The Demand Side of the Energy Transition



Future of Energy Seminar,

15 September 2025

UvA Institute for Advanced Studies, Amsterdam

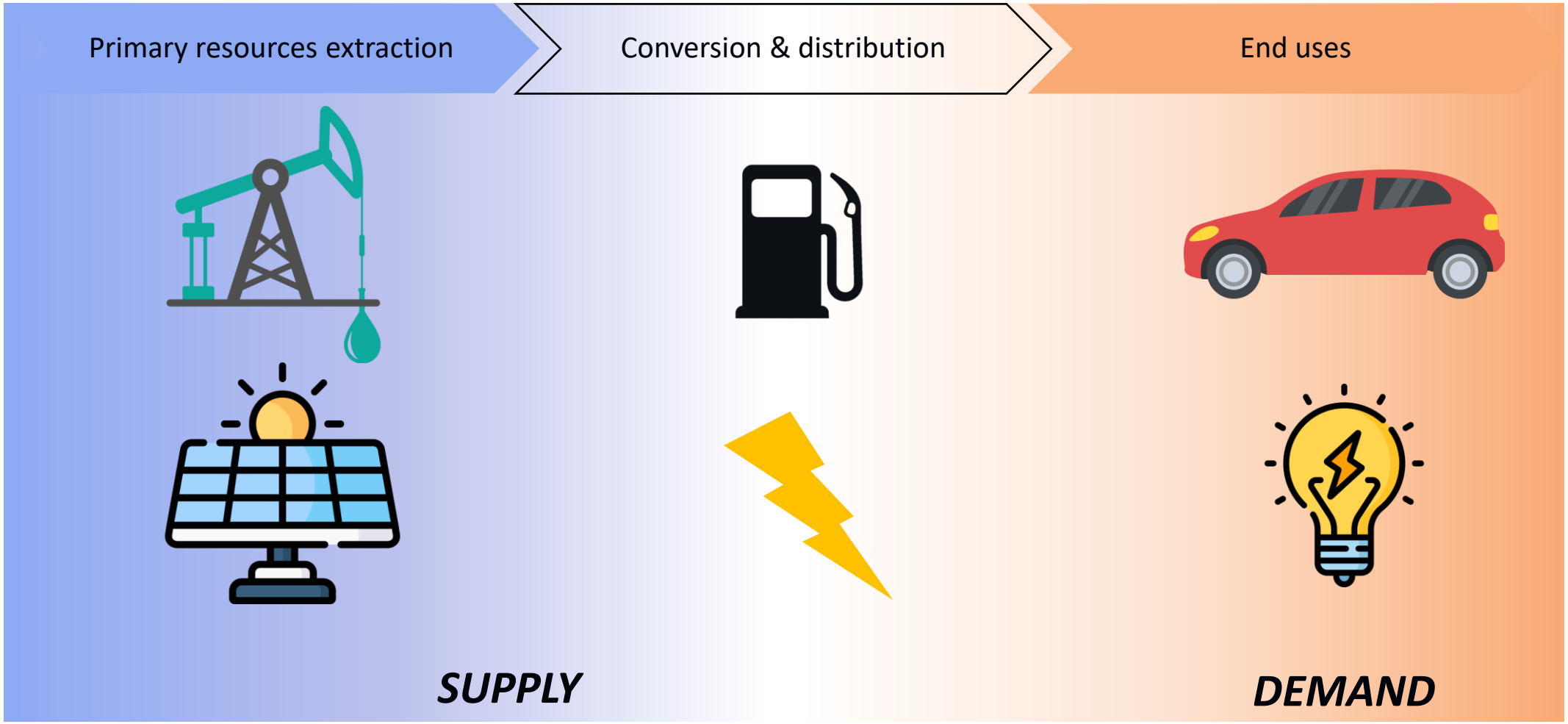
Francesco Dalla Longa

TNO & UvA

TNO innovation for life

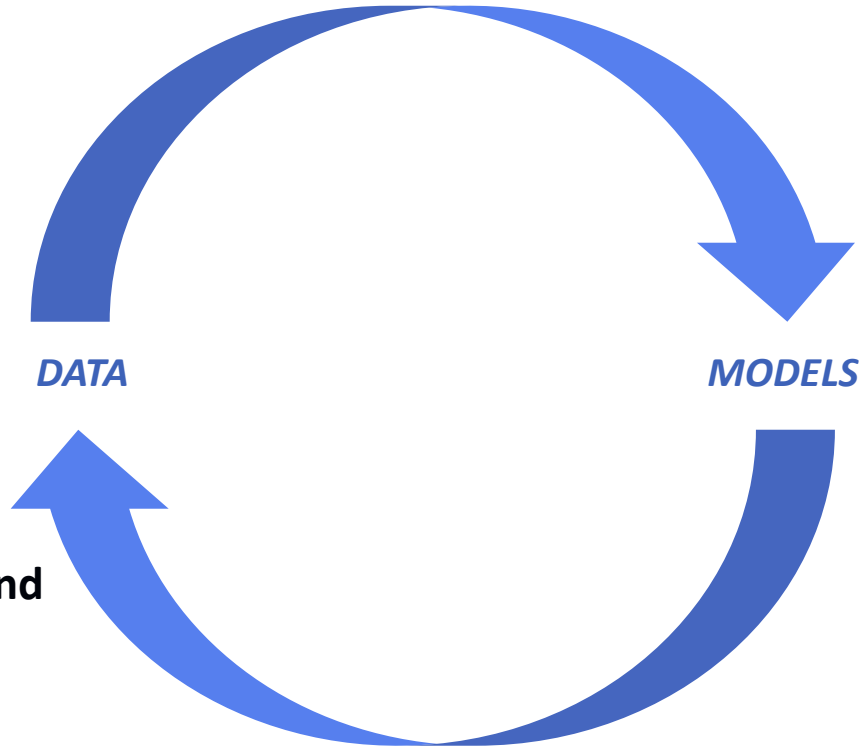
Universiteit van Amsterdam

The energy system



Outline

1. Global view on energy consumption

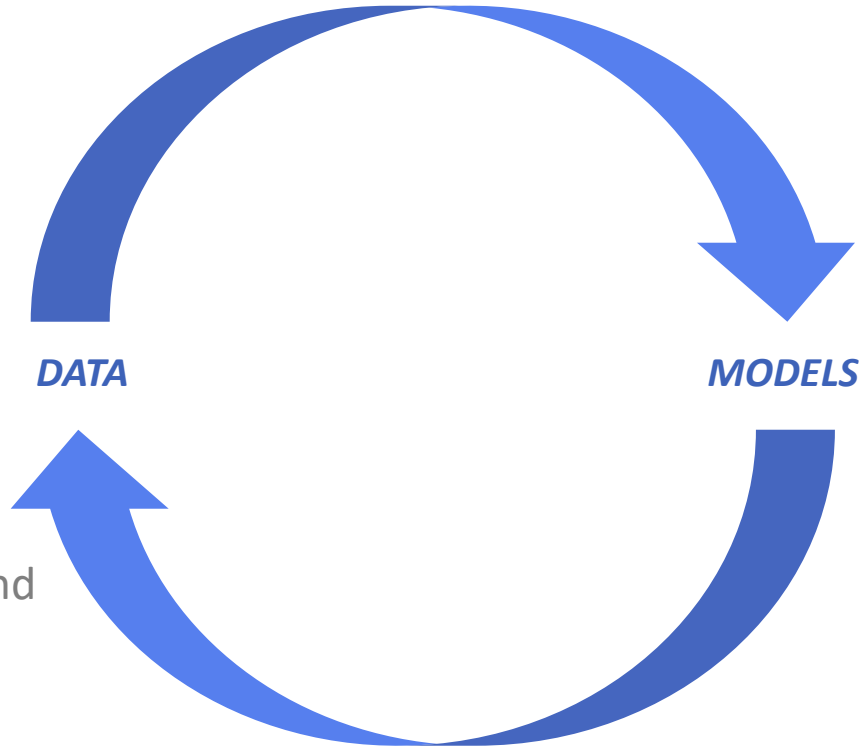


2. Decarbonizing end use sectors

3. Leaving no one behind

Outline

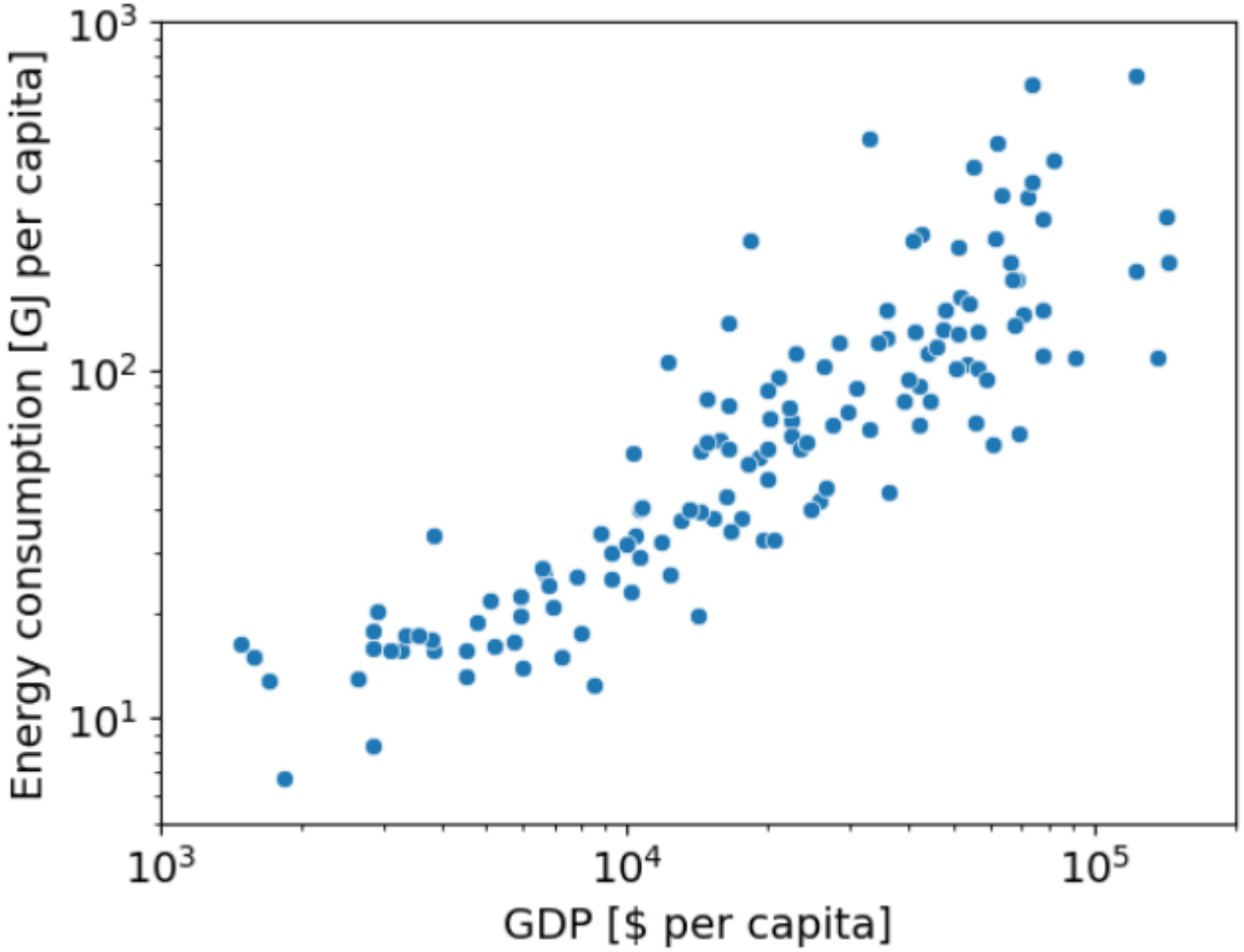
1. **Global view on energy consumption**



2. Decarbonizing end use sectors

3. Leaving no one behind

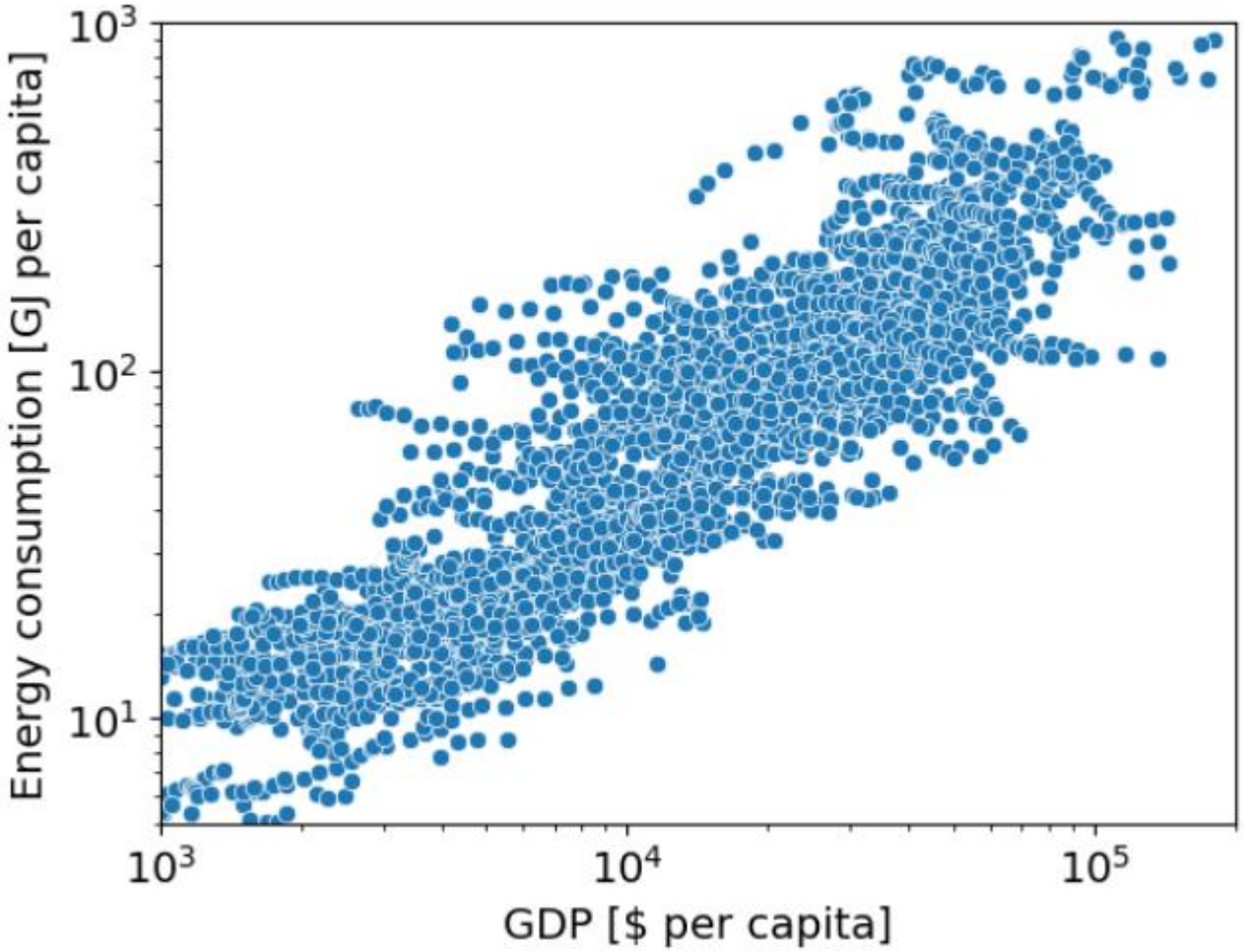
Patterns of energy consumption



Data source: World Bank

- Year 2022
- All countries in the world

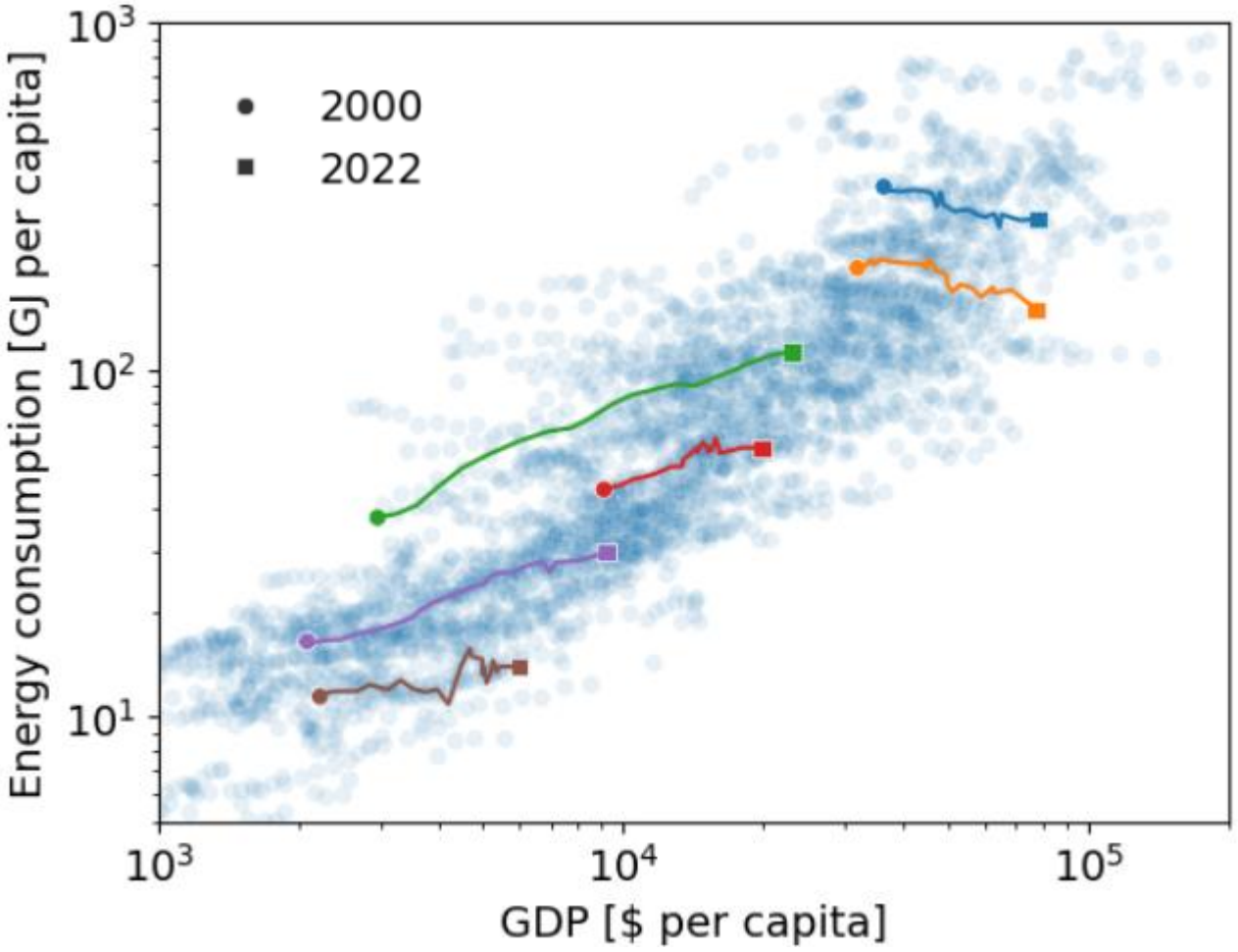
Patterns of energy consumption



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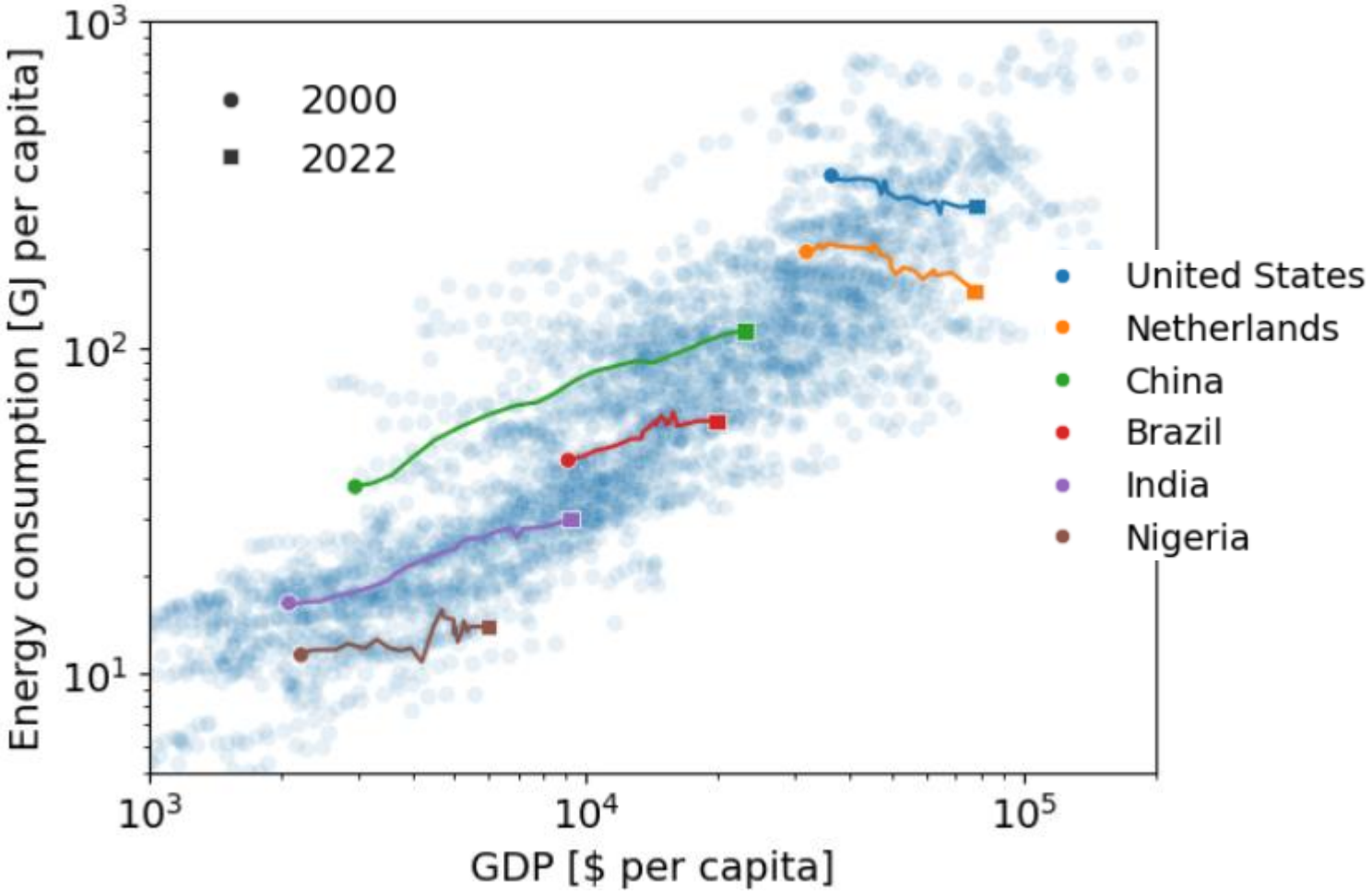
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Patterns of energy consumption

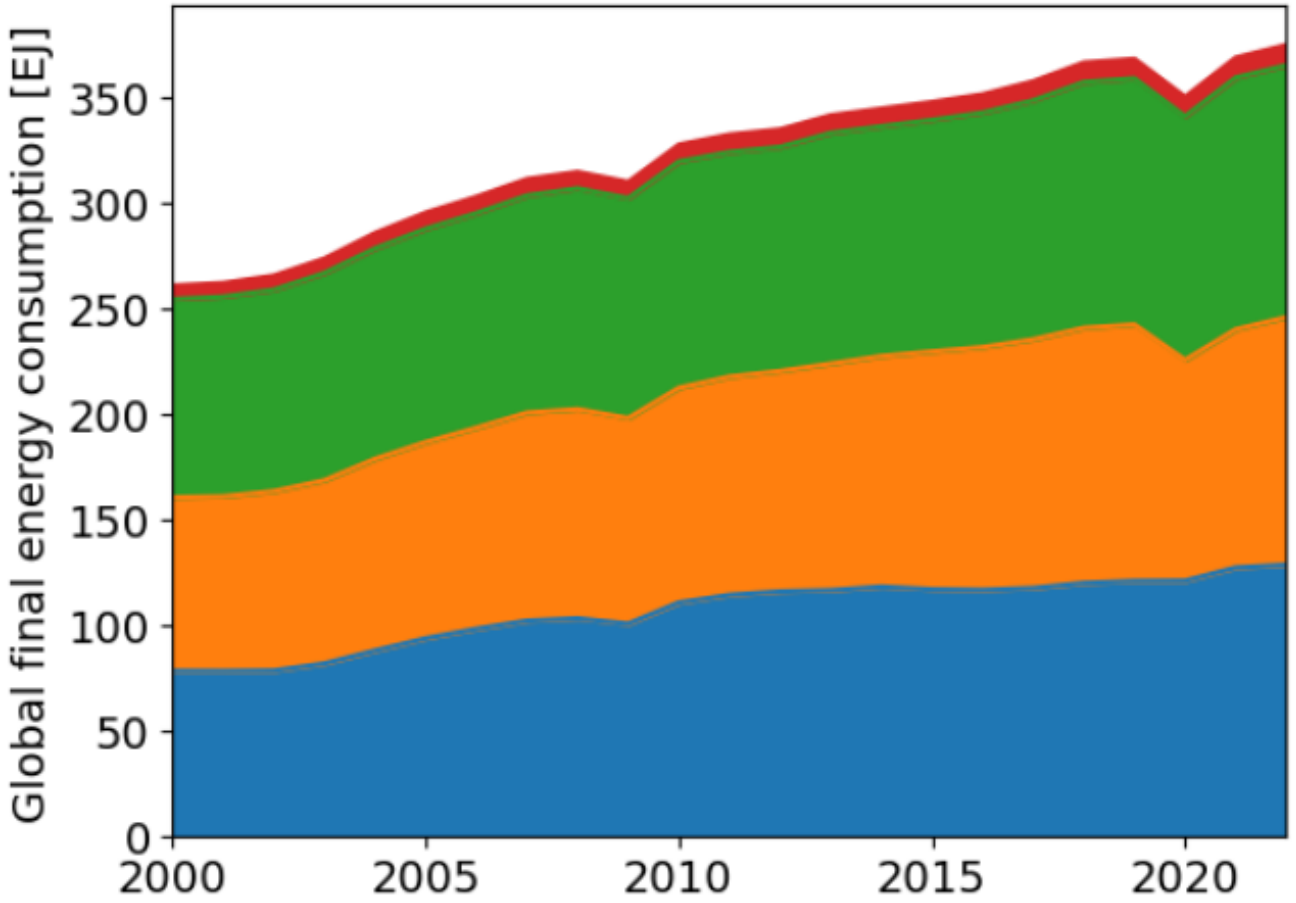


Data source: World Bank

- Years 2000 - 2022
- Selected countries

- Total consumption: 50 GJpp x 8 bln ~ 400 EJ
- Where is all this energy consumed?

End uses

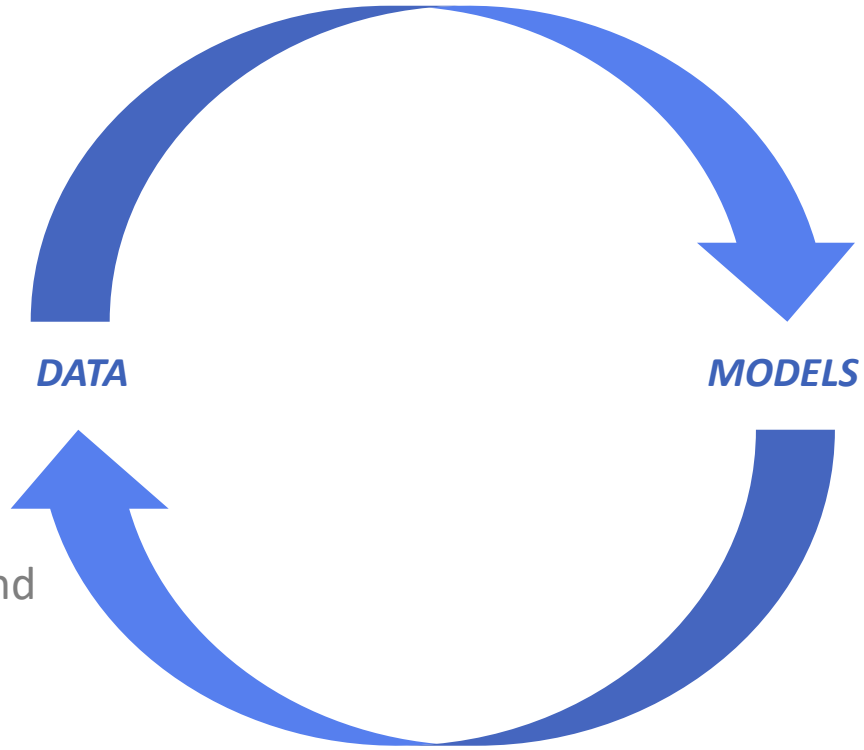


Data source: IEA

- What is the underlying energy mix?
- How do we make it carbon-free?

Outline

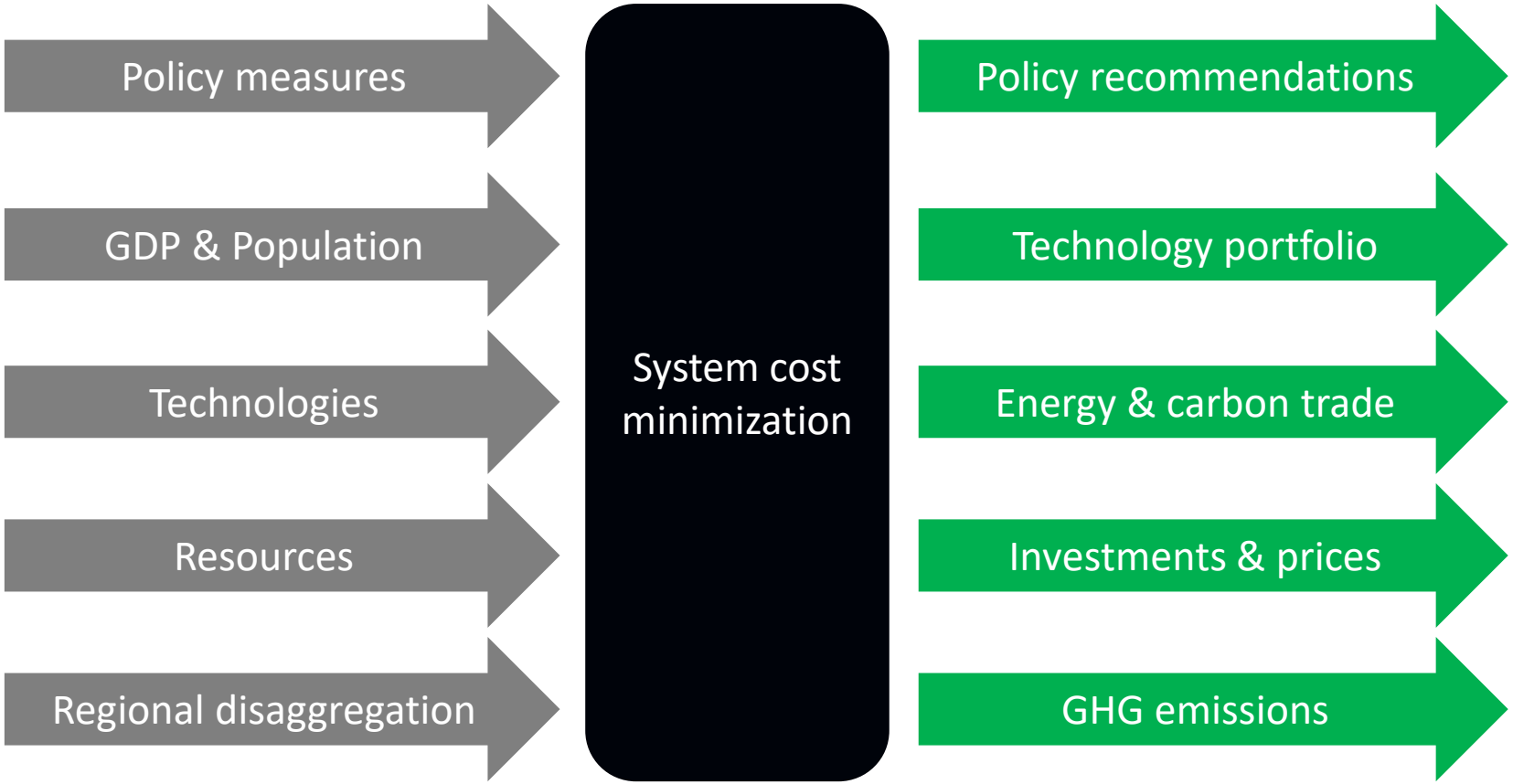
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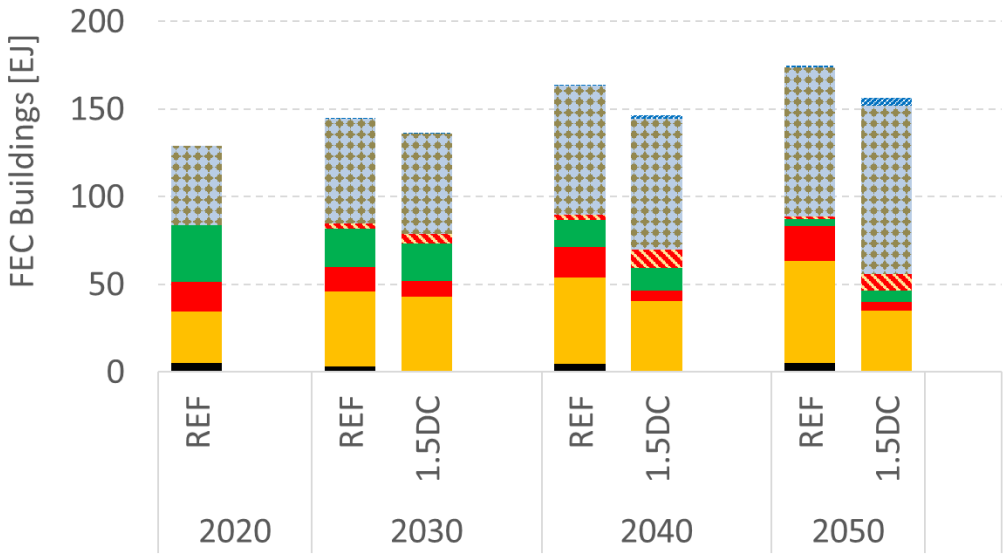
2. **Decarbonizing end use sectors**

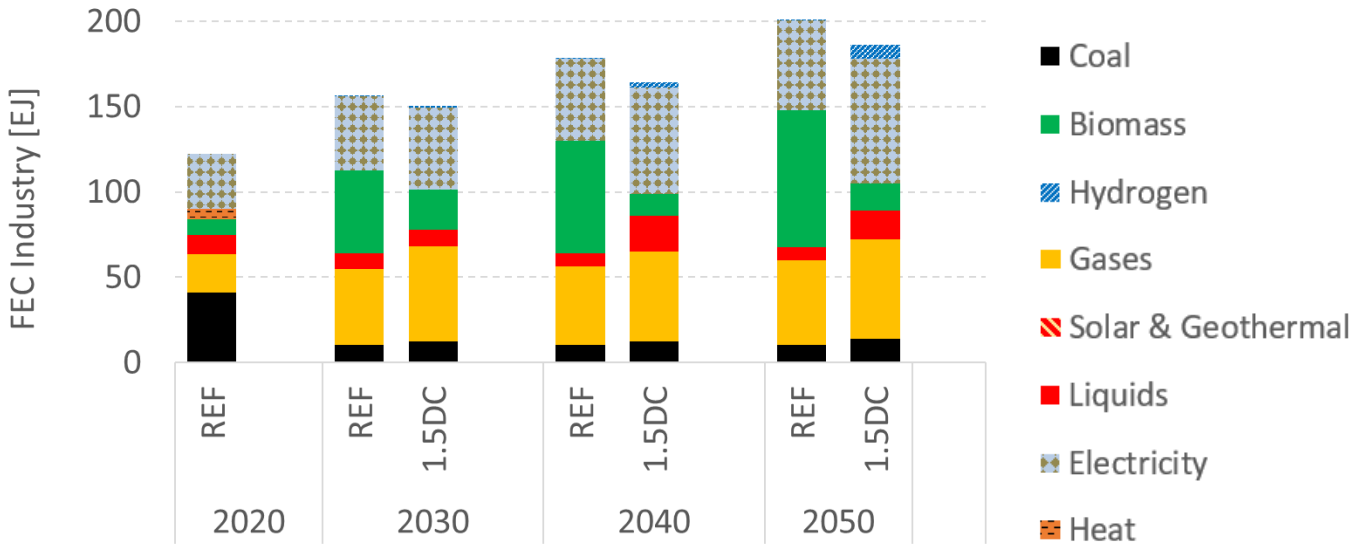
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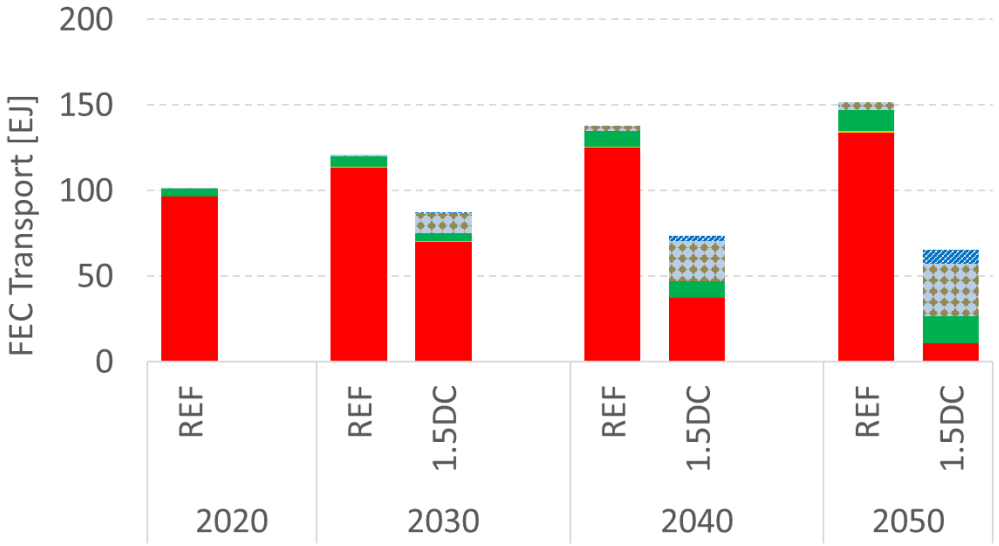
Energy system models



Final energy consumption projections (Global)



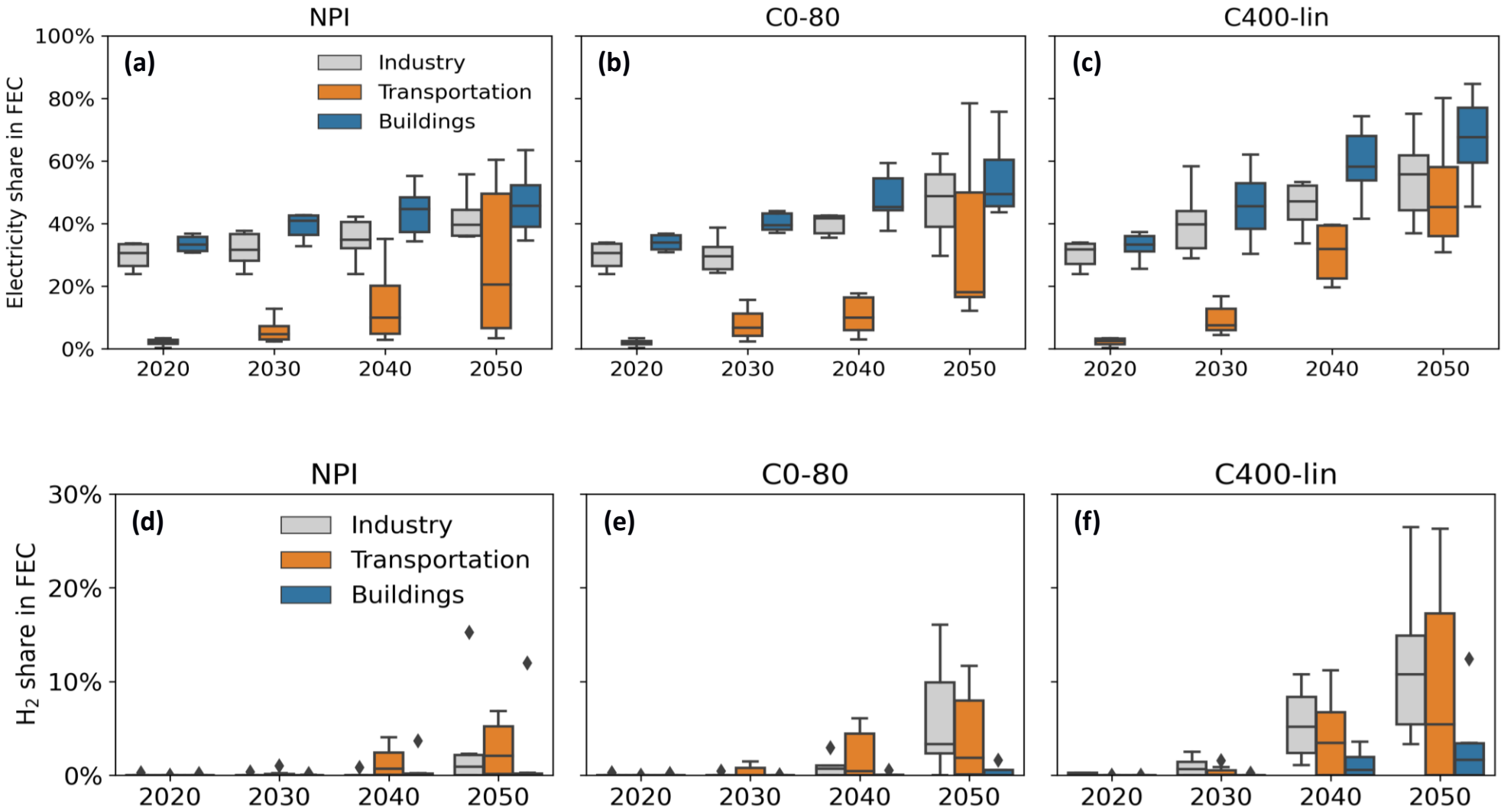




- Efficiency
- Electrification
- Hydrogen
- CCS

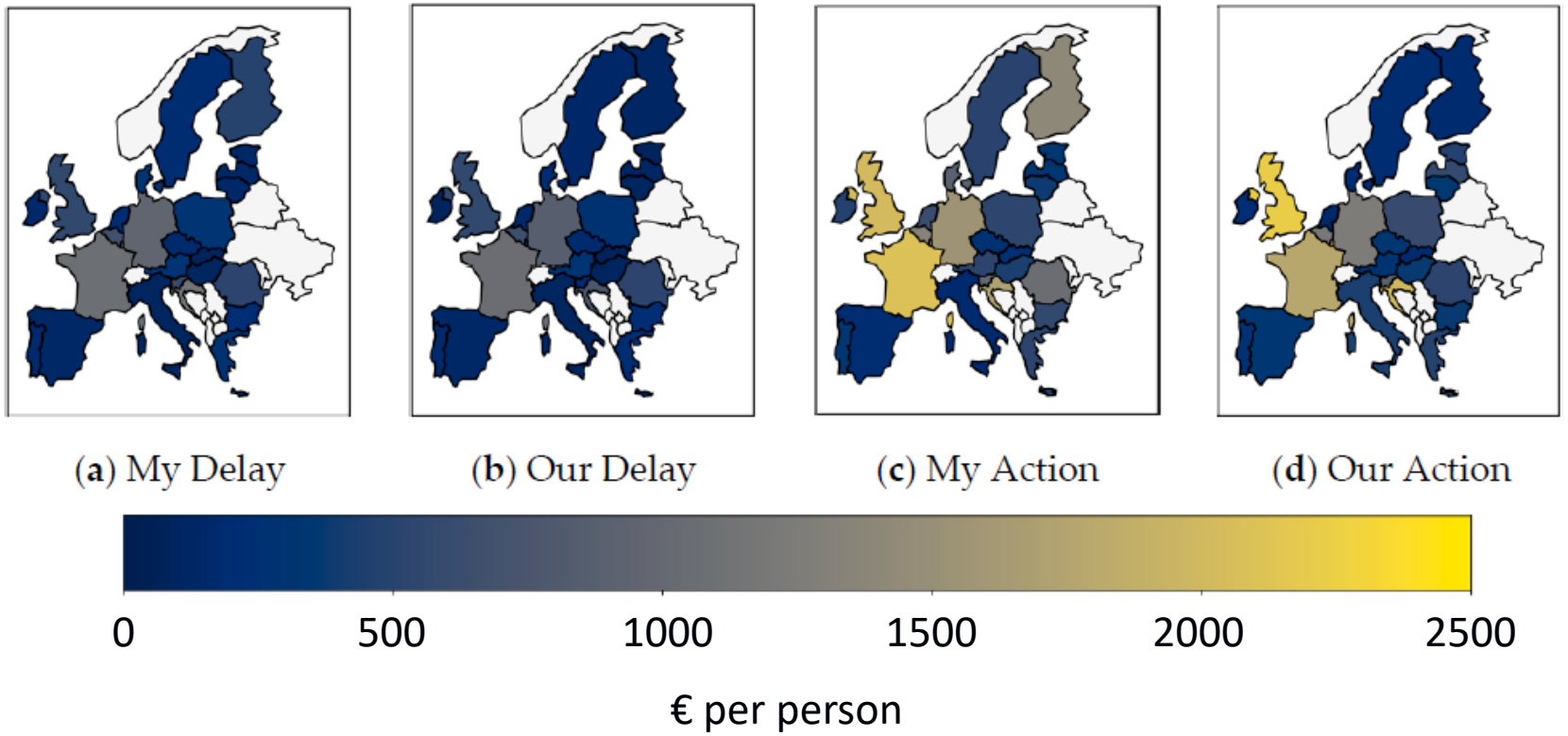
Adapted from: Dalla Longa et al., Computers and Industrial Engineering, 2022

Penetration of electricity and hydrogen (Europe)



Adapted from: van der Zwaan et al., Nature Communications, 2025

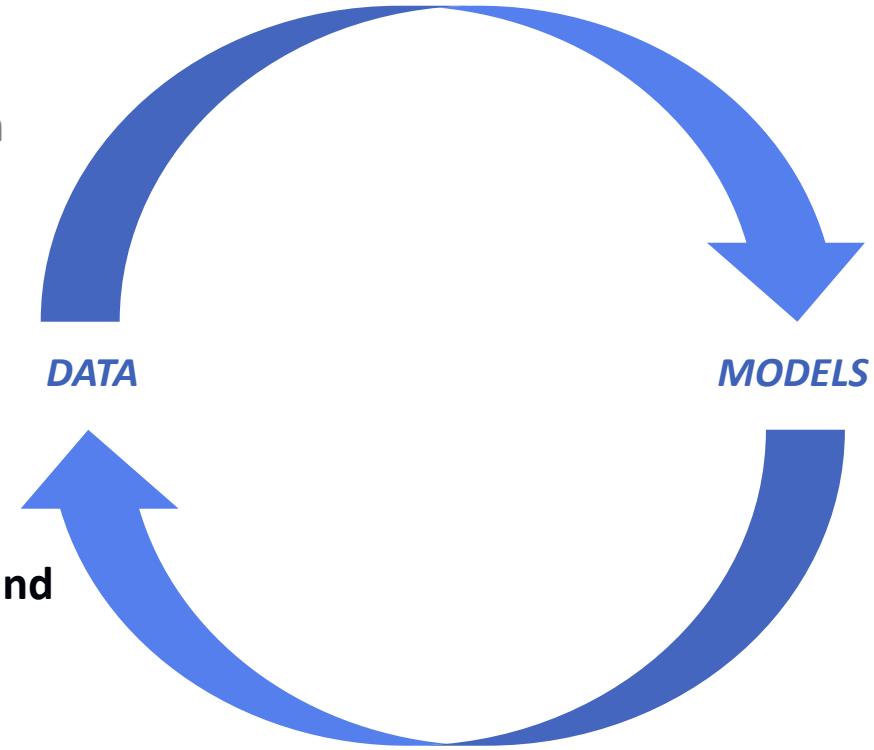
Cumulative renovation costs 2020–2050 (Europe)



Salim et al., Energies, 2024

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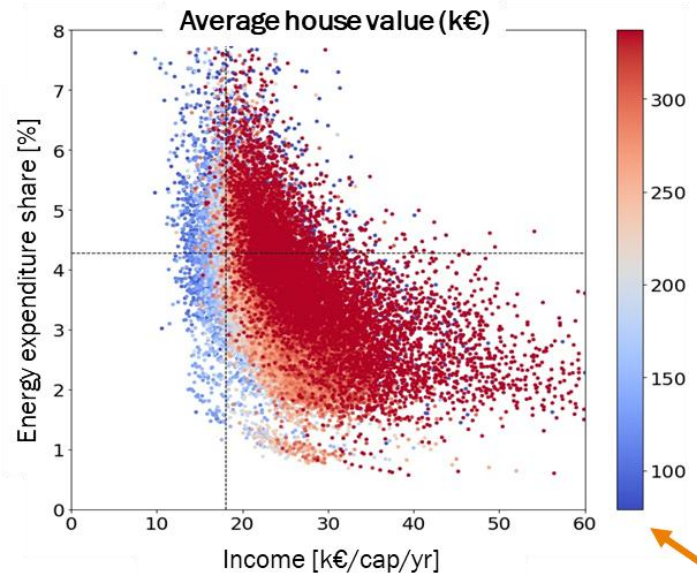


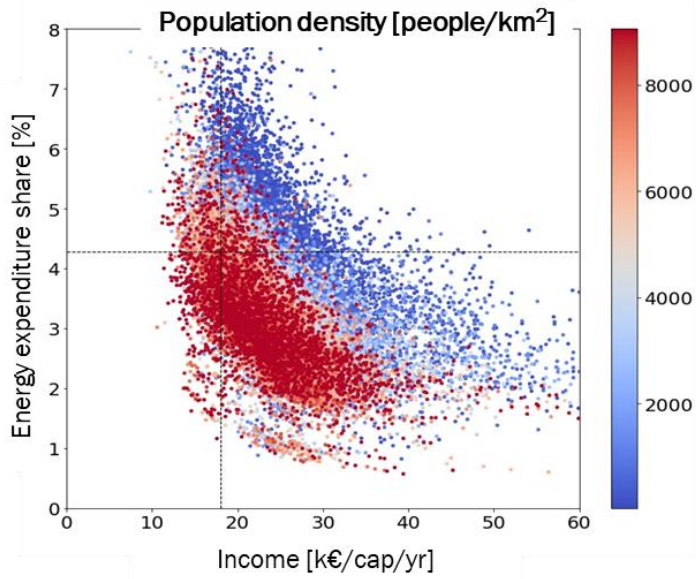
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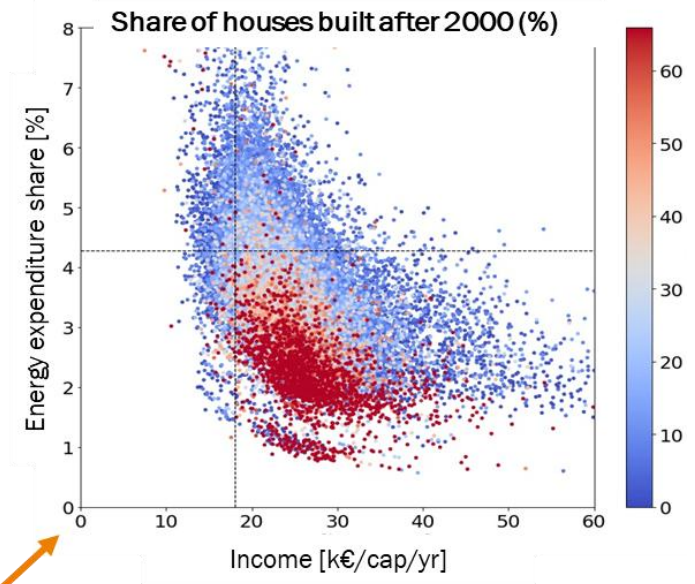
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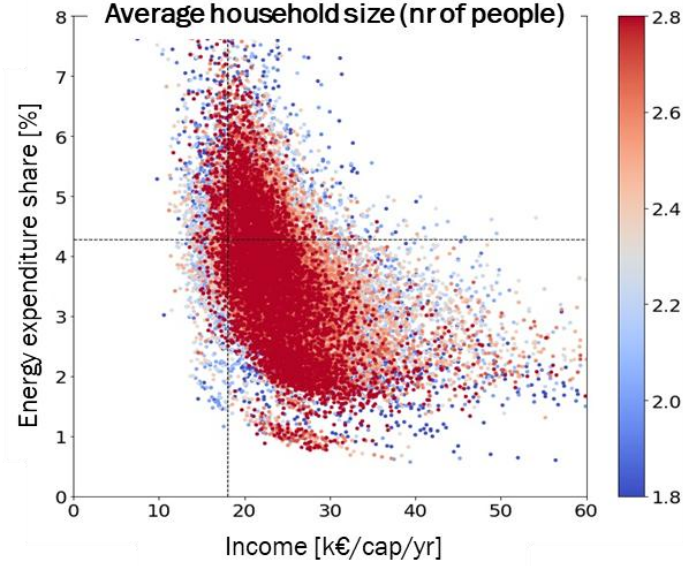
Energy poverty in NL – neighborhood level

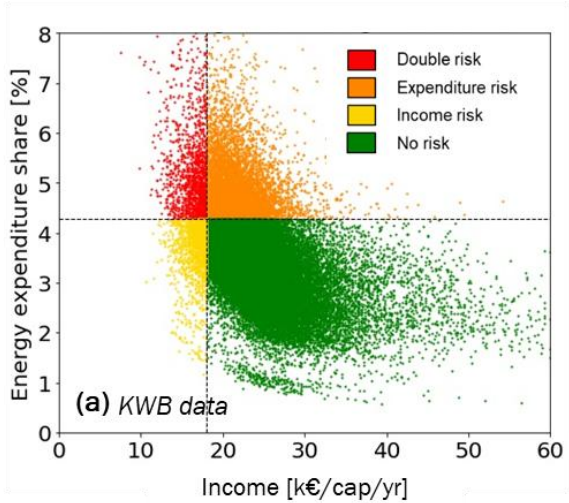
Adapted from: Dalla Longa et al., Energy Policy, 2021

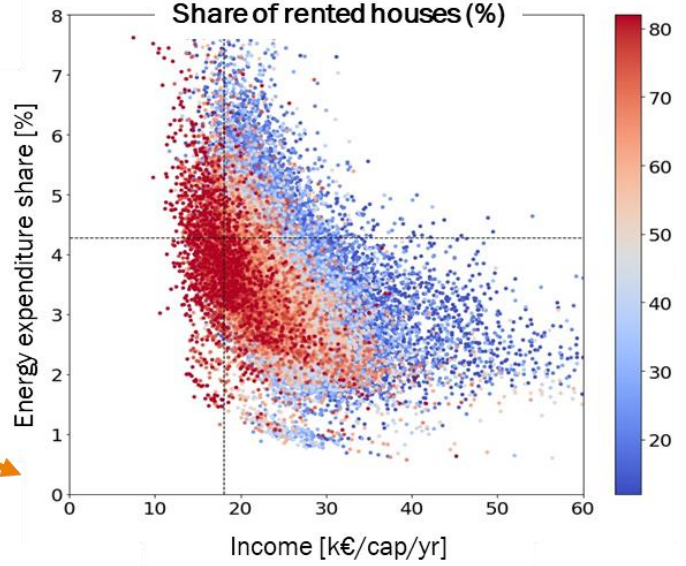








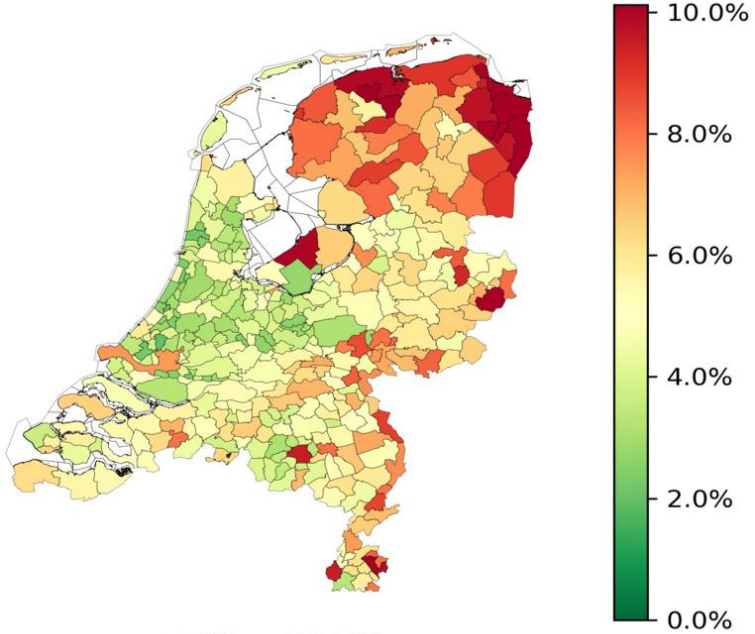




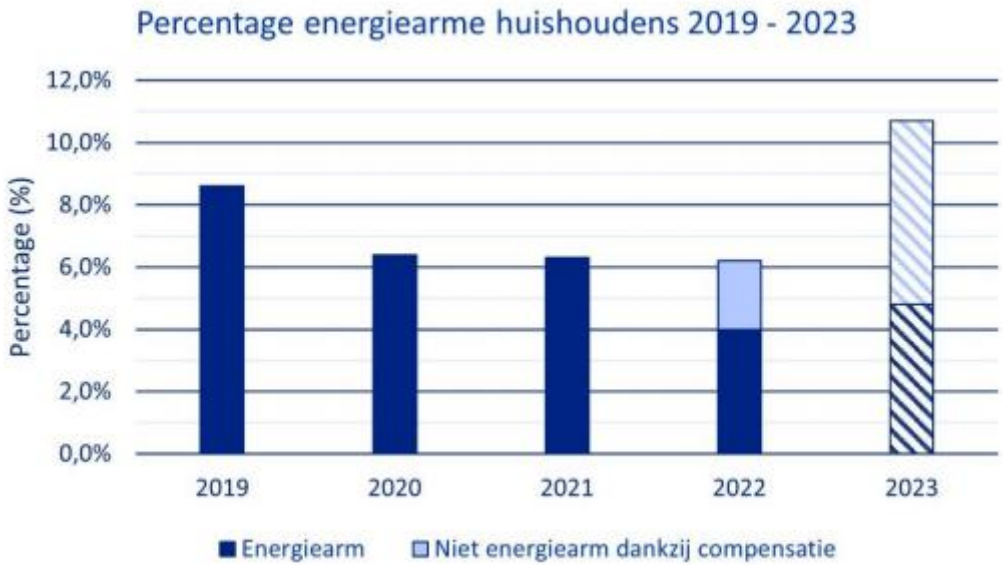
Energy poverty in NL – household level

Quantifying energy poverty:
- Low income (LI)
- High energy costs (HC)
- House with low energetic quality (LEQ)

→ For *all households* in NL, based on CBS administrative data



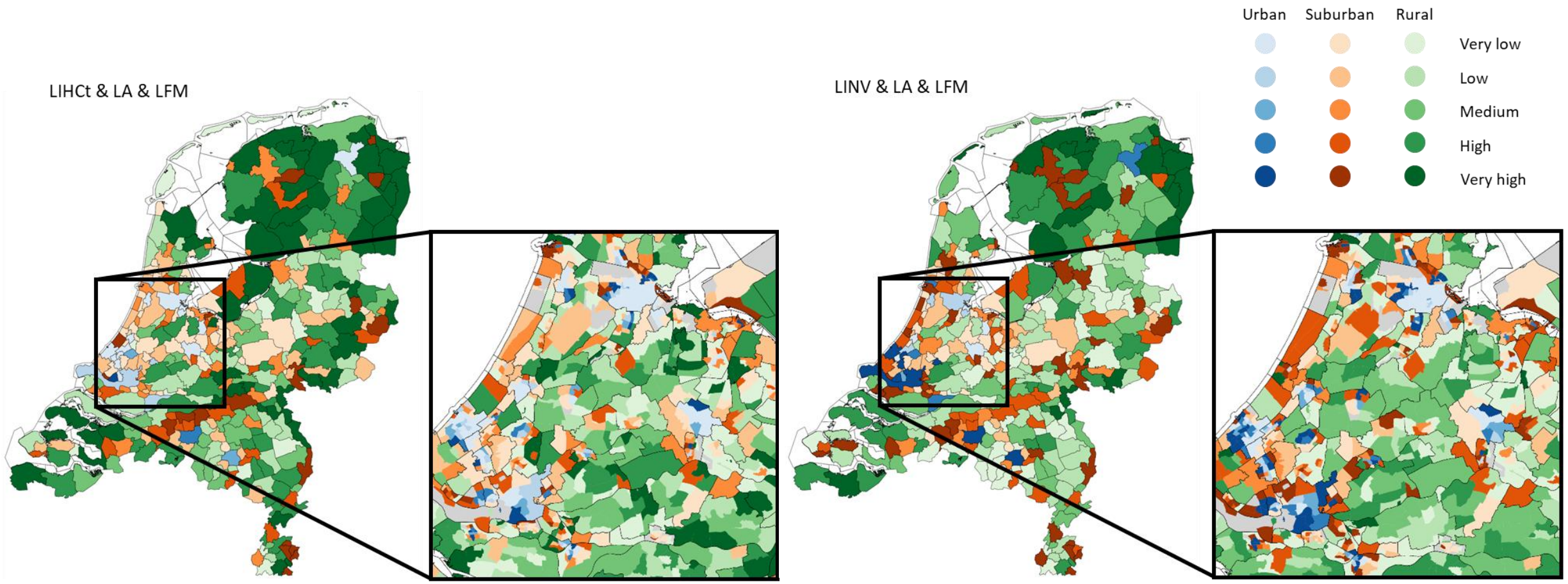
LIHC or LILEQ



Mulder et al., Energy Research and Social Science, 2024

Batenburg et al., Energiearmoede in Nederland 2019-2023

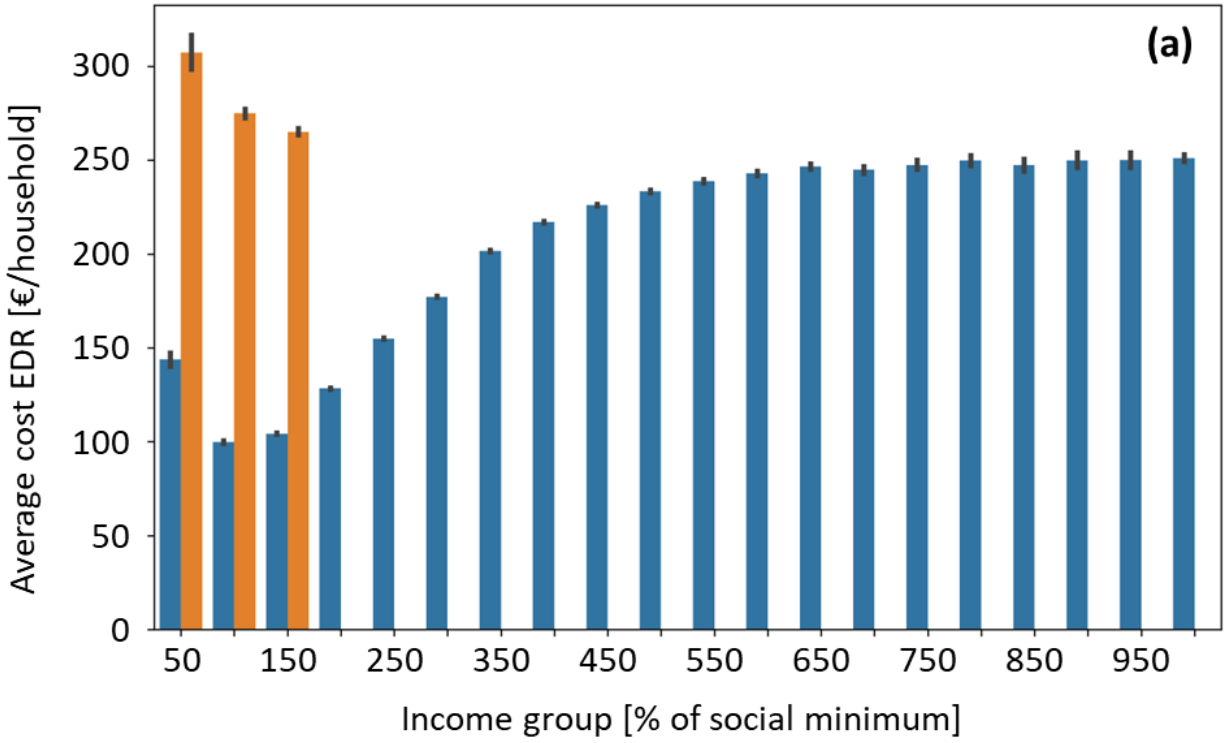
Transport poverty in NL – household level



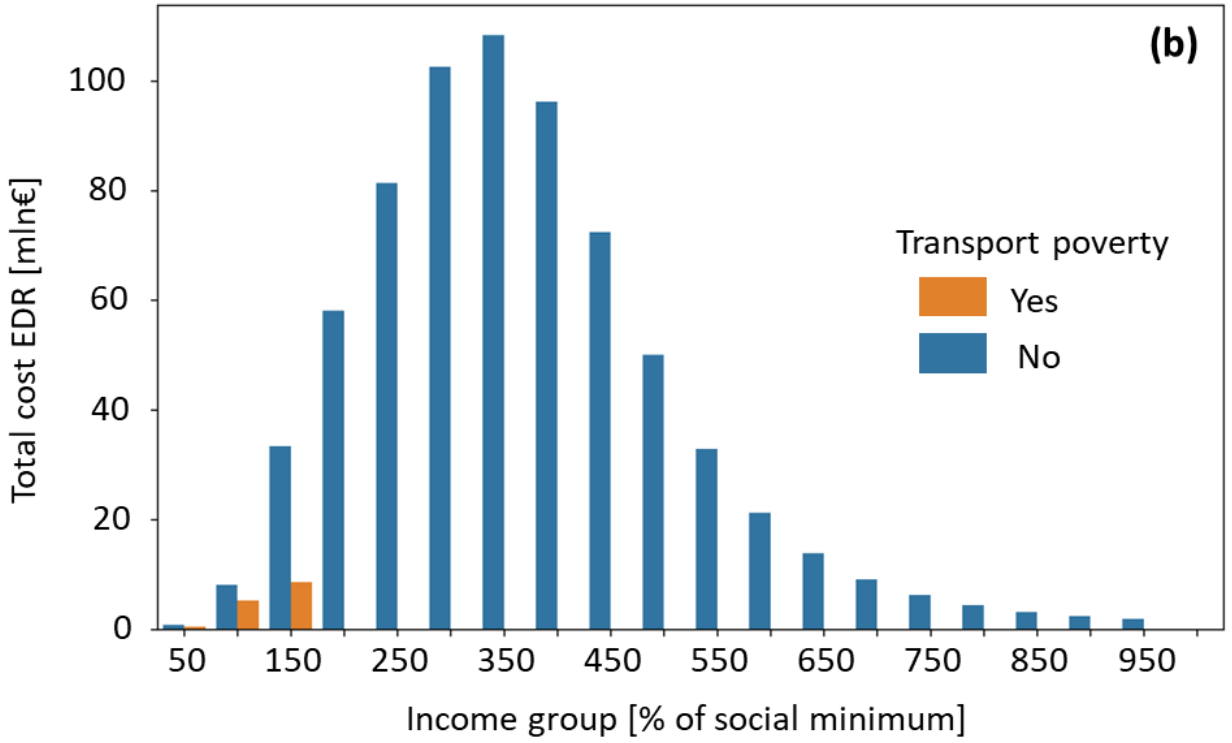
Dalla Longa et al., Journal of Transport Geography, 2025

Excise duty reduction: a good idea?

Mean per household



Total



Dalla Longa et al., Journal of Transport Geography, 2025

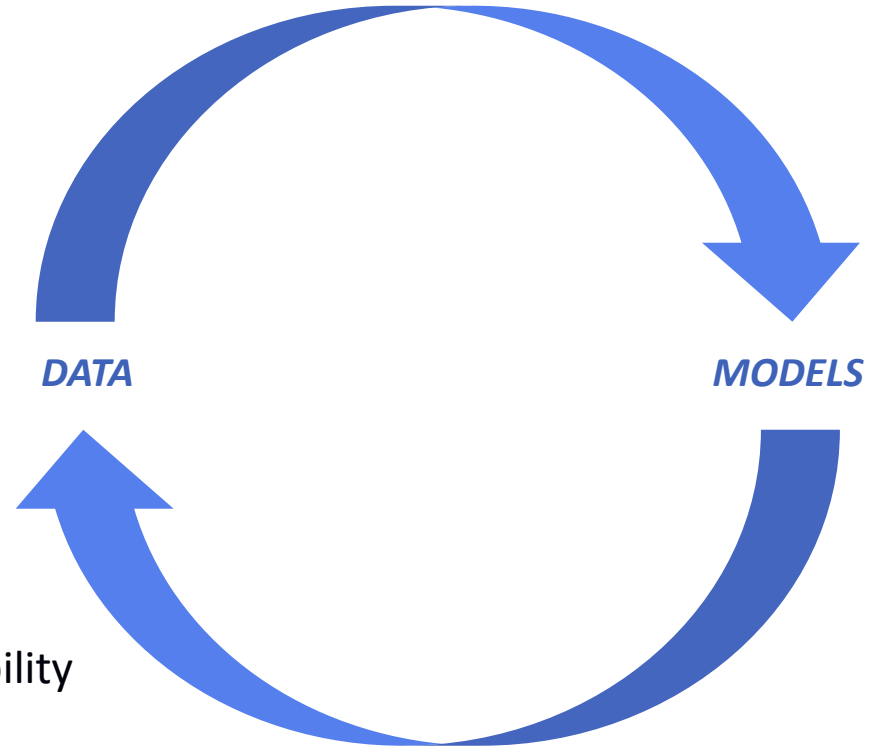
Main takeaways

1. **Global view on energy consumption**

- Diverging trends for developed and developing economies
- Most energy consumed in buildings, transport and industry

3. **Leaving no one behind**

- Heterogeneous vulnerability to energy and transport poverty…
- … calls for targeted policy measures

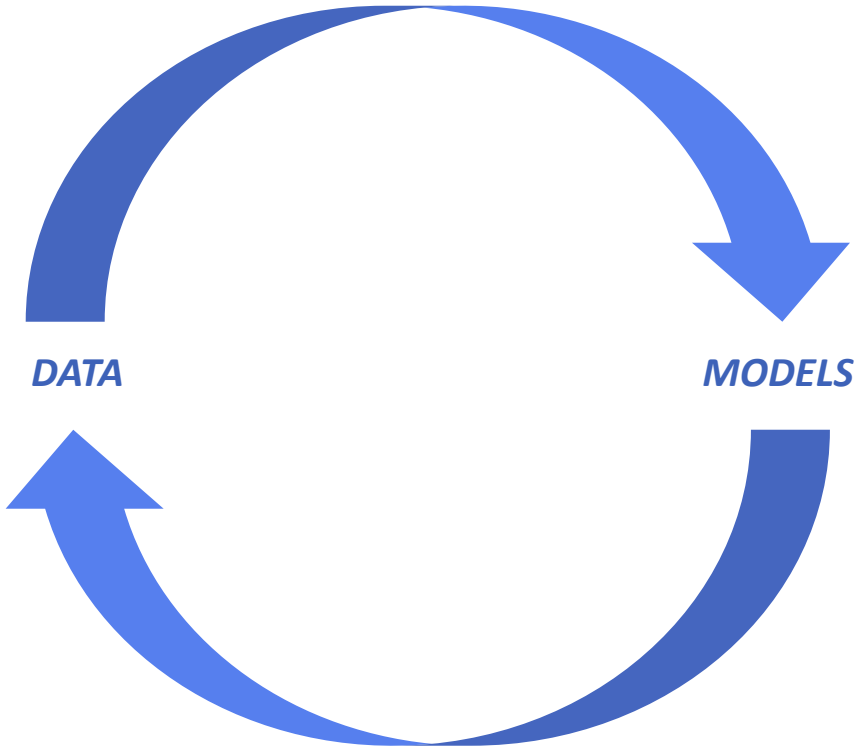


2. **Decarbonizing end use sectors**

- Efficiency, electrification, renewable fuels & carbon capture
- Uncertainty & high costs

Outlook

- Refined framework for transport poverty
- Heterogeneity of energy efficiency investments in NL industrial firms
- Gender & migration bias in energy poverty
- Finland energy poverty monitor



- Indirect uses of electricity and hydrogen in EU energy demand
- Decarbonization of EU industry
- From energy demand to materials demand