



ENERGY FLEXIBILITY BY STRUCTURAL THERMAL STORAGE IN DWELLINGS

IEA EBC ANNEX 67

*dr. ir. **Glenn Reynders***
KU Leuven, Building Physics Section
Glenn.Reynders@bwk.kuleuven.be



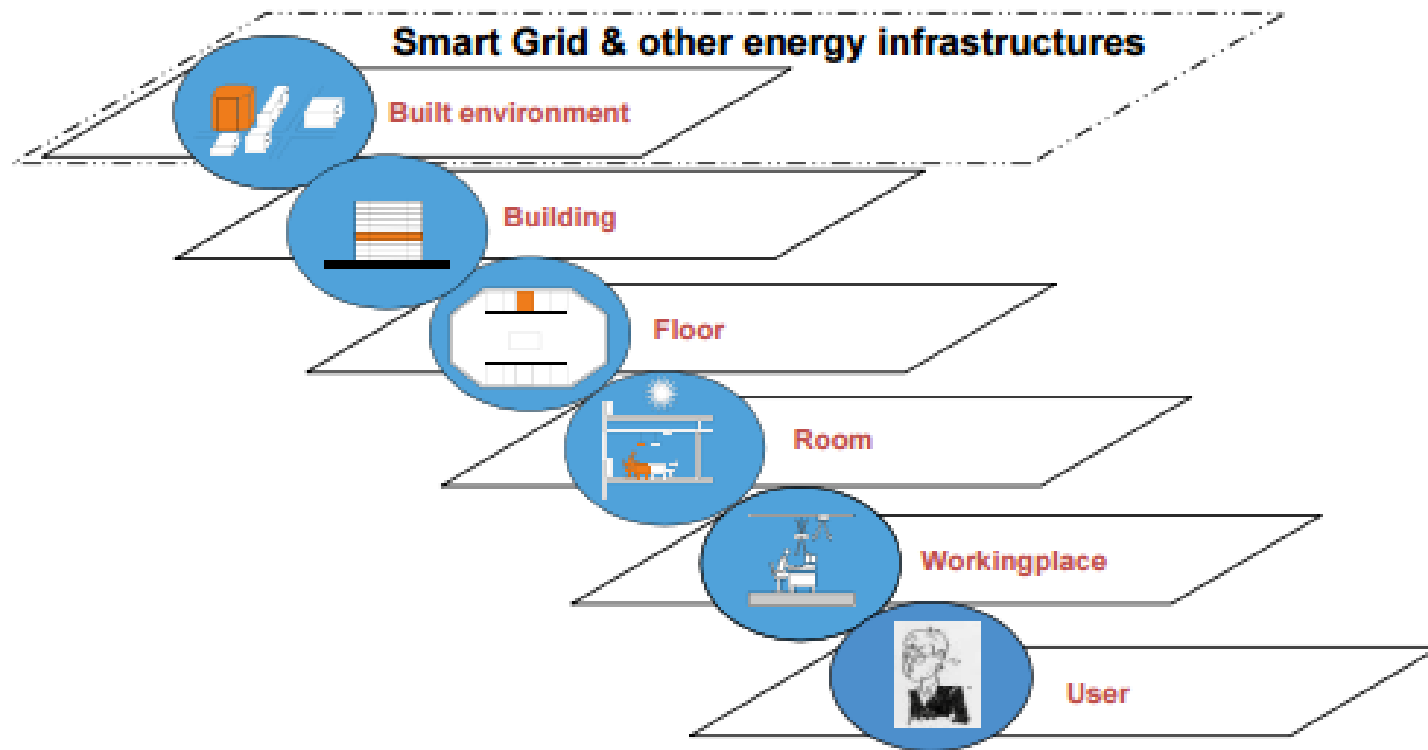
Energy Flexible Buildings

EBC



Energy in Buildings and
Communities Programme

ANNEX 67



Energy Flexible Buildings

ANNEX 67



Goal

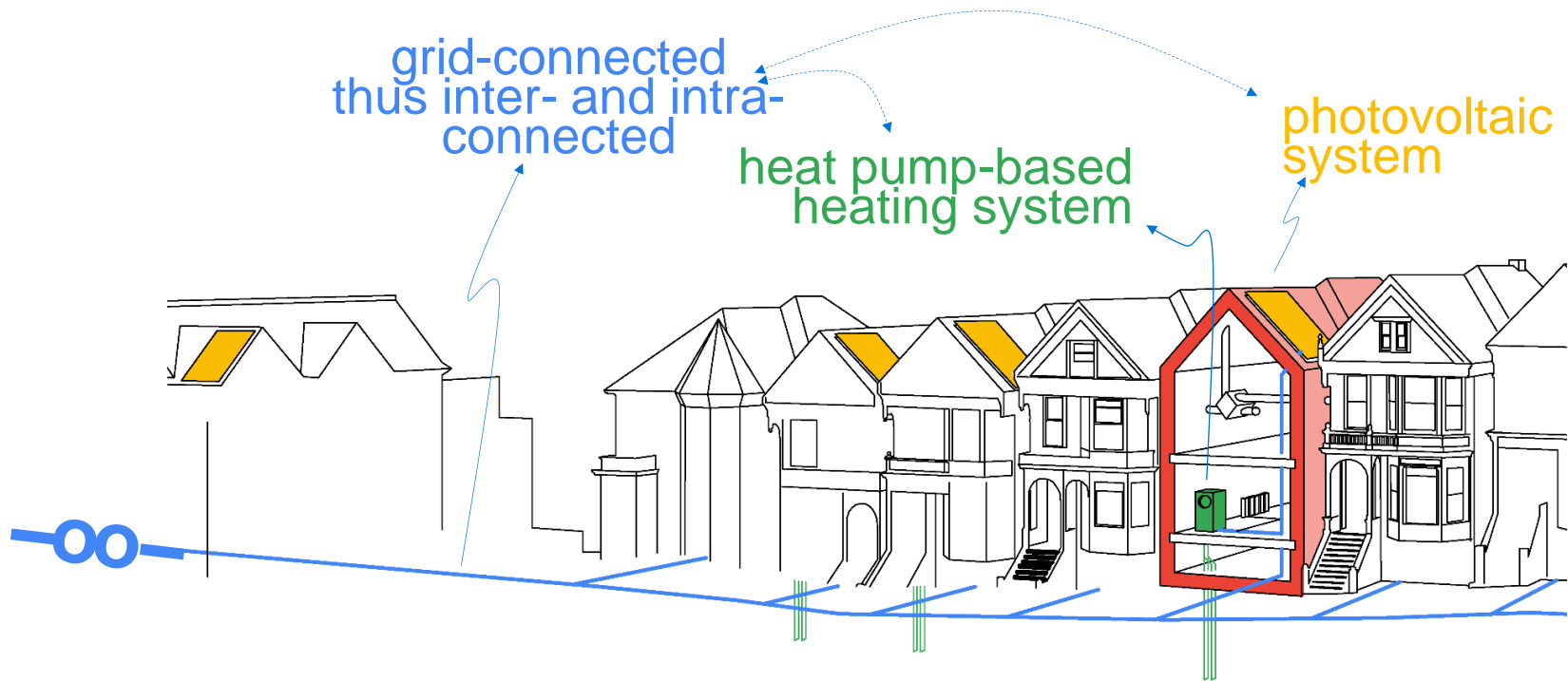
“Define and quantify energy flexibility in buildings”

Activities

- Subtask A: Definitions and Context
- Subtask B: Analysis, Development and Testing
- Subtask C: Demonstration and User Perspectives

3rd Work meeting: Bolzano, Italy. October 17-19, 2016

Contact O.A.: Søren Østergaard Jensen <sdj@teknologisk.dk>



- *What impact do buildings have on district energy system?*
- *What can buildings offer as flexibility to the grid?*



grid perspective

- Size (kWh)
- Power (kW)
- Availability (s)
- Investment cost (€ + kWh)
- Current state (-)



building perspective

- Comfort
- Cost / Profit (€)
- Energy use (€ + kWh)

Flexibility indicators

- Available capacity
- Storage Efficiency

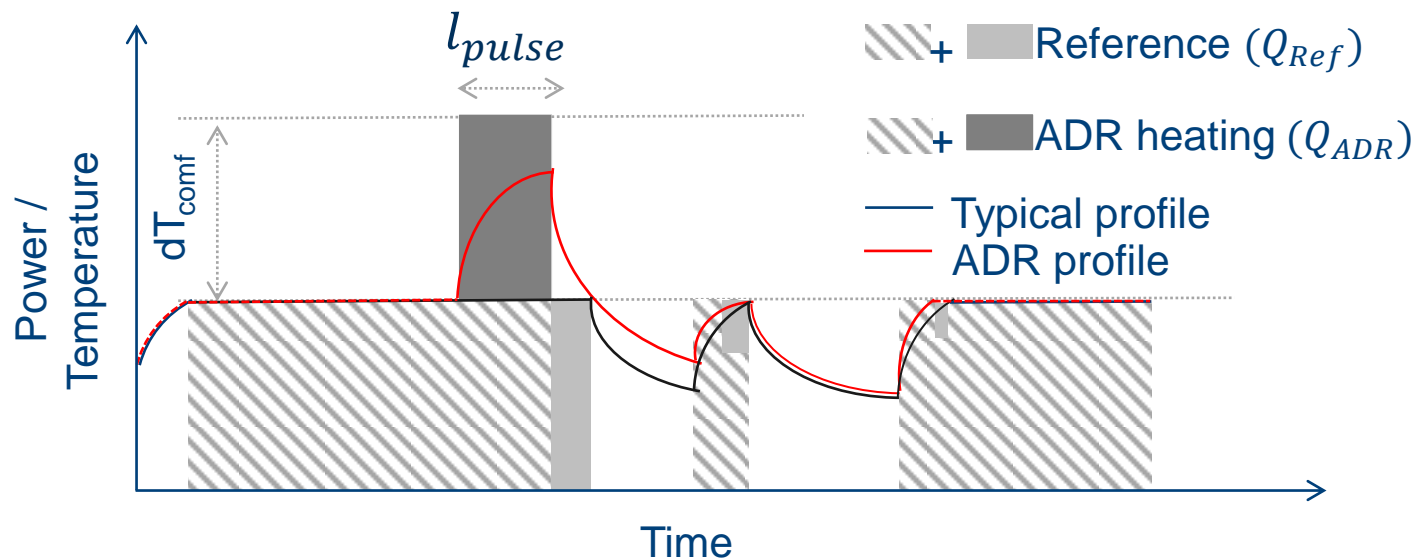
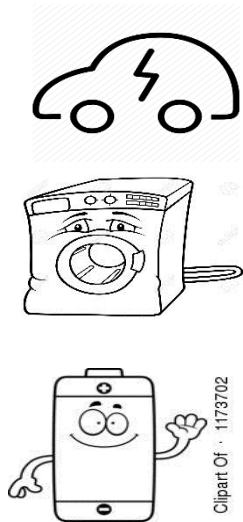
- State of Charge
- Power shifting capability

Generic Flexibility Characteristics

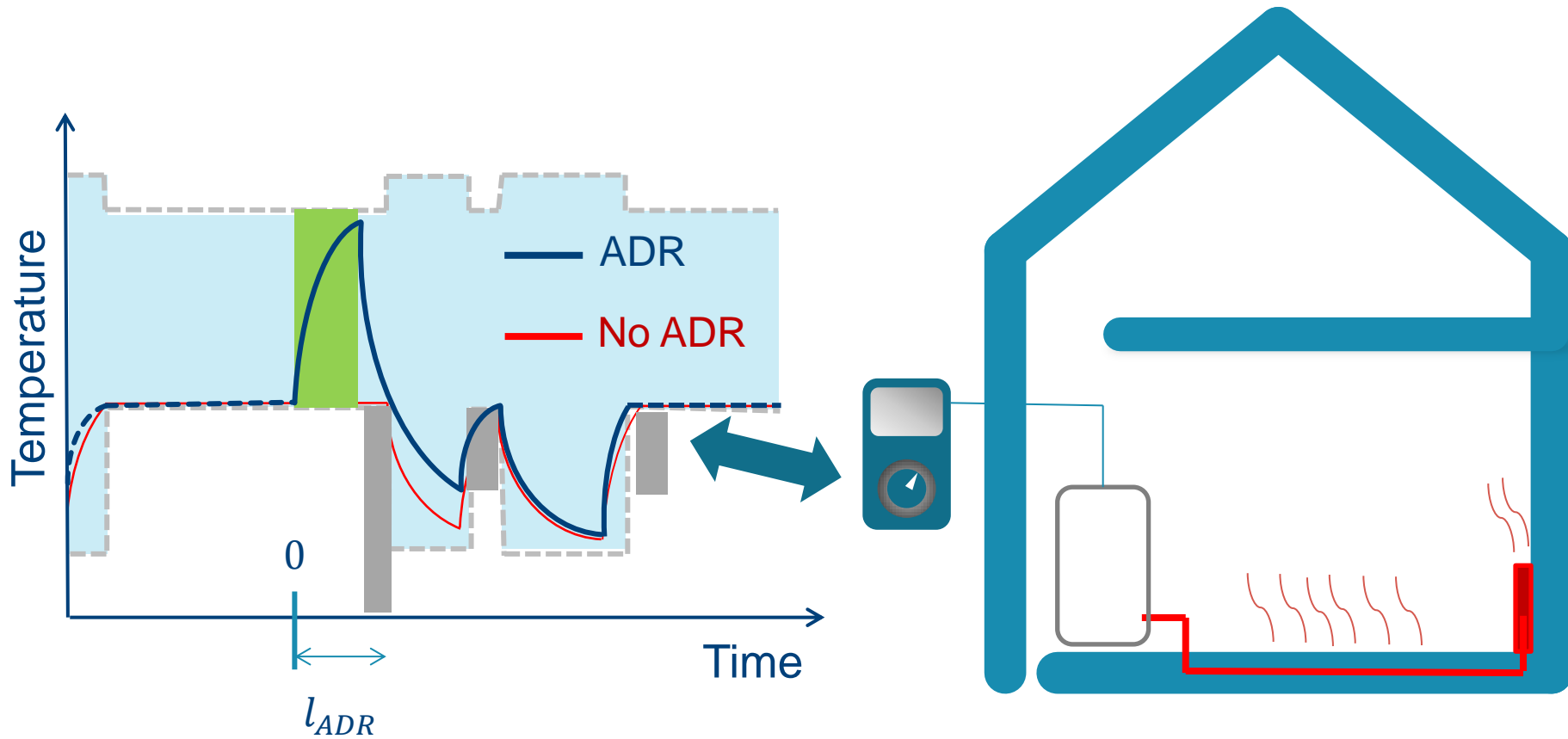
C_{ADR} : Available storage capacity [kWh]

η_{ADR} : Storage efficiency [%]

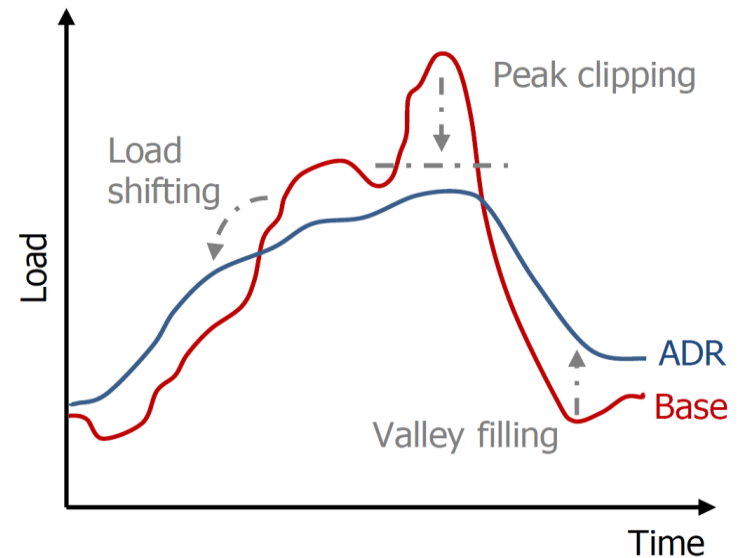
- Interpretation: ADR signature
- Interesting for: planning, design



Activation of structural thermal mass – The concept













“How do building design parameters of new and existing buildings influence the potential for active demand response using structural thermal storage?”

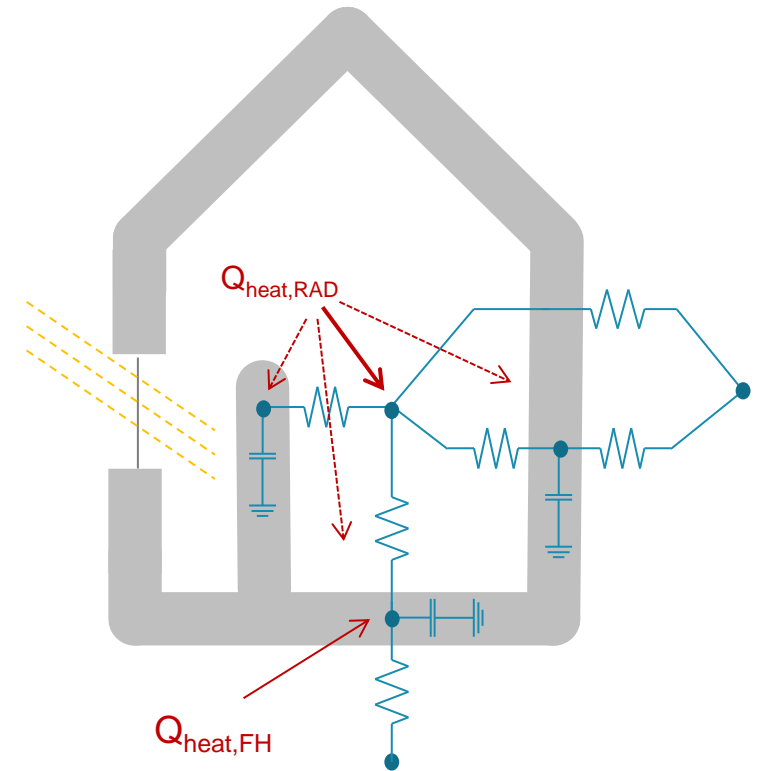


ADR potential of Belgian residential stock

I. REDUCED-ORDER BUILDING STOCK MODEL

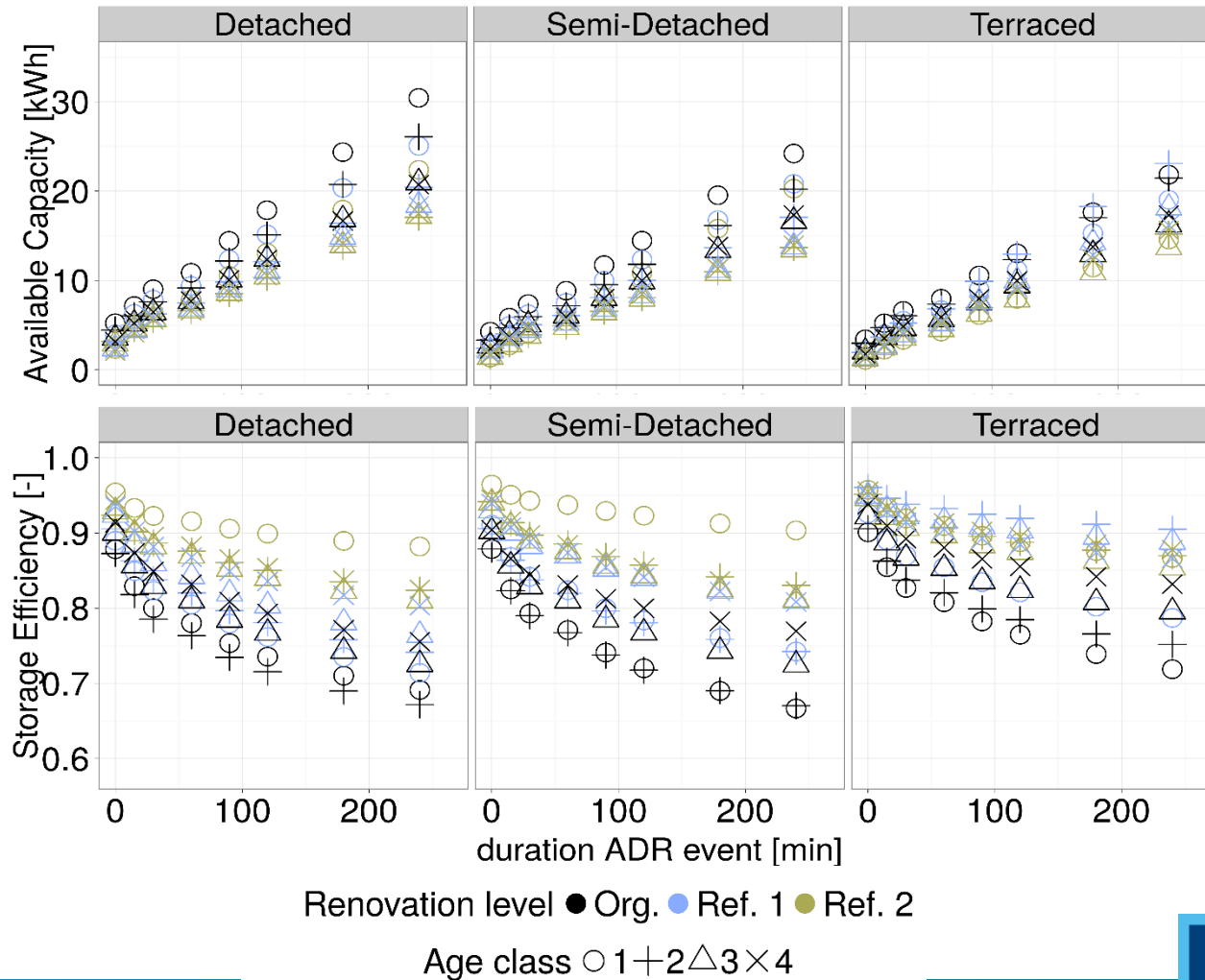
Main matrix of the Belgian housing typology

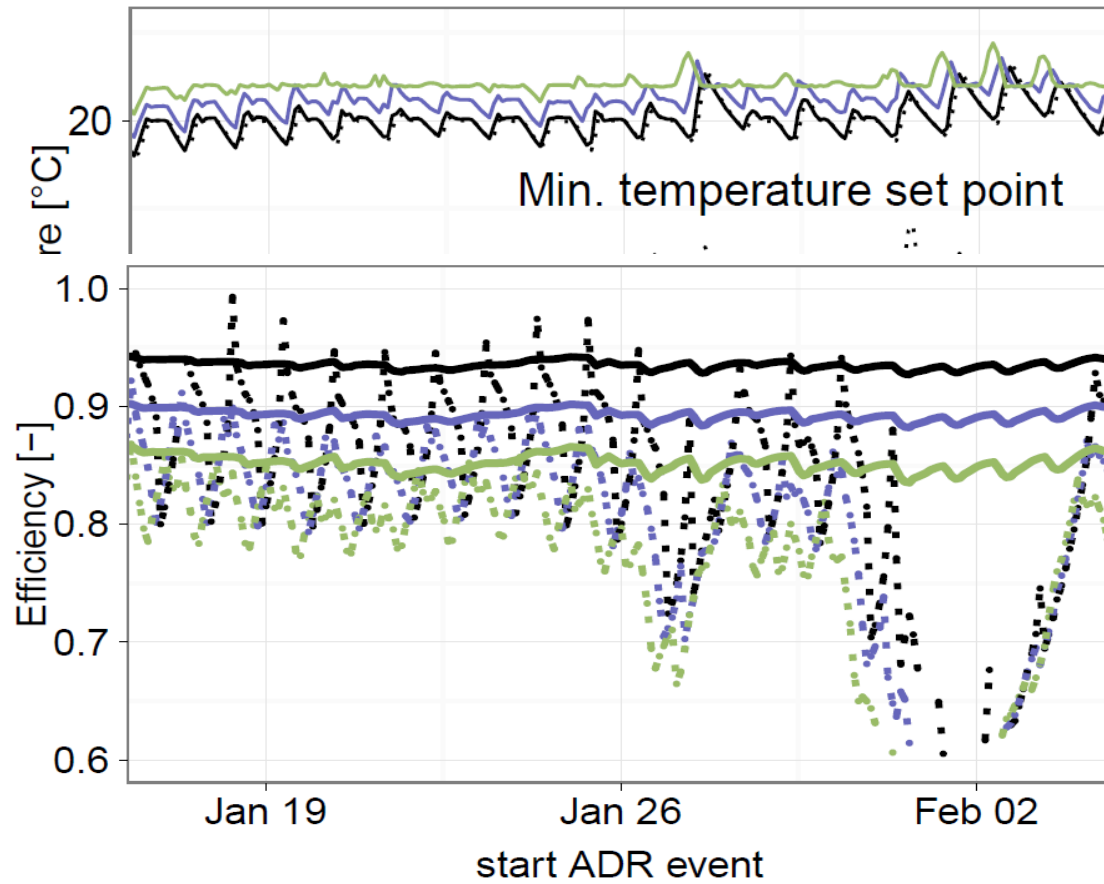
	Region	Construction Year Class	Single Family House - Detached	Single Family House - Semi detached	Single Family House - Terraced
1	national (Belgium)	... 1945	 BE.N.SFH.01.deta	 BE.N.TH.01.semi	 BE.N.TH.01.terr
6	national (Belgium)	1946 - 1970	 BE.N.SFH.02.deta	 BE.N.TH.02.semi	 BE.N.TH.02.terr
12	national (Belgium)	1971 - 1990	 BE.N.SFH.03.deta	 BE.N.TH.03.semi	 BE.N.TH.03.terr
18	national (Belgium)	1991 - 2005	 BE.N.SFH.04.deta	 BE.N.TH.04.semi	 BE.N.TH.04.terr
24	national (Belgium)	2006 ...	 BE.N.SFH.05.deta	 BE.N.TH.05.semi	 BE.N.TH.05.terr



ADR potential of Belgian residential stock

II. ADR CHARACTERISTICS

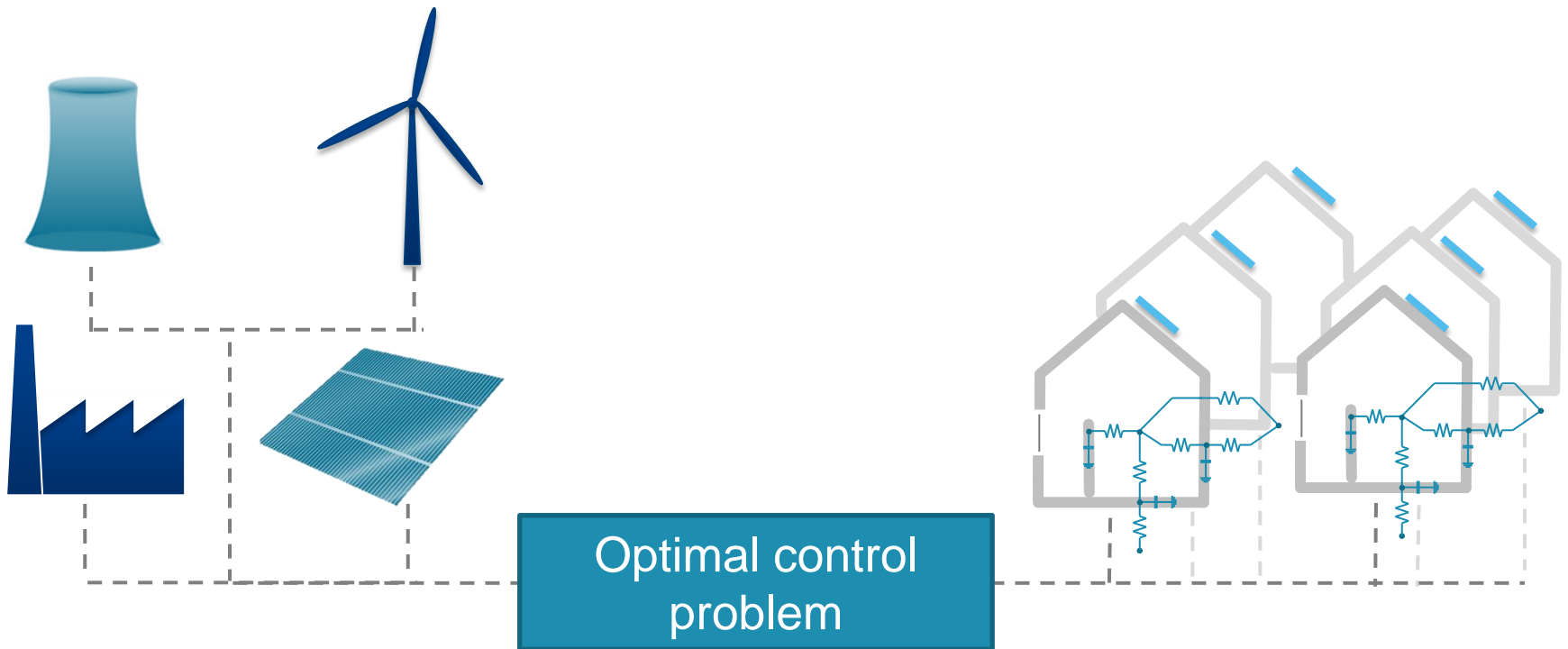




duration ADR-event [min] — 60 — 240 — 480

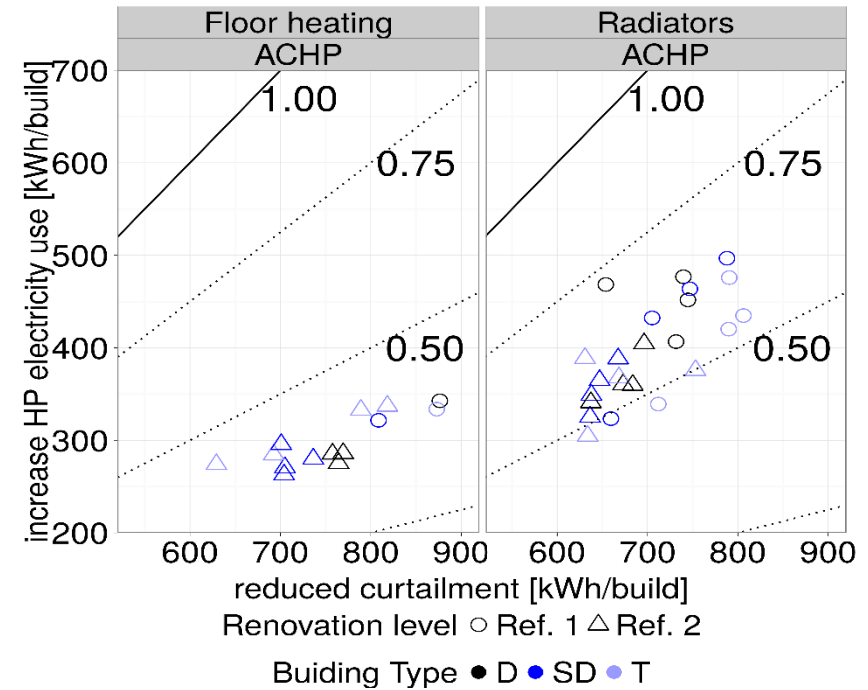
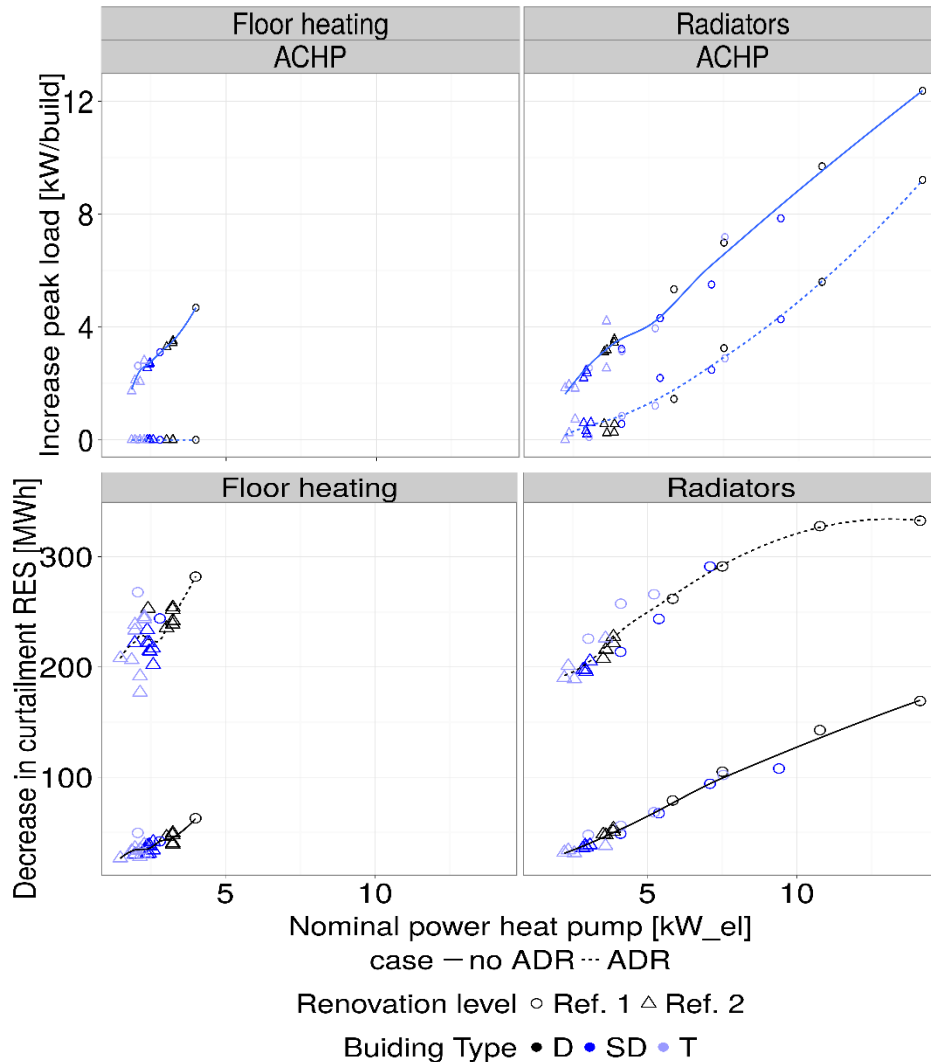
ADR potential of Belgian residential stock

III. INTEGRATED OPERATIONAL MODEL



ADR potential of Belgian residential stock

GRID IMPACT



Main conclusions

- Generic definition & dynamic quantification method
 - general comparison between buildings (and other storage technologies)
- Available capacity & storage efficiency
 - interpretable as building signature
 - mainly influenced by:
 - heat emission system
 - heat loss coefficient
 - heat loss coefficient / thermal mass
- Characteristics are coupled and not constant!
- Case study showed buildings have significant potential as short-term storage
 - 8-16 kWh (thermal) in 2h
 - 73-96 % efficiency



Thank you!

dr. ir. Glenn Reynders
Glenn.Reynders@bwk.kuleuven.be

KU LEUVEN