration of the Irish methodology.

# 3     Draft Irish Methodology for the Generation of MFAs

A draft methodology has been developed and recommended to be employed for conducting material flow accounts and balances for Ireland for all materials. This methodology is later demonstrated in the fossil fuels case study (Section 4). A preliminary estimate of MFAs for Ireland for all materials is also attempted using the methodology (Section 6). The methodology is based on the Eurostat guidelines. For the river basin case study (Section 5), a modification of the method is used, since several terms and aspects of the methodology do not apply at a local (i.e. non-national) level.

The main aspects of the recommended methodology are described in this section.

## 3.1     Material Flow Accounting Inputs and Outputs

Figure 3.1 shows the inputs and outputs that should be used in national material flow accounting, while Fig. 3.2 shows more detail on each of the inputs and outputs that should be considered as part of the methodology. Each of the terms is described and explained in the Main Report.

## 3.2     Data Sources for Irish Material Flow Accounting

Data sources for Irish material flow accounting are shown in Fig. 3.3.

## 3.3     Identification of Indicators

Material flow accounting indicators are divided into three different categories, namely input, output and consumption indicators. As well as tonnes, these indicators are often expressed on a kg per capita basis.

A list of input and output indicators and their relationships are as follows (Fig. 3.4):

### 3.3.1     *Input indicators*

- DMI (Direct Material Input) = domestic extraction + imports

- TMI (Total Material Input) = DMI + unused domestic extraction

- TMR (Total Material Requirement) = TMI + hidden flows (imports)

DMI is an illustration of the mass of actual material that goes into the Irish economy. It includes material that will be consumed within Ireland, as well as other materials that will go into products and ultimately be exported. TMR is also a measure of the amount of material that goes into the Irish economy, but it includes not just the actual material itself, but the amount of unused material associated with its extraction or production, both in the State and abroad. For all three of these indicators, reducing their value (in tonnes or in tonnes/capita), while maintaining or increasing fiscal activity, is to move in the direction of sustainability.



**Figure 3.1. Inputs and outputs that should be used in national material flow accounting.**

**INPUTS**

**Domestic extraction**
- Fossil fuels
- Minerals
- Biomass

**Imports**
- Raw materials
- Finished products
- Semi-manufactured products
- Packaging on products
- Waste

**Unused domestic extraction**
- Fossil fuel extraction
- Mineral mining/quarrying
- Harvesting losses
- Soil excavation
- Dredging

**Hidden flows (imports)**
- Raw material equivalent (e.g. transport fuel)
- Unused extraction abroad

**Irish Economy**

**OUTPUTS**

**To environment:**
- Used material
  - Air
  - Water
  - Landfill
  - Dissipative products/losses (e.g. fertiliser use)

**To environment:**
- Unused domestic extraction

**Exports**
- As per inputs

**Hidden flows (exports)**
- Raw material equivalent (e.g. transport fuel)
- Unused extraction

**Net addition to stock**
- Infrastructure
- Durable goods
- Material stocks

**Figure 3.2. Detailed inputs and outputs that should be considered as part of the methodology.**

**INPUTS**

**Domestic extraction**
- fossil fuels (*CSO*)
- minerals (*CSO*)
- biomass (*CSO, Teagasc/ Coillte/BIM*)

**Imports**
- Raw materials (*CSO*)
- Finished products (*CSO*)
- Semi-manufactured products (*CSO*)
- Packaging on products (*Repak*)
- Waste (*Not applicable*)

**Unused domestic extraction**
- Fossil fuel extraction
- Mineral mining/quarrying
- Harvesting losses
- Soil excavation
- Dredging

**Hidden flows (imports)** *see text*
- Raw material equivalent (e.g. transport fuel)
- Unused extraction abroad

**Irish Economy**

**OUTPUTS**

**To environment:**
Used material
- Air (*EPA emissions inventories Respiration $CO_2$ by calculation*)

- Water (*EPA IPC/waste licence records; LA licencees; LA abstractions & discharges (in future: RBD data)*)

- Landfill (*EPA waste database/licencees*)
- Dissipative products
  Agri-product use (seeds, pesticides, manure, etc.)(*Teagasc/ Coillte*)
  Sewage sludge (*LA sludge registers; EPA*)
- Dissipative losses
  Natural gas distribution (*Bord Gais*)

**To environment:**
Unused domestic extraction

**Exports**
- Raw materials (*CSO*)
- Finished products (*CSO*)
- Semi-manufactured products (*CSO*)
- Packaging on products (*Repak*)
- Waste (*EPA waste database/waste licensing*)

**Hidden flows (exports)** *see text*
- Raw material equivalent (e.g. transport fuel)
- Unused extraction

**Net addition to stock**
- Infrastructure
- Durable goods
- Material stocks

**Figure 3.3. Data sources for Irish material flow accounting.**

**INPUTS**

**OUTPUTS**

**Domestic extraction**
• Fossil fuels
• Minerals
• Biomass

**Imports**
• Raw materials
• Finished products
• Semi-manufactured products
• Packaging on products
• Waste

**Unused domestic extraction**
• Fossil fuel extraction
• Mineral mining/quarrying
• Harvesting losses
• Soil excavation
• Dredging

**Hidden flows (imports)**
• Raw material equivalent (e.g. transport fuel)
• Unused extraction abroad

**To environment:**
• Used material
  • Air
  • Water
  • Landfill
  • Dissipative products/losses (e.g. fertiliser use)

**To environment:**
• Unused domestic extraction

**Exports**
• Raw materials
• Finished products
• Semi-manu. products
• Packaging on products
• Waste

**Hidden flows (exports)**
• Raw material equivalent (e.g. transport fuel)
• Unused extraction

**Net addition to stock**
• Infrastructure
• Durable goods
• Material stocks

DMI  TMI  TMR  DPO  TDO  DMO  TMO

**Figure 3.4. Input and output material flow accounting indicators and their relationships.**

### 3.3.2   *Output indicators*

• DPO (Domestic Processed Output) = used material emitted to the environment

• TDO (Total Domestic Output) = DPO + unused extraction

• DMO (Direct Material Output) = DPO + exports

• TMO (Total Material Output) = TDO + exports

DPO illustrates the quantity of material that is discharged into the Irish environment after it has been used in the Irish economy (e.g. carbon dioxide emissions from the burning of fuel). TDO also takes into account material that is extracted in Ireland but is never actually used in an economic sense (e.g. natural gas losses during drilling). For all four of these indicators, reducing their value (in tonnes or in tonnes/capita), while maintaining or increasing fiscal activity, is to move in the direction of sustainability.
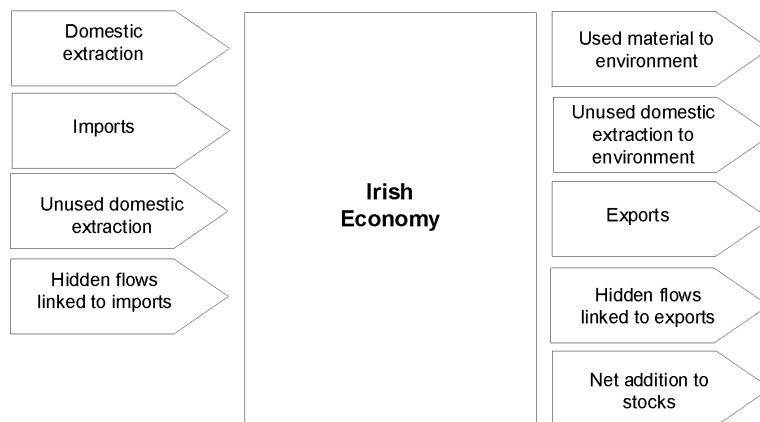
Material flow accounting consumption indicators and the basis of their calculation are shown in Fig. 3.5.
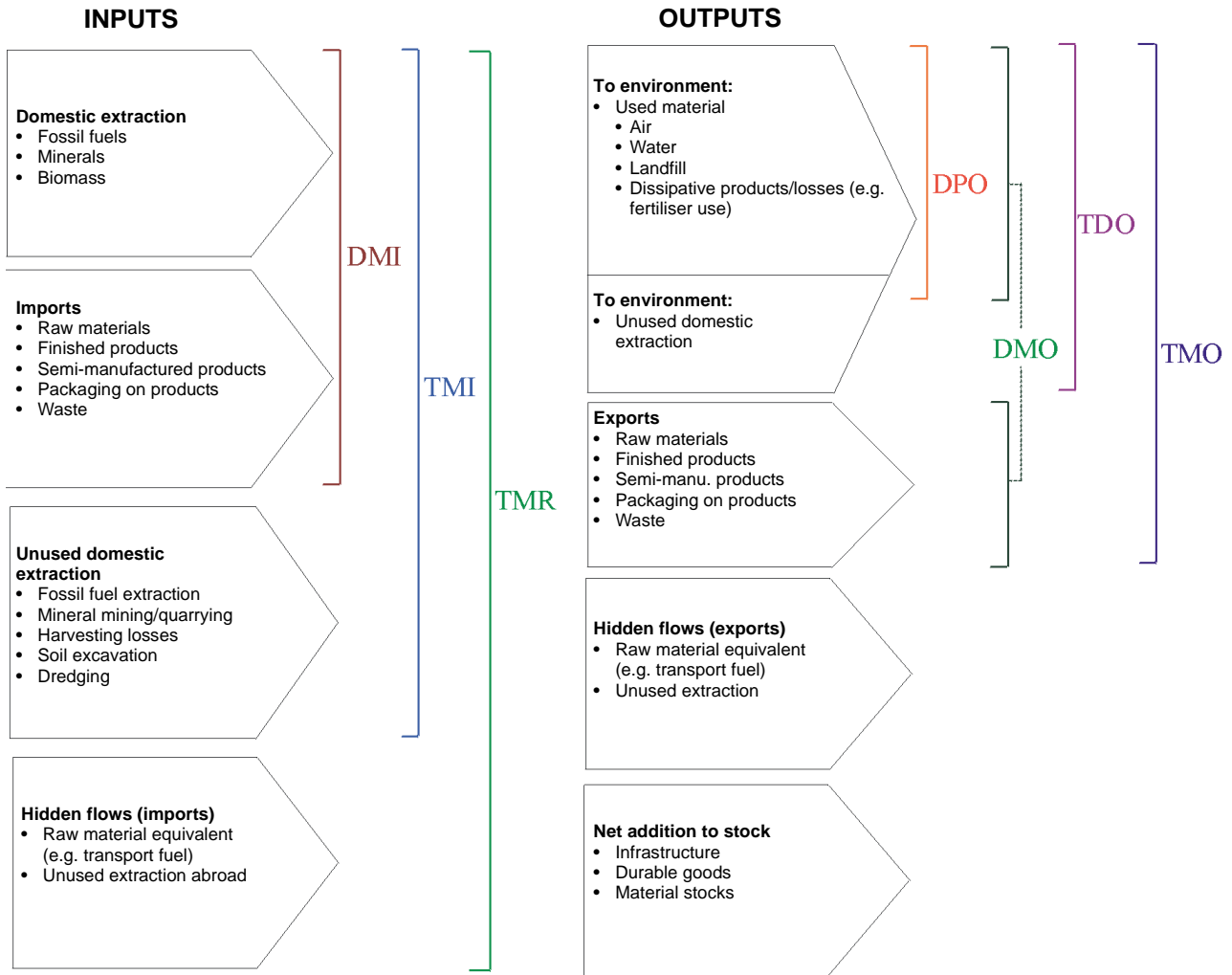
### 3.3.3   *Consumption indicators*

• DMC (Domestic Material Consumption) = DMI – exports

• TMC (Total Material Consumption) = TMR – exports – hidden flows (exports)

• PTB (Physical Trade Balance) = imports – exports
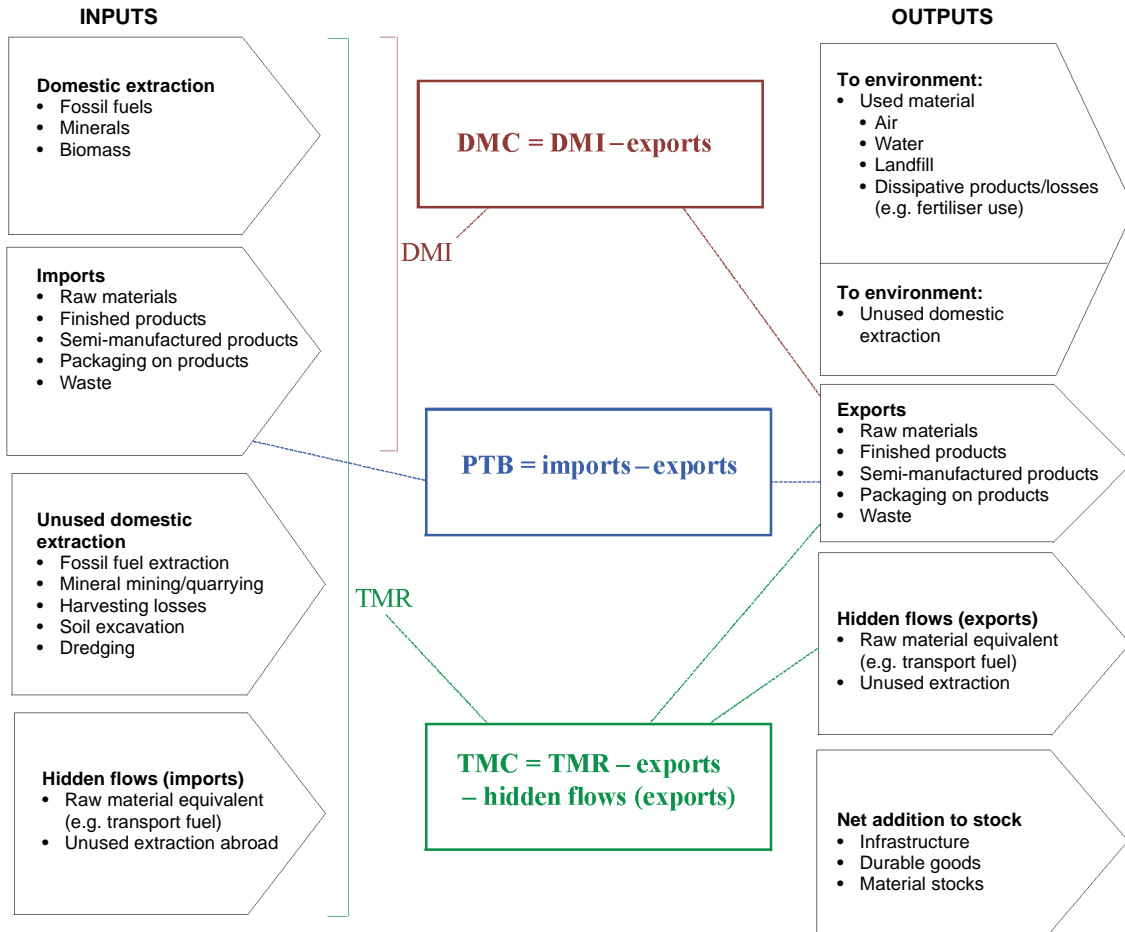
• NAS (Net Addition to Stock).

INPUTS

**Domestic extraction**
- Fossil fuels
- Minerals
- Biomass

**Imports**
- Raw materials
- Finished products
- Semi-manufactured products
- Packaging on products
- Waste

**Unused domestic extraction**
- Fossil fuel extraction
- Mineral mining/quarrying
- Harvesting losses
- Soil excavation
- Dredging

**Hidden flows (imports)**
- Raw material equivalent (e.g. transport fuel)
- Unused extraction abroad

DMI

TMR

$$DMC = DMI - exports$$

$$PTB = imports - exports$$

$$TMC = TMR - exports - hidden\ flows\ (exports)$$

OUTPUTS

**To environment:**
- Used material
  - Air
  - Water
  - Landfill
  - Dissipative products/losses (e.g. fertiliser use)

**To environment:**
- Unused domestic extraction

**Exports**
- Raw materials
- Finished products
- Semi-manufactured products
- Packaging on products
- Waste

**Hidden flows (exports)**
- Raw material equivalent (e.g. transport fuel)
- Unused extraction

**Net addition to stock**
- Infrastructure
- Durable goods
- Material stocks

**Figure 3.5. Material flow accounting consumption indicators and the basis of their calculation.**

# 4 Demonstration of Methodology: Case Study – National Fossil Fuel Flow Accounts

The first of two case studies involved the demonstration of the material flow accounting methodology and generation of MFAs and associated indicators for fossil fuels used in Ireland.

The outcome of this task is a set of physical accounts for fossil fuels used in Ireland for the years 2000, 1996, and 1990. It covers fossil fuel inputs, uses in various sectors, and associated emissions. The results of the MFAs for fossil fuels in Ireland for the year 2000 are shown in Table 4.1. There are similar tables for 1996 and 1990.

The results have been summarised in a set of Excel files. Figure 4.1 illustrates the fossil fuel MFAs for the year 2000 in the form of a Sankey diagram. The size of the arrow is proportional to the magnitude of each of the flows. This diagram has been generated using S.Draw.

Input, output and consumption indicators have also been calculated. The Irish Indicators have been compared with those of other countries. These comparisons are summarised in the following section.

**Table 4.1. Material flow accounts for fossil fuels in Ireland for the year 2000 (data in '000 tonnes).**

| Input | | | Output | | | |
|---|---|---|---|---|---|---|
| **Domestic extraction** | | **5,385** | **To environment (used material)** | | | **42,154** |
| Peat | 4,455 | | To air | $CO_2$ | 41,239 | |
| Natural gas | 930 | | | $N_2O$ | 5 | |
| **Imports** | | **13,967** | | $CH_4$ | 5 | |
| Hard coal | 2,929 | | | $SO_2$ | 131 | |
| Lignite | 33 | | | $NO_x$ | 122 | |
| Peat | 0 | | | $NH_3$/VOC | 45 | |
| Liquid fossil fuels | 8,598 | | | CO | 275 | |
| Natural gas | 2,406 | | To land | ash | 331 | |
| **Unused domestic extraction** | | **1,237** | To water | N, P | 0 | |
| Peat | 1,114 | | **To environment (unused extraction)** | | | **1,237** |
| Natural gas | 124 | | Peat | | 1,114 | |
| **Hidden flows (imports)** | | **8,715** | Natural gas | | 124 | |
| Hard coal | 7,595 | | **Exports** | | | **1,193** |
| Lignite | 283 | | Hard coal | | 9 | |
| Peat | 0 | | Lignite | | 0 | |
| Liquid fossil fuels | 558 | | Peat | | 18 | |
| Natural gas | 280 | | Liquid fossil fuels | | 1,166 | |
| **Oxygen (for balancing)** | | **29,992** | Natural gas | | 0 | |
| | | | **Hidden flows (exports)** | | | **211** |
| | | | Hard coal | | 8 | |
| | | | Lignite | | 0 | |
| | | | Peat | | 5 | |
| | | | Liquid fossil fuels | | 198 | |
| | | | Natural gas | | 0 | |
| | | | **Net addition to stock** | | | **65** |

2000, all weights in '000 tonnes, numbers factored down by 0.1
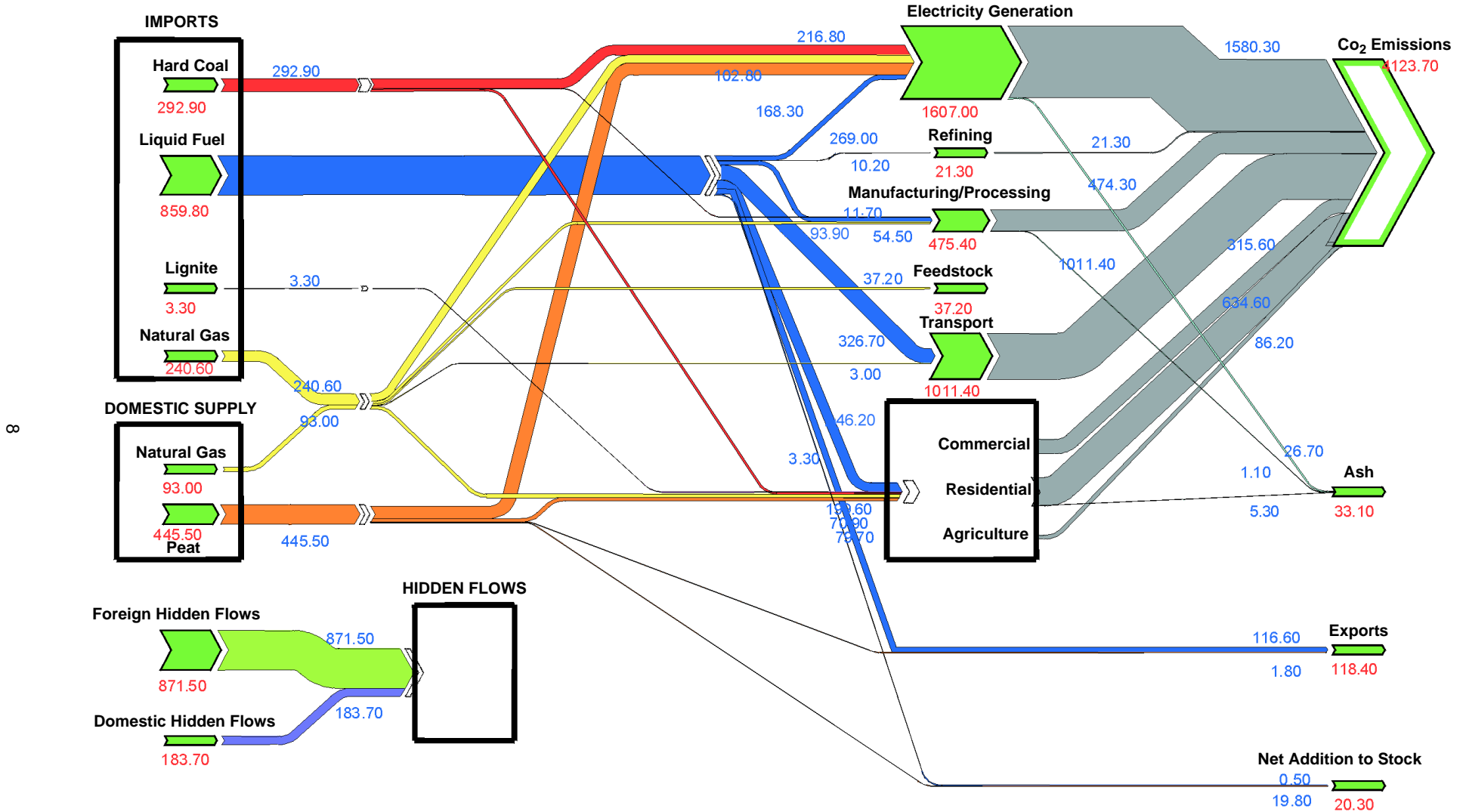
Figure 4.1. The fossil fuel material flow accounts for the year 2000.

*E. O'Leary and D. Cunningham, 2001-EEO/DS-(1/1)*

## 4.1 Irish DMI and DMC – Country Comparison

Table 4.2 illustrates the results of the fossil fuel case study and compares it with certain indicators recently compiled for each of the Member States based on European and international statistics (Jan 2003).

Ireland is above the EU average for DMI. This means that the per capita input of fossil fuels from imports and domestic extraction into Ireland's economy is somewhat higher than the EU average.

Ireland is well below the EU average for TMI and TMR for fossil fuels. This means that, taking the unused extraction associated with domestic and imported fossil fuels into account, as well as the fossil fuel input into the economy, Ireland is well below the EU average. This implies that the unused extraction associated with Ireland's domestic extraction and imports is low in comparison with other Member States. While a detailed breakdown on the sources of the EU figures is not available, one reason for this significant difference is likely to be the limited amount of domestic extraction of fossil fuels which occurs in Ireland, which is virtually all used in the Irish economy. Conversely, some EU Member States would have significant fossil fuel domestic extraction, which would increase both the TMI and TMR figures, because these indicators do not subtract exports, or hidden flows associated with exports.

Ireland's position relative to other EU countries in terms of DMI, Direct Material Input (domestic extraction plus imports) and DMC, Domestic Material Consumption (domestic extraction plus imports minus exports) is illustrated in Fig. 4.2 (overleaf).

As can be seen, Ireland is joint fifth highest out of all EU countries in terms of DMC. This means that Ireland has the fifth highest fossil fuel consumption per capita in the EU.

**Table 4.2. Results of the fossil fuel case study compared to European statistics.**

|  | As calculated in this project | | | ETC-WMF calculation[1] | | |
|---|---|---|---|---|---|---|
|  | **2000** | **1996** | **1990** | **2000** | **1996** | **1990** |
| **Irish fossil fuel extraction ('000 tonnes)** | 5,385 | 7,629 | 8,324 | 6,107 | 7,230 | 8,456 |
| **Irish fossil fuel imports ('000 tonnes)** | 13,967 | 10,841 | 9,025 | 12,478 | 9,639 | 8,595 |
| **Irish fossil fuel DMI ('000 tonnes)** | 19,352 | 18,471 | 17,349 | 18,585 | 16,869 | 17,051 |
| **Irish fossil fuel DMI (tonnes/capita)** | 5.1 | 5.1 | 4.9 | 4.9 | 4.6 | 4.9 |
| **Irish fossil fuel DMC ('000 tonnes)** | 18,159 | 17,565 | 16,742 | 16,734 | 15,275 | 15,863 |
| **Irish fossil fuel DMC (tonnes/capita)** | 4.8 | 4.8 | 4.7 | 4.4 | 4.2 | 4.5 |

[1]Input from the European Topic Centre on Waste and Material Flows (ETC-WMF) into the Kiev report – Moll 2003 Datasheet http://waste.eionet.eu.int/mf/4.

## DMI Fossil Fuels (tonnes per capita) 2000

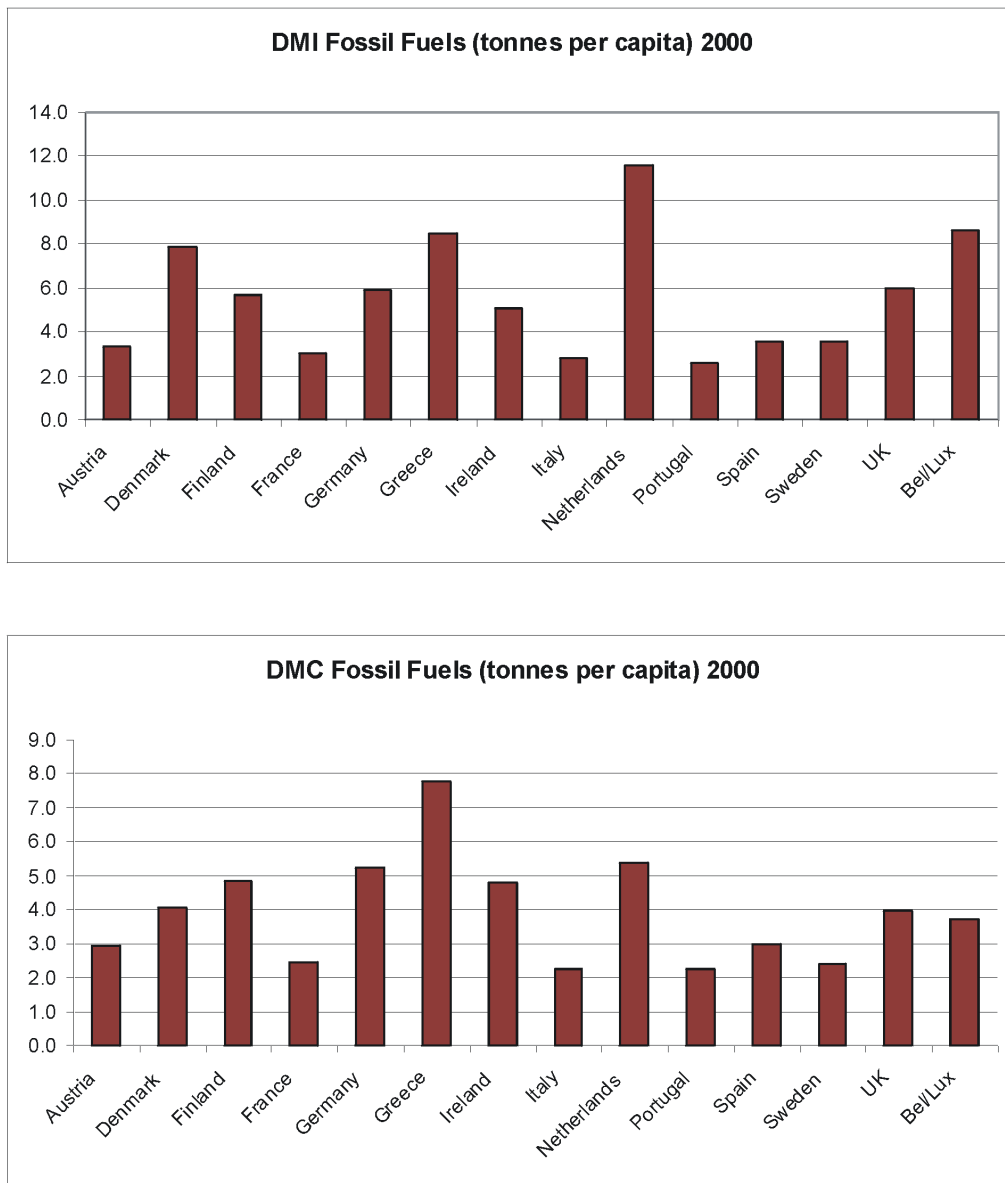## DMC Fossil Fuels (tonnes per capita) 2000

**Figure 4.2. Ireland's position relative to other EU countries in terms of DMI and DMC.**

# 5 Demonstration of Methodology: Case Study – Regional Water Flow Accounts

The second of two case studies involved the demonstration of the material flow accounting methodology and generation of water flow accounts for a particular region within Ireland.

Ireland has been divided into five river basin districts (RBDs) for the implementation of the Water Framework Directive. The South Eastern River Basin District (SERBD) is the region that is furthermost along in implementation of the Directive since it was the first SERBD project launched. Hence, this is the RBD chosen for demonstration of water flow accounts.

The SERBD covers the combined river basins of the Rivers Slaney, Barrow, Nore and Suir, as well as a number of other smaller rivers near the coast. Counties Carlow, Kilkenny, Laois, Tipperary South, and Wexford

are included in this RBD, as well as parts of Kildare, Offaly, Tipperary North, Waterford, Wicklow and a very small part of Limerick.

All water flows into and out of the RBD are taken into account in drawing up the water flow accounts. This includes both natural and anthropogenic flows of water. The boundary for the water flow accounts consists of the geographical area of the RBD as well as flows into and out of waterbodies within the RBD itself. A schematic of the RBD and associated flows is shown in Fig. 5.1 below.

Where data were available, each of these flows was determined and the overall MFAs presented in the form of a Sankey diagram. A Sankey diagram is shown in Fig. 5.2 overleaf.
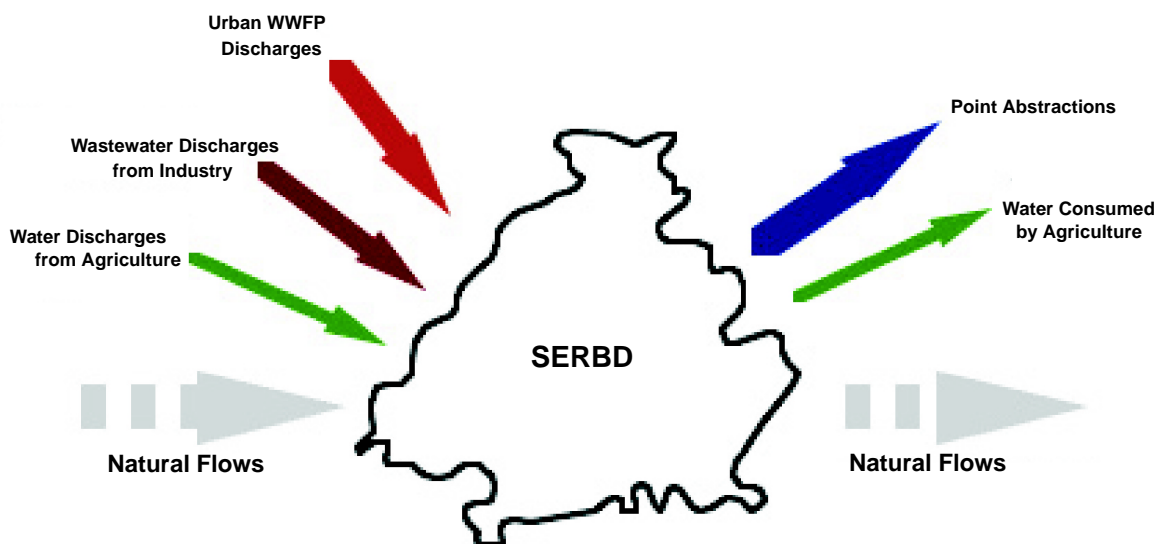
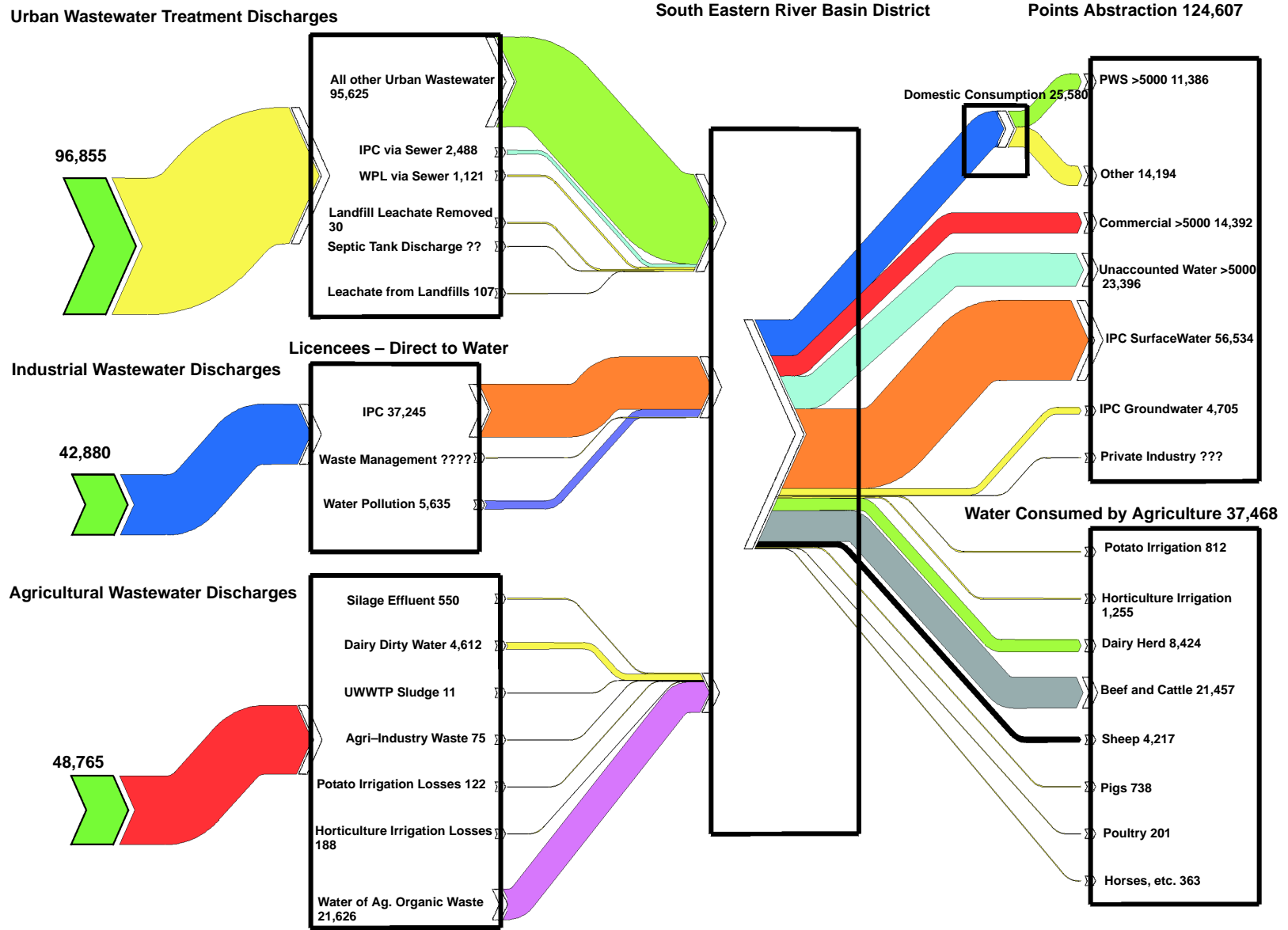

**Figure 5.1. A schematic of the RBD and associated flows.**

**Figure 5.2. Sankey diagram depicting the MFAs of the SERBD.**

# 6 Total Material Flows in Ireland

The data sources available for calculating flows of all materials in Ireland have been assessed and an initial estimate of such flows made – where data availability permits.

In addition to data gaps and data reliability, comments are made in the Main Report in relation to any differences between national sources of data and data that have been used in Eurostat estimates of material flows and indicators for Ireland, for example data from the FAO (Food and Agricultural Organisation of the UN).

Data sources, data gaps and data reliability have been examined for the following areas of the Irish material flow scenario:

- Domestic extraction

  ○ Agricultural biomass

  ○ Biomass from fishing

  ○ Biomass from forestry

  ○ Fossil fuels

  ○ Minerals

- Imports and exports (bar fossil fuels which are covered in Section 4)

- Unused domestic extraction

  ○ Harvesting losses

  ○ Fossil fuels

  ○ Minerals

- Material outputs to the environment

  ○ Landfill

  ○ Air

  ○ Water

  ○ Dissipative use of products

A preliminary estimate of total material flows in Ireland for the year 2000 is shown in Table 6.1.

**Table 6.1. A preliminary estimate of total material flows in Ireland for the year 2000 (NE, not estimated).**

| Inputs | '000 tonnes | | Outputs | '000 tonnes | |
|---|---|---|---|---|---|
| **Domestic extraction** | | **107,419** | **To environment – used material** | | **119,494** |
| Biomass | 64,293 | | Air | 47,059 | |
| Fossil fuels | 5,385 | | Landfill | 8,278 | |
| Minerals | 37,741 | | Water | – | |
| **Imports** | | **44,487** | Dissipative product use | 64,158 | |
| Fossil fuels | 13,967 | | Dissipative losses | NE | |
| All other materials/products | 30,452 | | **To environment – unused domestic extraction** | | **11,699** |
| Waste | 68 | | Fossil fuel extraction | 1,237 | |
| **Unused domestic extraction** | | **11,699** | Mineral mining/quarrying | NE | |
| Fossil fuel extraction | 1,237 | | Harvesting losses | 10,462 | |
| Mineral mining/quarrying | NE | | Soil excavation | NE | |
| Harvesting losses | 10,462 | | Dredging | NE | |
| Soil excavation | NE | | **Exports** | | **13,686** |
| Dredging | NE | | All other materials/products | 11,986 | |
| **Hidden flows (imports)** | | **NE** | Fossil fuels | 1,193 | |
| Biomass | NE | | Waste | 508 | |
| Fossil fuels | 8,715 | | **Hidden flows (exports)** | | **NE** |
| Minerals | NE | | Biomass | NE | |
| **Items for balancing** | | **29,992** | Fossil fuels | 211 | |
| Oxygen for combustion | 29,992 | | Minerals | NE | |
| | | | **Net addition to stock** | | **NE** |
| | | | Infrastructure | NE | |
| | | | Durable goods | NE | |
| | | | Material stocks | 65 | |

Based on these flows, preliminary estimates of certain indicators for the same year have been made. These are shown in Table 6.2.

When compared to other countries, the Irish estimates of DMI and DMC are at the upper end. See Tables 6.3 and 6.4.

This shows that Ireland has a stronger connection between material resource use and economic activity than other EU countries. However, not all of the estimates for the other countries include the same extent of products

as have been included in the Irish figure in this study (see discussion in the Main Report Section 6.7.3). DMI is an illustration of the weight of actual material that goes into the Irish economy. It includes material that will be consumed within Ireland, as well as other materials that will go into products and ultimately be exported, whereas DMC is an illustration of the weight of actual material that is consumed within Ireland. Reducing the values of DMI and DMC, while maintaining or increasing fiscal activity, is to move in the direction of sustainability.

**Table 6.2. Preliminary estimates of certain indicators in Ireland for the year 2000.**

| Indicators | | | '000 tonnes 2000 | tonnes/capita 2000 |
|---|---|---|---|---|
| **DMI**[1] | (Direct Material Input) | Domestic extraction + imports | 151,906 | 39.0 |
| **DMC**[2] | (Domestic Material Consumption) | DMI – exports | 138,220 | 35.5 |
| **PTB**[3] | (Physical Trade Balance) | Imports – exports | 30,800 | 7.9 |
| **DPO** | (Domestic Processed Output) | Used material flows to the environment | 119,494 | 30.7 |
| **DMO** | (Direct Material Output) | Used material flows to the environment + exports | 133,181 | 34.2 |

[1]DMI, a measure of how much material is input into the Irish economy.
[2]DMC, a measure of how much material is consumed in Ireland.
[3]PTB, a measure of whether an economy is a net importer or a net exporter of materials.

**Table 6.3. DMI for EU Member States.**

| | DMI tonnes/capita |
|---|---|
| **Norway** | 60.2 |
| **Finland** | 42.3 |
| ***Ireland*** | *39.0* |
| **Belgium/Luxembourg** | 34.7 |
| **Denmark** | 30.8 |
| **Sweden** | 28.3 |
| **Netherlands** | 26.3 |
| **Austria** | 22.8 |
| **Germany** | 21.1 |
| **Spain** | 19.2 |
| **France** | 18.7 |
| **Greece** | 18.1 |
| **EU15** | 16.8 |
| **Portugal** | 16.0 |
| **United Kingdom** | 14.9 |
| **Italy** | 14.6 |

**Table 6.4. DMC for EU Member States.**

| | DMC tonnes/capita |
|---|---|
| ***Ireland*** | *35.5* |
| **Finland** | 35.5 |
| **Denmark** | 22.7 |
| **Sweden** | 21.3 |
| **Austria** | 18.1 |
| **Germany** | 17.8 |
| **Spain** | 16.8 |
| **Belgium/Luxembourg** | 16.6 |
| **Greece** | 15.9 |
| **EU15** | 15.6 |
| **France** | 15.3 |
| **Portugal** | 14.5 |
| **Netherlands** | 12.9 |
| **Italy** | 12.6 |
| **United Kingdom** | 11.6 |
| **Norway** | 11.5 |

# 7 Evaluation and Recommendations

## 7.1 Applicability of MFAs in Ireland

The whole concept of MFAs is embedded in the principles of measurement and reporting. A concerted effort should be made to improve the quality of data, and to enhance their transparency. The continuing evaluation and improvement of data must work in conjunction with performance improvement measures (prevention, recycling, etc.). All countries recognise the need for sets of indicators and tools for data gathering and evaluation in order to improve environmental performance. In order to have any hope of achieving sustainable development, economic growth must be decoupled from other factors, such as resource consumption and waste generation (the so-called Factor 10+ approach). MFAs provide a mechanism for the measurement and reporting of such resource and waste flows. In order for Ireland to effectively compete in terms of environmental performance, it must develop comprehensive sets of MFAs. These allow priority areas for action to be identified – just as national fiscal accounts facilitate the prioritisation of economic measures.

MFAs provide a basis for policy decisions, and for the framing of environmental improvement programmes. As a simple – if obvious – example, MFAs might show an over-dependence in Ireland on the use of fossil fuels. This might then lead to increased measures for the promotion of renewable energy. Many individual company environmental audits have identified areas of resource use or waste production which are far greater than had been thought or anticipated. These audits allowed specific areas to be targeted for reduction. The same is true for all areas of anthropogenic activity. Until a comprehensive set of national and material-specific accounts is generated, it is not possible to know, with any certainty, where best to apply resources and to prioritise action policies. Economic policies are set with regard to economic indicators (GDP, GNP, etc.). The monetary flow through society has been much analysed. In a similar manner, the environmental policies of the future must be based on evaluation of the material and energy flows.

It is essential to decouple economic and material intensity. To do this requires an ongoing and accurate evaluation of material and energy flows. It should be a long-term aim to produce economic flows in conjunction with material flows. This will facilitate the decoupling process.

It is recommended that any future MFAs for Ireland on a national level follow the Eurostat methodology. There are certain areas, as outlined in Section 6 of the Main Report, where the preliminary figures for total material flows should be refined and the estimation methods improved.

### 7.1.1 Conclusions regarding material flow accounting applicability in Ireland

The following conclusions can be drawn in relation to the applicability of material flow accounting in Ireland:

- National total material flows are a key input into international and, in particular, European reporting protocols (for example, the Kiev Report). Many countries have been engaged in such accounting for several years. Ireland needs to develop a well-defined set of MFAs to meet reporting requirements.

- In addition to national total material flows for Ireland, there are a number of areas where the methodology could be applied, including:

  ○ Specific stream accounts (packaging, wastes, plastics, WEEE, etc.). (This should be based on prioritisation of important streams.)

  ○ Sector-specific MFAs – preferably by NACE sector. (This should be accompanied by prioritisation of important sectors.)

  ○ Regional MFAs. In particular, some pilot studies should be carried out to determine the typical 'ecological footprint' of different types of region (urban – small and large, rural, semi-rural).

  ○ Waste management facilities.

  ○ Industrial sites (voluntary exemplars could be used for a baseline study – wherein material and energy balances, normally presented under IPPC licensing reporting requirements could be evaluated in a different way).

The examples above would form part of a comprehensive set of accounts, which can form the basis for decision making. A parallel can be drawn with the production of the

National Waste Database (NWD) by the Environmental Protection Agency. The data in the NWD are used to determine the prioritisation of appropriate actions. There is, however, a constant need to improve the methodology of data collection and the reliability of data (hence the undertaking of waste characterisation studies). MFAs represent an additional tool, which can provide additional and alternative data and information. MFAs need to be piloted, methodologies developed and comprehensively applied. The information so gathered can aid with the development of programmes and activities to reduce the environmental footprint of Ireland.

The overall aim (in a medium term – 5- to 10-year scenario) should be to present a hierarchy of data. This would feed from:

- Overall national accounts for specific streams

- Regional accounts

- Sector-specific accounts

- Site-specific accounts

- Waste and energy management.

All of the above could feed into the various reporting requirements (international protocols, European requirements, national reporting requirements such as the State of the Environment Report, the National Waste Database, etc.).

## 7.2 Recommendations for Future Data Sourcing and Further MFA Generation

### 7.2.1 Data Sourcing

The following is a list of recommendations in relation to future data sourcing for total material flows for the Irish economy:

- There are a number of data gaps in relation to material flows in Ireland, in particular some of the domestic extraction data. Some of the initial estimates in Section 6 should be refined through contact with the industries involved. It should be noted that other countries have also experienced similar problems in obtaining data.

- In relation to hidden flows, national material flow accounting carried out elsewhere in the main tend to use international factors. It may be more appropriate

to generate specific factors for the Irish situation for some of the major flows.

- The concept of confidential information constitutes a barrier to information gathering. Whilst it is recognised that financial confidentiality has a role to play in a competitive market, it should be possible for government and state organisations to provide information which will simultaneously provide statistical information and protect economic interest.

### 7.2.2 Future MFA generation

It is recommended that MFAs be produced on an ongoing basis. This might best fit under the auspices of the National Waste Prevention Programme, since the production of MFAs can assist with prioritisation of prevention and reduction initiatives and programmes.

As outlined in Section 7.1.1, MFAs should be produced at several levels. These are as follows:

- **National Level**: accounts for specific waste streams would allow better compliance with EU Directives and international protocols. Examples include:

  - Solvent accounts (Solvents Directive)

  - WEEE accounts (WEEE Directive)

  - Greenhouse gas and climate change gas accounts (these are already reported under a different format, but a material flow accounting approach may be informative)

  - Packaging accounts (national targets).

- **Sector Level:** sector-specific accounts can facilitate sectoral reduction measures. Examples might be:

  - Agriculture

  - Food

  - Hospitality

  - Various industrial sectors.

- **Site Level:** site-specific accounts should be encouraged. This merely represents a sophistication in the type of data presented under AERs, PERs, etc.

The various MFAs could be produced on an ongoing basis under the auspices of the EPA. This would be similar to current EPA data production work – such as the National Waste Database, SNAP Sector 6 reporting, etc. In the past, the EPA has carried out some of this work itself, and

has subcontracted some of it. A similar scenario can be envisaged with MFAs. As stated above, the work might fit neatly into the programmes of the National Waste Prevention programme.

It is recommended that any future MFAs for Ireland on a national level follow the Eurostat methodology. There is more flexibility in the methods and approaches that can be used for accounts at levels other than the national level.

## 7.3 Implications for Irish Policies

Ireland is fully committed to the principles of Sustainable Development, and to the various international protocols on reporting, emissions reductions, etc. In order to effectively comply with our obligations, policy makers require the most comprehensive and comprehensible information possible. It is hard to imagine the formulation of economic policy without any economic information. In a like manner, the formulation of the best, most relevant, and most effective environmental policies requires high quality information and data. MFAs represent a mechanism towards achieving this.

Furthermore, development of a material flow accounting methodology could be such that economic and other flows are also incorporated. In this way, it should be clearer where policy improvements could best be applied to allow economic growth at the lowest environmental and social cost. These are the basic tenets of Sustainable Development.

Some implications for Irish policies include the following:

• The use of the Sankey illustration tool could be applicable for presenting a wide range of environmental data. Whilst it may appear that Sankey – being only a method of representing results – has no direct policy relevance, the clarity of the information presented makes it much easier to envisage problem areas, etc. Thus, there is an indirect benefit for the identification of priority areas for policy implementation.

• Policy decisions and planning can be based on an accurate representation of environmental flows (see above for the link between GDP and MFA, etc.).

• The formulation of future research programmes can be linked to information provision. It is possible to envisage a national development programme which evaluates economic, environmental, and social parameters in a similar manner, and which uses the results of all three to produce cogent policies and programmes consistent with the three pillars of Sustainable Development. Material flow accounting is an important tool in this regard. It is not sufficient to set development targets based on economic indicators alone, environmental targets based on environmental indicators alone, or social targets based on social indicators alone. All three must be integrated in order to ensure a National Sustainable Development Programme. The material flow accounting methodology represents a possibility to gather and present economic, environmental, and social information in the same format. This could greatly facilitate the development of holistic policies.

MFAs could be used to provide information which would allow better implementation of specific policies. Some examples include:

• Tracking of organic solvents to facilitate implementation of the Solvents Directive. This might involve import, use, discharge, losses, etc., of solvents in sectors such as dry-cleaning, vehicle refinishing, etc.

• Tracking of priority waste streams, such as tyres, WEEE, etc.

• Specific packaging streams for compliance with declared policies.

# References

Bringezu, S. and Schütz, H., 2001. *Total Material Requirement of the European Union*. Technical Report Nos 55 and 56, European Environment Agency.

Eurostat, 2001. E*conomy-wide Material Flow Accounts and Derived Indicators – A Methodological Guide*. Statistical Office of the European Union, Luxembourg.

# Glossary of Terms

For precise definitions of the mass balance terms in this report please refer to Section 3.3 (Identification of indicators).

| | |
|---|---|
| **DMC** | Domestic Material Consumption |
| **DMI** | Direct Material Input |
| **DMO** | Direct Material Output |
| **DPO** | Domestic Processed Output |
| **GDP** | Gross Domestic Product |
| **GHG** | Greenhouse Gas |
| **MFAs** | Material Flow Accounts |
| **NAS** | Net Addition to Stock |
| **NPV** | Net Production Value |
| **PIOT** | Physical Input Output Table |
| **PTB** | Physical Trade Balance |
| **RME** | Raw Material Equivalent |
| **SNA** | System of National Accounts |
| **TDO** | Total Domestic Output |
| **TMC** | Total Material Consumption |
| **TMI** | Total Material Input |
| **TMO** | Total Material Output |
| **TMR** | Total Material Requirement |
| **WRI** | World Resources Institute |