

ENV 501 / GR A3 30

Material Flow Analysis and resource management

Course room
GR A3 30

Computer lab
CM 1 111

• Laboratory on
Human-
Environment
Relations in
Urban Systems

Prof. Dr. Claudia R. Binder claudia.binder@epfl.ch

Dr. Francisco Xavier Felix Martin Del Campo francisco.felixmartindelcampo@epfl.ch

Exercises Teacher Assistant Jaír Campfens jair.campfens@epfl.ch

Exercises Teacher Assistant Léonard Léhot leonard.lehot@epfl.ch

Student Assistant Alicia Pérez Domouso alicia.perezdomouso@epfl.ch

Last week

- Course introduction
- Industrial ecology as the research field of MFA
- Overview of methodological approaches

8:15 - 9:00 and 9:15 - 10:00

13:15 - 14:00

14:15 - 15:00

Block I:
EW-MFA
global /
national

W1 - Sep 11	Introduction to the course and general concepts	All	Exercise	Project
W2 - Sep 18	EW – MFA and EW – MFA in the Swiss context	External Guest – Florian Kohler	Exercise	Project
W3 – Sep 25	Examples of EW – MFA. Scaling EW-MFA to Cantons	FMC	Exercise	Project
W4 - Oct 02	Urban Metabolism and Circular Economy	FMC	Exercise	Project

Block II:
MFA
regional /
urban


W5 - Oct 09	MFA method and the Stock-Flows-Service Nexus	CRB	Exercise	Project
W6 - Oct 16	Dynamic MFA	CRB	Exercise	Project
Oct 23	Autumn break			
W7 - Oct 30	Applications of MFA – case study	External Guest – Guillaume Massard	Exercise	Project
W8 - Nov 06	Input-Output Analysis and Material Flow Cost Accounting	External Guest – Vincent Moreau	Exercise	Project
W9 - Nov 13	Spatial MFA	FMC	Exercise	Project
W10 - Nov 20	Combined approaches: MFA + LCA; MFA + sociodemographics.	AS & FMC	Exercise	Project

Block III:
Social
sciences
and
public
policy

W11 - Nov 27	Combined approaches: MFA + surveys; Quasi-dynamic MFA	GF & FMC	Exercise	Project
W12 - Dec 04	Social metabolism	CRB	Past exam	Project
W13 - Dec 11	Agent-based model	CRB, FMC, MAH, SLC	Project	Project
W14 - Dec 18	Group Project Presentation	All	Project	Project

Content of lecture

- EW-MFA: definitions
- Main material categories in EW-MFA
- EW-MFA indicators
- Data Sources
- How to perform an EW-MFA
- EW-MFA in the Swiss context: Guest speaker Florian Kohler, Federal Statistical Office (FSO)

An aerial photograph of a desert landscape. A light-colored, winding road or path cuts through the terrain. The foreground is dominated by large, dark, rocky outcrops. The background shows a vast, sandy, and sparsely vegetated desert plain under a bright sky.

Introduction to Economy-wide MFA (EW-MFA)

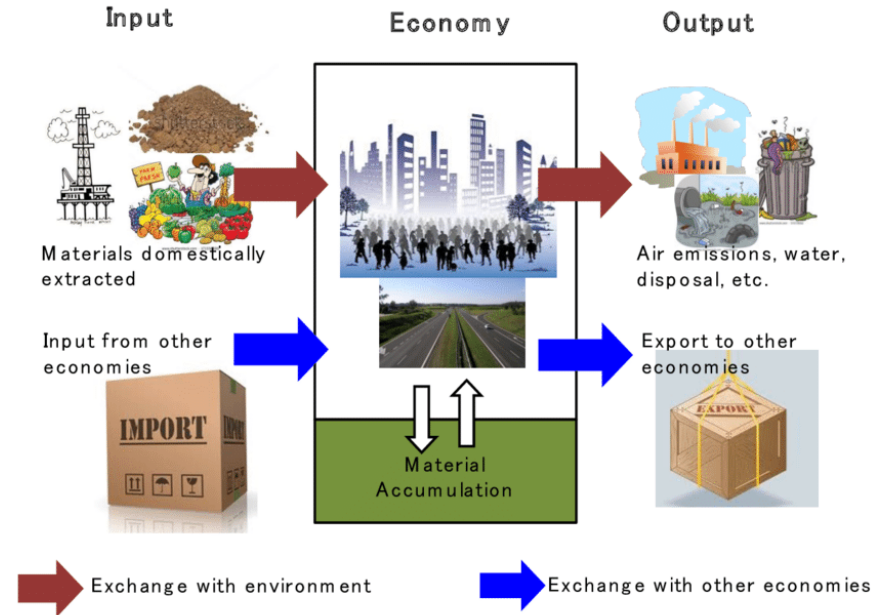
Definition, components, indicators

MFA – Different approaches

							EW-MFA	
Main objective	Substances	Materials	Products, Goods and Services		Businesses		Economic activities	Countries, Regions
	e.g., chemical elements or compounds (Cd, Cl, Pb, Zn, Hg, N, P, C, CO ₂ , CFC)	e.g., raw materials and semi-finished goods, energy carriers, metals (ferrous and nonferrous), sand and gravel, timber, plastics	e.g., batteries, transportation, packaging		e.g., offices, plants, small and medium sized enterprises, multi-national enterprises		e.g., mining, construction, chemical industry, iron and steel industry	e.g., aggregated mass of materials and related mixed or selected materials
Type of analysis	Substance Flow Analysis	Material Flow Analysis	Life Cycle Assessment		Business level Material Flow Analysis		Input-Output Analysis	Economy-wide Material Flow Analysis
Type of analytical tools	Substance Flow Accounts	Material Flow Accounts, Industrial, Urban or Regional Metabolism	Life-Cycle Inventory, Impact Assessment (ISO 14040)	Lif-Cycle Costing	Material Flow Cost Accounting (ISO 14051)	Business Material Flow Accounting	Physical Input-Output Tables, NAMEA approaches	Economy-wide Material Flow Accounts

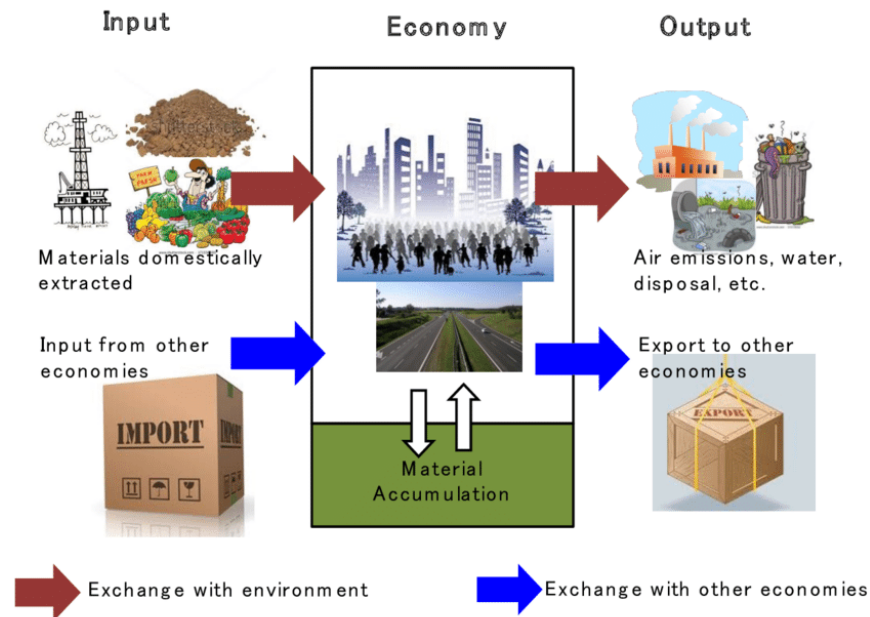
Economy-wide MFA (EW-MFA)

- ... accounts for all material flows (**inputs and outputs**) in national economies (socio-economic metabolism)
- ... describes the **interactions** of the domestic **economy** with the natural **environment** and the **rest of the world economy**

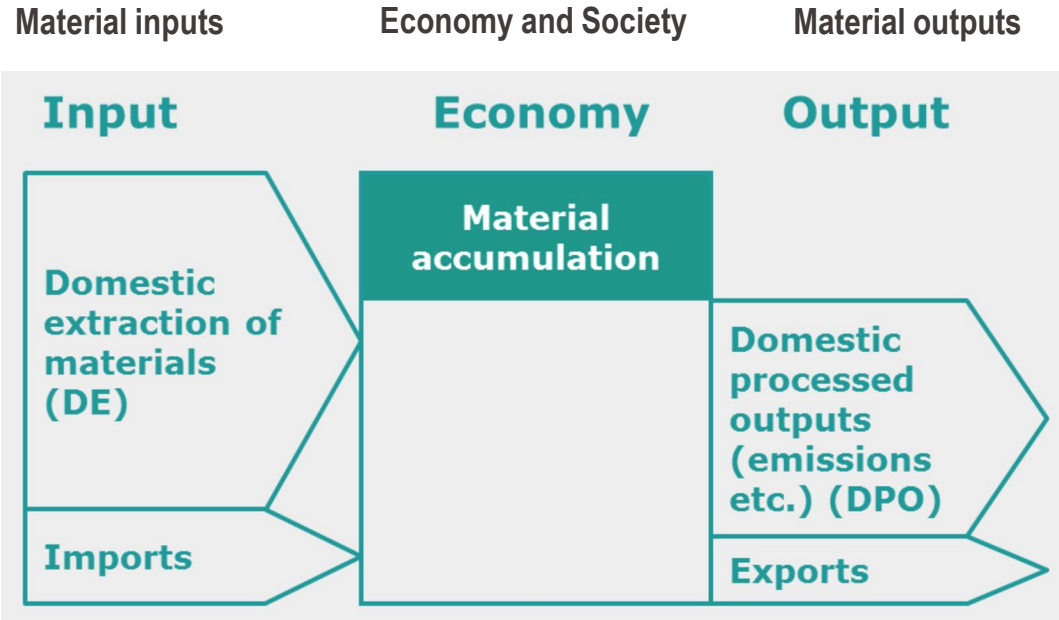


Economy-wide MFA (EW-MFA)

- ... represents **national accounts in physical** instead of monetary terms
- ... compatible with other national accounts (e.g. financial), enabling integrated analyses of environmental and economic aspects.
- ... part of official statistics, assessing the state of a nation's natural resources



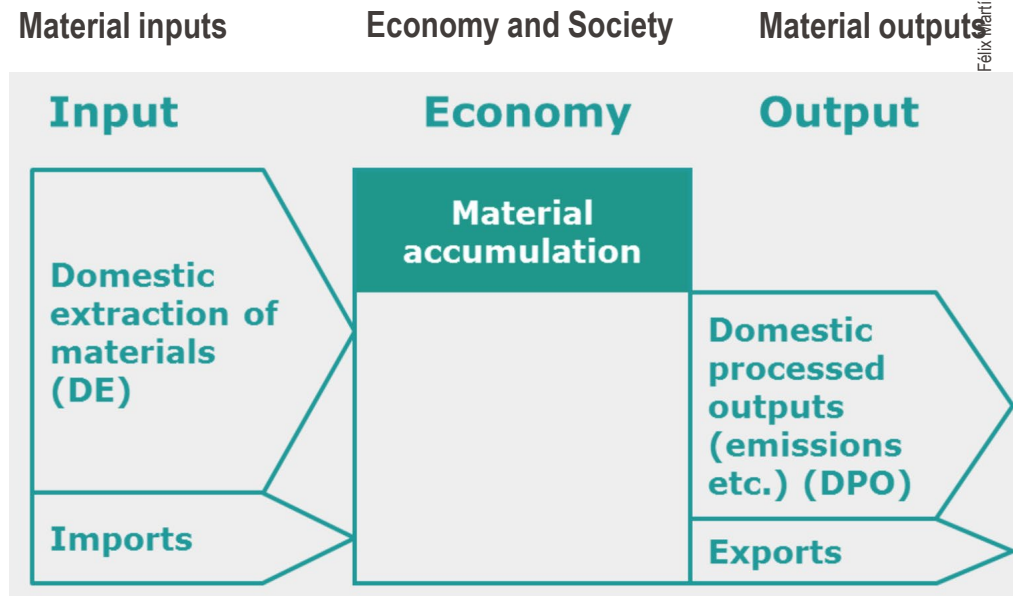
Economy-wide MFA (EW-MFA)



Material flows within the economy are not clearly represented in EW-MFA
Water and electricity flows are not represented as well

Materials classified in major categories:

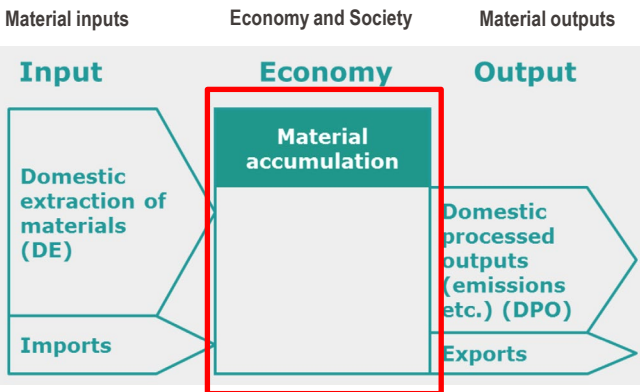
- **Fossil energy carriers**
 - Coal, peat, other solid energy resources
 - Oil and gaseous energy products
 - Products mainly from fossil energy
- **Biomass**
 - Crops, Fodder, fish
 - Timber
 - Products mainly from biomass
- **Metal ores**
 - Iron ores
 - Products mainly from metals
- **Non-metallic minerals**
 - Non-metallic minerals, raw and processed
 - Products mainly from non-metallic minerals



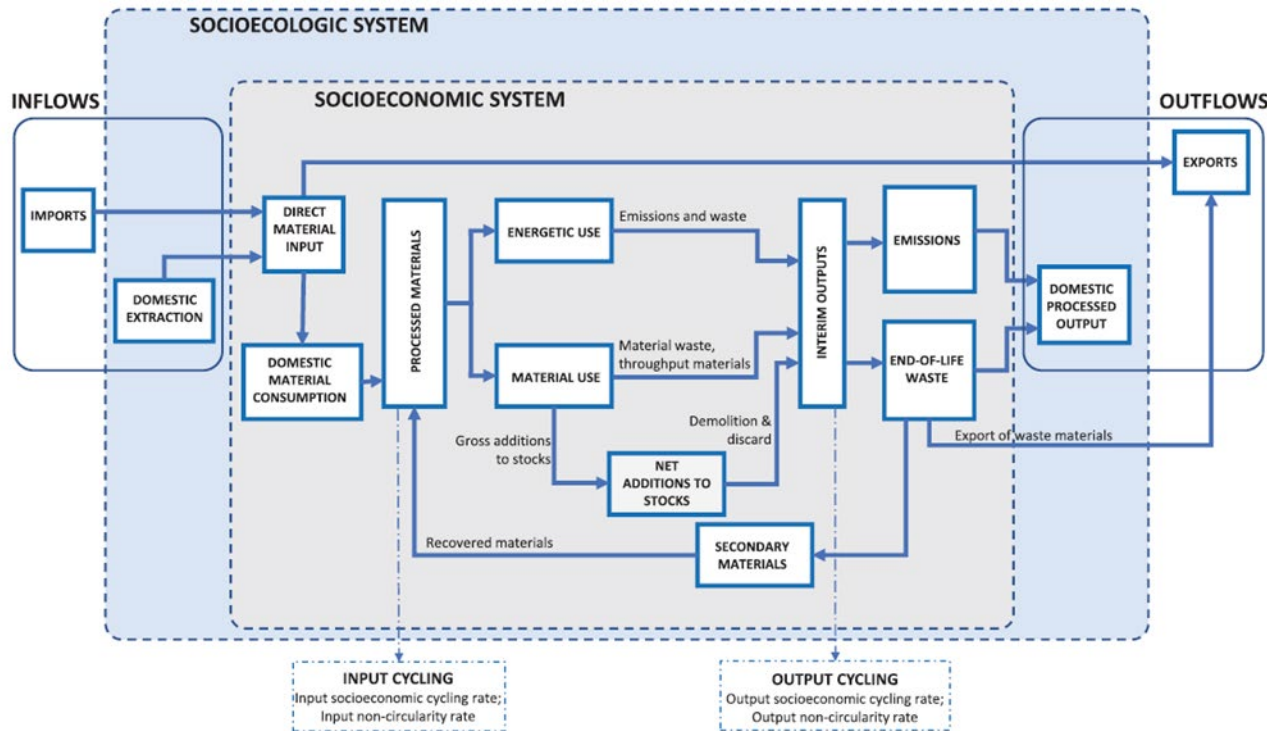
Economy-wide MFA (EW-MFA)

- **Fossil energy carriers**
 - Strategic relevance for industrial processes
 - Scarcity, Price fluctuations, dependency, emissions, climate change
- **Biomass**
 - Energetic use (food-feed-fuel) or Material use (e.g., construction)
 - Soil fertility, environmental degradation
- **Metal ores**
 - Strategic relevance for industrial processes
 - Scarcity (Critical Raw Materials), price fluctuation, pollution
- **Non-metallic minerals**
 - Strategic relevance for construction and industry
 - Scarcity, closely linked with energy flows

Economy-wide MFA (EW-MFA)



Note: Calculations also possible in **Raw Material Equivalents** = domestic extraction of natural material inputs that were necessary to produce the respective traded goods



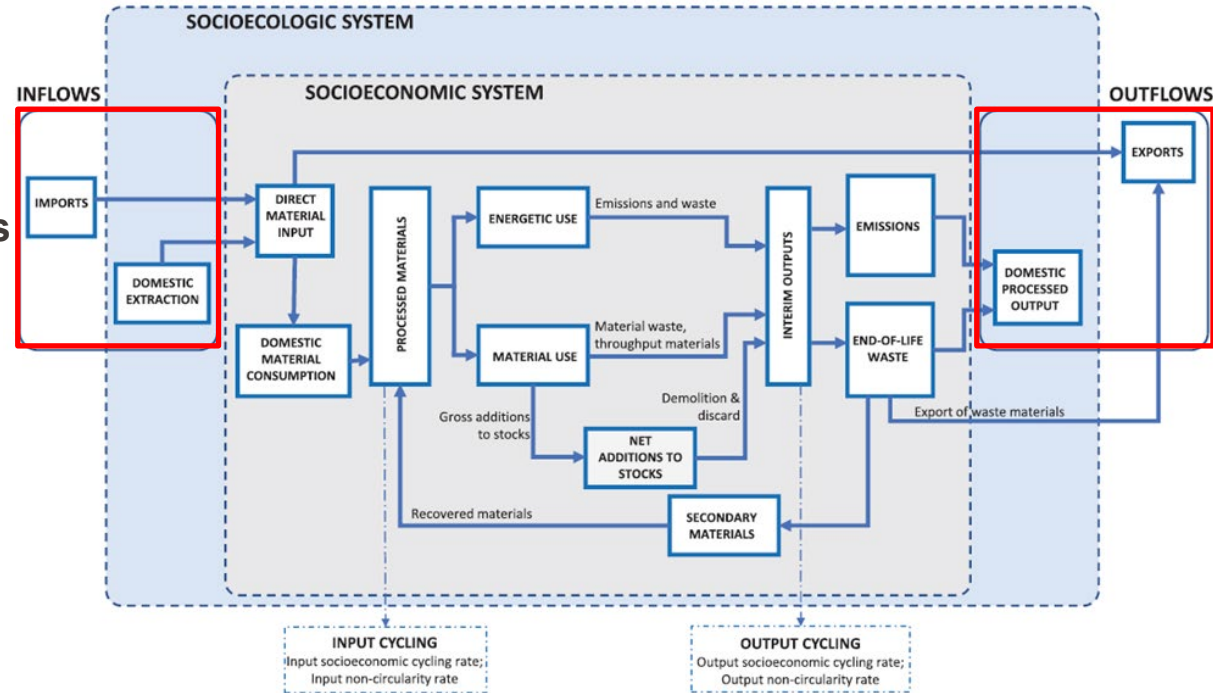
Basic flow types

- Domestic extraction (DE)
- Domestic processed output (DPO)
- Imports (IMP)
- Exports (EXP)

Flows types are basis for indicators

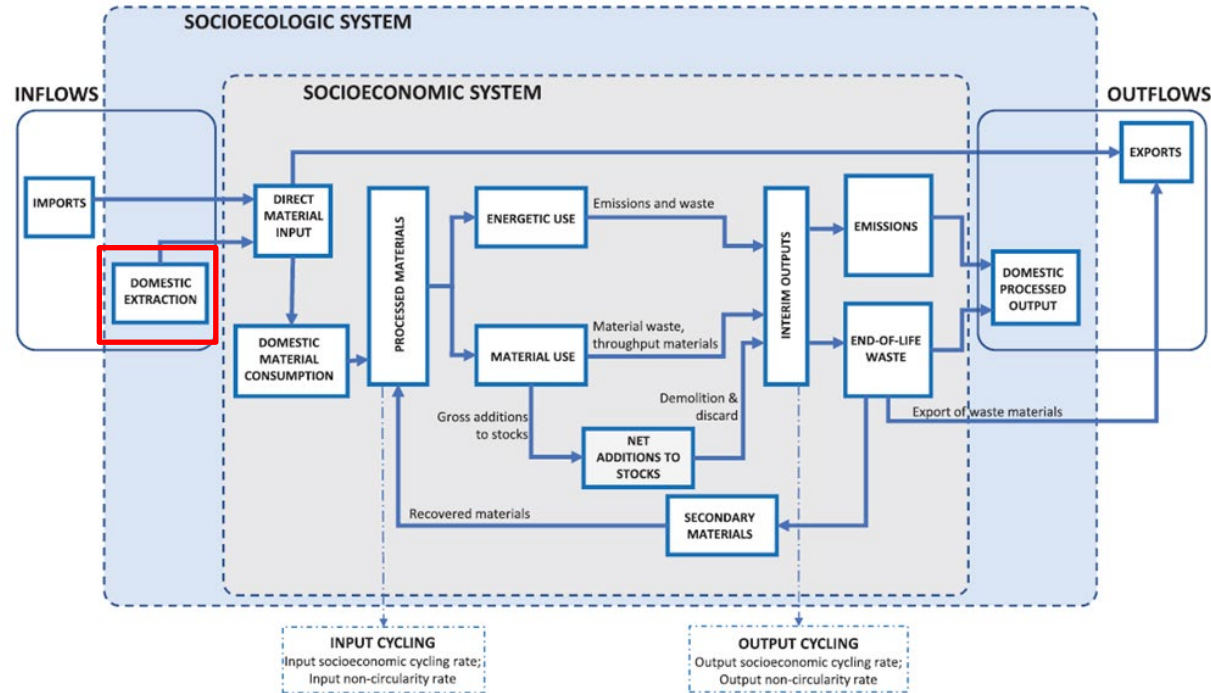
- Direct material input (DMI) = $DE + IMP$
- Domestic material consumption (DMC) = $DE + IMP - EXP$
- Physical trade balance (PTB) = $IMP - EXP$
- Net additions to stock = $DMI - DPO - EXP$

• Laboratory on
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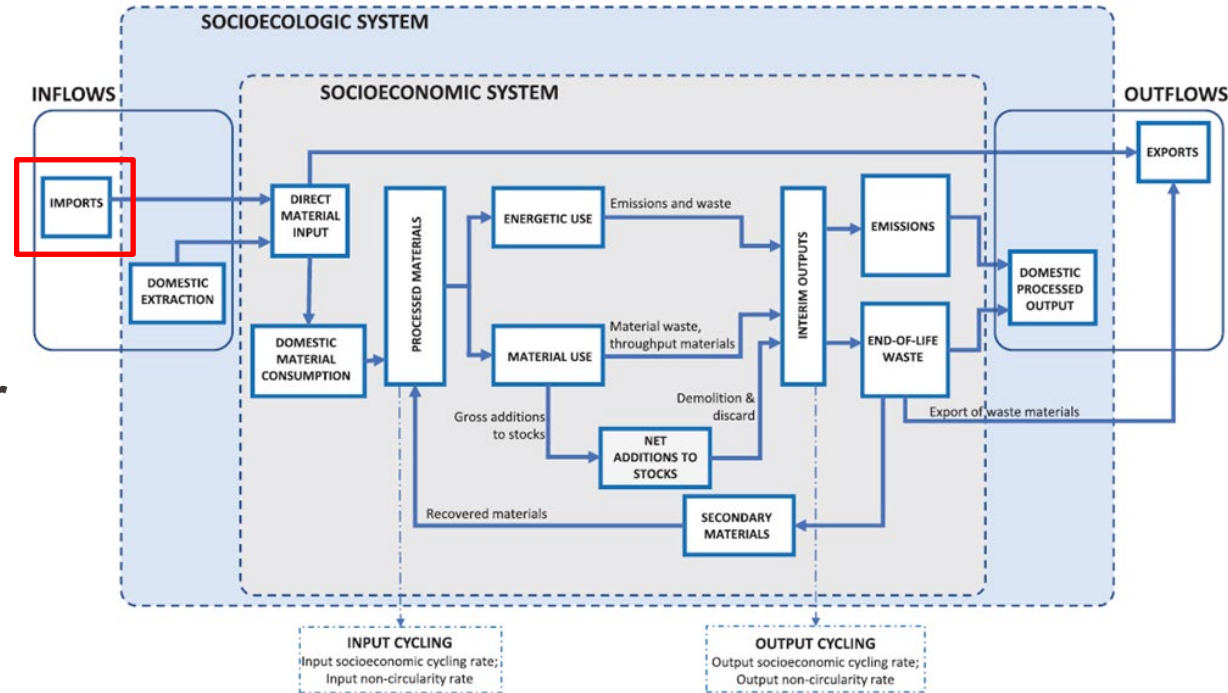


Domestic extraction (DE)

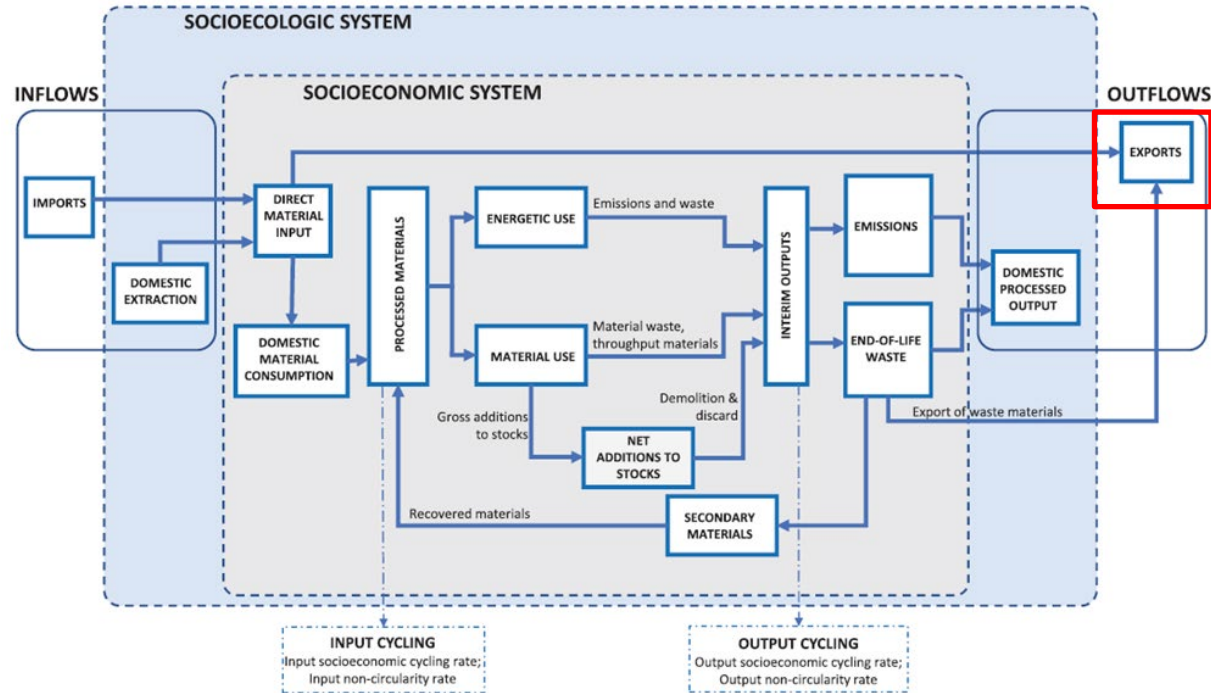
- All raw materials that are extracted from the domestic environment and further used in production processes (excluding air and water).



- Imported and traded goods at all stages of processing, from raw materials to highly processed products.
- Products are allocated to specific material categories, e.g. imported car produced from steel as the main component is allocated to metal ores.



- Exported and traded goods at all stages of processing, from raw materials to highly processed products
- Products are allocated to specific material categories, e.g. imported car produced from **steel** as the main component is allocated to **metal ores**.

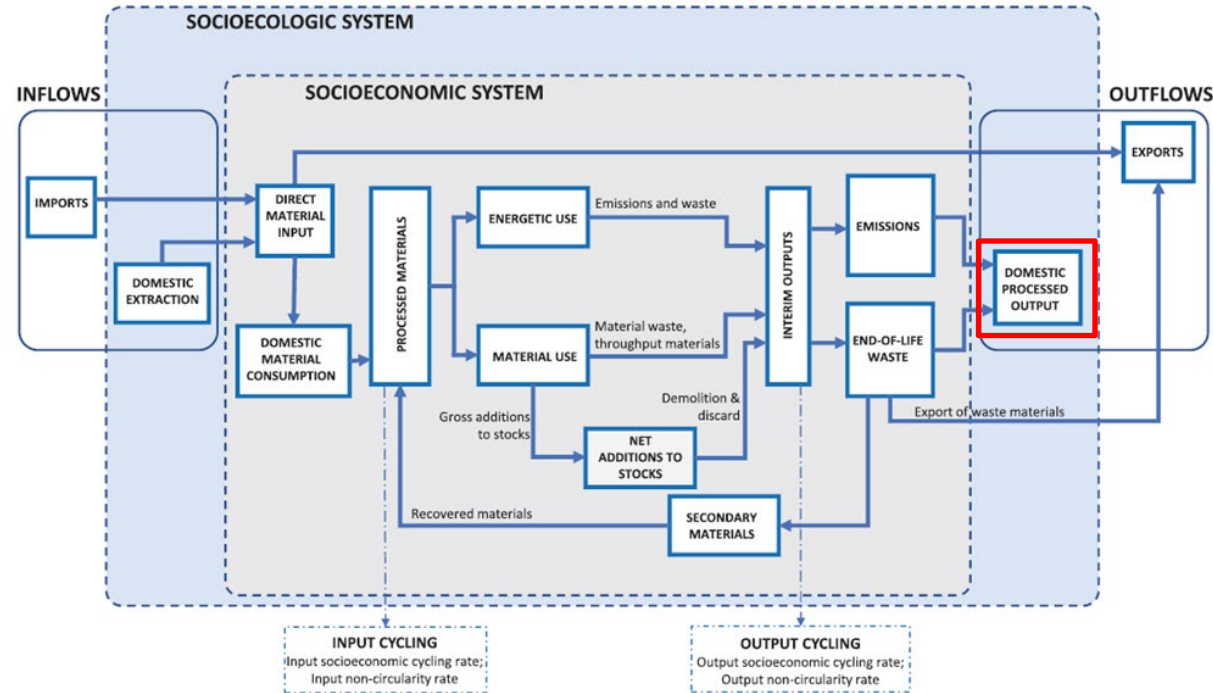


Context of use: DE, IMP, EXP

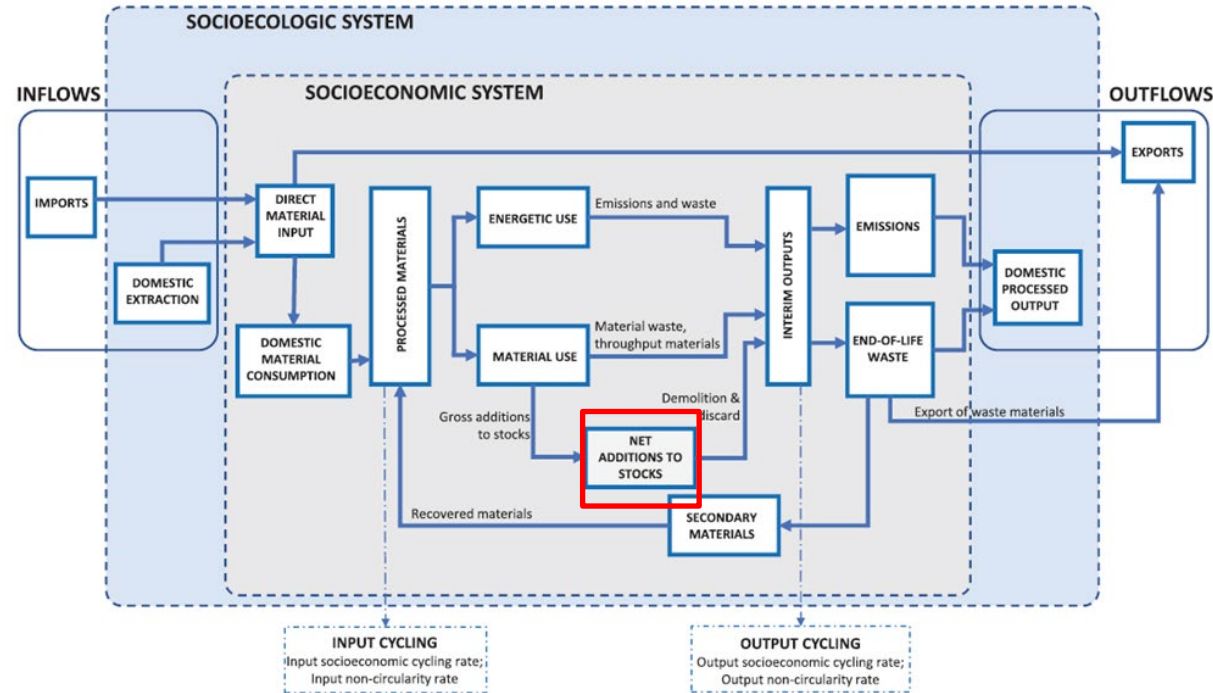
- The **domestic extraction** data can be useful information for a **national resource** conservation policy.
- **Import** and **export** data can be used to **assess the physical trade balance** of a nation.
- Together with the information on extraction, the **self-sufficiency** of a nation can be assessed.
- Countries can be characterized with regard to the nature of their economy: **resource producing** or **resource consuming** nations

Domestic Processed Output (DPO)

- **Total mass of waste materials** generated along the value added chain, including resource extraction, processing, manufacturing use, and waste management
- Includes emissions to air, water, and landfill



- Measure of **physical growth** in an economy
- New materials** are added to stocks (buildings, infrastructures, durable goods)
- Old materials** are removed from stock as buildings are demolished, and durable goods disposed of (removals)



General observations

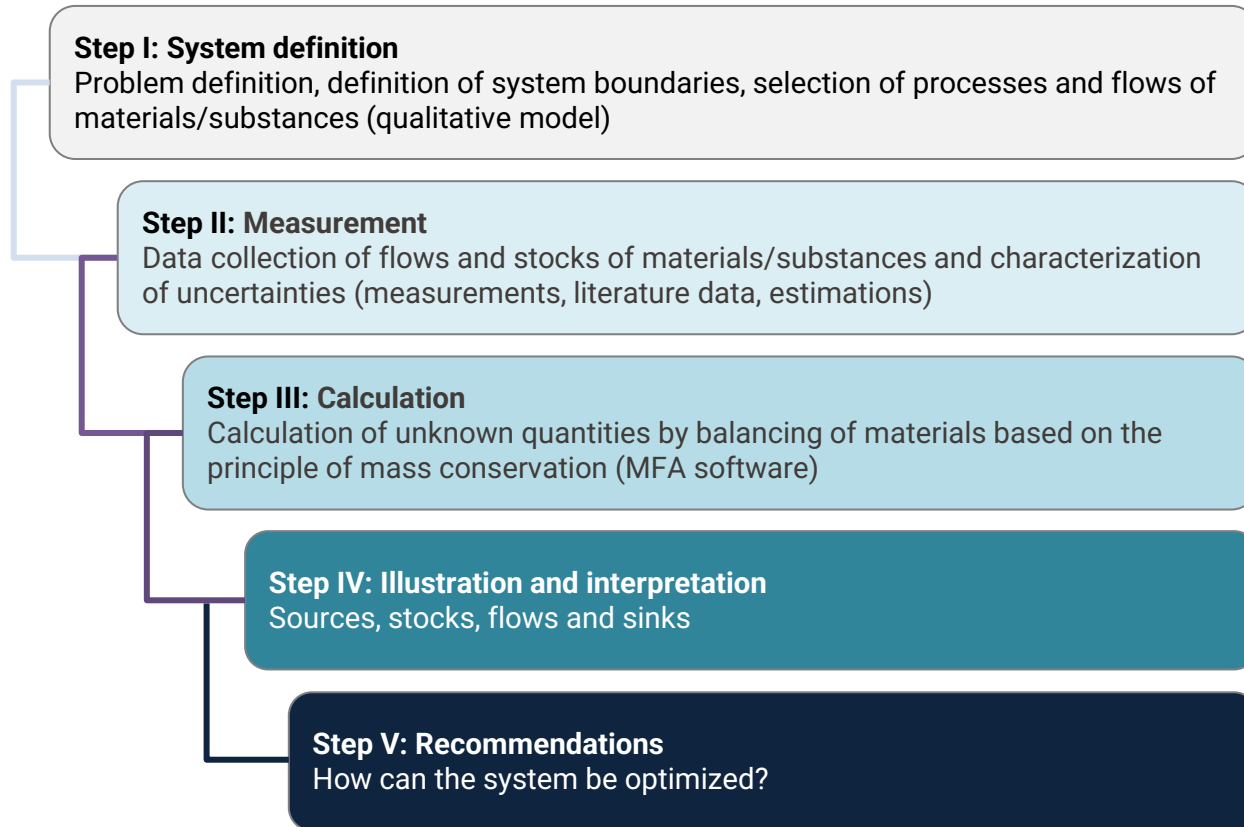
- Reminder: **Raw Material Equivalent** = domestic extraction of natural material inputs that were necessary to produce the respective traded goods
- In terms of mass weight, a **product** tends to have a relatively **lower weight** than the domestic extraction required for its production
- **Domestic extraction** basically measures **natural** inputs
- **Imports** and **exports** are **product** flows, and are therefore largely goods that have undergone at least some processing and often extensive processing.

How to carry out an EW-MFA

Steps, data sources, tool

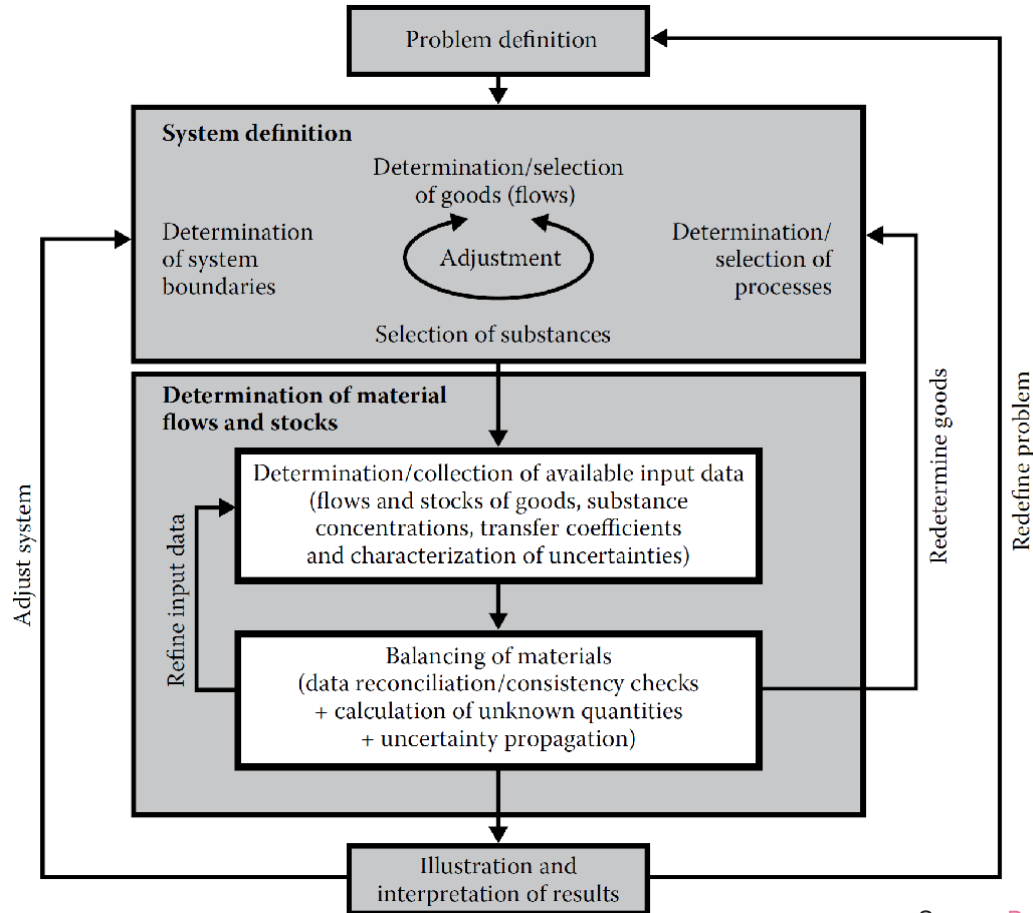


How to carry out an EW-MFA?



How to carry out an EW-MFA?

- System definition
- Data acquisition
- Calculation
- Representation and interpretation
- Recommendations



How to carry out an EW-MFA?

Formulate a precise question.

What problem should be tackled with the material flow analysis?

Define the system in space and time.

Determining the spatial and temporal boundary for material flow modelling.


Characterize the material balance system.

Which processes and material flows are relevant to the question formulated and have to be taken into account in the model?

Select material flow indicators.

Which material flow indicators are relevant for answering the question?

- Structure, instructions, parameters
- **Table A-D:** DE, IMP, EXP
- **Table F:** DPO
- **Table G:** Balancing items
- **Table H:** Indicators **calculated automatically** from tables
- **Compilation tools**
 - Grazed biomass, crop residues
 - Sand & gravel, clay, limestone
 - Balancing items



Enable automatic checks when closing workbook

Economy-wide material flow accounts (EW-MFA)

2024 EW-MFA questionnaire

INTRODUCTION

version 21 November 2023

This is Eurostat's electronic questionnaire for the 2024 data collection on **economy-wide material flow accounts (EW-MFA)**. It includes a number of sheets – an overview is provided in sheet **'structure'**. Reporting Tables A, B, and D are based on Regulation (EU) No. 691/2011.

Please specify your country by selecting from the drop-down list

Deadline for returning back the 2024 EW-MFA questionnaire is: **30 April 2024**

The sheet **'instructions'** provides you with detailed information on filling in the questionnaire. Please address any questions to the following e-mail address:

ESTAT-MFA@ec.europa.eu

This electronic questionnaire shall be submitted to Eurostat using the **EDAMIS** reporting system (Electronic Data files Administration and Management Information System). Please ensure that the following [EDAMIS parameters](#) are entered:

Domain: **ENVDATA**

Data set: **ENVDATA_MFA_A**

Year: **2022** (which is the most recent legally mandatory reference year). Eurostat greatly appreciates receiving EW-MFA data starting from 2000 ranging up to 2022.

The eDAMIS system has been installed in all National Statistical Institutes and your local eDAMIS coordinator will give you a user-id and password.

Should you have any questions regarding data transmission, please contact your local eDAMIS coordinator or the Eurostat eDAMIS helpdesk at:


estat-support-edamis@ec.europa.eu

or call +352 4301 33213.

Please provide the **primary contact person for EW-MFA in your country** (*institution, unit, name, email, telephone*):

Check the whole questionnaire

How to carry out an EW-MFA?

eurostat 

Enable automatic checks when closing workbook

**Economy-wide material flow accounts (EW-MFA)
2024 EW-MFA questionnaire**

Check the whole questionnaire

Table of contents

Sheet	Title	Content	Status
1 intro	EW-MFA questionnaire - Introduction	General information about the EW-MFA questionnaire	<i>to be filled out (please select country and provide primary contact person)</i>
2 structure	Table of content of the EW-MFA questionnaire	Overview of this electronic EXCELworkbook	for information
3 instructions	Instructions for completing the EW-MFA questionnaire and overview of the checking rules	Instructions on how to use and fill in the questionnaire	for information
4 footnote instructions	Instructions for reporting of the footnotes	Provides instructions for SDMX compliant reporting of footnotes	for information
5 footnotes_list	List of footnotes	Please insert footnote texts for each footnote symbol you use in tables A to I	for information
6 Table_A	Domestic extraction (DE)	Table A records material flows from the environment into the economy in a detailed breakdown by type of material	<i>to be filled out</i>
7 Table_B	Imports - total imports (intra- and extra-EU imports)	The physical trade tables (Tables B and D) record the imports and exports of products in thousand tonnes and grouped by materials. Table B accounts for total imports	<i>to be filled out</i>
8 Table_D	Exports - total exports (intra- and extra-EU exports)	The physical trade tables (Tables B and D) record the imports and exports of products in thousand tonnes and grouped by materials. Table D accounts for total exports	<i>to be filled out</i>
9 Table_F	Domestic processed output (DPO)	Table F records material flows from the economy to the domestic environment (e.g. emissions to air, water and soil)	<i>to be filled out</i>

How to carry out an EW-MFA?

Country: Go to Footnotes Show Footnote Check Data
 Unit: 1000 Metric tonnes Clean Checks

TABLE A: DOMESTIC EXTRACTION

TABLE A: DOMESTIC EXTRACTION

	2004	2022	2023
MF.1 Biomass			
MF.1.1 Crops (excluding fodder crops)			
MF.1.1.1 Cereals			
MF.1.1.2 Roots, tubers			
MF.1.1.3 Sugar crops			
MF.1.1.4 Pulses			
MF.1.1.5 Nuts			
MF.1.1.6 Oil-bearing crops			
MF.1.1.7 Vegetables			
MF.1.1.8 Fruits			
MF.1.1.9 Fibres			
MF.1.1.A Other crops (excluding fodder crops) n.e.c.			
MF.1.2 Crop residues (used), fodder crops and grazed biomass			
MF.1.2.1 Crop residues (used)			
MF.1.2.1.1 Straw			
MF.1.2.1.2 Other crop residues (sugar and fodder beet leaves, etc.)			
MF.1.2.2 Fodder crops and grazed biomass			
MF.1.2.2.1 Fodder crops (including biomass harvest from grassland)			
MF.1.2.2.2 Grazed biomass			
MF.1.3 Wood			
MF.1.3.1 Timber (industrial roundwood)			
MF.1.3.2 Wood fuel and other extraction			
MF.1.3 MEMO: Net increment of timber stock (memo item)			
MF.1.4 Wild fish catch, aquatic plants and animals, hunting and gathering			
MF.1.4.1 Wild fish catch			
MF.1.4.2 All other aquatic animals and plants			
MF.1.4.3 Hunting and gathering			
MF.2 Metal ores (gross ores)			
MF.2.1 Iron			
MF.2.2 Non-ferrous metal			
MF.2.2.1 Copper			
MF.2.2.1 MEMO: Copper - metal content			
MF.2.2.2 Nickel			
MF.2.2.2 MEMO: Nickel - metal content			
MF.2.2.3 Lead			
MF.2.2.3 MEMO: Lead - metal content			
MF.2.2.4 Zinc			
MF.2.2.4 MEMO: Zinc - metal content			
MF.2.2.5 Tin			
MF.2.2.5 MEMO: Tin - metal content			

MF.1 Biomass

MF.1.1 Crops (excluding fodder crops)

MF.1.1.1 Cereals

MF.1.1.2 Roots, tubers

MF.1.1.3 Sugar crops

MF.1.1.4 Pulses

MF.1.1.5 Nuts

MF.1.1.6 Oil-bearing crops

MF.1.1.7 Vegetables

MF.1.1.8 Fruits

MF.1.1.9 Fibres

MF.1.1.A Other crops (excluding fodder crops) n.e.c.

MF.1.2 Crop residues (used), fodder crops and grazed biomass

MF.1.2.1 Crop residues (used)

MF.1.2.1.1 Straw

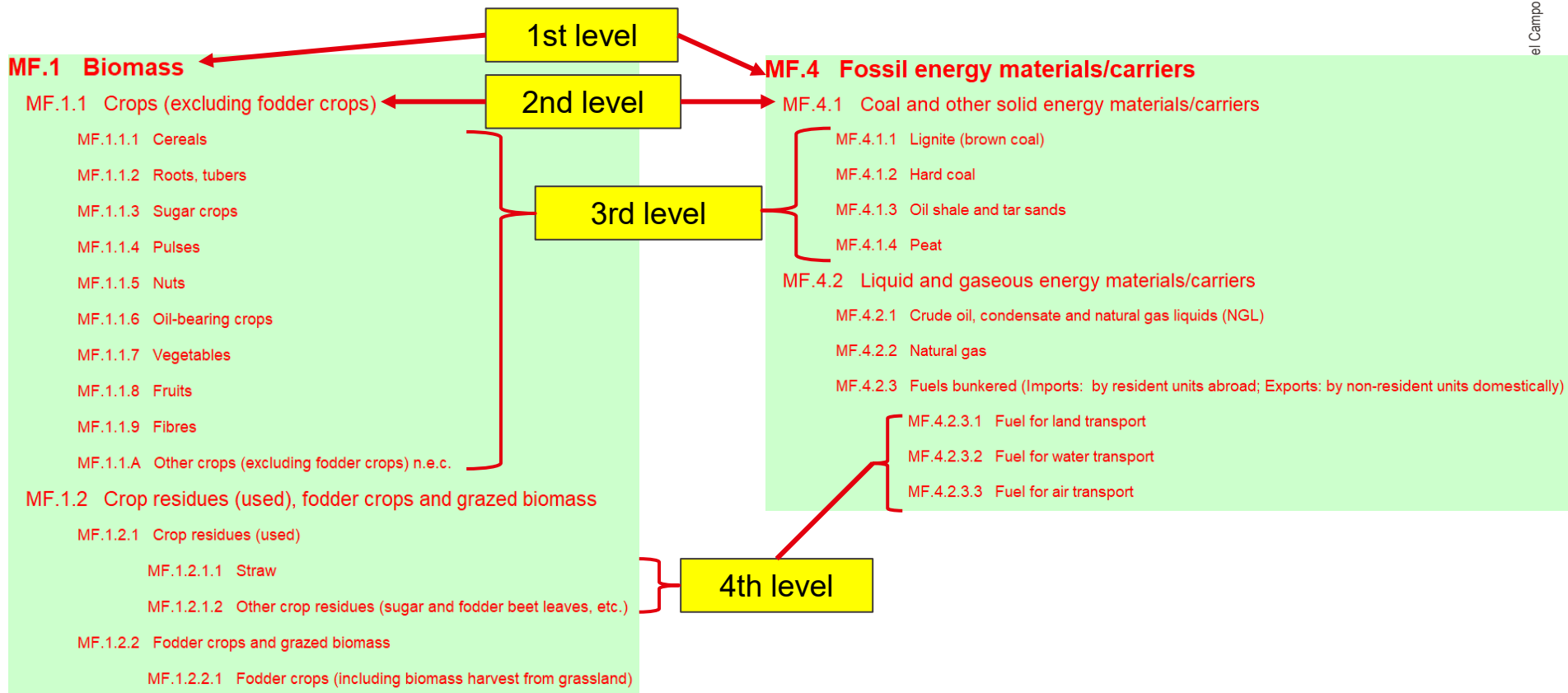
MF.1.2.1.2 Other crop residues (sugar and fodder beet leaves, etc.)

MF.1.2.2 Fodder crops and grazed biomass

MF.1.2.2.1 Fodder crops (including biomass harvest from grassland)

How to carry out an EW-MFA?

- Specific hierarchical classification.



How to carry out an EW-MFA?

Compilation tools

- **Grazed biomass**
 - Demand side estimate: Livestock numbers, fodder crops used
 - Supply side estimate: Grazed area
- **Crop residues:** Calculated from cereal harvest
- **Sand & gravel:** Concrete production, cement consumption, length of roads
- **Clay:** Production of bricks and roof bricks
- **Limestone:** Cement production
- **Balancing items**
 - Energy use data
 - Population numbers
 - Beverages

Note: **Balancing items** - Oxygen for **combustion** processes and **respiration**, and nitrogen; or water vapour from combustion, and gases from respiration

Where to find data?

- Open data portals (UN Comtrade database; FAOSTAT, etc.)
- Country statistics, Specialized reports

UN Comtrade Database | Data ▾ | Bulk Files ▾ | Visualization ▾ | Metadata ▾ | Publications ▾ | Ref

Showing 1 to 3 of 3 Results

Period ↑↓	Trade Flow ↑↓	Reporter ↑↓	Partner ↑↓	2nd Partner ↑↓	Customs Desc ↑↓	Transport Mode ↑↓	Commodity Code ↑↓	Trade Value (US\$) ↑↓	Net Weight(kg) ↑↓
2020	M	Cambodia	Switzerland	World	TOTAL CPC	TOTAL MOT	270111	\$2,472	110
2020	M	India	Switzerland	World	TOTAL CPC	TOTAL MOT	270111	\$17,392,404	165253000
2020	M	South Africa	Switzerland	World	TOTAL CPC	TOTAL MOT	270111	\$11,537	110000

World mineral production 2017-21

Production of crude steel

tonnes (metric)

Country	2017	2018	2019	2020	2021
Austria	8 134 600	6 885 000	7 423 500	6 765 100	7 920 000
Azerbaijan	387 258	381 617	325 895	264 506	304 077
Belarus	2 432 580	2 572 862	2 717 705	2 559 577	2 390 000
Belgium	7 842 300	7 980 000	7 760 000	6 120 000	6 910 000
Bosnia & Herzegovina	734 518	677 443	800 600	740 194	774 832
Bulgaria	652 400	666 100	565 900	483 800	547 500
Croatia	—	135 800	69 126	45 273	185 143
Czech Republic	4 553 000	4 966 000	4 600 000	2 900 000	4 700 000
Finland	4 003 634	4 100 000	3 511 000	3 482 000	4 322 000
France	15 504 683	15 387 355	14 449 651	11 595 698	13 946 700

Food Balances (2010-)

DOWNLOAD DATA | VISUALIZE DATA | METADATA | REPORT

COUNTRIES | REGIONS | SPECIAL ▾ M49

Filter results e.g. afghanistan

- Afghanistan
- Albania
- Algeria
- Angola
- Antigua and Barbuda
- Argentina

Select All | Clear All

ELEMENTS

Filter results e.g. total population - both s

- Total Population - Both sexes
- Production Quantity
- Import Quantity
- Stock Variation
- Export Quantity
- Domestic supply quantity

Select All | Clear All

ITEMS | ITEMS AGGREGATED ▾ CPC

Filter results e.g. population

- Wheat and products
- Rice and products
- Barley and products
- Maize and products
- Rye and products

YEARS

Filter results e.g. 2020

- 2020
- 2019
- 2018
- 2017
- 2016

Where to find data?

- **Fossil energy carriers**
 - National energy statistics and balances
 - International sources:
 - UN International Energy Agency (IEA)
 - United Nations Industrial Commodity Production Statistics
 - US Geological Survey (USGS)
 - British Geological Survey (BGS)

- **Biomass**
 - Agricultural crop statistics (tonnes, tonnes/ha)
 - Forestry statistics (tonnes, m³)
 - Fishery statistics (tonnes)
 - Economic Accounts for Agriculture EAA (€)
 - Agricultural land use statistics FSS (hectares)
 - National feed-, food- and wood-balances
 - International statistics
 - FAOSTAT: Comprehensive information on global agricultural, forestry, fisheries statistics

Where to find data?

- **Metal ores**

- PRODCOM
- Individual mining companies (e.g. annual business reports)
- International data sources:
 - British Geological Survey (BGS),
 - US Geological Survey (USGS)

- **Non-metallic minerals**

- PRODCOM
- Individual mining companies (e.g. annual business reports)
- International data sources:
 - British Geological Survey (BGS),
 - US Geological Survey (USGS)



Thank you for
your attention!

Next: Guest lecturer, Florian Kohler

- Head of the Natural Resources and Territory group at the Federal Statistical Office (FSO).
- Statistics on material flow accounts, economic accounts for the primary sector, agriculture and food analysis, and territorial analysis.
- Over 10 years of experience in producing and developing economy-wide material flow accounts for Switzerland.
- Represents Switzerland in various Eurostat groups and task forces related to material flow accounts.