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2016 Purdue Conferences
Compressor Engineering
Refrigeration and Air Conditioning
High Performance Buildings

Optimization of Air-Source Heat Pump Systems over the Heating Season through the Use of Renewable Energy Sources

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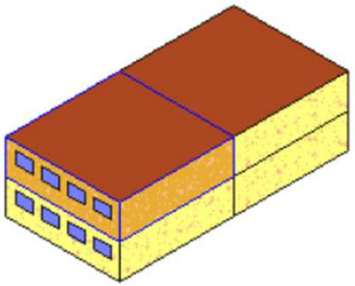
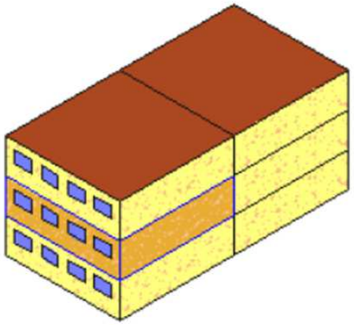
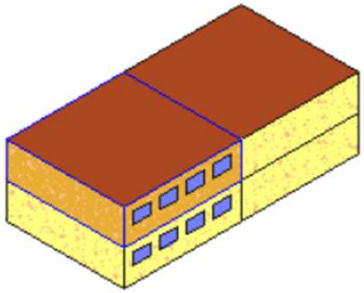
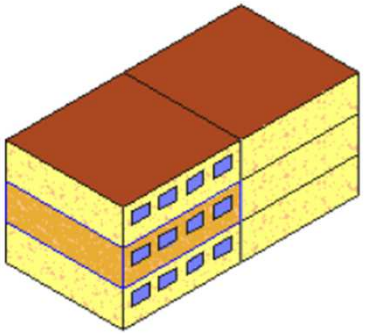
Center for High Performance Buildings at Purdue

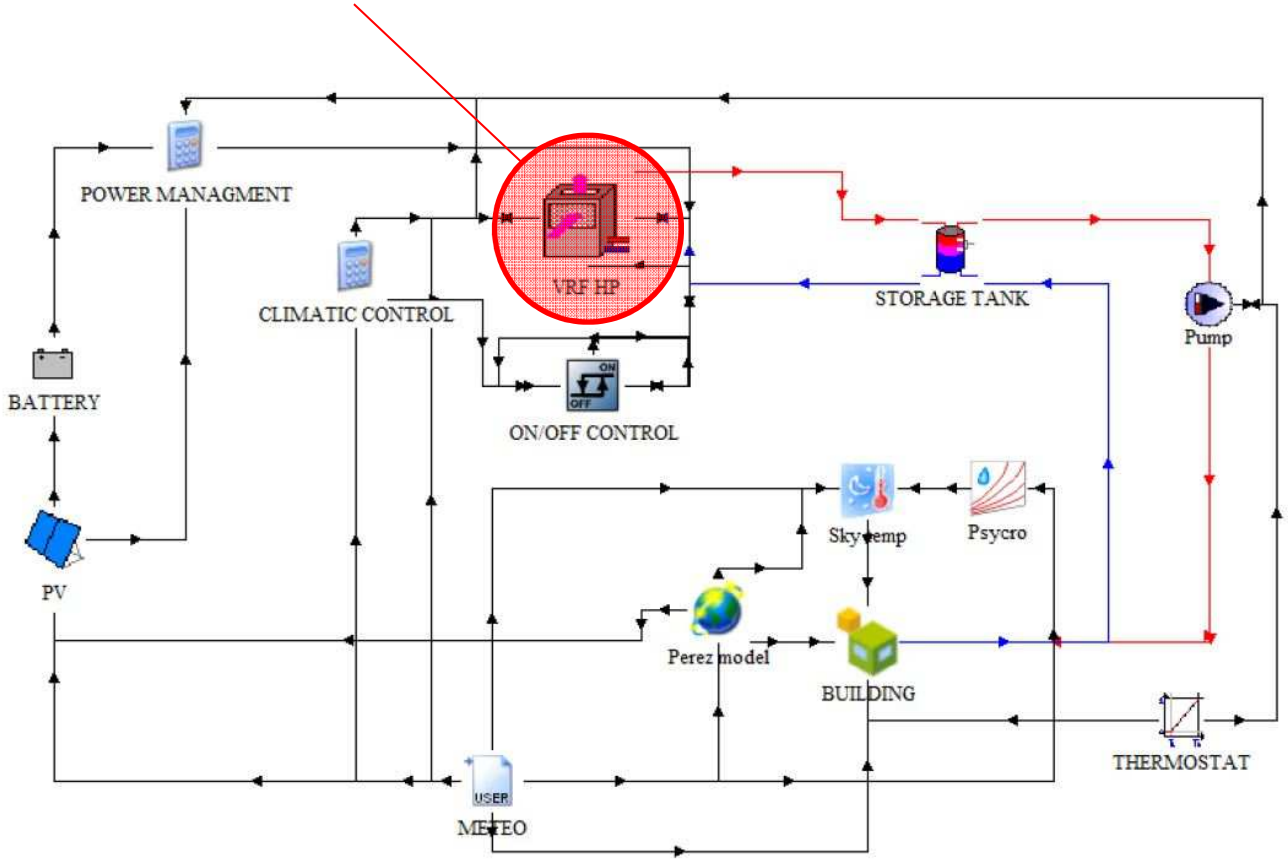
Test Buildings

	S/V=0.63	S/V=0.3
SOUTH ORIENTED GLAZINGS		
EAST ORIENTED GLAZINGS		

TRNSYS simulation layout

A new Type has been developed for TRNSYS :

AIR-TO-WATER HEAT PUMP WITH VARIABLE SPEED COMPRESSOR



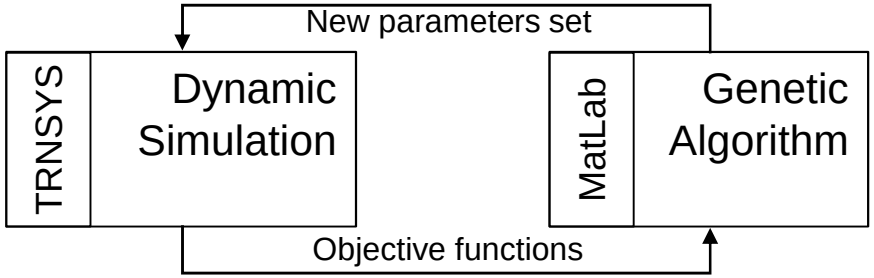
TRNSYS simulation layout

A new Type for TRNSYS has been developed (Bee et al., 2016):
AIR-TO-WATER HEAT PUMP WITH VARIABLE SPEED COMPRESSOR

- ✓ capable to calculate the performance at part load conditions
- ✓ can account for outside air-temperature dependent supply temperature control (i.e. hot water temperature reset)
- ✓ two different COP correction functions can be selected
- ✓ can account for on/off operation below the modulation limit

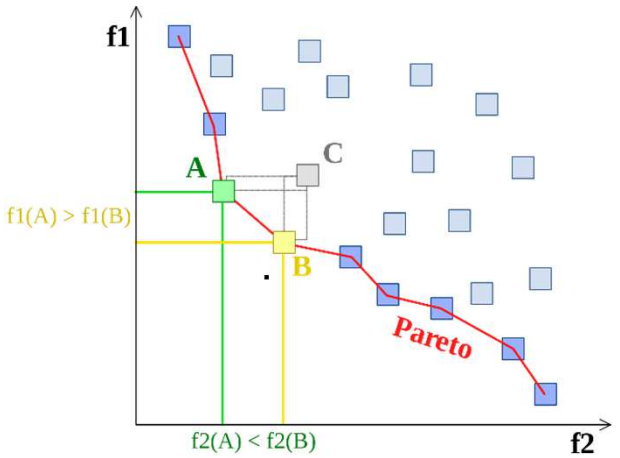
Optimization process: general approach

MULTI OBJECTIVE OPTIMIZATION: GENETIC ALGORITHM



PARETO FRONT: is made of dominating solutions.
A dominating solution is:

- no worse than the others in all objectives;
- strictly better than the others in at least one objective.



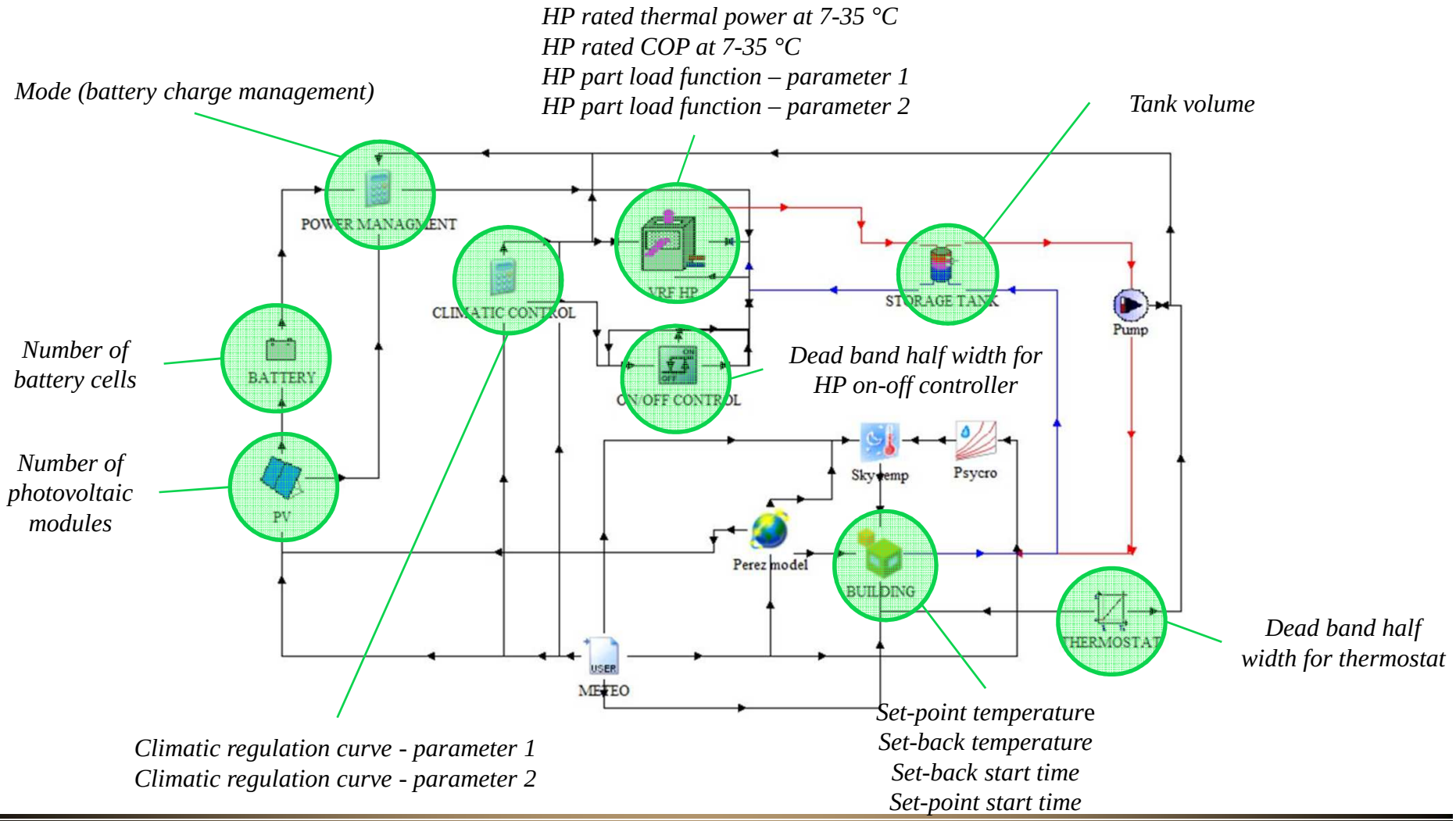
Objective functions

We defined three OBJECTIVE FUNCTIONS:

- Minimize energy demand for heating
- Maximize the fraction covered by PV (self-consumption)
- Minimize the power and the PV overproduction (surplus)

⟹ the Pareto front is a surface (3D domain)

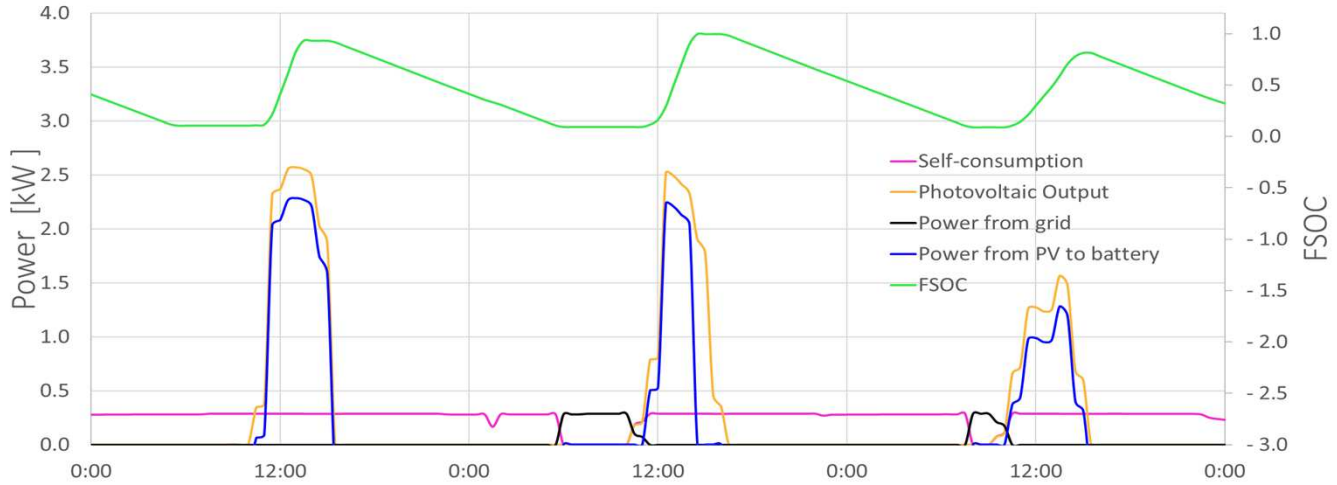
Optimization parameters



Power managing strategy

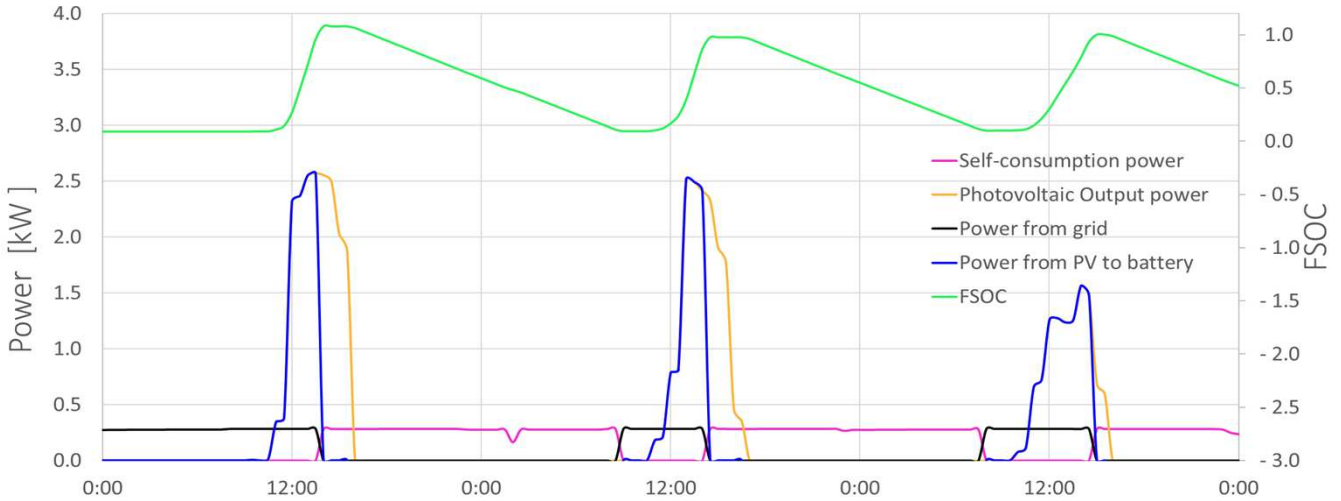
PV array in parallel with the grid

mode = 0



UPS like management

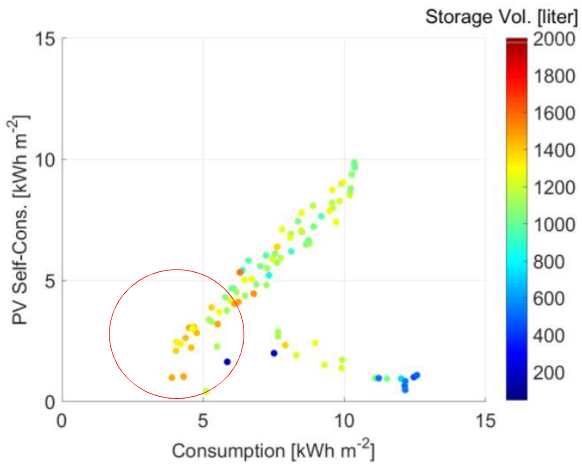
mode = 1

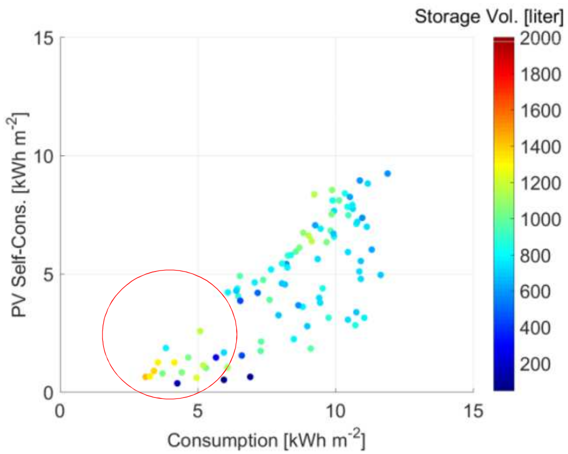


Results: storage volume

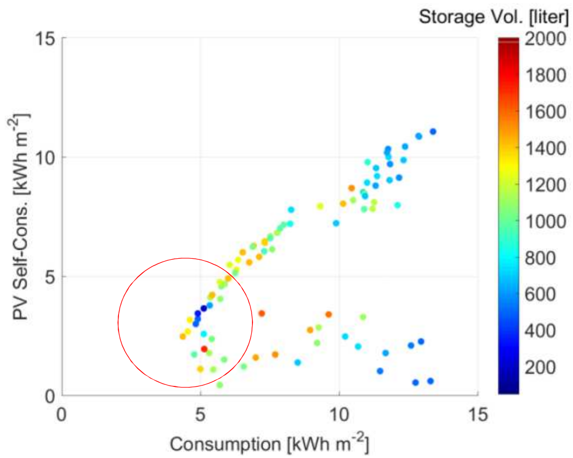
S/V=0.63 | S/V=0.3

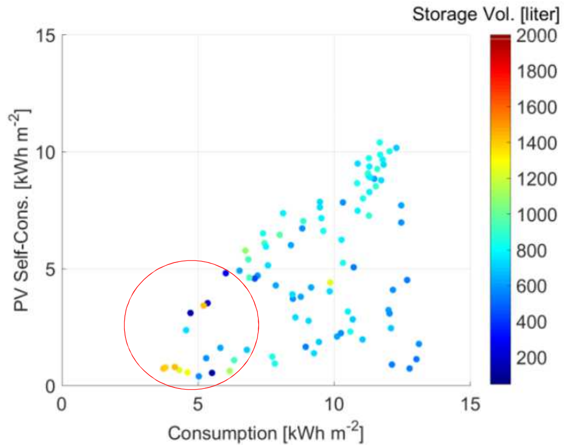
SOUTH ORIENTED GLAZINGS





EAST ORIENTED GLAZINGS





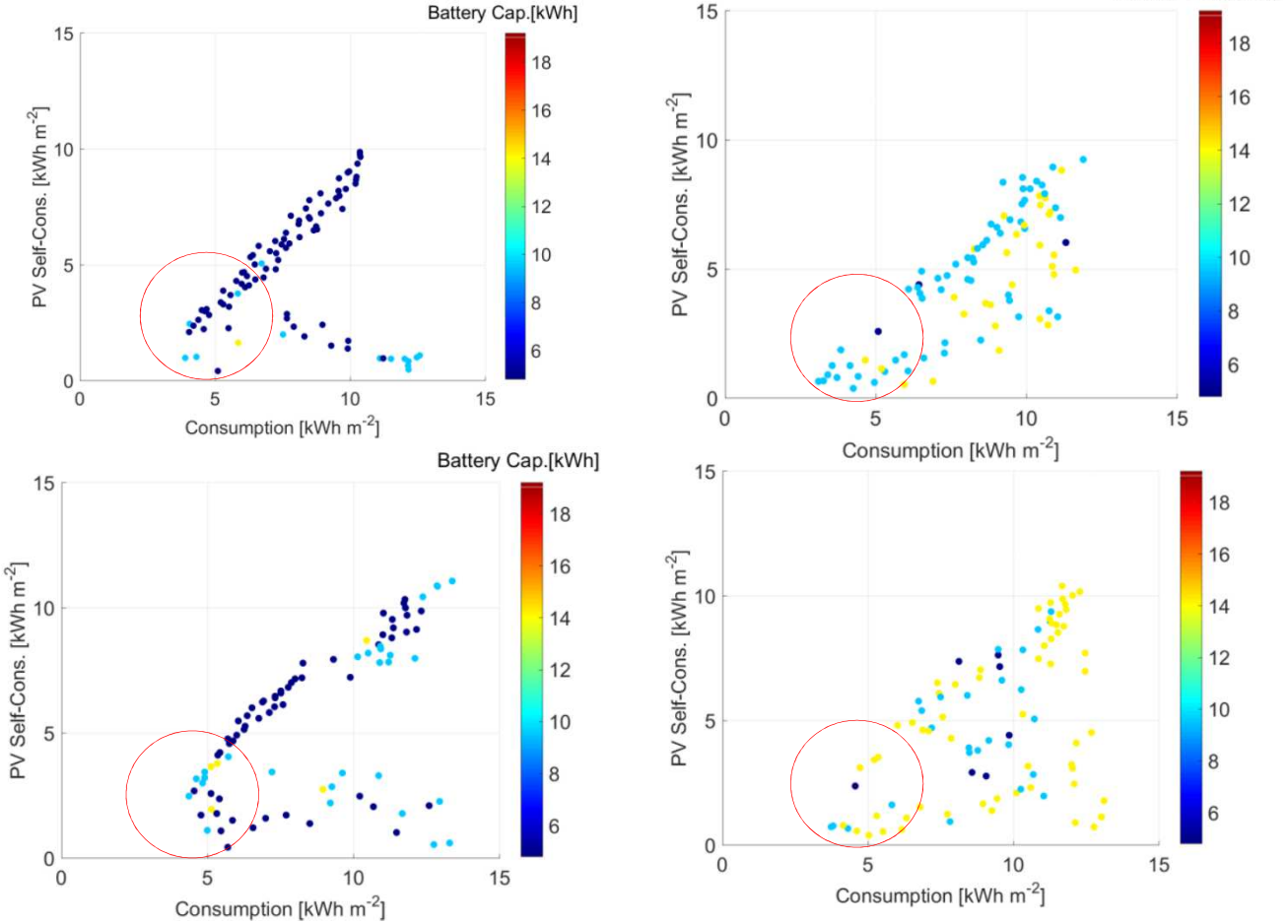
Results: battery capacity

S/V=0.63

S/V=0.3

SOUTH ORIENTED GLAZINGS

EAST ORIENTED GLAZINGS



Limits of the study

Despite we obtained some interesting results, in a MULTI OBJECTIVE OPTIMIZATION PROCESS is not easy to define:

1. how many and which **objective functions** to minimize (or maximize),

2. how many and which **parameters** can be changed.

⇒ Results depend on both these choices and also on the choice of the optimization algorithm: the effectiveness of the multi objective optimization has to be investigated.

⇒ The research work can be extended to a larger variety of buildings and climates.

Thank you for your attention!