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The role of building mass upgrade in the energy system transition - A Norwegian case study

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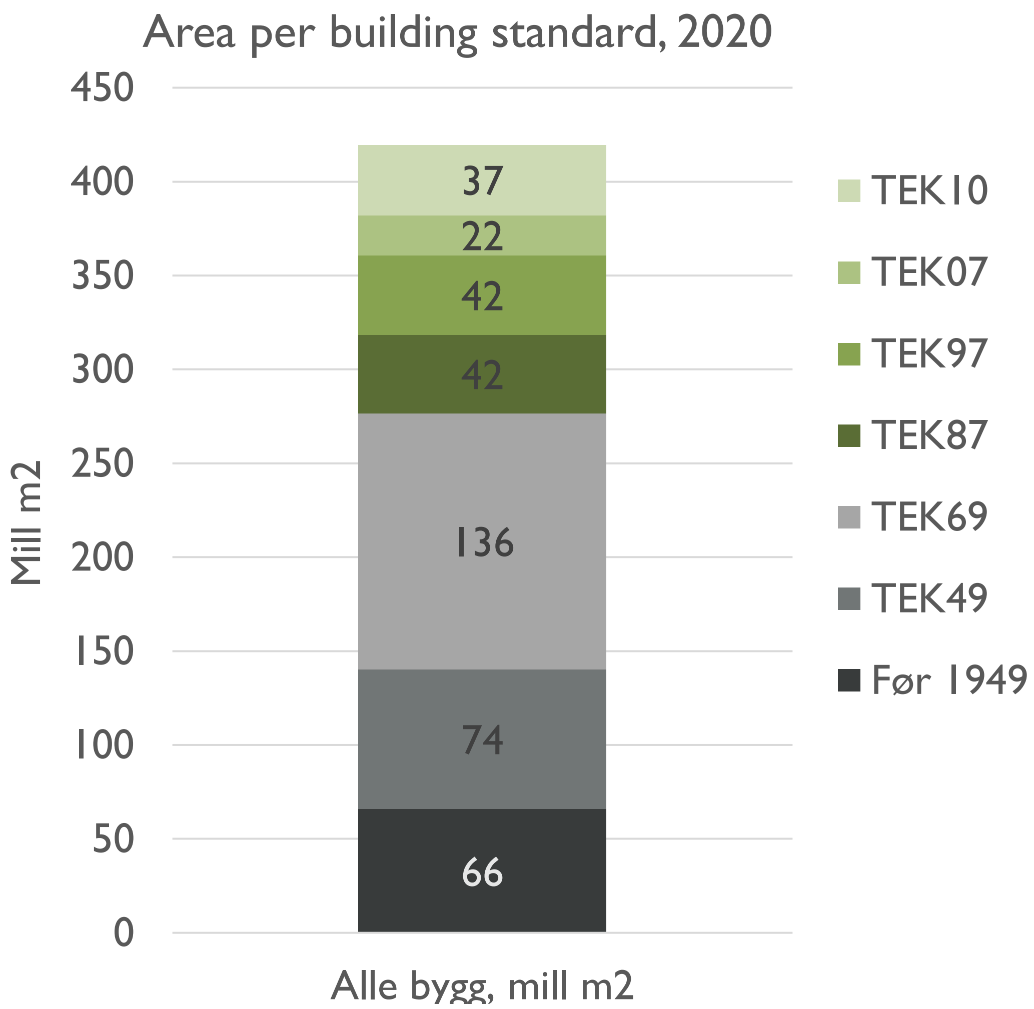
Background and motivation

- Energy efficiency
  - Lowers demand
  - Lowers energy costs of consumers

- Buildings in Norway
  - 22% of final energy demand (2020)
  - Large share old buildings

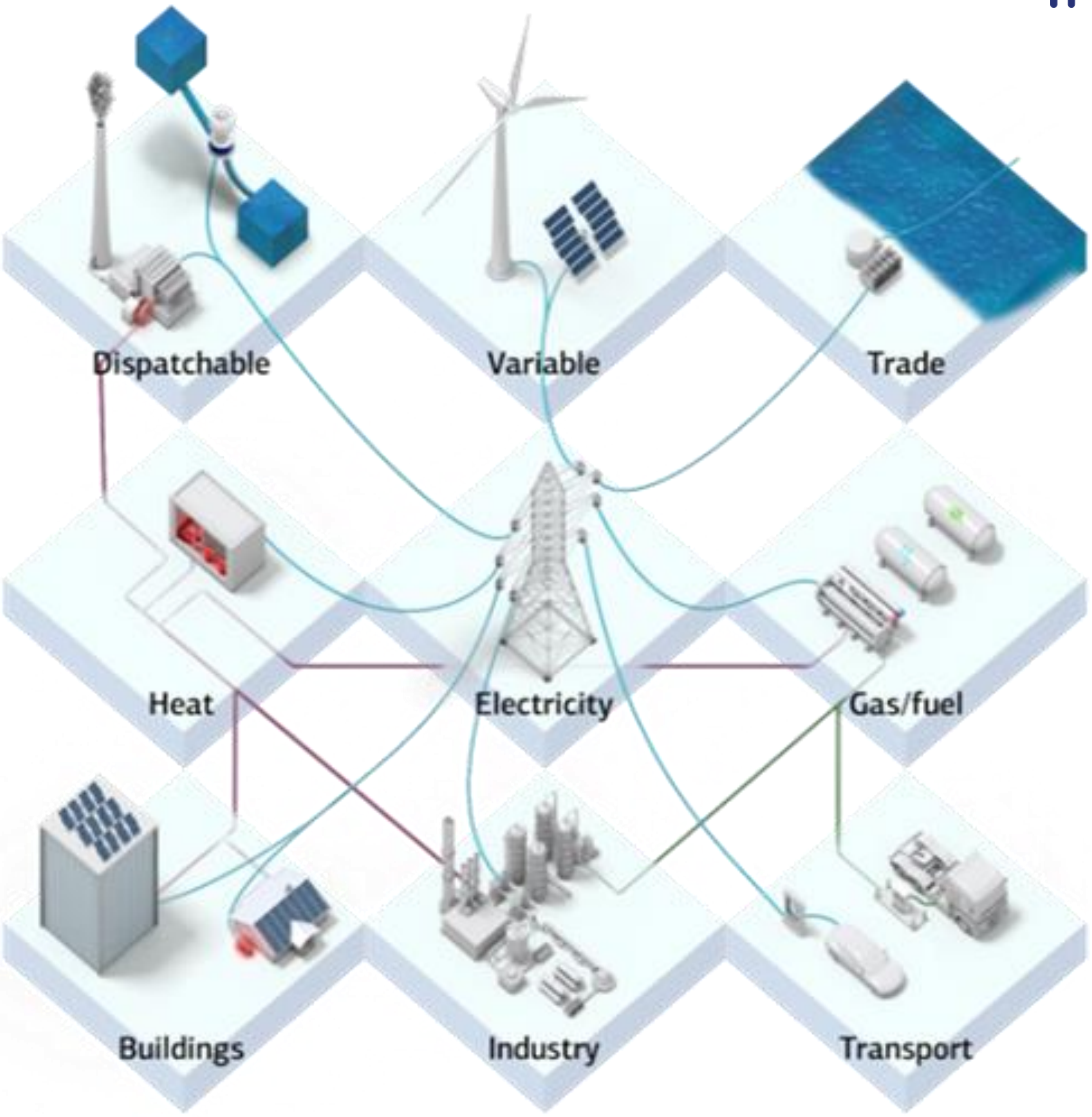
Research question:
What is value of **building mass upgrade** in the low-carbon energy system transition?



Norwegian energy system model

IFE-TIMES-Norway (2018-2055)

- Long-term optimization model
- Investments & operation to meet demand future demand for energy services
- Covers entire energy system
  - Sector coupling
  - Competition between technologies and energy carriers
  - Detail representation of end-use



Figur: IEA, NETP 2016

Building mass upgrade measures

- NVE/ Multiconsult 2021 study: Potentials, lifetime and costs

13 building mass upgrade measures

1. Insulation of walls
2. Insulation of roof
3. Insulation of floor
4. New windows and doors
5. Lower indoor temp., nights & weekends
6. Improved heat recovery in ventilation
7. Improved power efficiency
8. Improved ventilation regulation
9. Lighting regulation
10. Energy efficient lighting
11. Automatic sun protection
12. Demand controlled ventilation
13. Energy management systems

13 building type categories

1. Single-family houses
2. Multi-family houses
3. Kindergarten
4. Offices
5. Schools
6. University/higher education
7. Hospitals
8. Nursing homes
9. Hotel
10. Sports
11. Wholesale and retail
12. Culture
13. Light industry / workshop

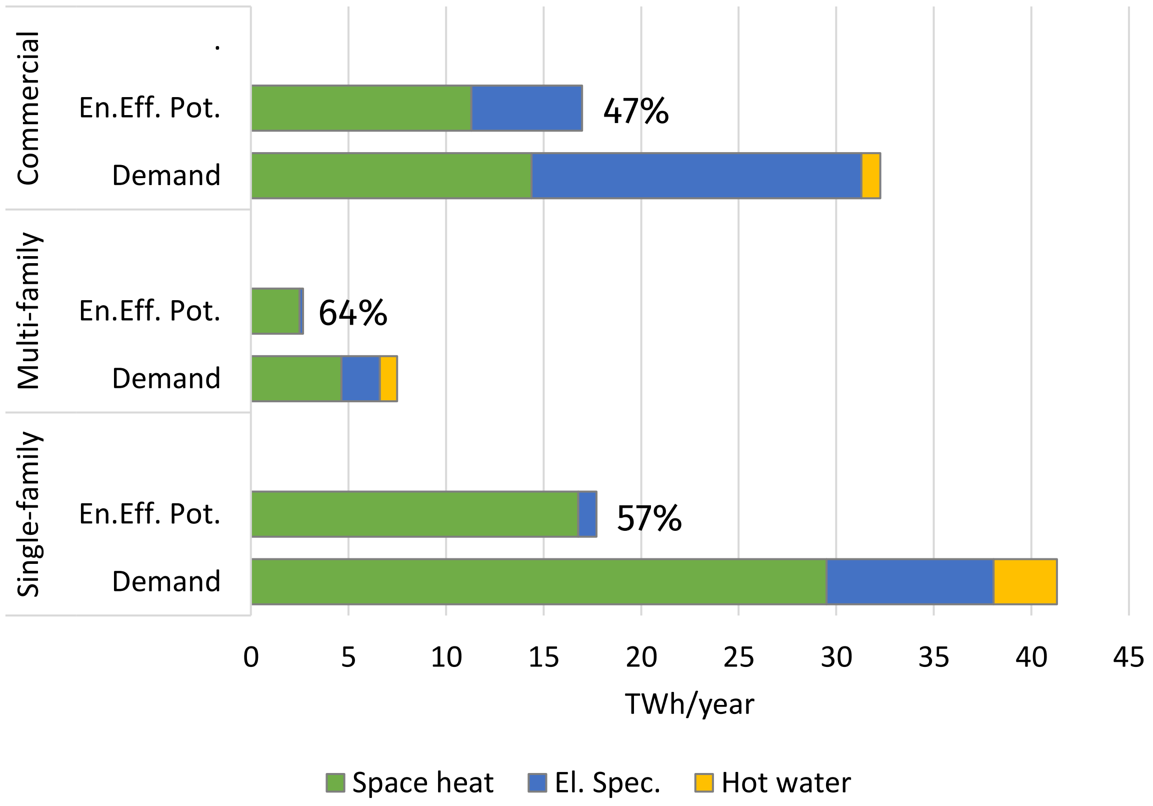
More information: https://www.nve.no/energi/energisystem/energibruk/energieffektivisering/

Building mass upgrade measures

- **Potential split by**
  - 4 technical building standards
  - 5 electricity spot regions

- **Endogenous investment options**
  - ~ 3800 options included
  - Rank of implementation order based on LCOE

Max energy efficiency potential in 2025



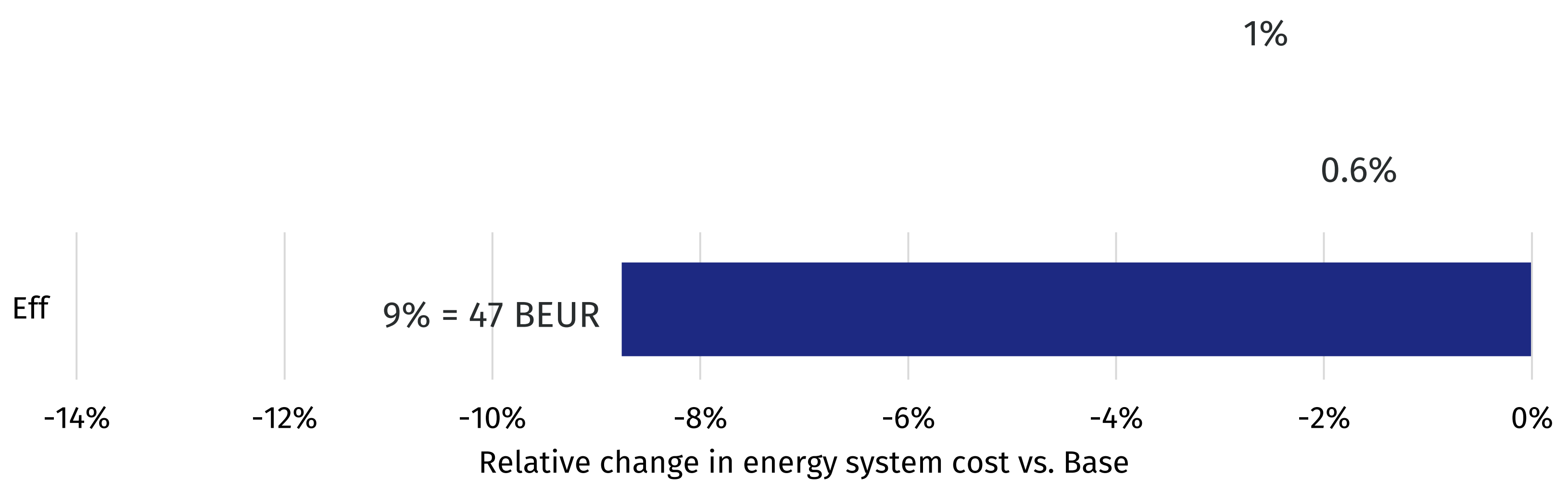
Model cases

- Case: On/ off building mass upgrade, building applied PV & flexible EV charging

Case	Building mass upgrade	Building applies PV	Flexible EV charging
Base			
Eff	x		
PV		x	
Flex			x
All	x	x	x

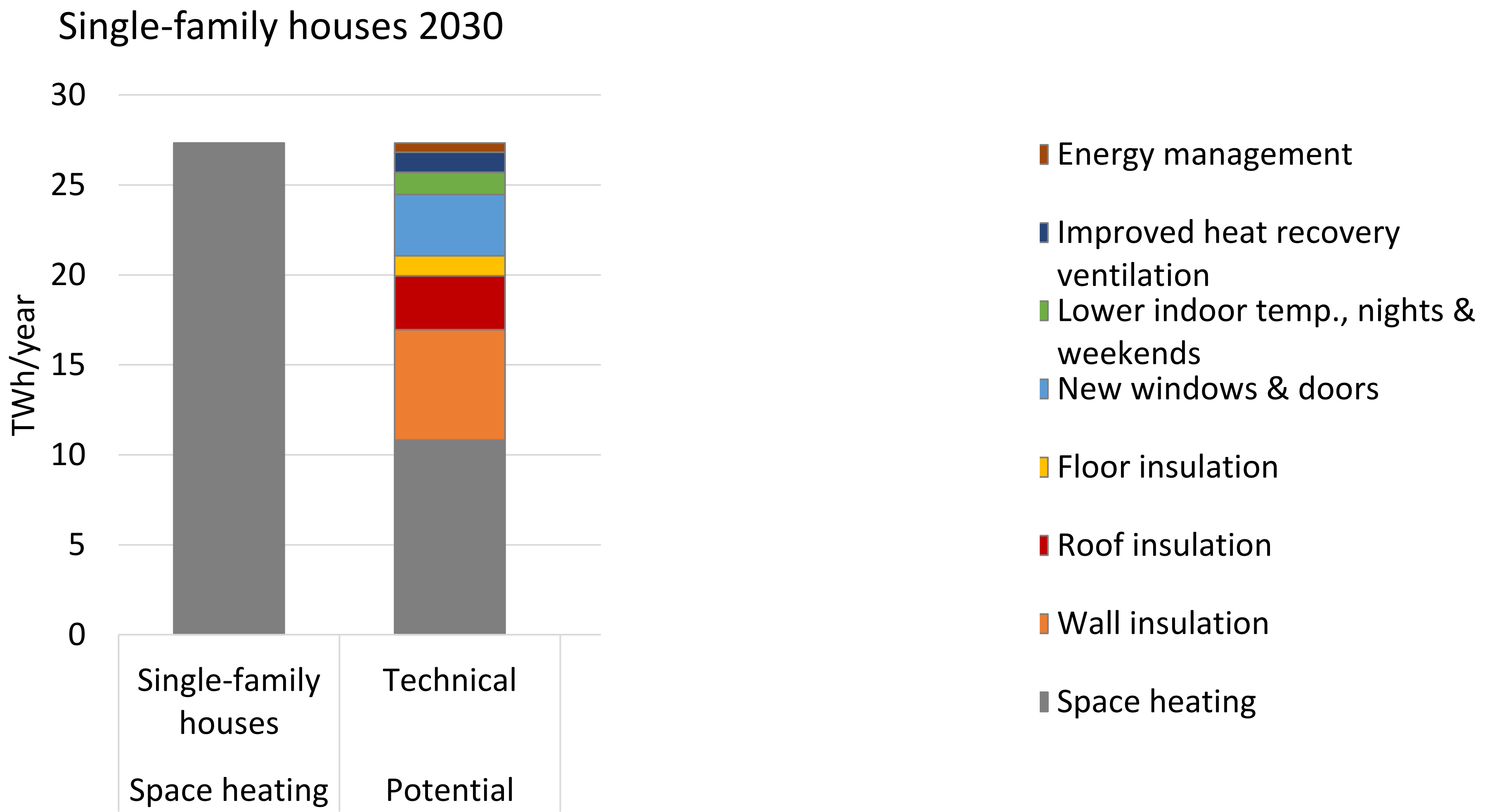
Results

Building mass upgrades lower energy transition cost



- Building mass upgrade lower the cost of the energy transition more than PV and Flex

Investments in building mass upgrade is a techno-economic solution but depends on energy behaviour



Space heat: 27 TWh

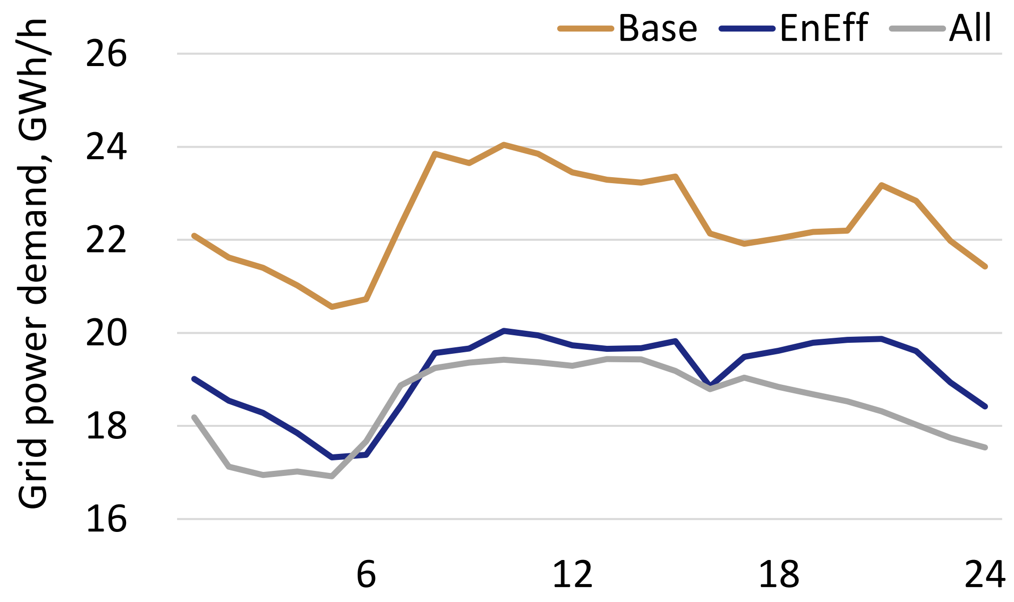
Technical: 11 TWh

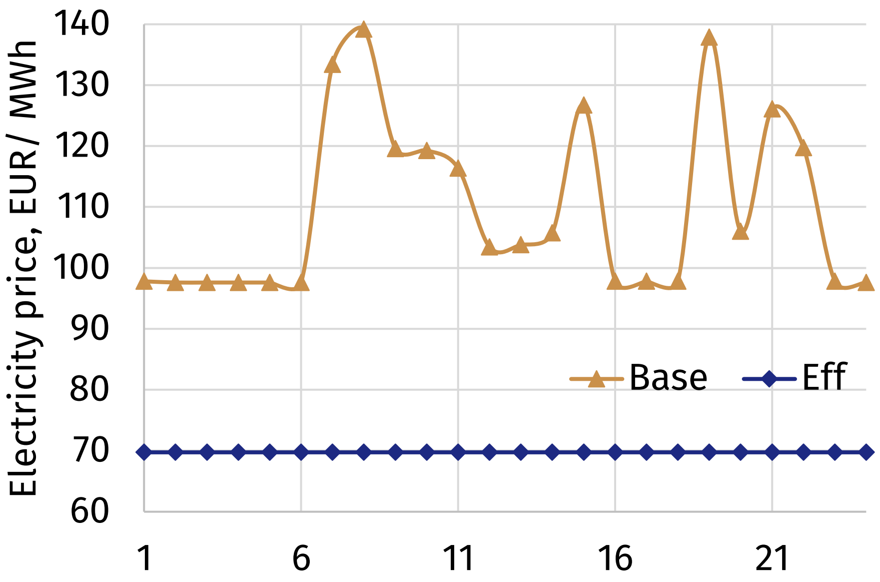
4% rate: 13 TWh

20% rate: 22 TWh

Building mass upgrades lowers peak electricity demand and price

Figure: Winter 2050





- Peak demand reduction: 17%
- Larger impacts on distribution grid level

NO1	NO2	NO3	NO4	NO5
11%	10%	21%	20%	20%

Main takeaways

Building mass upgrades lowers energy costs of buildings

- Lower demand
- Lower peaks → lower distribution tariffs
- Lower electricity price

= Lower energy bill

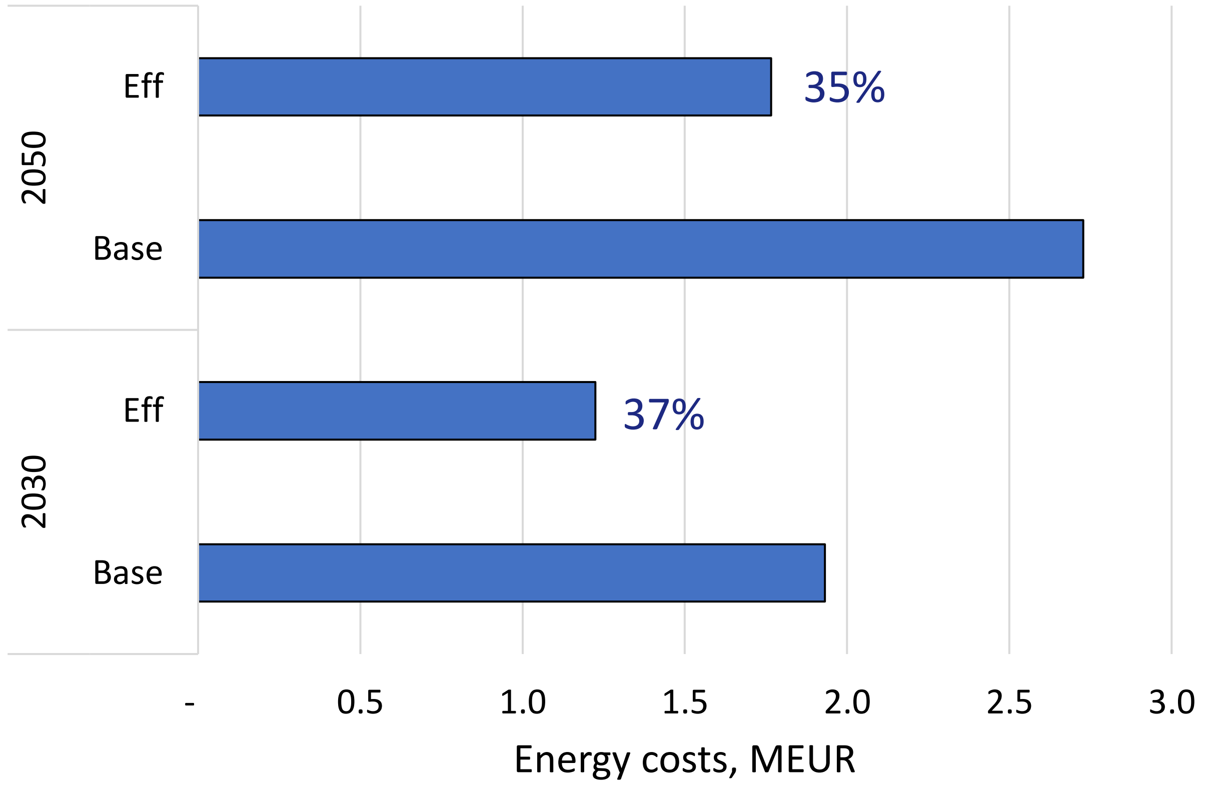


Figure: NO1 Residenitial single family houses

Main takeaways

- Techno-economic implementation of building mass upgrades significantly lowers
  - cost of the energy transition
  - energy costs of end-users

- There is a mismatch between techno-economic and real-world implementation

- **Necessary steps**
  - understand drivers and barriers for building mass upgrade
  - design policies that enables the potential