The structure of life-cycle environmental impact of the U.S. economy

Using a multi-regional hybrid framework

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Content

- Background and objectives
- Method and data
- Results
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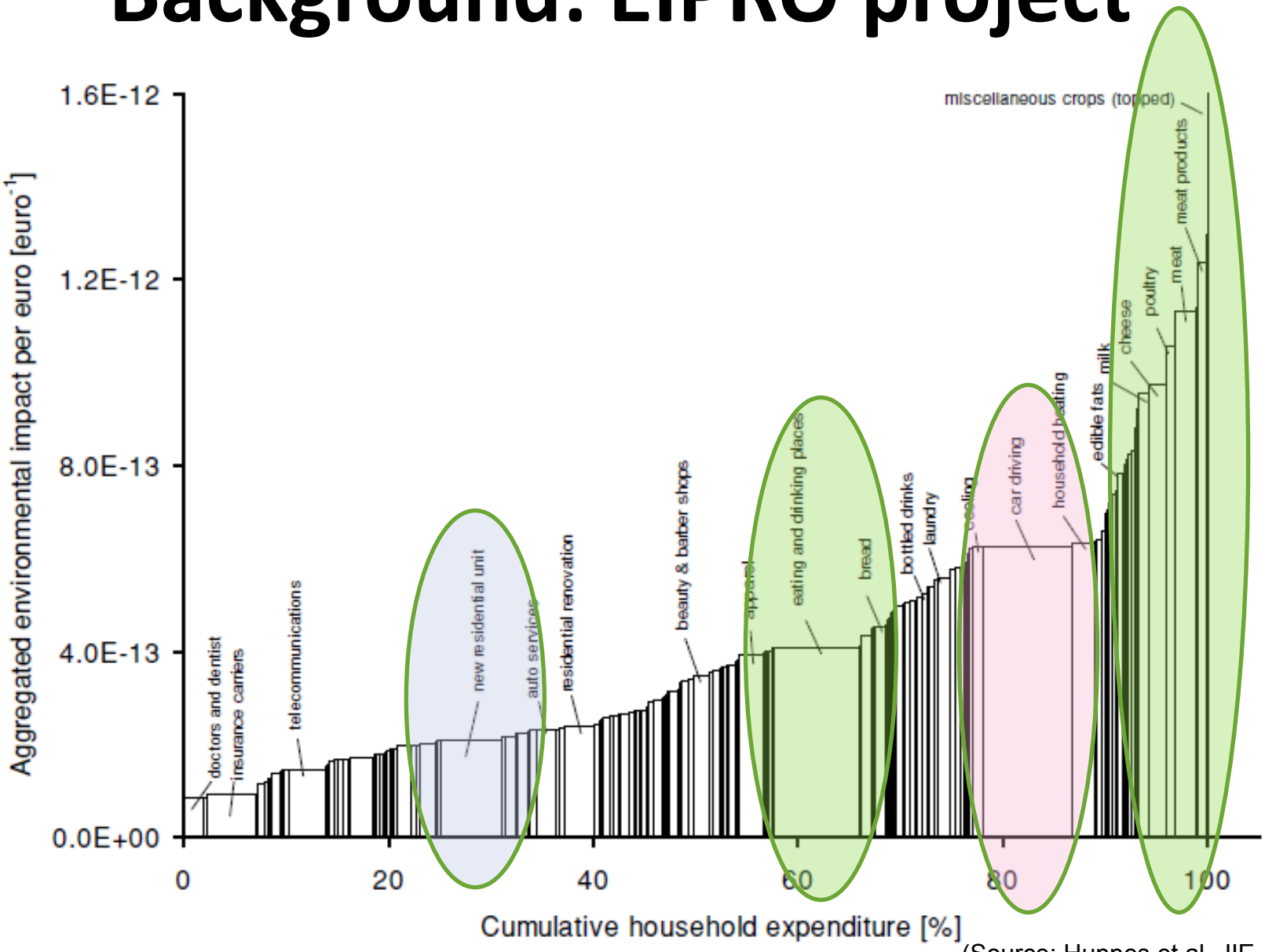
Background: EIPRO project



(Source: Huppes et al. JIE, 2006)

Background: US EPA vision study

Source: http://www.epa.gov/osw/inforesources/pubs/vision2.pdf

	Material, Product, or Service	Final Rank			Environmental Aspects Significantly[1] Contributing to Final		
		DI	IC	FC	Direct Impact/Resource Use/Waste Perspective	Intermediate Consumption Perspective	Final Co
Food Products & Services	Dairy farm products	19	–	–	LUC		
	Poultry and eggs	20	–	–	LUC		
	Meat animals	6	6	–	LUC	LUC, FAETP, TETP, EP	
	Food grains	13	–	–	LUC, EP		
	Feed grains	9	15	–	LUC, FAETP, TETP, EP, MU	ADP, LUC, FAETP, TETP, EP	
	Miscellaneous crops	16	–	–	FAETP, TETP, EP		
	Meat packing plants	–	11	7		LUC, FAETP, TETP, EP	L
	Poultry slaughtering and processing	–	–	17			
	Eating and drinking places	–	16	5		LUC, GWP, FAETP, TETP, POCP, EP	LUC, GWP, ODP, HTP, POCP,
	Food preparations, n.e.c.	–	–	19			
	Fluid milk	–	–	20			
Textiles	Cotton	2	2	–	FAETP, TETP, EP	FAETP, TETP, EP	
	Apparel made from purchased materials	–	13	2		FAETP, TETP, EP	ODP, HTP
	Broadwoven fabric mills and fabric finishing plants	–	10	–		FAETP, TETP, EP	
Nonrenewable Organics	Coal	5	9	–	ADP, MU, MW	ADP, MU, MW	
	Crude petroleum and natural gas	4	4	–	ADP, GWP, POCP	ADP, GWP, POCP, AP, EP	
	Industrial inorganic and organic chemicals	3	3	–	ODP, HTP, MSETP, MW	ODP, HTP, MSETP, POCP, EP, MW	
	Petroleum refining	8	5	3	MU, MW	ADP, GWP, POCP, AP, EP, MU, MW	ADP, GWP, C
	Electric services (utilities)	1	1	1	GWP, HTP, MAETP, FSETP, POCP, AP, EP, WU, EU	ADP, GWP, HTP, MAETP, FSETP, POCP, AP, EP, MU, MW, WU, EU	ADP, GWP, HTP, MA

Background

- National-level studies on environmental impact of consumption were either:
  - Highly aggregated in sector classification
  - Limited in environmental pressures
  - Limited in one region or
  - Using a different region's data

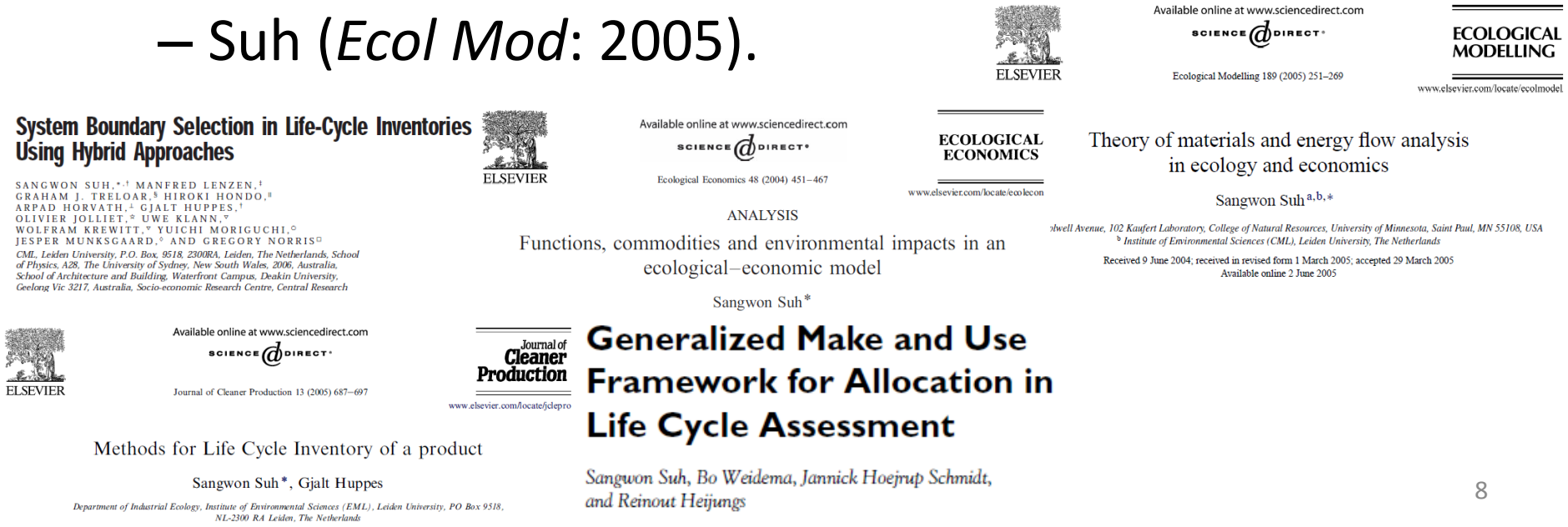
Objectives

- This study aims at
  - quantifying the environmental impact of the U.S. economy
  - analyzing its composition and structure.
- Integration of
  - hybrid,
  - bi-regional IO and
  - Life Cycle Impact Assessment (LCIA) approaches

Method and data

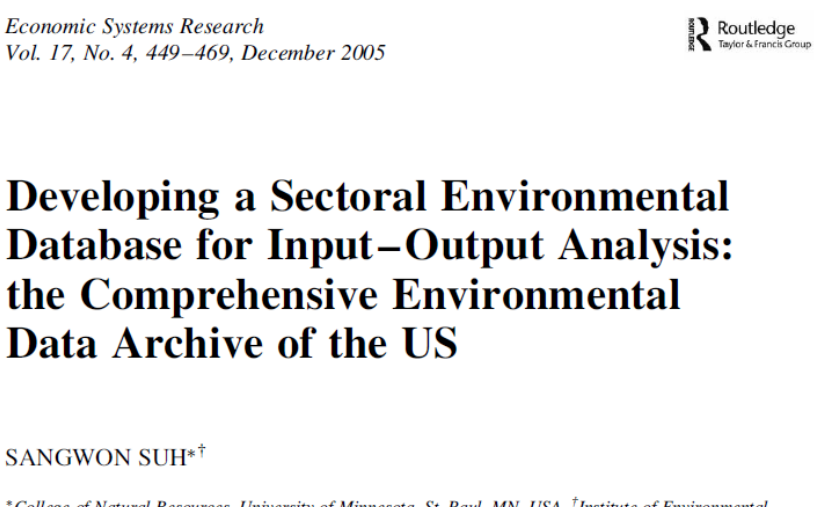
Method

- Overall framework: Integrated hybrid method
  - Suh (*Ecol Econ*: 2004), Suh et. al. (*ES&T*: 2004), Suh and Huppes (*JCP*: 2005).
- Analytical tool: Generalized *environ* analysis
  - Suh (*Ecol Mod*: 2005).



Data

- The Comprehensive Environmental Data Archive (CEDA) 4.0 for the U.S.
  - Contains information on 2,600 environmental pressure
  - 430 sectors
  - 2002 base year
- CEDA for China (Yi and Suh, *ES&T*: 2011)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Developing a Sectoral Environmental Database for Input–Output Analysis: the Comprehensive Environmental Data Archive of the US

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Environmental Impacts of Products in China

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Supporting Information

ABSTRACT: As the Chinese economy has become an integral part of the global supply chain, quantifying the environmental impacts by Chinese industry is indispensible to understanding the environmental performance of products in general. Comprehensive and consistent environmental data infrastructure, however, is lacking in China, hindering such an understanding. In this paper, we demonstrate a simplified method for assembling and harmonizing various data sources to develop a sectoral environmental database for input-output life cycle assessment (IO-LCA). We first identified key substances by analyzing previous normalization studies and other countries'

$$A^* = \begin{bmatrix} A_{Ecoinvent} & & & & \\ & & & C_{Eco\text{-}US} & \\ & & A_{China} & C_{China\text{-}US} & \\ & & & A_{US} & Y \\ & C_{US\text{-}Eco} & & & \end{bmatrix}$$

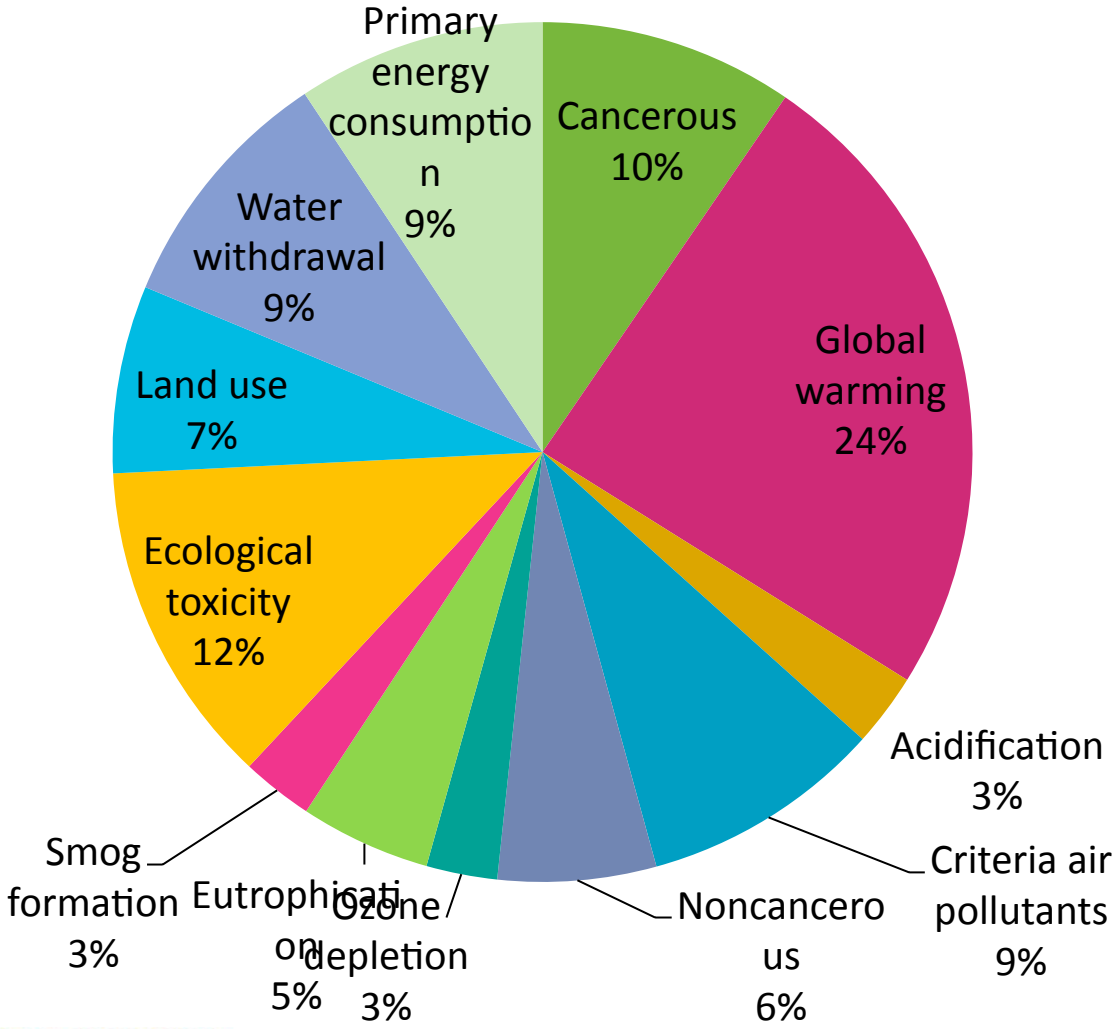
Impact Assessment

- Characterization:
  - TRACI (by US EPA; Bare, *JIE*: 2008)
- Normalization:
  - Kim et al. (newly developed NR for the U.S.: under review)
- Weighting:
  - National Institute of Standards and Technology (NIST) based on Panel method (Gloria et al., *ES&T*: 2007).

Results

Consumption activities			Description	Monetary share
Private	Expenditure	Mobility	gas, automobile and repair for passenger cars, air, water and railway transportation, etc.	6%
		Food	grocery, prepared food, refrigerator, gas and electricity for food preparation and refrigeration, restaurants, etc.	9%
		Shelter	building construction, renovation, electricity and gas for lighting, heating and cooling, gardening, etc.	6%
		The rest	all other private consumption expenditures	38%
	Investment		private investment	13%
Government	Expenditure		government expenditure	19%
	Investment		government investment	3%
Export			all exports	7%

Composition of the total environmental impact induced by the U.S. final consumption



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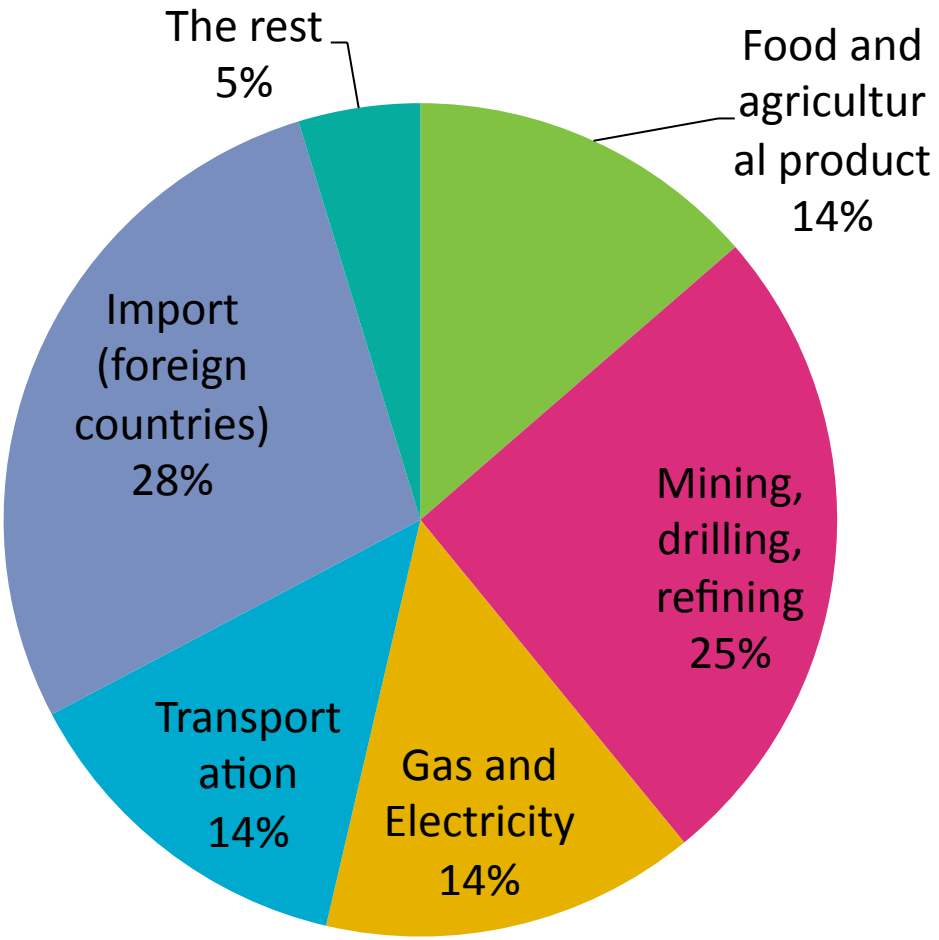
Who directly generated the impact?



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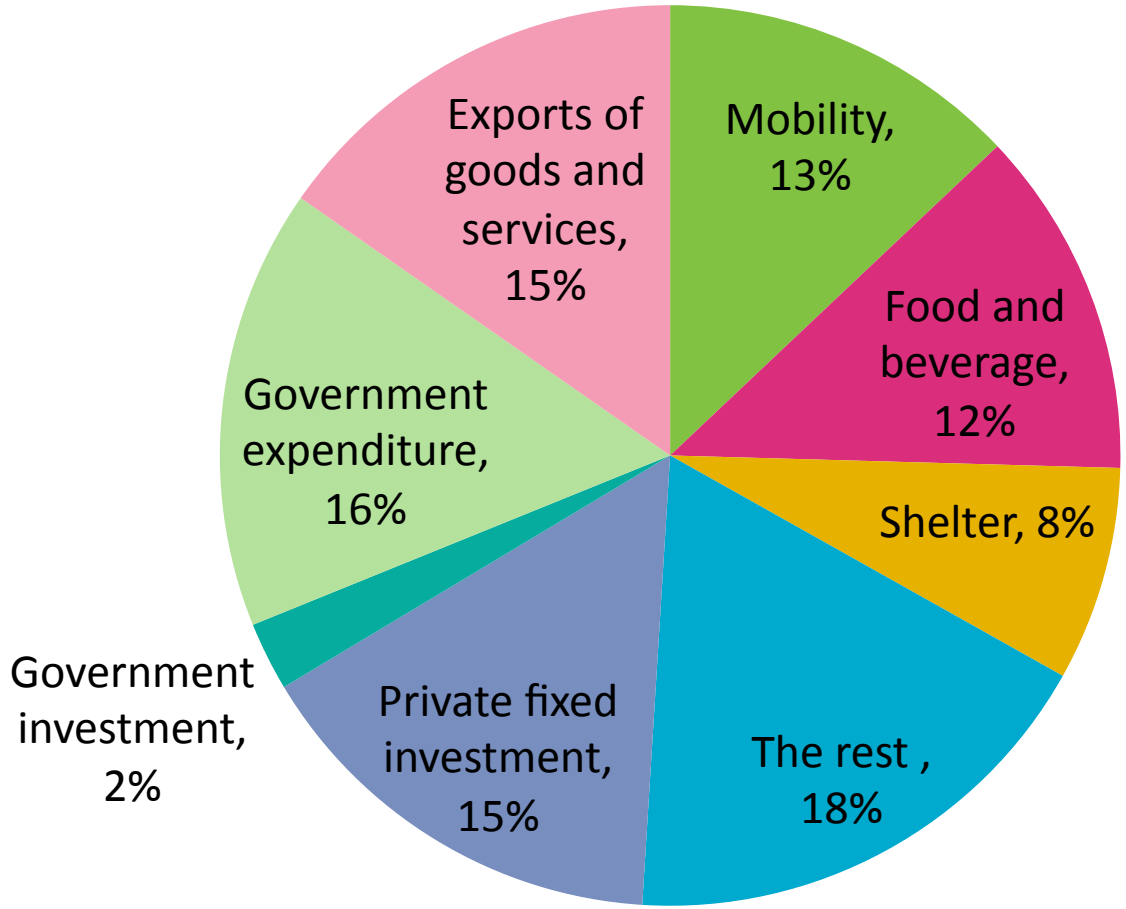
Environmental impact embodied in final consumption



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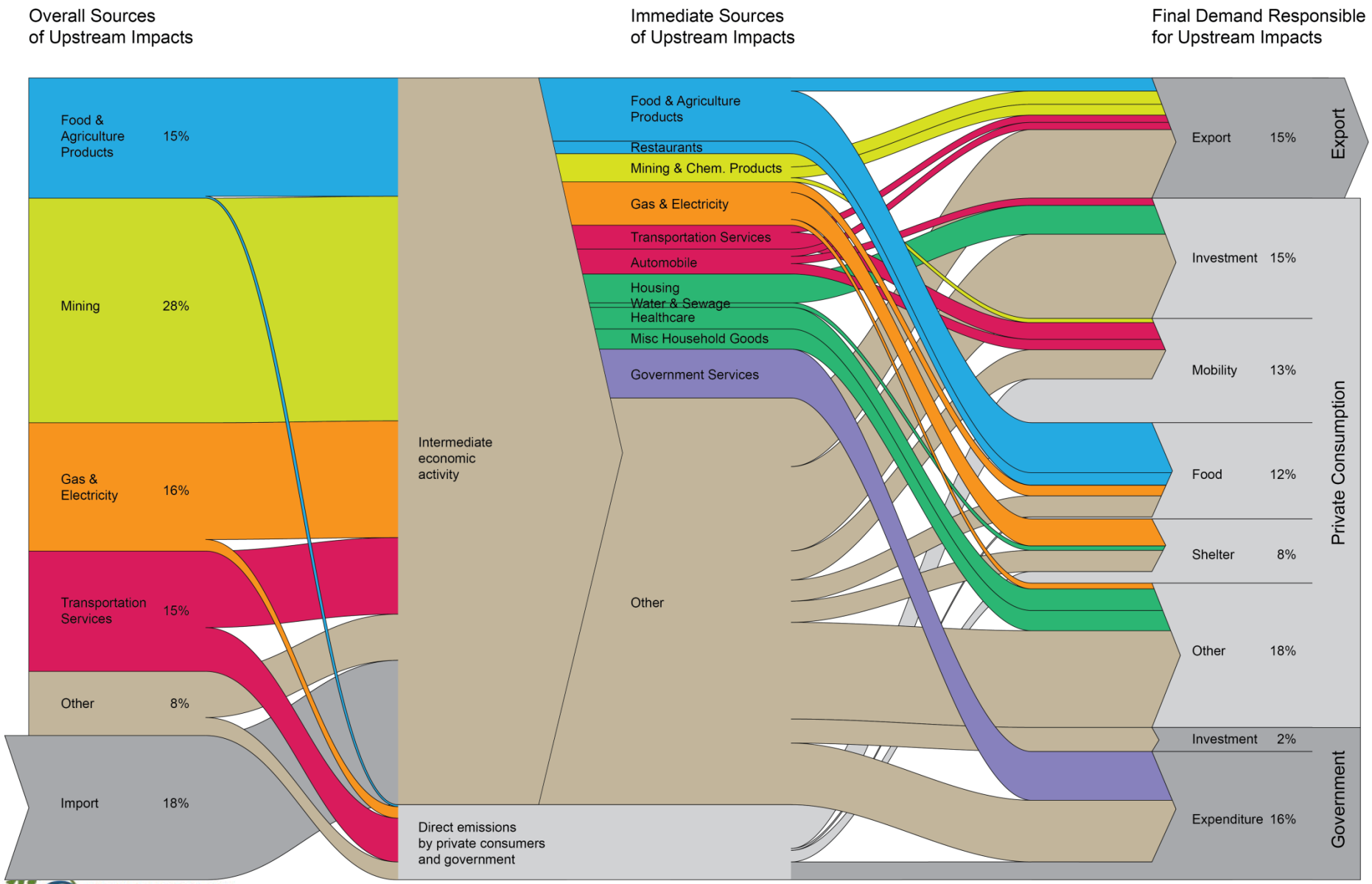

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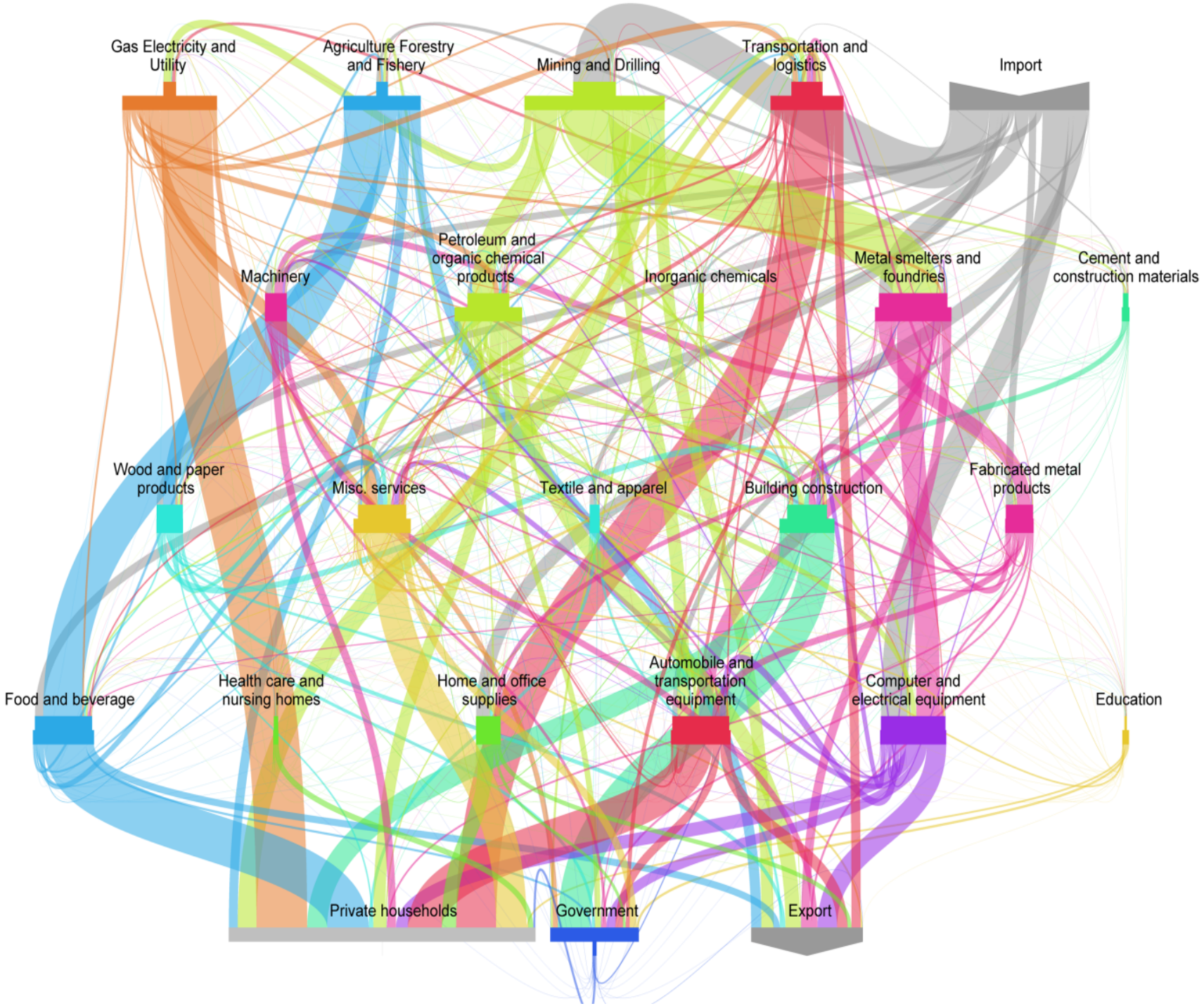
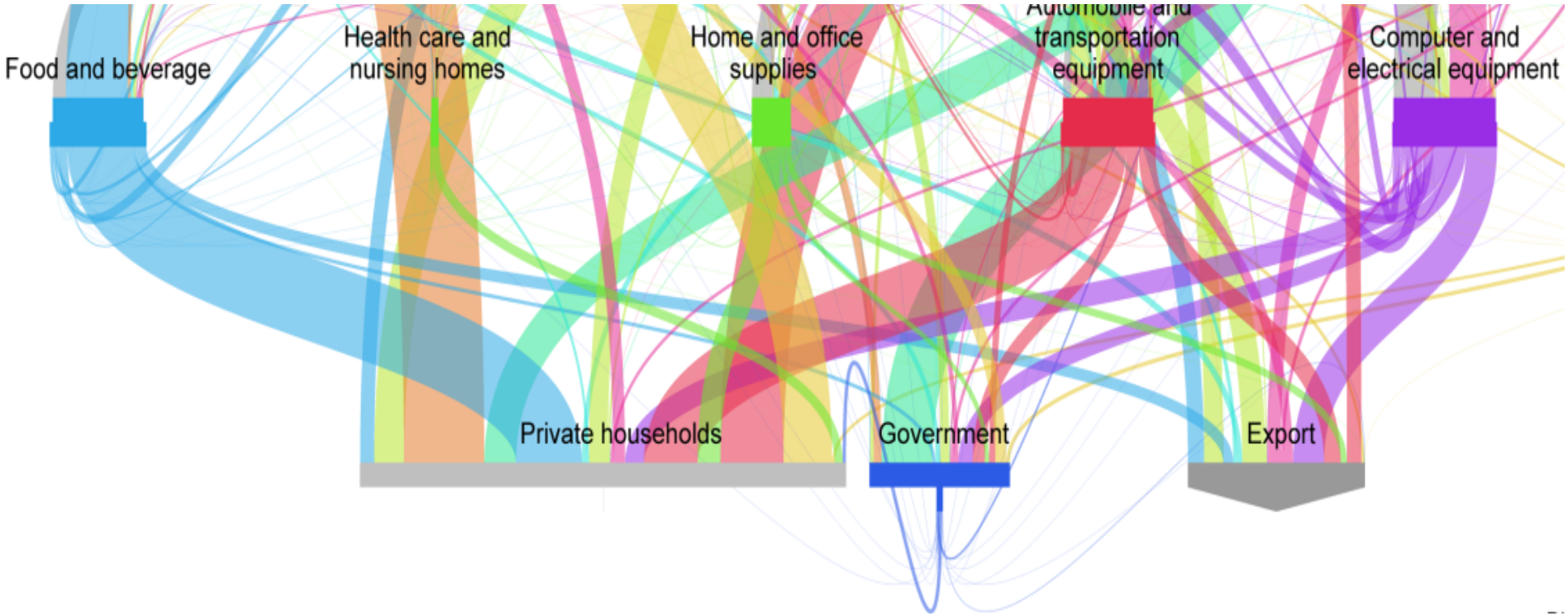

Gas Electricity and Utility
Agriculture Forestry and Fishery
Mining and Drilling
Transportation and logistics
Import
Petroleum and organic chemical products
Machinery
Inorganic chemicals
Metal smelters and foundries
Cement and construction materials
Wood and paper products
Misc. services
Textile and apparel
Building construction
Fabricated metal products
Automobile and transportation equipment
Health care and nursing homes
Home and office supplies
Computer and electrical equipment
Food and beverage
Education
Private households
Government
Export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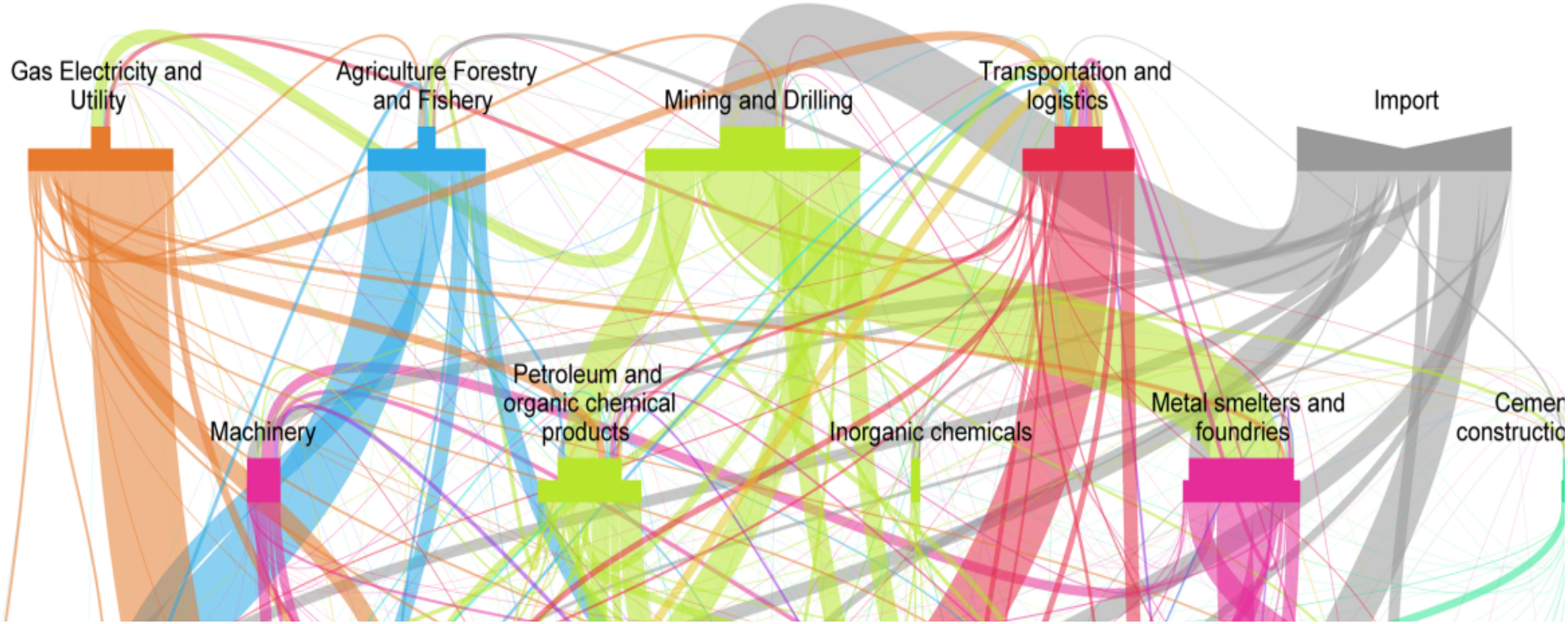

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Conclusions

- Private household consumption and investment is responsible for about 66% of the total environmental impacts.
- Half of which is caused by the consumption expenditures for the provision of ‘Mobility’, ‘Food’ and ‘Shelter’.
- Major industrial activities that generate direct environmental impacts were ‘Gas, Electricity and Utility’, ‘Mining and Drilling’ and ‘Agriculture, Forestry and Fishery’.

Conclusions

- Impacts by imports to the U.S. is estimated to be responsible for about 28% of the total impact.
- Impacts of mining and drilling, imports, and transportation-related activities are relatively higher than EIPRO.
- Combination of various methods and techniques developed in natural science, engineering, ecosystem science and input-output economics.

Acknowledgement

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Thank you!