

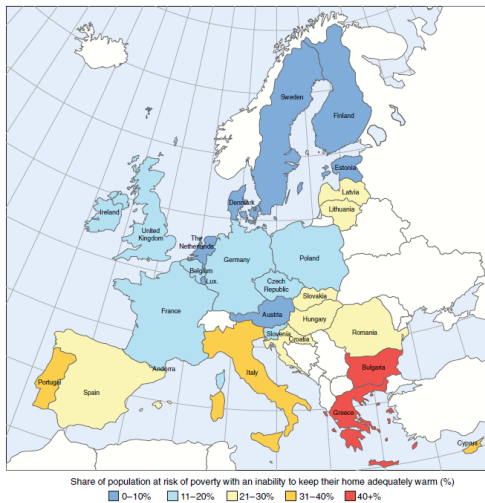


System analysis of the significance of energy poverty on household energy use and emissions in Germany

**Audrey
Dobbins**

Motivation and Outline

1. Introduction and challenges
2. Household energy vulnerability
3. Methodology: Energy System analysis
4. Results: Integrated energy poverty assessment
5. Conclusion and outlook



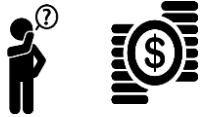
Pictures: Dobbins et al, 2019. *Nature Energy* Vol. 4, Issue 1,

https://en.wikipedia.org/wiki/Yellow_vests_protests#Other_countries_or_regions; [sportpoin74/Bigstockphoto.com via: bit.ly](https://www.sportpoin74.com/via/bit.ly); <https://www.bbc.com/news/science-environment-59049770>; <https://newnol.org/a-green-recovery-and-the-fight-ahead-to-avoid-a-return-to-business-as-usual/>

Fig. 1 | Vulnerability to energy poverty across EU member states in 2016. The map shows the percentage of the population in each member state who are at risk of poverty with an inability to keep

1. Introduction and challenges

Framework and challenges in Germany



Energy Poverty

Energy poverty on the rise:

Estimates of 3-18% of the population **vulnerable** to or in **energy poverty** due to *high energy bills* (increasing energy prices and low efficiency), *low income* (incomes increase slower than energy prices) and *poor energy efficiency* (in buildings and appliances). However, energy poverty is not a phenomenon recognised by the national government.

- Access, affordability

Sources: Pye et al 2015, Heindl 2014, EPOV 2020



Households

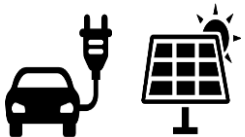
Significant consumers of energy:

Households consumed **~28% of the final energy consumption** in 2018.

The majority of the household's direct energy budget is for space heating (35%), 60% of energy demand met with fossil fuels; 45% home owners

- Decision-making power

BMWK 2020, Destatis 2018



Energy Transition

Households key to successful energy transition and expected to contribute to decarbonisation targets:

- Decarbonisation by 2045
- Heating with renewables
- Efficiency in electricity demand
- Efficiency in heating demand

- Mobilisation of private sector capital, averaged household modelling

BMWK 2021

Outline

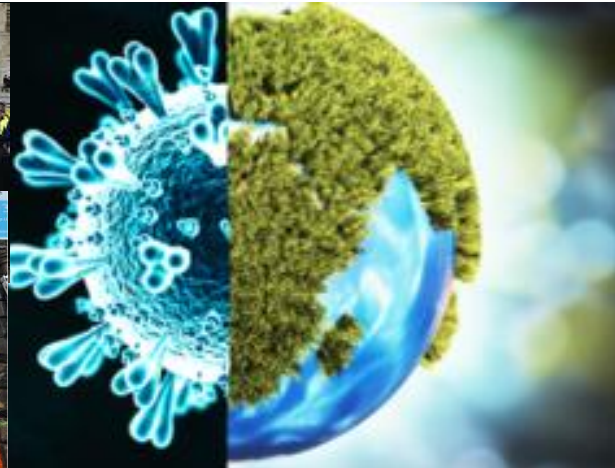
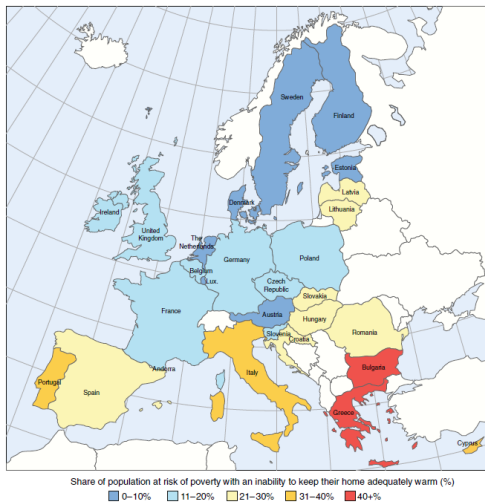
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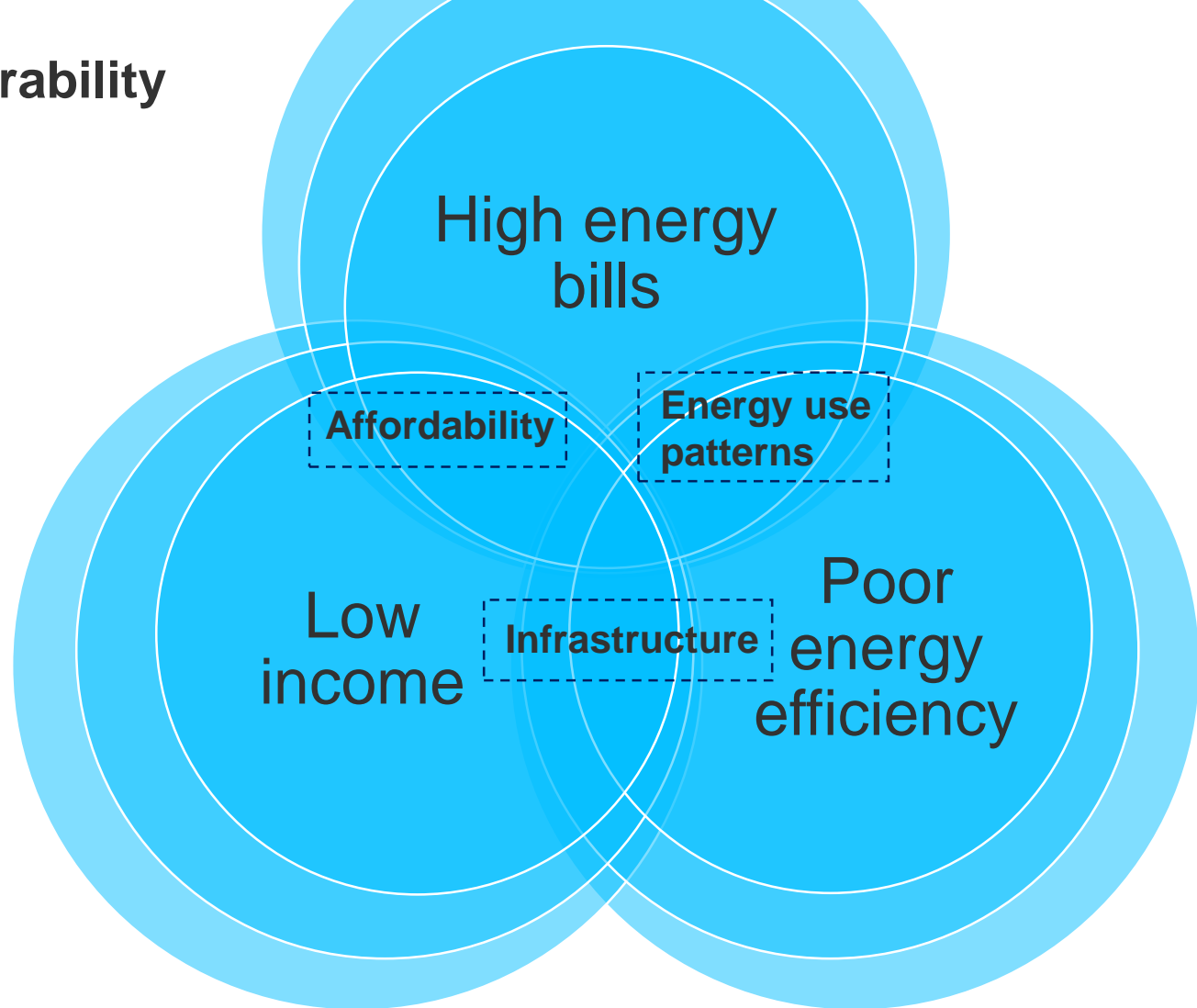
https://en.wikipedia.org/wiki/Yellow_vests_protests#Other_countries_or_regions; [sportpoin74/Bigstockphoto.com via: bit.ly; https://www.bbc.com/news/science-environment-59049770](https://www.bbc.com/news/science-environment-59049770); <https://newpol.org/a-green-recovery-and-the-fight-ahead-to-avoid-a-return-to-business-as-usual/>

Fig. 1 | Vulnerability to energy poverty across EU member states in 2016. The map shows the percentage of the population in each member state who are at risk of poverty with an inability to keep

2. Household energy vulnerability

What is energy poverty?

Commonly defined as a situation where households are not able to adequately meet their energy needs at **affordable** cost, and is caused by a combination of overlapping factors including **low income**, **high energy bills**, **poorly insulated buildings and inefficient technologies** and sometimes limited **access** to clean and affordable energy sources



2. Household energy vulnerability

Energy poverty

Official definition	Definitions under consideration...
Ireland, France, UK, Cyprus, Slovakia	Austria, Italy, Malta

Vulnerable Consumers

Definition type
Receipt of social welfare
Range of socio-economic groups (e.g., age, income, health)
Energy affordability (low income / high expenditure)
Disability / health

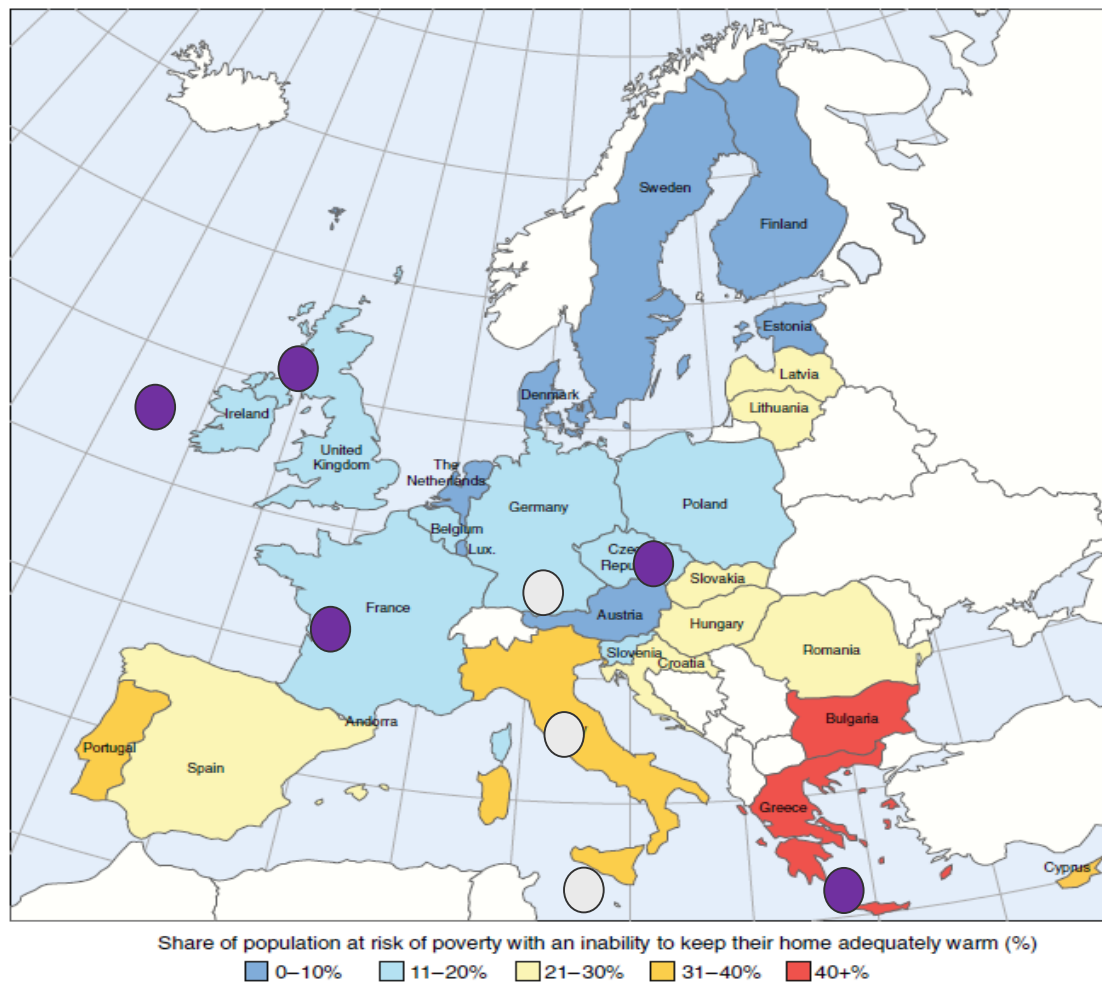


Fig. 1 | Vulnerability to energy poverty across EU member states in 2016. The map shows the percentage of the population in each member state who are at risk of poverty with an inability to keep their home adequately warm²².
16.05.2022 6

2. Household energy vulnerability

	Vulnerable Consumer	vs.	Energy Poverty
Concept	May include individuals at risk of or in energy poverty, but also a broader group of specific consumers who may be at a disadvantage in the purchasing and use of energy in the electricity and gas retail markets		<i>Commonly</i> understood to describe a situation where individuals are not able to adequately heat or purchase other energy services for their homes and needs at affordable cost (based on review of definitions applied)
Fuel types	Electricity and gas	vs.	All forms of energy (+ mobility)
Timeframe	Short-term curative approach	vs.	Longer-term preventative approach
Target group	Targets specific disadvantaged groups	vs.	Focus on energy affordability
Actors	Main actors: regulator, consumer protection agencies, utilities, government	vs.	Broader range of stakeholders

2. Household energy vulnerability

Energy poverty

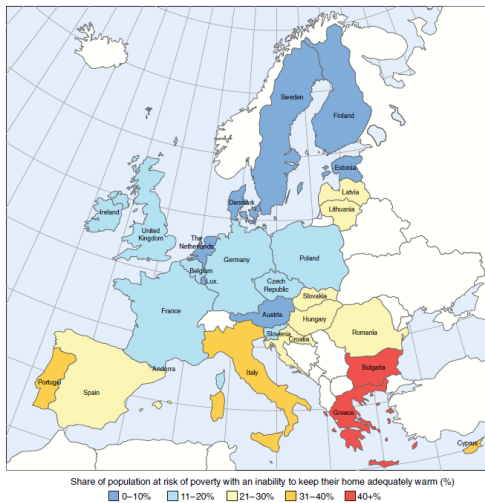
Why is energy poverty not recognised and how can the issue be addressed in Germany?



- >Access and affordability
- >Energy poverty vs. vulnerable consumers
- >Linking the debate to the underlying causes and harmonising the policy approach across policy domains

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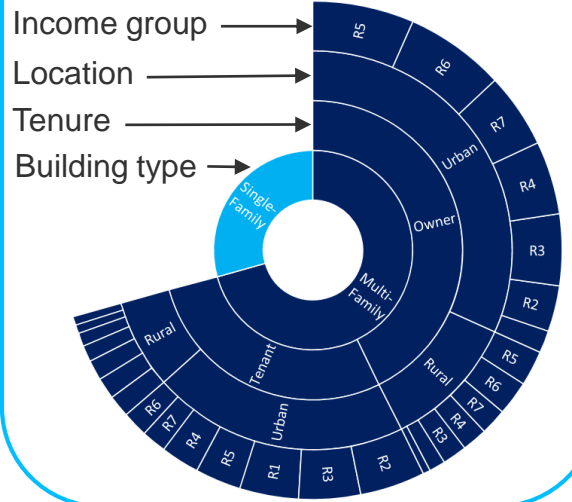
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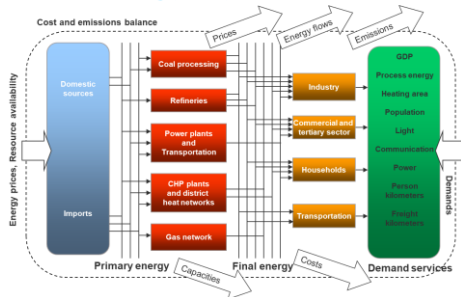
Fig. 1 | Vulnerability to energy poverty across EU member states in 2016. The map shows the percentage of the population in each member state who are at risk of poverty with an inability to keep

3. Methodology

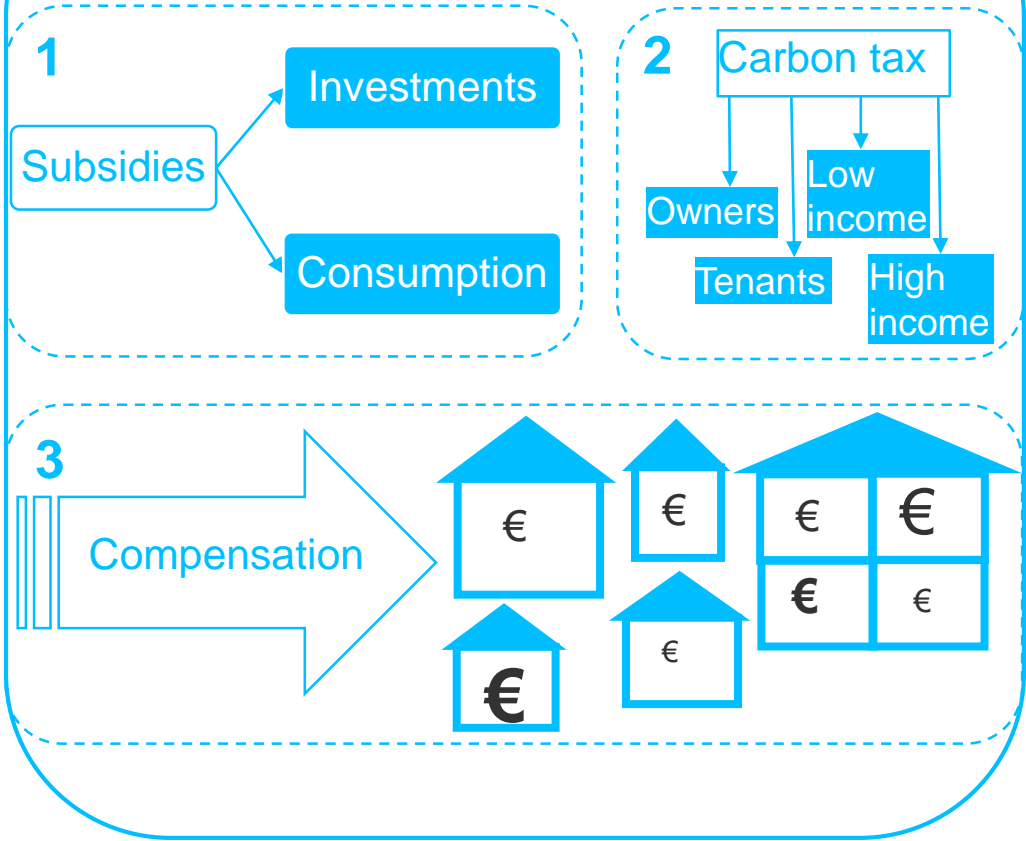
Disaggregation into profiles + budget constraints €



Energy system model

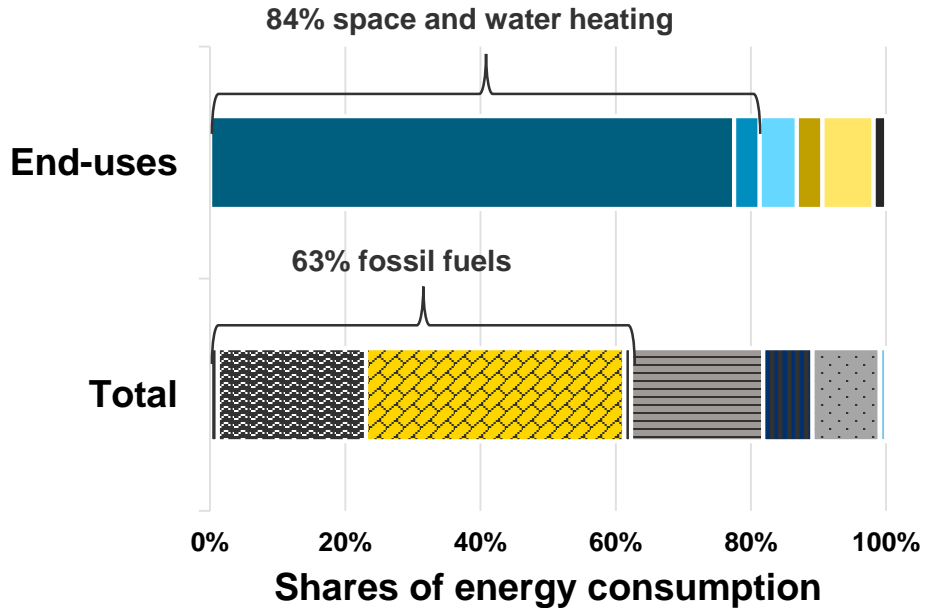


Selected scenario analysis



3. Methodology

1. Disaggregation

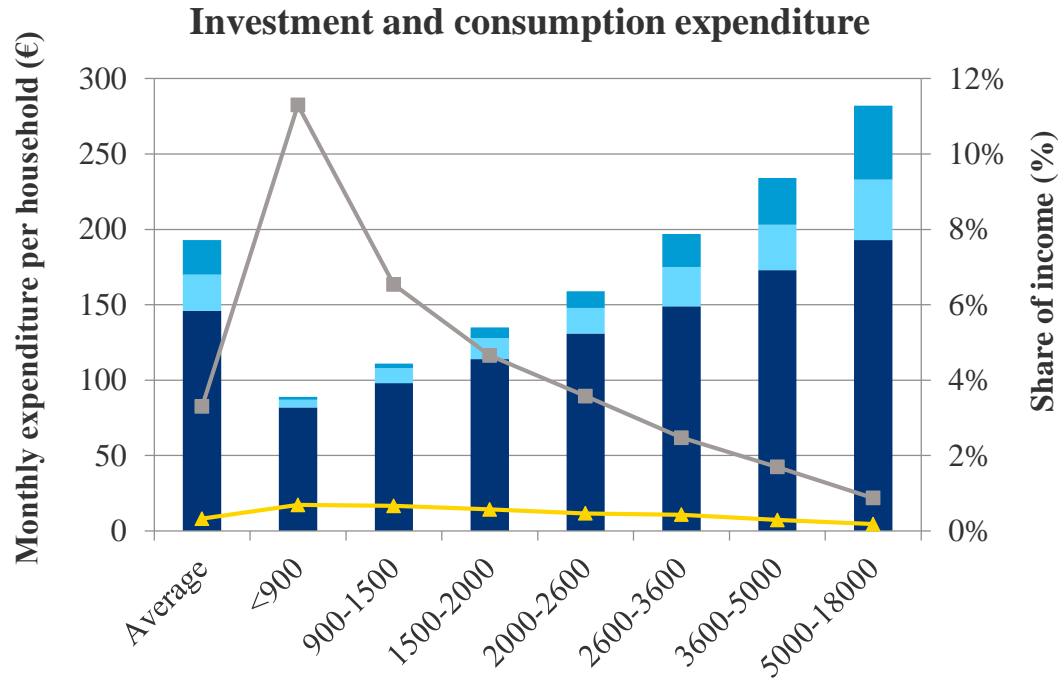


- + renewables
- + energy efficiency

- Investment costs
 - Building renovation
 - Heater exchange
 - Appliance upgrade
 - ...

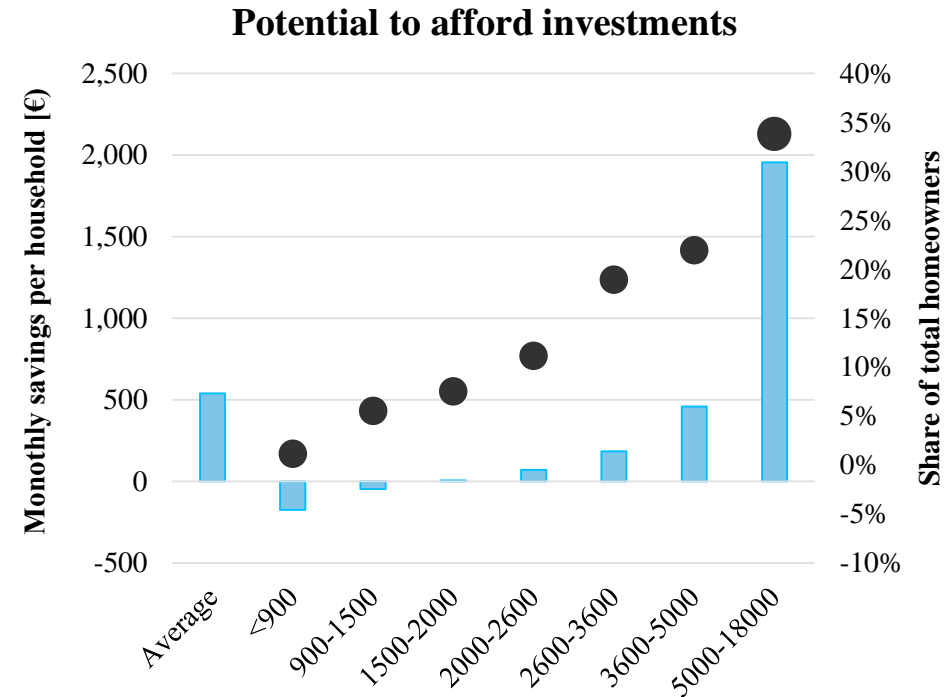
3. Methodology

1. Disaggregation



Income groups by monthly household income

- Household maintenance and renovations (indirect)
- Household appliances (indirect)
- Household energy consumption (direct)
- ■ Share of income on direct energy expenses
- ▲ Share of income on indirect energy expenses



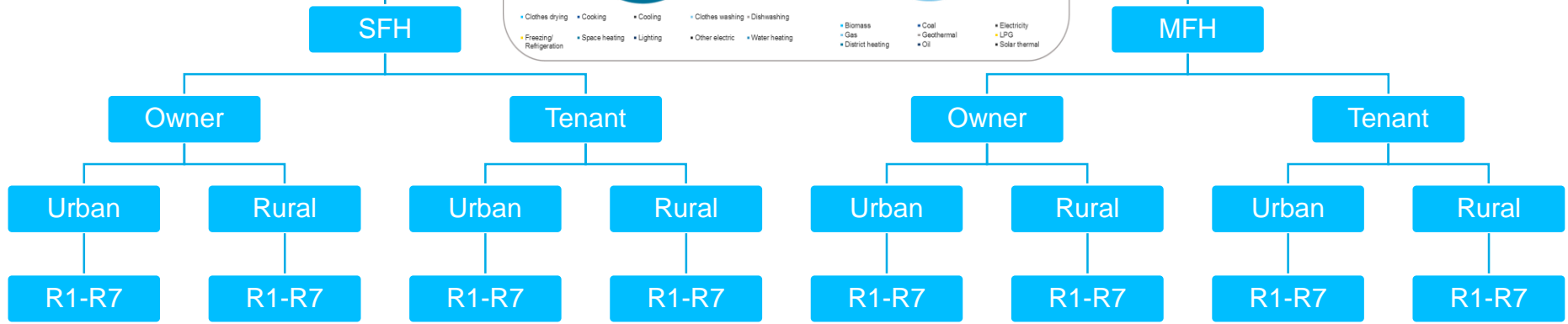
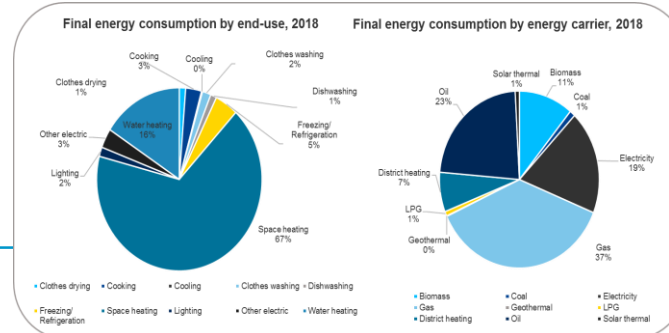
Income groups by monthly household income group (€ per household)

- 2018 Average monthly household savings
- 2018 Share of total homeowners

3. Methodology

1. Disaggregation

Final energy consumption by end-use and energy carrier

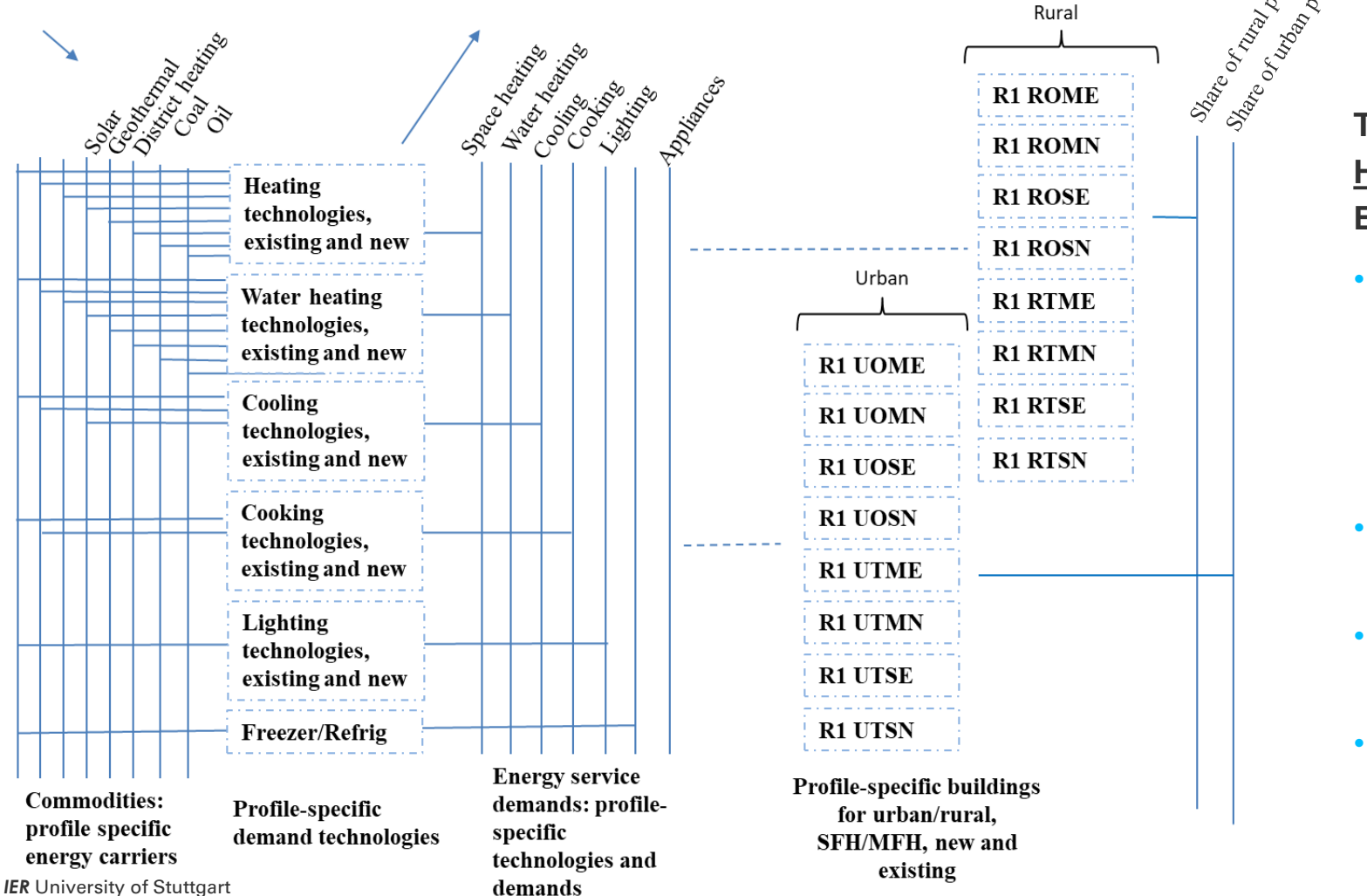


Building type + Location + Tenure + Income + Standard of living + Energy sources/ infrastructure + Typical appliance ownership + Energy prices + Policies and measures

Typical consumption patterns for end-use for each profile based on income group, location, tenure, building type

3. Methodology

2. Energy system optimisation model



TIMES Actors Model (TAM)- Households Reference Energy System

- Disaggregation of households according to socio-economic characteristics (income), location, tenure, building type into profiles
- Demands and technologies all profile-specific
- Profile-specific energy carrier access and resource potential
- + Budget constraints -> dual objective

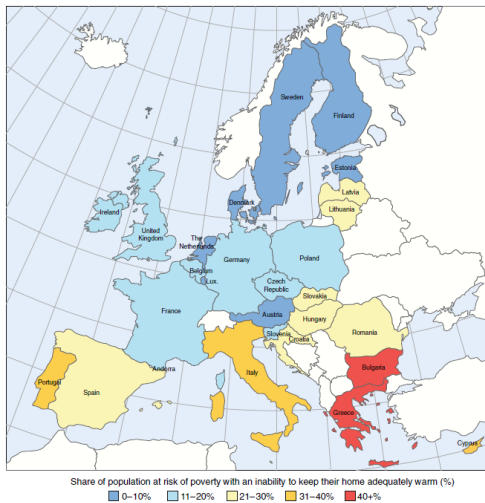
3. Methodology

3. Scenario overview and summary of results format

Scenario	Scenario description
Reference (REF)	Disaggregation, budget constraints, implemented policies
Energy poverty (EP) vs. Vulnerable consumers (VC)	Subsidisation of investment in renewables and energy efficiency vs. consumption
Carbon Tax	Consumer pays
	Carbon tax split 50:50 tenants/landlords (CO2TO)
Compensation schemes (CB)	Carbon tax & Renewable energy levy collected -> "Climate Bonus" -> 100€ per capita
	Carbon tax & Renewable energy levy collected -> "Climate Bonus Low Income" -> 200€ per capita but only to lower income half of the population (CBLI)
Coping mechanisms	Case study: lack of upfront investment capital -> use of second-hand appliances for freezing/refrigeration services (2HM) or extending their lifetime beyond the economic lifetime (EXT)

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Fig. 1 | Vulnerability to energy poverty across EU member states in 2016. The map shows the percentage of the population in each member state who are at risk of poverty with an inability to keep

4. Integrated energy poverty assessment

Comparison of policy approach

Energy poverty

- Beneficiaries: Energy affordability
- Fuels and purposes: all
- Measures: underlying causes – energy efficiency

Vulnerable consumers

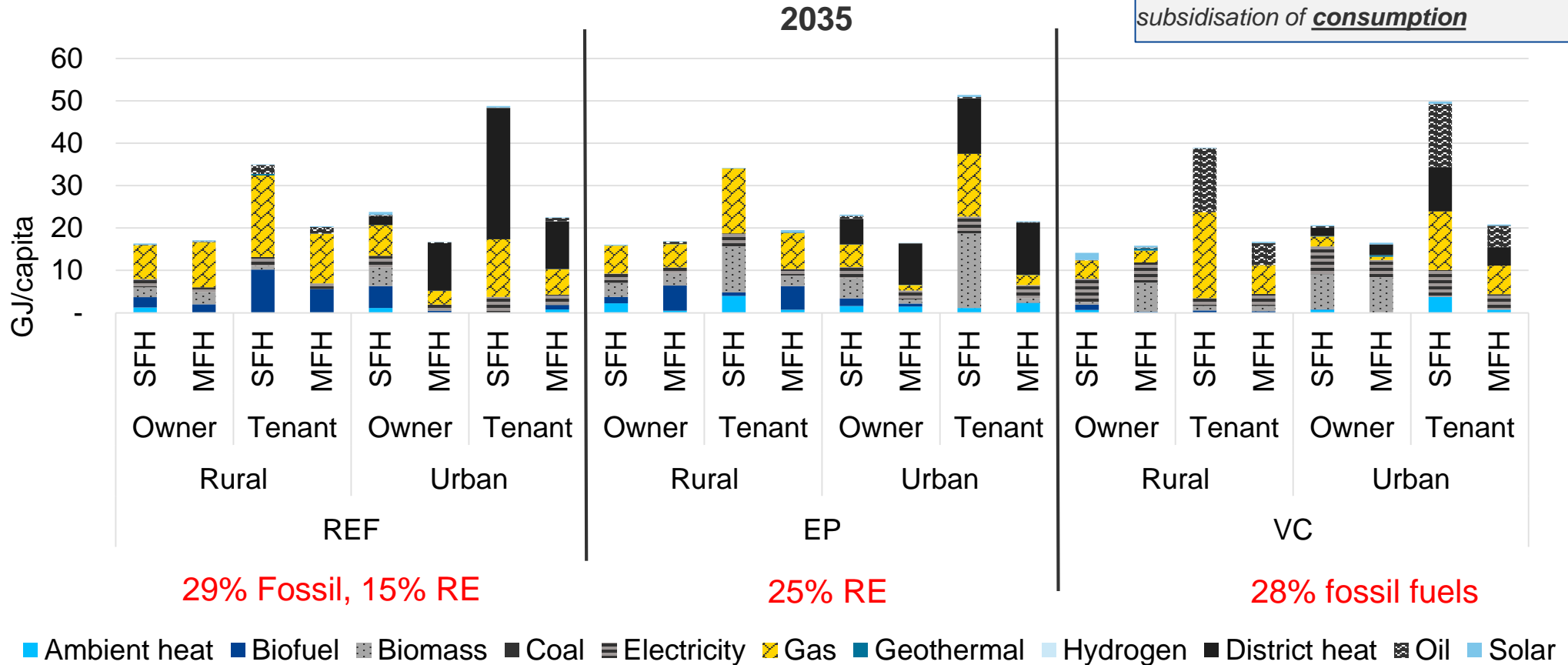
- Beneficiaries: typically social welfare recipients within the energy markets
- Fuels and purposes: electricity and gas, electrical uses, heating
- Measures: disconnection protection and financial aid for consumption expenditure

Scenario	Objective
Energy poverty (EP)	Explore access and affordability and subsidisation of investment in renewables and energy efficiency (EP) vs. consumption (VC)
Vulnerable consumers (VC)	

4. Integrated energy system assessment

Impact of access and affordability in TAM-Households model

Scenarios:
REF: TAM-HHs with disaggregation and budget constraints; implemented policies
EP: Energy poverty – subsidisation of **investment**
VC: Vulnerable consumer - subsidisation of **consumption**



4. Integrated energy system assessment

Suppressed demand by scenario

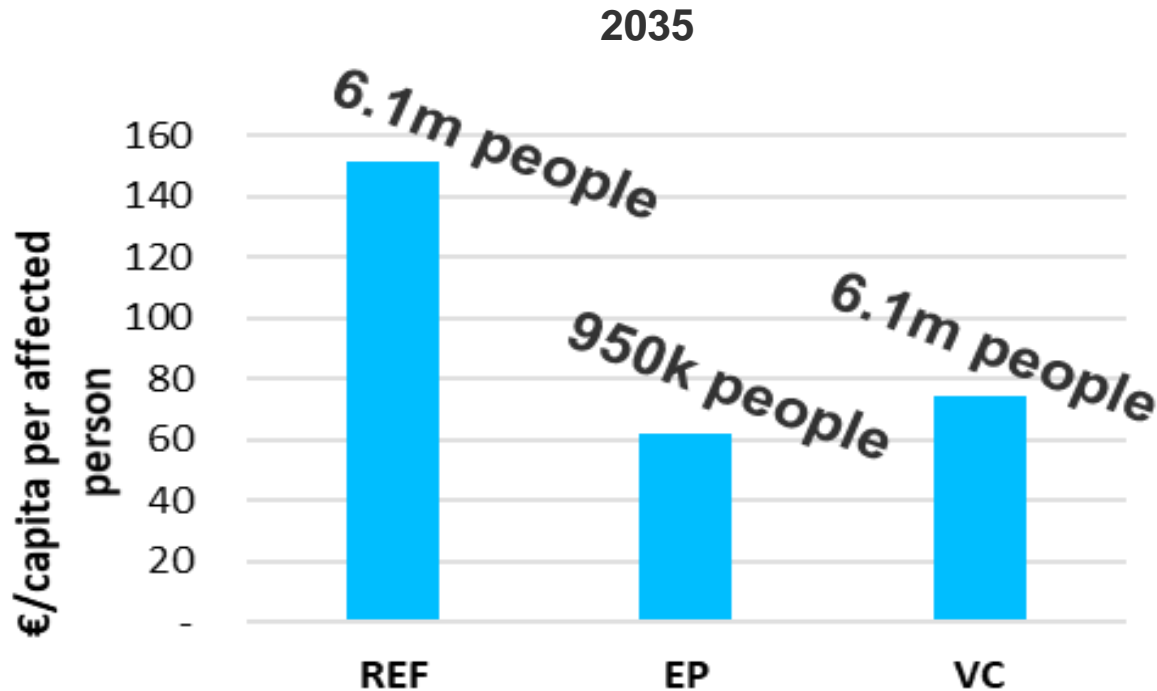
€/ capita applies to affected population only (of 3 lowest income groups)

Scenarios:

REF: TAM-HHs with disaggregation and budget constraints; implemented policies

EP: Energy poverty – subsidisation of investment

VC: Vulnerable consumer - subsidisation of consumption



4. Integrated energy poverty assessment

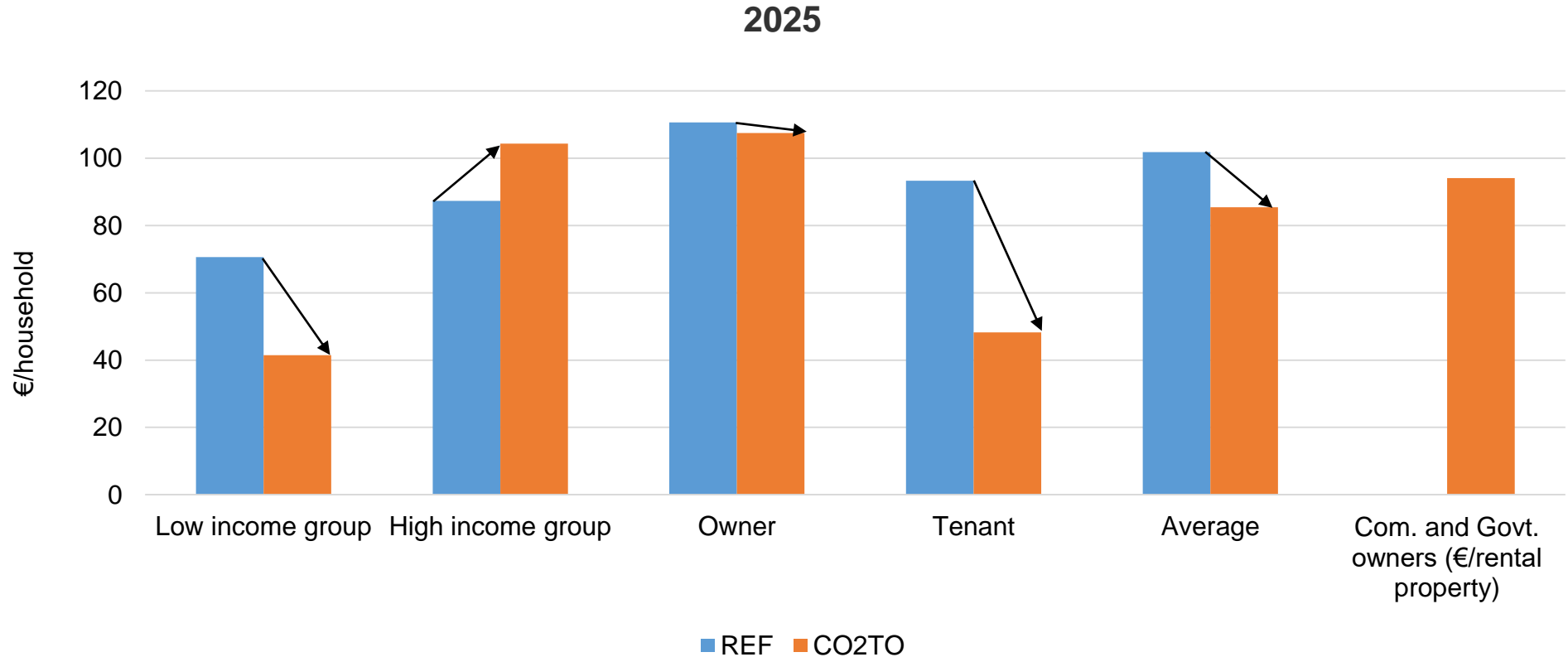
Scenarios

Scenario	Objective
Carbon Tax	Consumer pays (REF)
	Carbon tax split 50:50 tenants/landlords (CO2TO)
Compensation schemes	Carbon tax & Renewable energy levy collected -> “Climate fund” -> 100€ per capita (CB)
	Carbon tax & Renewable energy levy collected -> “Climate fund” -> 200€ per capita but only to lower income half of the population (CBLI)

4. Integrated energy system assessment

Impact of carbon tax in TAM-Households model

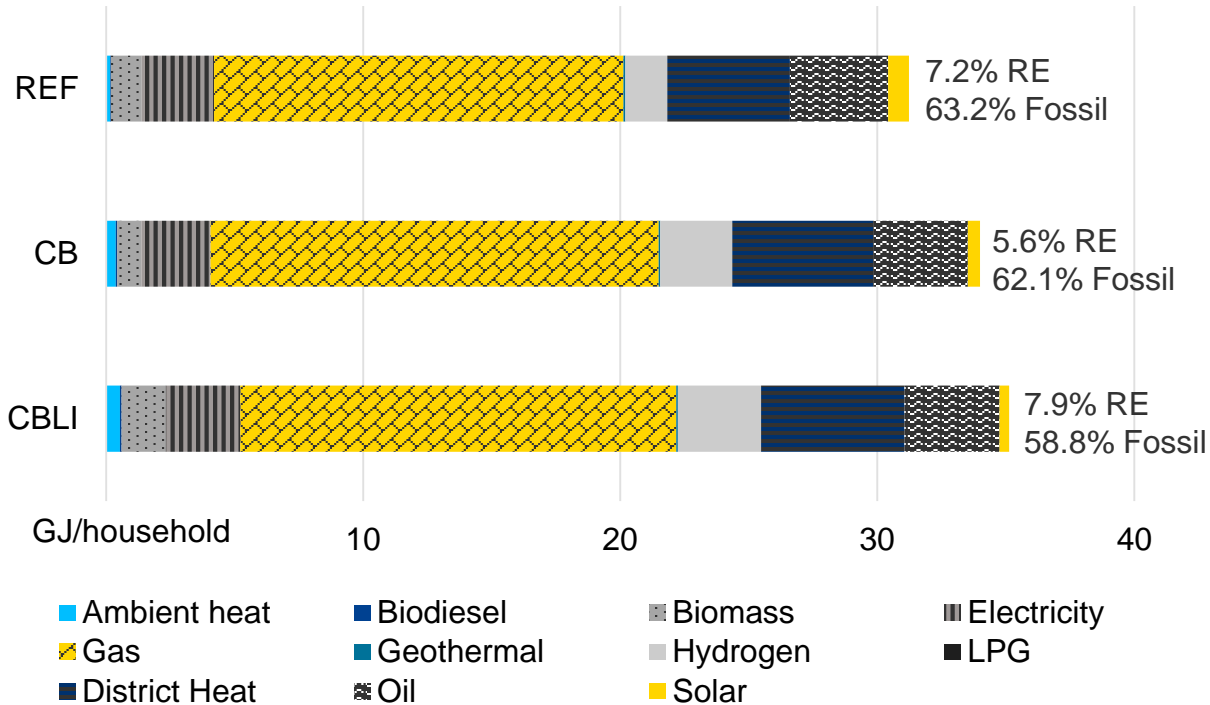
Scenarios:
REF: TAM-HHs with disaggregation and budget constraints; implemented policies
CO2TO: 50:50 distribution of carbon tax between landlords and tenants



4. Integrated energy system assessment

Impact of carbon tax redistribution schemes on lowest four income groups

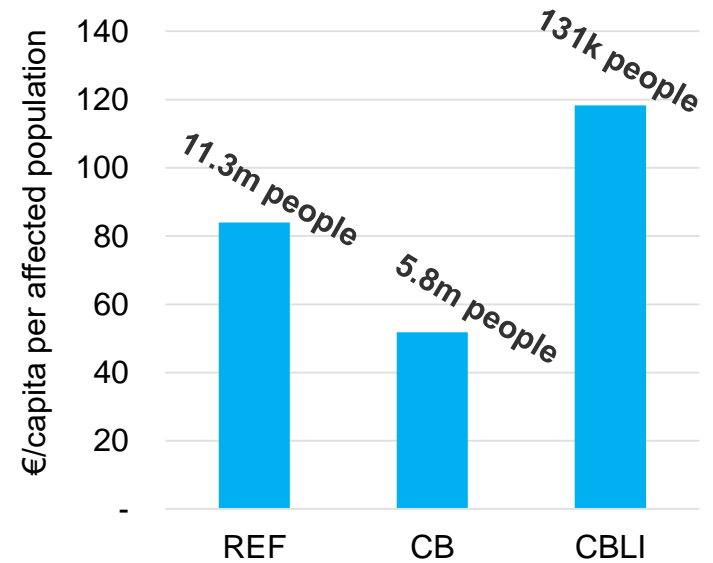
2030



Scenarios:

CB (Climate Bonus): 100€ per capita

CBLI (Climate Bonus Low Income): 200€ per capita to lower 50% of population



Suppressed demand by scenario
 €/capita applies to affected population only
 (of 4 lowest income groups)

5. Conclusions

- **Support addressing energy poverty AND the energy transition:** Identifying and unifying the objectives to address overarching and household challenges
- **Method** is a template and can be expanded to fit the socio-economic challenge to be addressed (e.g., age, gender, household composition)
- **Targeting policies** to be cost-effective and improving the energy welfare of households is possible!



A young child with blue eyes, wearing a black beanie, a dark jacket with a green scarf, and blue jeans, is sitting on a white radiator. The child is looking off to the side with a thoughtful expression. The background is a light-colored brick wall.

Thank you!

Questions?

Comments?

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