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FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT FLOW, HEAT & COMBUSTION MECHANICS
RESEARCH GROUP < ... >

DESIGN RULES AND PRE-STANDARD CALCULATIONS FOR ENERGY STORAGE TECHNOLOGIES IN BUILDINGS

Brussels 27 September 2017

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Atic for HVAC professionals

Burnay Price 2016

RENEWABLE ENERGY

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SOLAR FRACTION FOR HEATING AND APPLIANCES

$$Solar\ Fraction = 100\ x \left(1 - \frac{energy\ from\ the\ grid}{electrical\ energy\ demand\ heat\ pump\ without\ storage + \ energy\ appliances}\right)$$

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PARAMETERS

- Surface PV [m²]
- Volume thermal energy storage [l]
- Capacity electrical storage [Wh]
- Energy use appliances [kWh/a]
- Energy performance building [kWh/m²a]
- Building size [%]
- Energy efficiency inverter PV [%]
- Energy efficiency PV panels [%]

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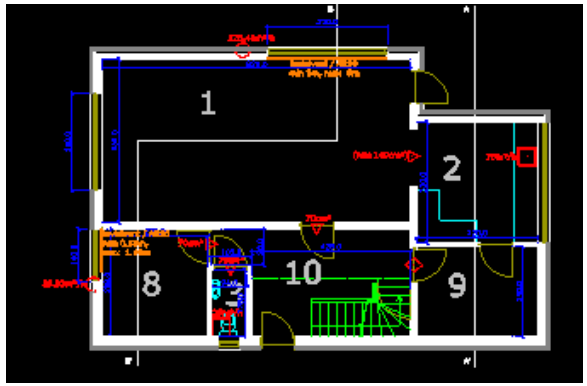
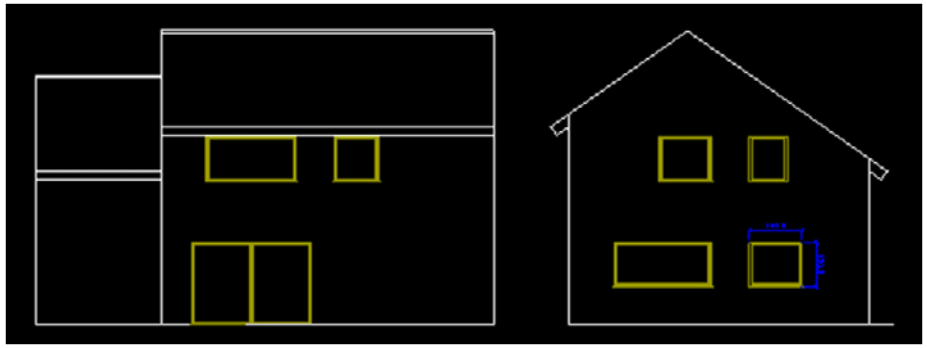
BUILDING TYPOLOGY

- Detached house

  147 m² heated surface
  Uccle
  Under floor heating
  Heat pump



- Building size: 50% 100% 150% 200%
- Energy Performance Building:
  - ➢15 kWh/m²a
  - ➢30 kWh/m²a
  - ➢60 kWh/m²a



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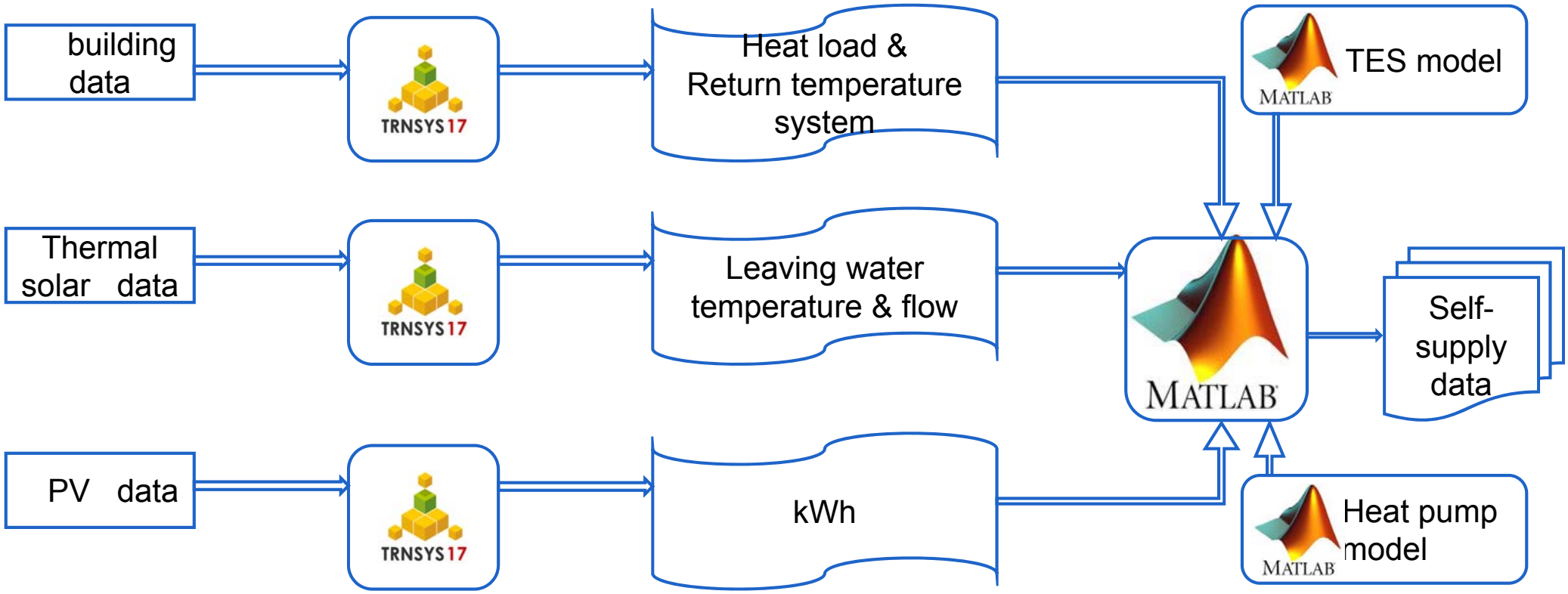
METHODOLOGY



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METHODOLOGY - CONTROL SYSTEM

- DHW profile : guidelines Ecodesign
- Appliances profile: data Linear project
- Battery efficiency: 90%
- Priority DHW
- Direct heating has priority to thermal energy storage
- Battery is only used for appliances and direct heating
- Use of battery has priority to use of thermal energy storage as long as battery charge > 50%
- Maximum temperature thermal energy storage: 50°C
- No thermal energy storage during summer
- Time step simulations: 0,05 h

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APPLIANCES

Field test: Linear project (2009-2014)

- Family : 2 adults, 2 children
- Detached building
- Gas heating for building and DHW
- Electric cooking
- Measurement : time step 15min, during 2 years
- Total electricity use:
    - Case 1: 5011 kWh/year
    - Case 2: 2505 kWh/year (data ‘case 1’ /2)
    - Case 3: 1253 kWh/year (data ‘case 1’ /4)

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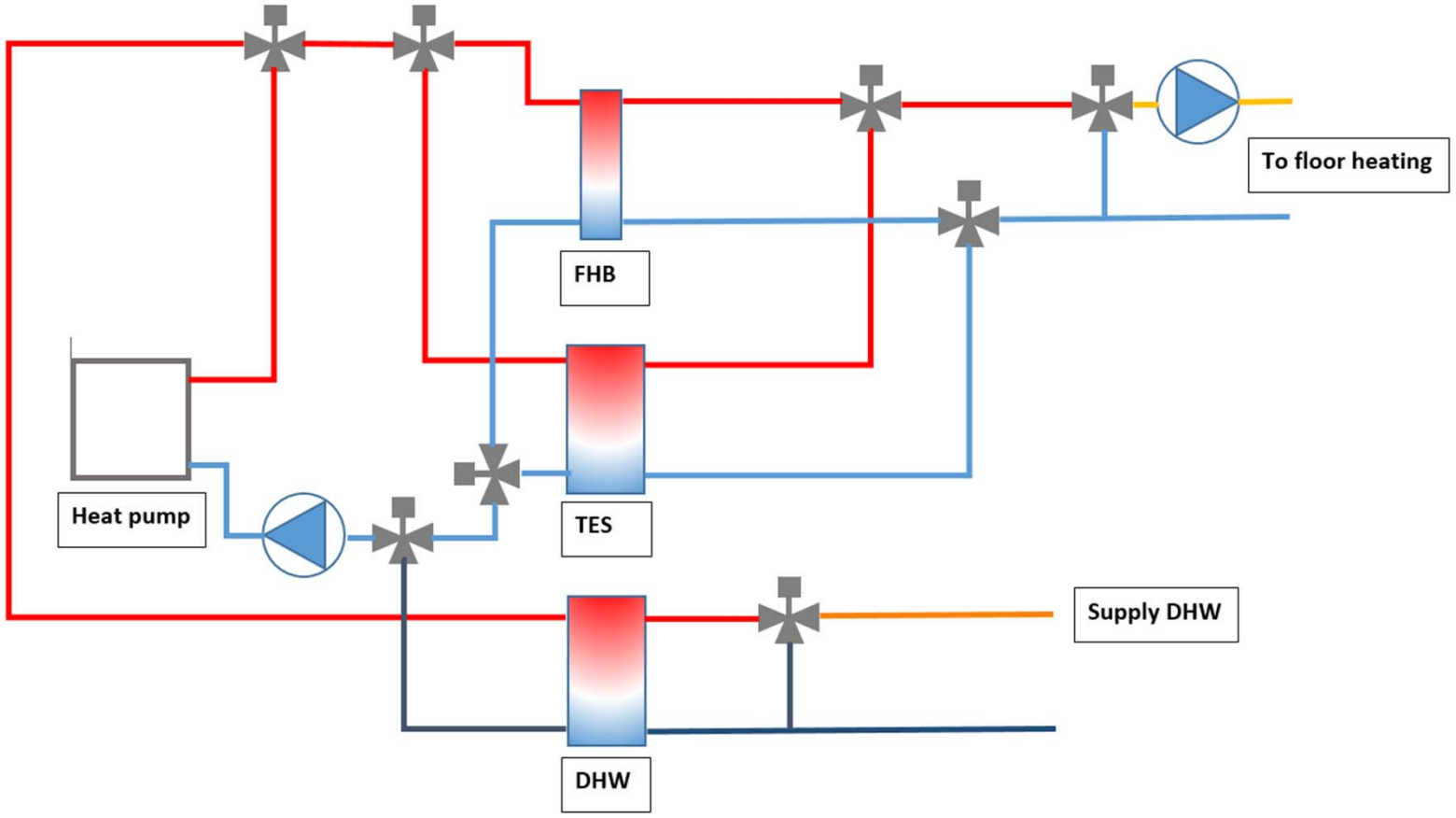
HYDRAULIC SCHEME



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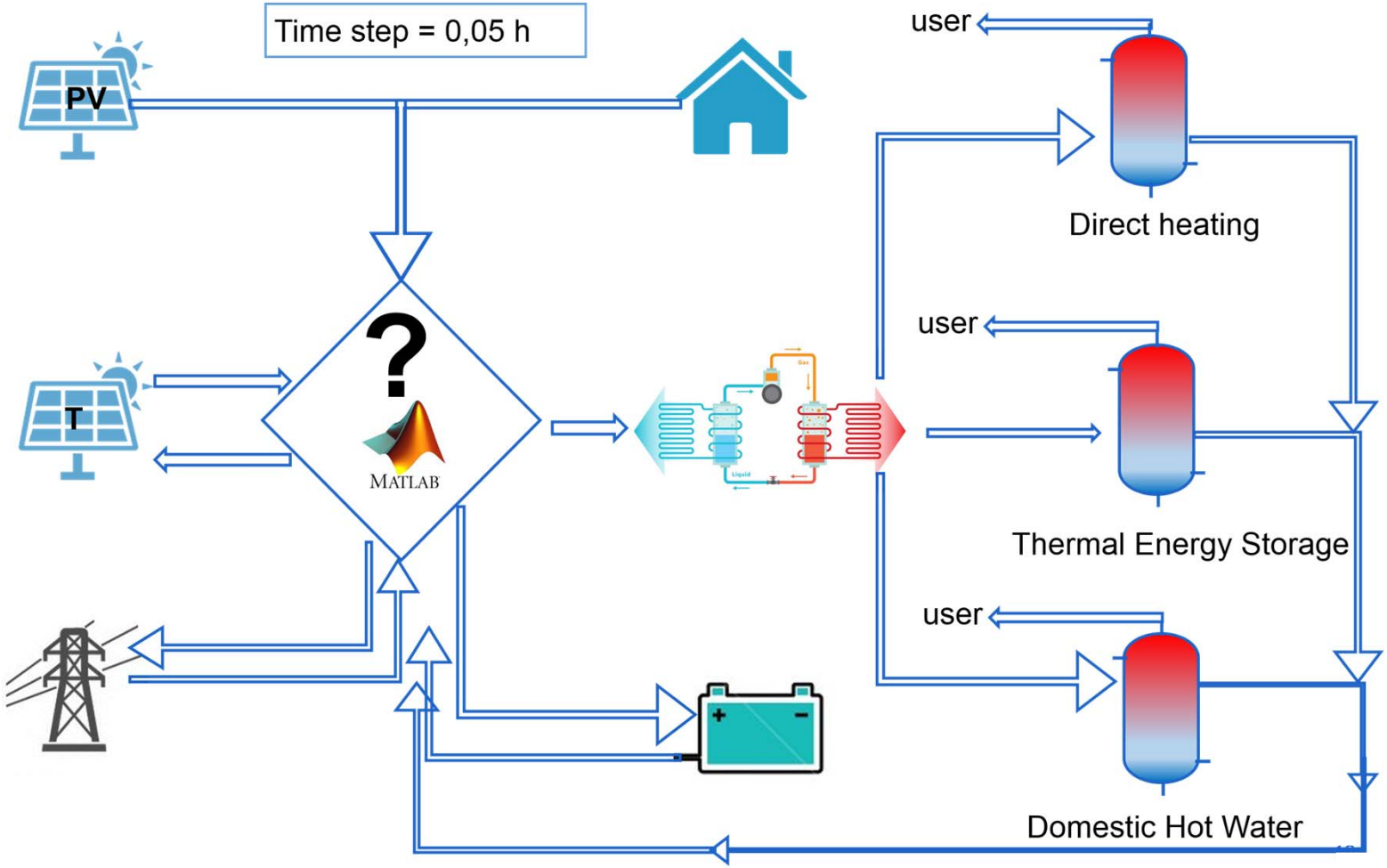
METHODOLOGY – SYSTEM FLOW CHART



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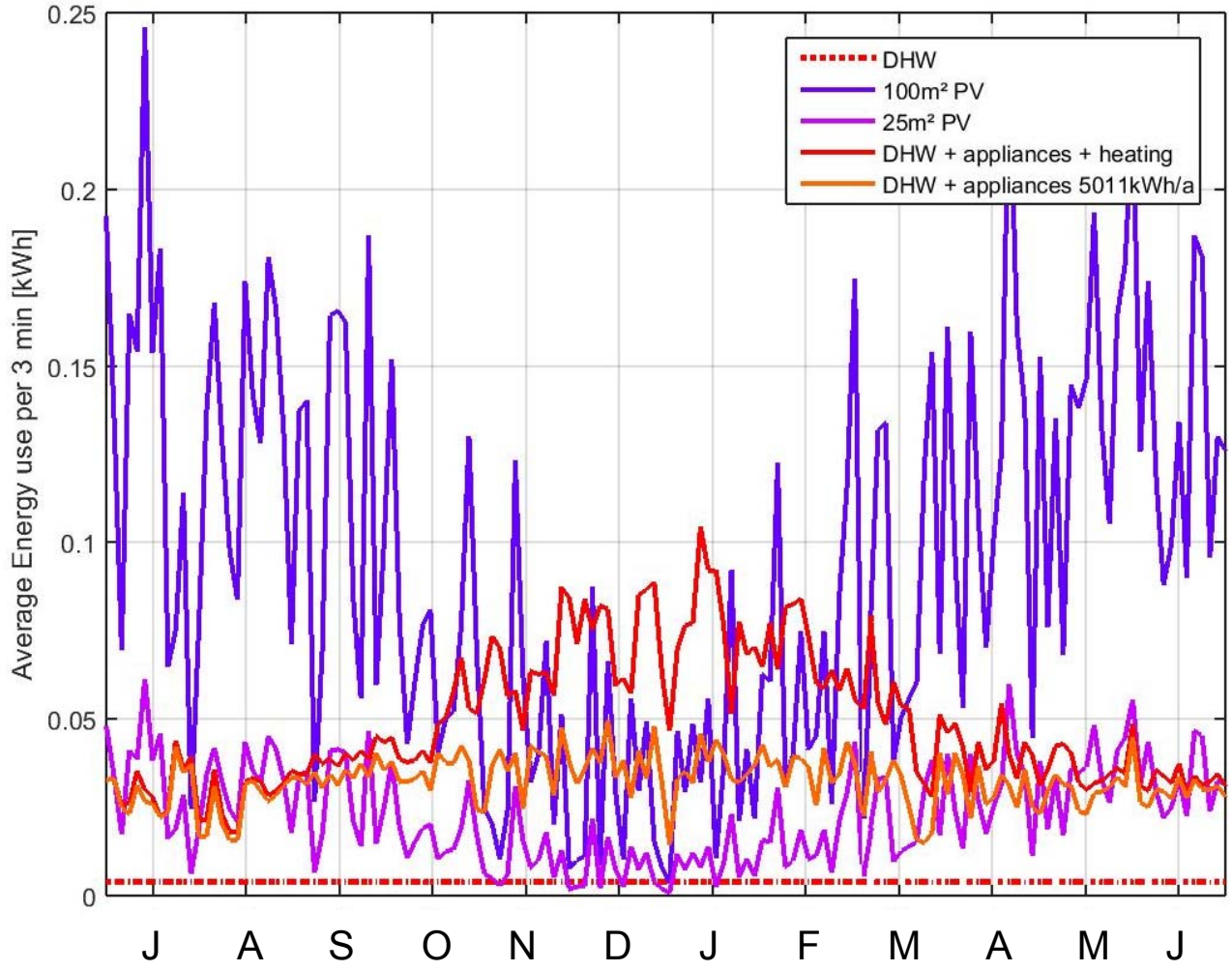
HEATING DEMAND + DHW + APPLIANCES



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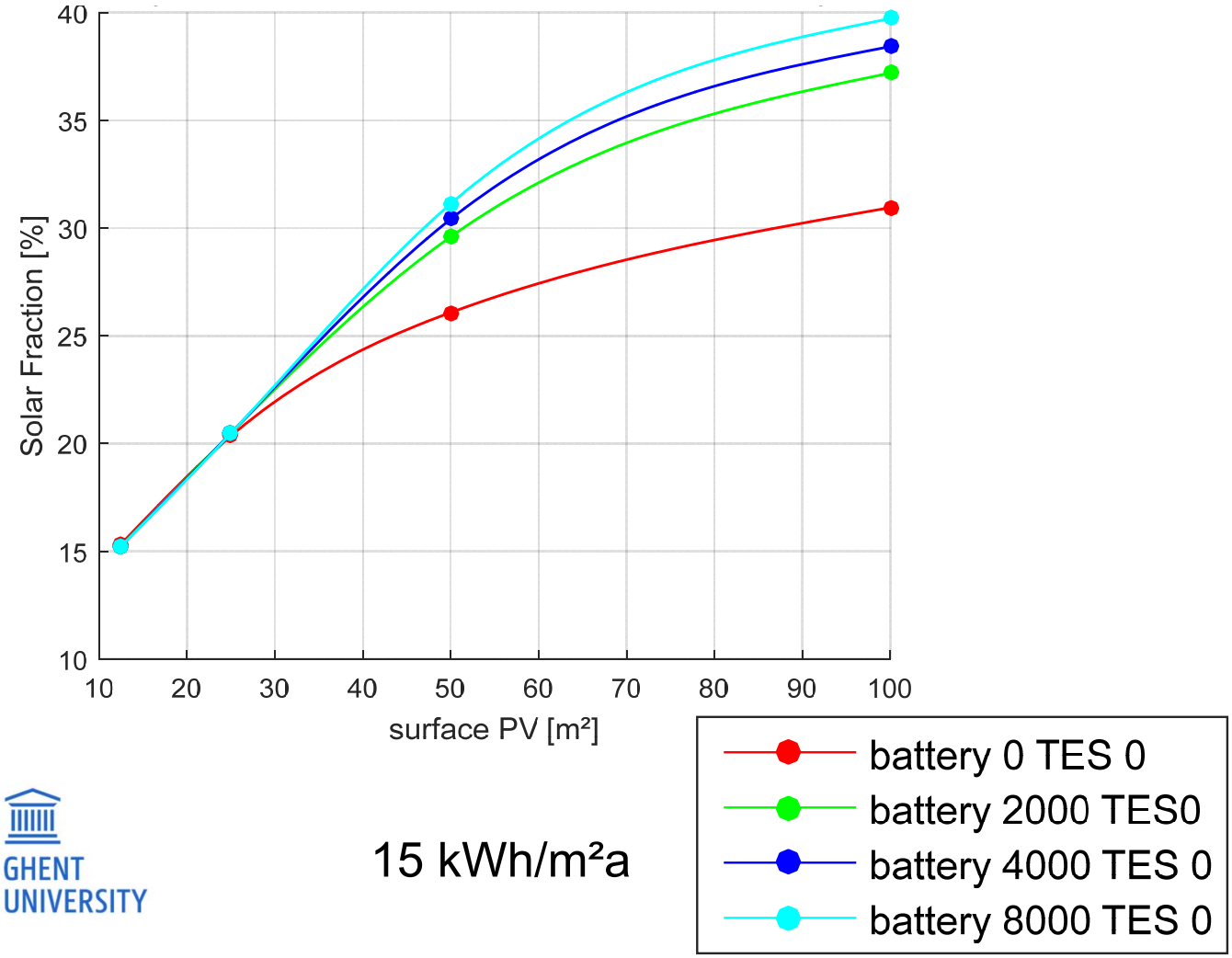
THERMAL STORAGE

Appliances 5011 kWh/a – building scale 1



15 kWh/m²a

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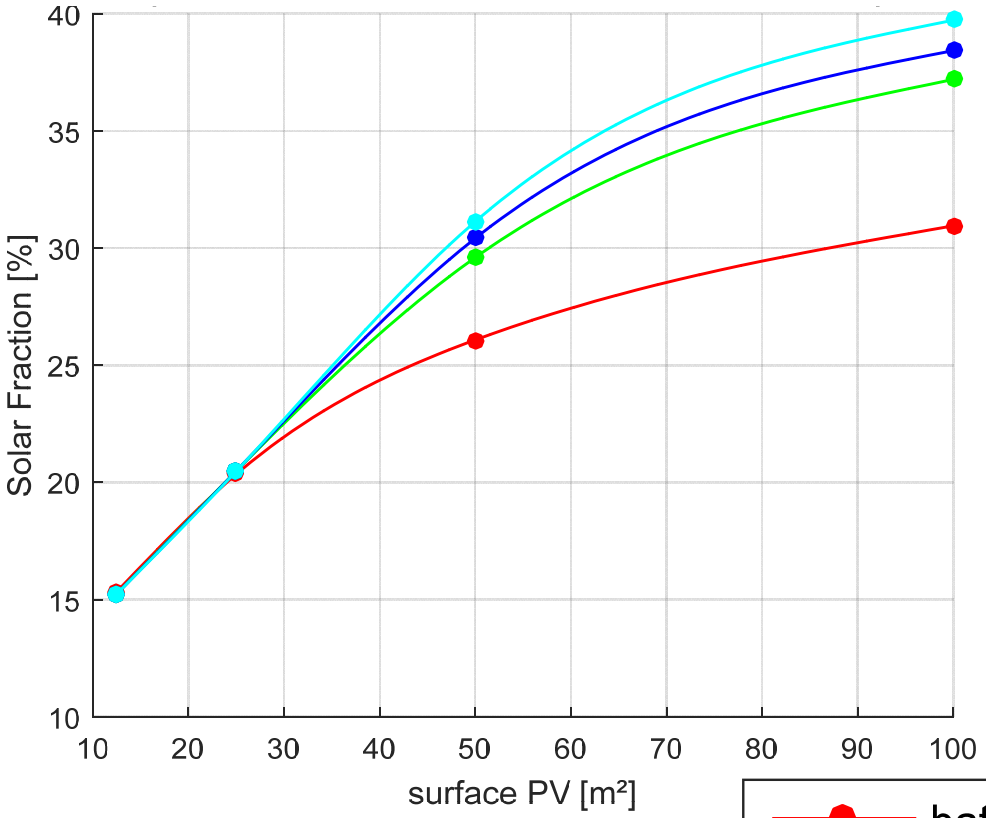
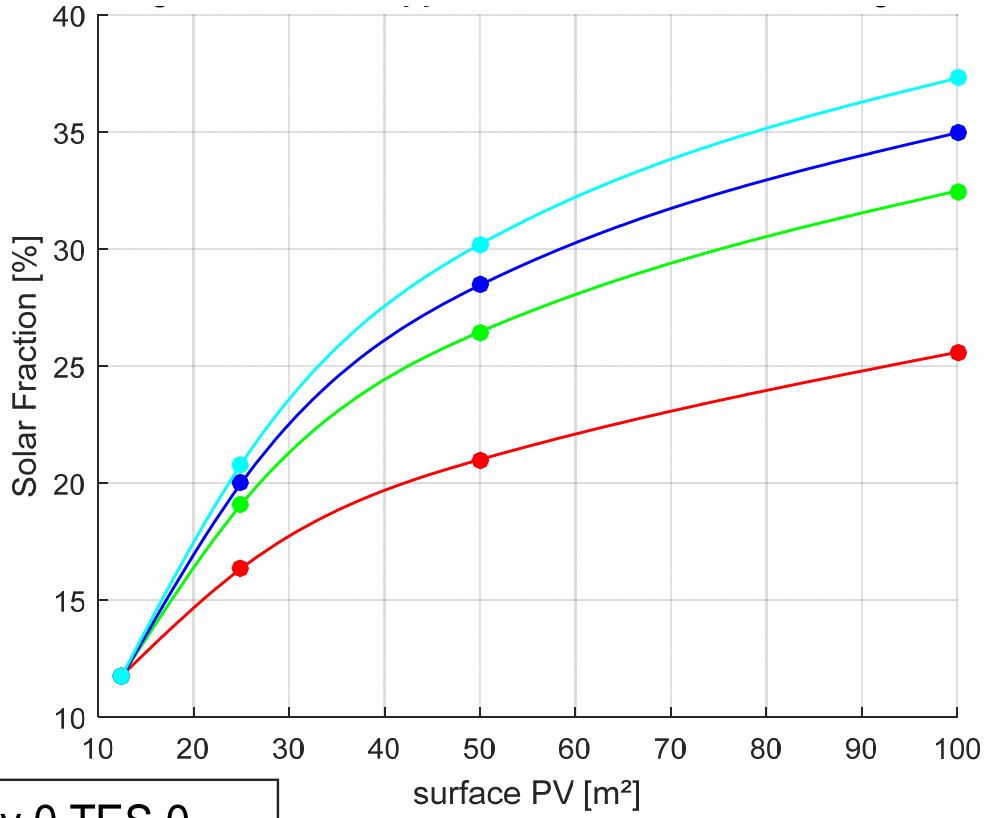
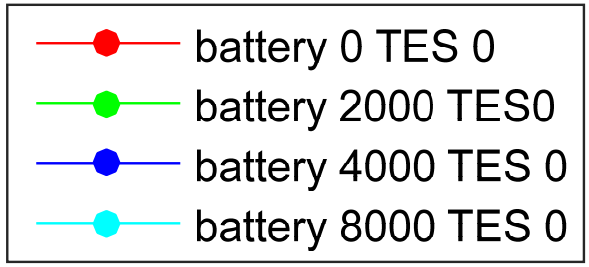
THERMAL STORAGE

Appliances 5011 kWh/a – building scale 1







15 kWh/m²a

60 kWh/m²a

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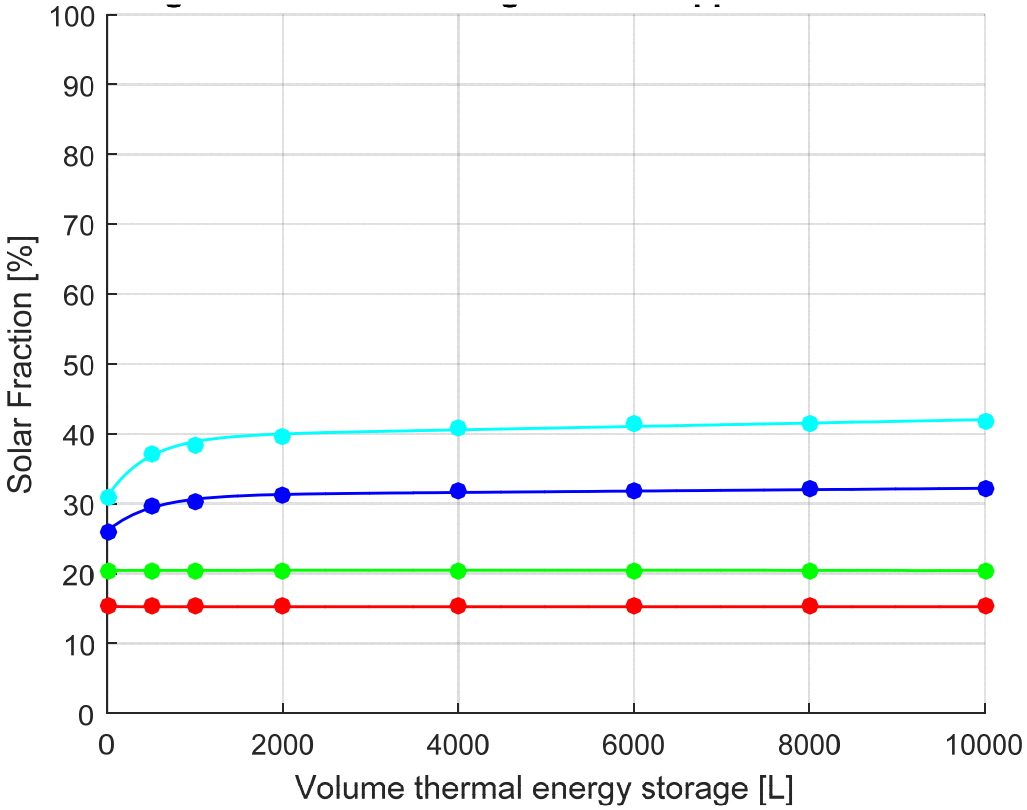
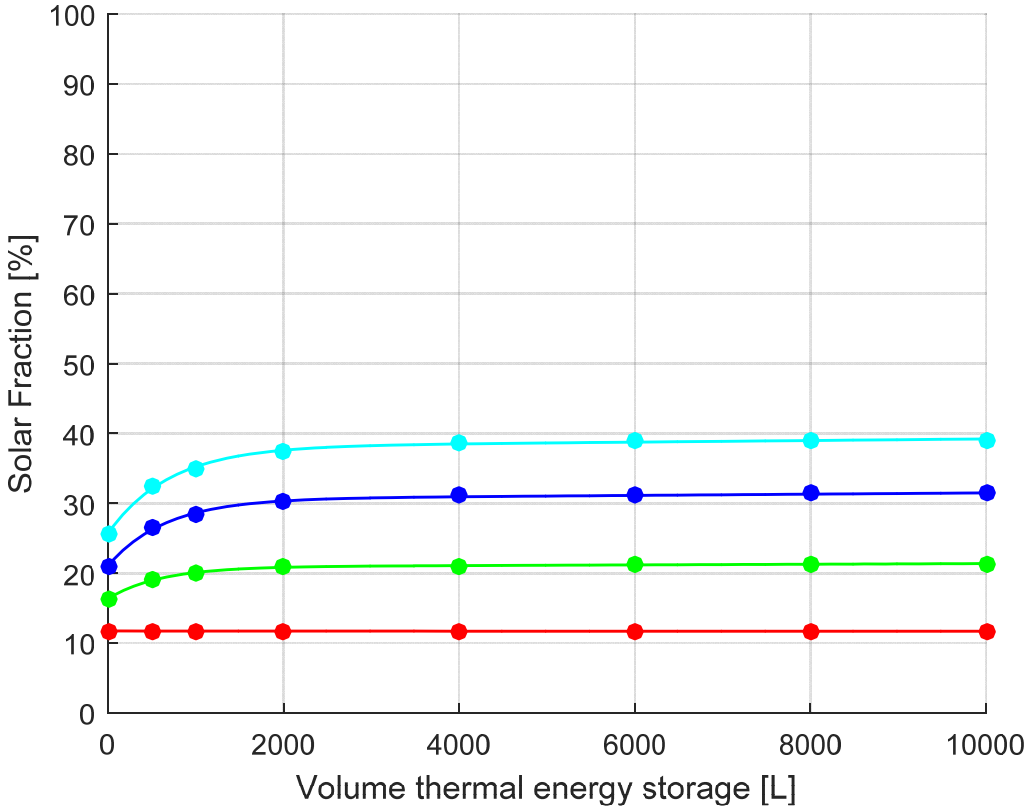
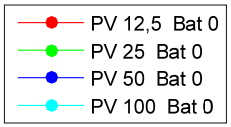
THERMAL STORAGE

Appliances 5011 kWh/a – building scale 1





15 kWh/m²a



60 kWh/m²a

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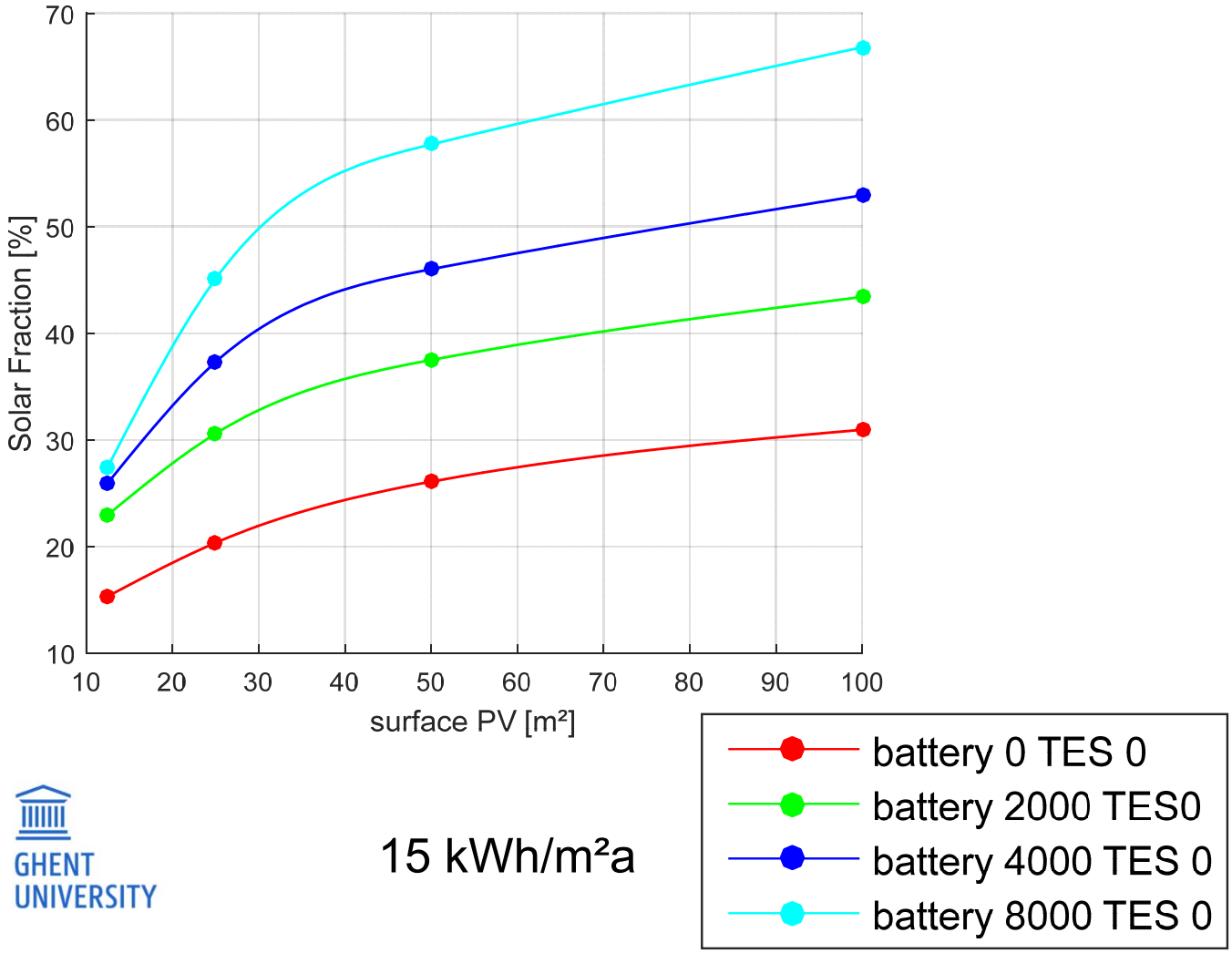
ELECTRICAL STORAGE

Appliances 5011 kWh/a – building scale 1



15 kWh/m²a

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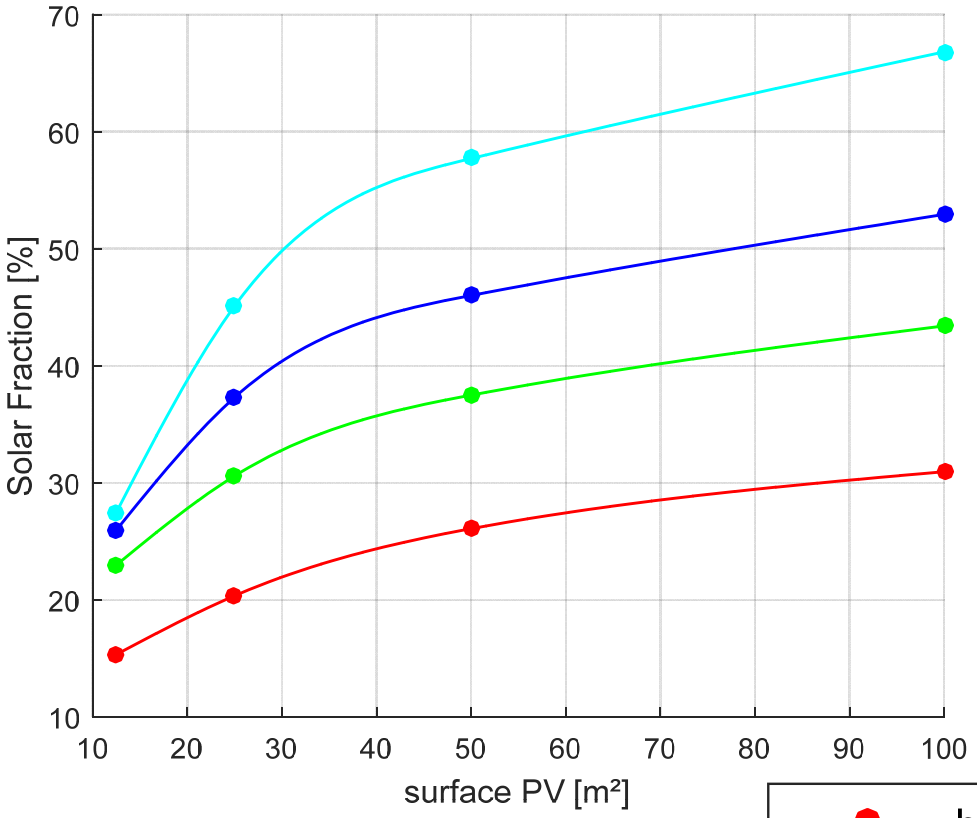
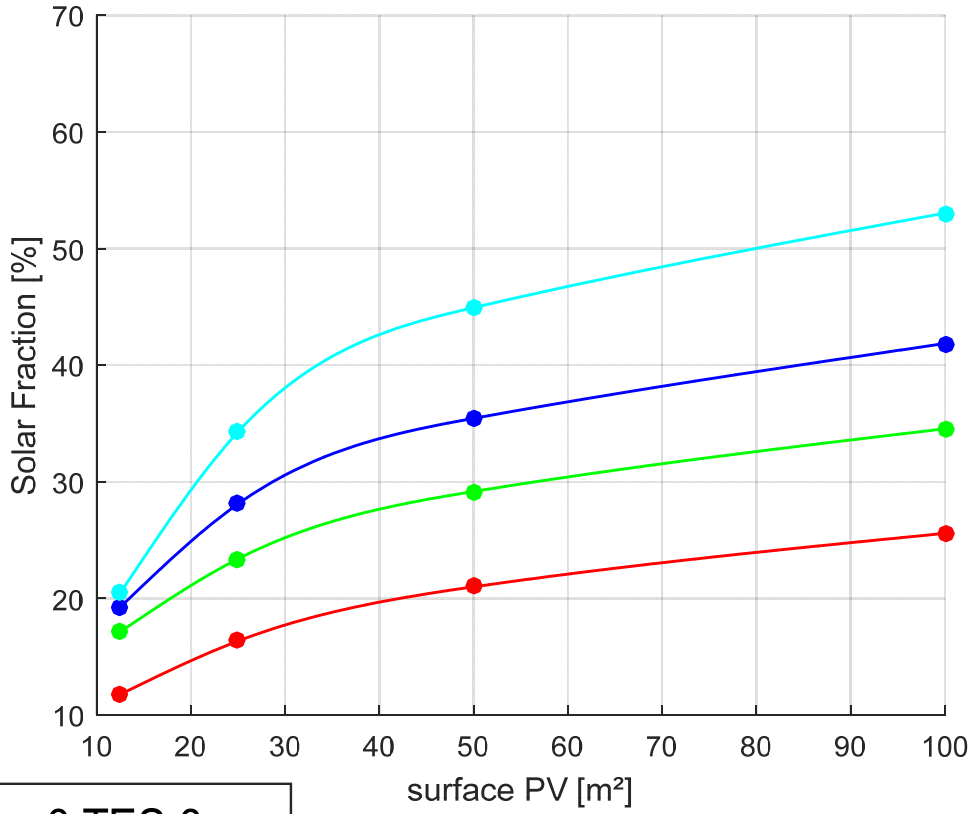
ELECTRICAL STORAGE

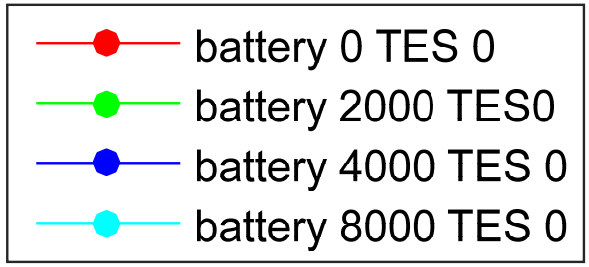
Appliances 5011 kWh/a – building scale 1



15 kWh/m²a



60 kWh/m²a



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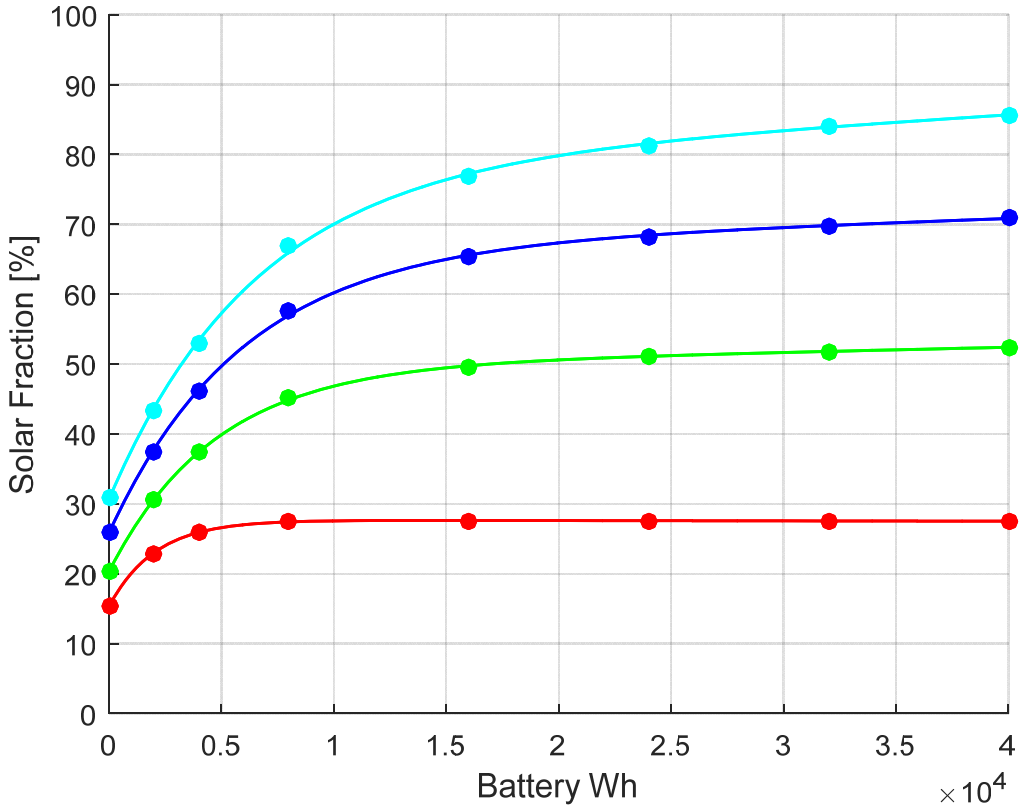
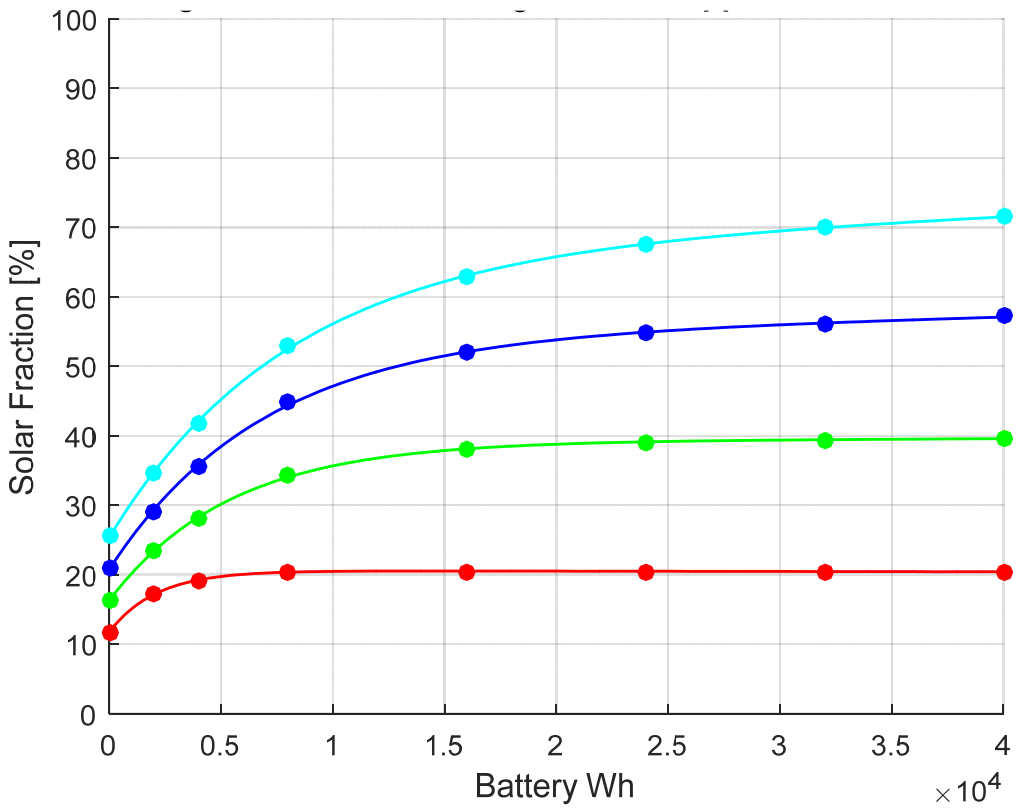
ELECTRICAL STORAGE

Appliances 5011 kWh/a – building scale 1





PV 12,5 TES0
PV 25 TES0
PV 50 TES0
PV 100 TES0

15 kWh/m²a

60 kWh/m²a

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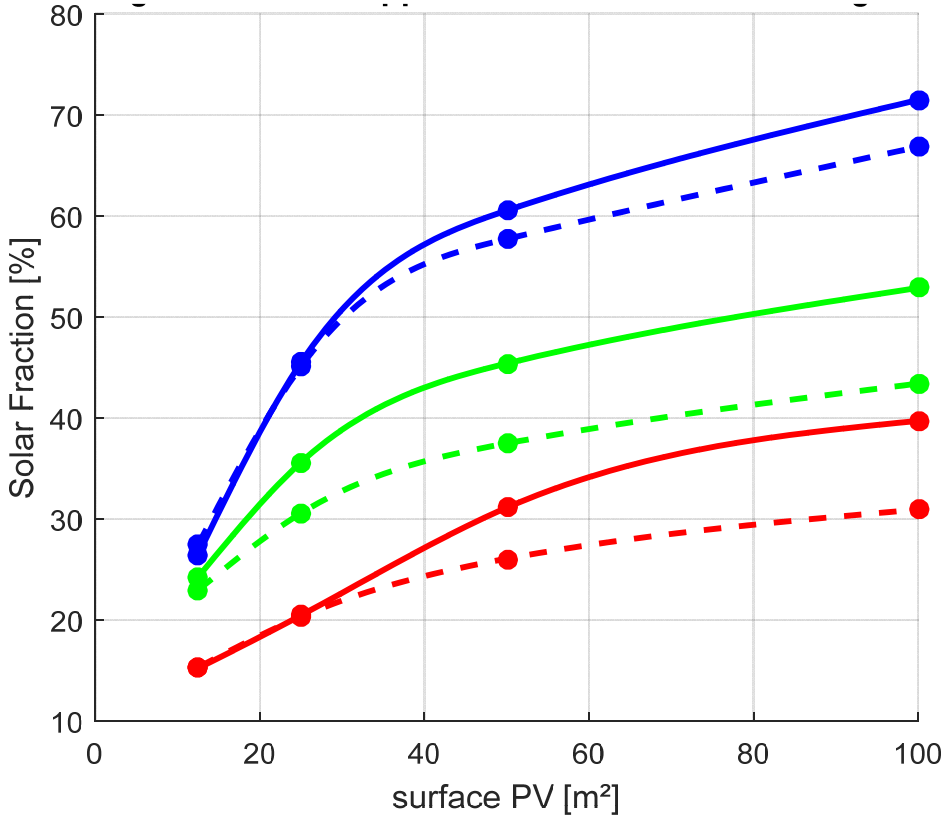
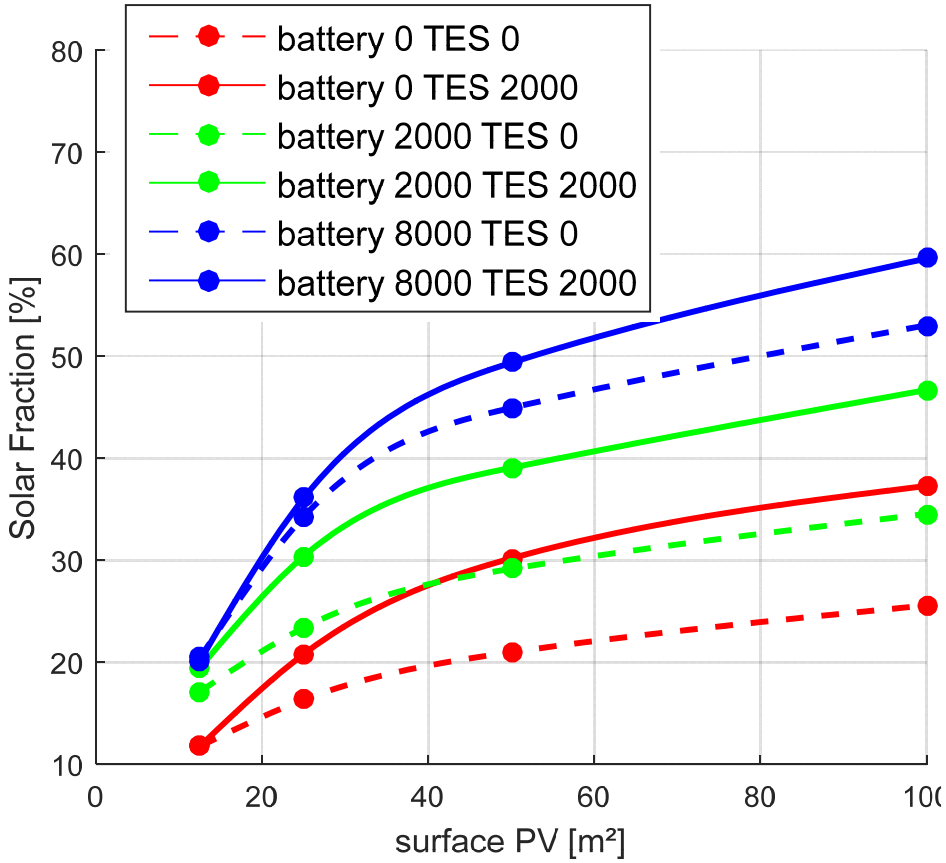
THERMAL AND ELECTRICAL STORAGE

Appliances 5011 kWh/a – building scale 1



15 kWh/m²a



60 kWh/m²a

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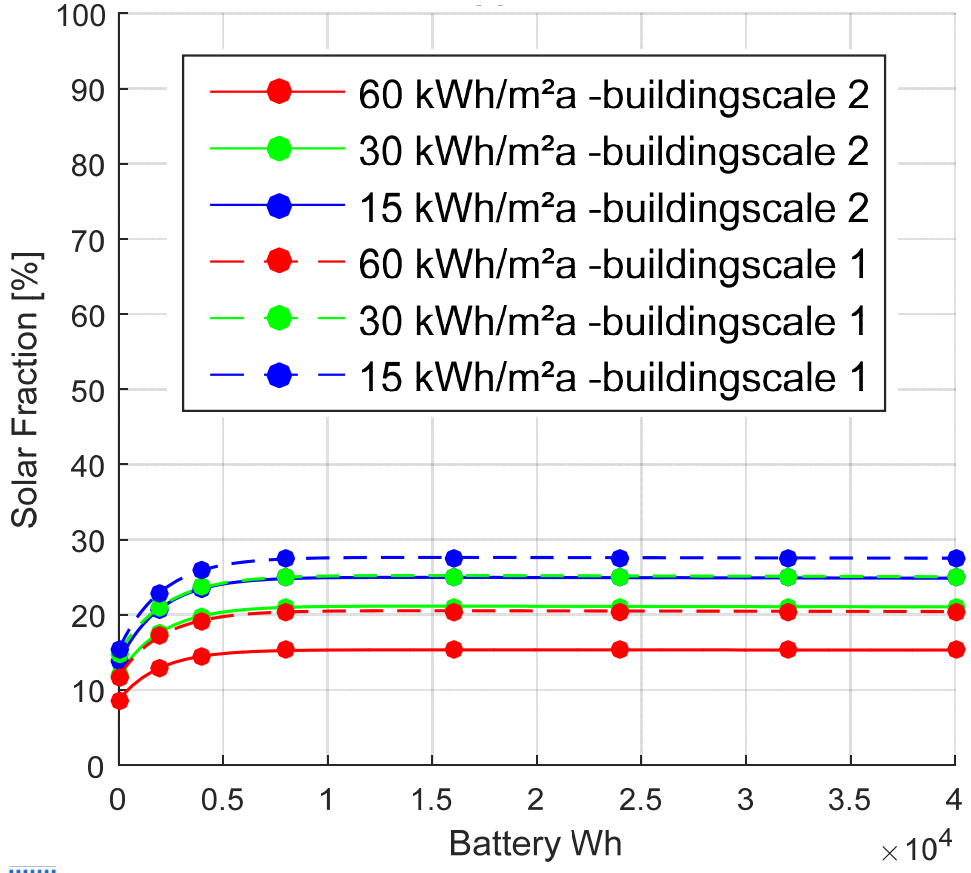
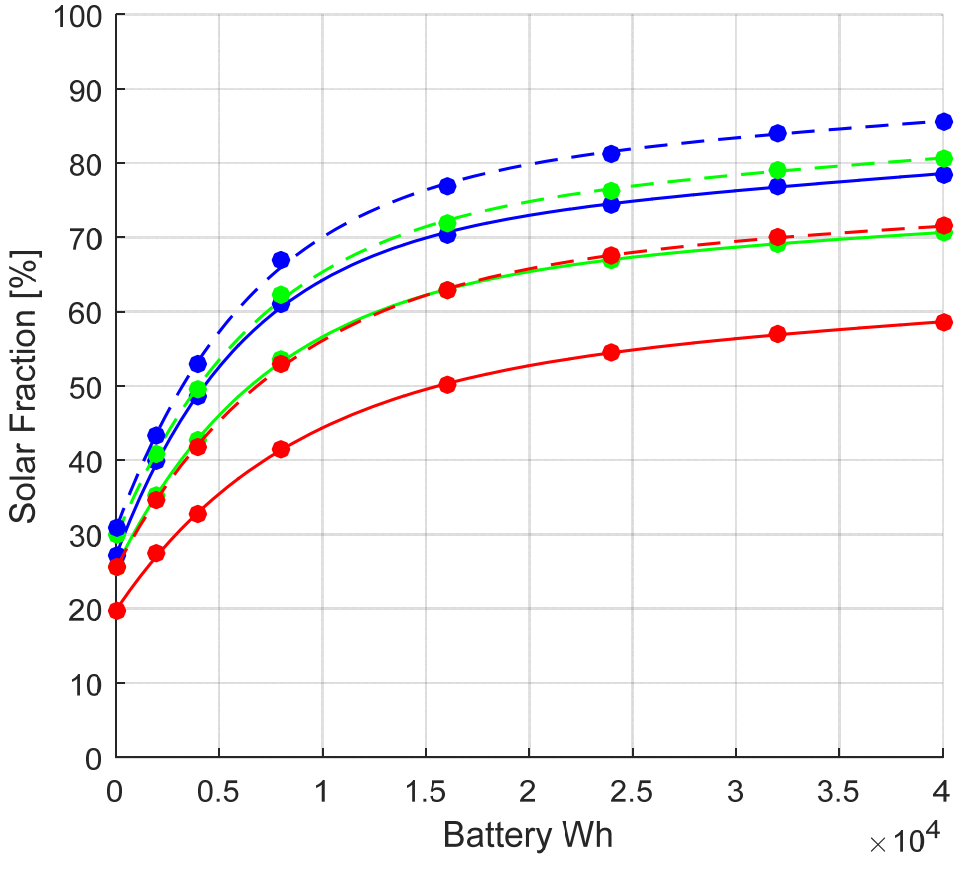
ELECTRICAL STORAGE - DIFFERENT BUILDINGS

Appliances 5011 kWh/a



12,5 m² PV



100m² PV

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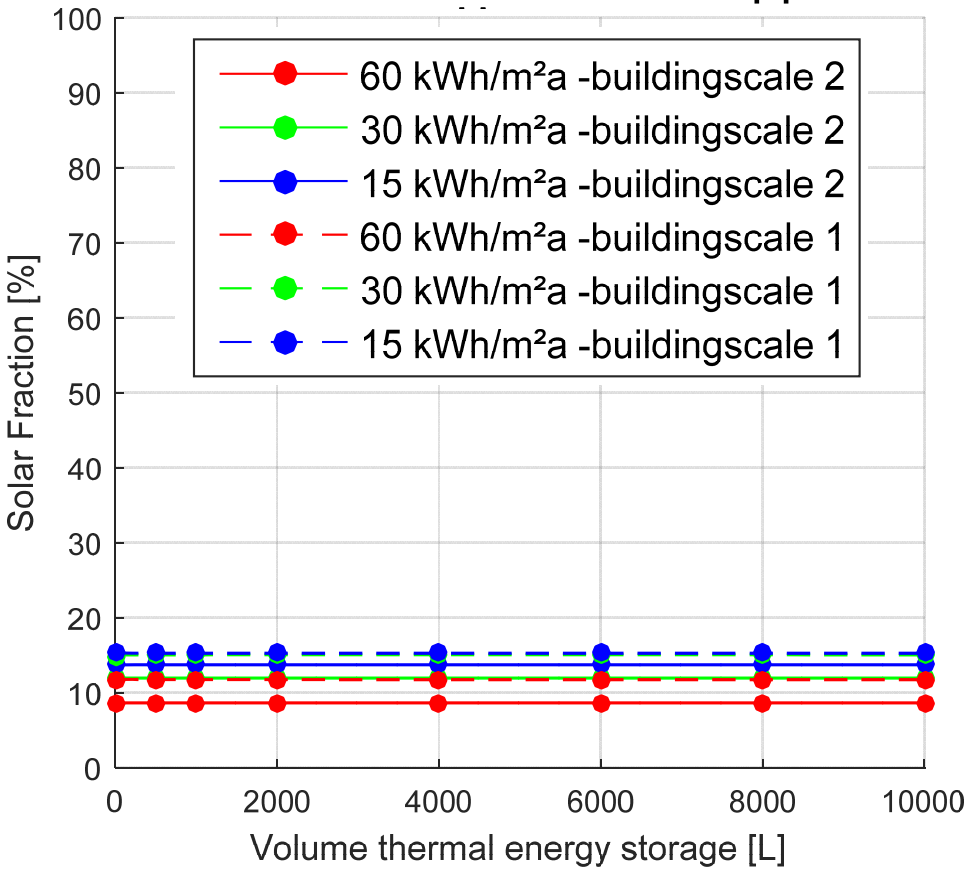
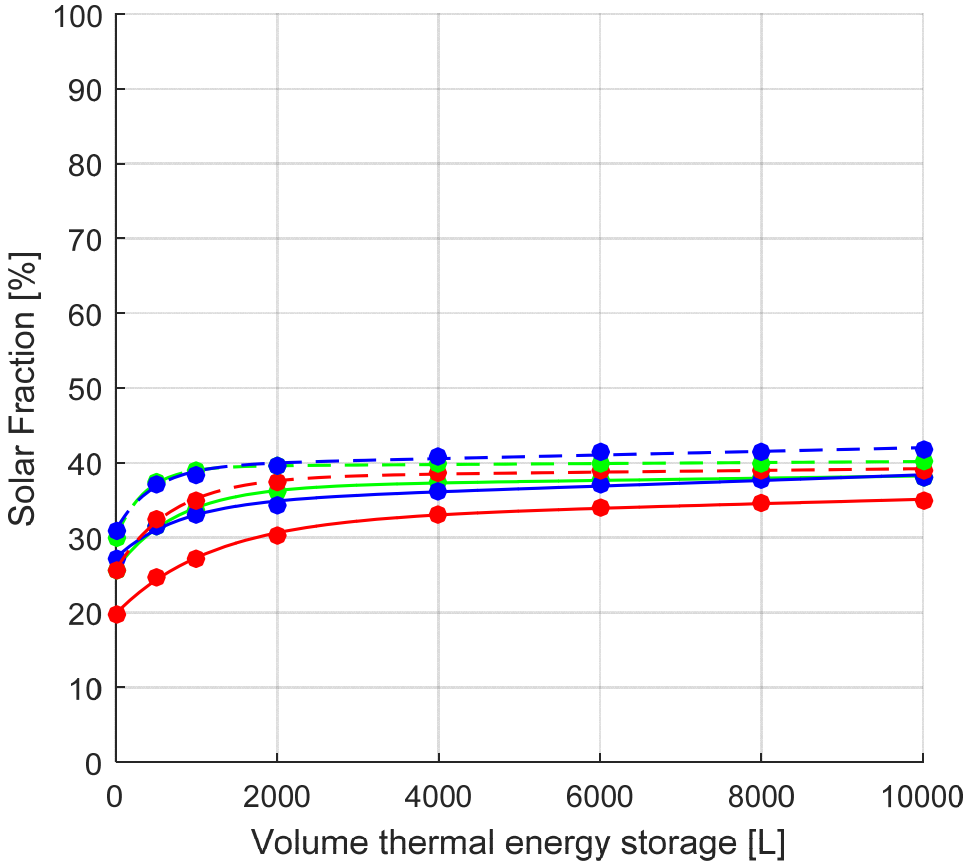
THERMAL STORAGE - DIFFERENT BUILDINGS

Appliances 5011 kWh/a





12,5 m² PV

100m² PV

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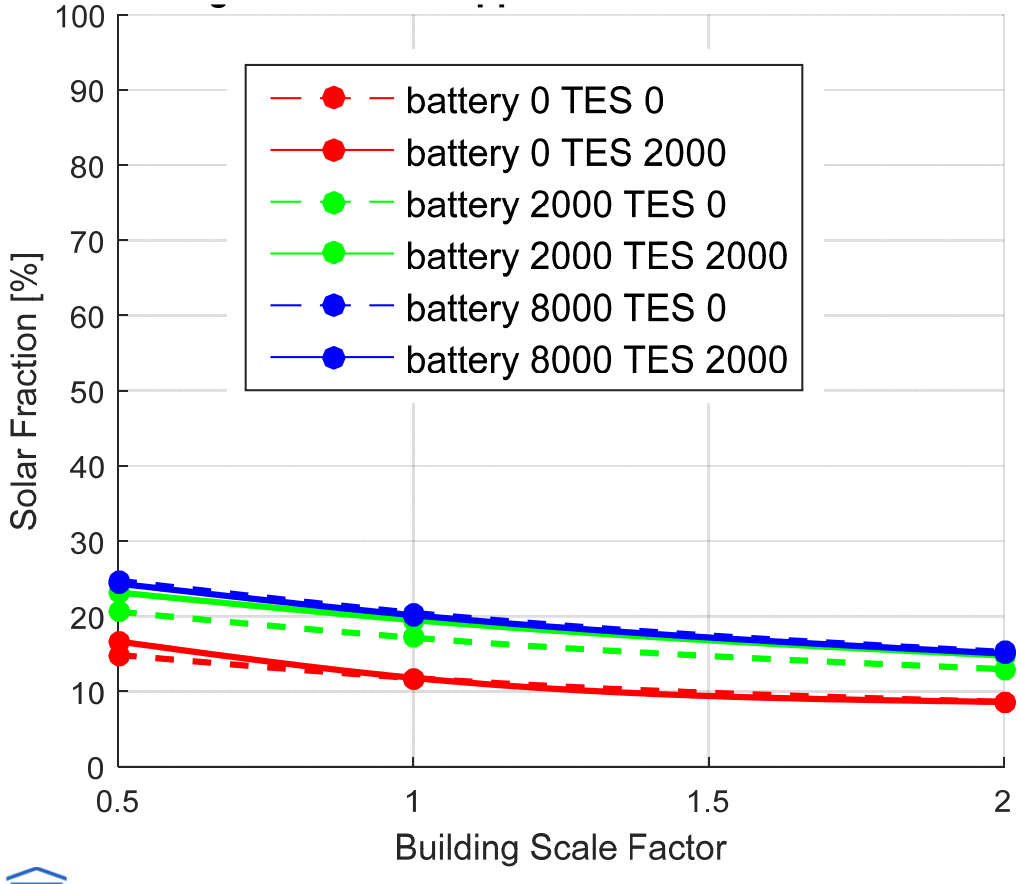
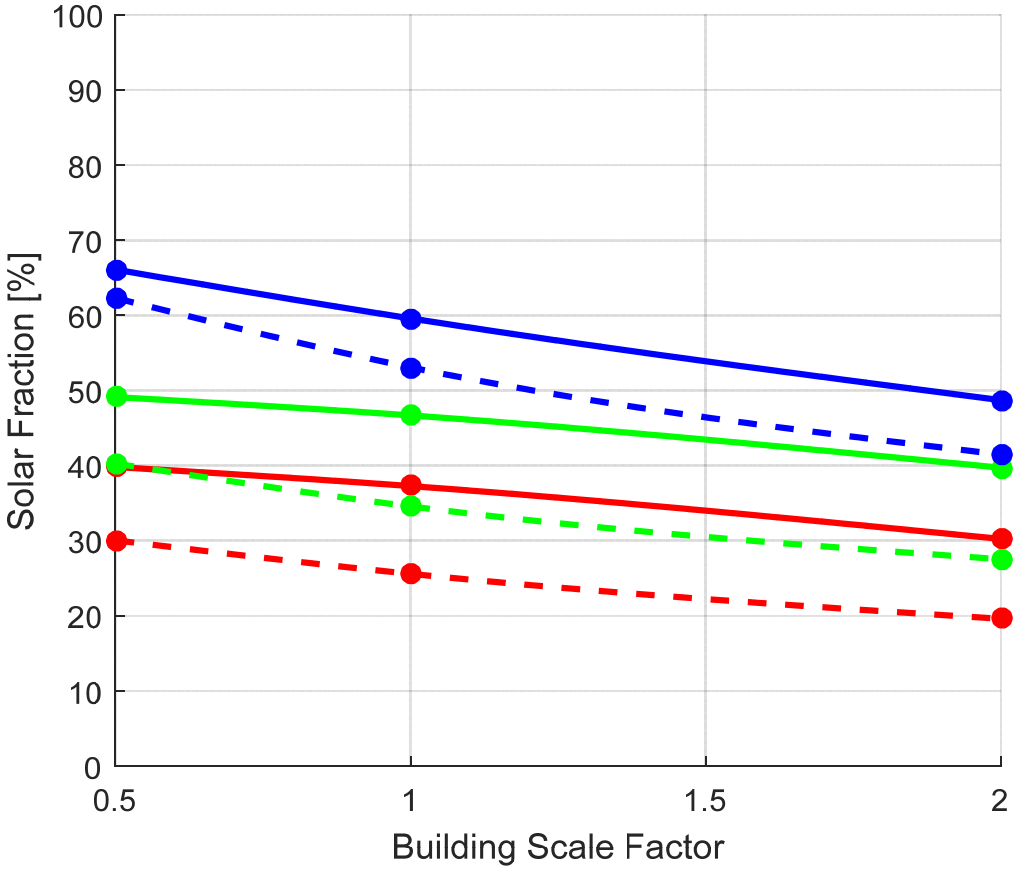
IMPACT BUILDING SCALE - 60 kWh/m²a

Appliances 5011 kWh/a



12,5 m² PV



100m² PV

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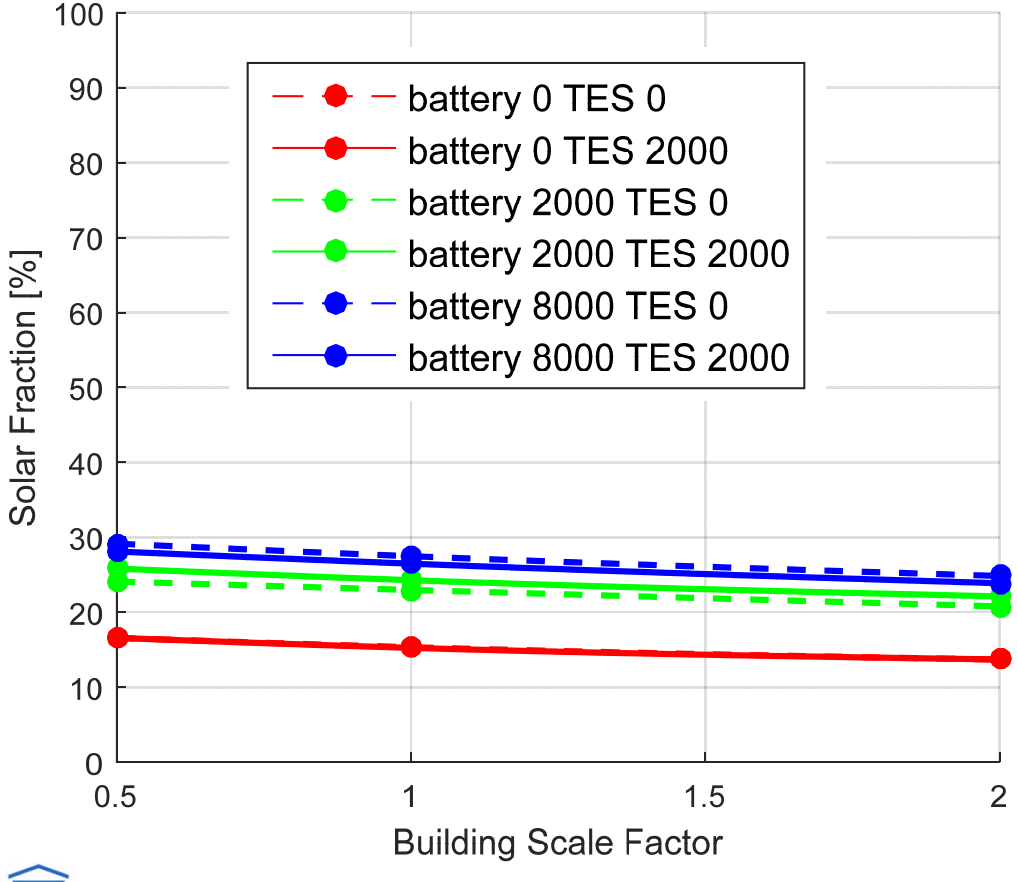
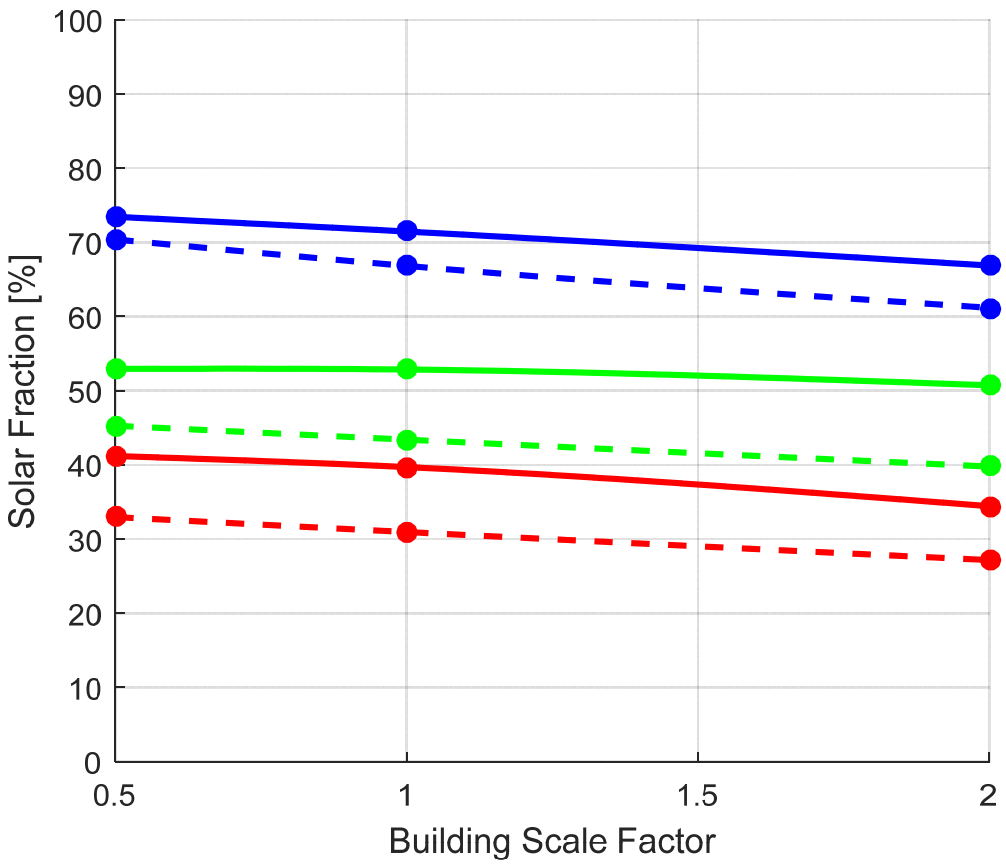
IMPACT BUILDING SCALE - 15 kWh/m²a

Appliances 5011 kWh/a



12,5 m² PV



100m² PV

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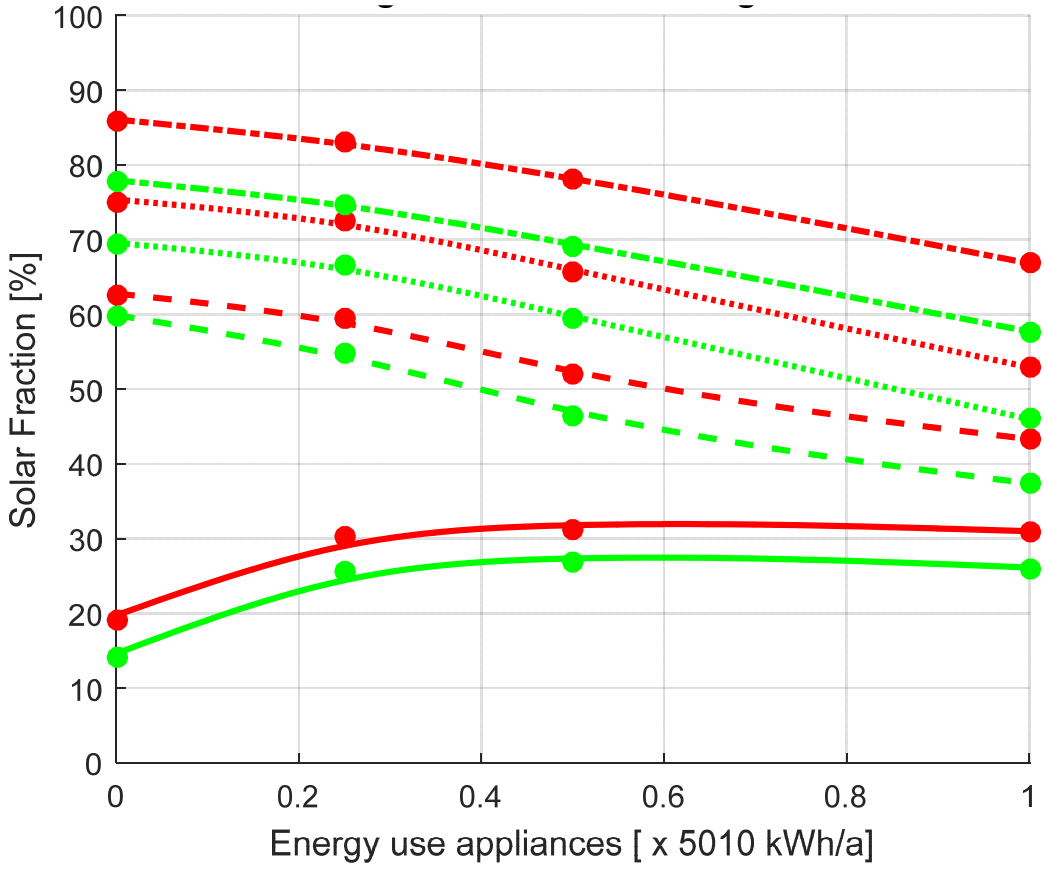
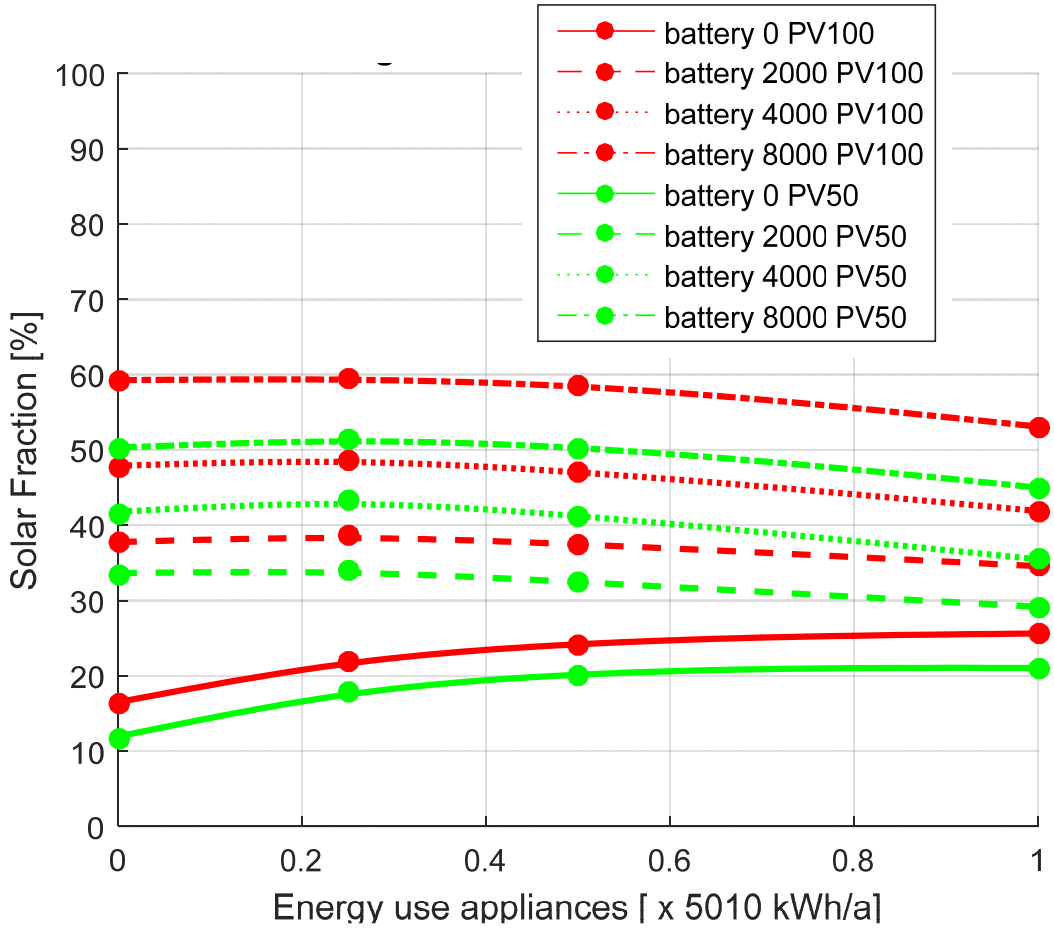
IMPACT APPLIANCES - BUILDING SCALE 1



15 kWh/m²a



60 kWh/m²a

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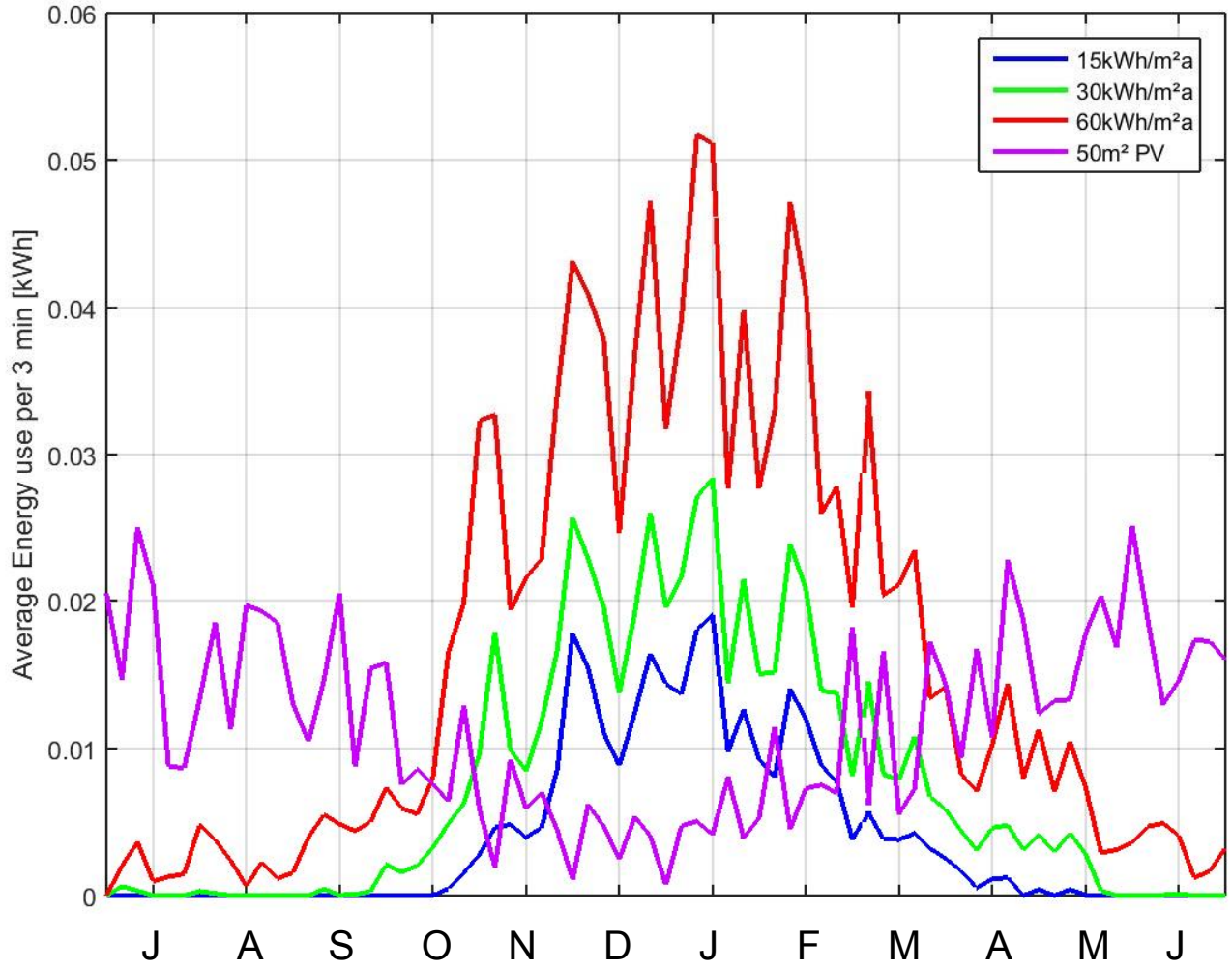
HEATING DEMAND ⟺ ENERGY PRODUCTION



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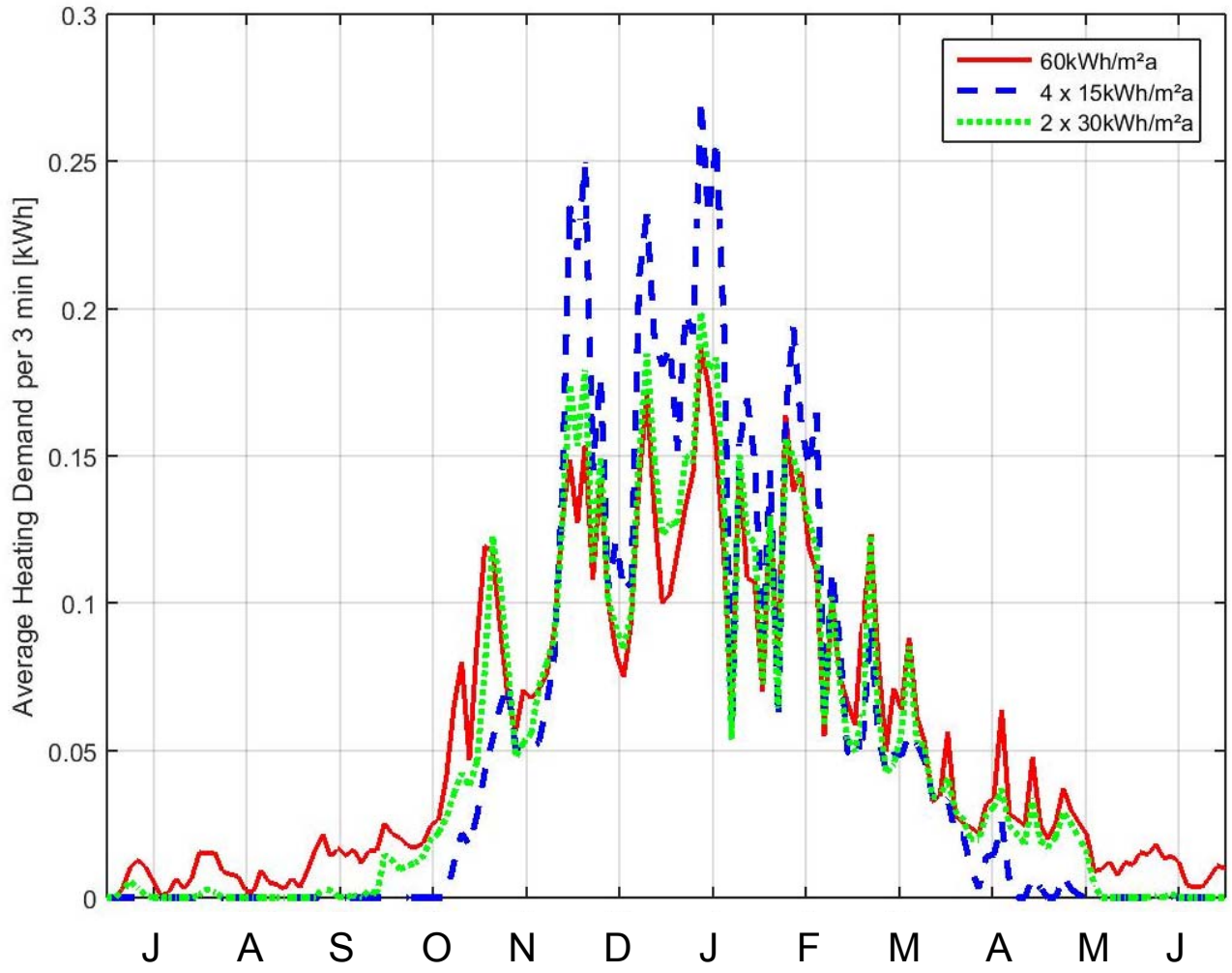
SAME YEARLY HEATING DEMAND BUILDING



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CONCLUSION

- Thermal energy storage increases the solar fraction up to 11%
- TES volume for 100m² PV< 1000 liter
- No TES for small PV surfaces
- Electrical storage 8000Wh increases the solar fraction up to 37% in a 15kWh/m²a building
- Electrical storage 8000Wh increases the solar fraction up to 27% in a 60kWh/m²a building
- Battery capacity for 100m² PV < 15kWh
- Battery capacity for 12,5m² PV < 4 kWh
- The larger the capacity of the battery, the smaller the impact of TES
- Battery capacity and TES volume = f(PV surface, appliances, building performance,…)

- An Excel tool is developed to calculate the solar fraction

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