PROFITABILITY OF ACTIVE RETROFITTING IN MULTI-APARTMENT BUILDINGS – A SPECIAL FOCUS ON PV AND DIFFERENT HEATING SYSTEMS

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MOTIVATION

• 40 % of the total energy consumption and…

• 36 % of the CO$_2$ emissions in the EU are caused by the building sector

Furthermore

• 35 % of the European building stock is older than 50 years, and thereof…

• 75 % are energy inefficient

→ Retrofitting of the old housing stock is highly necessary!

• 50 % of the European buildings are multi-apartment buildings → addressing this building segment most important
MODEL AND METHOD

- Mixed-integer linear optimisation model is developed
- Objective Function: Maximising the Net Present Value (NPV)
- Major Outputs of the Model:
  - Net Present Value
  - Profitability of active retrofitting measures
  - According optimal system capacities

For more detailed information concerning the model and the results which are presented in the following please see:
BUILDING SET-UP AND ACTIVE RETROFITTING MEASURES
RESULTS – HEATING SYSTEM CHANGE

Default Setting:

- 145 kWh/m²a heat load
- Gas heating
- Stand-alone building
- 30° roof pitch
RESULTS – DIFFERENT PV SYSTEMS

- Building-attached rooftop PV most profitable
- Building-integrated PV also profitable despite additional basic retrofitting costs
- Northern part of the roof not used for PV implementation → not profitable
IMPACT OF BUSINESSES ON THE PROFITABILITY OF PV

• **Characteristics:**
  - Good correlation to sunshine hours
  - Most energy consumption during the day

• **Impact:**
  - Optimal PV installation capacities rise
  - Profitability of PV increases
  - Northern part of the roof is used for PV implementation: Profitability despite weaker solar irradiation
In blue:
Retrofitting costs, which occur when improving the building standard (passive renovation)

versus

In red:
Monetary value of energy savings achieved by better building standard
IMPACT OF RETAIL ELECTRICITY PRICE VARIATIONS

- Within the past ten years: annual retail electricity price increase by 2.37% in Europe (linear assumption)

- Rising retail electricity price leads to:
  - Increasing optimal PV system capacities
  - Decreasing NPV

- Cost saving potential of PV systems rises
IMPACT OF INTEREST RATES

- Rising interest rates lead to:
  - Decreasing optimal PV system sizes
  - Increasing NPV

- Future cash flows are reduced by increasing interest rates:
  - Decreasing cost saving potential of PV systems
  - But also: Decreasing influence of future payments for electricity and heat
CONCLUSION

• Building-attached and building-integrated PV achieve break-even

• Heating systems like heat pumps, pellets and district heat not competitive with conventional gas

• Profitability of PV strongly depends on retail electricity price development and expectations of the rate of return

• Sustainable building retrofitting contains a combination of active and passive retrofitting measures

• Profitability gap can be addressed by:
  → Governmental incentives like subsidies
  → True cost pricing of CO₂ emissions
THANK YOU!

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