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Flexibility potentials of prefabricated façade elements with integrated active layer

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Renovation backlog

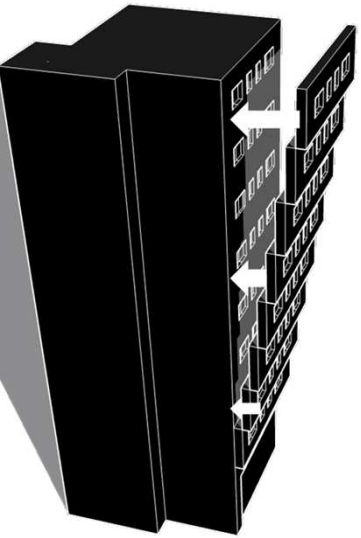
- European Green Deal demands net zero GHG emissions by 2050
- 85-95% of the buildings that exist today will still be standing in 2050

> "The objective is to **at least double** the annual energy renovation rate of residential and non-residential buildings by 2030 and to foster deep energy renovations."

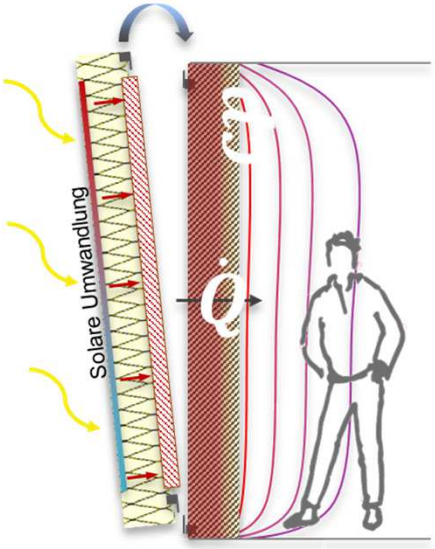
- We are lacking working force, money and time
- Current geopolitical situation could even increase the pressure

Source: European Commission 2020 A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives

Active Façade Concept

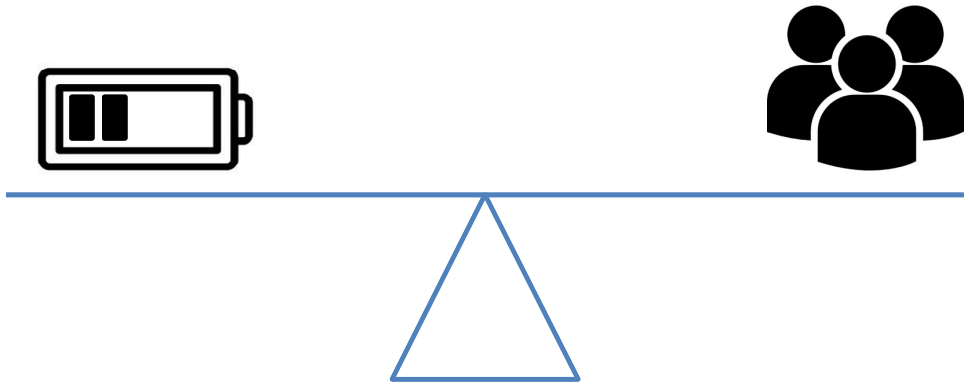


- Prefabricated active façade elements
- Thermal activation layer as part of the façade.
- Innovative coupling of existing walls and prefabricated curtain façade elements (Patent)
- Using the existing building structure for heat/cold storage and as the heating/cooling dissipation system
- Active solar technologies (integrated PV) and heat pump systems for high solar shares



Active flexibility potential

- Energy flexibility in the building context is a trade-off between **storage size** and interference with the **users interests**



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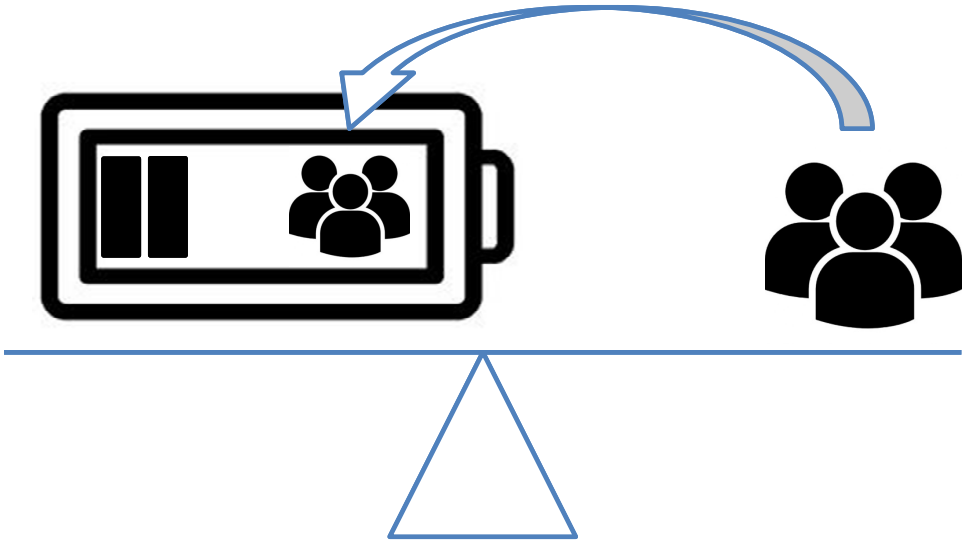
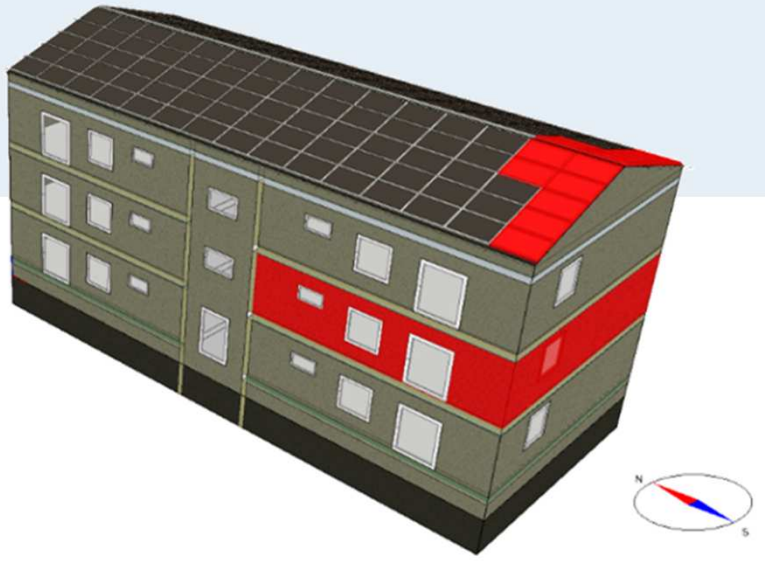
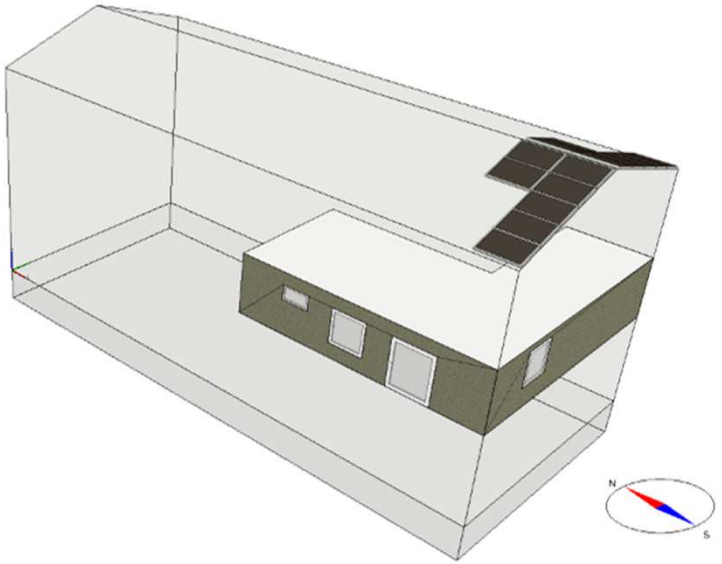


- In our concept the users are living in the storage which brings serious complexity

Demonstration Case



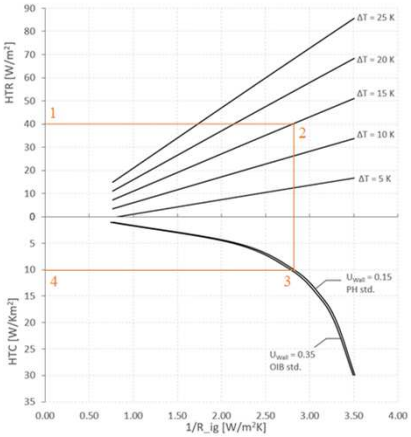
- IDA ICE building energy model
- Typical multi family housing from 60s to 80s
- 70 m² dwelling
- Building hull renovation with façade elements
  - heat load 17,9 W/m²
  - PV share 4,5 kW_{peak}



Wall material	Thickness [m]	Thermal conductivity [W/mK]	Spec. heat capacity [J/kgK]	Density [kg/m³]
Ferroconcrete	0,21	2,30	1000	2300
Vertical coring brick	0,30	0,55	1000	1200
Solid Brick	0,34	0,80	936	1700
Mantle Concrete Block	0,25	0,40	1116	500

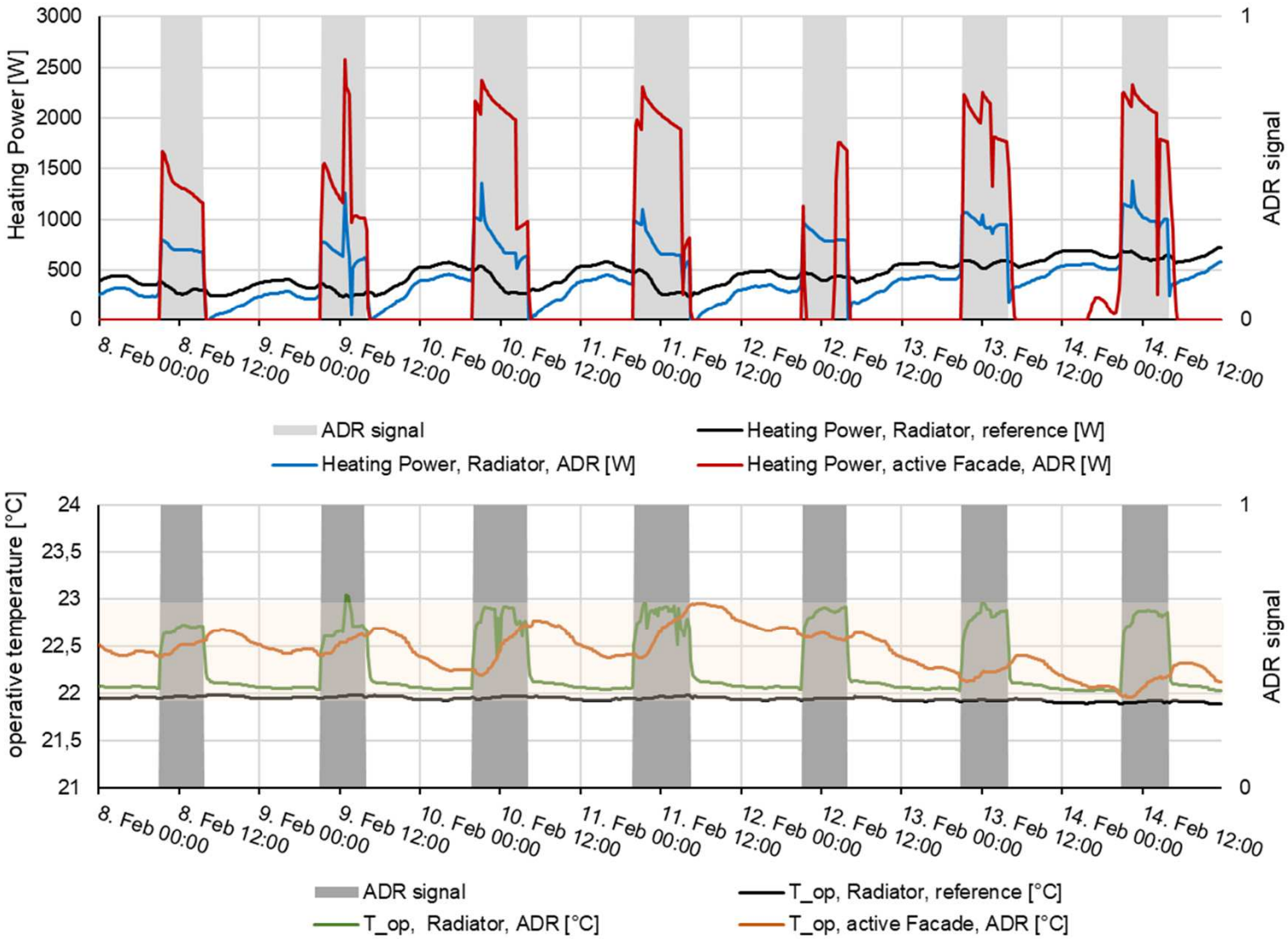
Heating System

- Façade scenario with dimensioning of the heat dissipation system according to our design guidelines [1] and ÖNORM1264
  - Maximum flow temperature of 34 °C
- Reference scenario: Radiator heating
- Active demand response signal
  - Based on PV generation
  - Store local renewable energy into building mass

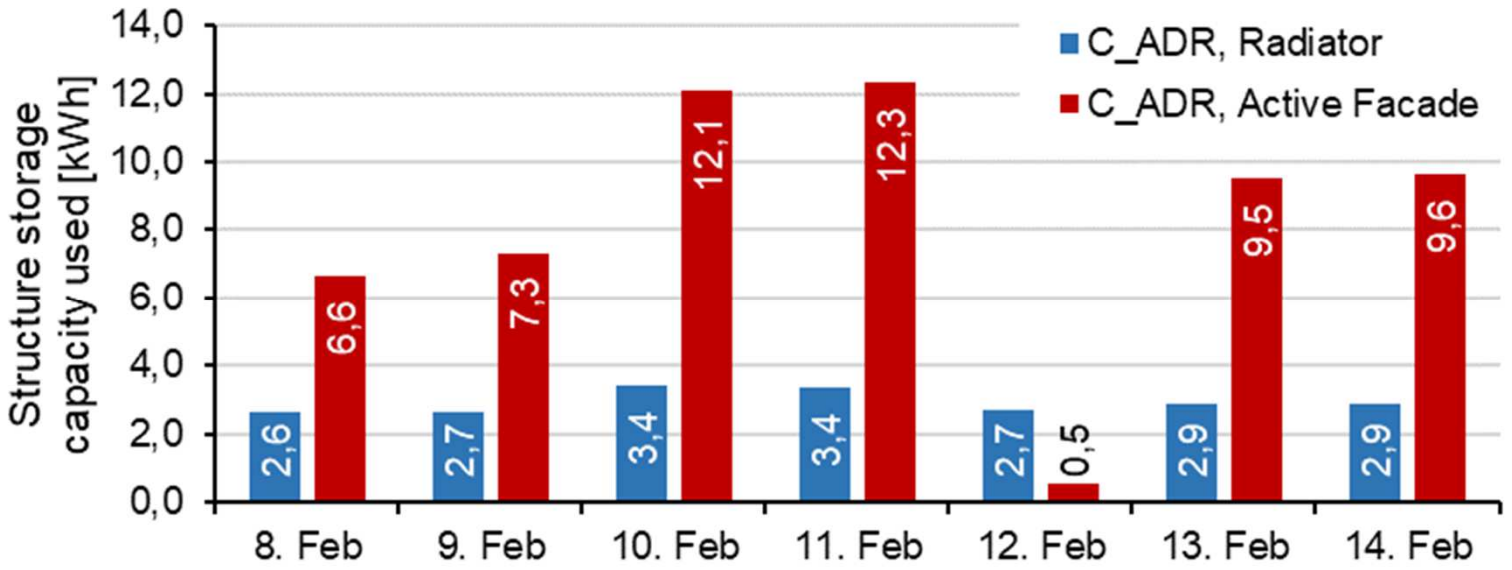


[1] Hengel F., Ramschak T., Gumhalter M., Venus D. (2020) SHOWING NEW CONCEPTS WITH THERMAL ACTIVATED PREFABRICATED FAÇADES FOR RETROFITTING RESIDENTIAL BUILDINGS, BauSim 2020 Graz

Dynamic behaviour



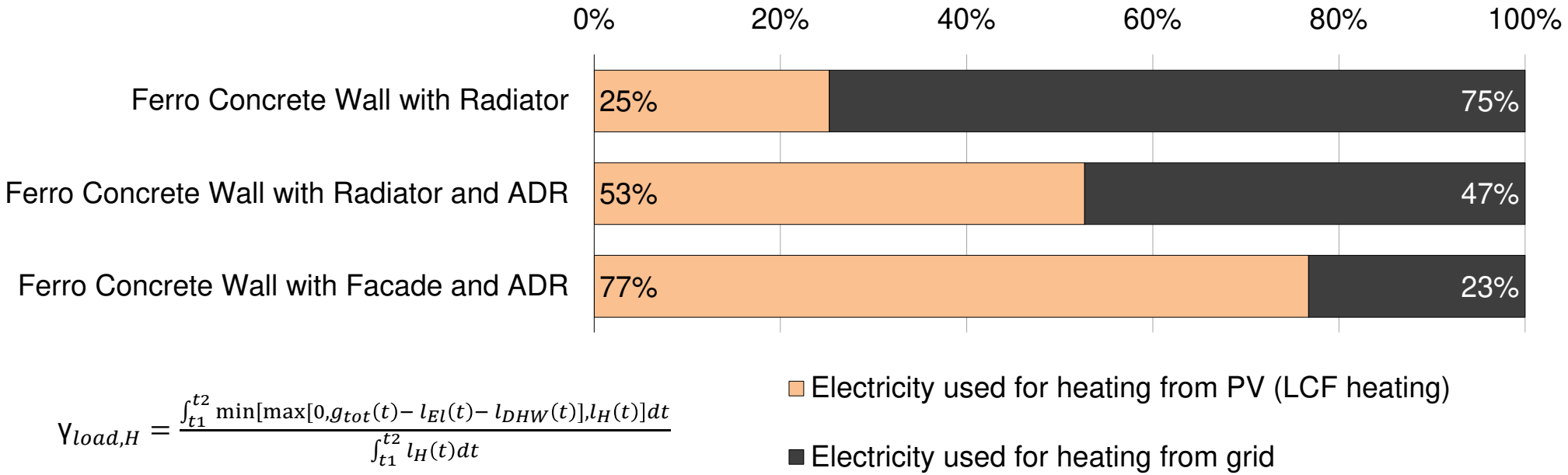
Structure Storage Capacity



$$C_{ADR} = \int_0^{t_{ADR}} (\dot{Q}_{h,ADR} - \dot{Q}_{h,ref}) dt$$

- The **average** daily value of used structural storage capacity within the heating season (Oct. 1st to Apr. 30th) is 5,8 kWh (0,12 kWh/m²$_{Wall}$) for the active façade system.
- In comparison the thermal capacity of the wall is 0,13 kWh/m²K

Load cover factor for space heating



$$\gamma_{load,H} = \frac{\int_{t1}^{t2} \min[\max[0, g_{tot}(t) - l_{El}(t) - l_{DHW}(t)], l_H(t)]dt}{\int_{t1}^{t2} l_H(t)dt}$$

- Not just annual net balance improvement
  -> This is proper renewable load coverage!

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