

Economy wide Material Flow Accounts (EW-MFA)

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- MFA in policy
- Guidelines, concepts and definitions
- Extraction
- Import and exports
- Domestic Processed Outputs
- (Raw material equivalents – Resource footprint)

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Introduction

- **MFA = material flow accounting**
- **Purpose:** to account for all relevant material flows within the economy, with the environment and the rest of the world
- In **physical units**
- Consistent with **System of national accounts**
- Policy relevant indicators
- Here focus is on **economy wide material flow accounts (EW-MFA)**:
 - 1) good starting point,
 - 2) relative easy to compile,
 - 3) most common,
 - 4) Provides key indicators on resource productivity

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MFA in environmental policies

EW-MFA feeds into several environmental policies:

→Decoupling policies: Flagship initiative „A resource-efficient Europe“

Circular economy initiatives

→Indicators are under discussion

Sustainable Development Goals (SDGs)

08 Decent Work and Economic Growth (resource efficiency; decoupling)

12 Responsible Consumption a. Production (sust. management, res. efficiency)

→Indicators:
Material footprint (MF)
Domestic material consumption (DMC)
per capita and per GDP



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MFA provides headline indicators on ...

- **Patterns of resource use:** how many and what kind of materials do we use? why and how do economies vary in their metabolic patterns?
- **Trends and resource productivity:** how does material use develop over time and in relation to economic development? Do we find dematerialisation?
- **Globalisation:** how is resource extraction, industrial production and final consumption distributed around the globe? Is resource use in industrialized countries declining due to externalisation?
- **Circular economy:** what fraction of resource inputs is released into the environment within one year? Is recycling successfully substituting for primary resource inputs?

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Guidelines



- **SEEA-CF, 2012**, chapter 3: Physical flow accounts, chapter 3.3.6 Economy Wide – Material Flow Accounts (EW-MFA)
- **Eurostat, 2017**, Economy Wide – Material Flow Accounts (EW-MFA) – compilation guide.
- **OECD, 2008**, Measuring material flows volume 1 to 4.

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MFA in SEEA CF

- Describe all material flows
 - a) from the environment to the economy,
 - b) within the economy,
 - c) from the economy to the environment
- In physical units (kg)
- Physical supply and use tables

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Supply table						
Natural inputs					Flows from the environment	Total supply of natural inputs
Products	Output			Imports		Total supply of products
Residuals	Residuals generated by industry	Residuals generated by final household consumption	Residuals from scrapping and demolition of produced assets			Total supply of residuals
Use table						
Natural inputs	Extraction of natural inputs					Total use of natural inputs
Products	Intermediate consumption	Household final consumption	Gross capital formation	Exports		Total use of products
Residuals	Collection and treatment of waste and other residuals		Accumulation of waste in controlled landfill sites		Residual flows direct to environment	Total use of residuals

Economy wide MFA

The purpose of economy-wide material flow accounts (EW-MFA) is to provide an aggregate overview, in tonnes, of the **material inputs and outputs of an economy**

Inputs

- Domestic extraction
- Imports

Outputs

- Domestic processed outputs (residuals, emissions)
- Exports

→ So no recording of flows within the economy, no allocation to ISIC

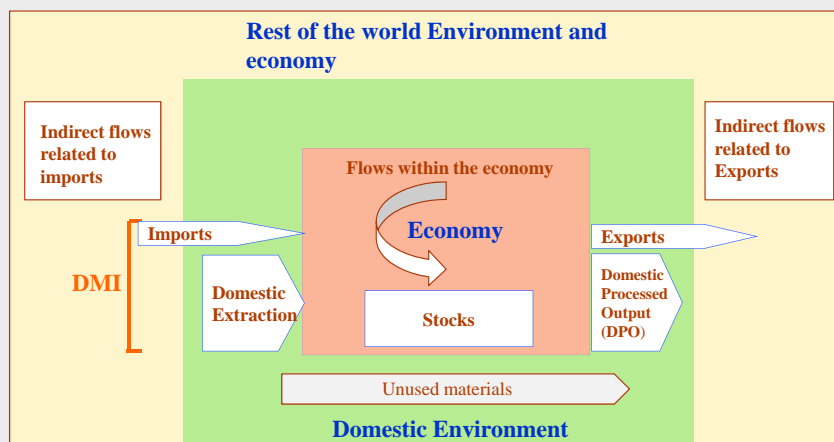
Some key characteristics of EW MFA

- **All material flows** (excl. water and air)
- **Measurement unit:** metric tons per year
- **System boundaries ...**
 - between the natural and the socio-economic system
 - DE = extraction or movement on purpose by human activity
 - DPO = materials on whose location, composition, transformation society loses control
 - between national economies : imports and exports
- **Stocks** within the socio-economic system:
 - Animal livestock (domestic)
 - Artefacts (buildings, infrastructure, machines, devices)
- **Flows** pass system boundaries
 - Inputs: domestic extraction; imports
 - Outputs: emissions, wastes, dissipative uses/losses; exports
- **Accounting identity:** inputs = outputs +/- stock changes

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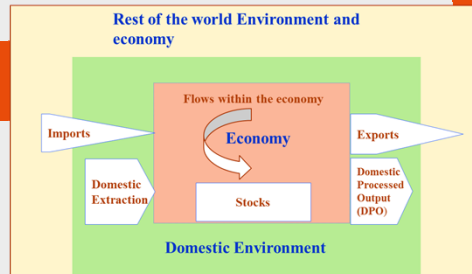
Concept: Material flow accounts



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EW MFA indicators



- **DMI** (Direct Material Input) = Domestic Extraction (DE) + Imports
- **DMC** (Direct Material Consumption) = DMI – Exports
- **PBT** (Physical Trade Balance) = Imports – Exports
- **DPO** (Domestic Processed Outputs) = air and water emissions, (waste disposal), dissipative uses and losses
- **RMC** (Raw Material Consumption = resource footprint) = DE + Imports in RME – Exports in RME
- **RP** (resource productivity) = : GDP/DMC or GDP/RMC

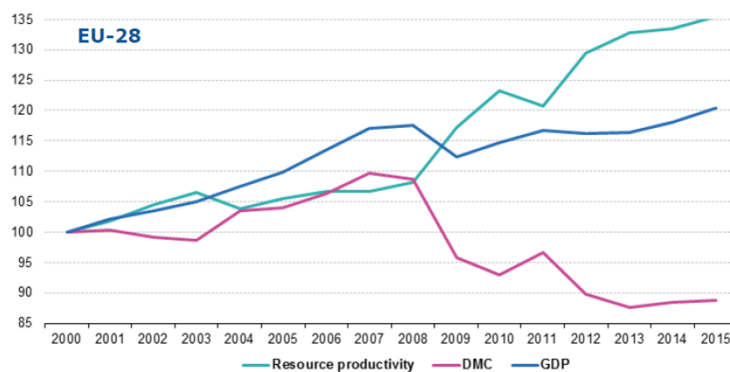
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Indicators for policy applications

Lead indicator: resource productivity

$$\text{Resource productivity} = \frac{\text{GDP}}{\text{Domestic material consumption}}$$



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Material categories

Biomass

- Crops, Fodder, fish
- Timber
- Products mainly from biomass

Fossil energy carriers

- Coal, peat, other solid energy resources
- Oil and gaseous energy products
- Products mainly from fossil energy

Metallic minerals

- Iron ores
- Non ferocious iron ores
- Products mainly from metals

Non-metallic minerals

- Non-metallic minerals, raw and processed
- Products mainly from non metallic minerals

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Stage of production

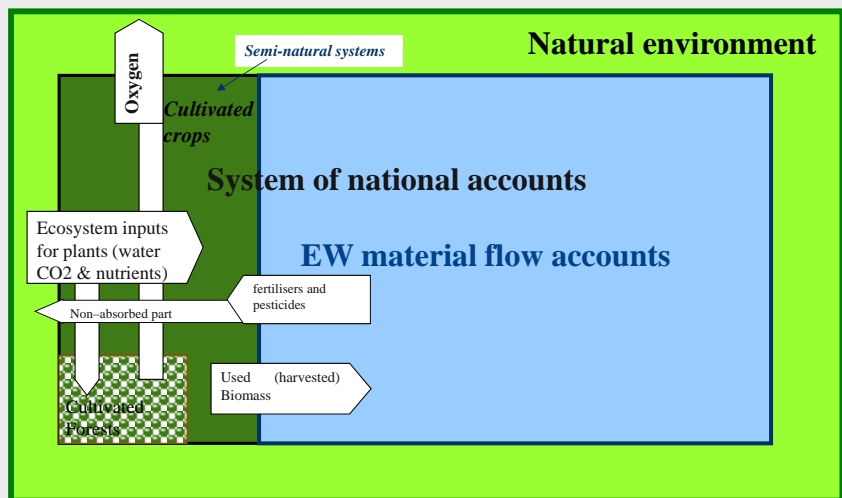
Traded goods can also be classified according to their level (“stage”) of manufacturing. The following three levels (or stages) of manufacturing are common:

- **raw materials** alike products produced by primary industries such as agriculture, forestry, fishing, and mining;
- **semi-manufactured** products: products which are further processed raw products but do not yet constitute finished products; they obviously need to be further processed;
- **finished products**: products which are finalised, i.e. are not processed or transformed anymore; note that finished products potentially are used for final consumption by households, governments etc. but also as intermediate input to industries.

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Different system boundary between SNA and EW-MFA



Eurostat



- Legal base in Europe for EW-MFA
- Annual questionnaire:
 - Table A: Domestic Extraction
 - Table B-E: physical trade
 - Table F: Domestic processed output
 - Table G: Balancing items
 - Table H: Indicators



Domestic extraction



Material category	Socio-economic activity
biomass	Agriculture, forestry, fishery, hunting
fossil energy carriers	Mining
Metallic ores	Mining
Non-metallic minerals	Mining

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Extraction

A.1 Biomass

- A.1.1 Crops (excluding fodder crops)
- A.1.2 Crop residues (used), fodder crops and grazed biomass
- A.1.3 Wood
- A.1.4 Wild fish catch, aquatic plants/animals, hunting and gathering

A.2 Metal ores (gross ores)

- A.2.1 Iron
- A.2.2 Non-ferrous metal

A.3 Non metallic minerals

- A.3.1 Non-metallic minerals

A.4 Fossil energy materials/carriers

- A.4.1 Coal and other solid energy materials/carriers
- A.4.2 Liquid and gaseous energy materials/carriers

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Extraction

- All natural resources including cultivated biomass (not according to SNA)
- Account for all products that are the first appearance of (transformed) natural resources into the products' world (the economy).
- Physical product flows are a proxy for extraction the nearer they are to the natural resources taken from nature.
- Take into account moisture content for products whose moisture content can vary, e.g. hay.

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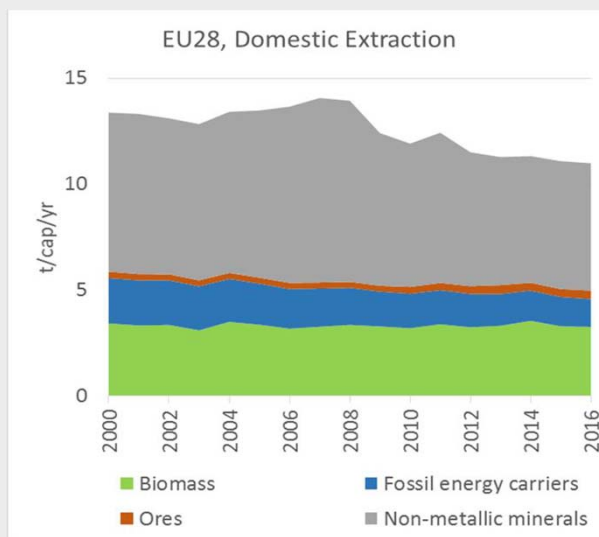
Extraction: data sources

- **National statistics**
 - Agricultural crop statistics, Forestry statistics, Fishery statistics, Mining statistics, Mining surveys
- **Statistics from ministries, geological surveys and from industrial associations, annual business reports of individual mining companies**
- **International data sources**
 - FAOSTAT, British Geological Survey, US Geological Survey, UN International Energy Agency (IEA), UN Industrial Commodity Production Statistics

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Example: Extraction in de EU



Exercise: extraction, import, export, DPO or not to be recorded in EW MFA?

- Import bottle of water?
- Wood from cultivated and non-cultivated forest
- Harvest crops?
- Grass eaten by cows?
- Fish catch?
- Biomass residuals left on the land?
- Waste to controlled and uncontrolled landfill?
- Sand used for infrastructural project?
- Oil leak from tanker?
- Import of electricity?

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Import and export



- Trade flows are different than extraction, they comprise basic commodities and manufactured products
- **Allocation to material categories** according to the main material component; sometimes very difficult because products are very heterogeneous
- Categories: “Products mainly from biomass” etc.
→e.g. road vehicles, furniture, machinery, plastics, pharmaceutical products
- Trade contains “categories” that do not apply to DE (and vice versa)
→e.g. meat, eggs, live animals, aluminium, gasoline, electricity, etc.
- Bulk water excluded
- Residence principle (according to SNA) ; important for energy carriers.
- Goods sent for processing; transaction of physical flows is recorded (not according to SNA).

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Imports and exports

- B.1 Biomass and biomass products**
 - B.1.1 Crops, raw and processed
 - B.1.2 Crop residues and fodder crops
 - B.1.3 Wood and wood products
 - B.1.4 Fish capture and other aquatic animals and plants, raw and processed
 - B.1.5 Live animals other than in 1.4., and animal products
 - B.1.6 Products mainly from biomass
- B.2 Metal ores and concentrates, raw and processed**
 - B.2.1 Iron ores and concentrates, iron and steel, raw and processed
 - B.2.2 Non-ferrous metal ores and concentrates, raw and processed
 - B.2.3 Products mainly from metals
- B.3 Non-metallic minerals, raw and processed**
 - B.3.1 Non-metallic minerals, raw and processed
 - B.3.2 Products mainly from non-metal minerals
- B.4 Fossil energy materials/carriers, raw and processed**
 - B.4.1 Coal and other solid energy products, raw and processed
 - B.4.2 Liquid and gaseous energy products, raw and processed
 - B.4.2.3 Adjustment for residence principle
 - B.4.3 Products mainly from fossil energy products
- B.5 Other products**
- B.6 Waste imported for final treatment and disposal**

Eurostat distinguishes around 70 types of import and export

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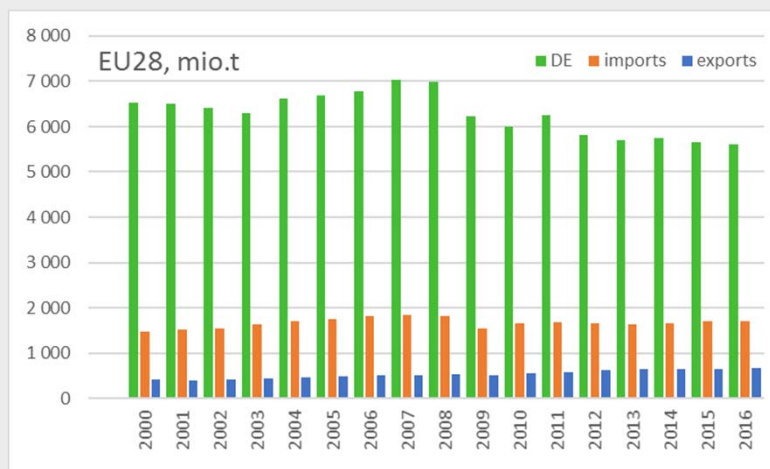
International trade: data sources

- Data source: foreign trade statistics : monetary and physical data
- Physical data: kg, or other: numbers, m³
- Conversion: difficult! E.g. "number of ships"
- Data is reported in „as is weight“ that is the weight when crossing administrative borders.
- Problems may occur with different moisture content between DE a. trade, e.g. wood DE (15% mc), directly traded with a mc of 20-40%.
- Specific problems:
 - Packaging: should be included, Foreign trade statistics usually reports net weight, i.e. excludes the packaging material
 - confidential trade
 - Transit flows (re-exports): Imports exported again without processing excluded from EW-MFA

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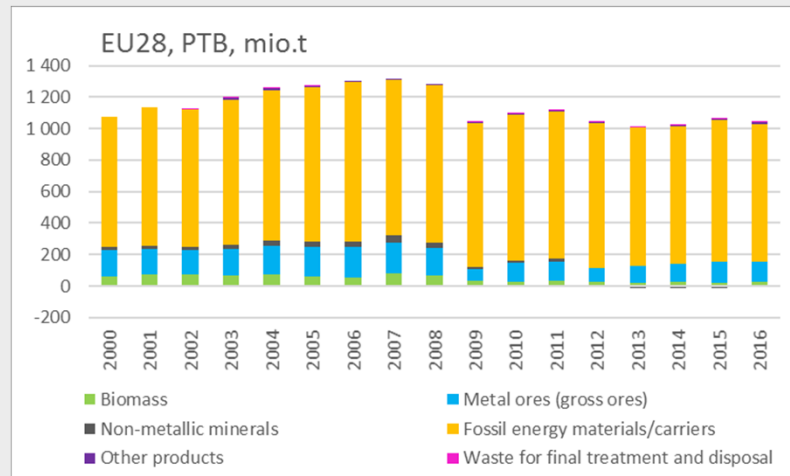
Example



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Example



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Domestic Processed Outputs (DPO)

- DPO indicates the total weight of materials, which are released back to the environment after having been used in the domestic economy.
- DPO flows occur at the processing, manufacturing, use, and final disposal stages of the economic production and consumption chain.
- Exported materials are not included in DPO because they are yet to be used in other countries.

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DPO classification (Eurostat)

Category	Examples
F.1 Emissions to air	CO ₂ , CH ₄ , N ₂ O, NO _x , HFCs, PFCs, Sulphur hexafl., CO, NMVOC, SO ₂ , NH ₃ , POPs, heavy metals, particles.
F.2 Waste disposal	Disposal of municipal waste, industrial waste
F.3 Emissions to water	N, P, heavy metals, other organic subst., dumping at sea
F.4 Dissipative use of products	Fertilizers, sewage sludge, compost, pesticides, seeds, salt and other thawing material, solvents, laughing gas, etc.
F.5 Dissipative losses	Abrasion from tires, friction products, buildings and infrastructure

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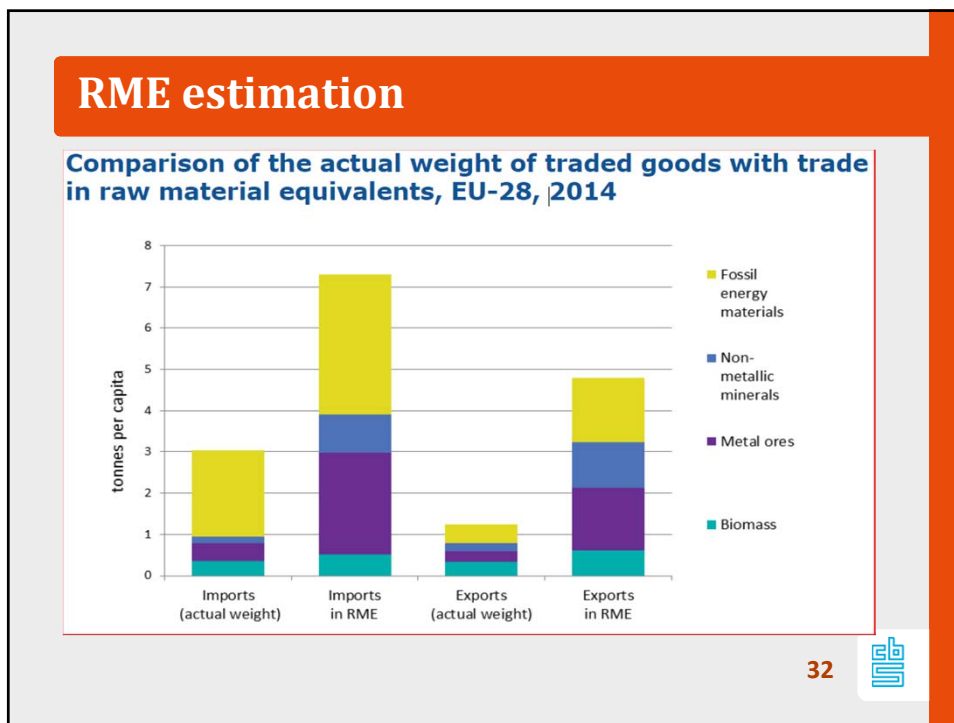
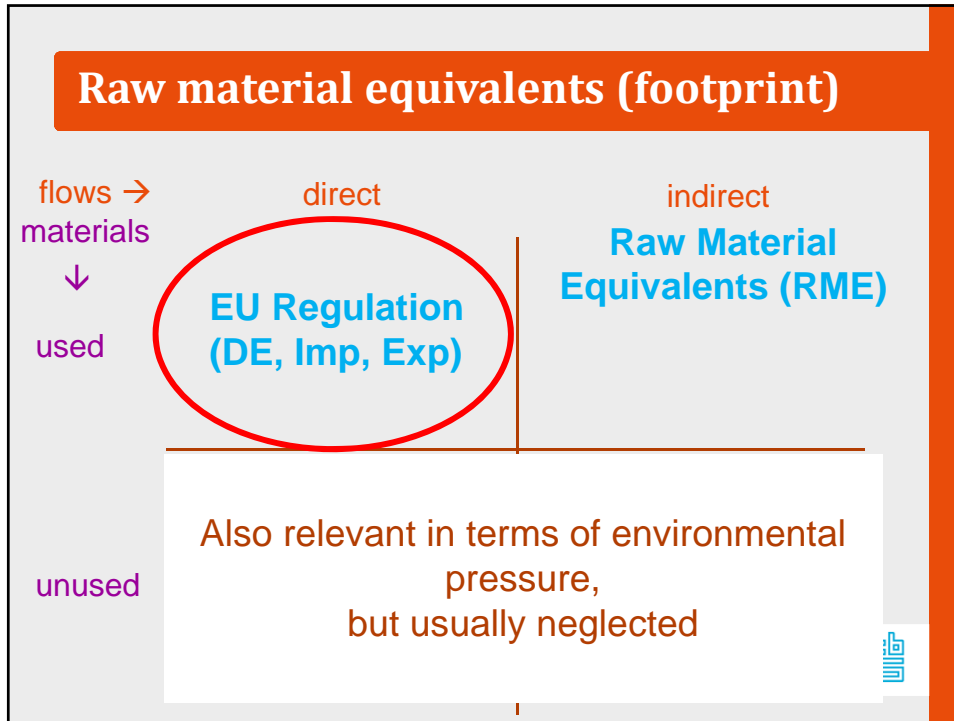


RME estimation

- Express imports and exports not at the weight of goods crossing the border but the weight of natural resources extracted
- by using coefficients (as promoted by Eurostat)
- by input-output modelling
- The results are better suited to compare material use across countries than DMC, but also have a higher statistical uncertainty

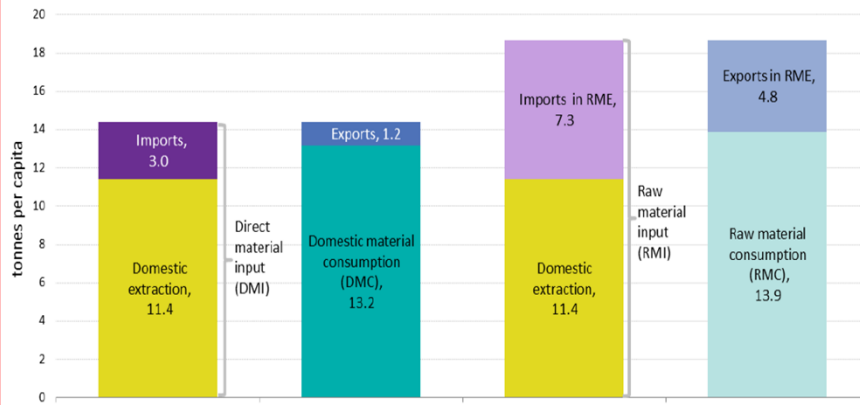
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RME estimation

Material flow indicators derived from EW-MFA and MFA in raw material equivalents, EU-28, 2014



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Thanks for your attention!

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