ETH zürich

73nd LCA Discussion Forum

21 November 2019

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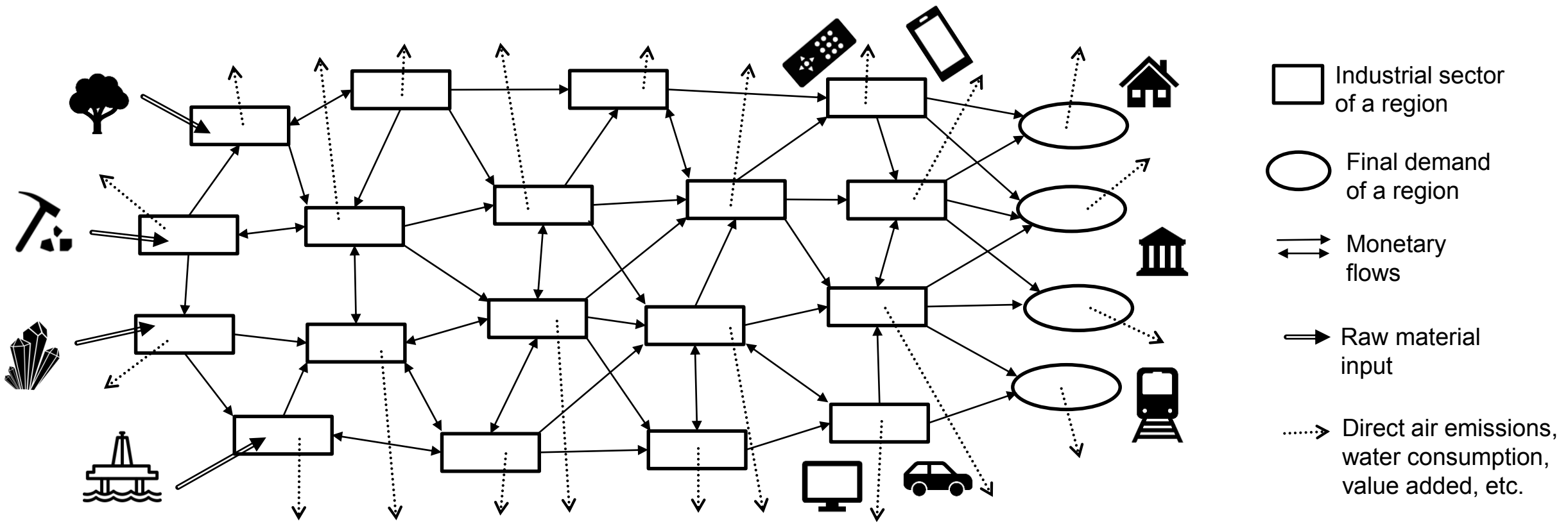
Institute of Science, Technology & Policy

Global supply chain analysis of material-related impacts in ICT (MRIO approach)

Questions:

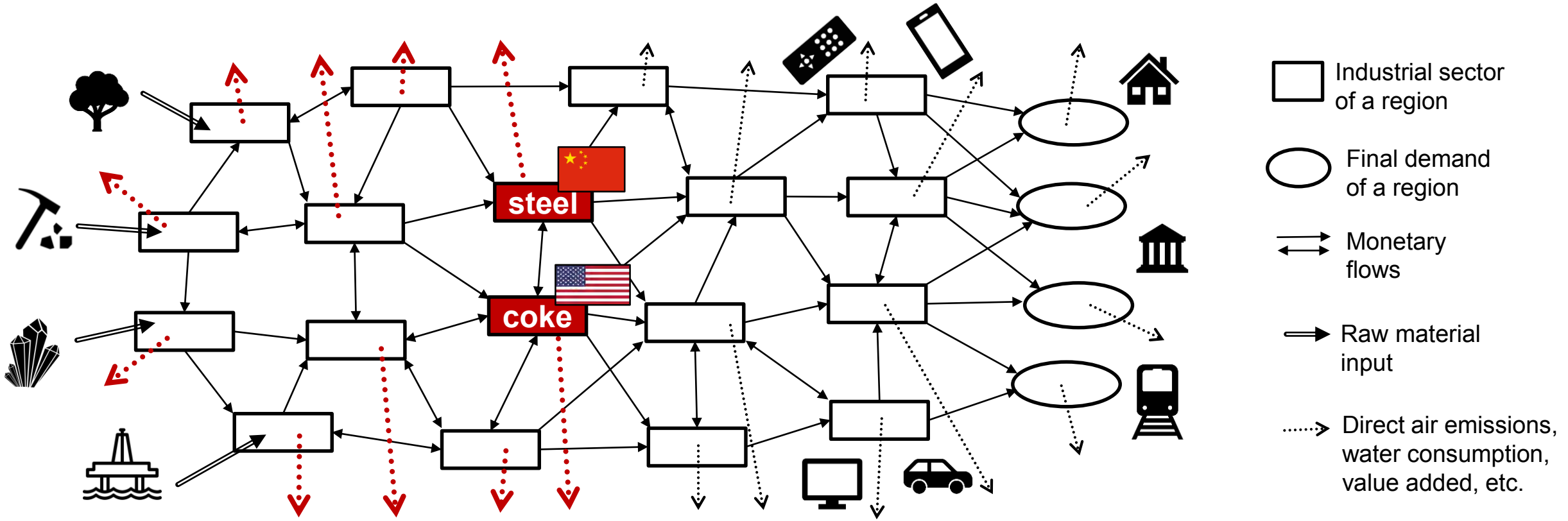
- Why are materials important in ICT?
- What are key materials?
- Where on globe are the material-related impacts caused?
- Which regions consume ICT?
- What is the role of trade?
- Has trade changed over time?
- How does Switzerland compare to the global average?
- How to reduce material-related impacts in Swiss ICT?

How does my method work?



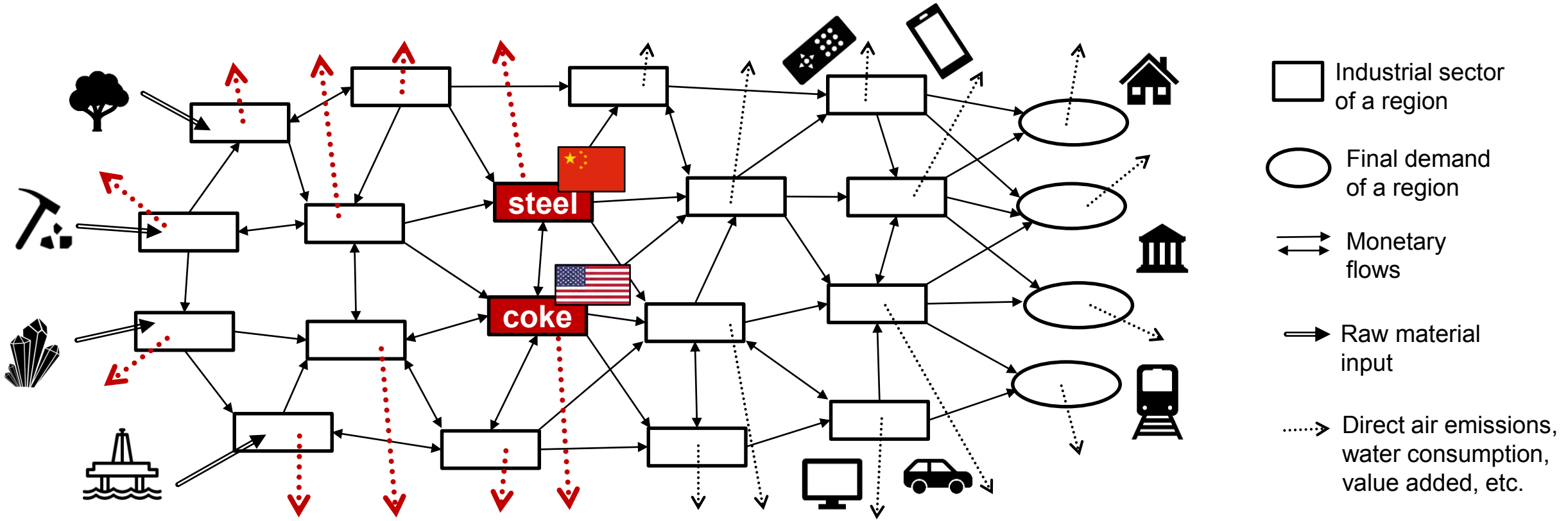
MULTI-REGIONAL INPUT-OUTPUT ANALYSIS (MRIO):
simplified example

1. Assess the cumulated upstream impacts of target-sector-regions without double counting



MULTI-REGIONAL INPUT-OUTPUT ANALYSIS (MRIO):
simplified example

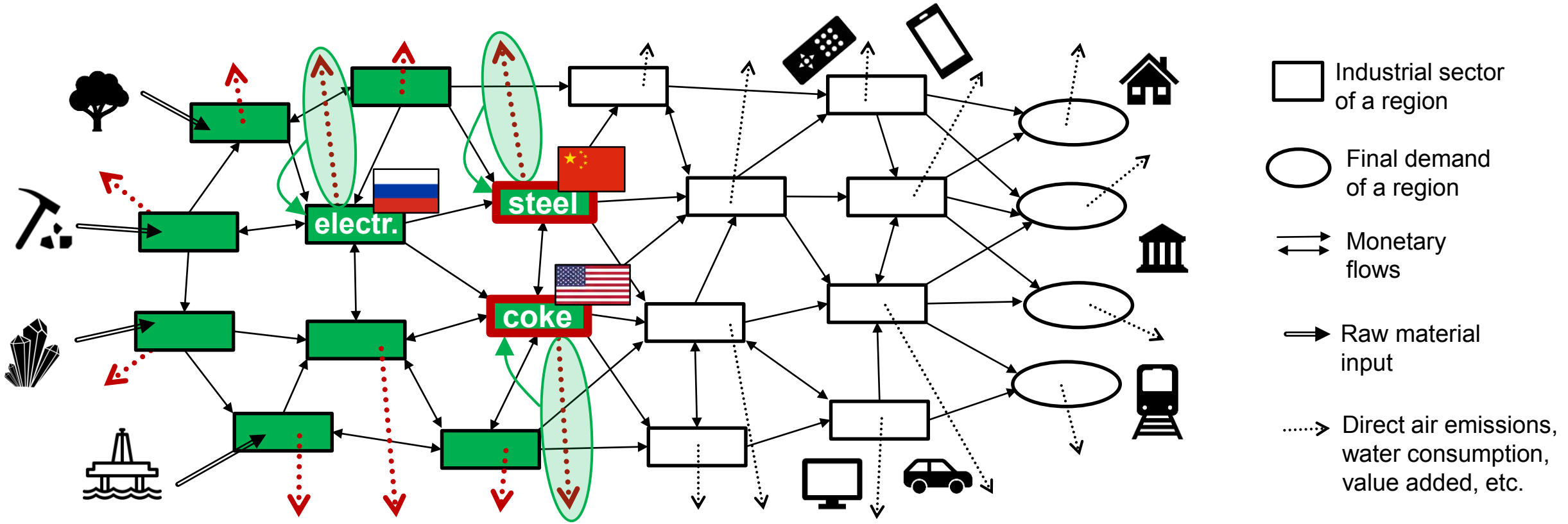
2. Track the cumulated upstream impacts of target-sector-regions without double counting along several steps of the global value chain



PERSPECTIVES:

ESD ecological systems design ISTP

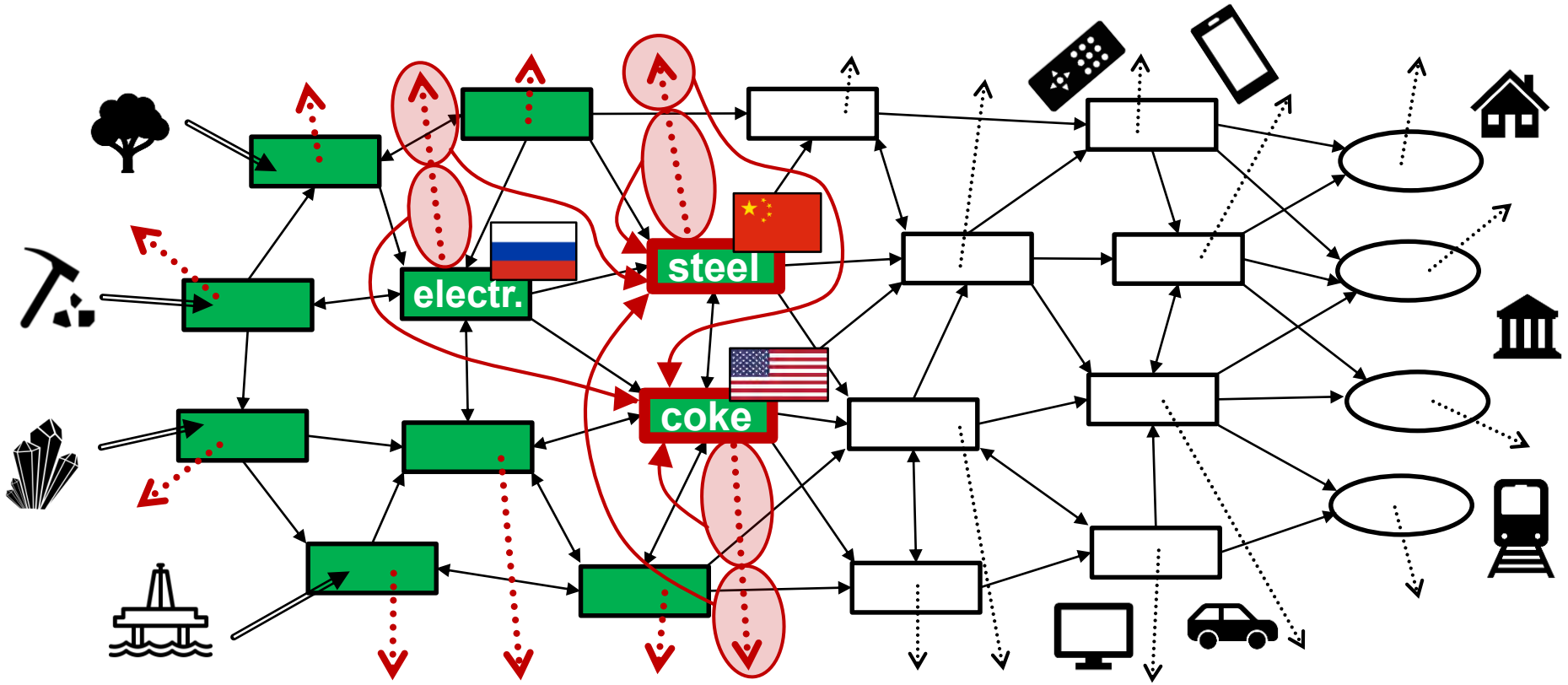
2. Track the cumulated upstream impacts of target-sector-regions without double counting along several steps of the global value chain



PERSPECTIVES: **PRODUCTION**

ESD ISTP ecological systems design

2. Track the cumulated upstream impacts of target-sector-regions without double counting along several steps of the global value chain



Industrial sector of a region

Final demand of a region

Monetary flows

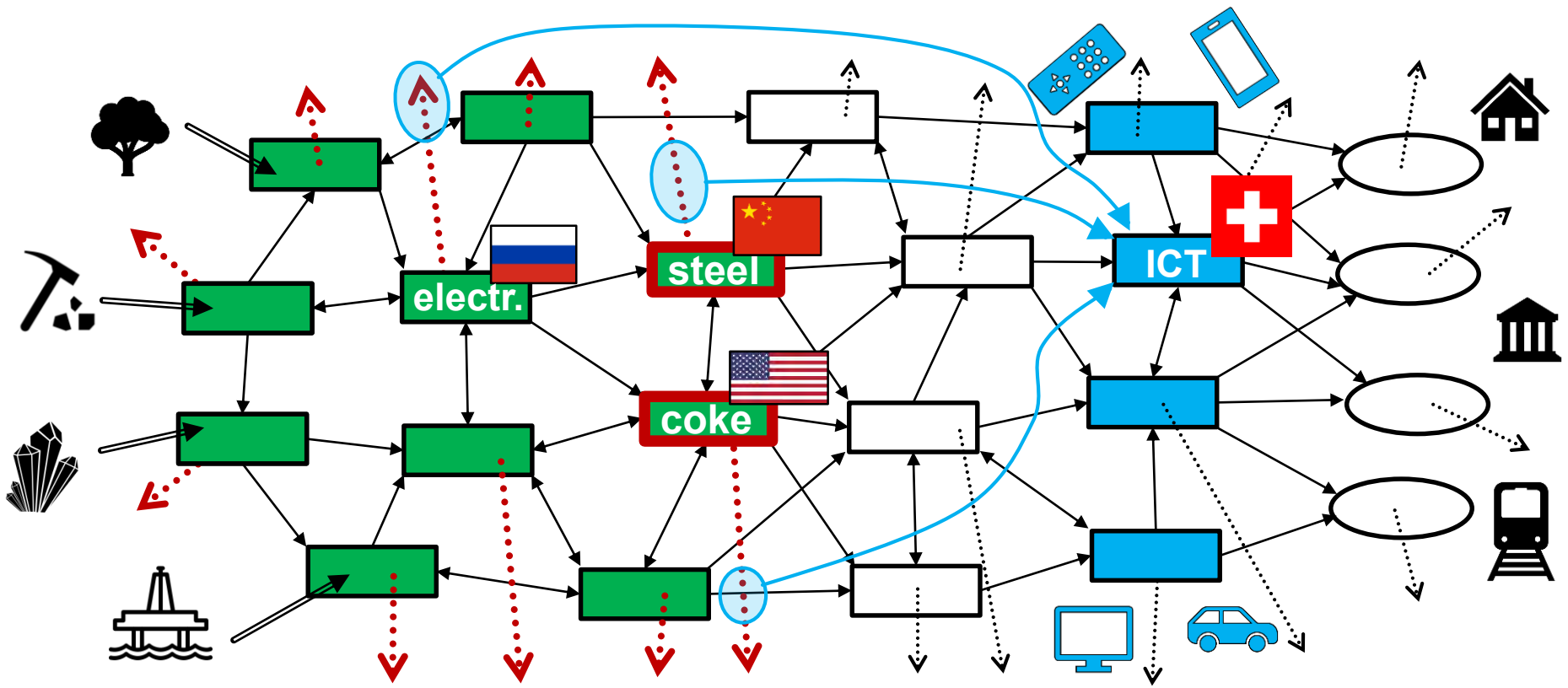
Raw material input

Direct air emissions, water consumption, value added, etc.

PERSPECTIVES: PRODUCTION **TARGET**

ESD ISTP ecological systems design

2. Track the cumulated upstream impacts of target-sector-regions without double counting along several steps of the global value chain



Industrial sector of a region

Final demand of a region

Monetary flows

Raw material input

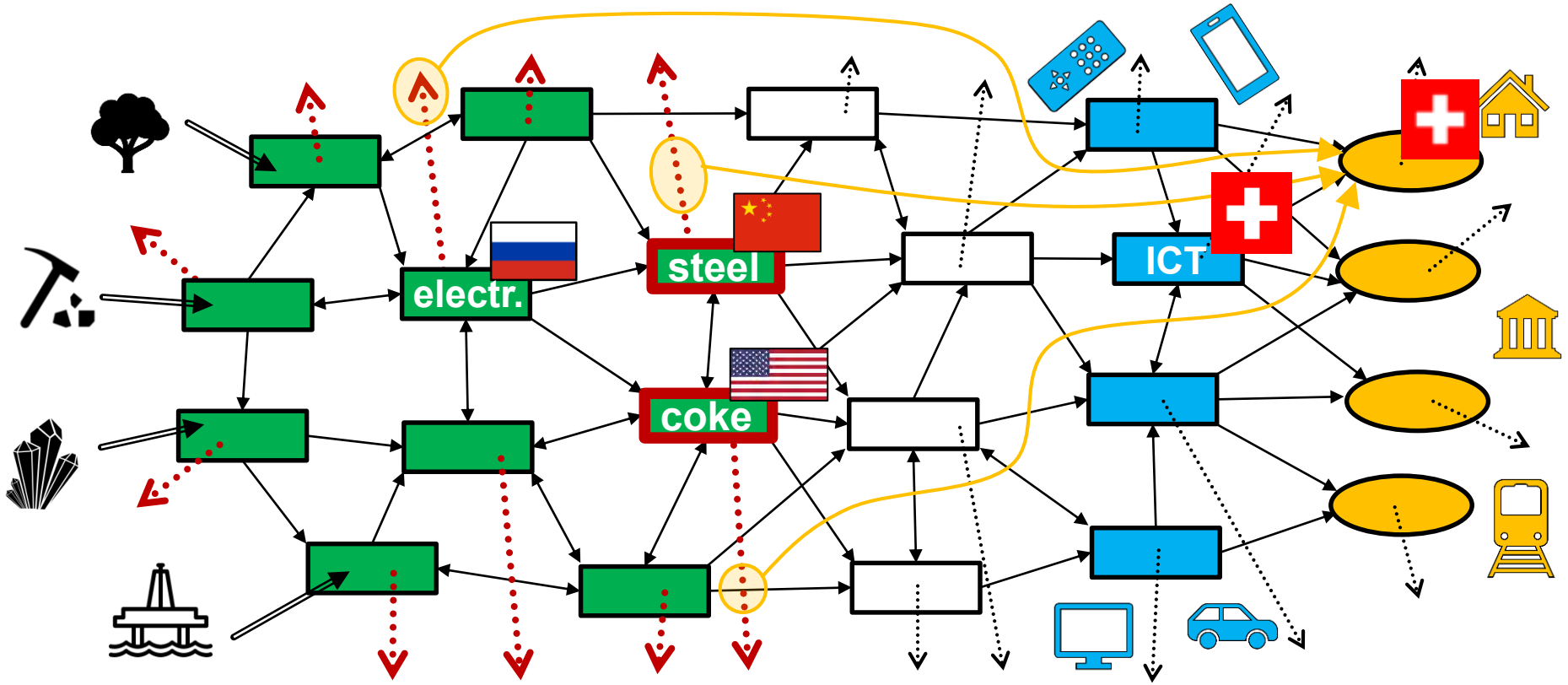
Direct air emissions, water consumption, value added, etc.

PERSPECTIVES: PRODUCTION | TARGET | FINAL SUPPLY

Upstream supply chain | **Downstream value chain**

ESD ecological systems design ISTP

2. Track the cumulated upstream impacts of target-sector-regions without double counting along several steps of the global value chain



Industrial sector of a region

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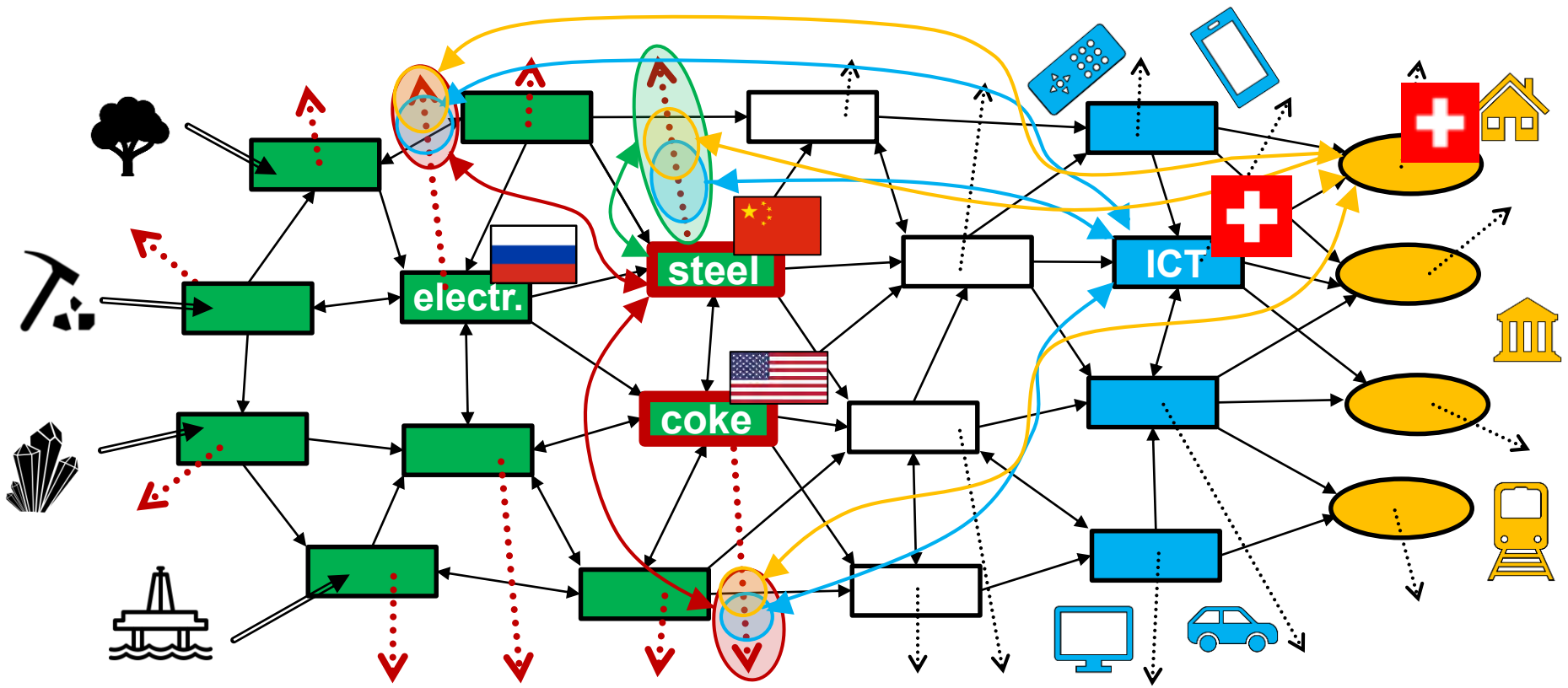
PERSPECTIVES: PRODUCTION | TARGET | FINAL SUPPLY | FINAL DEMAND

Upstream supply chain

Downstream value chain

ESD ecological systems design ISTP

3. Evaluate the linkages in the global supply chain to identify the leverages



Industrial sector of a region

Final demand of a region

Monetary flows

Raw material input

Direct air emissions, water consumption, value added, etc.

LINKAGES: PRODUCTION ↔ TARGET ↔ FINAL SUPPLY ↔ FINAL DEMAND

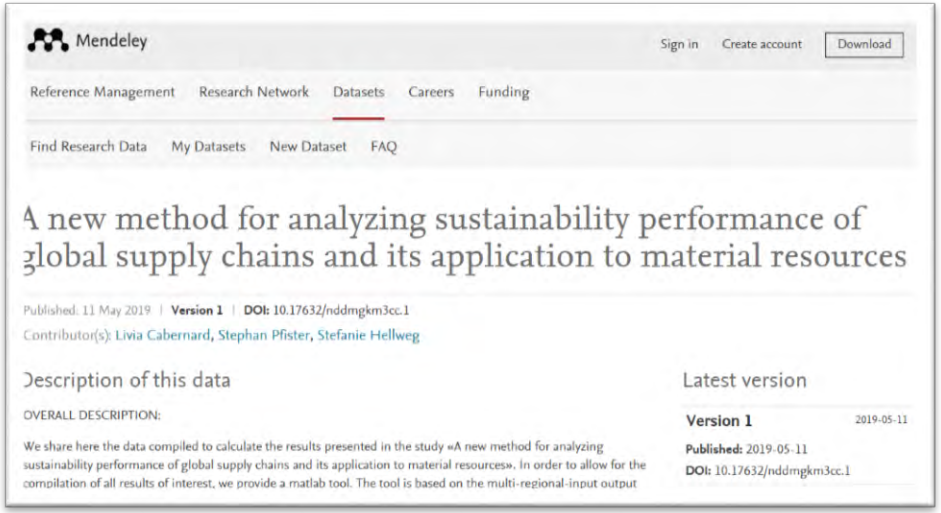
Upstream supply chain

Downstream value chain

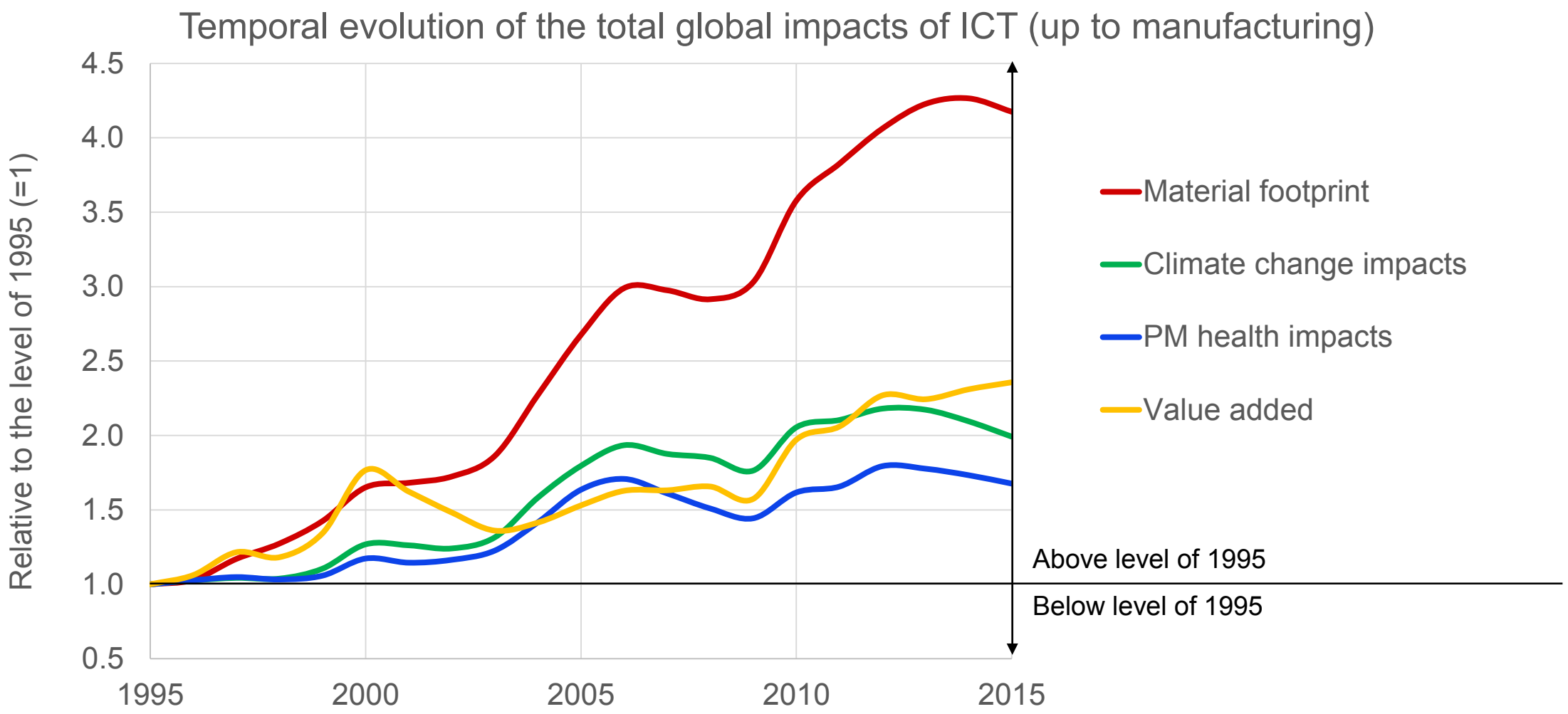
ESD ecological systems design ISTP

Application to EXIOBASE3

- EXIOBASE3: 163 industrial sectors x 49 regions
- Set of (regionalized) environmental and socio-economic indicators
  - Climate change impacts
  - PM health impacts
  - Water stress
  - Land-use rel. Biodiversity loss
  - …
  - Compensation of Employment
  - Taxes
  - Workforce
  - ….
- Method provided as a tool:
  →**Open access**: **http://dx.doi.org/10.17632/nddmgkm3cc.2**



Why are materials important in ICT?



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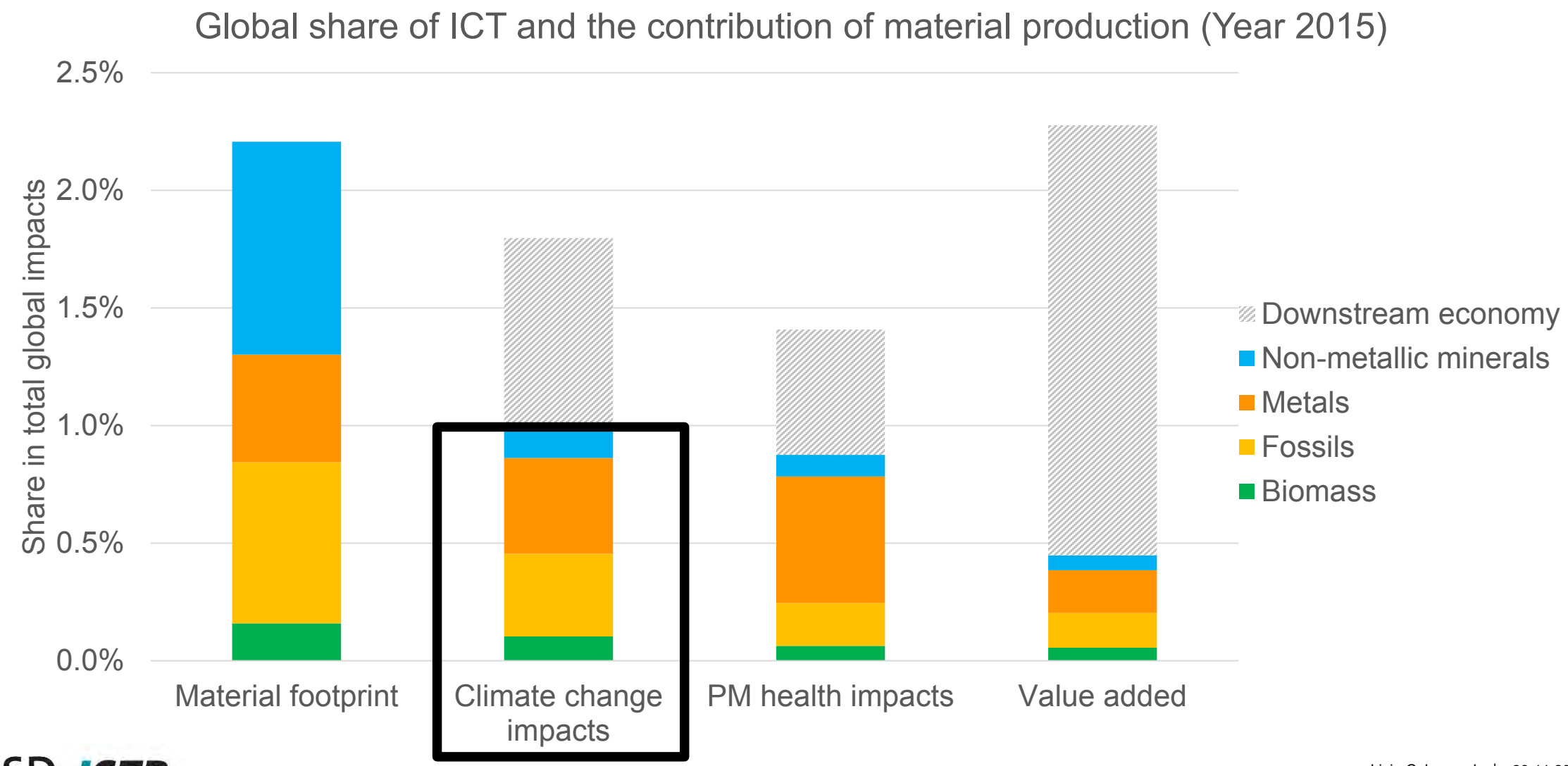
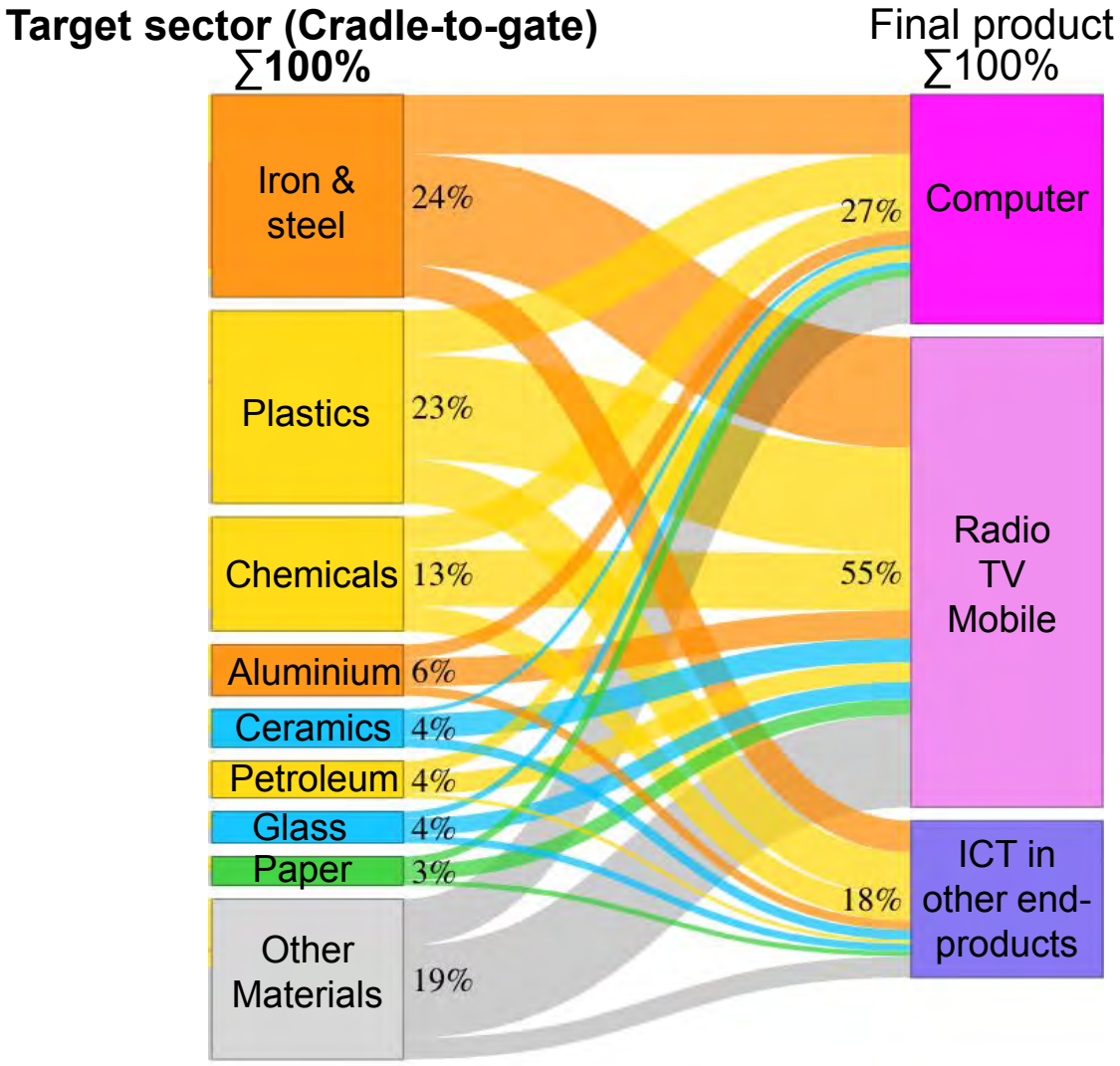
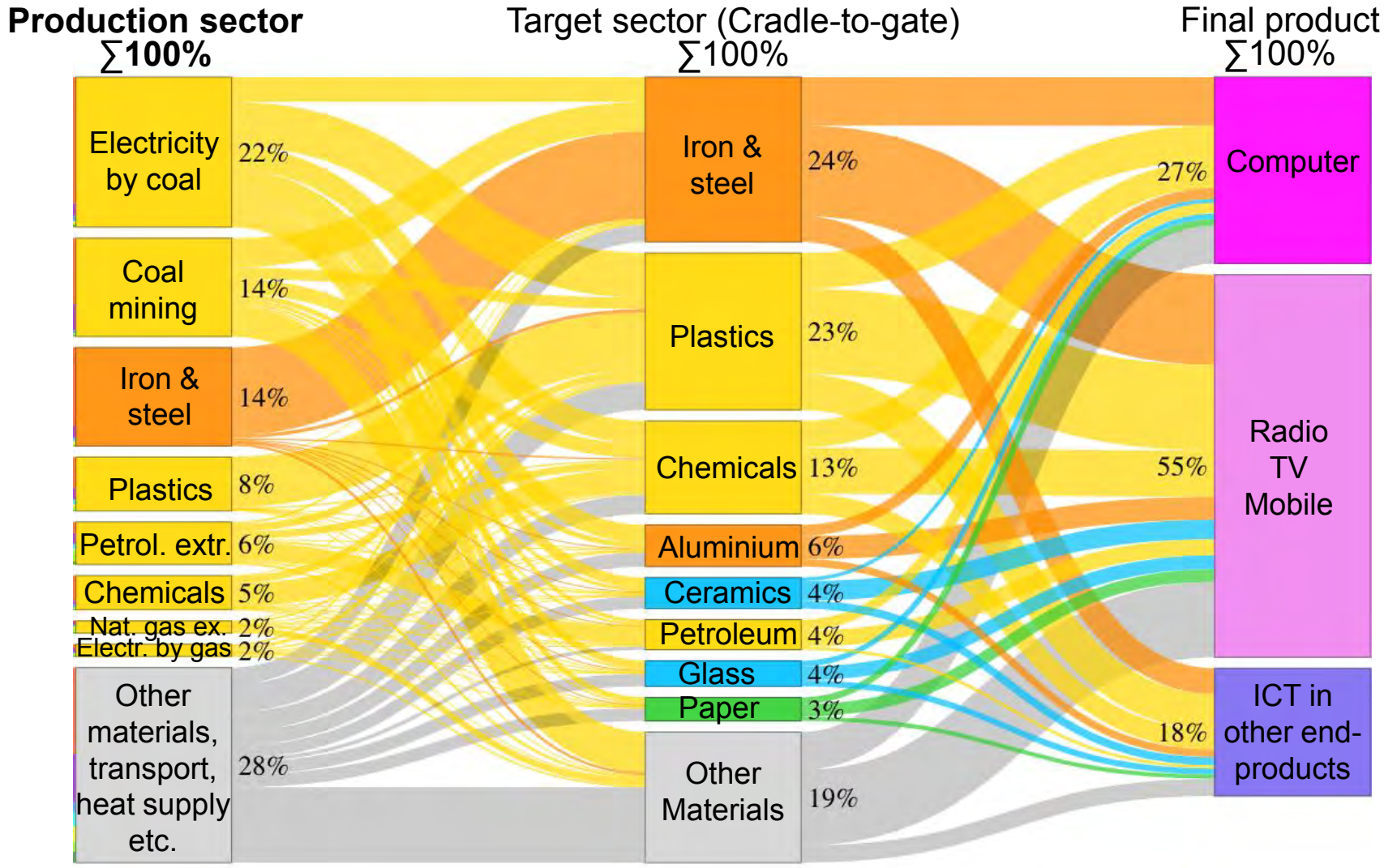


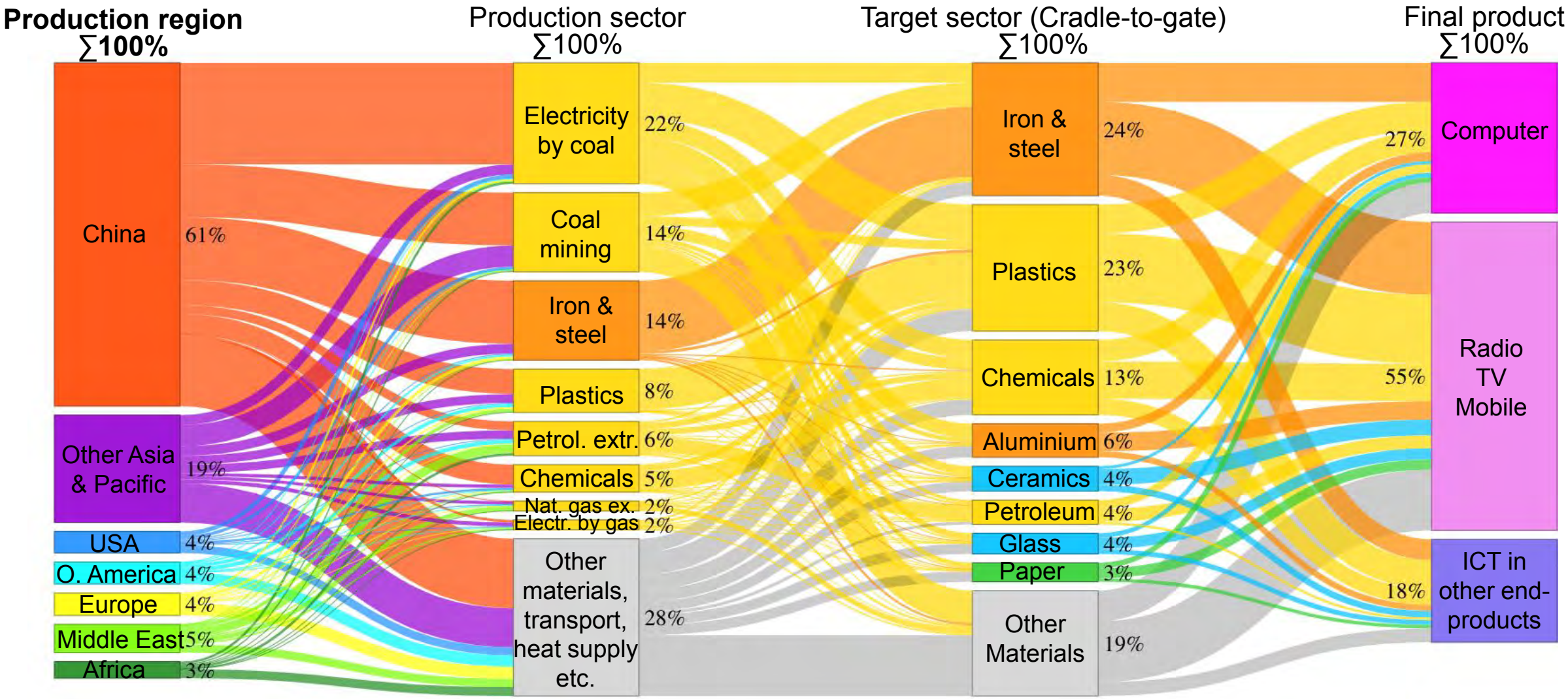
What are the key materials in ICT causing climate change impacts? (Year 2015)



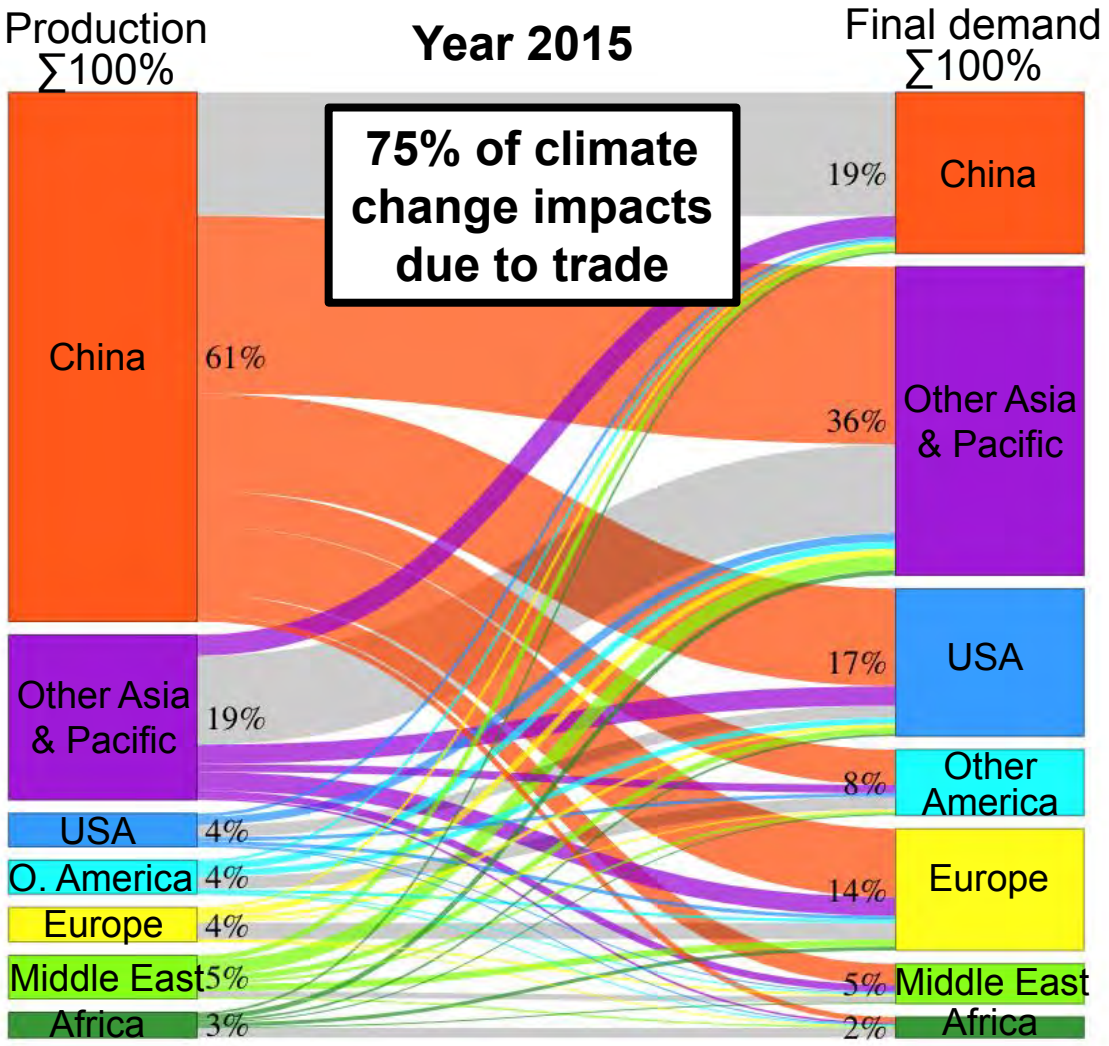
Which industrial sectors emit the GHGs directly? (Year 2015)



In which regions are the climate change impacts caused? (Year 2015)

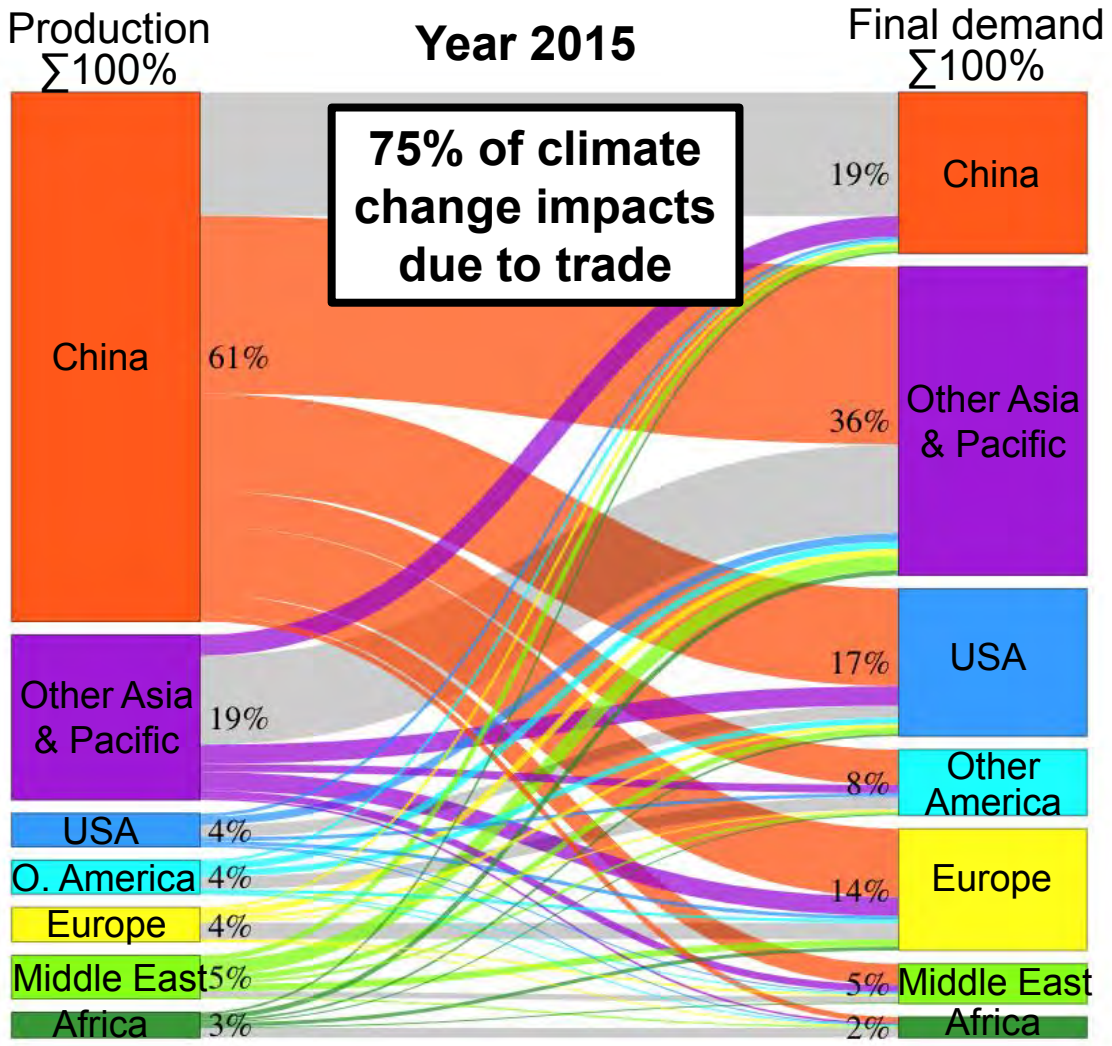


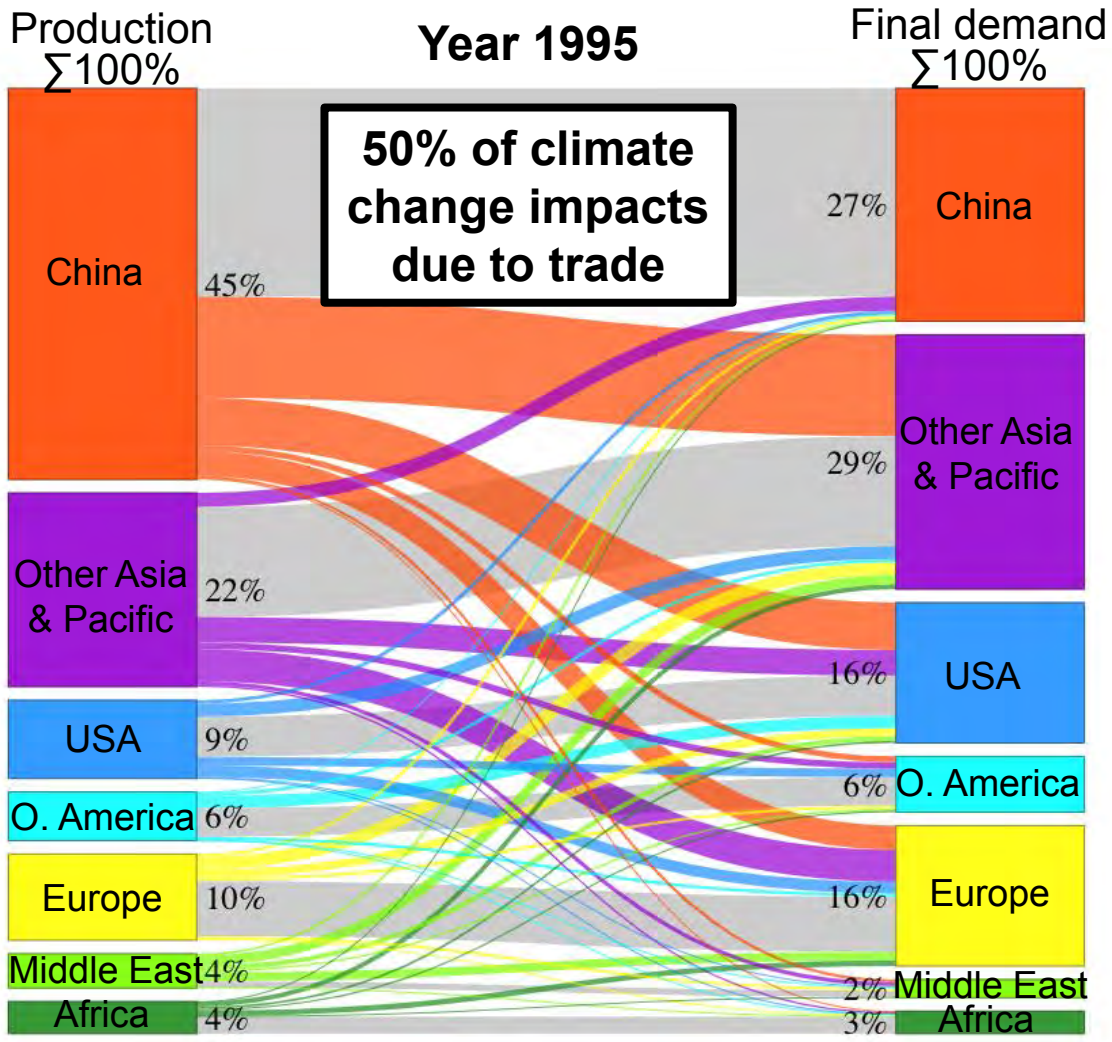
What is the role of trade for material-rel. climate change impacts in ICT?



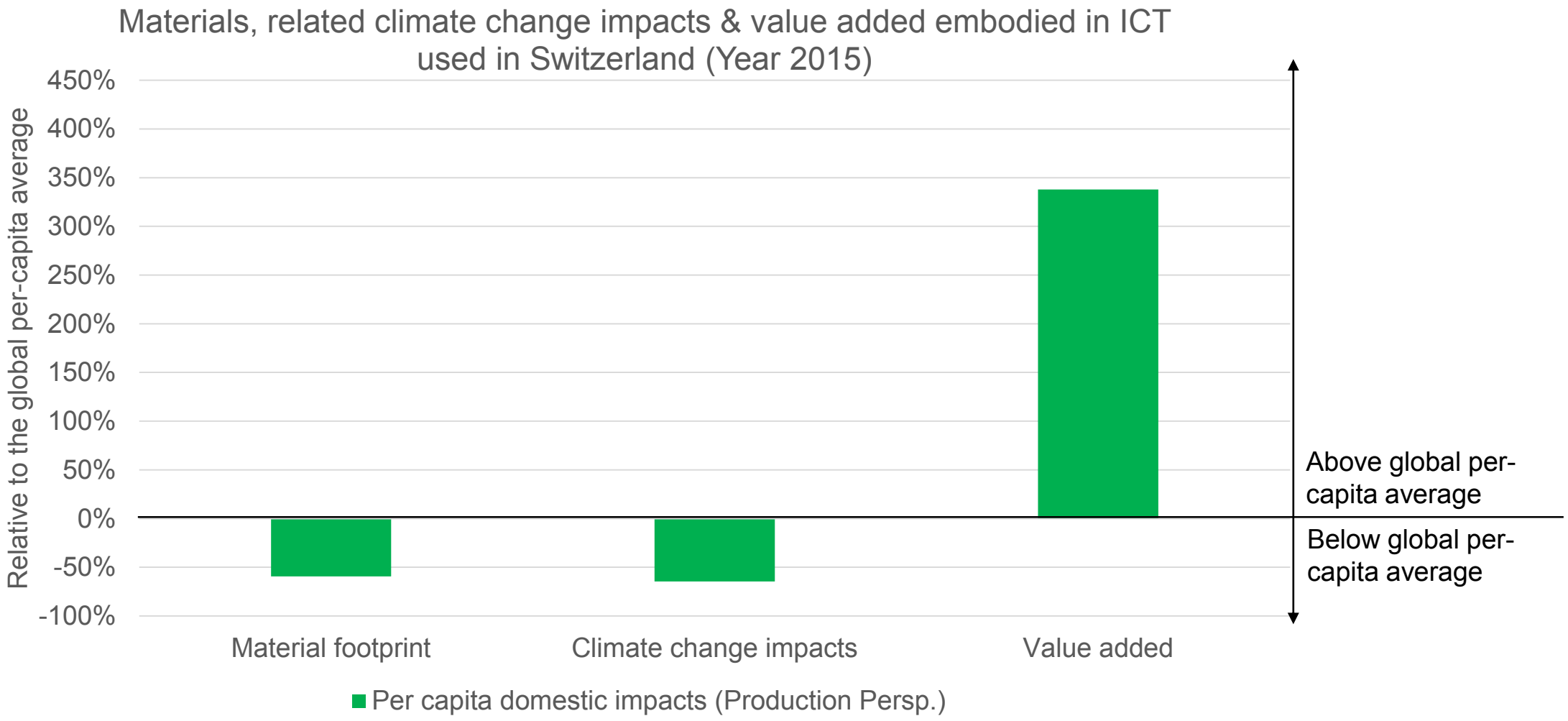
Grey flows: domestic
Colored flows: trade

Have trade pattern changed over the past 20 years?





How does Switzerland compare to the global average?



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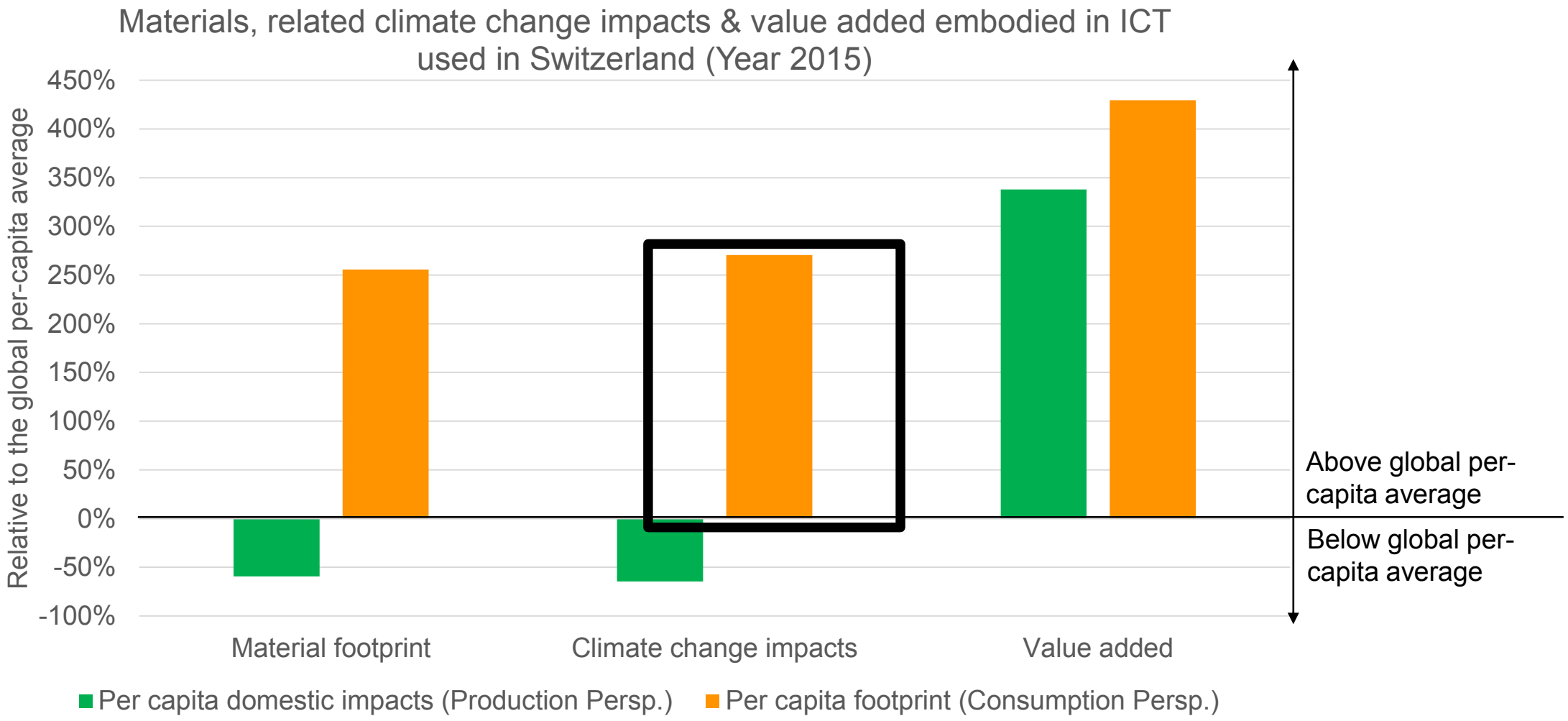
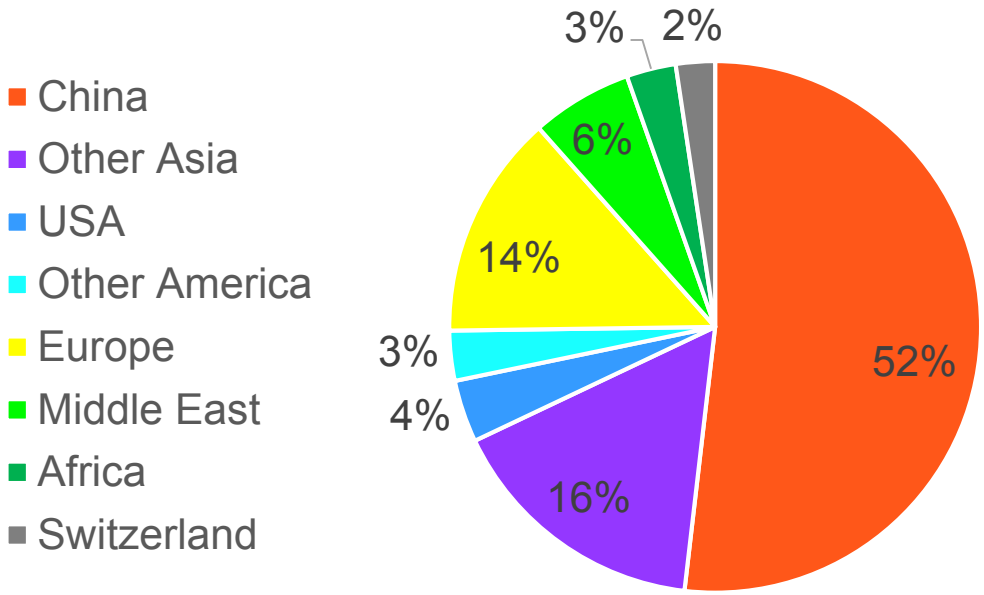
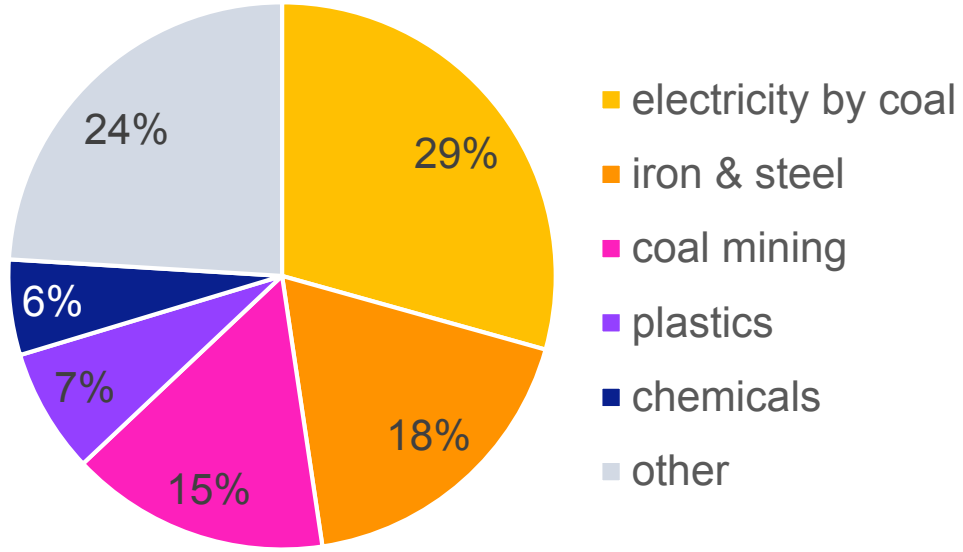


How to reduce material-related climate change impacts in Swiss ICT?

In which region are the impacts caused?

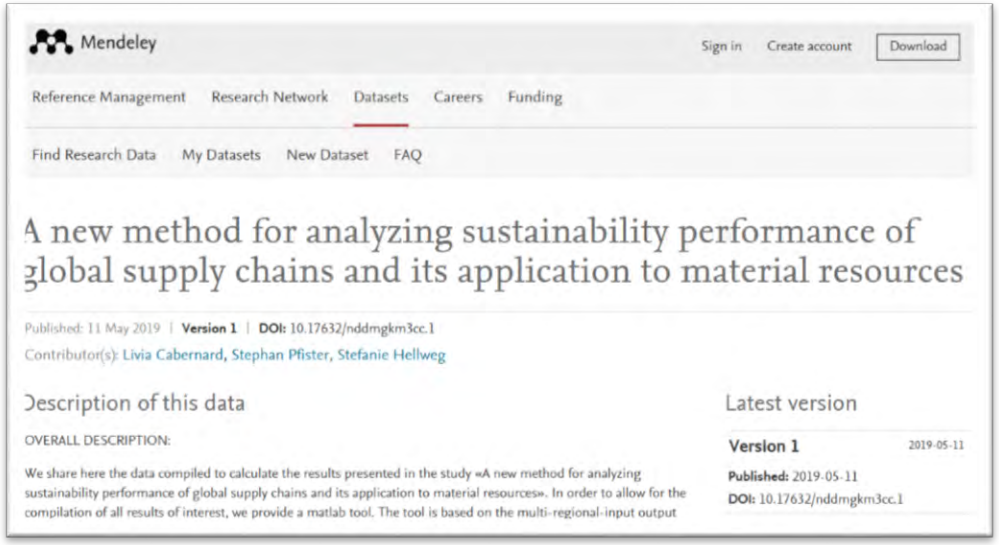


In which sector in China are the impacts caused?



Conclusions & Outlook

- ICT relevant on a global scale (increasing trend, almost 2% of global climate change impacts)
- Materials in ICT are important (increasing trend , 60% of climate change impacts of ICT)
- Key materials: Iron & steel, plastics & chemicals
- In the upstream chain: coal mining & electricity in China
- Increasing role of trade and outsourcing to China
- Improved supply chain management essential
- Tool for in depth-analysis:
- http://dx.doi.org/10.17632/nddmgkm3cc.2
- Limitations:
  - Limited resolution in sectors (163) and regions (49)
  - Impacts of use of ICT unknown



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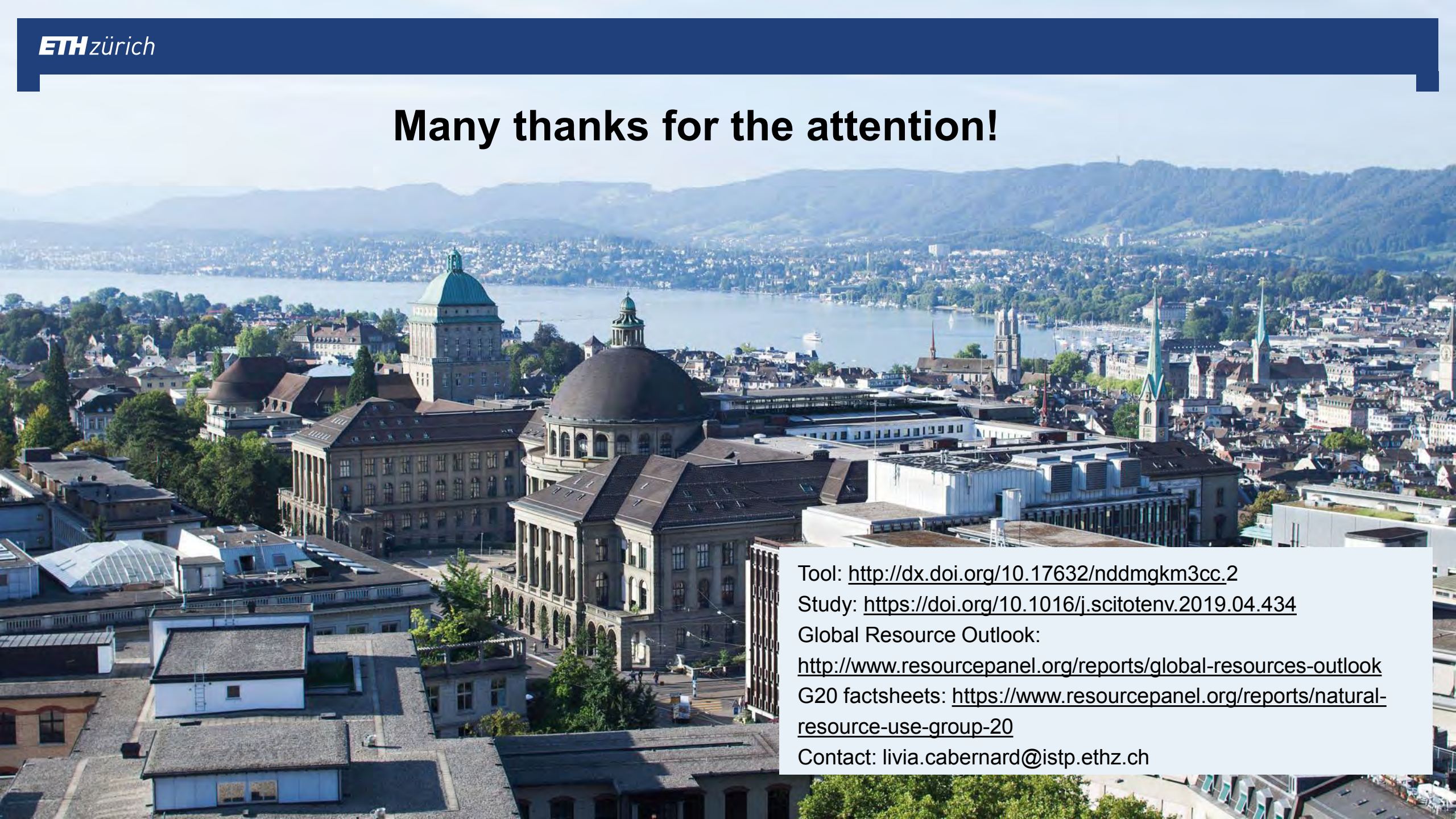
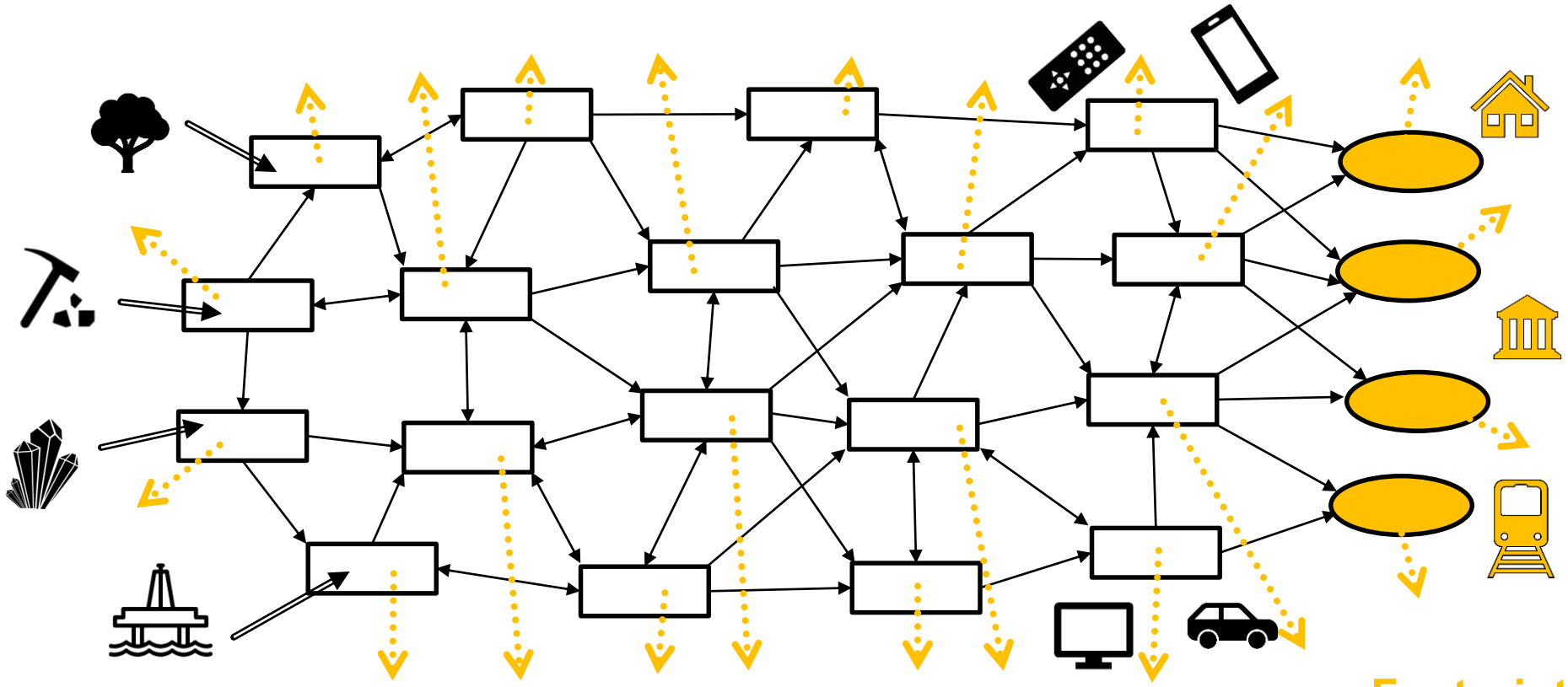
Many thanks for the attention!



Tool: http://dx.doi.org/10.17632/nddmgkm3cc.2
Study: https://doi.org/10.1016/j.scitotenv.2019.04.434
Global Resource Outlook: http://www.resourcepanel.org/reports/global-resources-outlook
G20 factsheets: https://www.resourcepanel.org/reports/natural-resource-use-group-20
Contact: livia.cabernard@istp.ethz.ch

Previous studies



MULTI-REGIONAL INPUT-OUTPUT ANALYSIS (MRIO):
simplified example

Footprints of regions

Industrial sector of a region

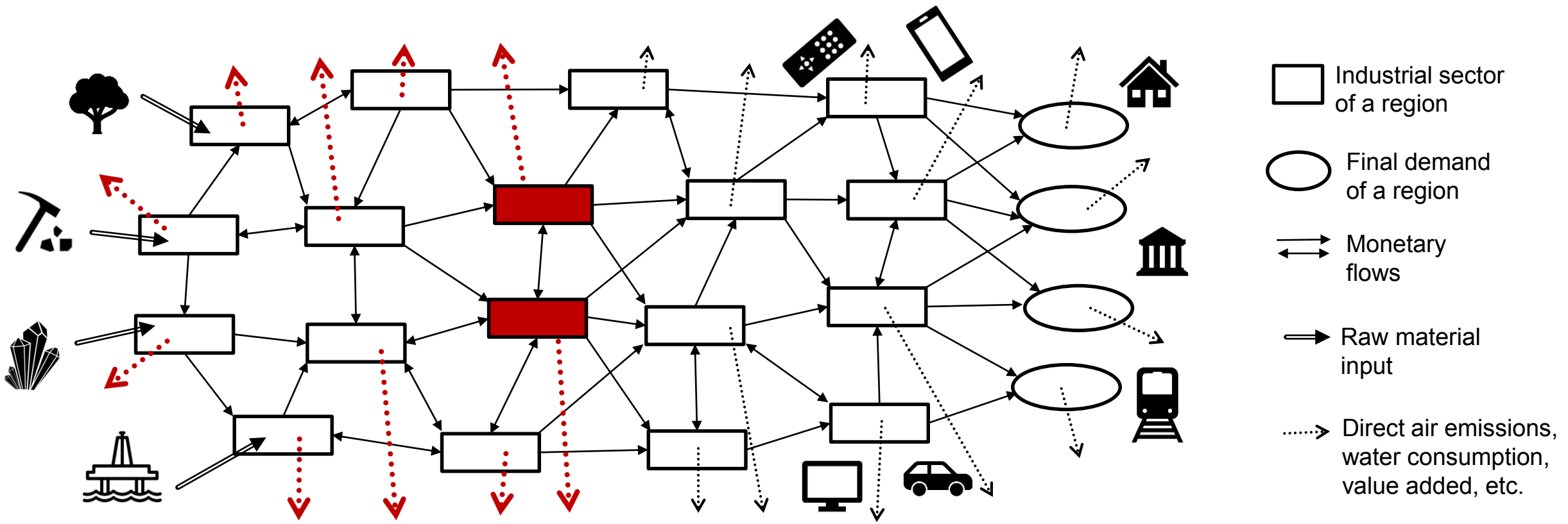
Final demand of a region

Monetary flows

Raw material input

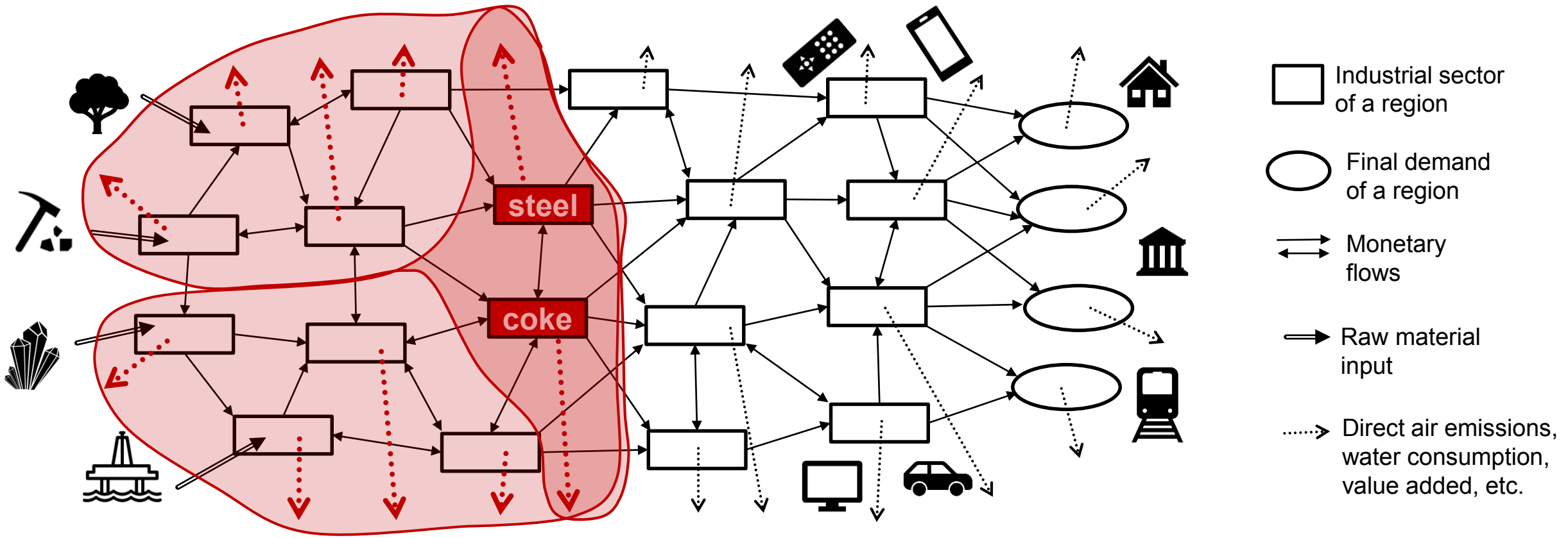
Direct air emissions, water consumption, value added, etc.

Previous limitations



Cumulated upstream impacts of intermediate sectors → Issue of double counting

Previous limitations



Cumulated upstream impacts of intermediate sectors → Issue of double counting

INTERFACE

Matlab Tool to Analyze Sustainability Performance along the Global Value Chain

1) Make your Settings (press command to select several items)

Target-Sectors

Biomass extraction:	Cultivation of paddy rice
Biomass extraction:	Cultivation of wheat
Biomass extraction:	Cultivation of cereal grains nec
Biomass extraction:	Cultivation of vegetables & fruit and nuts
Biomass extraction:	Cultivation of oil seeds
Biomass extraction:	Cultivation of sugar cane and sugar beet
Biomass extraction:	Cultivation of plant-based fibers
Biomass extraction:	Cultivation of crops nec
Biomass extraction:	Cattle farming

Target-Regions

Africa:	South Africa
Africa:	RoW Africa
Australia:	Australia
China:	China
China:	Taiwan
Europe:	Austria
Europe:	Belgium
Europe:	Bulgaria
Europe:	Czech Republic

Environmental (E) & Socioeconomic (S) Indicators

E:	Material footprint (kt)*
E:	Unused material footprint (kt)
E:	Climate change impacts: total (kg CO2-eq)*
E:	CO2-related climate change impacts (kg CO2-eq)
E:	CH4-related climate change impacts (kg CO2-eq)
E:	N2O-related climate change impacts (kg CO2-eq)
E:	HFC-related climate change impacts (kg CO2-eq)
E:	PFC-related climate change impacts (kg CO2-eq)
E:	Particulate-matter rel. health impacts: total (DALYs)*

Years

1995
1996
1997
1998
1999
2000
2001
2002
2003

Which results do you want to display?

Single Perspectives (one table for each year and indicator):	Production (Sectors & Regions)
Single Perspectives (one table for each year and indicator):	Target (Sectors & Regions)
Single Perspectives (one table for each year and indicator):	Final Supply (Sectors & Regions)
Single Perspectives (one table for each year and indicator):	Final Demand (Categories & Regions)
Linkages (one table for each year and indicator):	All linkages between Production and Target**
Linkages (one table for each year and indicator):	All linkages between Target and Final Supply**
Linkages (one table for each year and indicator):	All linkages between Target and Final Demand**
Linkages (one table for each year and indicator):	All linkages between Production and Final Demand**
Linkages (one table for each year and indicator):	Sectoral linkages between Production and Target

How to display your results?

In the unit of the resp. indicator
As shares in total global impacts

2) Insert the name of your folder where the results will be stored

3) Start Calculation (Press Button)

Progress:

INTERFACE

→Application to global material production

Target-Sectors

Chose between 163 industrial sectors

→ 75 material sectors

Target-Regions

Choose between 49 regions

→All regions

Environmental (E) & Socioeconomic (S) Indicators

- Climate Change Impacts
- PM Health Impacts
- Water Stress
- Land-use related Biodiversity Loss
- ....

Years

Time-frame: 1995 – 2011

Which results do you want to display?

- Production, Target, Final Supply, Final Demand Perspective
- Linkages
- Multiple indicators
- Timelines

How to display your results?

Unit &/ Global Shares

2) Insert the name of your folder where the results will be stored

3) Start Calculation (Press Button)

Progress: