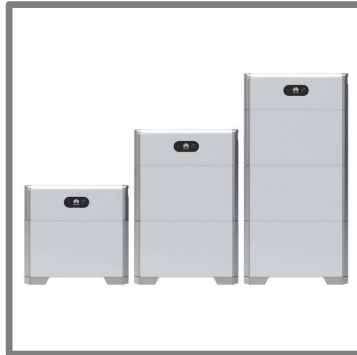
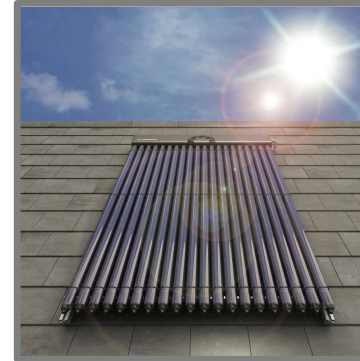


USE OF ENERGY STORAGE TO INCREASE THE AUTONOMY IN LOW ENERGY BUILDINGS WITH PV

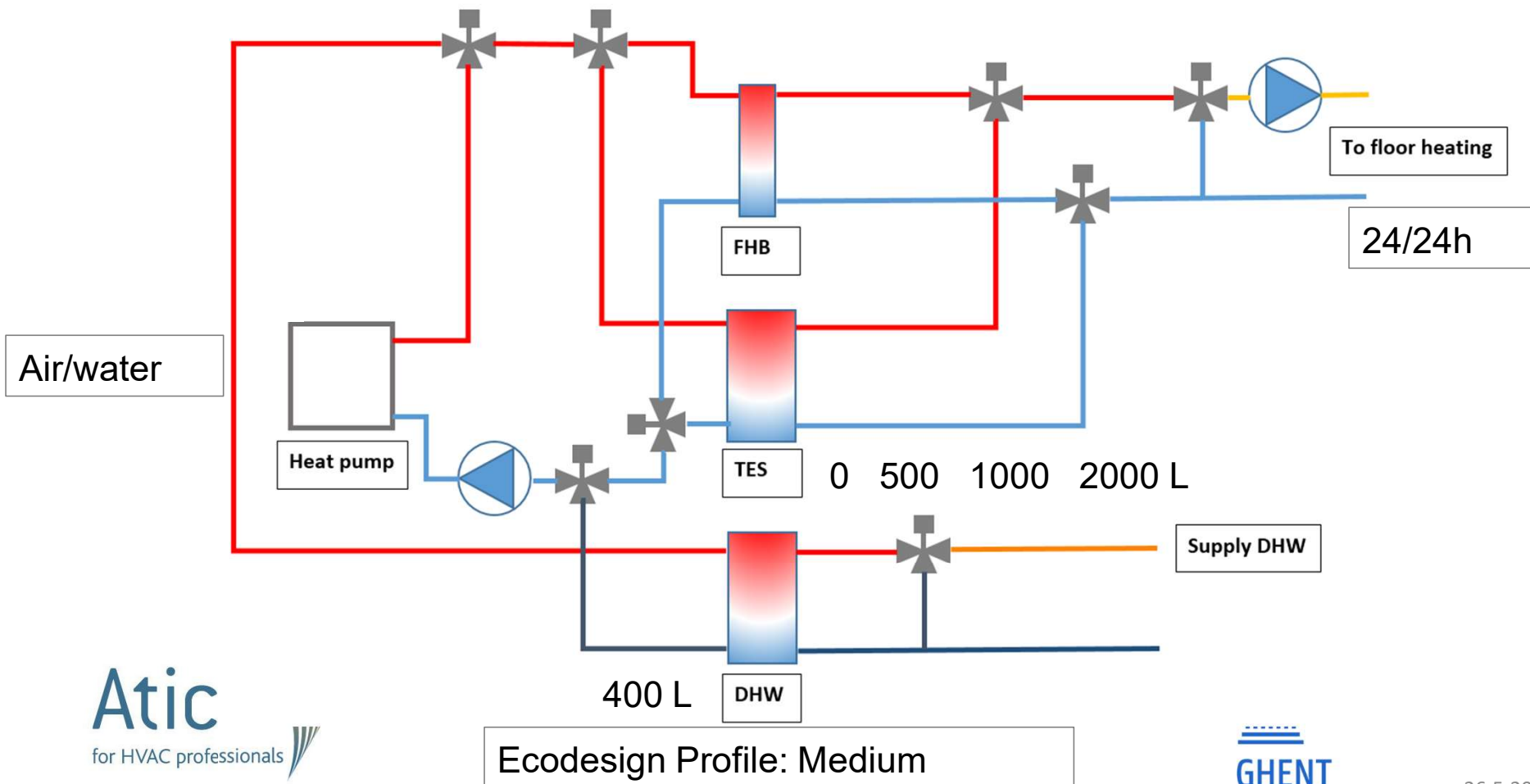
UGENT 27 mei 2025

prof. Michel De Paepe
ir. Hugo Monteyne

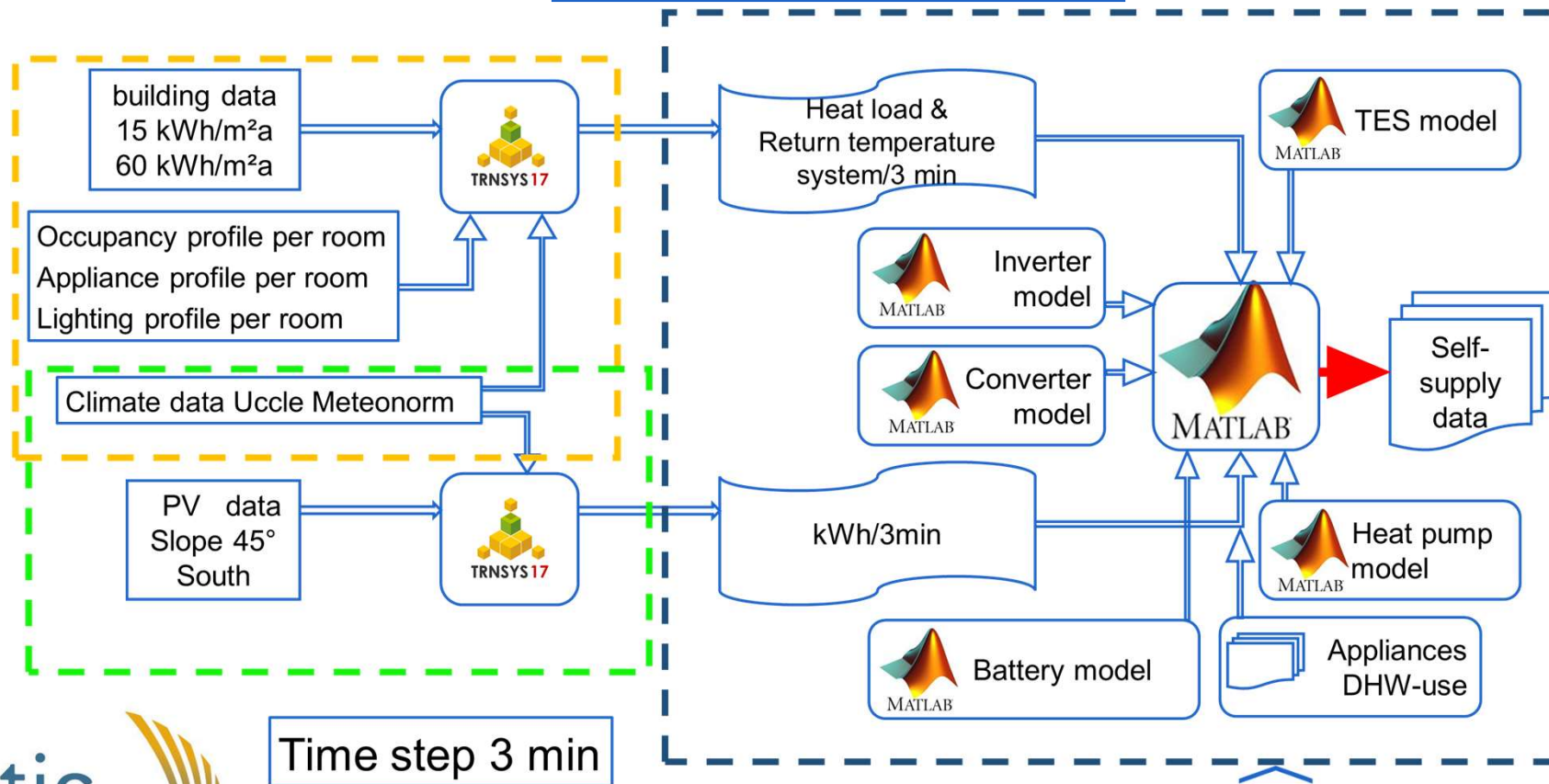
RESEARCH UGENT



METHODOLOGY - HYDRAULIC SCHEME



METHODOLOGY



OUTPUT: SOLAR FRACTION FOR HEATING AND APPLIANCES

Solar Fraction

$$= 100 \times \frac{\text{renewable energy used in the building}}{\text{electrical energy demand heat pump without storage} + \text{energy appliances}}$$

$$= 100 \times \left(1 - \frac{\text{energy from the grid}}{\text{total energy demand}} \right)$$

BUILDING TYPOLOGY

- Detached house

130 m² net heated surface

Under floor heating

Heat pump: air - water

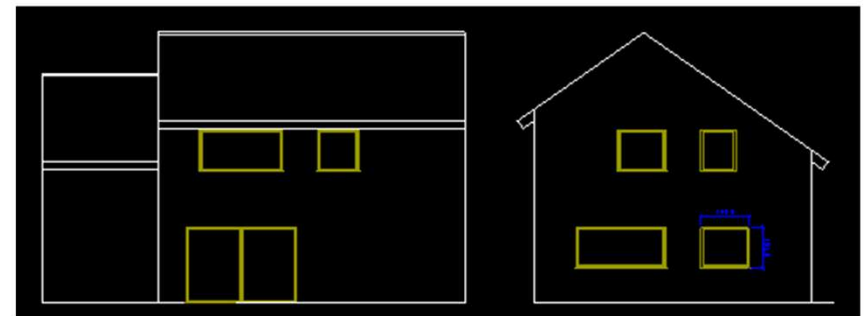
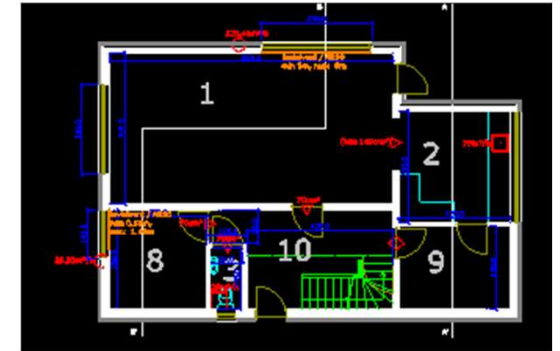
- Energy Performance Building:

- 15 kWh/m²a

- 30 kWh/m²a

- 60 kWh/m²a

- 100 kWh/m²a

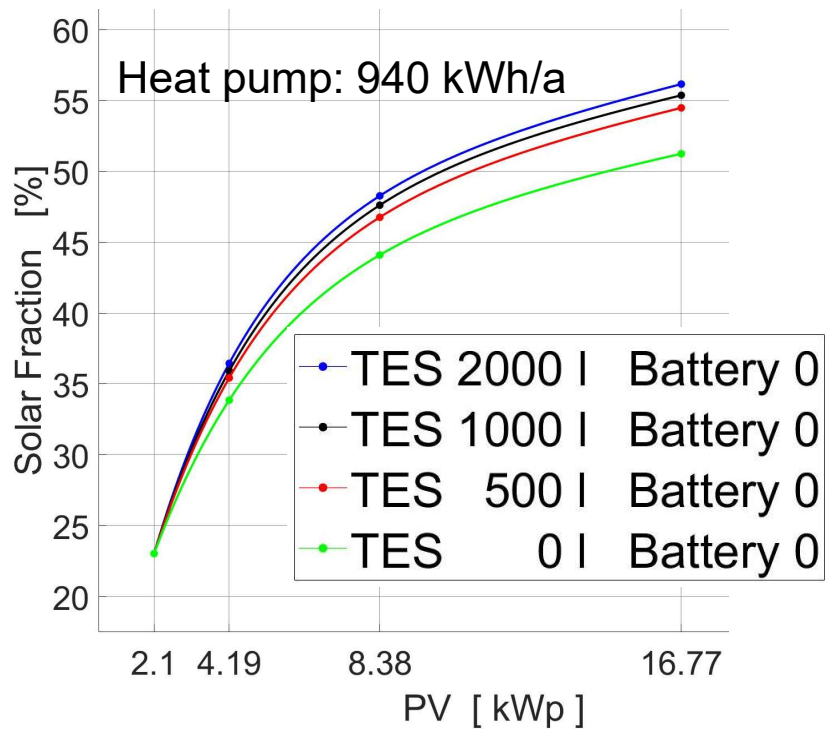


APPLIANCES

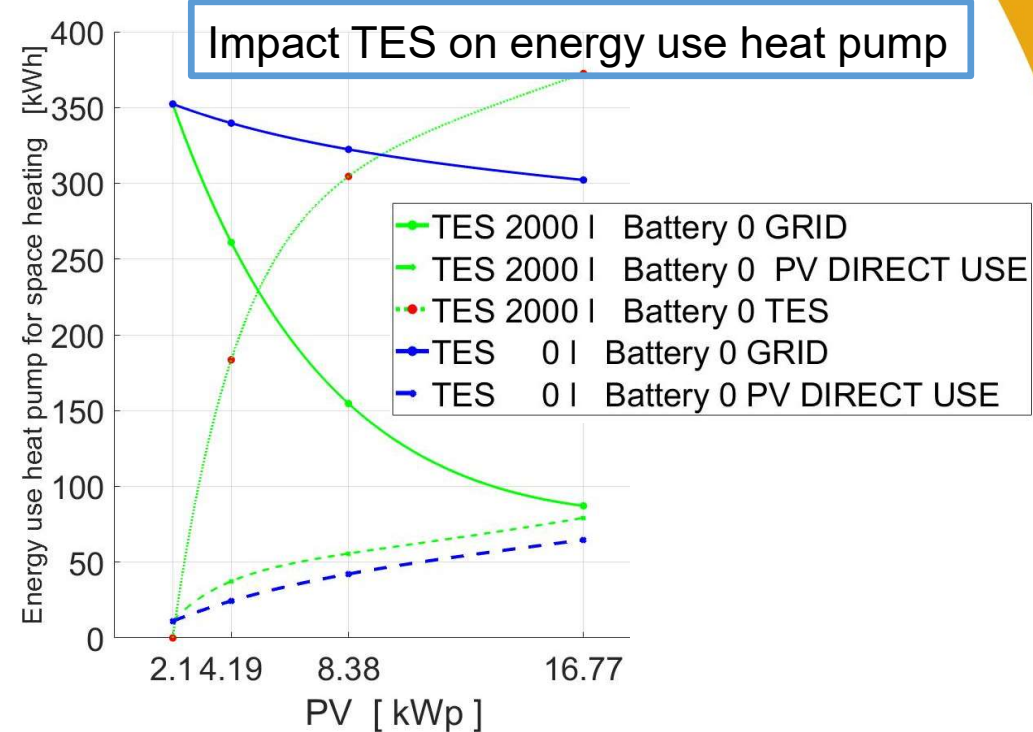
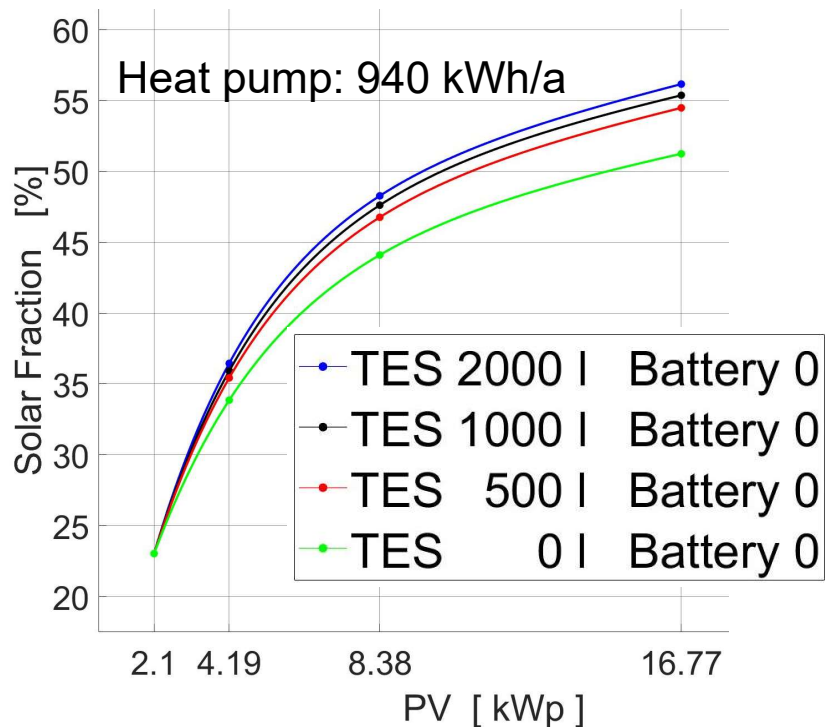
Users: 2 adults, 2 children

- 19 different appliances (data Prof. Reinhardt time step 1 sec)
 - Electric cooking, mechanical ventilation, laundry drier, washing machine, fridge, freezer, dishwasher, microwave, TV, vacuum cleaner, iron, laptop, multimedia, light, water kettle, printer, coffee machine, small units
- Total electricity use:
 - Case 1: 5000 kWh/year (this presentation)
 - Case 2: 3750 kWh/year
 - Case 3: 2500 kWh/year

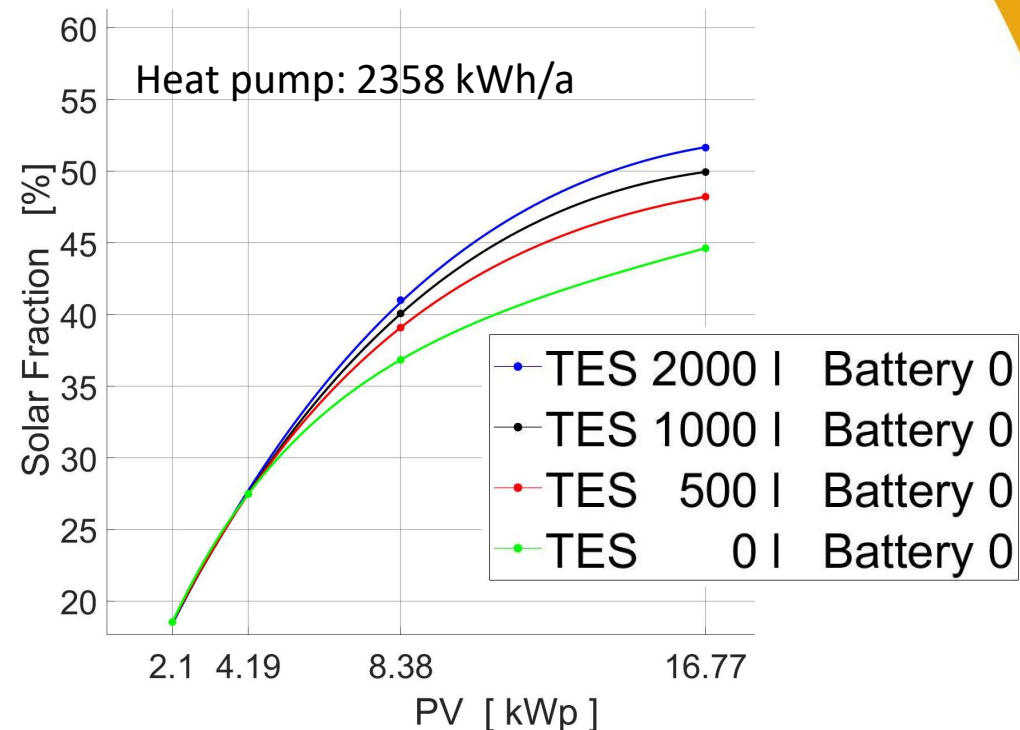
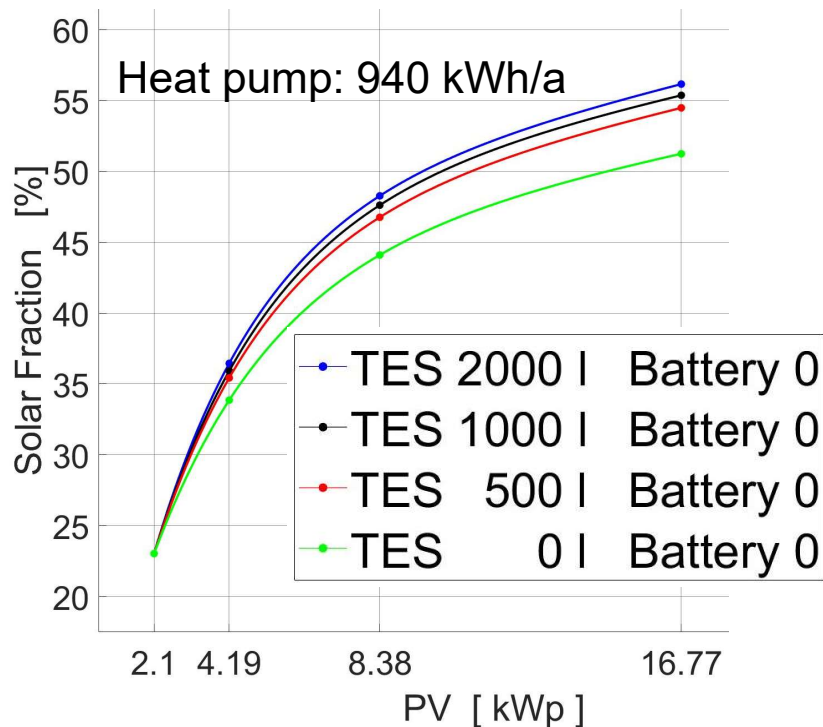
THERMAL STORAGE



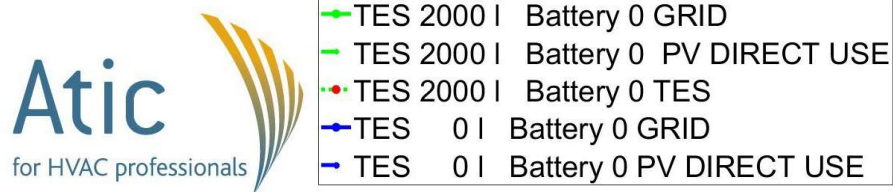
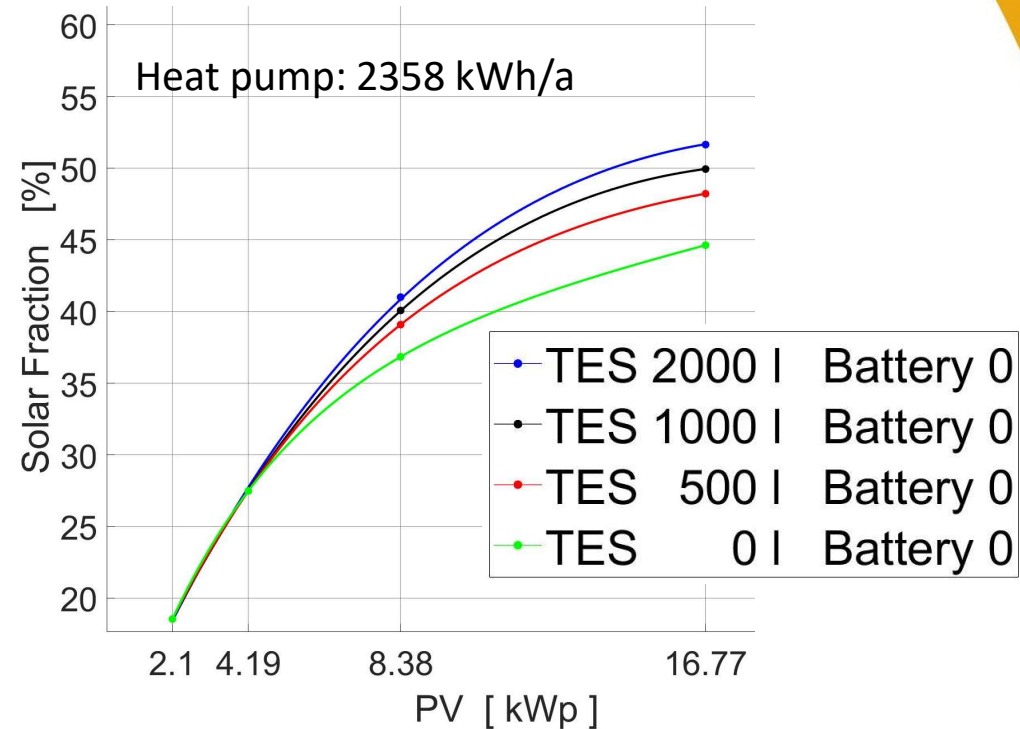
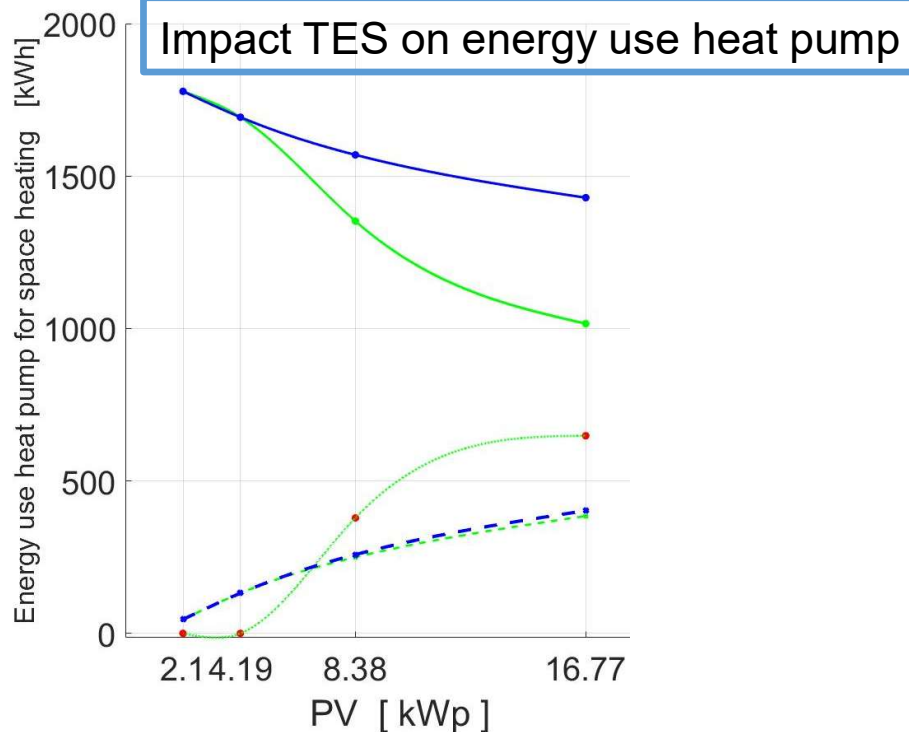
THERMAL STORAGE



THERMAL STORAGE



THERMAL STORAGE

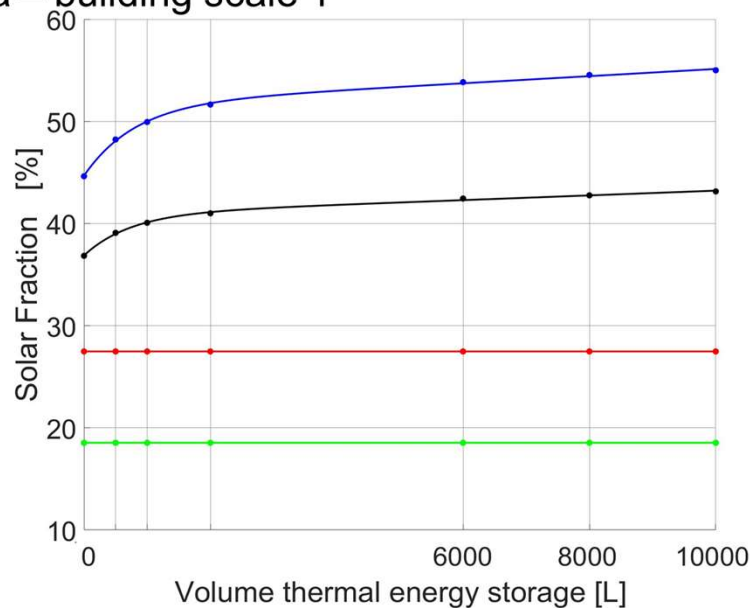
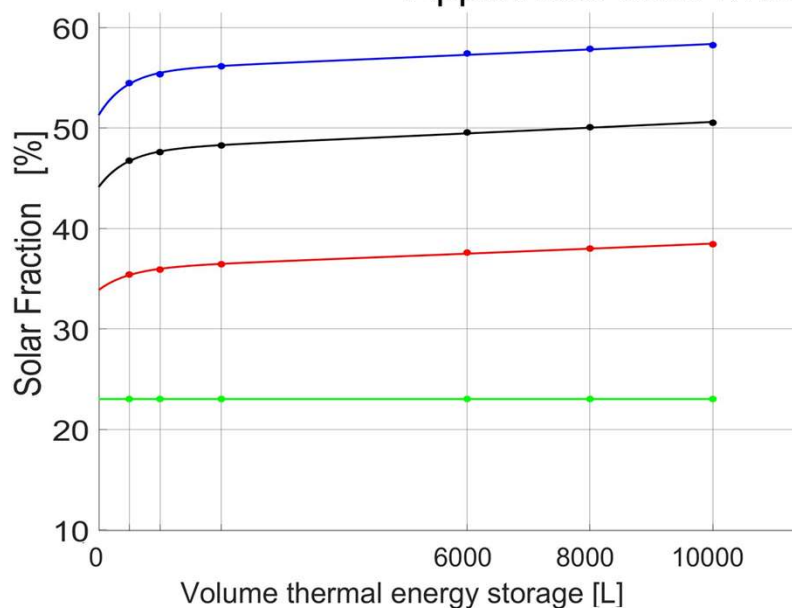


60 kWh/m²a

Appliances 5000 kWh/a – building scale 1

THERMAL STORAGE - LARGE VOLUMES

Appliances 5000 kWh/a – building scale 1

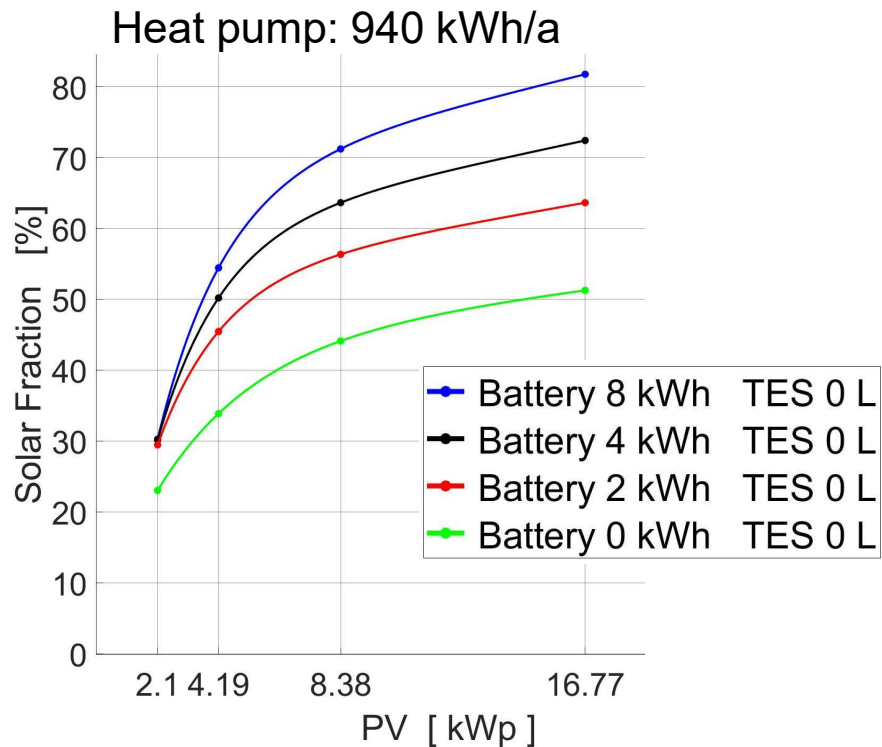


- 16.8 kWp Battery 0
- 8.4 kWp Battery 0
- 4.2 kWp Battery 0
- 2.1 kWp Battery 0

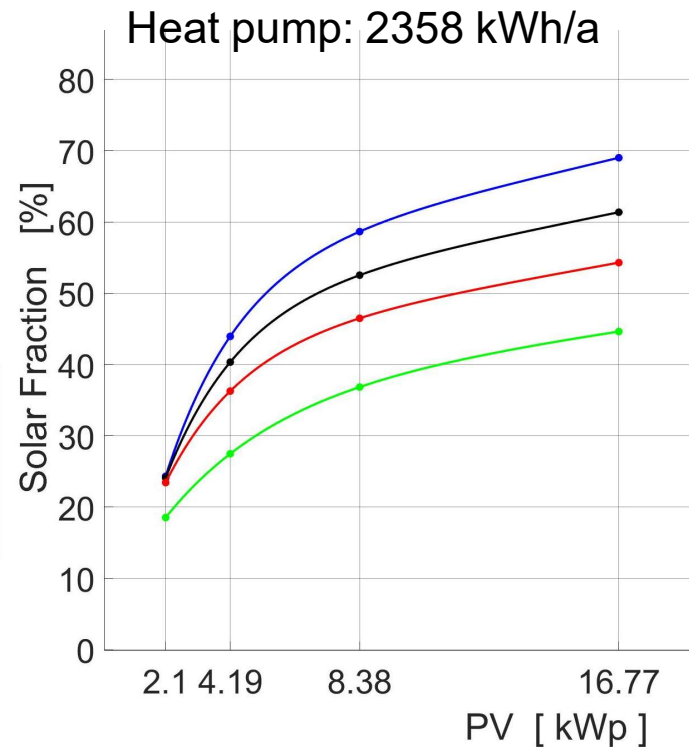
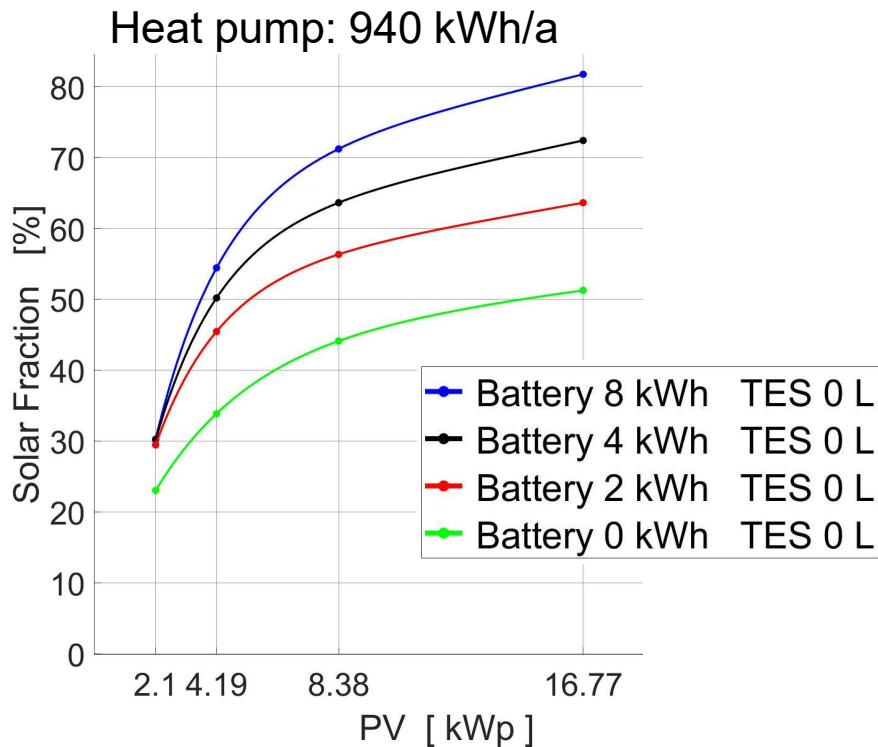
15 kWh/m²a

60 kWh/m²a

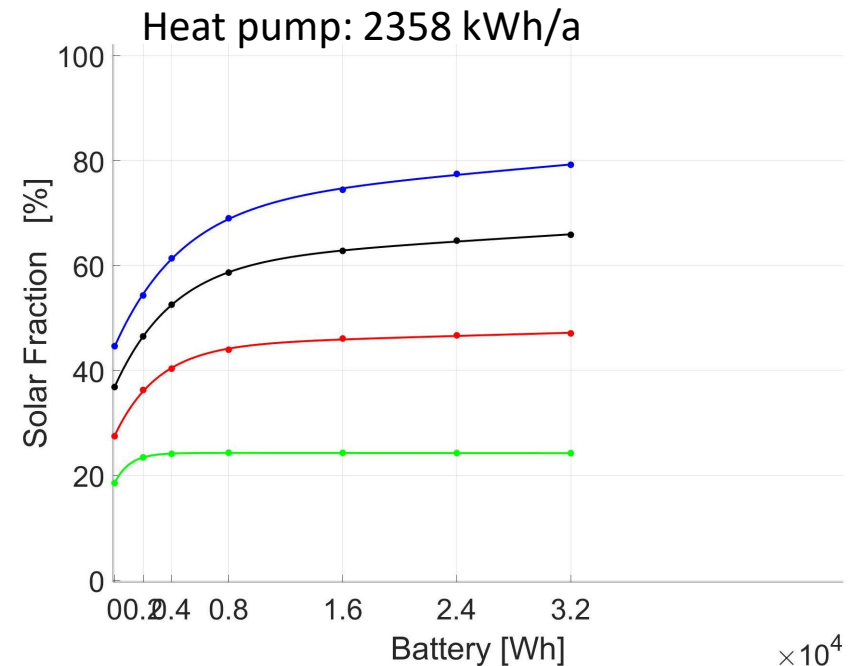
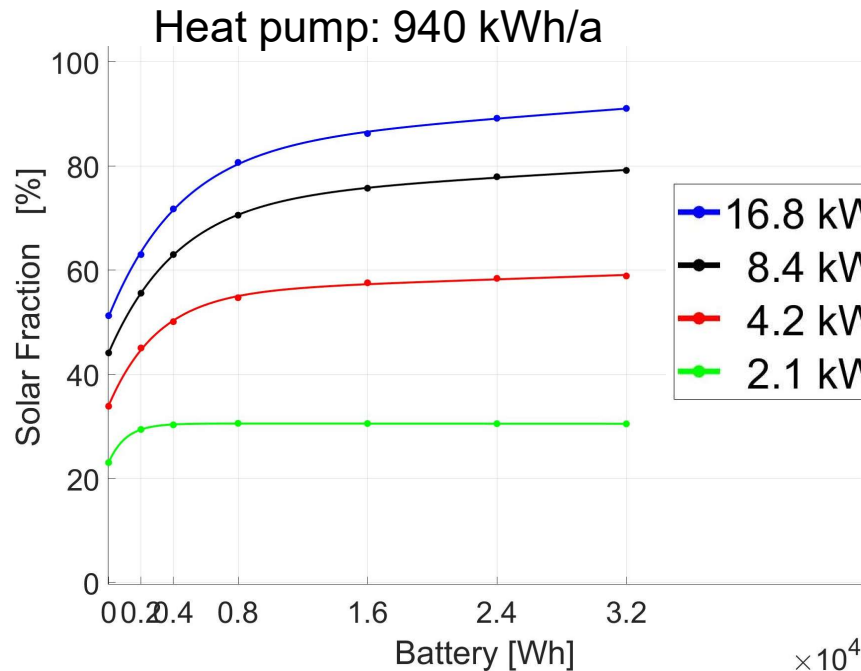
ELECTRICAL STORAGE



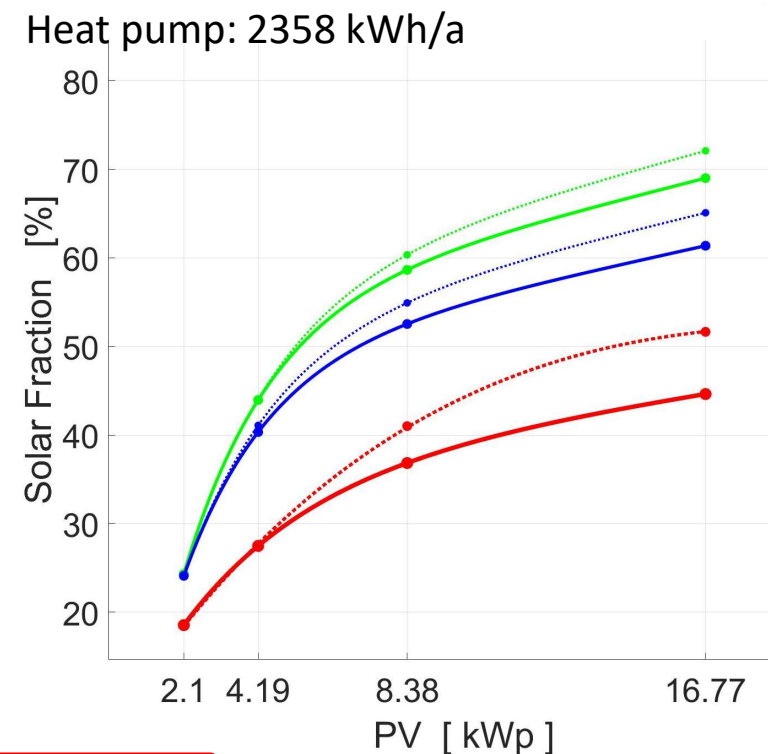
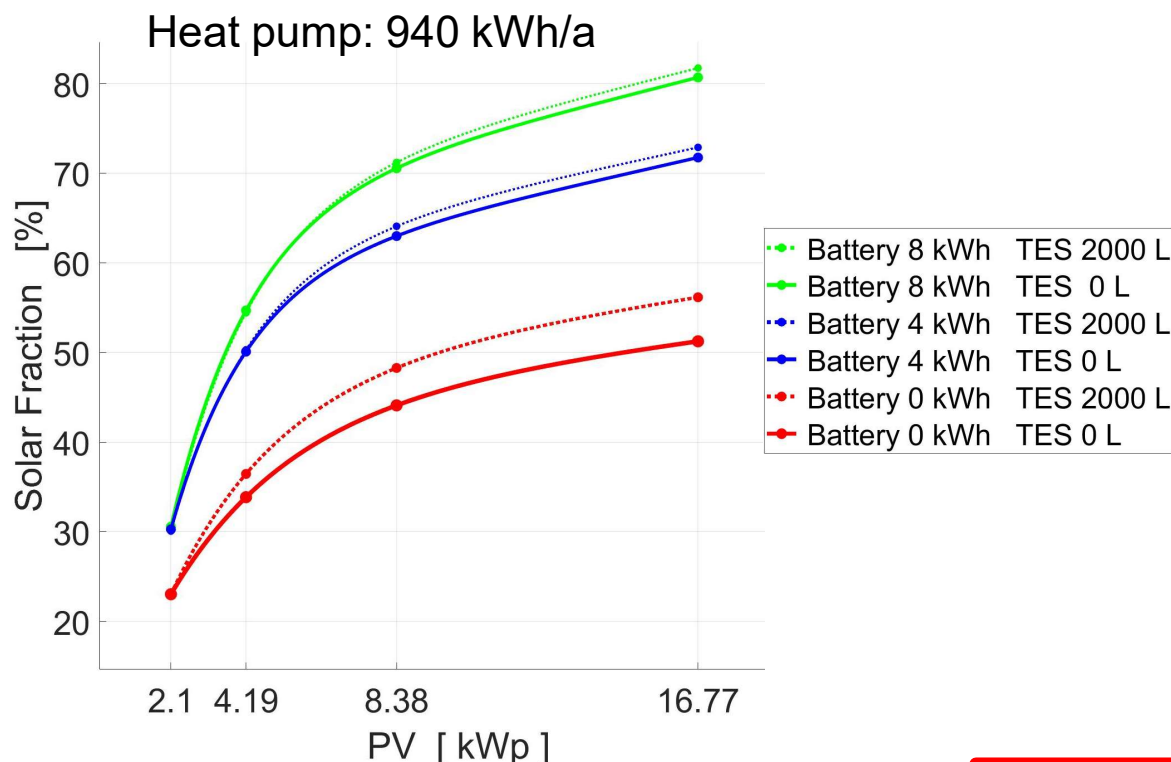
ELECTRICAL STORAGE



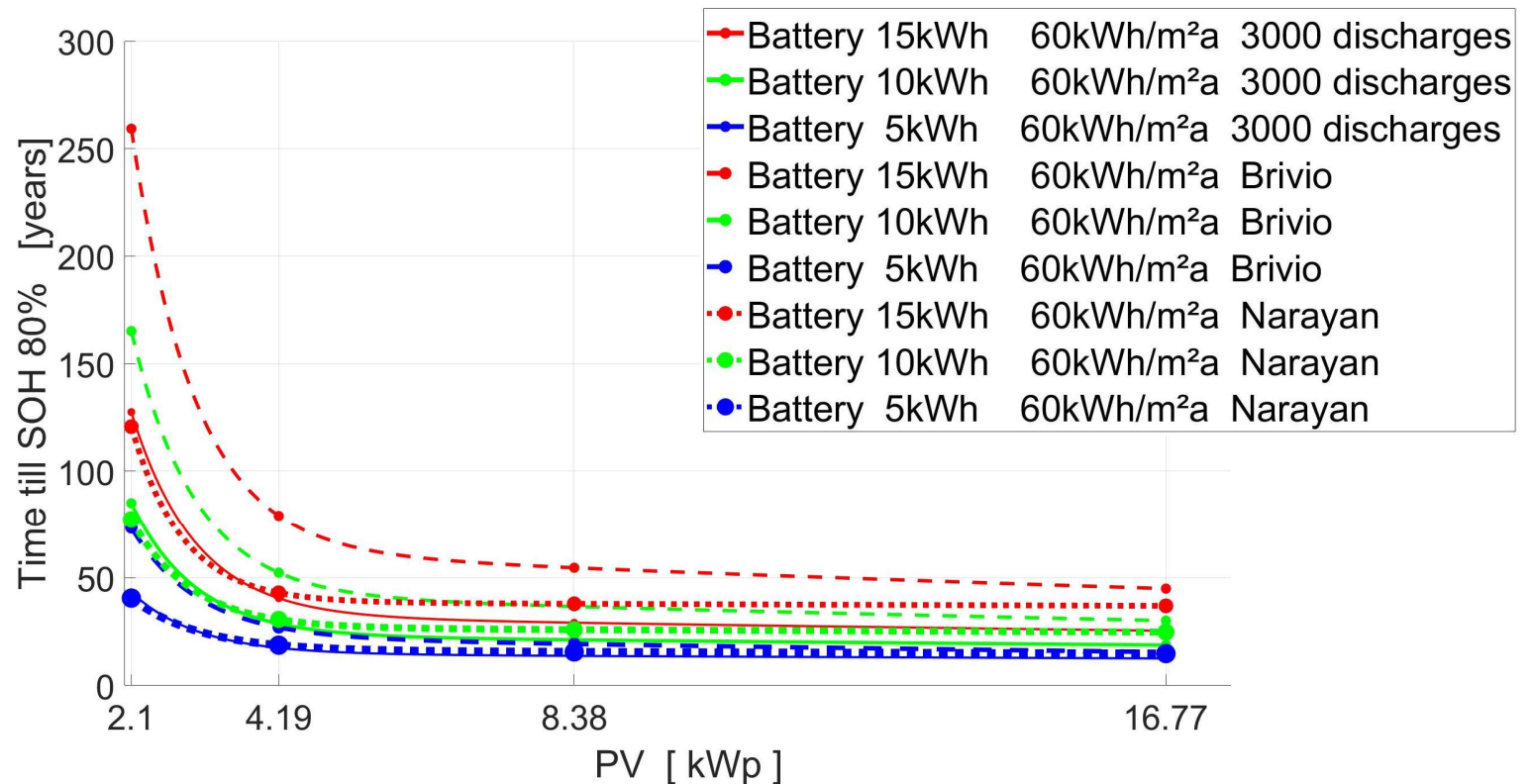
ELECTRICAL STORAGE - LARGE BATTERIES



THERMAL AND ELECTRICAL STORAGE

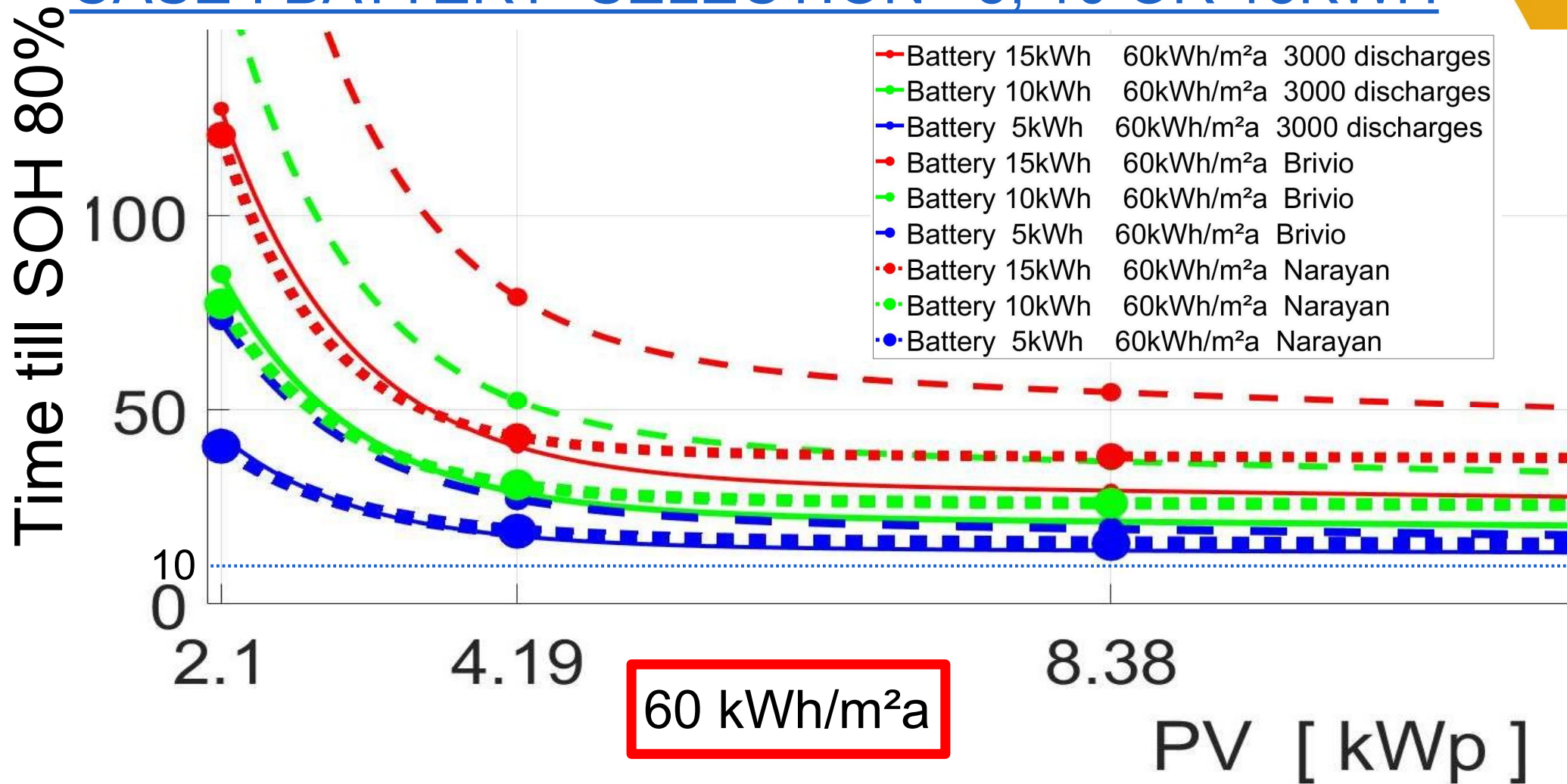


CASE : BATTERY SELECTION 5, 10 OR 15KWH



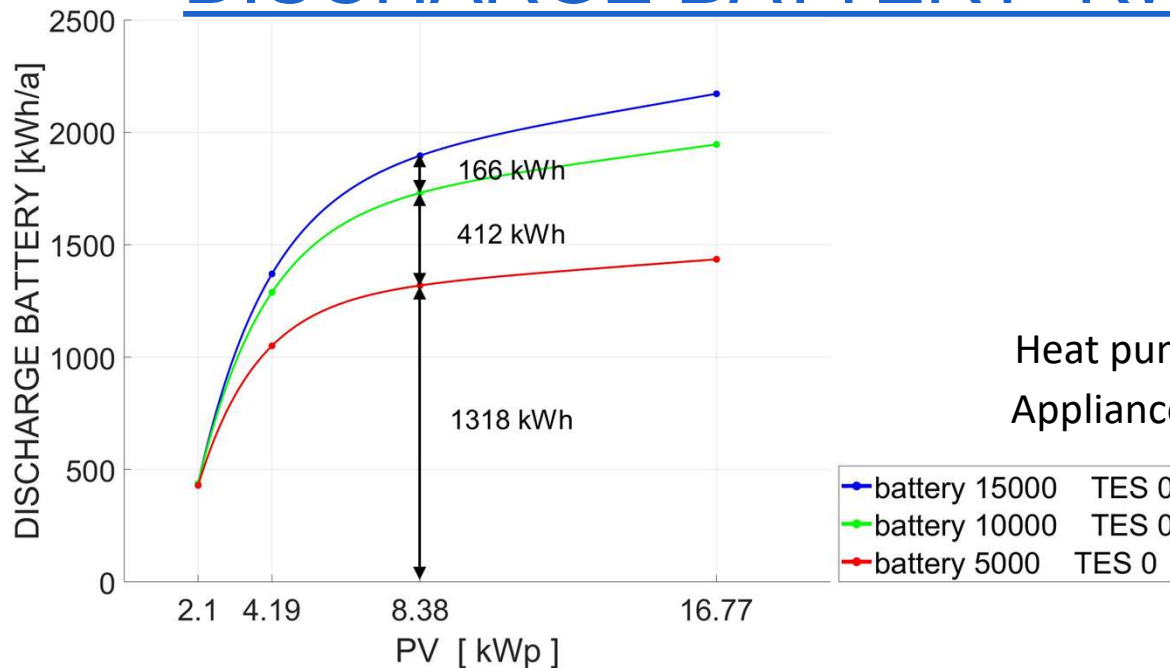
60 kWh/m²a

CASE : BATTERY SELECTION 5, 10 OR 15KWH



CASE : BATTERY SELECTION 5, 10 OR 15KWH

DISCHARGE BATTERY KWH/YEAR



Heat pump: 2358 kWh/a

Appliances 5000 kWh/a – building scale 1

60 kWh/m²a

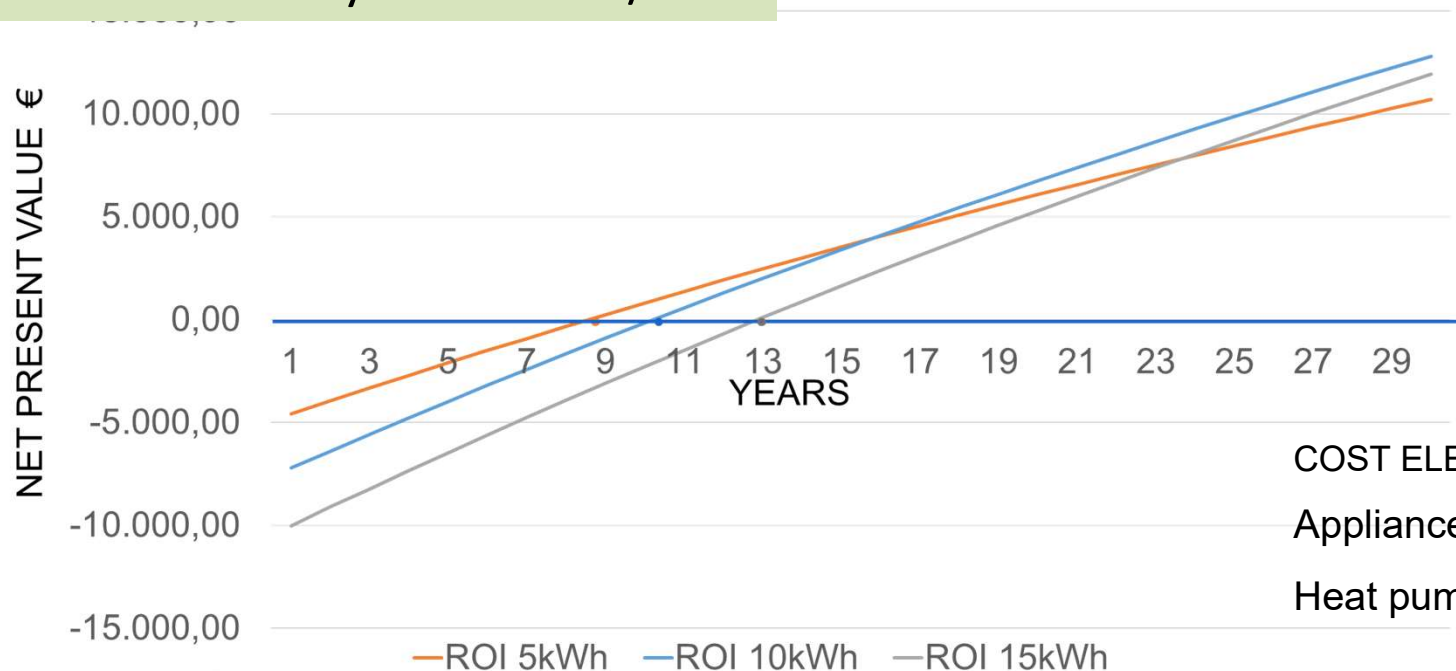
CASE : BATTERY SELECTION 5, 10 OR 15KWH

– Input ROI calculation:

- Output battery 5kWh: 1318 kWh/a cost 5199 € incl.6% VAT
- Output battery 10kWh: 1730 kWh/a cost 8050 € incl.6% VAT
- Output battery 15kWh: 1896 kWh/a cost 10927 € incl.6%VAT
- Electricity 0.5 €/kWh
- Discount rate 3.36%
- Yearly price increase electricity 2%
- Cost based on market prices April 2023

CASE : BATTERY SELECTION 5, 10 OR 15KWH

COST ELECTRICITY year 1: 0.5 €/kWh



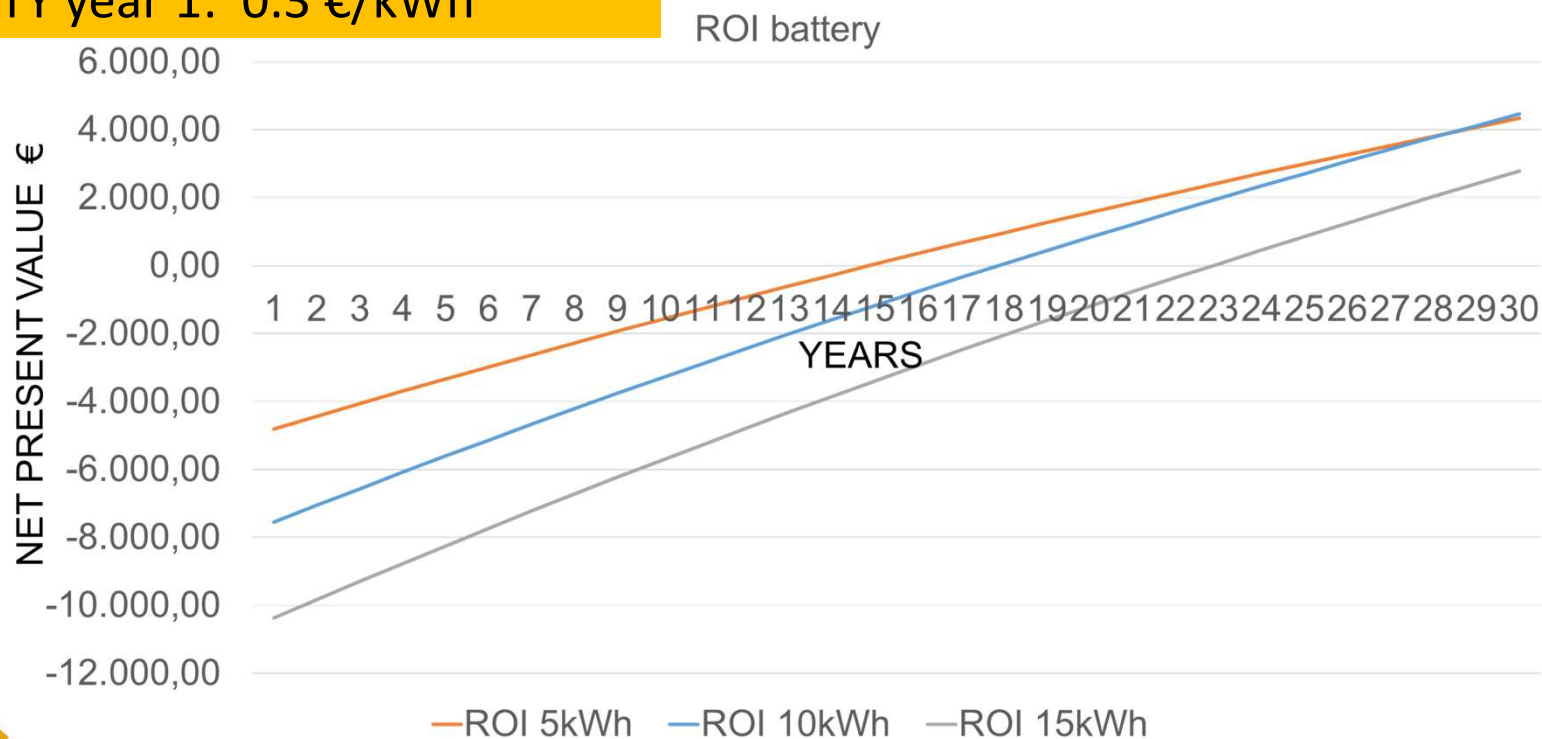
COST ELECTRICITY year 1: 0.5 €/kWh

Appliances 5000 kWh/a

Heat pump: 2358 kWh/a

CASE : BATTERY SELECTION 5, 10 OR 15KWH

COST ELECTRICITY year 1: 0.3 €/kWh



CONCLUSION

- Thermal energy storage increases the solar fraction up to 7%
- The thermal storage system will not have a return on investment
- Electrical storage 8000Wh + 8.4kWp adds 27% to the solar fraction in a 15kWh/m²a building
- Electrical storage 8000Wh + 8.4kWp adds 22% to the solar fraction in a 60kWh/m²a building
- Rule of thumb: battery capacity kWh = PV capacity kWp x 1 à 1.5
- Life cycle of residential battery systems is expected to be larger than 20 years
- The ROI of a battery is rather between 10 and 15 years.



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