



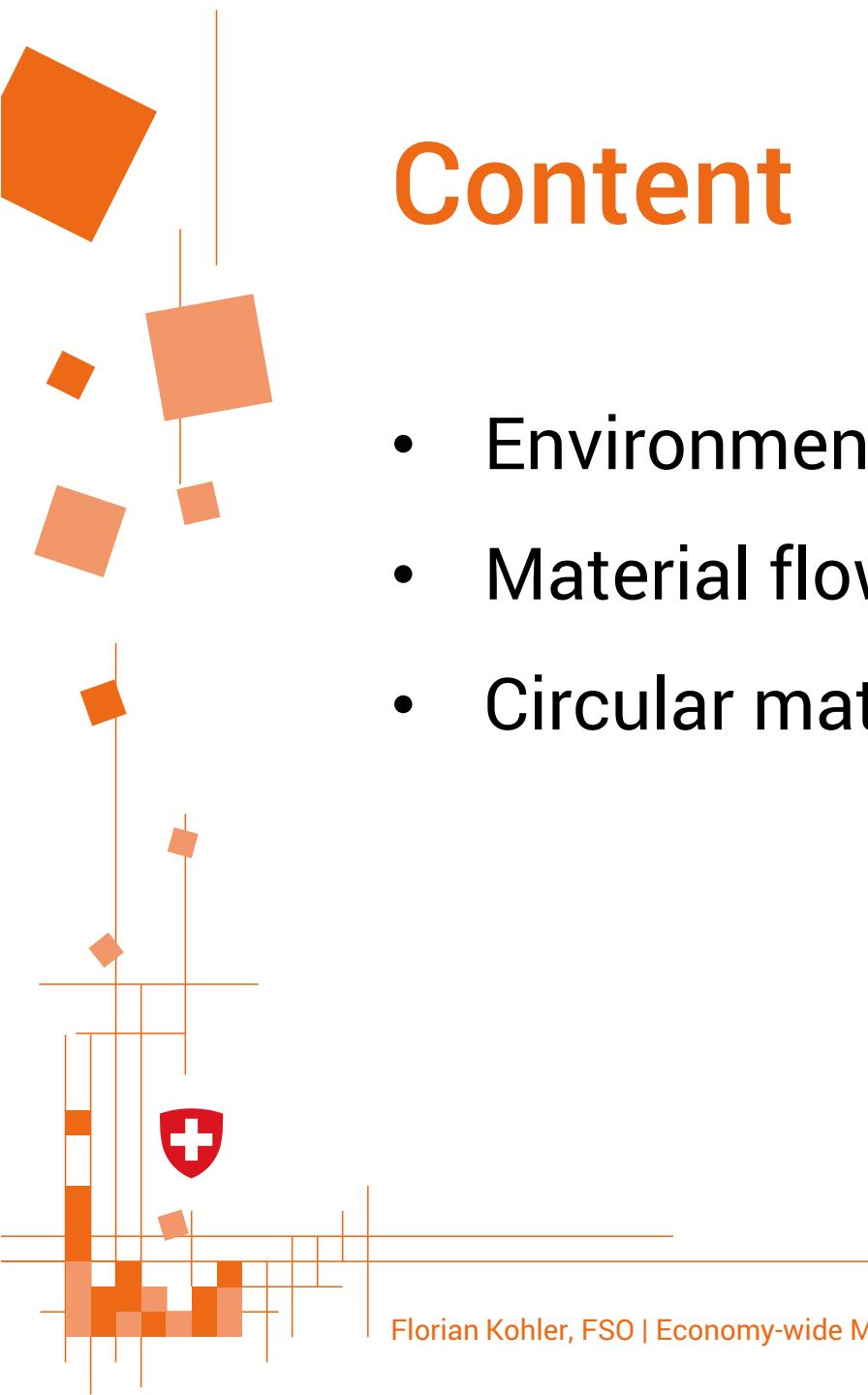
Environmental Accounts

Economy-wide Material flow accounts and
their extension to circular flows

Dr. Florian Kohler, FSO

Material and energy flow analysis - EPFL

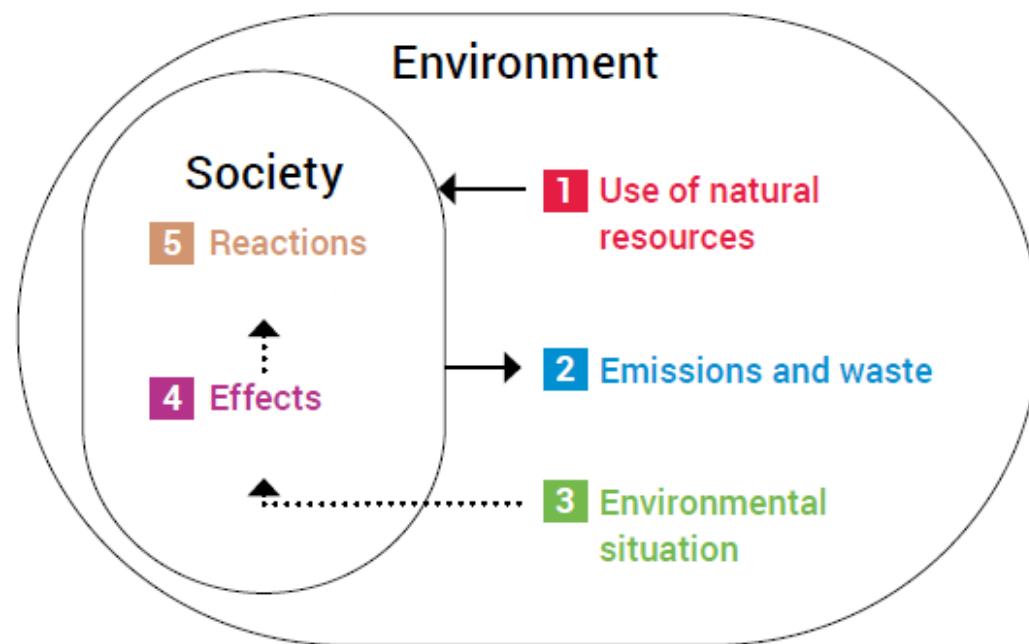
26.09.2024



Content

- Environmental accounts at FSO
- Material flows accounts
- Circular material use

Environmental accounts at FSO



Fundamental purpose

Statement

Increasing interactions between the economy and the environment

Needs

To have integrated and comparable environmental and economic statistics for powerful analysis

Difficulty

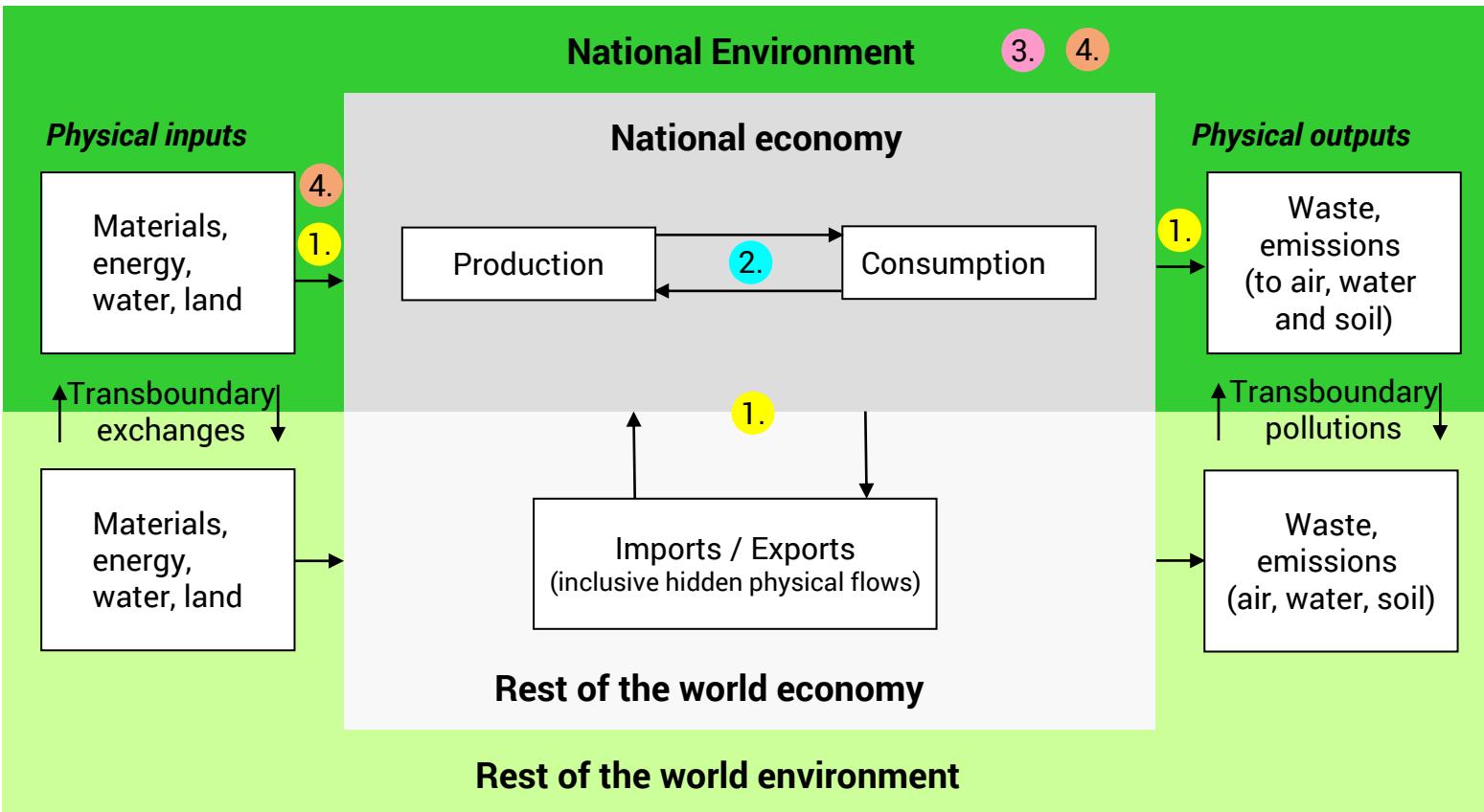
Environmental and economic statistics are very frequently not comparable because of use of different definitions and classifications

Solution

To adjust the environmental statistics to the principles, definitions and classifications of the National accounts / economic statistics

→ **Environmental accounts**

Principles



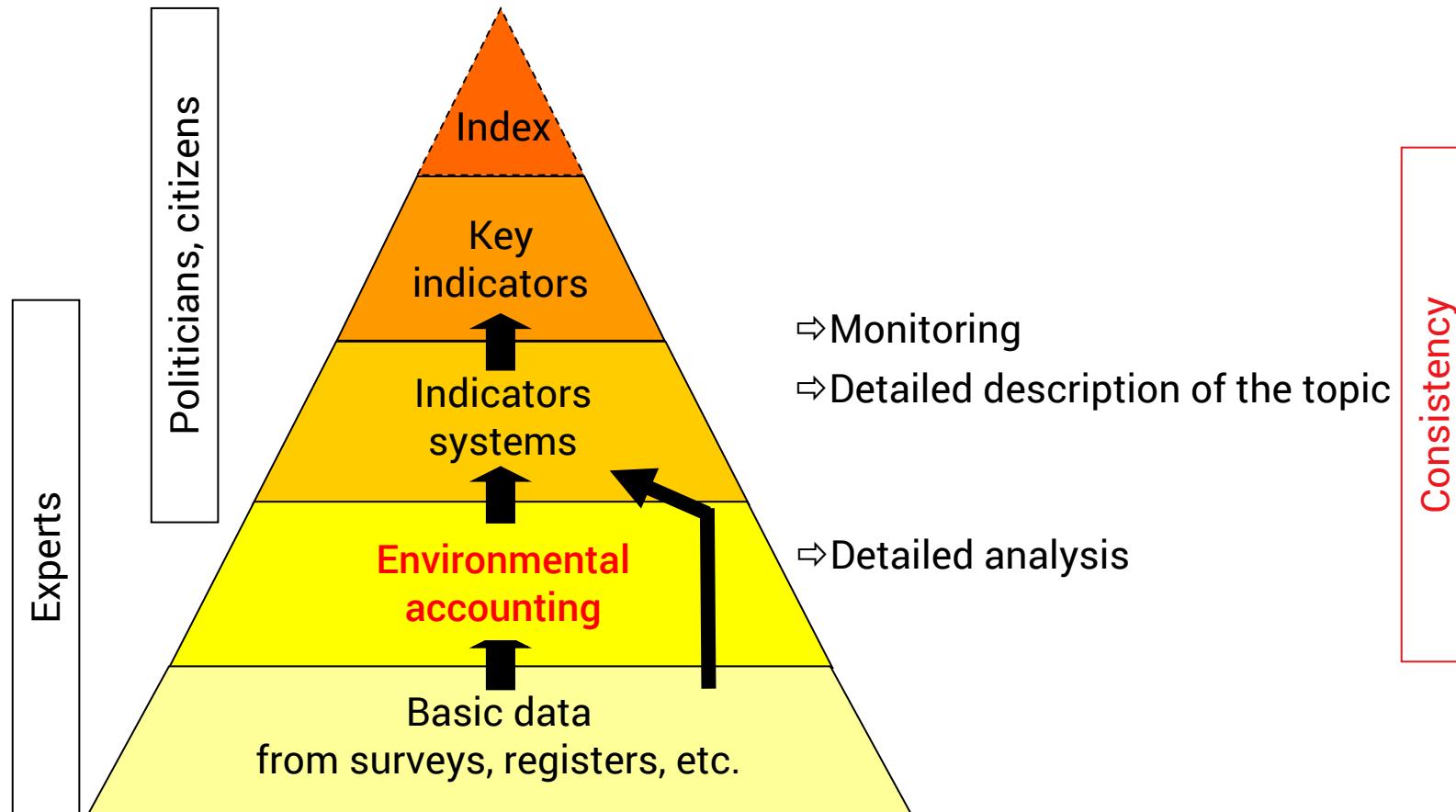
1. Physical flow accounts

2. Monetary flow accounts

3. Asset accounts for natural resources

4. Ecosystem accounts

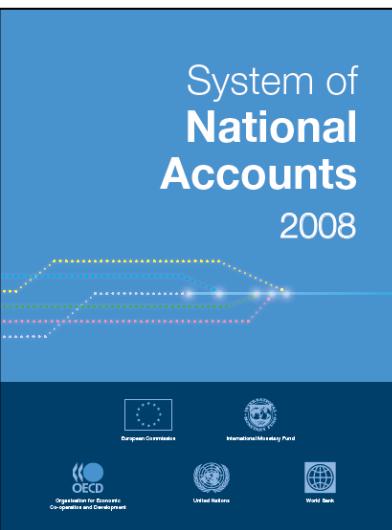
Position in the statistical system



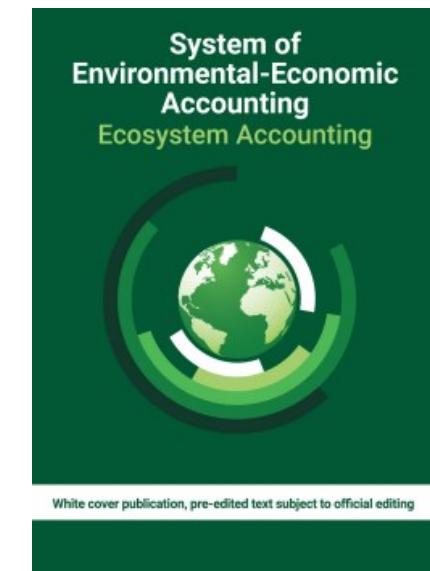
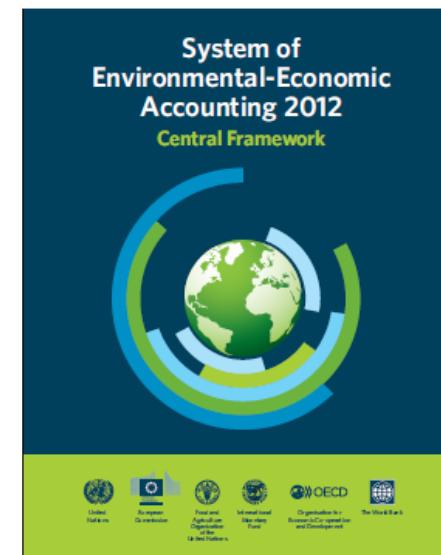
Developments at UNO

System of Environmental and Economic Accounting 2012

The international statistical standard



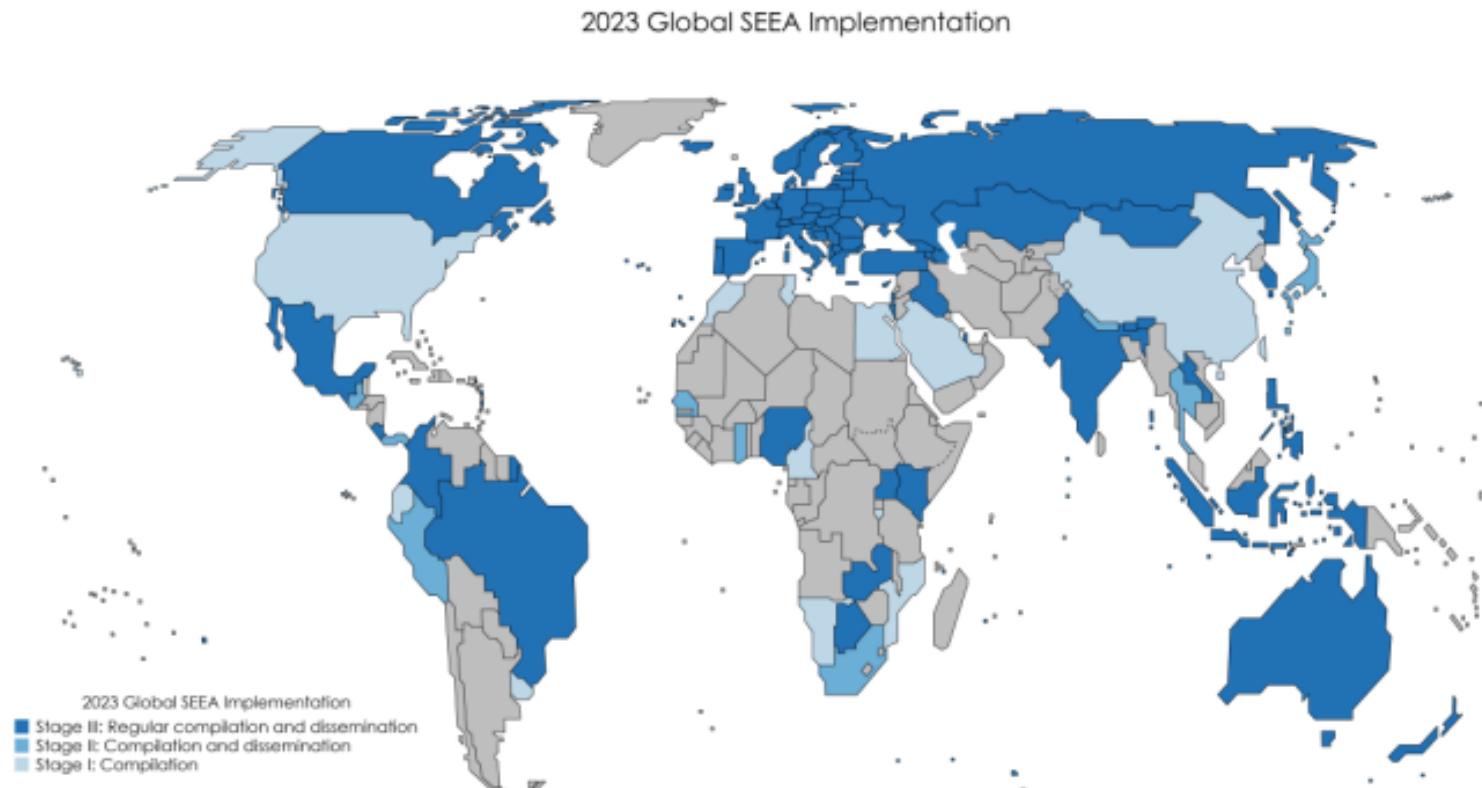
← Counterpart →



<https://seea.un.org/>

adopted by the UN
Statistical Commission in
March 2021

Developments at UNO – Countries involvement in 2023



90 countries:

- 67 publish at least one account on a regular basis (**stage III**)
- 10 publish their accounts on an ad-hoc basis (**stage II**)
- 13 compile, but do not yet publish their accounts (**stage I**)

<https://seea.un.org/>

Current stage at European level

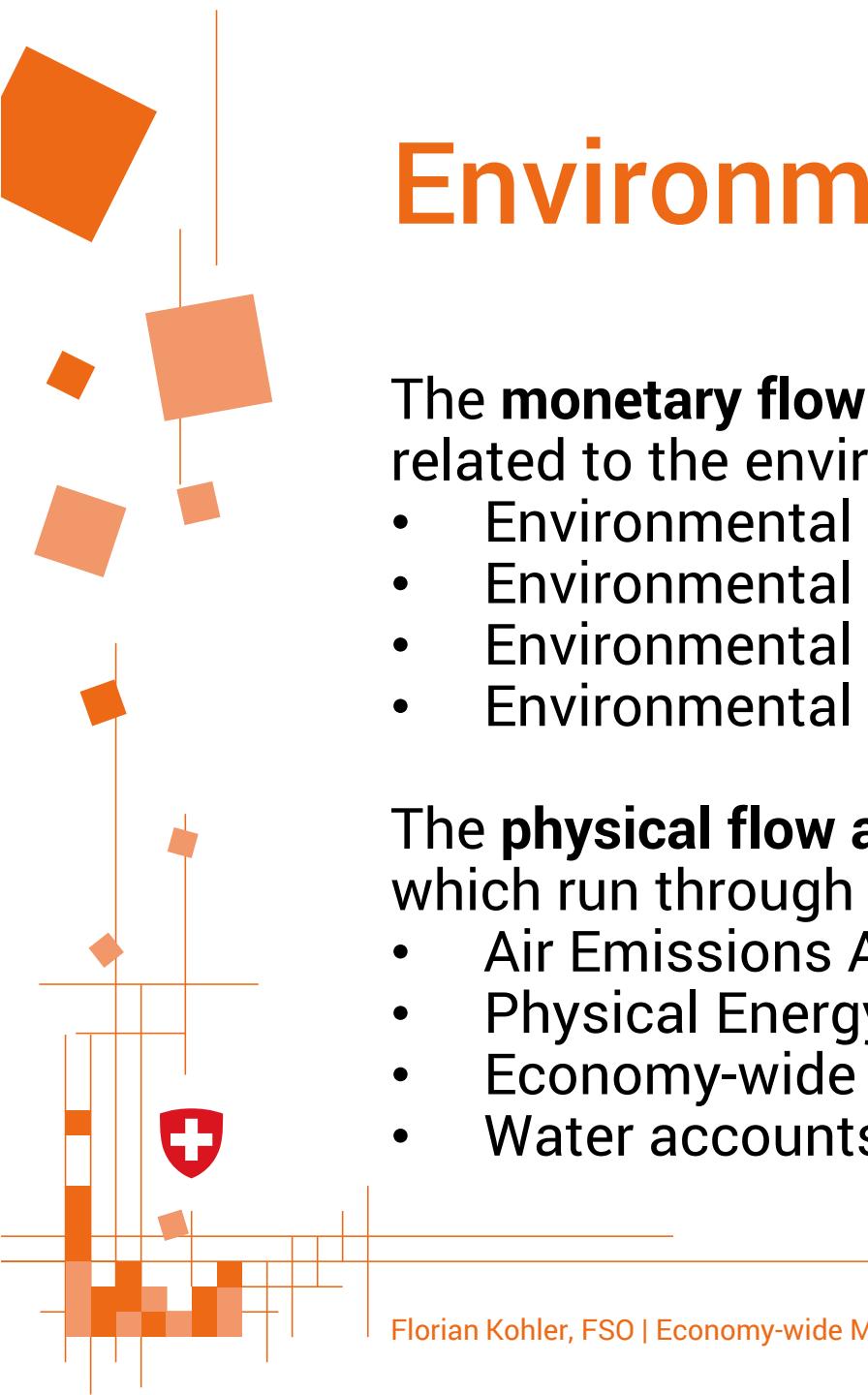


The legal base 691/2011

- EW-MFA - Economy-wide Material Flow Accounts (since 2011)
- AEA - Air Emission Accounts (since 2011)
- TAX - Environmental Taxes by economic activity (since 2011)
- EPEA - Environmental Protection Expenditure Accounts (since 2014)
- EGSS - Environmental Goods and Services Sector accounts (since 2014)
- PEFA - Physical Energy Flow Accounts (since 2014)

Three new modules in the proposed amendment of Regulation (start expected in 2025)

- Environmental subsidies accounts
- Forest accounts
- Ecosystem accounts



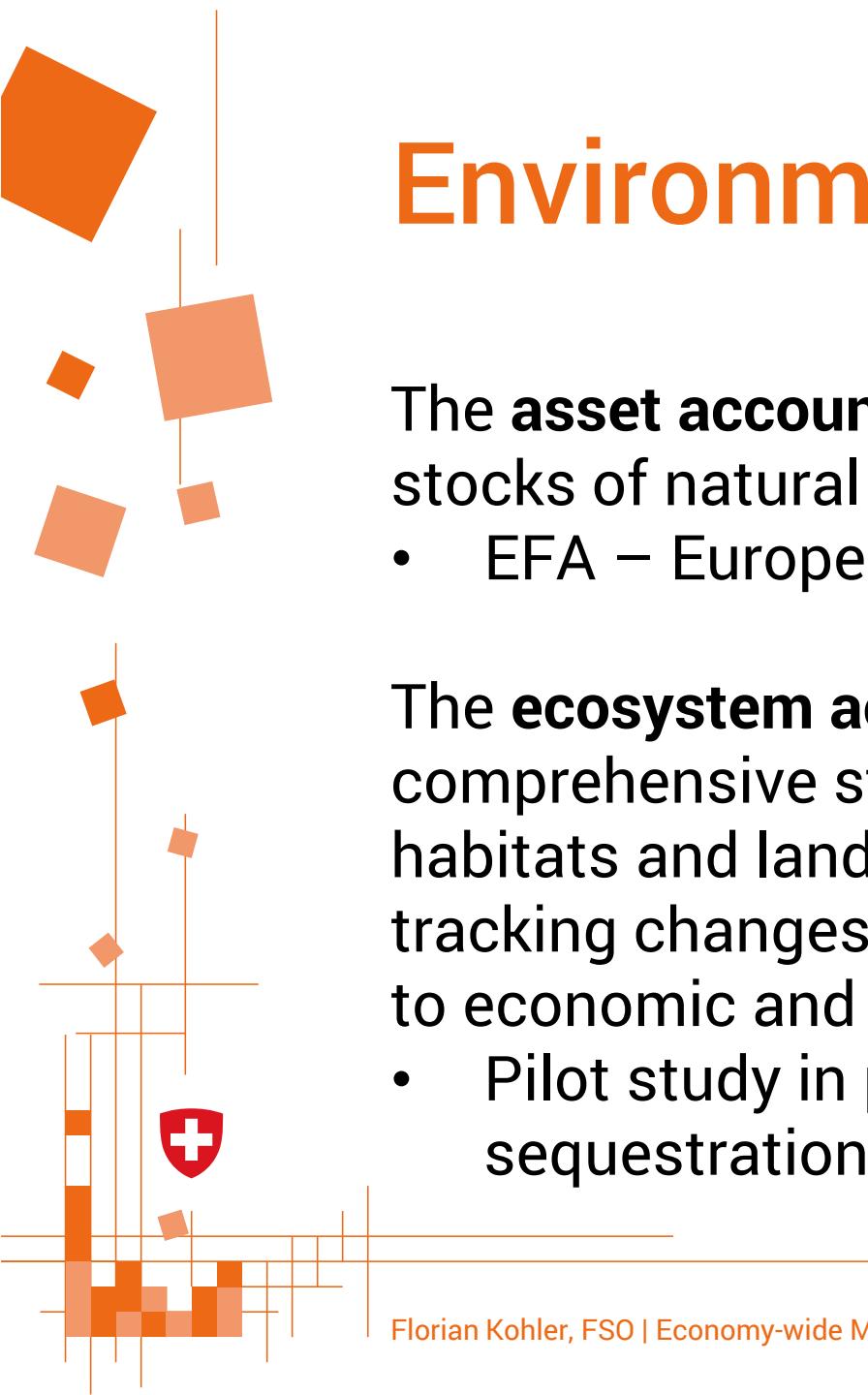
Environmental accounts at FSO

The **monetary flow accounts** provide information on financial transactions related to the environment

- Environmental protection expenditure
- Environmental taxes
- Environmental goods and services sector
- Environmental subsidies and other transfers

The **physical flow accounts** provide information on the physical flows, which run through the economy

- Air Emissions Accounts
- Physical Energy Flow Accounts
- Economy-wide Material Flow Accounts
- Water accounts (pilot study ends in 2025)



Environmental accounts at FSO

The **asset accounts for natural resources** provide information on the stocks of natural resources and their variations

- EFA – European Forest Accounts

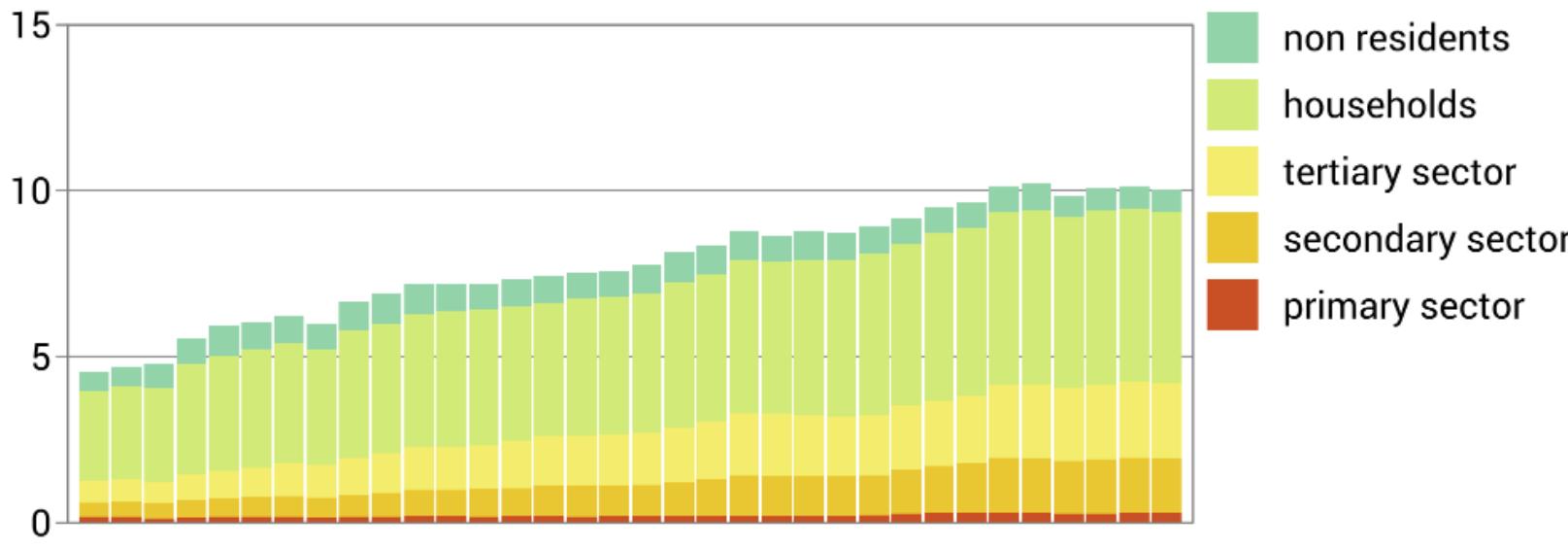
The **ecosystem accounts** constitutes an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity

- Pilot study in progress (focus on Forest ecosystems and Carbon sequestration)

Environmental taxes

Environmentally related taxes revenue
By economic player

CHF billion, at current prices



2022: provisional, 2023: estimates

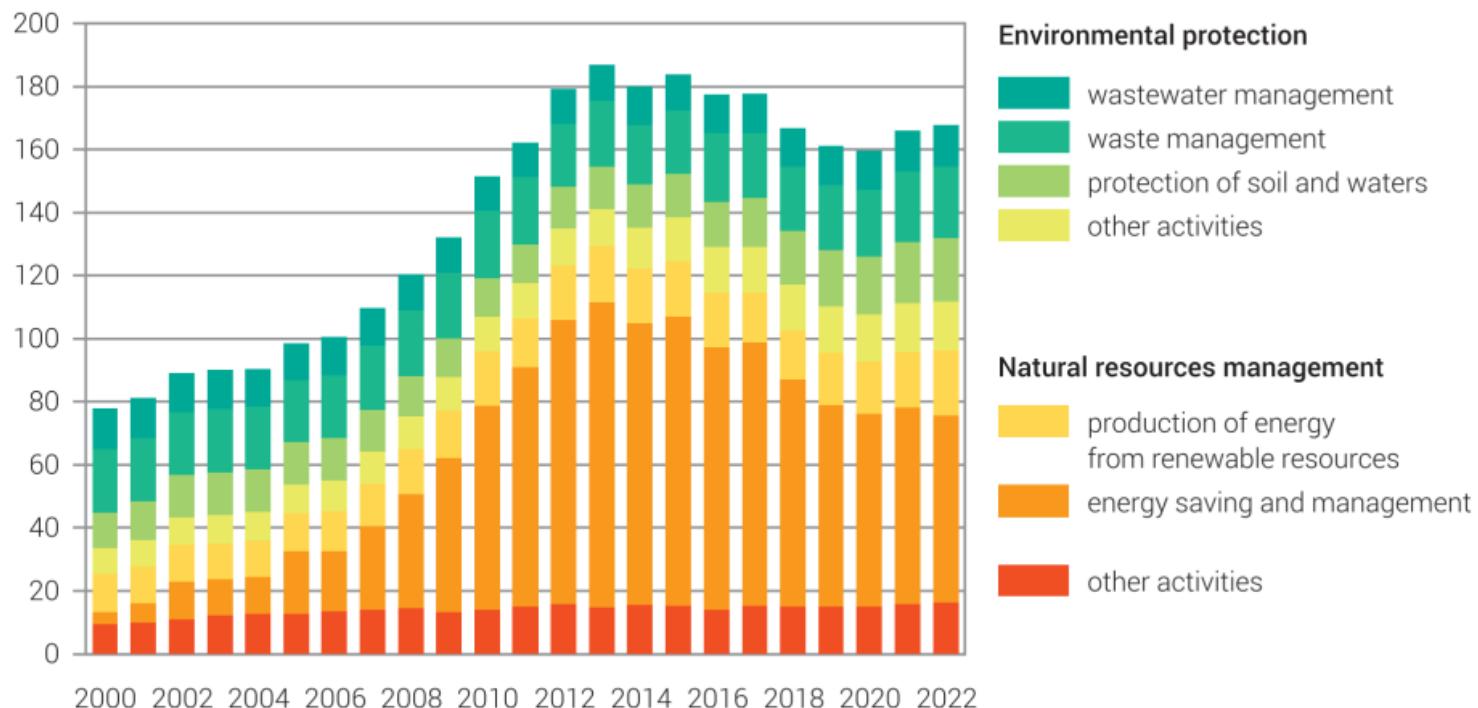
Source: FSO – Environmental accounting

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Environmental goods and services sector

Employees of the environmental sector by domain

Thousand full time equivalents



2022: provisional

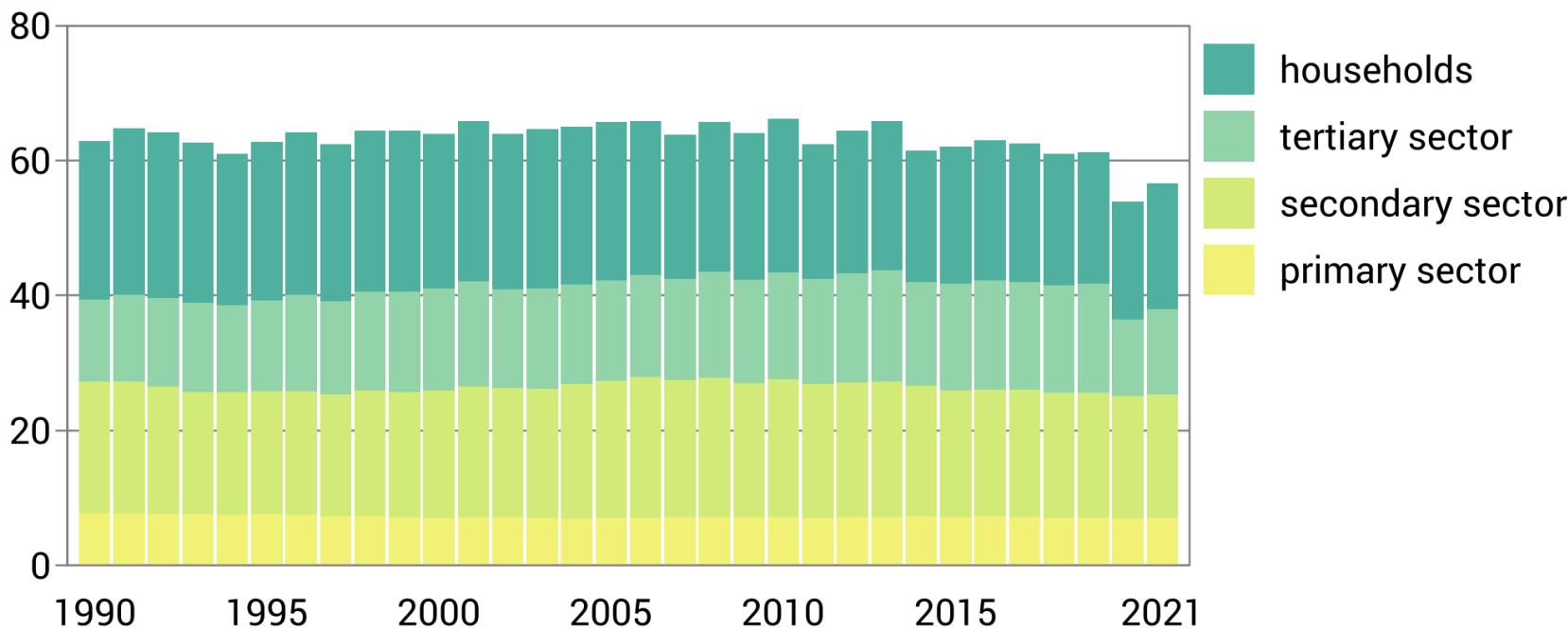
Source: FSO – Environmental accounting

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Air Emissions Accounts

Greenhouse gas emissions by economic player

Million tonnes of CO₂ equivalent, inclusive CO₂ from biomass combustion



Source: FSO – Environmental accounting

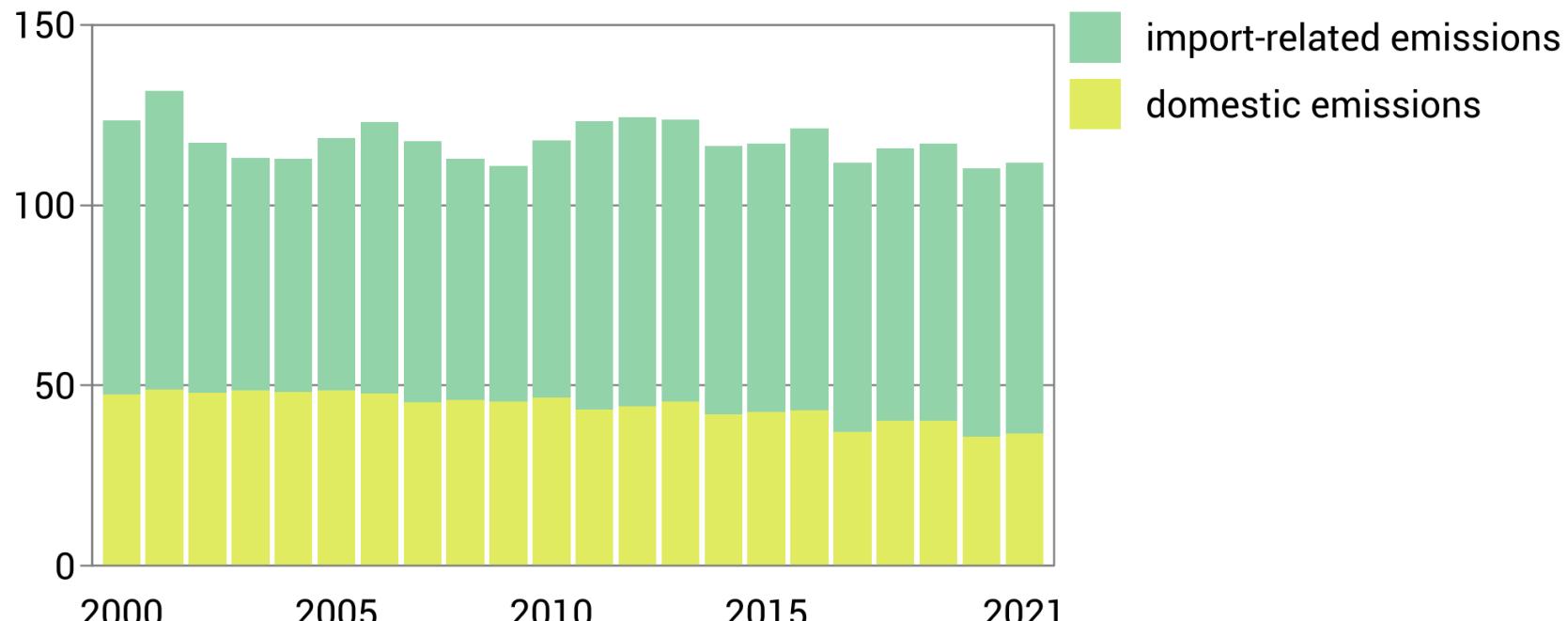
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Air Emissions Accounts

Greenhouse gas footprint

Greenhouse gas emissions due to final domestic demand

Million tonnes of CO₂ equivalent



Source: FSO – Environmental accounting

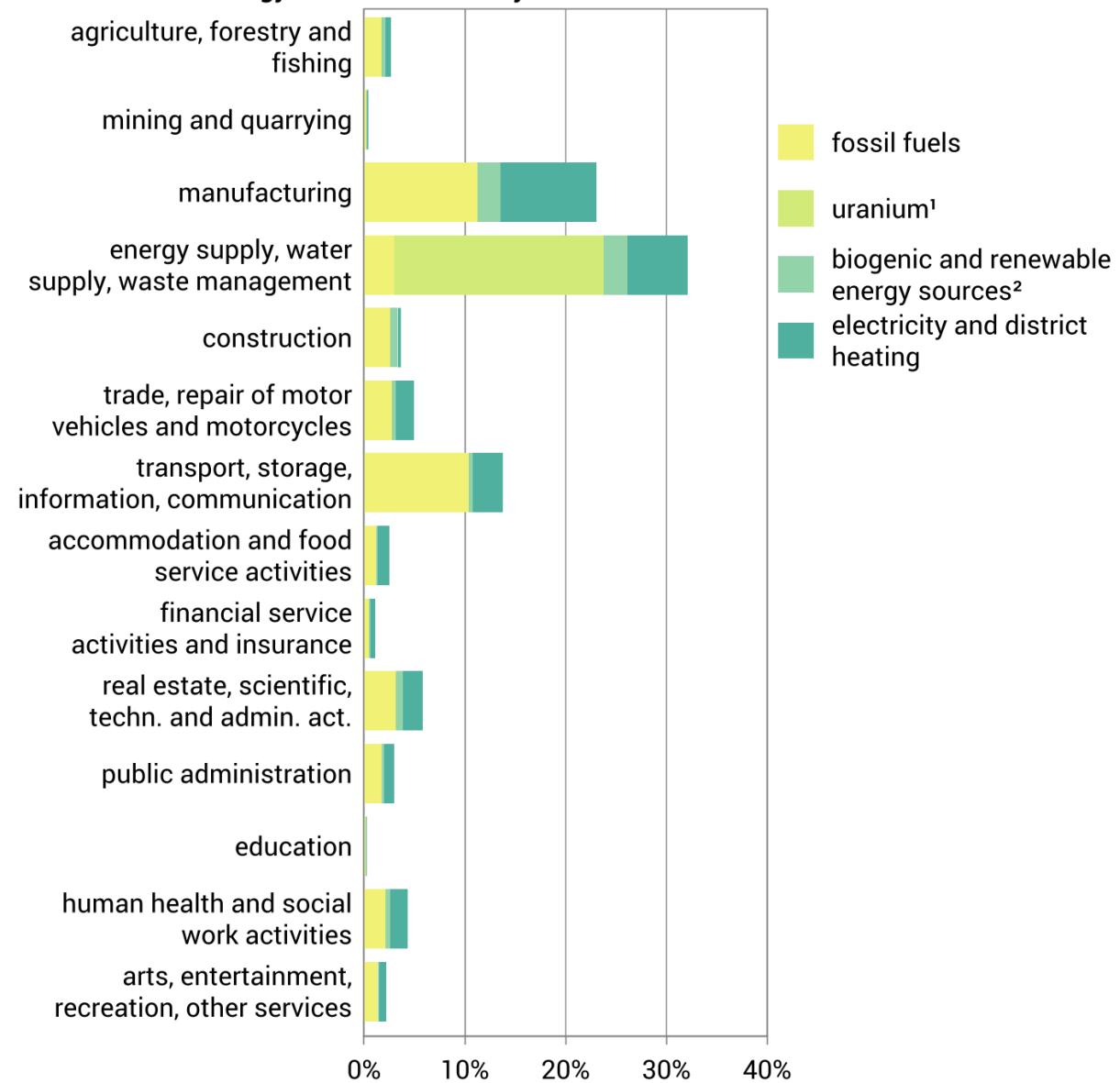
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Physical Energy Flow Accounts

Florian Kohler, FSO | Economy-wide Material flow accounts | EPFL |

Energy use by economic activity, 2021

Percent of total energy use of the economy



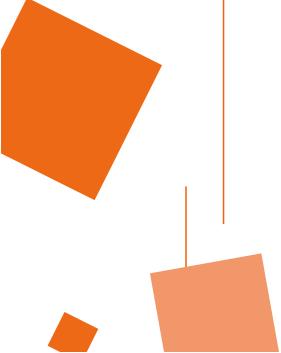
¹ transformation losses of nuclear energy to electricity and district heating

² hydraulic, wind and solar energy transformed in electricity is accounted in electricity

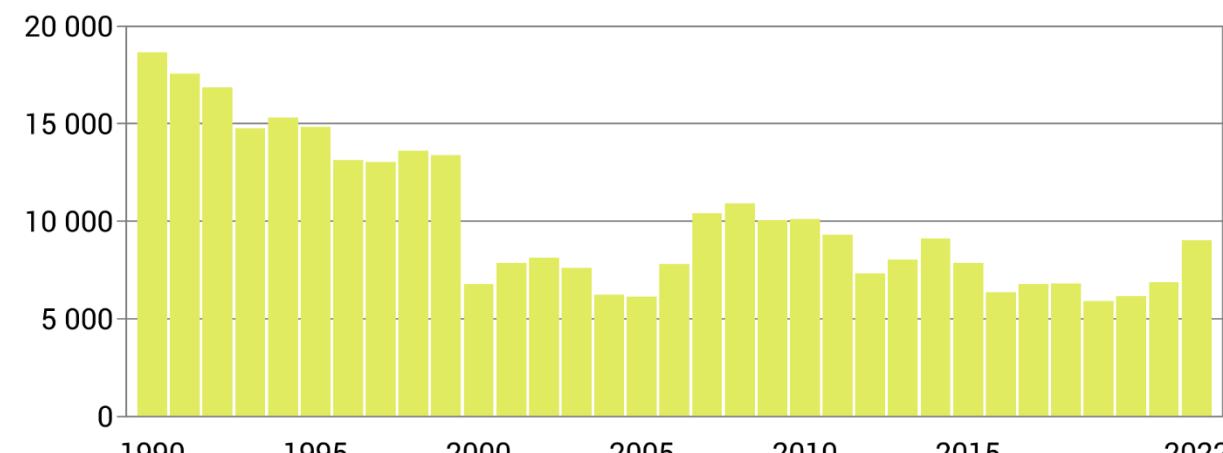
Source: FSO – Environmental accounting

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Forest accounts - standing timber in Swiss forests



Stock économique de bois sur pied
A prix courants, en millions de francs



2021 provisoire, 2022 estimation

Source: OFS – Comptes économiques de la sylviculture

© OFS 2023



Stock de bois sur pied
Volume en écorce, en millions de m³



2021 provisoire, 2022 estimation

Source: OFS – Comptes économiques de la sylviculture

© OFS 2023

Economy-wide Material Flow Accounts EW-MFA



International context

- Eurostat and OECD play a key role
- In 2007, 2009 and 2011, questionnaires were filled by countries (inclusive CH) under gentlemen agreements
- Since 2013 EU member states have to deliver yearly data to Eurostat (Legal base 691/2011)
- Indicators are used in numerous international reports on the environment and sustainable development (SDGs)

EW-MFA - Concept

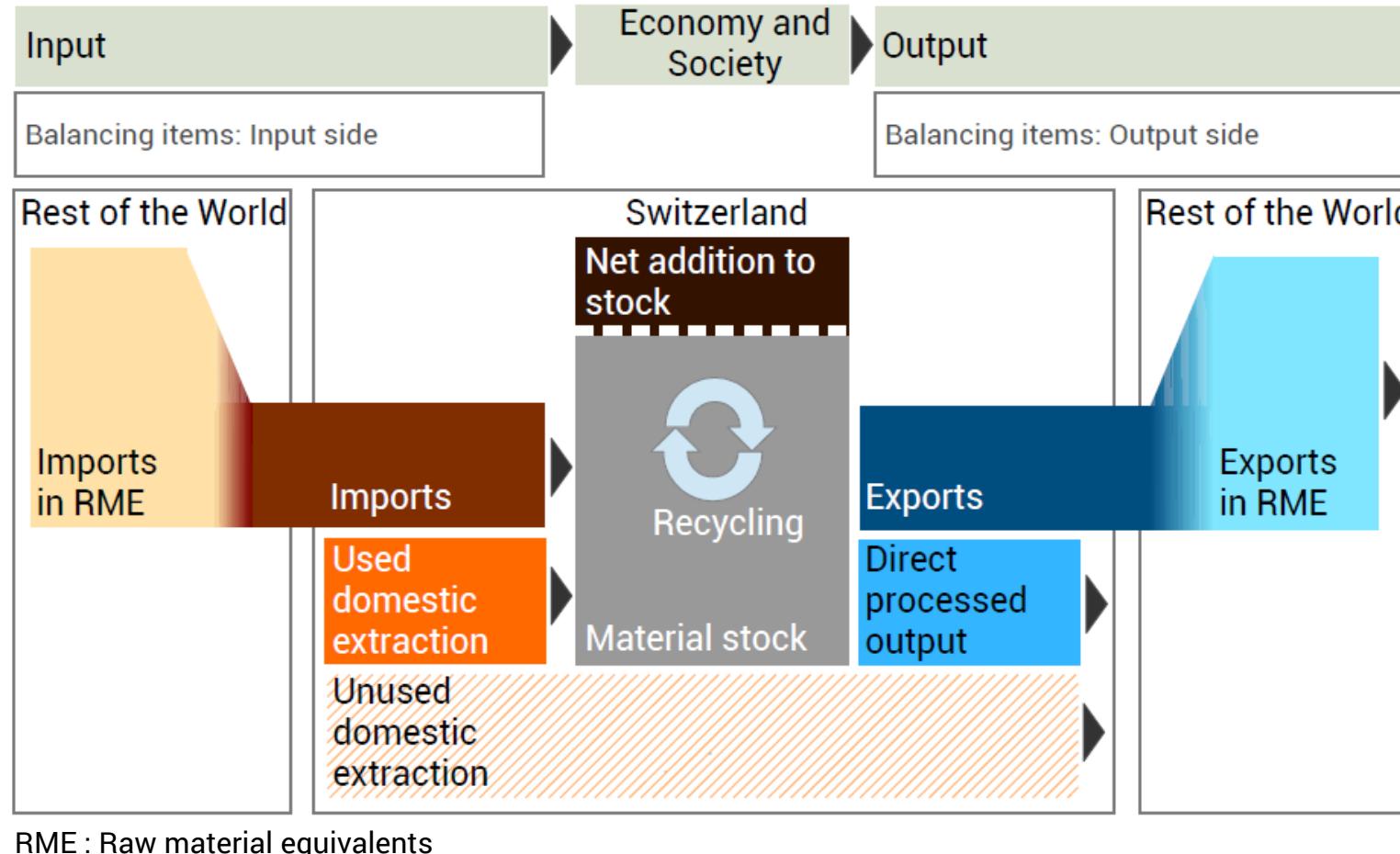
Objective

To measure, in tonnes and yearly, material flow which passes through the economy (inclusive households)

System boundaries

- by the extraction of primary (i.e., raw, crude or virgin) materials from the national environment and the discharge of materials to the national environment
- by the political (administrative) borders that determine material flows to and from the rest of the world (imports and exports)
- only flows which cross these boundaries are taken into account the economy is considered as a black box

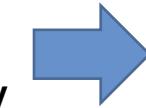
EW-MFA – Overview



EW-MFA – Methodological approach

Production of such a statistic depends on a high number of basic statistics

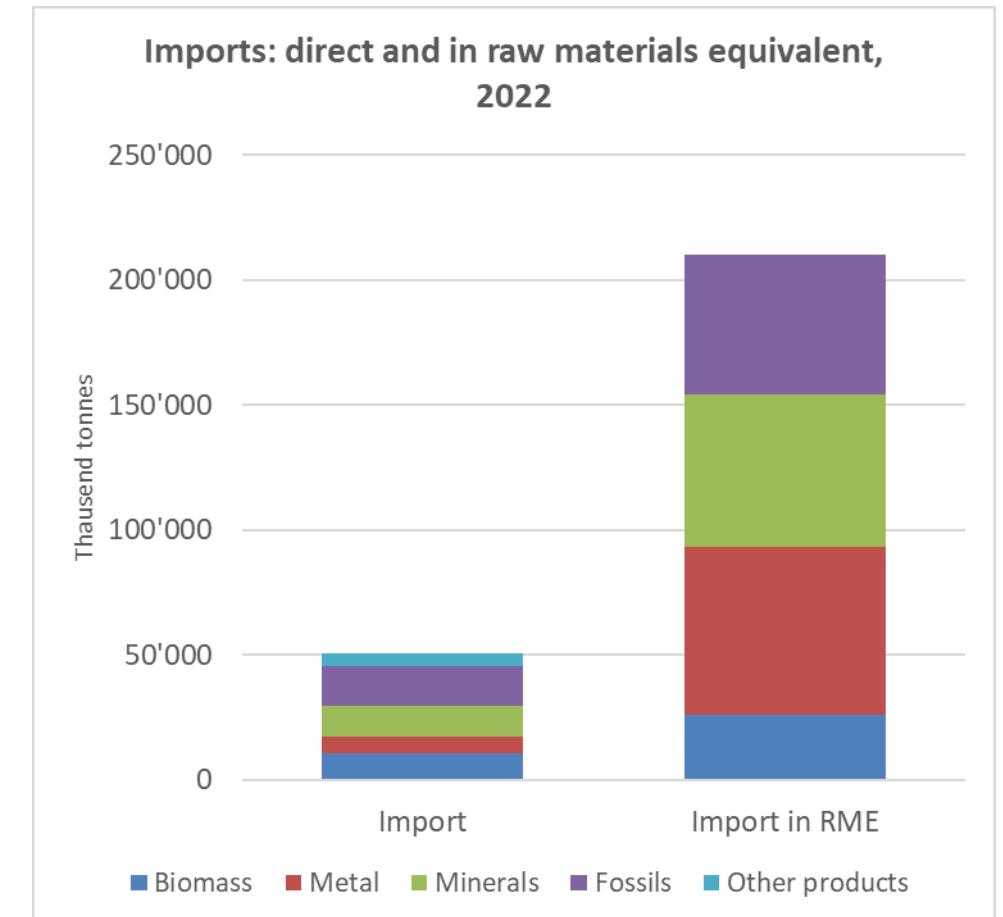
- Economical Accounts for Agriculture EAA
- Economical Accounts for Forestry
- Livestocks and crop area statistics
- Foreign trade statistics
- Energy statistics
- Fishery and Hunting Statistics
- UNFCCC-greenhouse gas emission inventory
- CLRTAP-air pollutants inventory
- Air Emissions Accounts
- Waste statistics
- Industries annual reports
- Estimates for lacking information
- ...



- find the best data source
- gather data in the same database
- harmonize and adjust to the system boundaries
- follow closely if new data sources appear

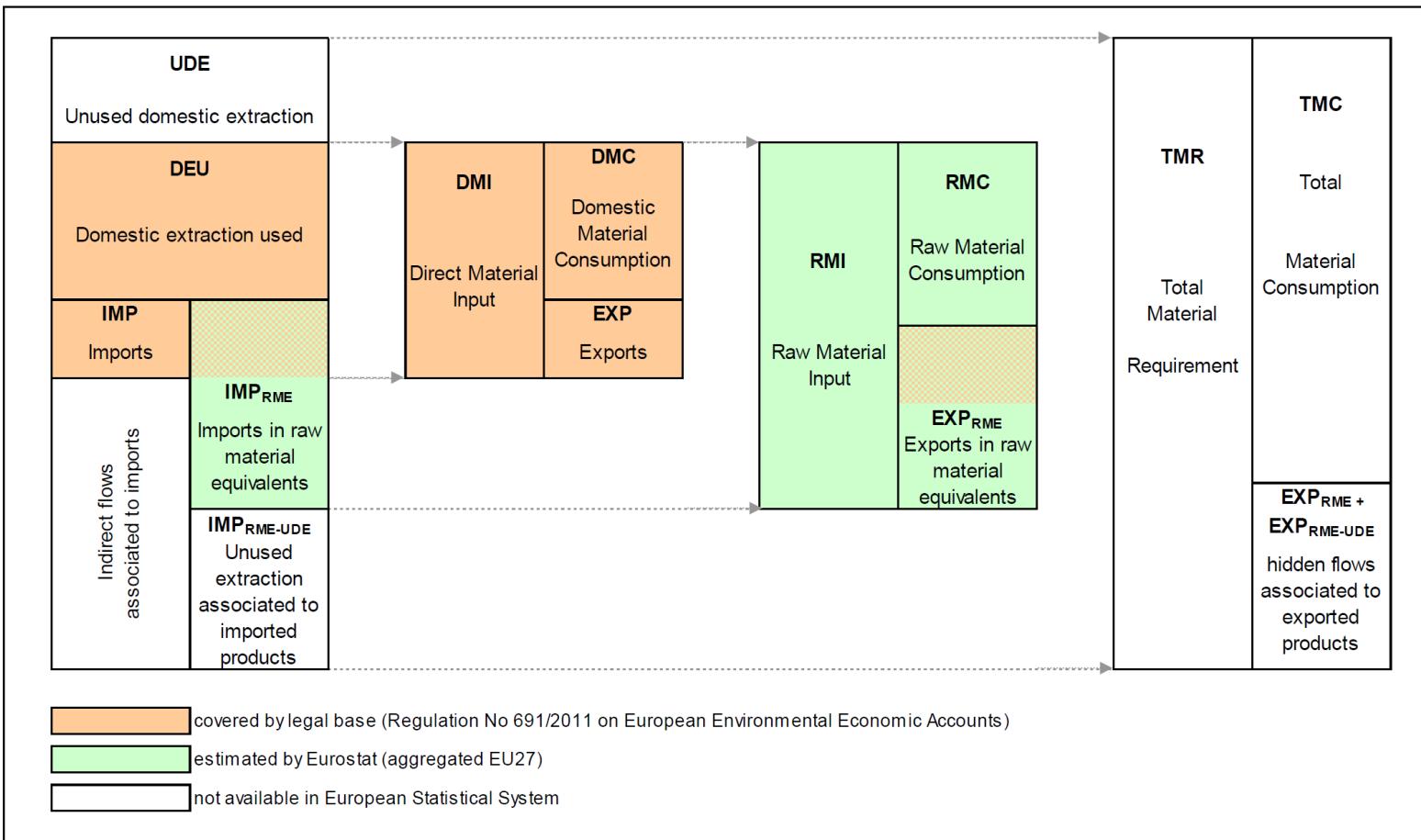
Trade in Raw material equivalent

- The RME flows represent the total mass of raw material extracted for the production and transport of goods and services until they cross the border.
- The RME indicators are the result of modelling and are less reliable than the indicators of direct flows.



Indicators

Figure 1: Scheme for EW-MFA and derived Indicators



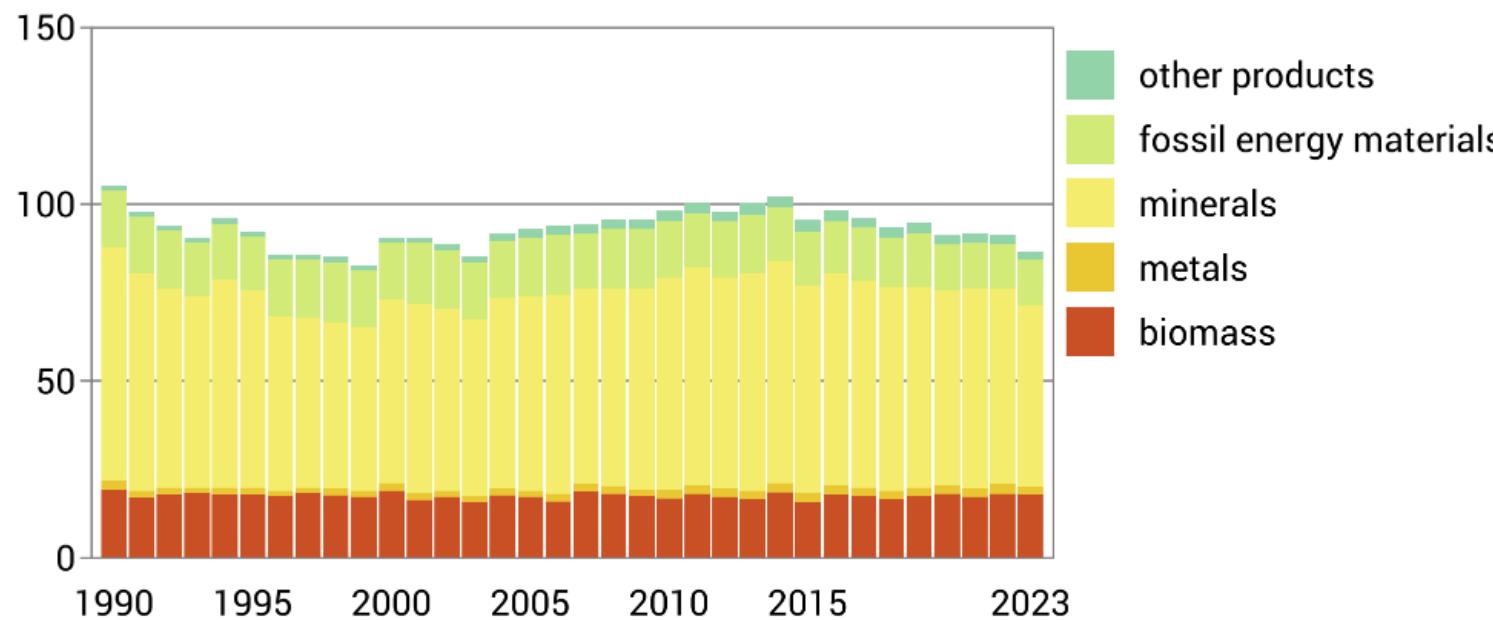
Source: Eurostat, 2013

Direct material consumption - DMC

Domestic extraction + Imports - Exports

Direct material consumption DMC

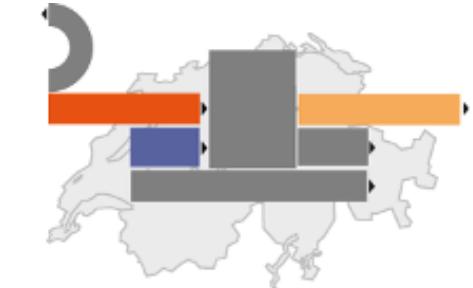
Million tonnes



2023: estimates

Source: FSO – Environmental accounting

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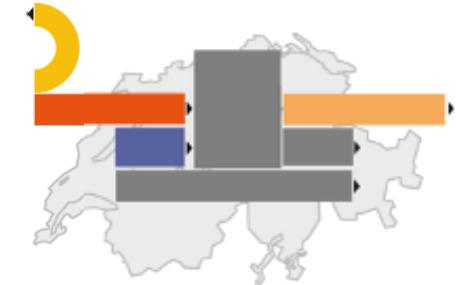
- 2023: 9.7 tonnes of materials per inhabitant and year
- 2023:
 - 3% others
 - 15% fossil fuels
 - 59% minerals
 - 3% metals
 - 20% biomass

Raw material consumption - RMC

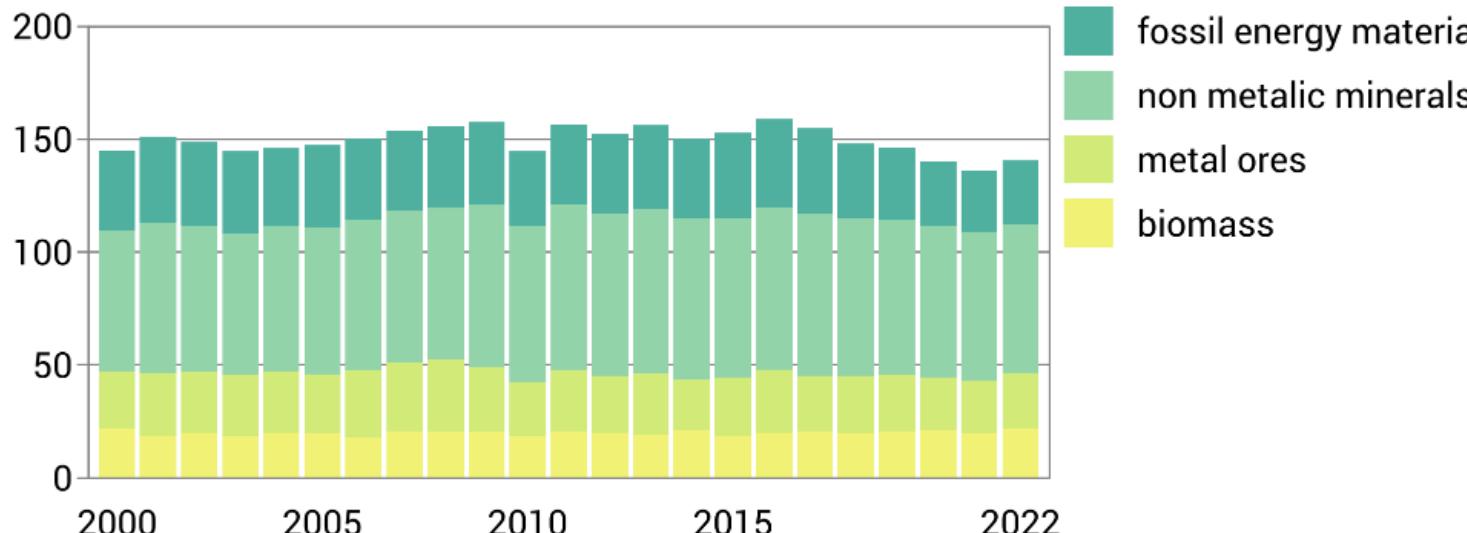
Domestic extraction + Imports in RME – Exports in RME

Material footprint

Raw material consumption RMC¹



Million tonnes



¹ modelling estimates

2022: provisional

Source: FSO – Environmental accounting

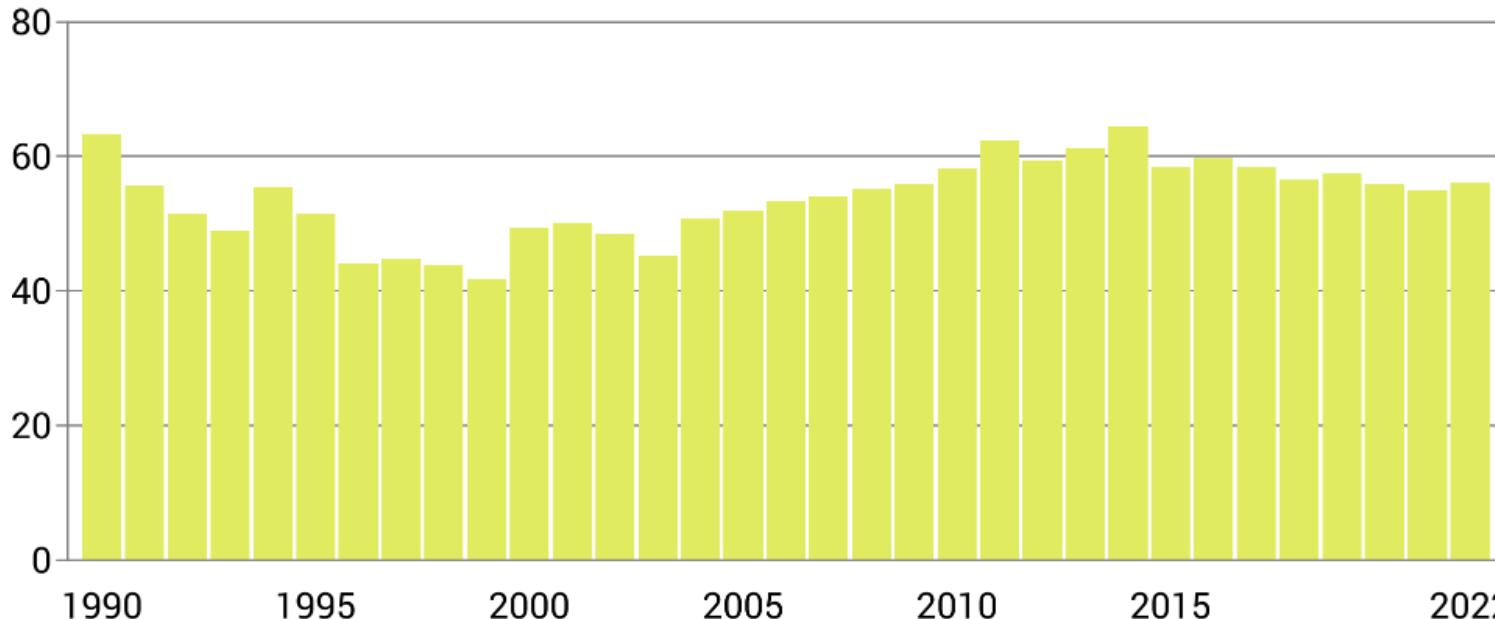
- 2022: 15,9 tonnes of materials per inhabitant and year
- 2022:
 - 16% biomass
 - 47% minerals
 - 17% metals ores
 - 20% fossil fuels

© FSO 2024

Net additions to stock

Net additions to stock¹

Million tonnes



¹ without waste in landfills

- calculated indirectly by difference (input-output)
- 2022: 6,4 tonnes of materials per inhabitant and year

Source: FSO – Environmental accounting

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EW-MFA and the circular economy



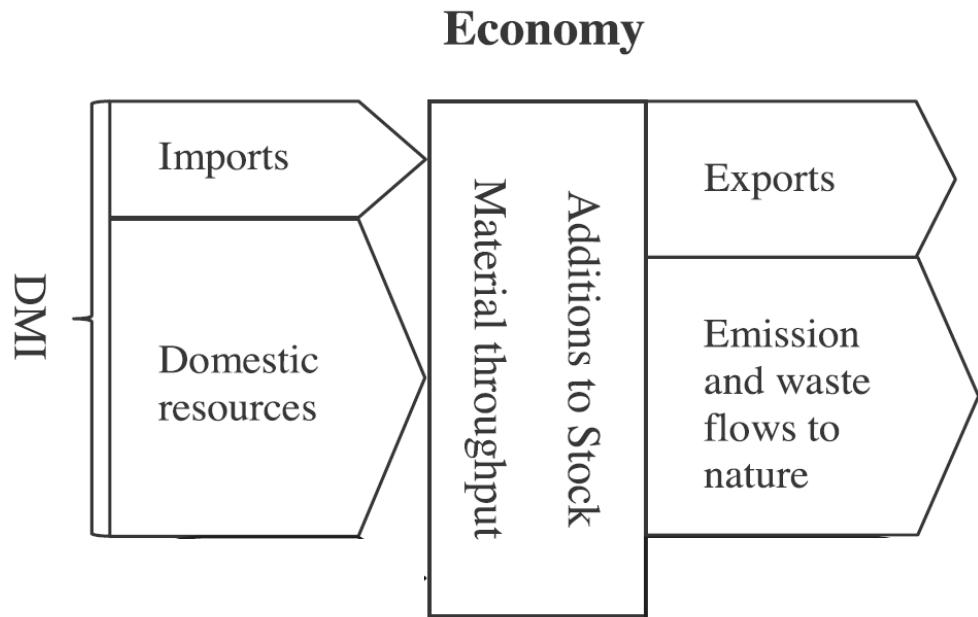
Source: FOEN 2019

Indicators for the EU Circular Economy Action Plan

Code	Indicator	Code	Indicator	Code	Indicator
Production and consumption		Waste management		Secondary raw materials	
1	EU self-sufficiency for critical raw materials	5a	Recycling rate of municipal waste	7a	Contribution of recycled materials to raw materials demand for 26 critical raw material
2	Green Public Procurement in EU-wide public procurement	5b	Recycling rate of all waste excluding major mineral waste	7b	Circular material use rate
3a	Generation of municipal waste	6a	Recycling rate for overall packaging	8	Trade in recyclable raw materials
3b	Generation of waste, excluding major mineral waste per GDP unit	6b	Recycling rate of plastic packaging	Competitiveness and innovation	
3c	Generation of waste, excluding major mineral waste per domestic material consumption	6c	Recycling rate of wooden packaging	9	Private investments, jobs and gross added value to circular economy sector
4	Food waste	6d	Recycling rate of e-waste	10	Number of patents related to recycling and secondary raw materials
		6e	Recycling rate of biowaste		
		6f	Recycling rate construction and demolition mineral waste		

Source: Eurostat 2020

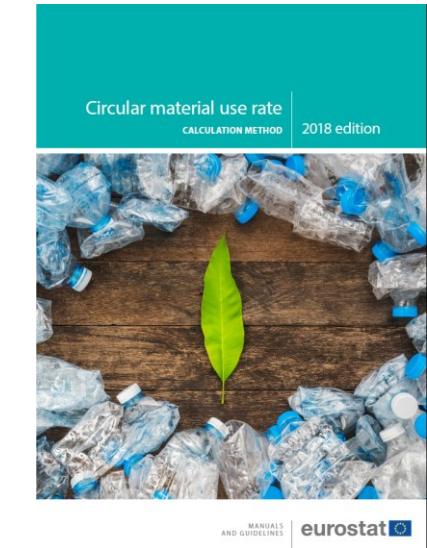
Material flow accounts and the circular economy



Circular material use rate

$$CMU = \frac{U}{M}$$

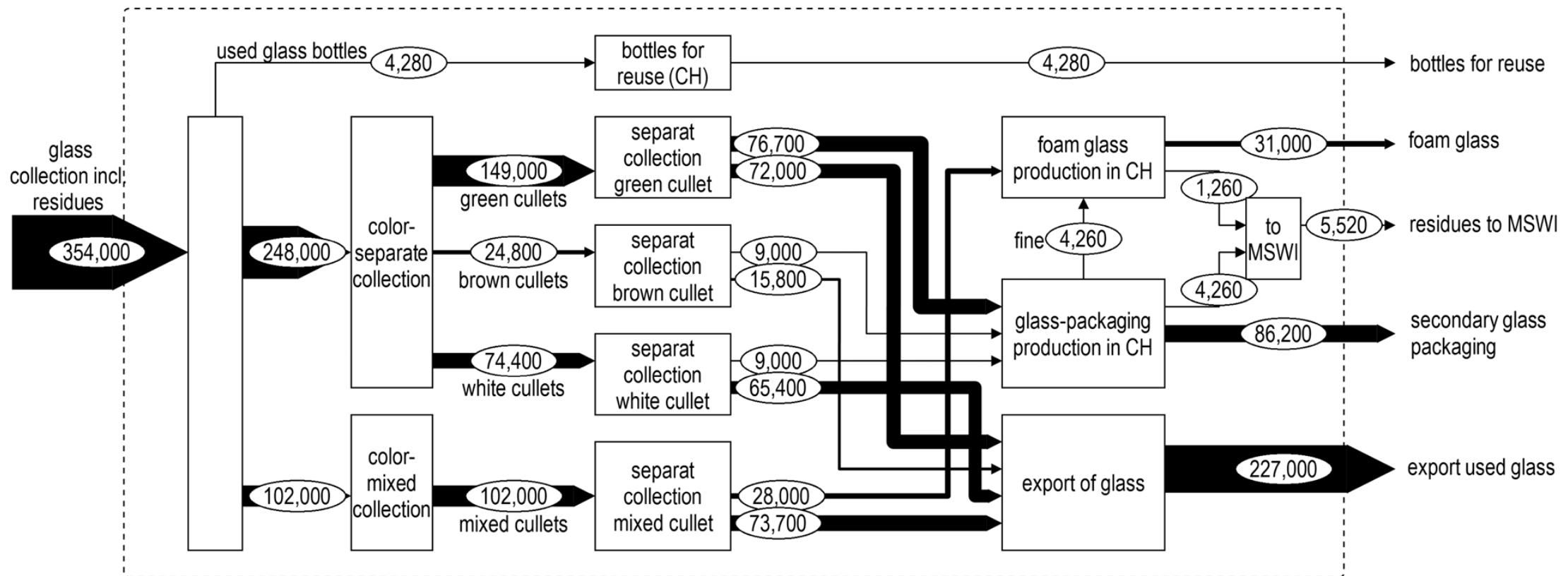
CMU cyclical material use
U cyclical use of materials
M overall use of materials



Source: Kovanda 2014, Eurostat 2018

From theory to practice

Example: material flow analysis, glass recycling in Switzerland, 2012 (Haupt et al. 2017)



The «pragmatic» approach of eurostat



The quantity of secondary raw materials (U) is approximated on the basis of three existing statistics:

- Material flow accounts
- Waste statistics (recovered quantities)
- Foreign trade (waste)

The «pragmatic» approach of eurostat

eurostat

RCV_R = Recovery (excluding
energy recovery and backfilling)

IMP_w = imported waste for recovery

EXP_w = exported waste for recovery

$$CMU = \frac{U}{DMC + U} = \frac{(RCV_R - IMP_w + EXP_w)}{DMC + (RCV_R - IMP_w + EXP_w)}$$

DMC= Domestic material consumption

CMU= Circular material use rate

Source: Eurostat 2018

Specificities for Switzerland

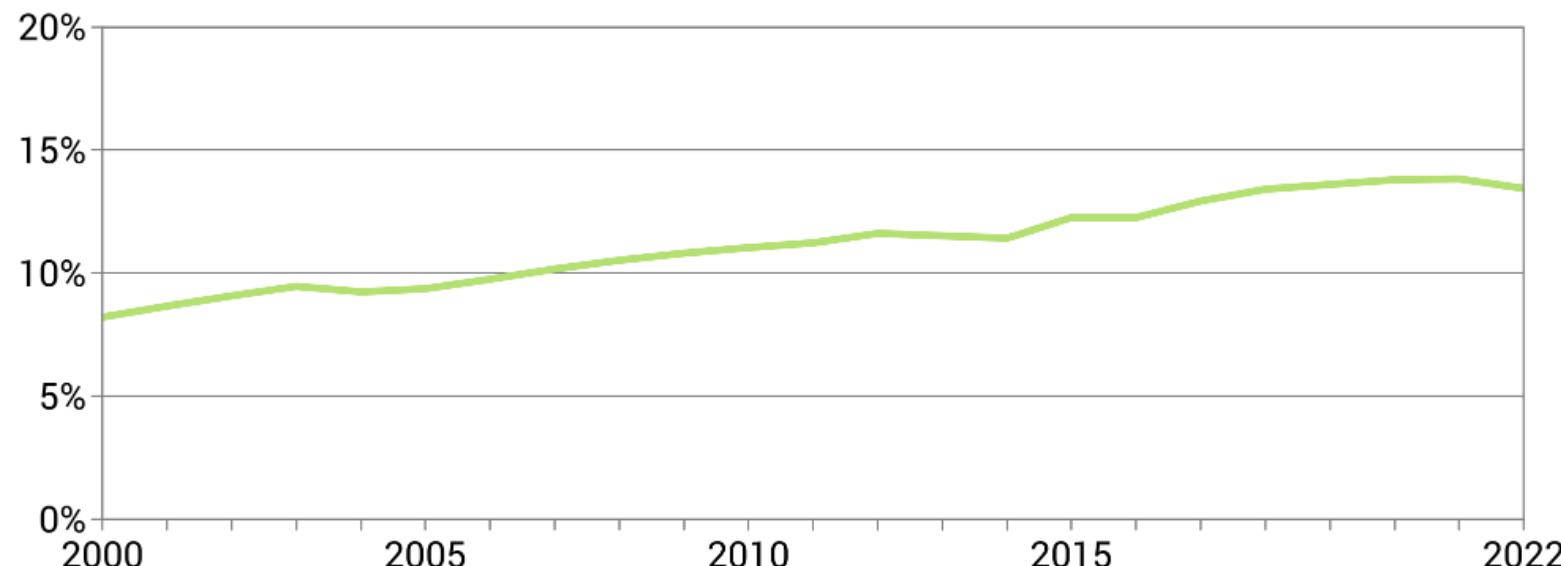
In Switzerland, there are no comprehensive statistics on waste treatment according to the Eurostat approach.

The information must be gathered from the various existing statistics (municipal waste, special waste, construction waste, etc.), trying to come as close as possible to the Eurostat definitions.

Results

Circular material use rate¹

Share of waste recovery streams in total material consumption



¹ estimates

Source: FSO – Environmental accounting

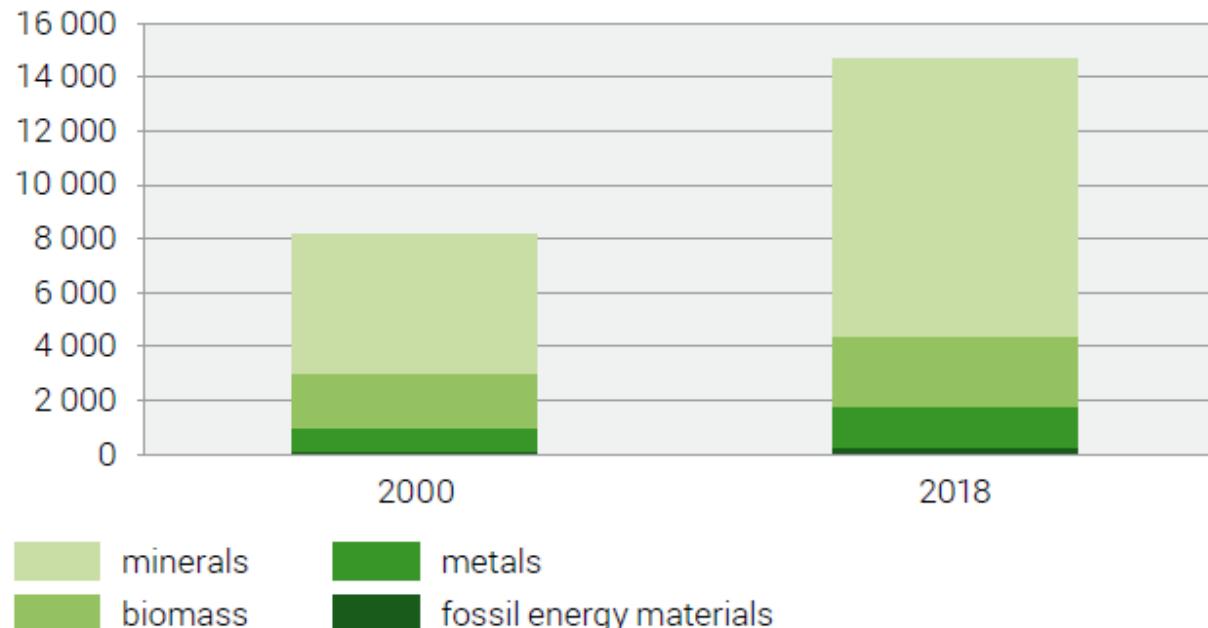
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Results

Circular material use¹

By material categories, in thousand tonnes

G 4



¹ estimates

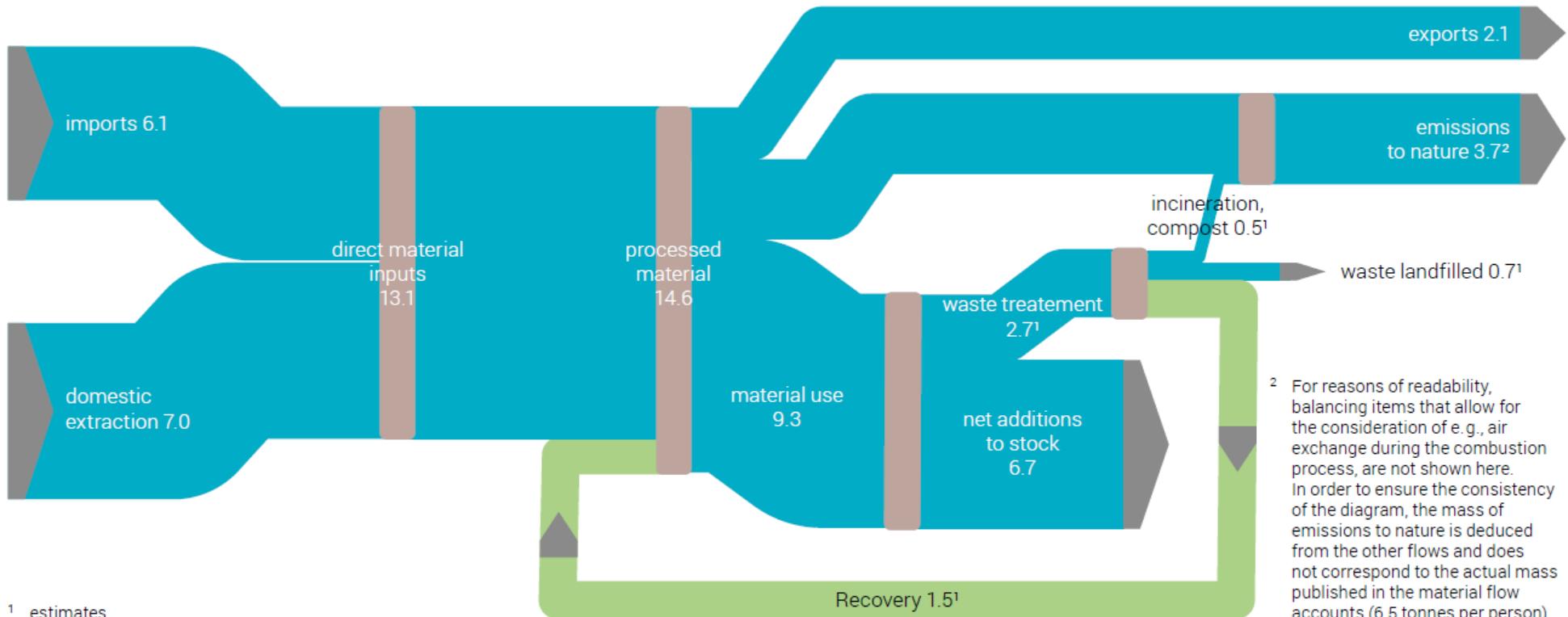
Source: FSO – Environmental accounts

© FSO 2020

Sankey diagram

Material flows in tonnes per person, 2018

G 5



Source: FSO – Environmental accounts

© FSO 2020

Publications and use

Online

OFS: <https://www.bfs.admin.ch/bfs/en/home/statistics/territory-environment/environmental-accounting.html>

The publication about circular economy: <https://www.bfs.admin.ch/bfs/en/home/statistics/territory-environment/environmental-accounting.assetdetail.13487975.html>

Eurostat: <https://ec.europa.eu/eurostat/web/environment/overview>

Data

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

STAT-TAB - interactive tables (FSO)

[px-x-0204000000_101 / Material flow accounts - Direct input flows and their aggregates](https://px-x-0204000000_101)

Material flow accounts - Direct input flows and their agg

Choose variables

About table

Unit of measure Mandatory *

Select all
 Deselect all

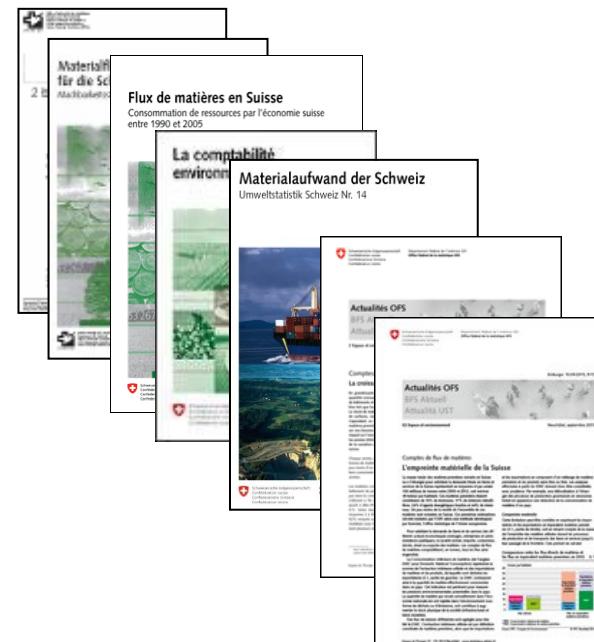
Selected 0 of total 2
Thousands tonnes
Tonnes per capita

Flow Mandatory *

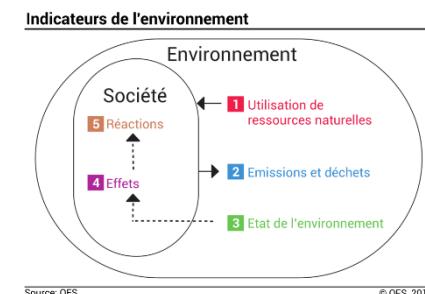
Select all
 Deselect all

Selected 0 of total 6
Domestic extraction used DEU
Imports
Exports
Direct material input DMI
Domestic material consumption DMC
Physical trade balance PTB

Print



Indicators



Thanks
for your attention !

