Steps in Mercury Mass Flow Development

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Sector Definitions, Identifying and Quantification of Flows

Sector Definitions

Sector Definitions from the Toolkit

Using the sector definitions in the UNEP Mercury Inventory Toolkit is recommended for national mercury mass flow assessments:

- ❑ Many things have been given and predefined.
- ❑ Based on the flows of mercury, focusing on where mercury enters society.
- ❑ Toolkit Level 2 offers users the possibility to add extra sectors.

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Extraction and Use of Fuels/Energy Sources

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.1.1	Coal combustion in large power plants	III	I	I	I	III	Coal washing, combustion, residue and discharge management
5.1.2	Other coal combustion	III		I	I	I	Coal washing, combustion, residue and discharge management
5.1.3	Extraction, refining and use of mineral oil	III	III	I	I	I	Extraction, refining, combustion
5.1.4	Extraction, refining and use of natural gas	III	III	III	I	III	Extraction, refining, combustion
5.1.5	Extraction and use of other fossil fuels	III	I	I		I	Extraction, refining, combustion
5.1.6	Biomass fired power and heat production	III	I	I		I	Combustion, residues and discharges management
5.1.7	Geothermal power production	III					Emissions/releases management

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Sector Definitions

Primary (Virgin) Metal Production

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.2.1	Primary extraction and processing of mercury	III	III	III	III	III	Extraction and processing
5.2.2	Gold and silver extraction with mercury-amalgamation process	III	III	III			Extraction and processing
5.2.3	Zinc extraction and initial processing	III	III	III	III	III	Mining and production of concentrates. Extraction of primary zinc from concentrate
5.2.4	Copper extraction and initial processing	III	III	III	III	III	Mining and production of concentrates. Extraction of primary zinc from concentrate
5.2.5	Lead extraction and initial processing	III	III	III	III	III	Mining and production of concentrates. Extraction of primary zinc from concentrate
5.2.6	Gold extraction and initial processing by other processes than mercury amalgamation	III	III	III	III	III	Mining (and production of concentrates). Extraction of primary zinc from concentrate
5.2.7	Aluminum extraction and initial processing	III		I		III	Production of alumina from bauxite. Production of aluminium from alumina
5.2.8	Extraction and processing of other non-ferrous metals	III	III	III		III	Extraction and processing
5.2.9	Primary ferrous metal production	III				I	Sintering and blast furnace

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Sector Definitions

Production of Other Minerals and Materials

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.3.1	Cement production	III		I	I	I	Cement clinker production
5.3.2	Pulp and paper production	III	I	I		I	Pulp production (whether integrated in paper production facility or not)
5.3.3	Lime production and light weight aggregate kilns	III			I		Production phase
5.3.4	Others minerals and materials						All steps with significant mercury releases (depending on individual process sequence)

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Sector Definitions, Identifying and Quantification of Flows

Sector Definitions

Intentional Use of Mercury in Industrial Processes

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.4.1	Chlor-alkali production with mercury-technology	III	III	III	III	III	All core production steps of the mercury-cell technology (normally conducted in the "cell room")
5.4.2	VCM (vinyl-chloride-monomer) production with mercury-dichloride ($HgCl_2$) as catalyst	I	I			III	VCM production (with acetylene process only)
5.4.3	Acetaldehyde production with mercury-sulphate ($HgSO_4$) as catalyst	?	?	?	?	?	Production applying mercury-sulphate
5.4.4	Other production of chemicals and polymers with mercury compounds as catalysts	?	?	?	?	?	All steps with significant mercury releases (depending on individual process sequence)

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Consumer Products with Intentional Use of Mercury

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.5.1	Thermometers with mercury	III	III	III	III	III	Production, use and disposal
5.5.2	Electrical and electronic switches, contacts and relays with mercury	III	I	III	III	III	Production, use and disposal
5.5.3	Light sources with mercury	III	I	III	III	III	Production, use and disposal
5.5.4	Batteries containing mercury	III	I	III	III	III	Production, use and disposal
5.5.5	Polyurethane with mercury catalyst	III	I	I	III	III	Production, use and disposal
5.5.6	Biocides and pesticides	III	III	III	III	III	Production, use and disposal
5.5.7	Paints	III	I	I	III	I	Production, use and disposal
5.5.8	Pharmaceuticals for human and veterinary uses	III	I	I	I	III	Production, use and disposal
5.5.9	Cosmetics and related products		III		III	I	Production, use and disposal

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Sector Definitions

Other Intentional Product / Process Uses

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.6.1	Dental mercury-amalgam fillings	I	III		III	III	Preparation of fillings, use (in the mouth) and excavation/extraction/disposal
5.6.2	Manometers and gauges	I	III	I	III	III	Production, use and disposal
5.6.3	Laboratory chemicals and equipment	I	III		III	III	Production, use and disposal
5.6.4	Mercury metal use in religious rituals and folklore medicine	III	III	III	III	III	Production, use and disposal
5.6.5	Miscellaneous product uses, mercury metal uses and other sources	III	III	III	III	III	All steps with significant mercury releases (depending on individual products and processes)

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Production of Recycled Metals

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.7.1	Production of recycled mercury ("secondary production)	III	III	III	III	III	Collection and treatment/processing
5.7.2	Production of recycled ferrous metals (iron and steel)	III	I	I		I	Collection and treatment/processing
5.7.3	Production of other recycled metals	III	I	I		I	Collection and treatment/processing

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

Waste Incineration / Burning

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.8.1	Incineration of municipal/ general waste	III	I	I	I	III	Controlled waste incineration (high-tech, with filters, etc.), management of solid residues and liquid discharges
5.8.2	Incineration of hazardous waste	III	I			III	Controlled waste incineration (high-tech, with filters, etc.) , management of solid residues and liquid discharges
5.8.3	Incineration of medical waste	III	I			III	Incineration/burning of medical waste, management of solid residues and liquid discharges
5.8.4	Sewage sludge incineration	III	III			III	Controlled sludge incineration (high-tech, with filters, etc.) , management of solid residues and liquid discharges
5.8.5	Open waste burning on landfills and informally	III	III	III			Open burning of waste (MSW and other)

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

Waste Deposition/Landfilling/Dumping and Wastewater Treatment

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.9.1	Controlled landfills/deposits	I	I	III		III	At and after disposal
5.9.2	Diffuse deposition under some control	I	III	III		III	At and after disposal
5.9.3	Informal local disposal of industrial production waste	III	III	III			At and after disposal
5.9.4	Informal dumping of general waste	III	III	III			Considered direct releases to land; Phases: At and after disposal
5.9.5	Waste water system/treatment		III	III		I	Releases to waterways and with sludge to land, etc.

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Crematoria and Cemeteries / Burial sites

Chapter	Sub-category	Air	Water	Land	Product	Waste	Life cycle phases to include
5.10.1	Crematoria	III				I	Cremation, and if equipped with mercury filter: disposal of filter materials
5.10.2	Cemeteries			III			Burial and later

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

Hot-spots, that may Cause Secondary Releases

Sub-category	Air	Water	Land	Product	Waste
Closed/abandoned chlor-alkali production sites	I	III	III		III
Other sites of former chemical production where mercury compounds were produced (pesticides, biocides, pigments etc.), or mercury or compounds were used as catalysts (VCM/PVC etc.)	I	III	III	I	III
Closed production sites for manufacturing of thermometers, switches, batteries and other products	I	III	III	III	I
Closed pulp and paper manufacturing sites (with internal chlor-alkali production or former use of mercury-based slimicides)	I	III	III		III
Tailings/residue deposits from mercury mining	I	III	III	III	III
Tailings/residue deposits from artisanal and large scale gold mining	I	III	III		III
Tailings/residue deposits from other non-ferrous metal extraction	I	III	III	III	III
Sites of relevant accidents	I	III	III		III
Dredging of sediments	I	III	III		III
Sites of discarded district heating controls (and other fluid controls) using mercury pressure valves		III	III		
Sites of previous recycling of mercury ("secondary" mercury production)	I	III	III	III	III

Notes: Products include by-products or recovered mercury, Waste management includes recycling/recovery (except open dumping/burning)
III - Release pathway expected to be predominant for the sub-category;
I - Additional release pathways to be considered, depending on specific source and national situation.

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Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Sector Definitions

Identification of Flows

Identifying Flows

A flow is any movement of the material from one physical place or environmental medium to another.

- Any flow going into and coming out of one physical place or environmental medium.
- Flow to another sector or environmental medium within the boundary.
- The most important out flow from each source sub-category, or sector, is indicated in the source category of the Toolkit Reference Report.

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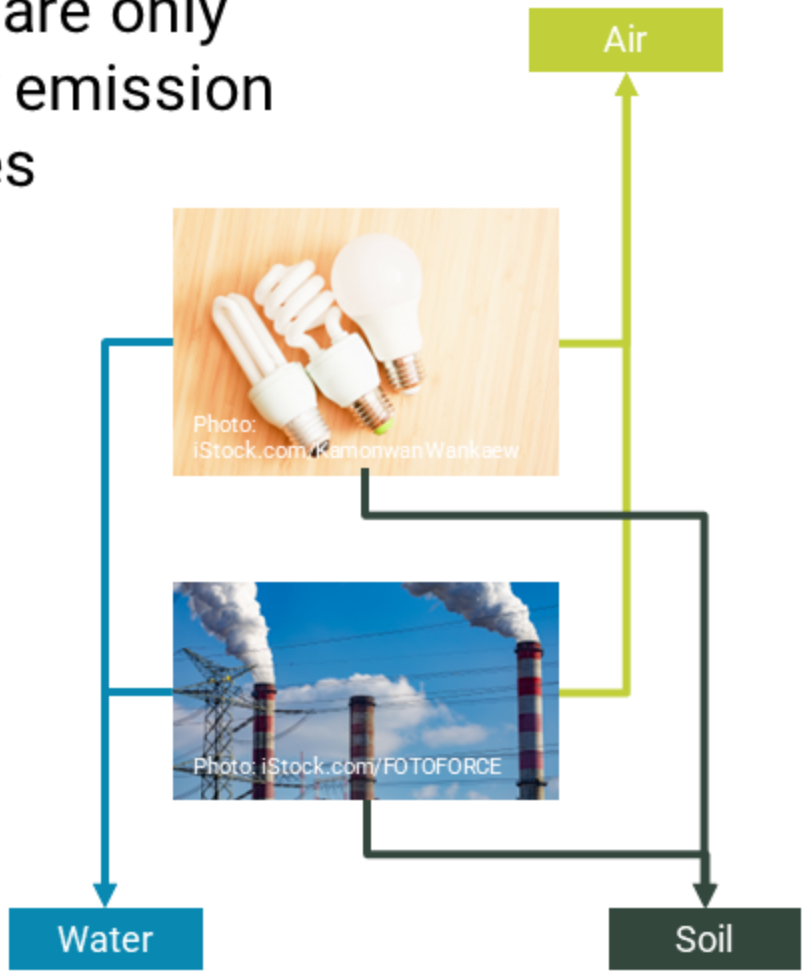
Mercury Releases to the Environment

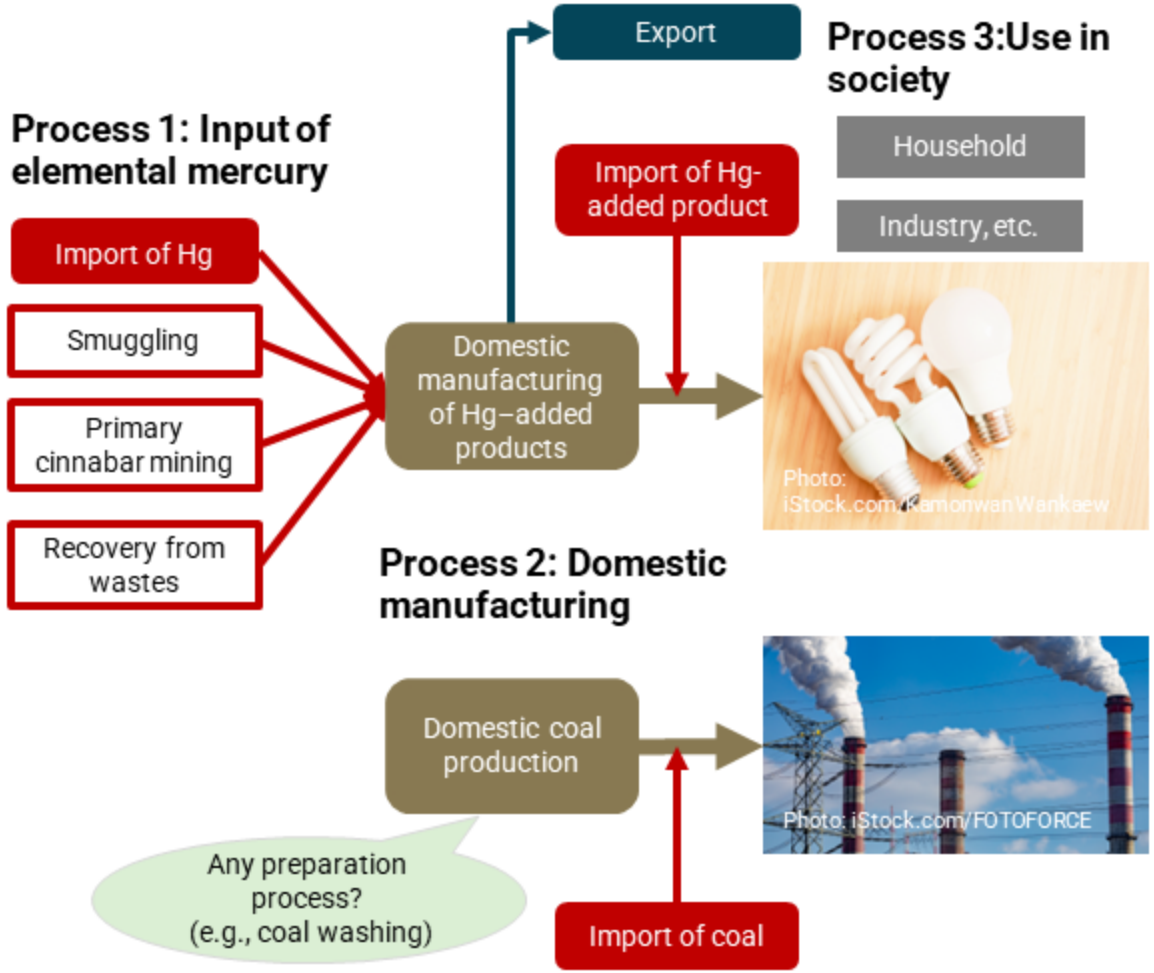
Assume that there are only two major mercury emission and release sources

Mercury-added products

Coal-fired power plants



Inflow of Mercury



Where is mercury coming from?

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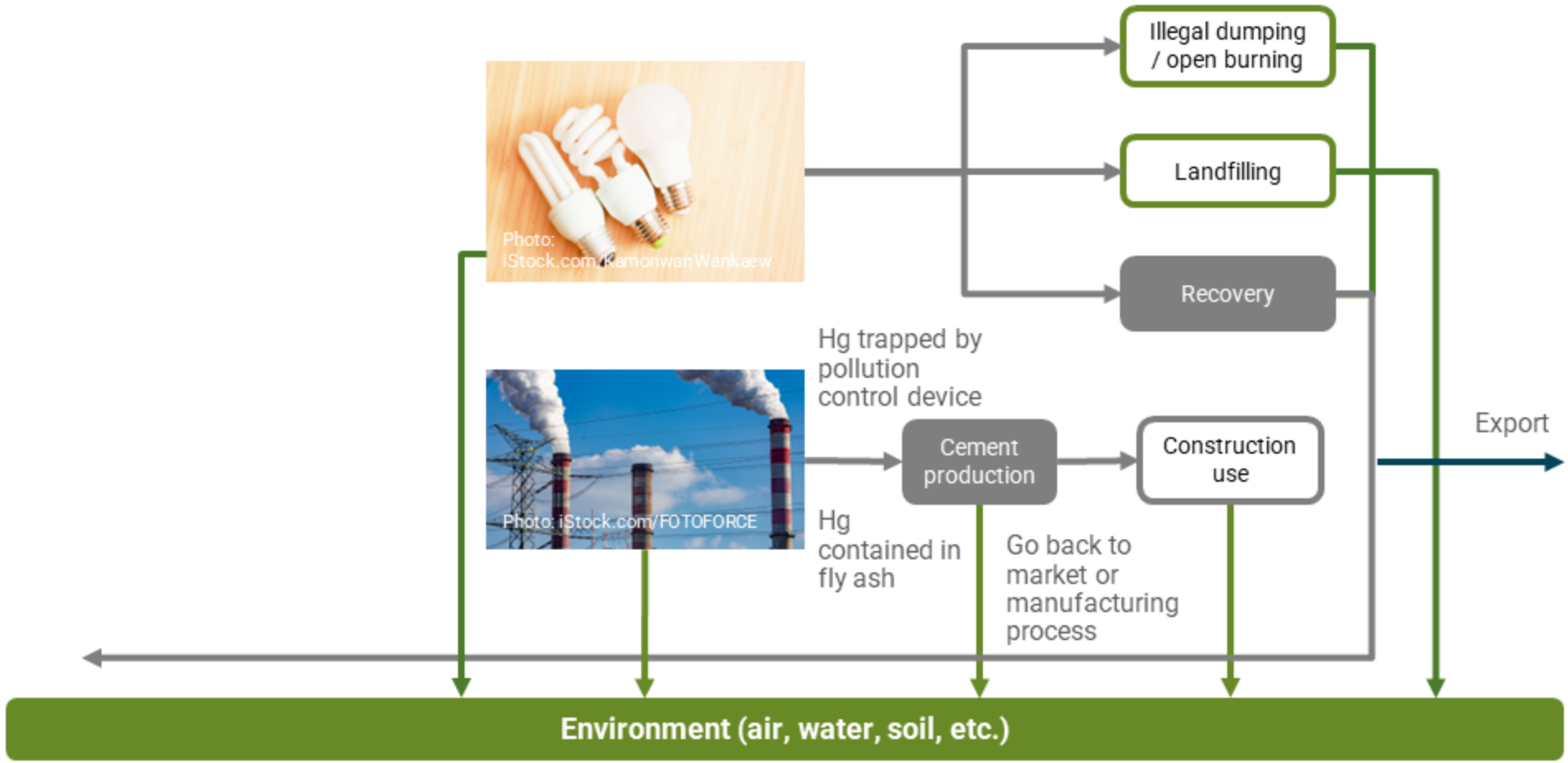
Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Identification of Flows

Outflow of Mercury

Where does mercury go from those sectors?



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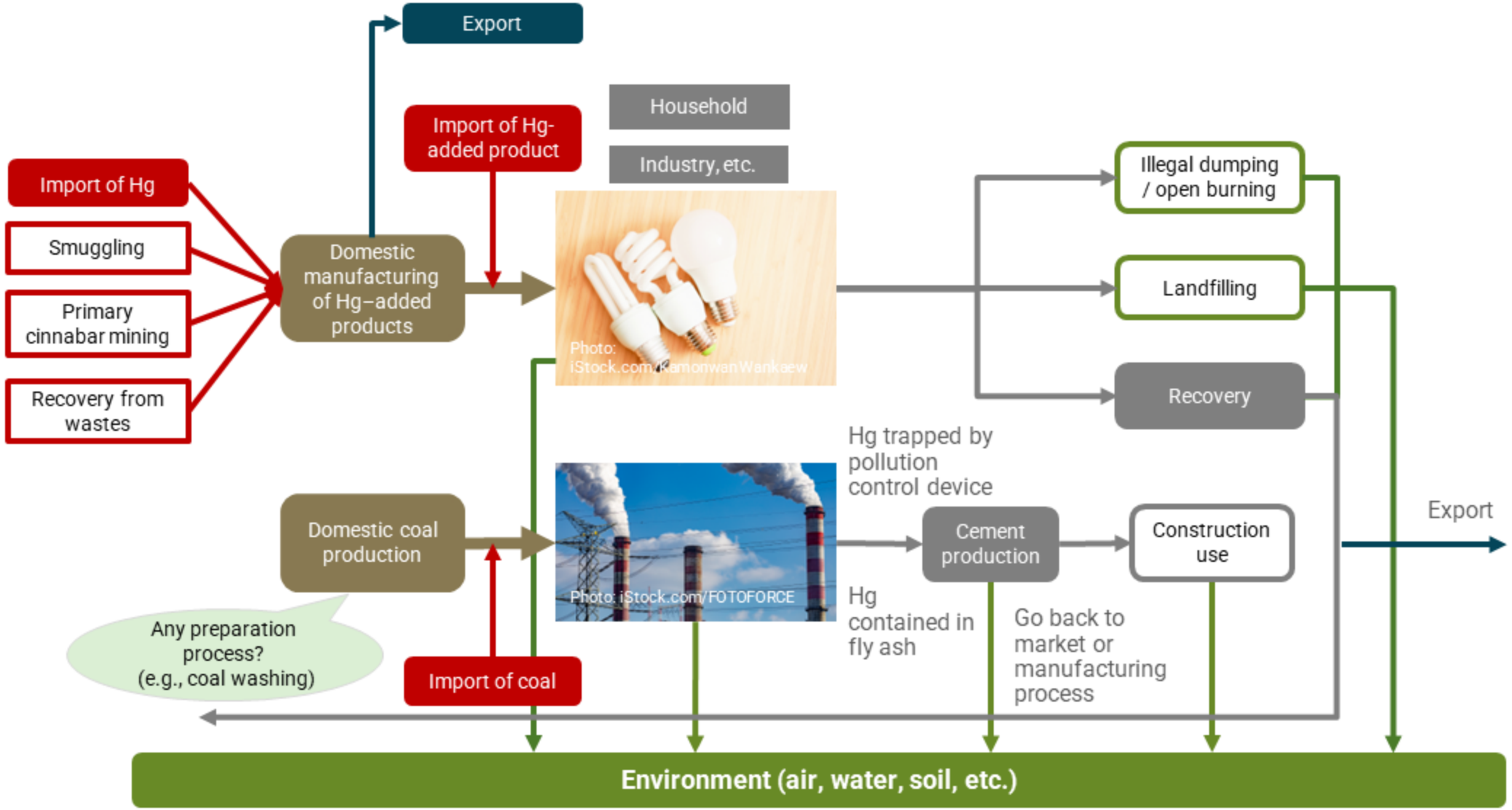
Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Identification of Flows

Example of Mercury Mass Flow



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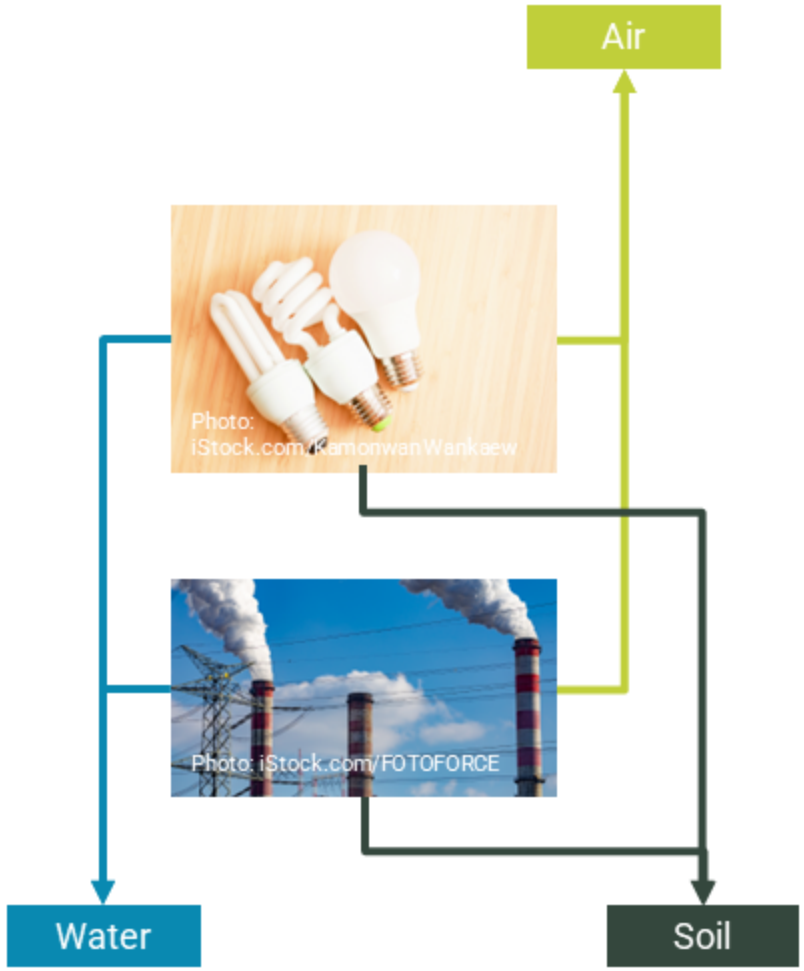
Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Identification of Flows

Example of Mercury Inventory



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Steps in Mercury Mass Flow Development

Sector Definitions, Identifying and Quantification of Flows

Identification of Flows

Quantification of Flows

Quantification of Flows

The major part of national mercury flows can be quantified directly with results from the Toolkit inventory

- Partly from the main results, partly from the sub-calculation results available in the Toolkit Level 2 spreadsheets.
- In some cases, the inventory made may not have accounted for all flows individually, and additional data may need to be collected.
- The data types needed in Inventory Level 2.
  - Activity rate data (nationally, where relevant by point source)
  - Local input factor data (if available, most needed for major sources)
  - Local output distribution factors for major sources
  - Information on pollution abatements equipment and efficiency particularly mercury mass balance data

Types of Data for Mass Flow Calculation

Mercury release to pathway (e.g. "land")

= Activity rate × Input factor × Output distribution factor (land)

The amount of feed material or product (*e.g.* tonnes or pieces per year)

Mercury content (*e.g.* in grams of Hg) per unit of feed material processed or product produced (background data)

Fraction of the mercury input that is released through a particular pathway: air, water, land, by-products, general waste, or sector-specific waste treatment (background data)

Data Types Needed for Mass Flows (1/2)

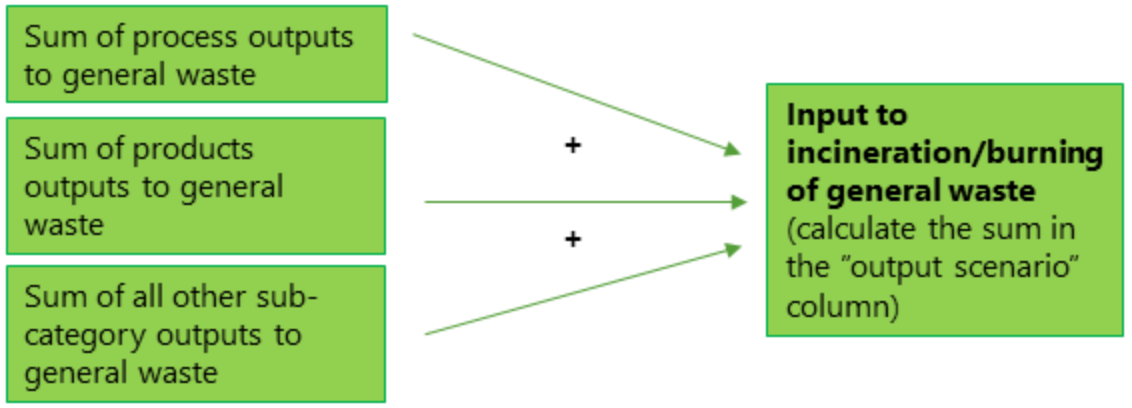
- Examples of additional data types for mass flow development:
  - Production data and imports/exports from specific sectors (or companies, if possible)
  - Specification of sector specific waste treatment: a) recycling, b) on-site dumping, others
  - The fate of wastewater: a) released directly into the environment, or b) fed into wastewater treatment
  - Mercury contributions from high-volume/trace-concentration wastes: plastic, paper, etc.

Data Types Needed for Mass Flows (2/2)

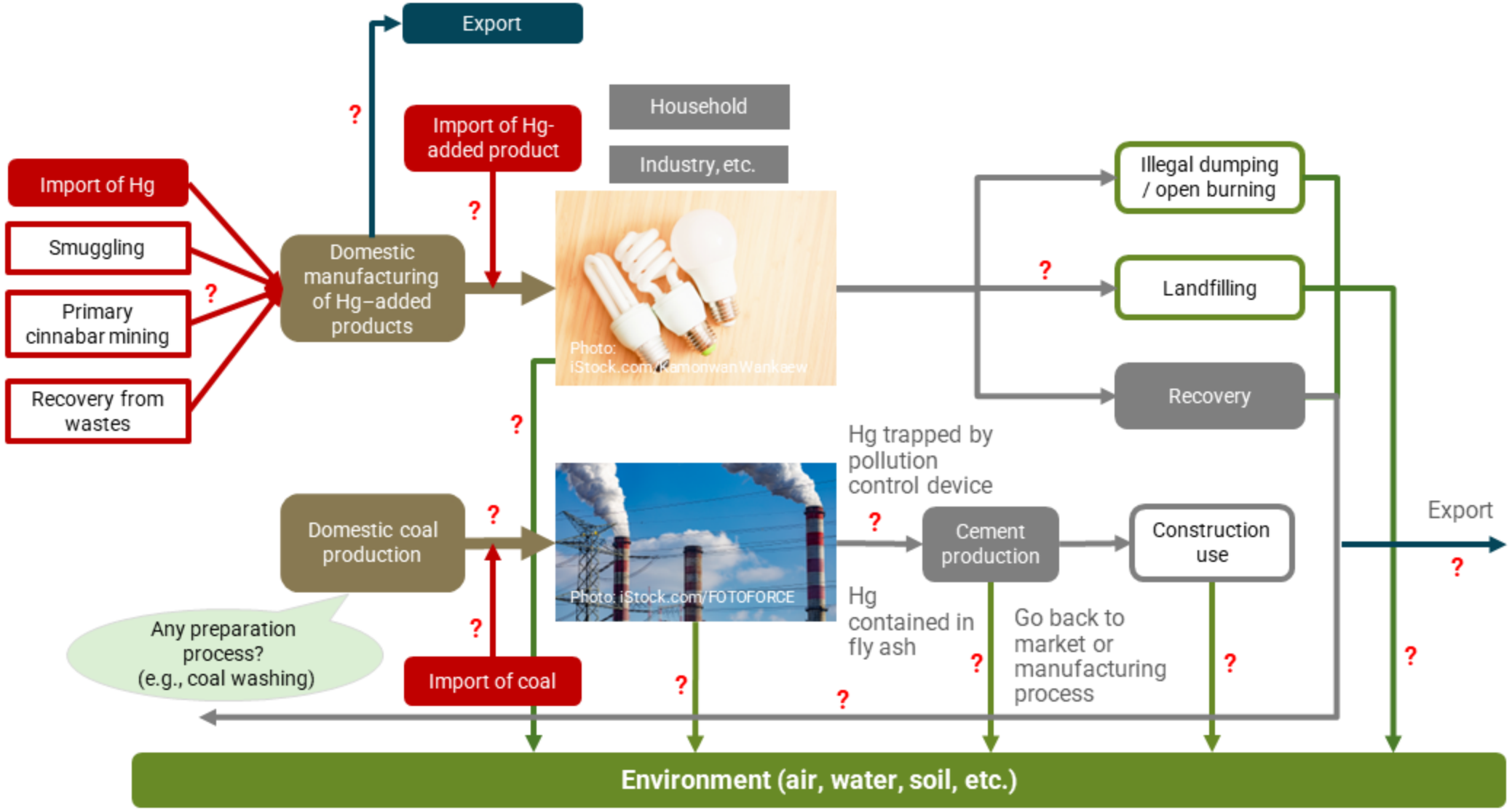
- Data from the Toolkit Level 2 spreadsheets will have to be partly collected from the main results, and partly from sub-calculations.
- The Toolkit Level 2 spreadsheet can be modified to reflect mass flow-derived inputs to waste management sub-categories.

By-pass the standard INPUT calculations for waste treatment sub-categories. Instead, calculate the input to each waste treatment sub-category as the sum of all outputs from products and processes to that waste output pathway.

Example: mass flow-derived Inputs to incineration /burning

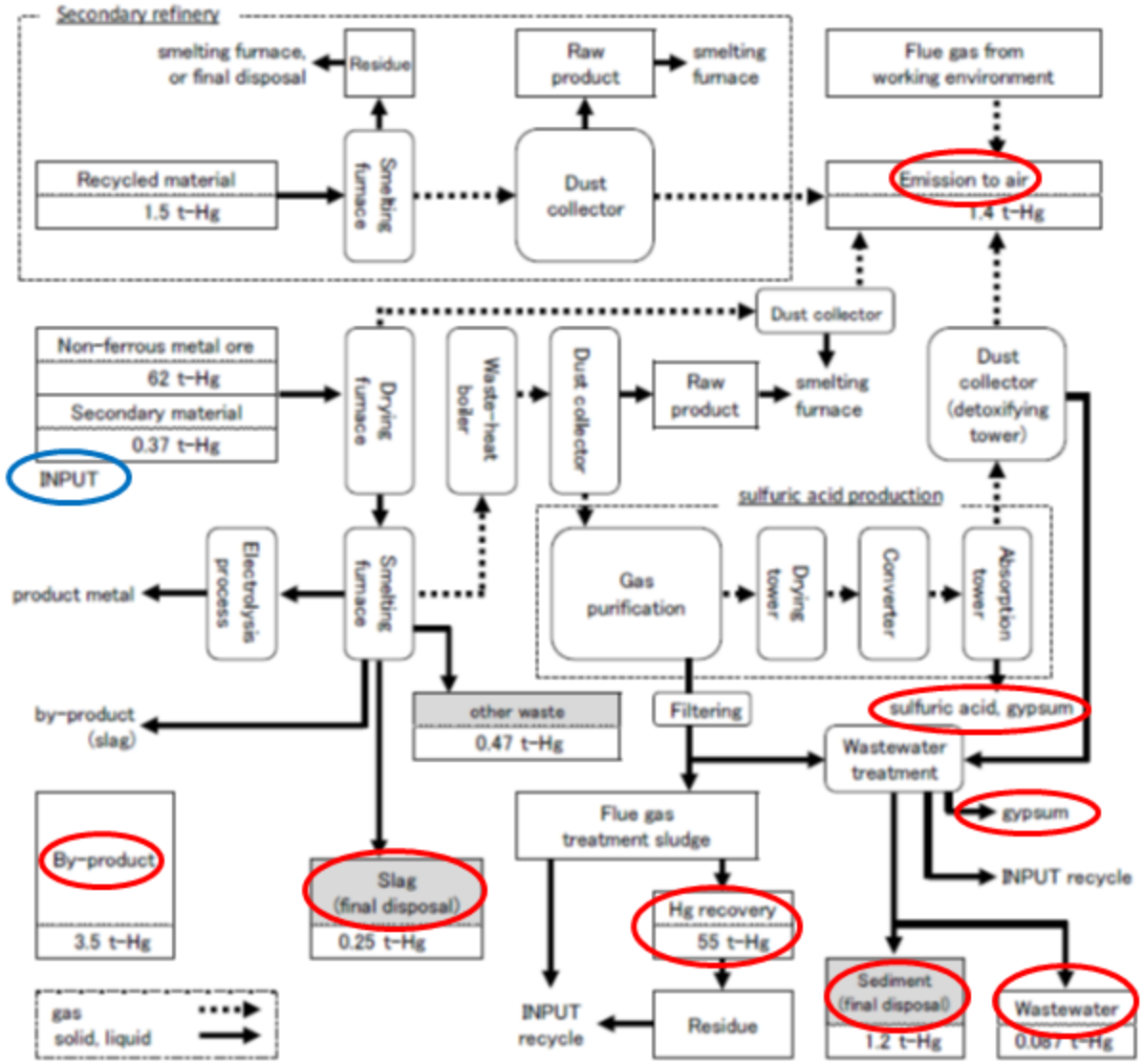


Mapping Available Data and Data Gaps



Examples of Sector Flows

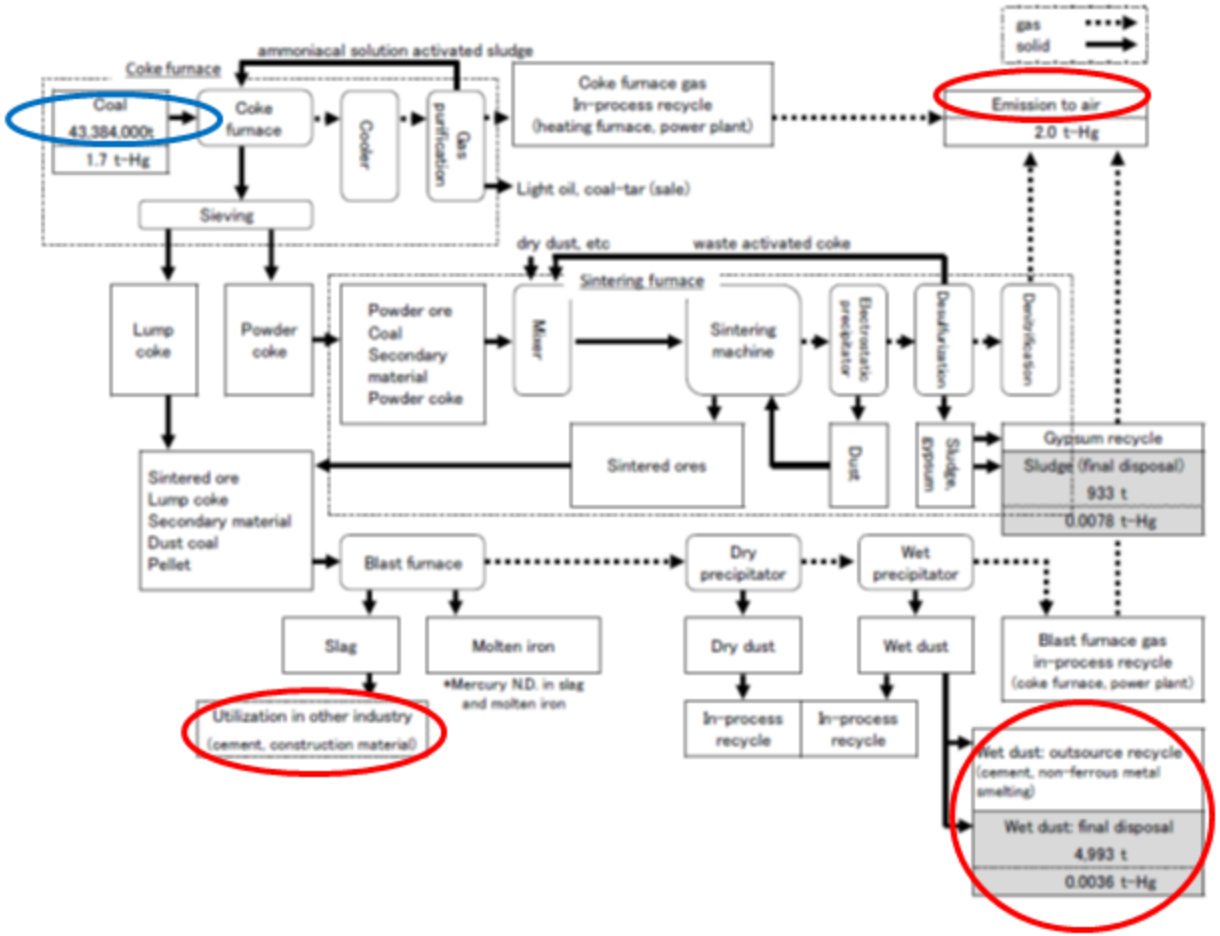
Non-ferrous Metal Smelting Facilities



Flow: Based on interviews with Japan Mining Industry Association
Values in the flow: interviews with Japan Mining Industry Association, FY2016 (average data between FY2013 and FY2015)

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

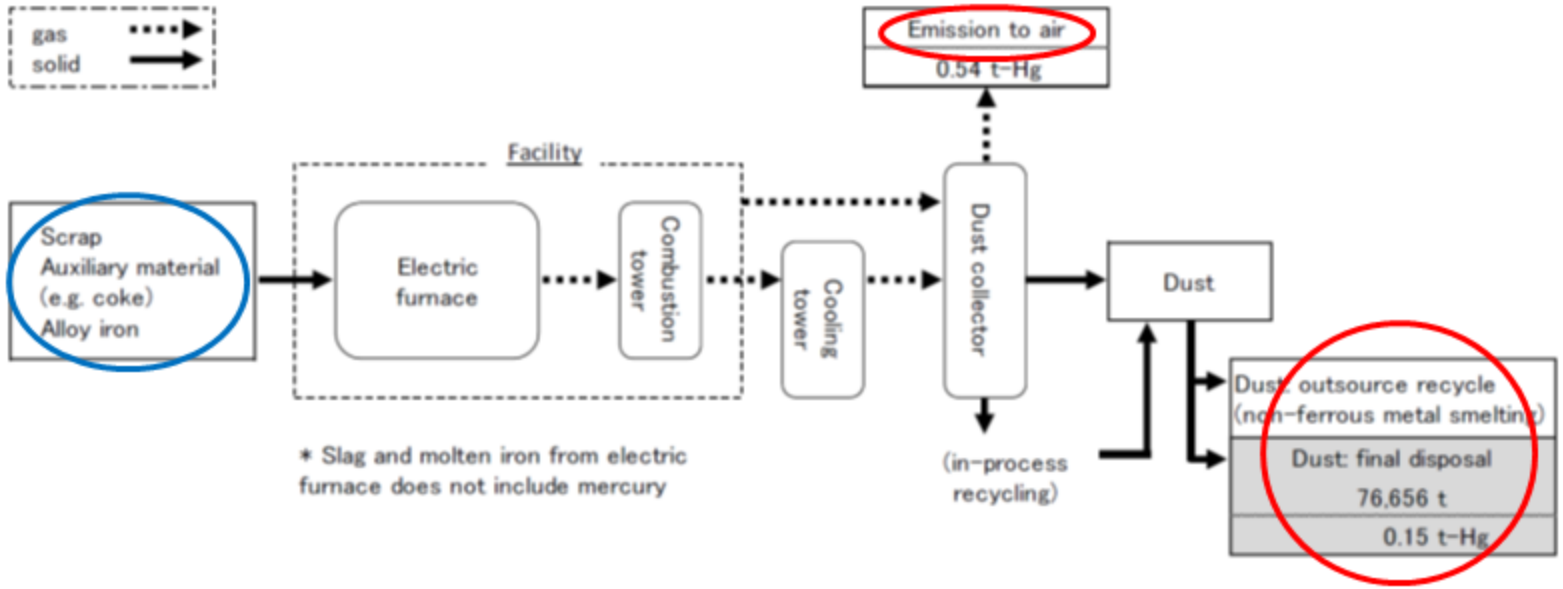
Primary Iron Production Facilities



Flow: Based on interviews with Japan Iron and Steel Federation
Final disposal in flow: Interview with Japan Iron and Steel Federation in FY2016
Amount of mercury in the flow: Estimated by MOEJ based on the final disposal above and the concentration of mercury in residue ("Mercury Emission Behaviour in the Iron and Steel Industry", Masaaki Takaoka, Kazuyuki Oshita, 2007). It needs to be noted that a limited number of data samples were available (n=1 or 3)

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

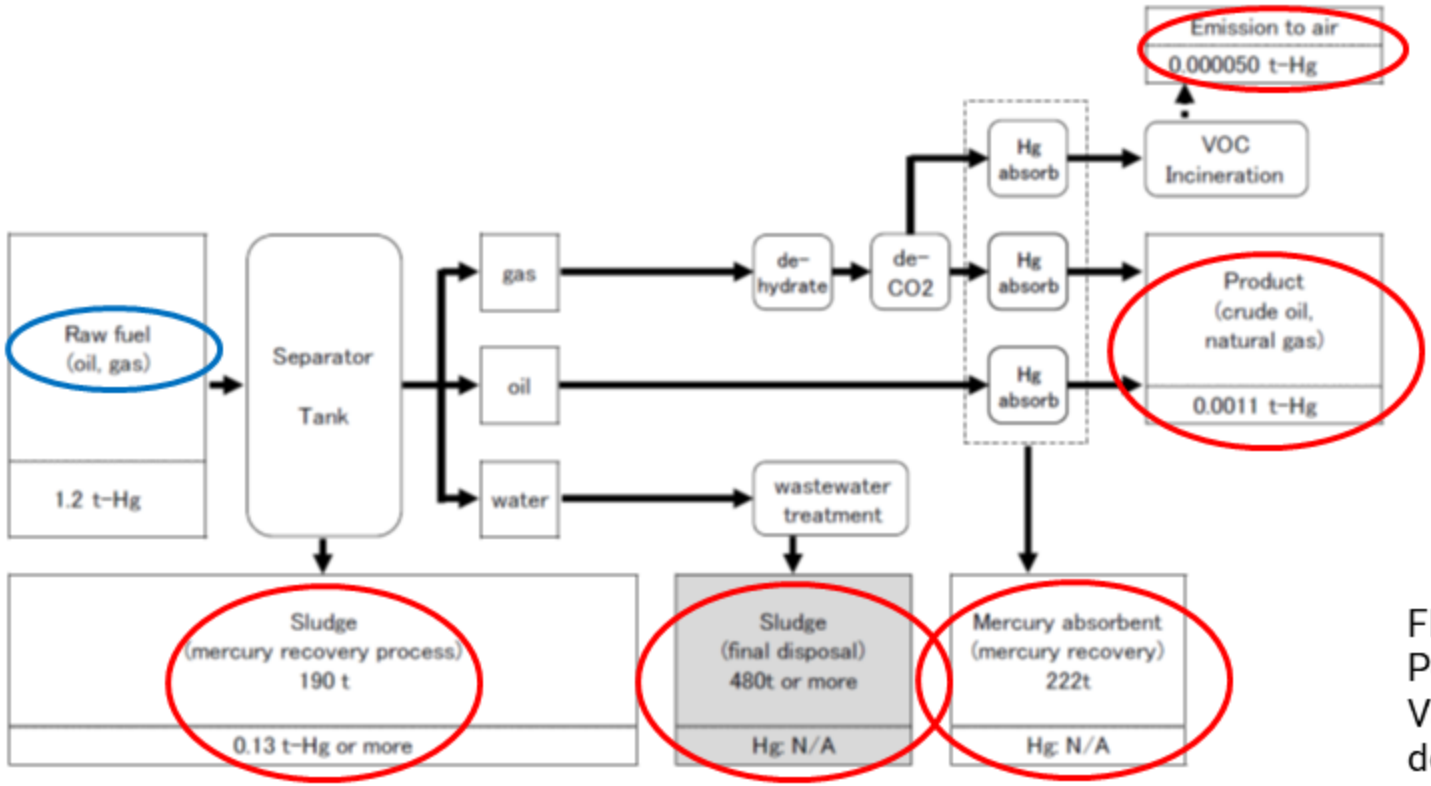
Secondary Iron Production Facilities



Based on interview with Japan Iron and Steel Federation.
Final disposal in the flow: Interview with Japan Iron and Steel Federation in FY2016.
Amount of mercury in the flow: Estimated by Ministry of the Environment, Japan based on final disposal above and the mercury concentration in waste (result of an independent survey conducted by Japan Iron and Steel Federation obtained from Interview with the federation in FY2013).It needs to be noted that only a limited number of mercury-concentration-data samples (n = 19) were used because the independent survey was conducted at limited number of manufacturers.

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

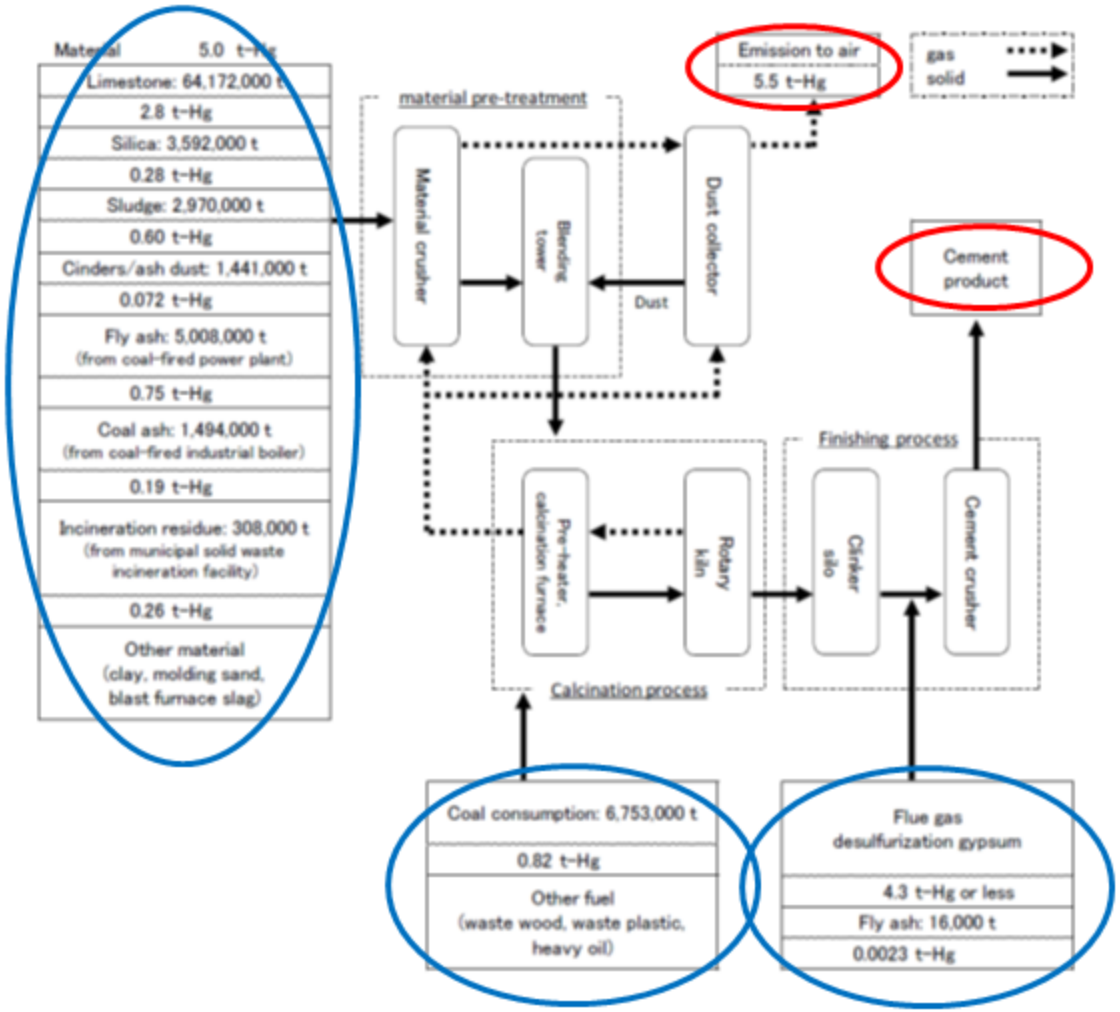
Oil and Natural Gas Production Facilities



Flow: Based on interview with Japan Petroleum Development Association. Values in the flow: Interview with domestic companies in FY2016.

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

Cement Production Facilities

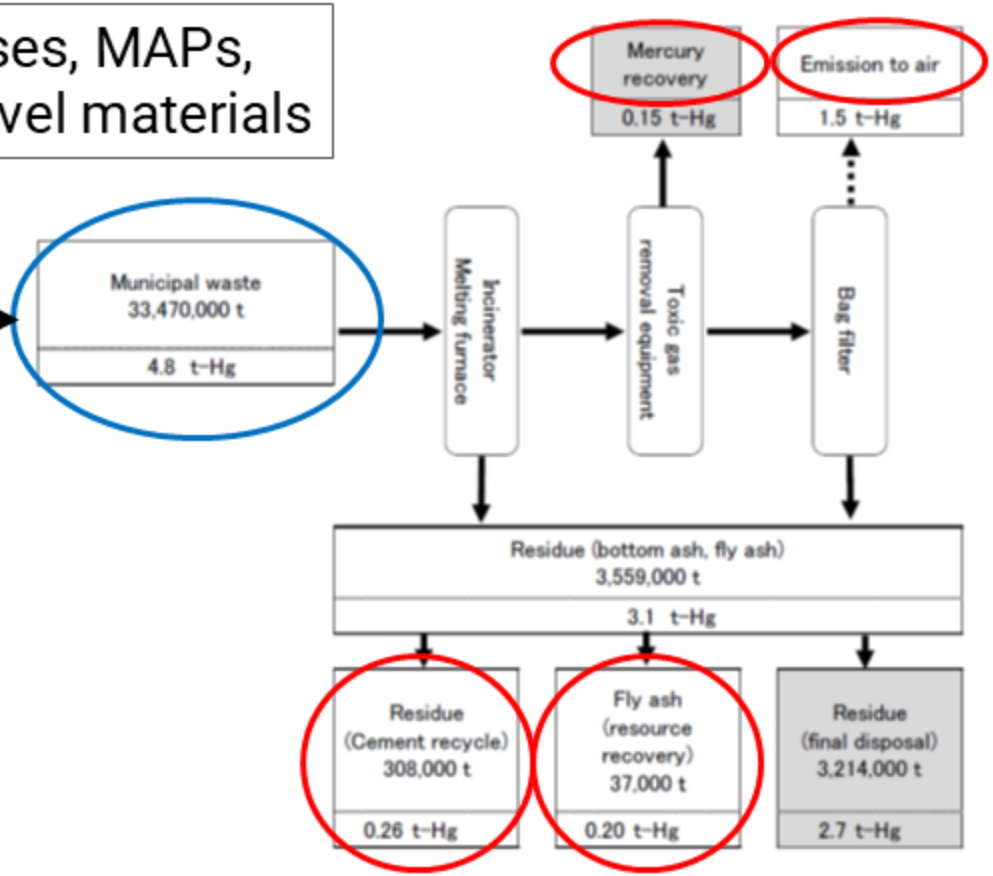


Flow: Based on interview with Cement Association of Japan. Values in the flow: Interview with Cement Association of Japan in FY2016,and estimated mercury flow of other industries.

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

Municipal Solid Waste Incineration Facilities

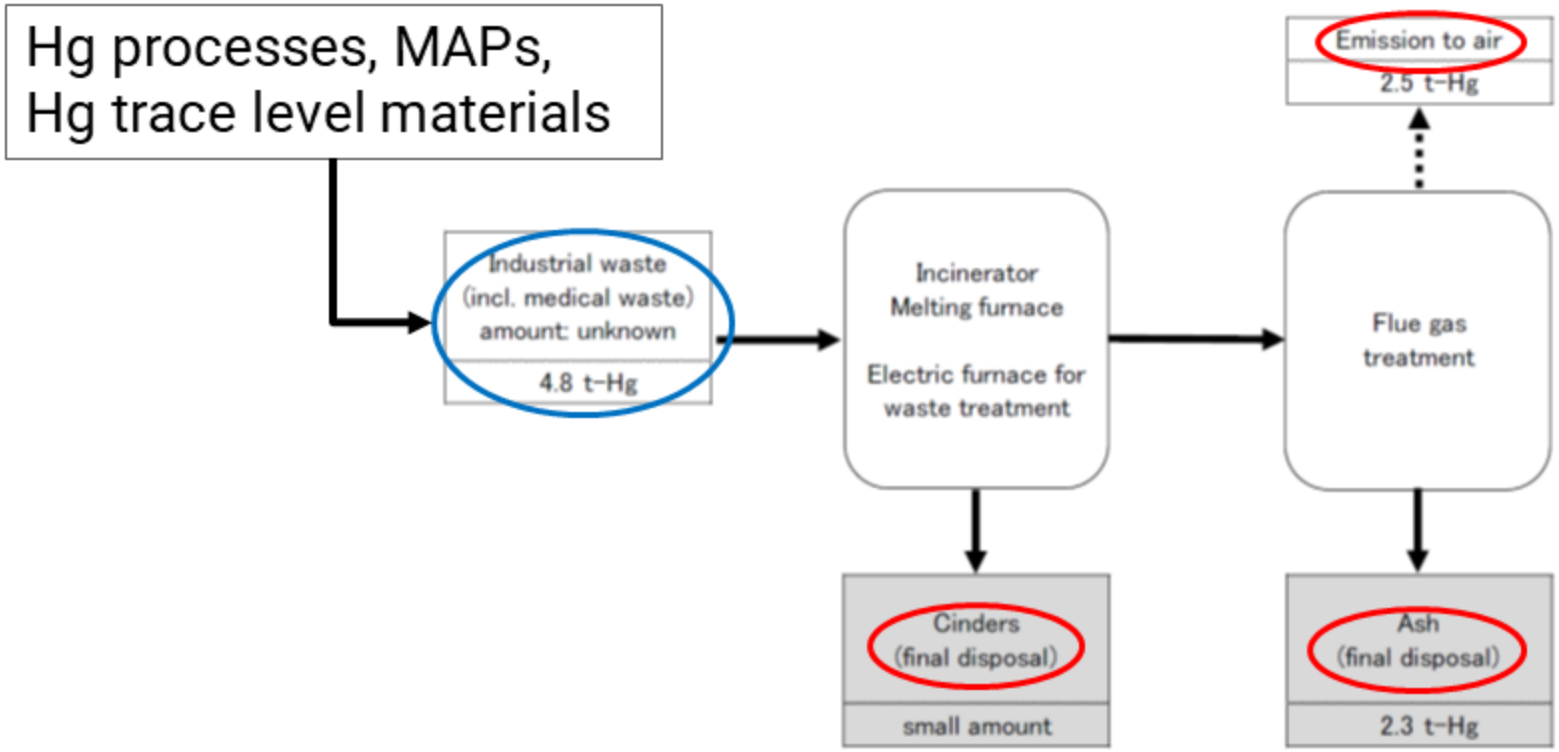
Hg processes, MAPs,
Hg trace level materials



Flow: Based on the interview with non-industrial waste treatment companies.
Values in the flow: Estimation result based on on-site measurement of on-industrial waste treatment (FY2014), and interview with companies that recover mercury, FY2016.

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

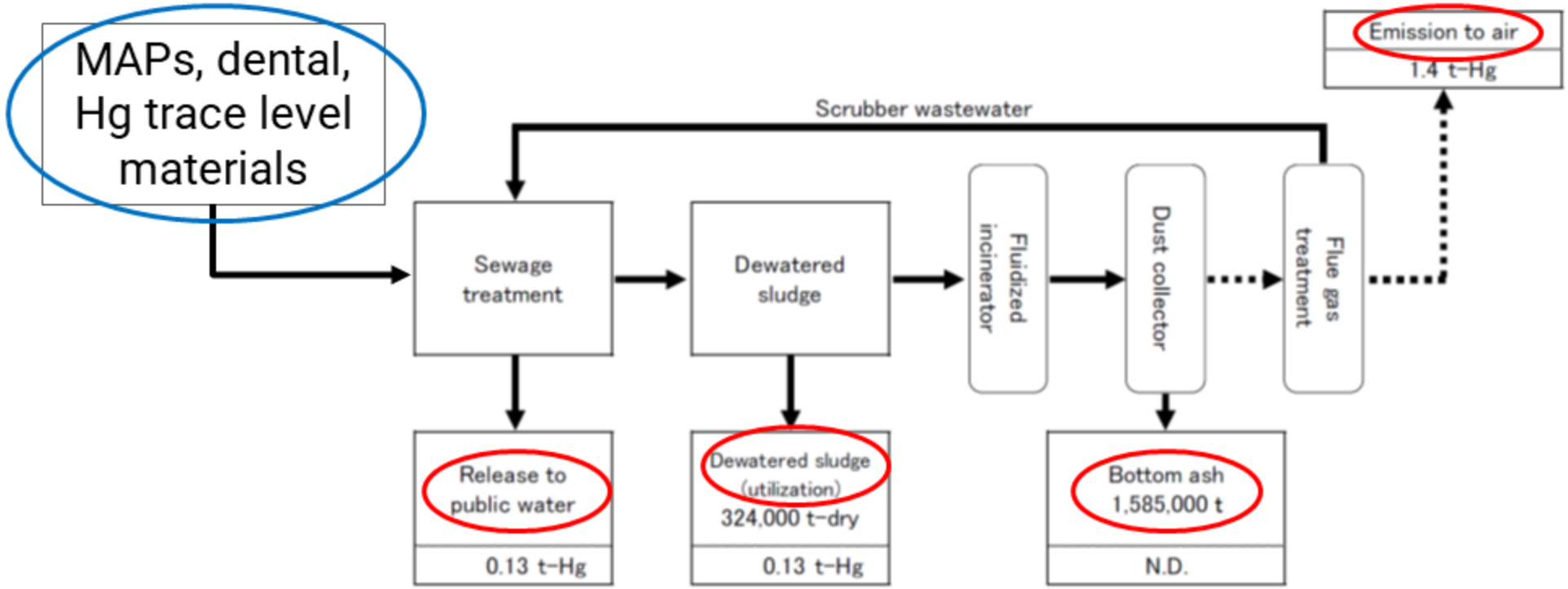
Industrial Waste Incineration Facilities



Flow: Based on the interview with non-industrial waste treatment companies.
Values in the flow: Estimation result based on on-site measurement of on-industrial waste treatment (FY2014), and interview with companies that recover mercury, FY2016.

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

Sewage Sludge Incineration Facilities



Flow: Data provided by Ministry of Land, Infrastructure and Transport, Japan
Values in the flow: Data provided by Ministry of Land, Infrastructure and Transport, Japan (actual amount in FY2014)

Source: MOEJ (2022). Overview of Mercury Material Flow in Japan (FY2016).

Quantification of Stocks, Collection of Data, Working with Intervals

Quantification of Stocks

Quantification of Mercury Stocks

- For the identification and quantification of regular stocks of mercury and its compounds
  - Interviews and/or questionnaire surveys with companies and organisations
  - Time consuming, especially the first time
  - Subsequent data collection can be contacted more easily

Recommended Data Collection Steps (1/4)

1. Examine statistical trade data on the import and export of mercury and amalgam are examined for as many years back as is relevant and consistent for the purpose.
   - Consumption = Import + Production – Export
   - Look for any data or indications of illegal import

Recommended Data Collection Steps (2/4)

2. Identify major intentional mercury use sectors from mercury input estimates. For example:

- Gold mining with mercury amalgamation (small or large scale)
- Producers of mercury-added products
- Chlor-alkali production with mercury cells

Recommended Data Collection Steps (3/4)

3. Contact major intentional mercury users from identified sectors and ask:
   - How large stocks of mercury they have themselves at present
   - Their stock records for at least the last five years or more
   - Suppliers of mercury

Recommended Data Collection Steps (4/4)

4. Contact mercury suppliers and ask:
   - Total mercury supply to the countries of interest in the past five years or more
   - Amount of mercury stored in their facilities at present
   - Annual exports and imports in the past five years or more
   - For waste recyclers, the amount of unprocessed waste in stock and the estimated amount of mercury to be recovered from them

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Reporting Minamata convention on Stocks

- Party to the Convention is obliged to report:
  - Large stocks of more than 50 tons at a premise
  - Mercury suppliers that supply more than 10 metric tons per year
  - Not add up across countries for a multinational company

Quantification of Product Stocks in Society

- Product stocks in society (consumer stocks):
  - Stocks of products and processes where mercury is at workplaces
  - Mercury in active use in products, or not in use anymore but not yet disposed of

Recommended Quantification Steps (1/3)

1. Examine existing publications to identify the estimates of product in active use and in stocks.
   - Earlier publication fits better for consideration
   - For some product types, the literatures, or expert statements about when the products were originally introduced into the market
   - Information may not cover the entire market and may need extrapolation before applying for analysis

Recommended Quantification Steps (2/3)

2. Collect production statistics, import and export data as far back in time as possible to ensure the consistency of data
3. Collect data on estimating mercury content per product over time
    - Mercury in a discharge lamp has been diminished over time due to technological advancement or pressure from regulations
4. Collect information on average lifetimes for the products in question

Recommended Quantification Steps (3/3)

5. Collect data on mercury product amounts received by recyclers and other waste treaters for cross-checking
6. Calculate a stock for a particular year in relation to the base year by adding or subtracting the annual accumulations
    - Stock (y1) = Stock (y0) + Consumption (y1) – Disposed (y1) – Released (y1)
7. Add up stock for every product and material to obtain total product stocks in society

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Quantification of Stock at Work in Industries

- Similar approach to estimate stocks:
  - Interviews and questionnaires to collect information
  - The response rate and accuracy are usually high for well managed interviews
  - Requires proper extrapolation to estimate the total value
  - Collect information on mercury purchases data, data on recorded disposal of mercury, mercury concentrations in the products and materials in question

Data Sources

UN COMTRADE Database

- Covers import and export data at a global level as far as countries have reported them
  - Available guidance: UNEP Toolkit's Level 1 guidelines, MercuryLearn e-learning modules

Product/material name in Toolkit Inventory Level 1	Use this search word	Examples of product name(s) and code(s) in Comtrade (others may exist)	Remarks
		Cells and batteries; primary, mercuric oxide [HS as reported code 850630]	
Other batteries [potentially] with mercury (plain cylindrical alkaline, permanganate)		… Manganese dioxide [HS as reported code 850610]	
Light sources with mercury	lamp		
Fluorescent tubes (double end) and Compact fluorescent lamp (CFL single end)		……Electric discharge lamps (excl. ultra-violet lamps), fluorescent, hot cathode [HS as reported code 853931]	The 6 digit HS code includes both "Fluorescent tubes (double end)" and "Compact fluorescent lamp (CFL single end)", but not the distribution on the types; distribution on types must be based on other data.
		……Electric discharge lamps (excl. ul- tra-violet lamps; excl. of 8539.31 & 8539.32) [HS as reported code 853939]	
		……Ultra-violet/infra-red lamps [HS as reported code 853949]	Includes such mercury containing ultra- violet fluorescent lamps used for tanning beds as well as infra-red lamps which do not contain mercury.
Other Hg containing light sources (see guideline)		……Electric discharge lamps (excl. ul- tra-violet lamps), mercury/sodium va- pour lamps; metal halide lamps [HS as reported code 853932]	Includes some of the lamps with high mercury contents, but not all.
Other relevant product/material groups that can potentially be used for cross-checking of mercury inputs			
Metal mercury	Mercury	Mercury [HS as reported code 280540]	
Mercury compounds	Mercury compounds	…Inorganic or organic compounds of mercury, excluding amalgams, whether or not chemically defined [HS as reported code 2852] + …Inorganic or organic compounds of mercury, excluding amalgams, chemically defined [HS as reported code 285210] + …Inorganic or organic compounds of mercury; excluding amalgams, not chemically defined [HS as reported code 285290]	

Source: UNEP (2019). Toolkit for identification and quantification of mercury releases, Reference report and guideline for inventory Level 1.

IEA Energy Statistics Database

- Provides statistics on fuel uses
  - Data are given in Terajoules that requires unit conversion
  - Available guidance: UNEP Toolkit's Level 1 guidelines

Toolkit fuel/energy entry (and unit used in Toolkit)	Unit in IEA statistics (to be converted to Toolkit unit)	IEA data entries that should be included in your inventory
Combustion of coal in large power plants (t coal combusted/y:	Kilo-tonnes/year (= 1000 metric tons/year)	Sum of consumption for Electricity plants and CHP plants for the coal types Anthracite + Other bituminous coal + Sub-bituminous coal + Lignite (+ coking coal if reported for these uses)
Other coal uses	Kilo-tonnes/year (= 1000 metric tons/year)	Sum of consumption for Heat plants, Other transformation, Industry, Transport, Residential, Agriculture/Forestry, Fishing, Other non-specified and Non-energy use for the coal types: Anthracite + Coking coal + Other bituminous coal + Sub-bituminous coal + Lignite + Patent fuel + BKB (brown coal briquettes)
Combustion/use of petroleum coke and heavy oil	Kilo-tonnes/year (= 1000 metric tons/year)	Domestic supply: Fuel oil (Toolkit sub-category "heavy fuel" only; petroleum coke consumption must be found elsewhere)
Combustion/use of diesel, gasoil, petroleum, kerosene and other light to medium fractions	Kilo-tonnes/year (= 1000 metric tons/year)	Domestic supply of Natural gas liquids + Naphtha + Liquefied petroleum gases + Motor gasoline + Aviation gasoline + Jet kerosene + Other kerosene + Gas/diesel
Oil extraction (t crude oil produced/y)	Kilo-tonnes/year (= 1000 metric tons/year)	Production, Crude oil

Source: UNEP (2019). Toolkit for identification and quantification of mercury releases, Reference report and guideline for inventory Level 1.

USGS Country Overviews

- Website provided mineral yearbooks for most of the countries in the world
  - Data on mining and minerals production
  - Semi-quantitative information, for example on how much gold is from small scale mining and how much is from large scale mining.

National Literature and Resource Centres

- National literature on relevant sectors
- National economic surveys
- Dioxin/furan (uPOPs) inventories, obsolete pesticides inventories, other POPs inventories
- Greenhouse gas (GHG) inventories for climate work
- Waste inventories, waste characteristics studies (national or regional)
- Internet, universities and other knowledge centres as potential sources

Public Statistics

- Commodity statistics: Import and export, production (overview level)
- Access to detailed customs statistics, Tax/VAT registers (may be restricted)
- Energy statistics, by sector/fuel (national, international: IEA)
- Pollution release and transfer registers (PRTR), if available
- Pesticide statistics: Use of mercury-containing pesticides/biocides, if any
- Waste statistics:
  - Waste of mercury containing products (batteries, lamps, etc.)
  - Amount of total municipal solid waste and waste incinerated
  - Obsolete pesticides, etc.

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Market Associations and Companies

- Trade associations
- Industry associations
- Public service providers, or their associations
- Large producers or users
- Suppliers of release reduction equipment
- Shop surveys (preferably in large retailer chains)
- Existing trade surveys/registers on Internet and in books, journals

Own Measurements (1/2)

- Own measurement can make a breakthrough in the mass flow if financially and technically feasible
- Recommended to look at firstly the existing data sources as much as possible
- Focus measurements on key data gaps and key uncertainties (based on a sensitivity assessment)
- Examples of prioritised measurements:
  - Hg concentration in cement kiln, raw materials and fuels
  - Products with uncertain Hg profile

Own Measurements (2/2)

- Measurements made should be on a mass balance basis
- Focused on the mercury inputs, such as the raw materials and fuels for cement kilns, etc.
- Supplemented by some output measurements (rest of the output can be estimated with the default output distribution factors of the Toolkit)

Unit Conversion

The Toolkit requires data in the correct units

- A unit conversion tab is available in the Toolkit spreadsheets for some data types where conversion is often needed:
  - Natural gas
  - Zinc production
  - Copper production
  - Lead production
  - Industrial gold extraction (non-amalgam)
  - Alumina production from bauxite (aluminium production)
  - Medical Hg thermometers
  - Fluorescent tubes (double end)
  - Compact fluorescent lamps (CFL single end)
  - Chlor-alkali production with mercury cells
- For other sectors, factors need to be calculated and reported

Data Collection Principles and Methods

Principles and Strategies

Creativity and flexibility

- Collect data for the same year (basis year), if available
- Supplementary questions about the other informants to be asked
- Verify the relevance of data before use
  - Triangulation is a good practice to qualify collected data

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Approximation

- National data are often missing for some mercury source types that needs extrapolation
  - Regional versus national population
  - Share to the total market
  - Expanding sampled results to nation-wide
- Although extrapolation introduces uncertainties, mercury inventories or mass flows have the strength of seeing the overall picture

Uncertainties and Working with Intervals

Uncertainties to All Numbers

- All data are in fact associated with uncertainties
- Interval around a figure indicates the uncertainty
- Based on the variation in available data for the same item
- Simple representation of minimum and maximum data, or alternatively "best estimate" of +/- by own judgement

Data Crosscheck Whenever Possible

- Supply of raw materials/semi-manufactured goods registered in the statistics vs. consumption of raw materials of the manufacturers
- Consumption of raw materials of the manufacturers vs. their production and estimated losses to wastewater, soil, air and waste as well as the volume recycled
- Estimated total loss to solid waste from enterprises and consumers vs. volumes measured in solid waste
- Estimated total loss to wastewater from enterprises and consumers vs. volumes measured in wastewater
- Estimated total loss to chemical waste vs. total volumes received by treatment facilities for chemical waste
- Volumes presumed to be recycled vs. volumes received by the recycling companies

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Working with Intervals

- Show values of mercury mass flow in a range, based on the observed variation in the data used.
- Summation of interval can be simply done by adding all minimums and all maximums to represent total
- Stochastic variables reduce the uncertainty intervals for the results, but it is a long process and becomes more “black box”

Use of Online Helper Tools

Some Online Tools that May be Useful

MIRO

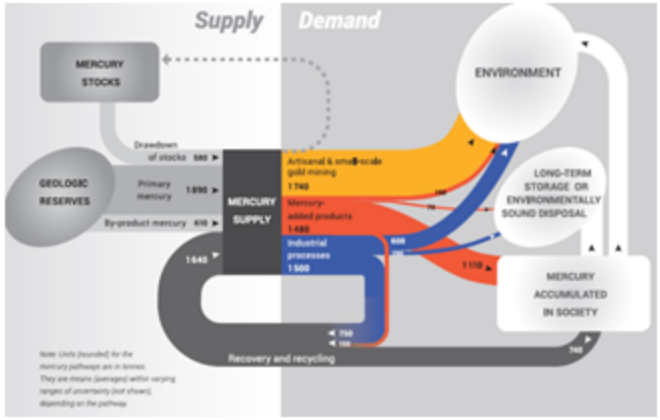
MURAL

Online discussions with need for common illustration (like a ”whiteboard”)

Rawgraph

Sankeymatic

Making sophisticated mass flow charts such as a Sankey diagram



Source: UNEP (2017). Global mercury supply, trade and demand.

Identifying and Reducing Uncertainties, Reporting and Review

Identifying and Reducing Uncertainties and Gaps

Identifying Uncertainties and Gaps

- To check the accuracy of mass flow
  - Carefully identify the numbers that affect the overall results most (high, uncertain numbers)
  - Conduct a sensitivity analysis, if possible
  - Carefully list and report all identified data gaps
  - Collect additional data with priority to the identified most significant uncertainties and gaps this time, or next time

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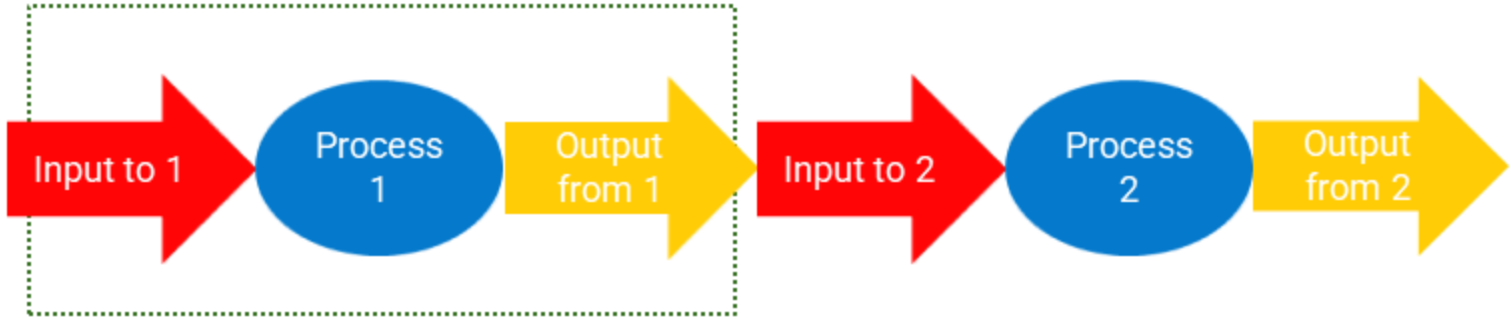
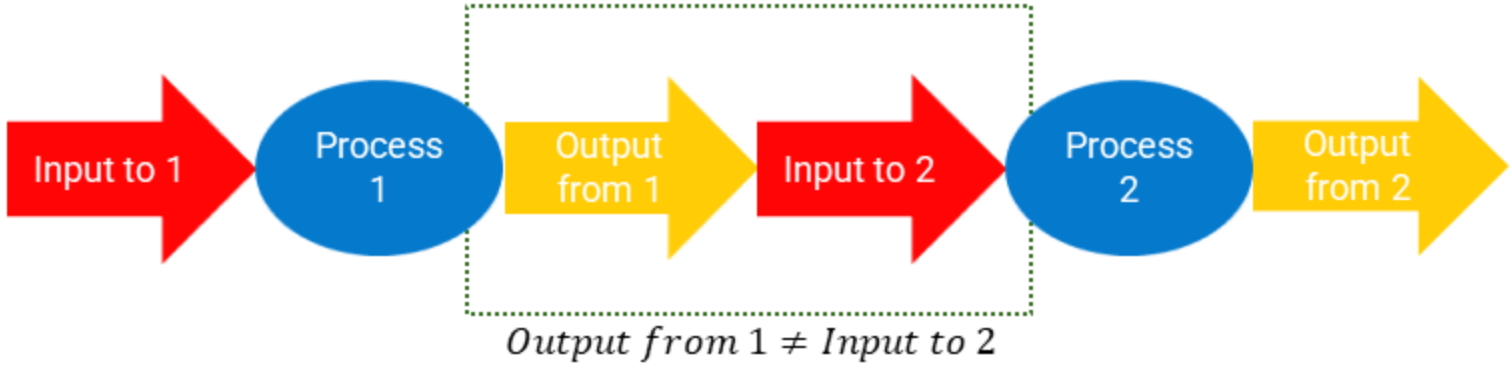
When Input ≠ Output



$Input\ to\ 1 \neq Output\ from\ 1$

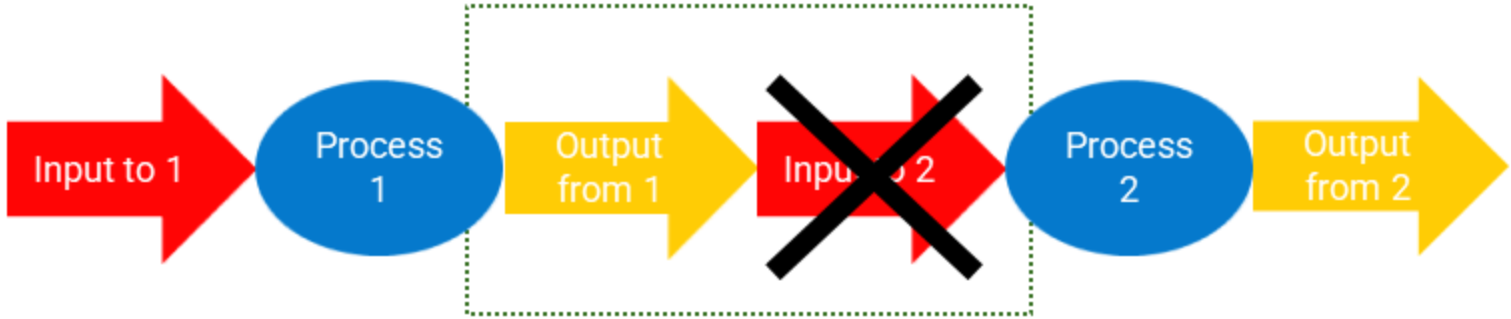
- Possible causes may be:
  - Real change in accumulation
  - Incompleteness or errors in the data although the input and the output were balanced
  - Appropriate interpretation and possible modification if reasons are identified

When Output from 1 ≠ Input to 2



- Possible causes may be:
  - Incomplete or erroneous data, although the output and the input are actually equal
  - Truly different due to some other processes, which was not identified at the time of the study, but is influencing the flow
  - Flow tends to fluctuate, and the data may have been taken at different times
  - In any case, it should be investigated to determine the cause

When Input to 2 Not Available



- Such a case will be encountered more frequently
  - Theoretically, more efforts to obtain independent data that can qualify the estimates (recommended to explore other ways to bridge the data gap, whenever possible)
  - Assume the output from process 1 as an input to process 2 without substantial information for the input to process 2 (commonly applied)

Closing and Calibrating Mass Balance

- Close the mass-balance means to make the numbers fit together into one big picture
  - Confirm the sum of all the inputs to the economy matches the sum of all the outputs from the economy
  - If not, some of the numbers may be missing, wrong or misinterpreted
  - When re-assessing the estimate, the most uncertain numbers or the largest numbers could be examined
  - If collecting additional data, it may influence the whole mass balance as all the flows are interconnected

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Reporting Principles and Review

Reporting Principles

- Focus on the key data needed: Activity rates (from import + production – export data); any local input factors and output distribution factors used
- Report and discuss data uncertainties openly
- Use best available approximations whenever possible rather than omitting
- Report explicitly how the approximation is done
- Report explicitly if no data could be found
- Give full references to all the data used
  - Personal contacts: Institution's name, institution's town, contact person, date of contact
  - Literature: Author, year of publication, title of publication, institution or publisher, town, country

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Review by Stakeholders and Incorporating Feedback

- Reviewed by selected resource persons with relevant expertise in key internal stakeholders
- External key stakeholders (e.g., industrial associations) may also be invited
  - Better to get stakeholders' feedback before publication
  - Incorporate useful and reliable feedback

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