Building Global Physical Input-Output Tables for Iron and Steel in a Virtual Laboratory

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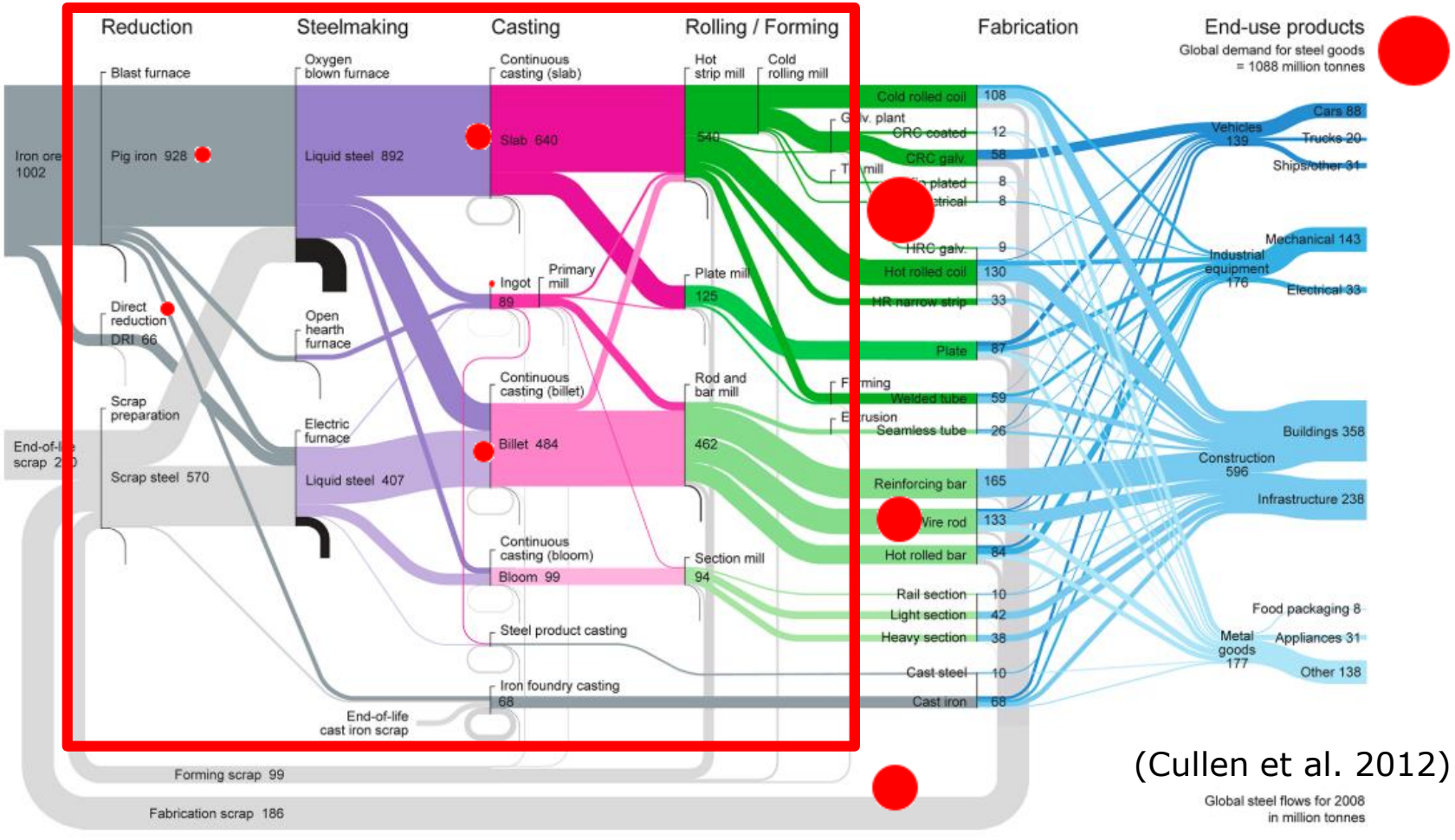
MFA model of the global steel sector

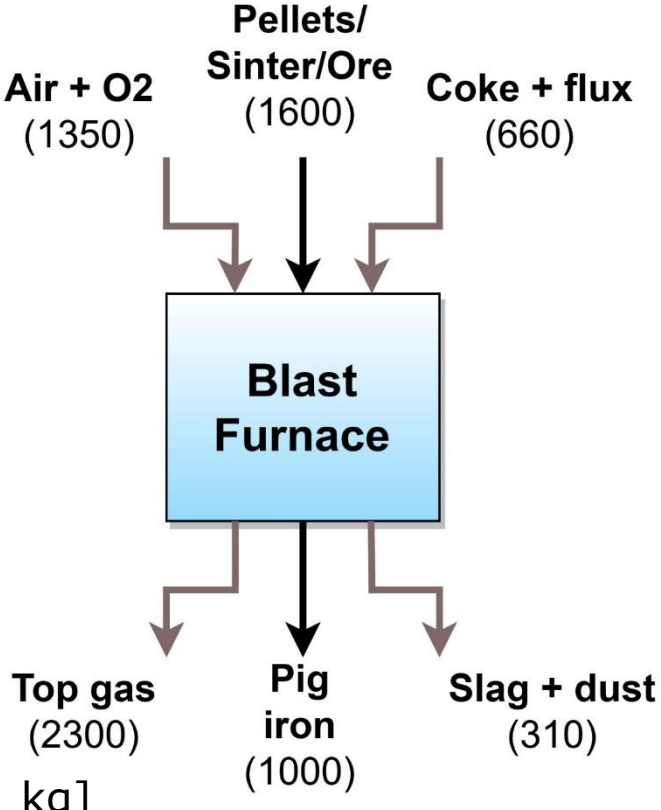


(Cullen et al. 2012)

Global steel flows for 2008
in million tonnes

Iron & steel metallurgy basics

Ironmaking



[UNIT: kg]

Steelmaking

Oxygen Blown Furnace

- Pig Iron
- Scrap: 10-25%

Electric Arc Furnace

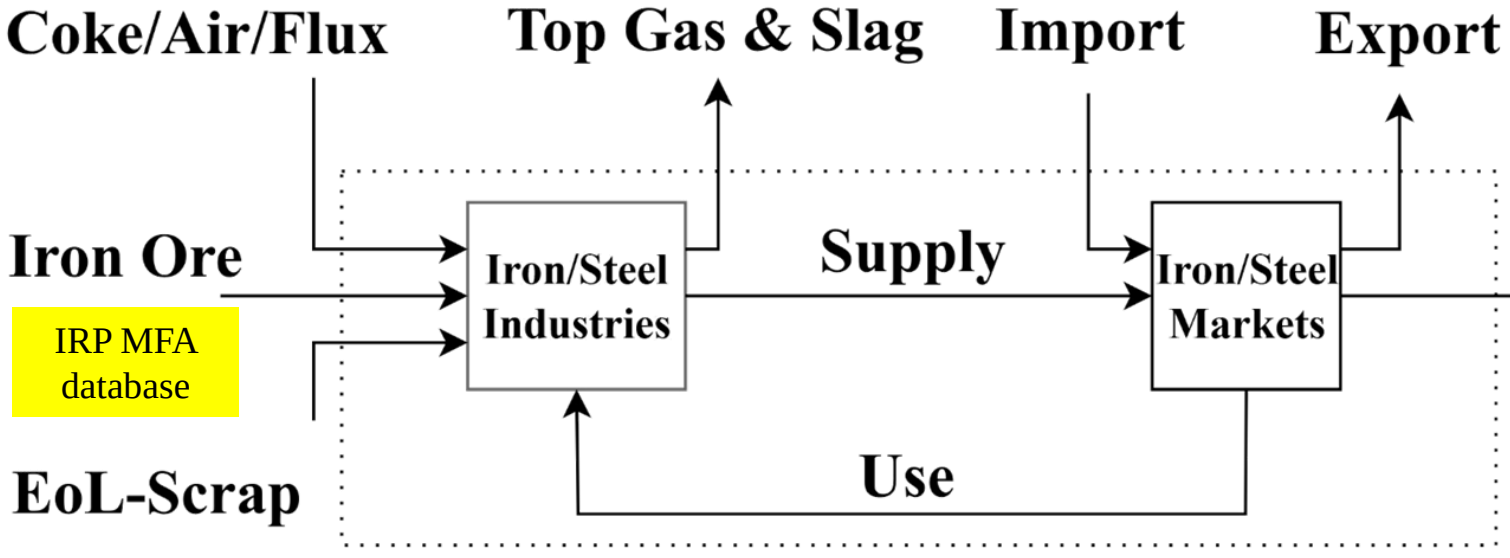
- Mostly Sponge Iron
- Scrap: Up to 100%

Source: Steel Manual 2019

Step 1 (MFA): From extraction to fabrication

Material balances from metallurgy literature

Trade accounts from UN COMTRADE



End-use shares (Cullen 2012)

IRP MFA database

1. Vehicles
2. Ind. Machinery
3. Metal Goods
4. Construction

Dynamic MFA results (Pauliuk 2013)

Production values & yield factors from World Steel Association

(Adapted from Pauliuk et al. 2015)

Flow of commodities | System boundary | Transformation nodes | Distribution nodes

Step 2 (hybrid IO): From manufacturing to end-use

„Waste IO approach“ → Synthesize a physical IO table from a monetary IO table!
(Nakamura et al. 2007)

1. **Filter matrix to remove non-physical flows.**

→ Calculate Inverse (L)

→ Calculate new gross production vector (x)

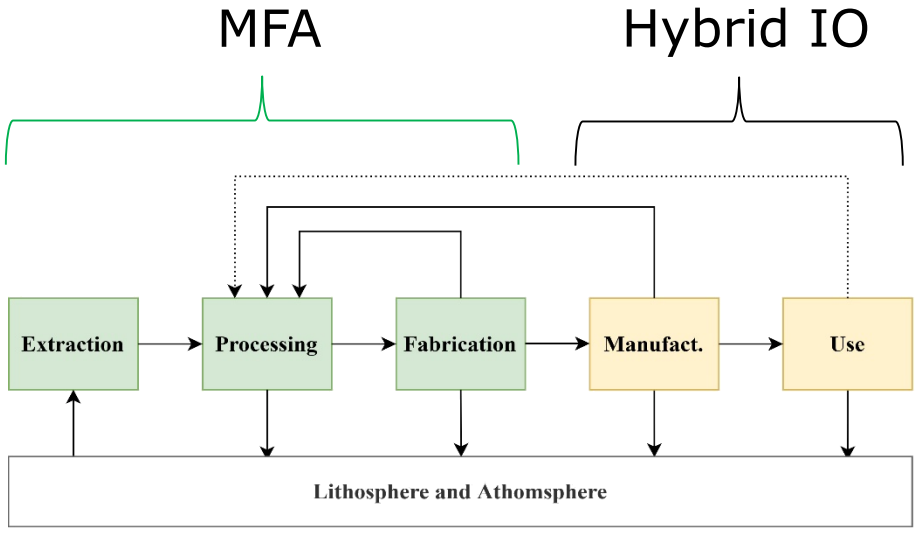
→ Allocate output of steel sector to final use

2. **Yield factors → scrap flows from manufacturing**

EXIOBASE MRIO: 1995-2016, 44 countries + 5 RoW, 200 products, 163 industries

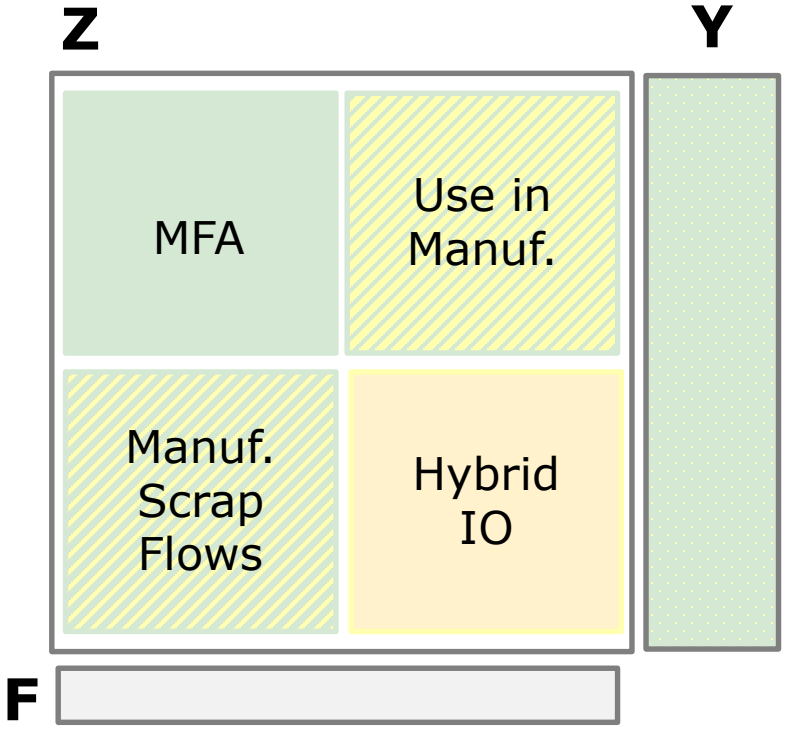
Linking material flow & hybrid IO model

Graph View

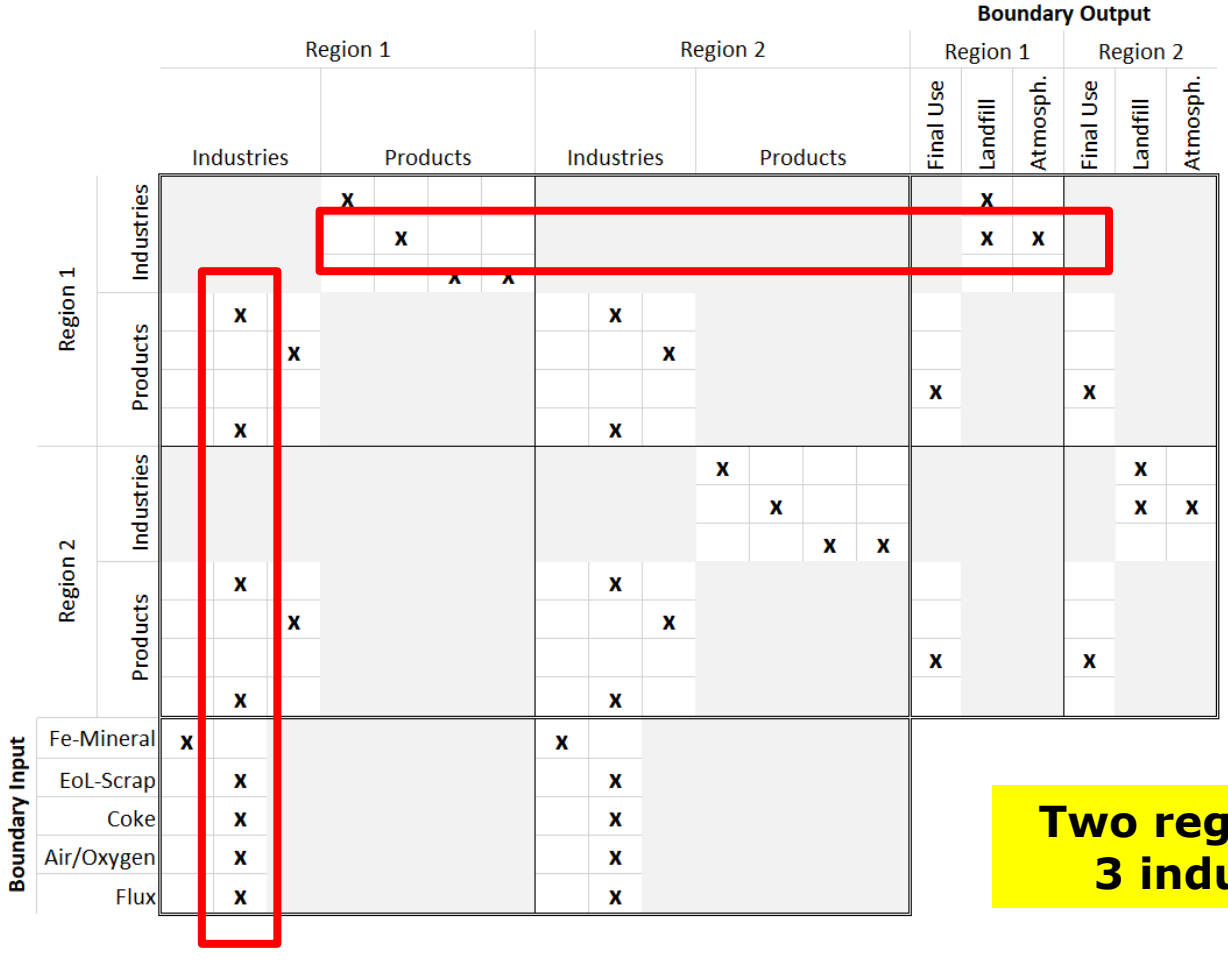


Status Quo: **34 countries + RoW, 22 iron-containing products**

Tabular View



General structure of physical supply-use tables



	Industry	Product
1	Mining	Iron Ore
2	Steelmaking	Rolled Steel
3	Manufact.	Car
4		Scrap

Two region example SUT with 3 industries & 4 products

PIOLab: The Physical Input-Output Laboratory

Root classification

- 244 regions, 76 processes, 266 products
- 10 final demand categories
- 13 primary inputs

Constraint data feeds

- Raw data: IRP/MFA, WorldSteel, COMTRADE, dynamic MFA results for EoL Scrap
- Process descriptions: material balances & yield factors
- End-use shares

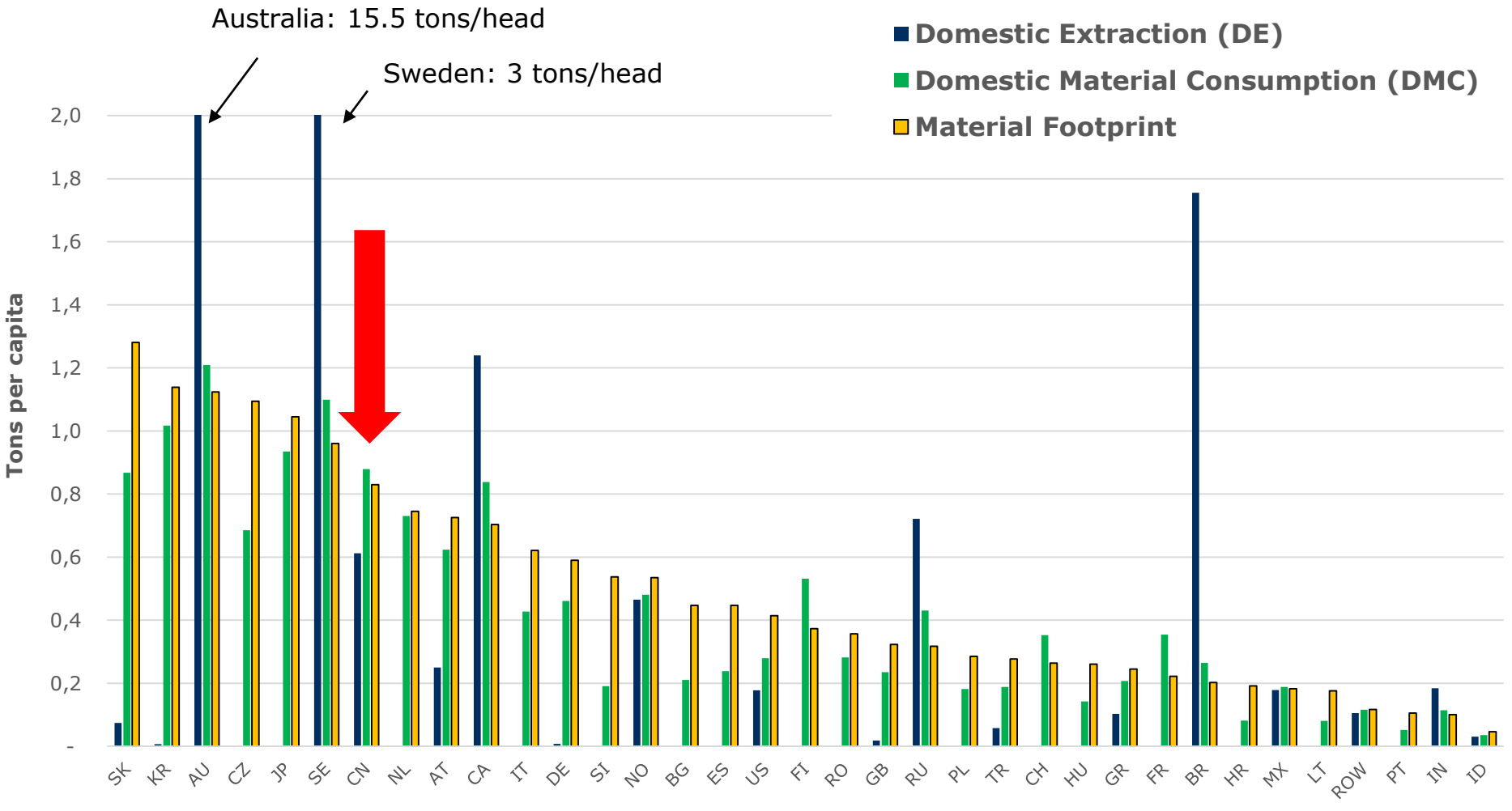
Initial Estimate

- 34 regions + RoW, 20 industries, 22 products
- Hybrid IO with EXIOBASE: from manufacturing to end-use!
- IEA energy data for gap filling

22 products in base classification

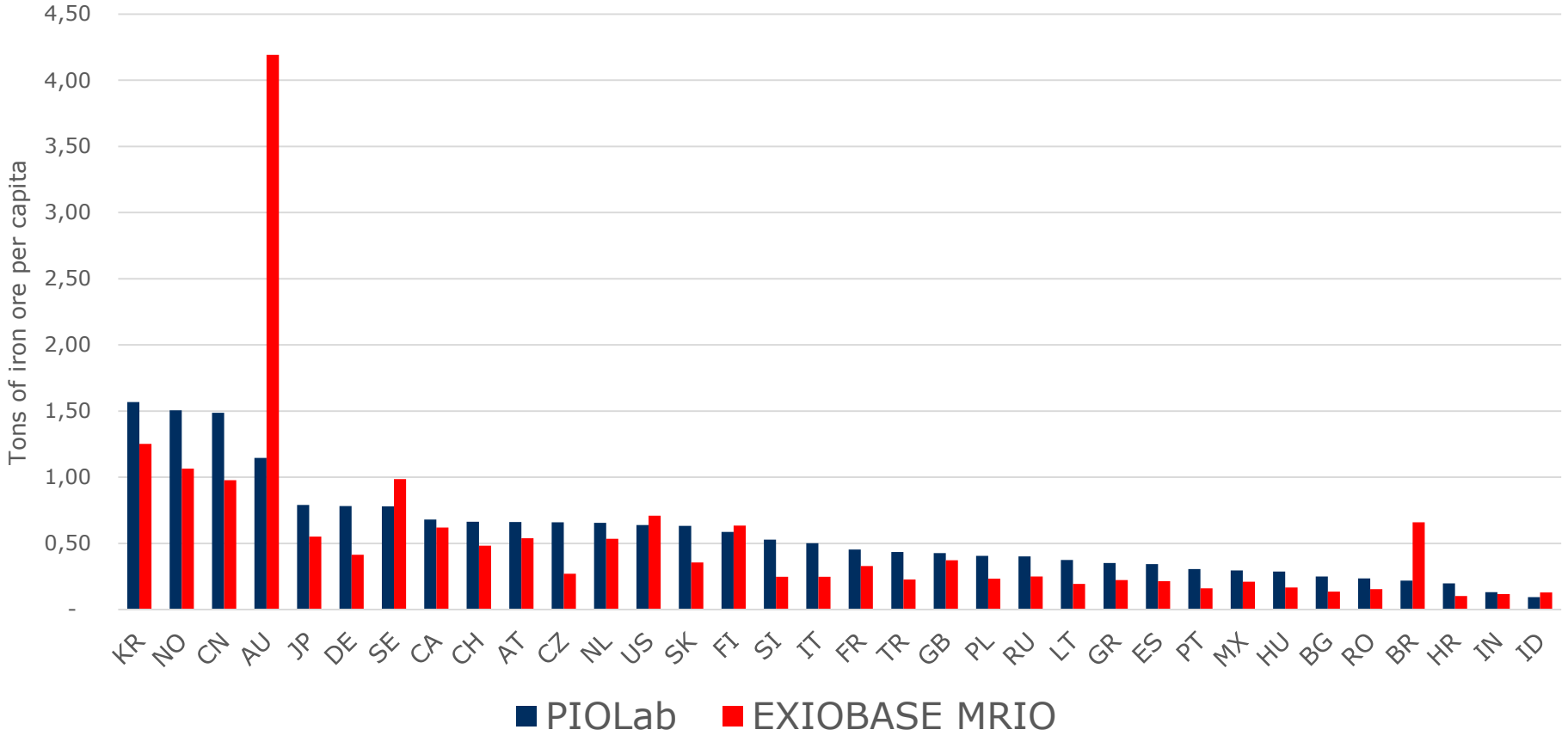
Iron Ore
Pig Iron
Sponge Iron
Forming & fabrication scrap
Scrap steel
Liquid steel from OBF
Liquid steel from EAF
Slab
Ingot
Billet & Bloom
Flat rolled products
Long rolled products
Fabricated metal products
Machinery and equipment n.e.c.
Office machinery and computers
Electrical machinery nec
Radio/television; communication equipment
Medical, precision and optical instruments
Motor vehicles, trailers and semi
Other transport equipment
Furniture; other manufactured goods
Construction work

Integrated set of material flow indicators (2008)

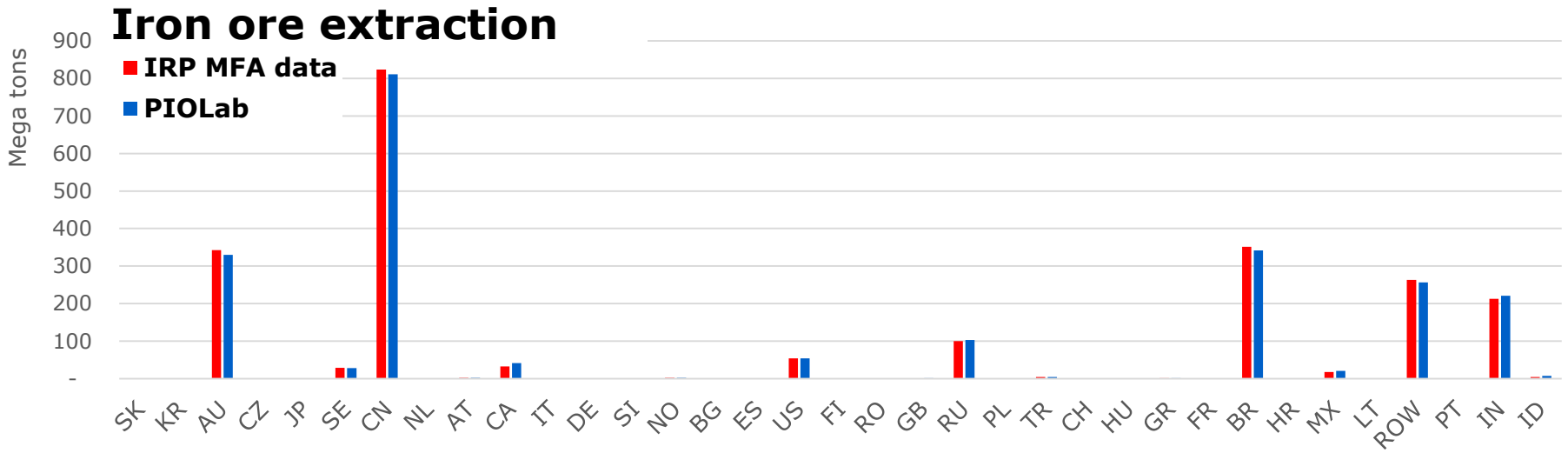


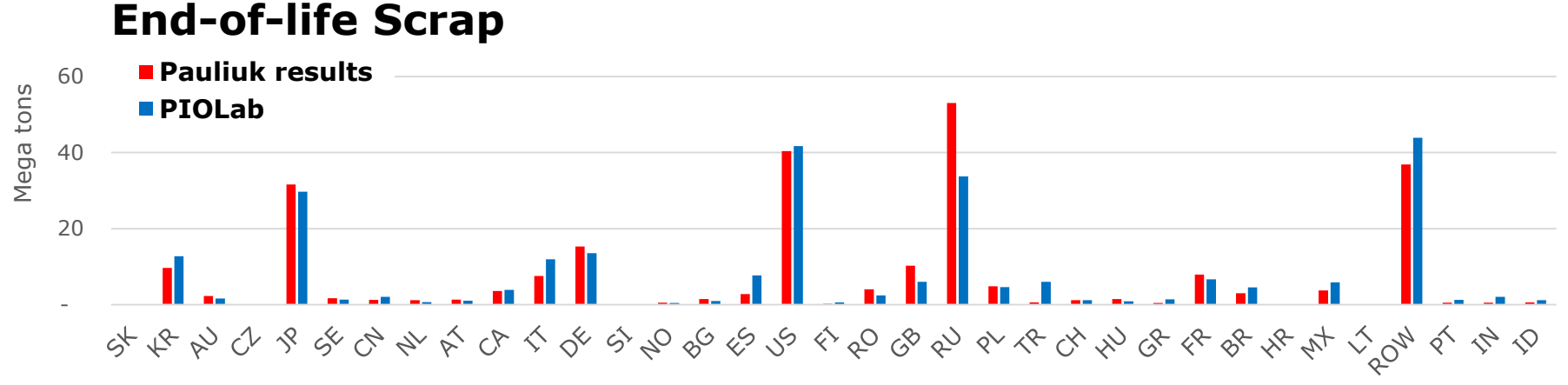
Material footprint of nations

PIOLab vs. EXIOBASE (2014)



First results for 2008:
Raw data vs. PIOLab result





Next steps and outlook

1. **Initial Estimate**
   - Increase number of countries to 44 and 5 RoW regions
   - Disaggregate finished steel products?
2. **Constraint data feeds**
   - Ratio constraints to better incorporate material balances

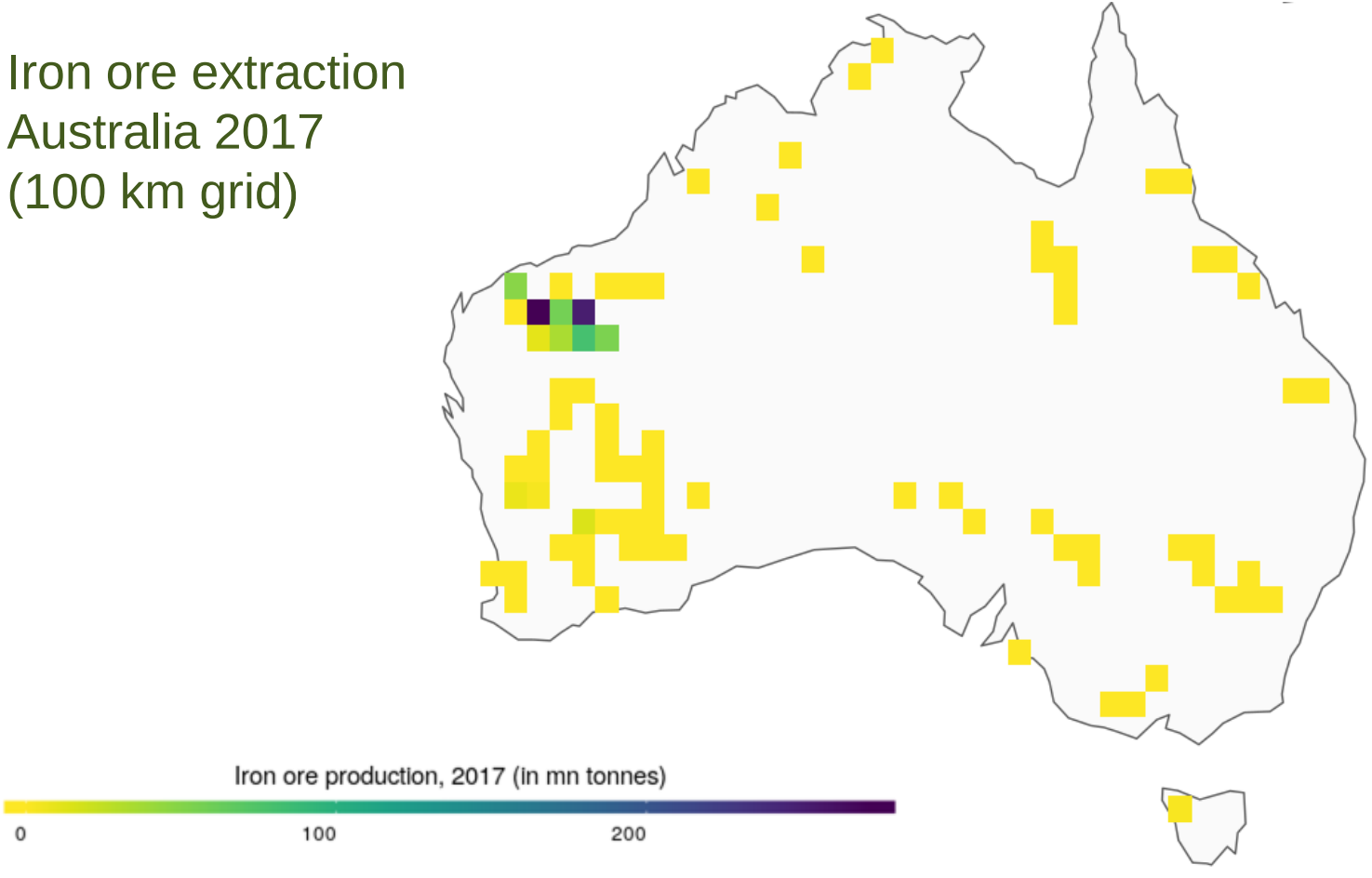
2020/21/22

- **PIOTs for bauxite, copper and other metals**
- **Sub-nation PIOTs for hot-spot countries**

How to get robust initial estimate for sub-national trade?

Outlook: Sub-national PIOTs for hot-spot regions

Iron ore extraction
Australia 2017
(100 km grid)



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