INTERACTION HEAT PUMPS AND THE ELECTRICITY GENERATION SYSTEM

System value of residential heat pump demand response

27 September 2017

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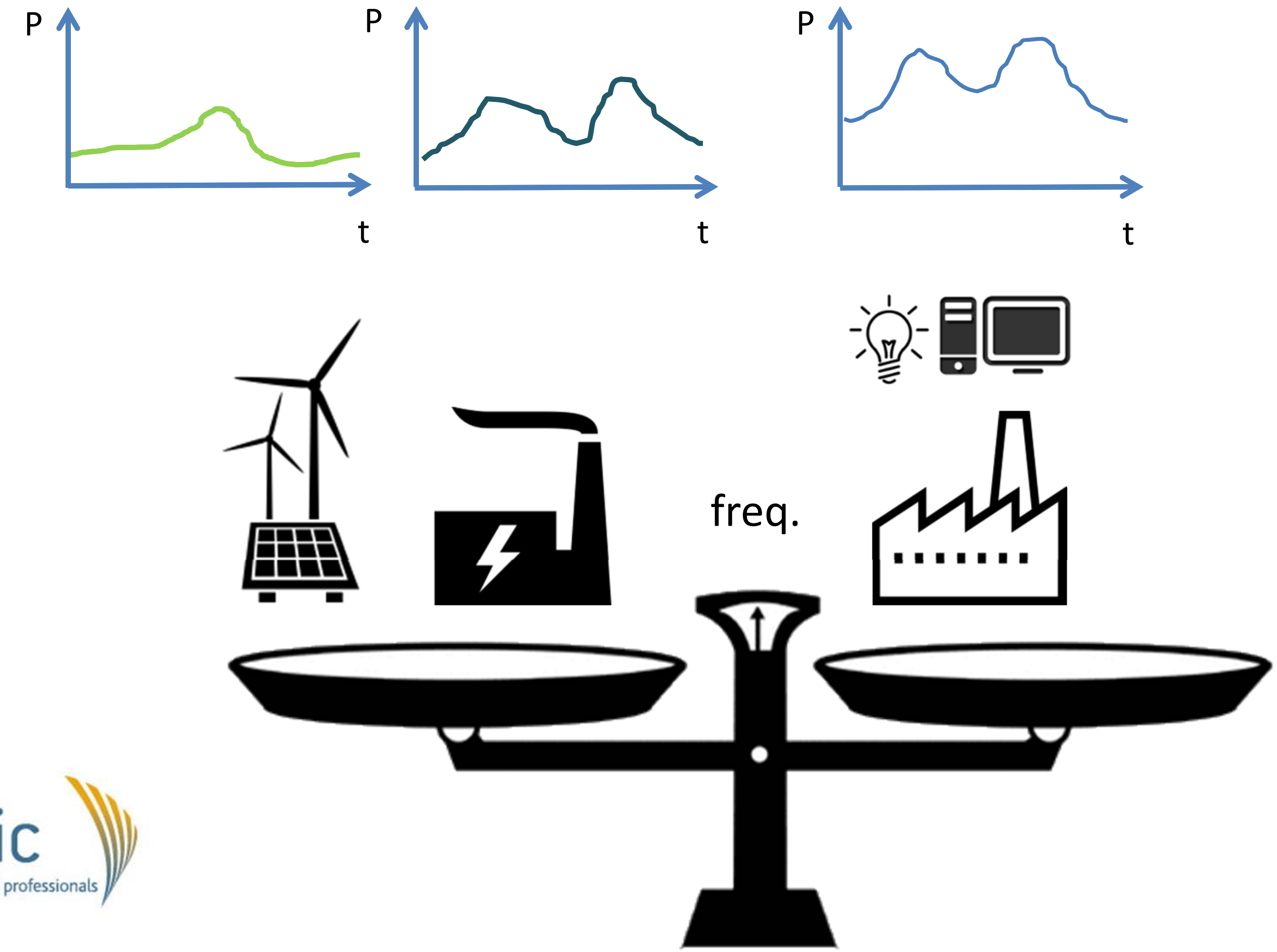
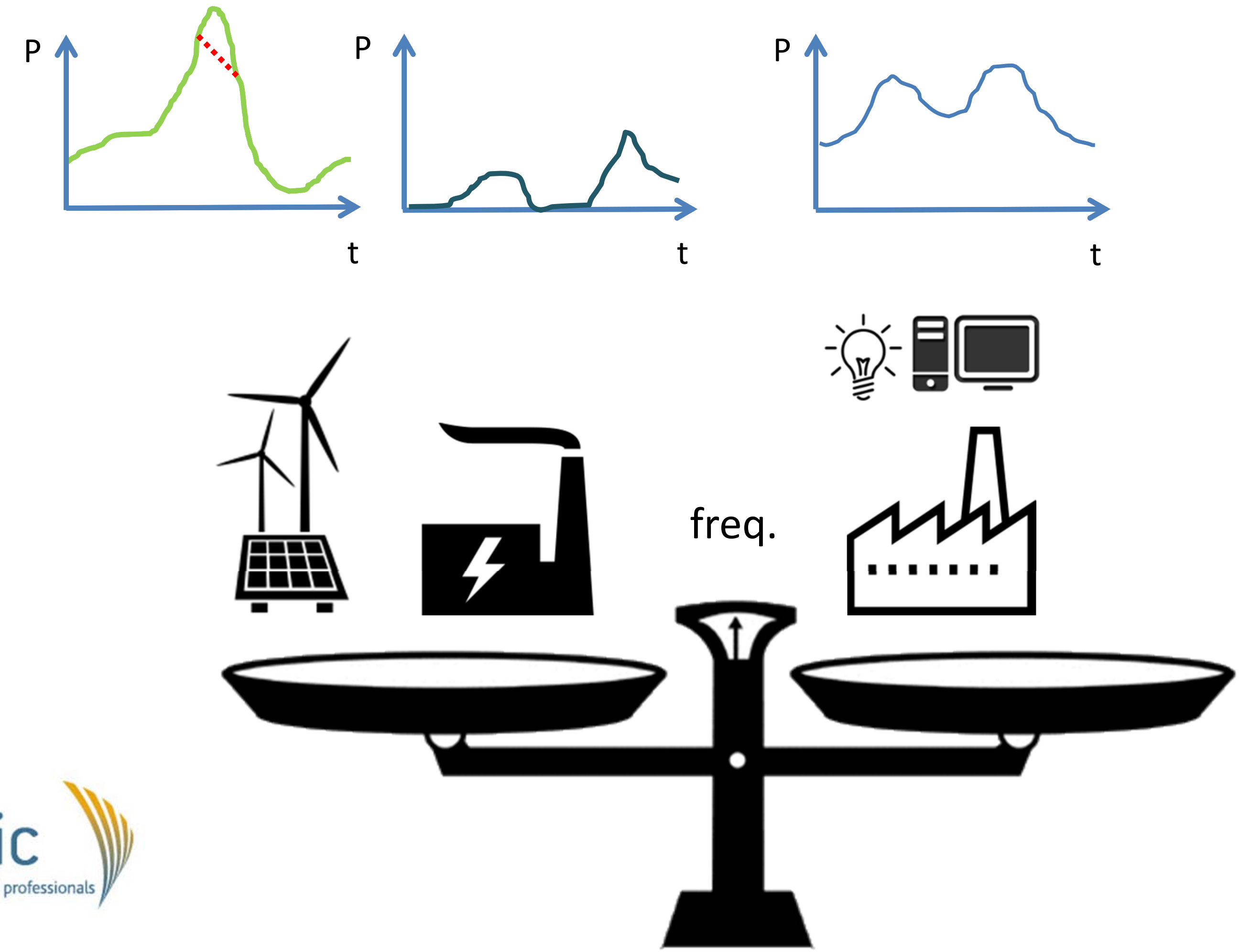
Balance electric grid: now

SUPPLY = DEMAND



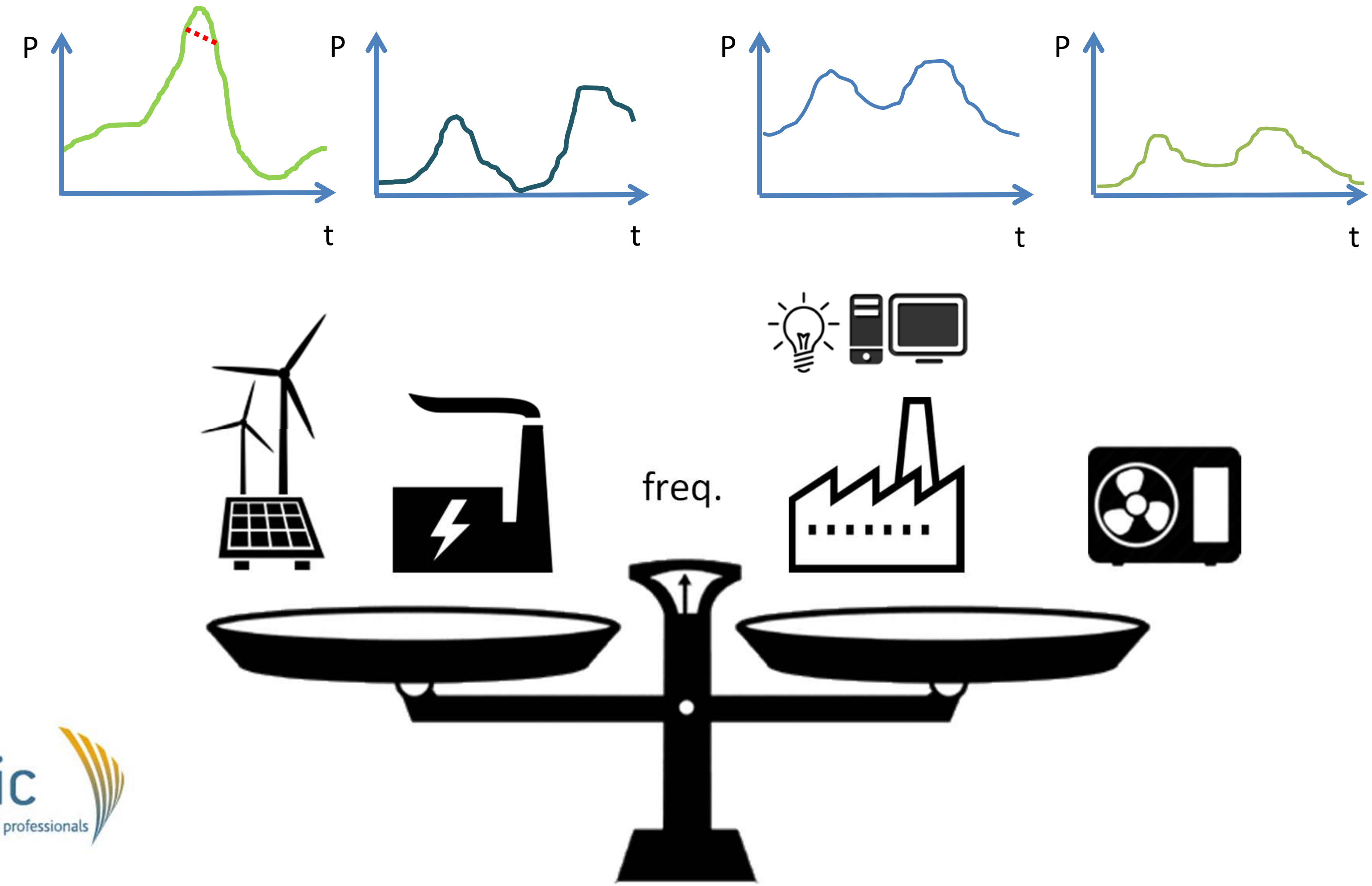
Balance electric grid: future

SUPPLY = DEMAND

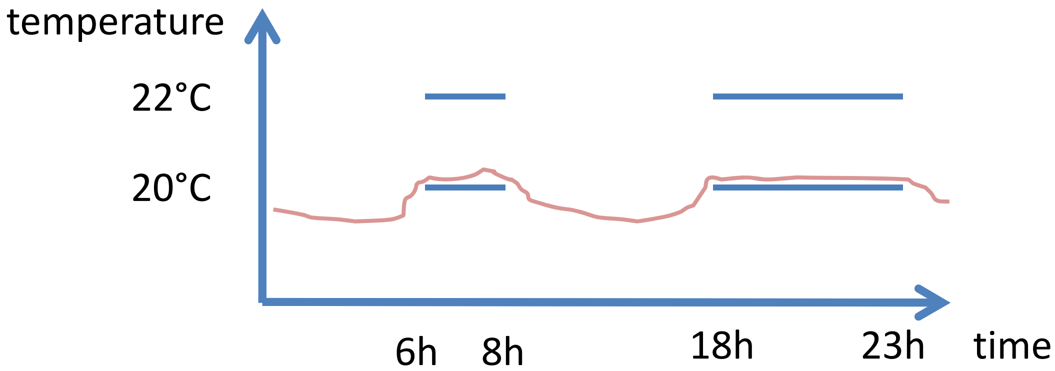


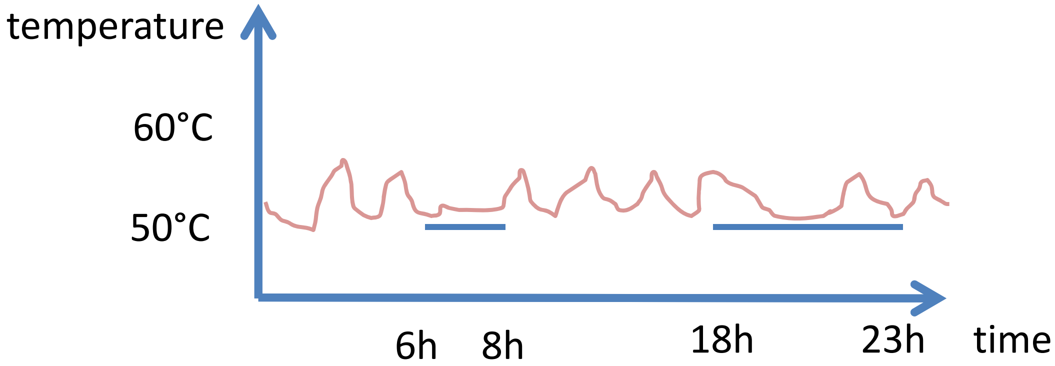
Balance electric grid: future

SUPPLY = DEMAND



Flexibility heat pump





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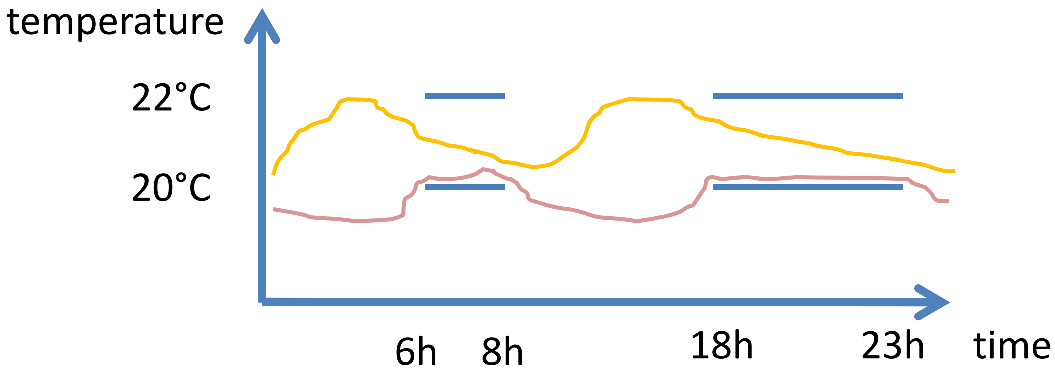
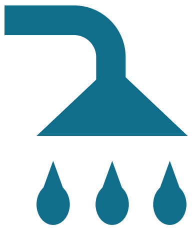
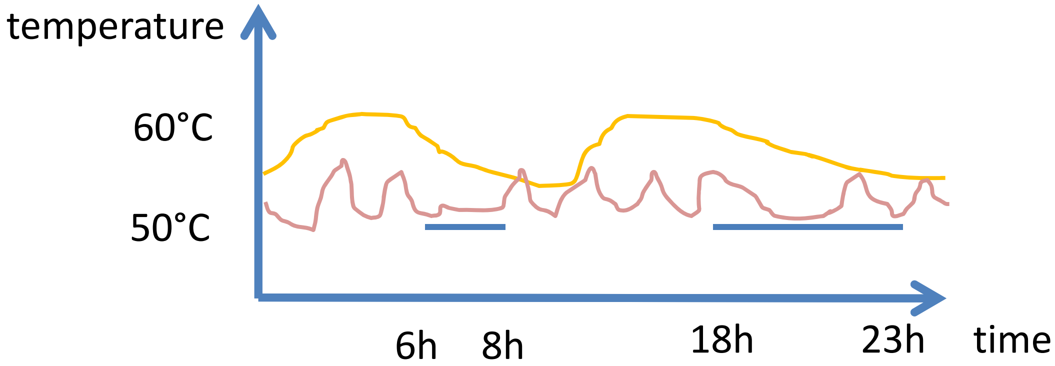
Flexibility heat pump

"Demand response"

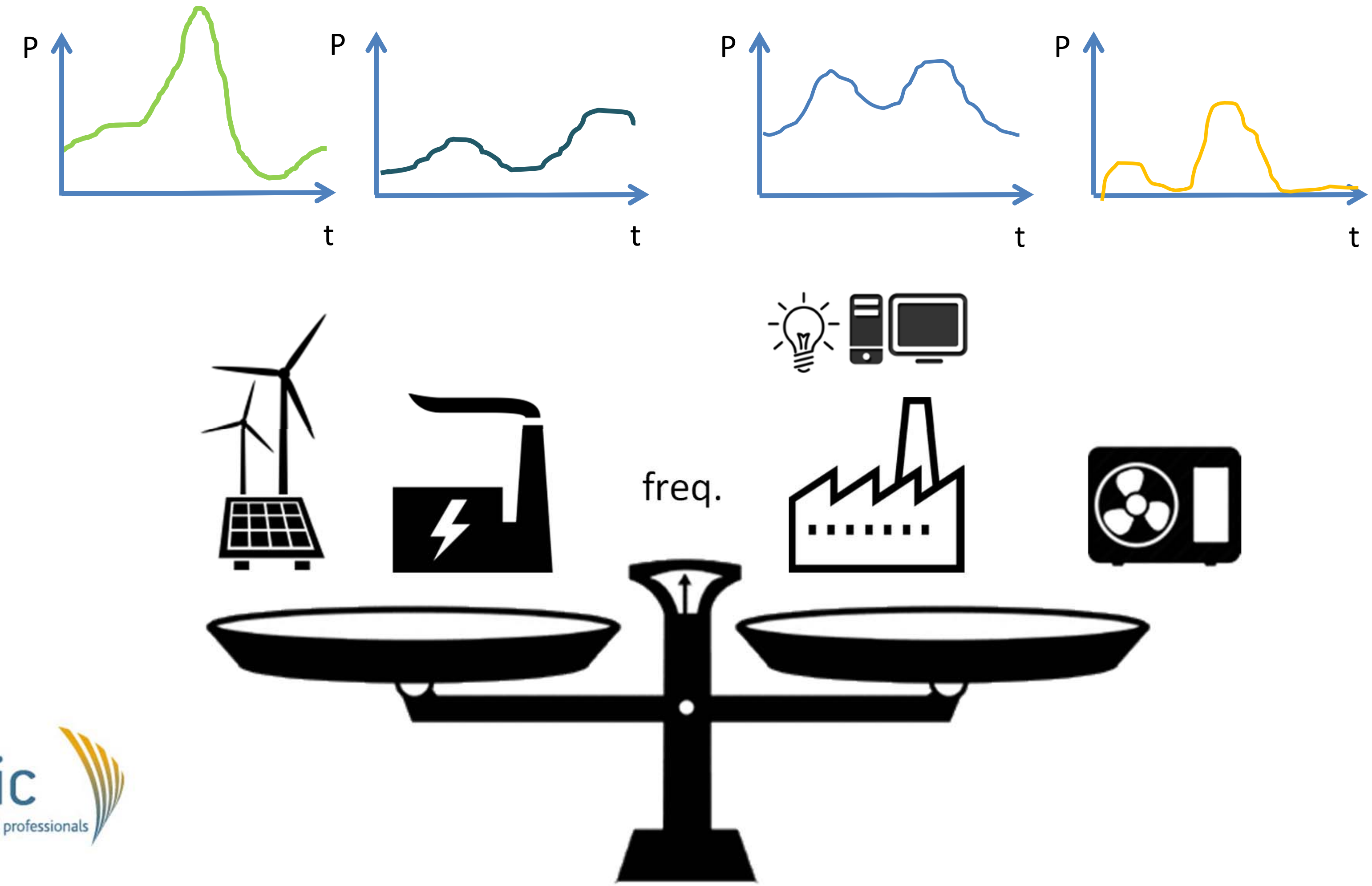






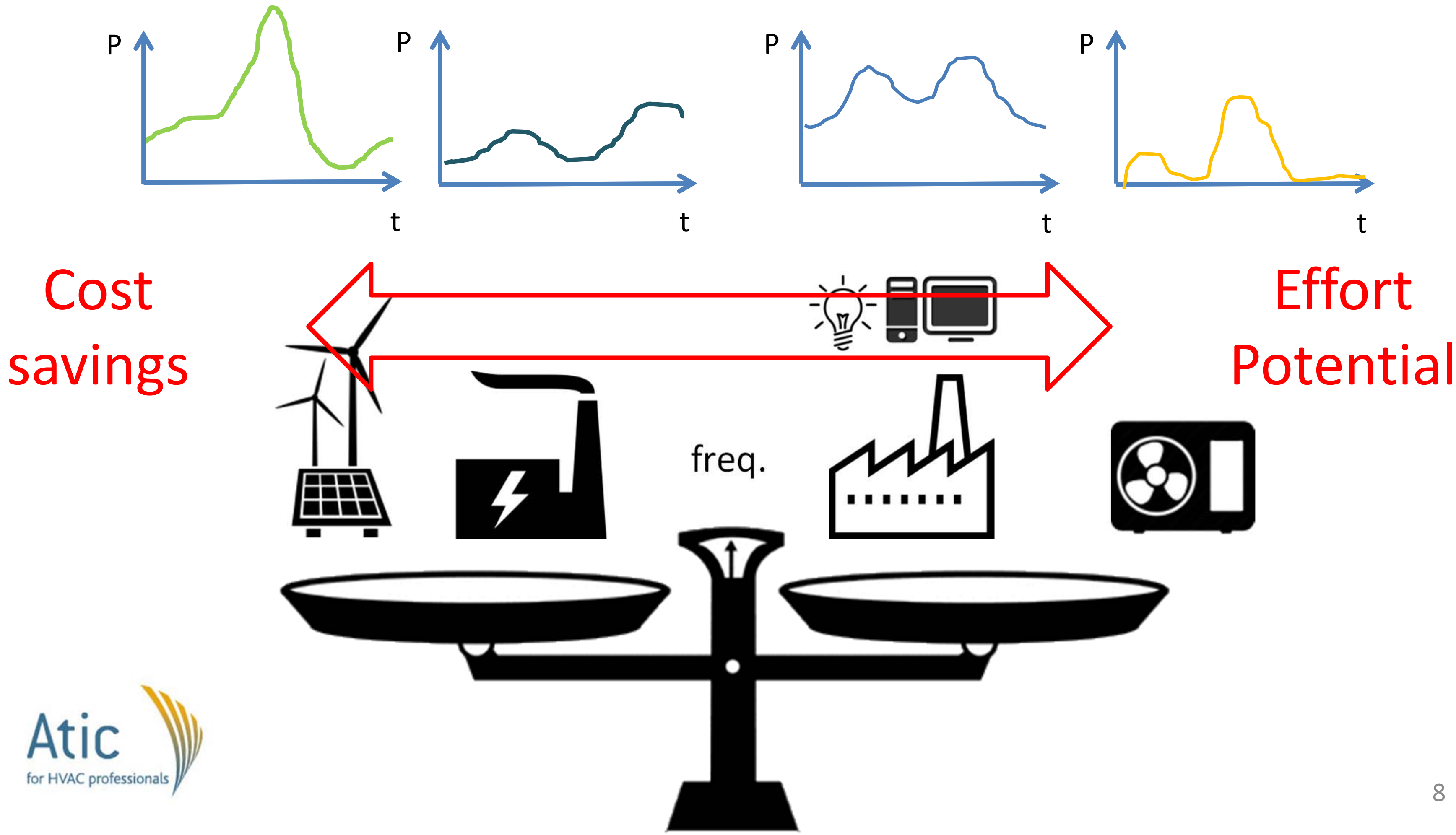
Balance electric grid: future

SUPPLY = DEMAND

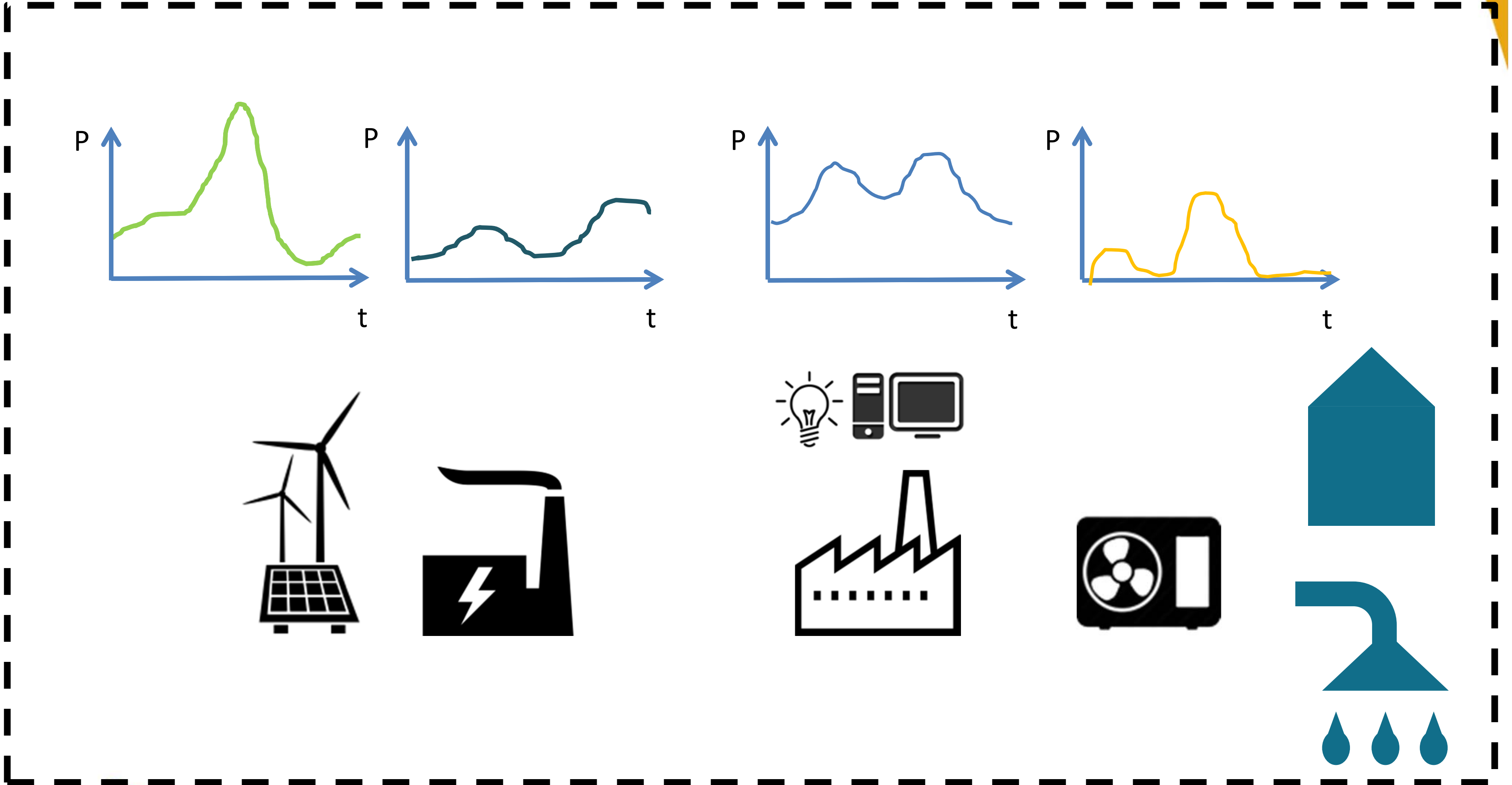


Integrated operational model

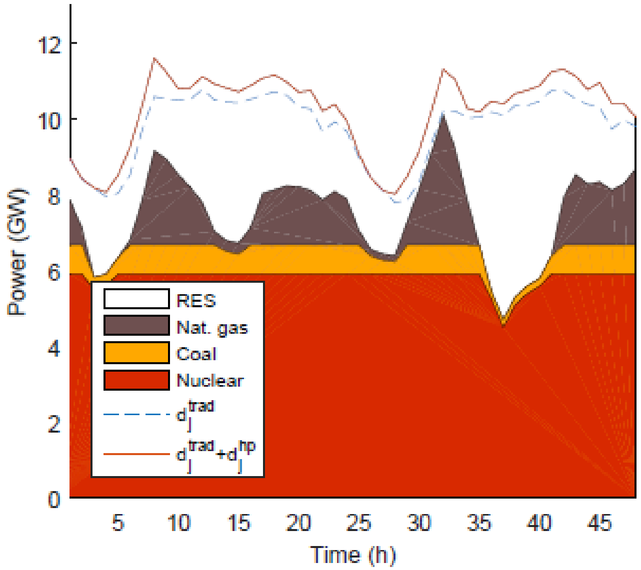
SUPPLY = DEMAND



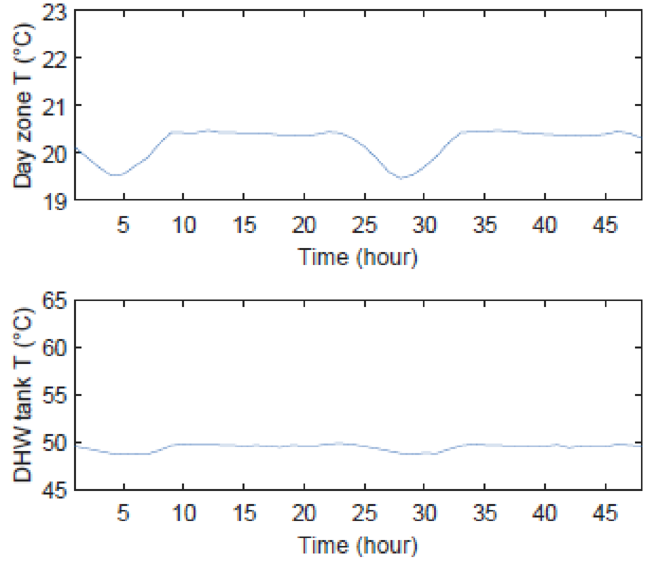
Integrated operational model



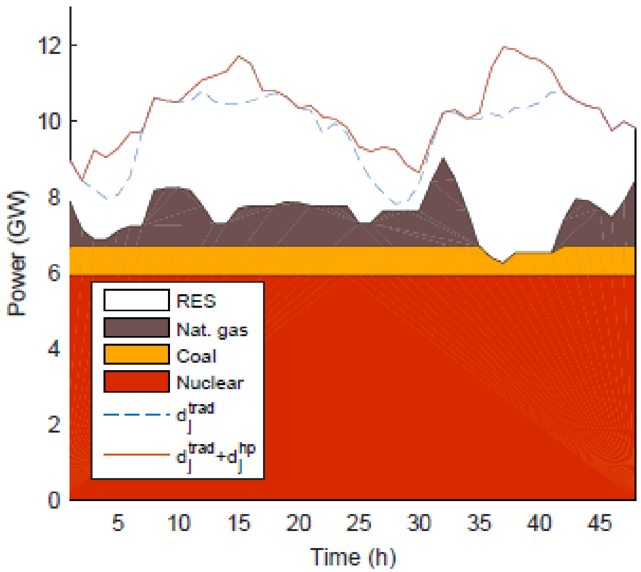
Example output. 2 days



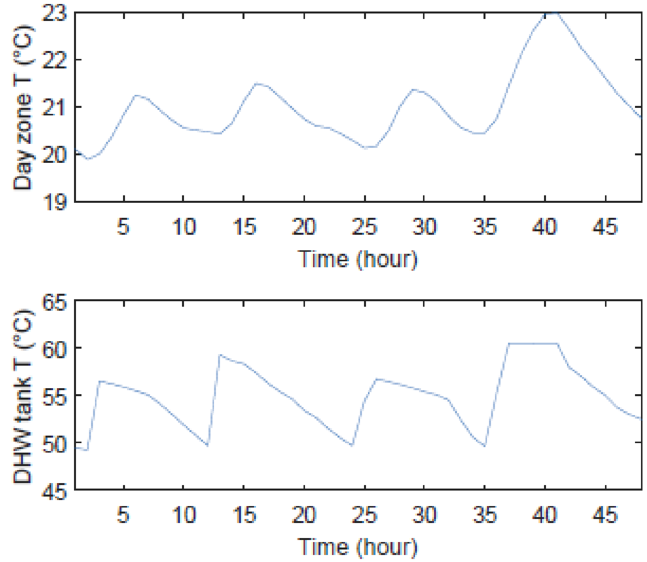
(a) Electricity generation, no DR



(b) Mean temperatures, no DR



(c) Electricity generation, with DR



(d) Mean temperatures, with DR

Overview

- Context
- Integrated operational model
- Highlights research
- Conclusion

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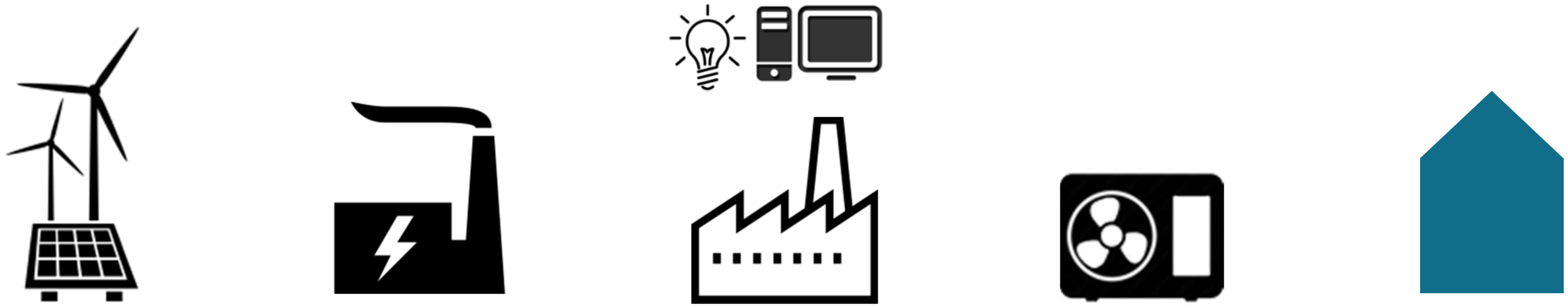
Belgian case study: model

- Scenario 2030
- Impact 250 000 heat pumps with/without demand response



30% wind
10% PV

CCGT
OCGT

Inflexible demand
Profile 2013

3 types
Air HP + rad
Air HP + fh
Ground HP+ fh

6 periods
3 types
2 renovations

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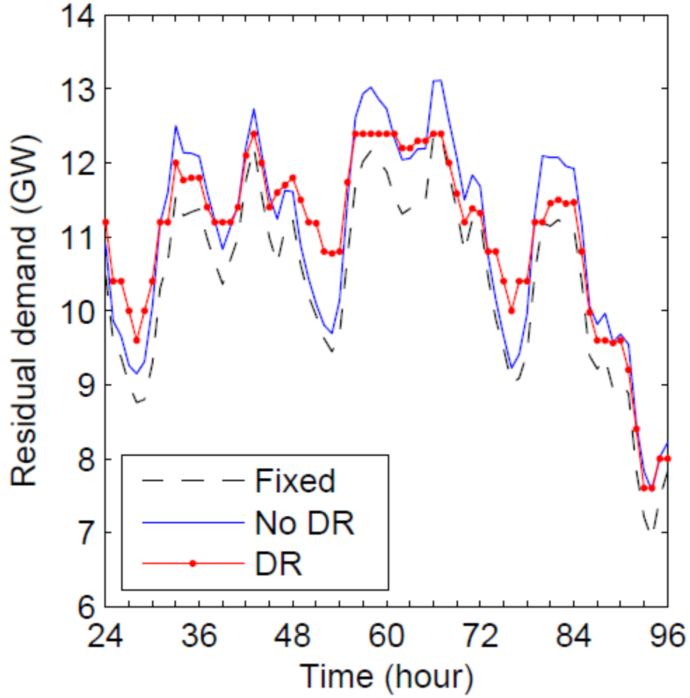
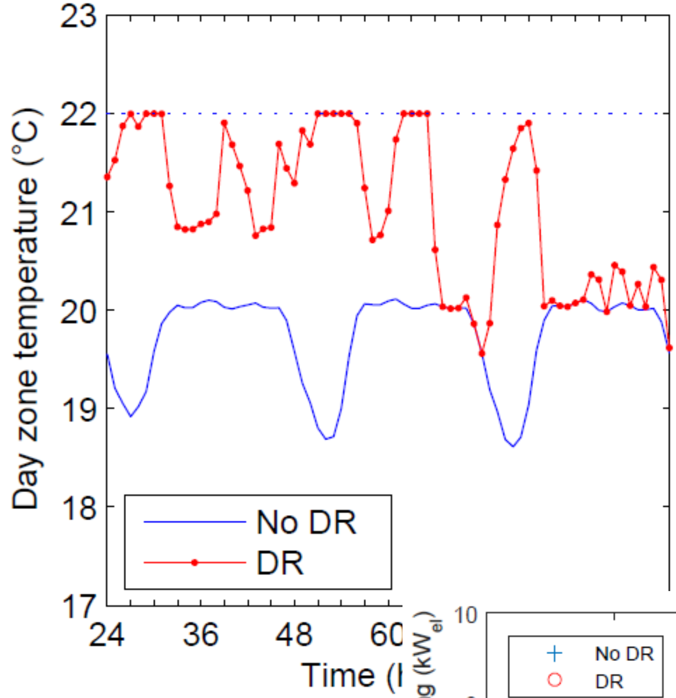
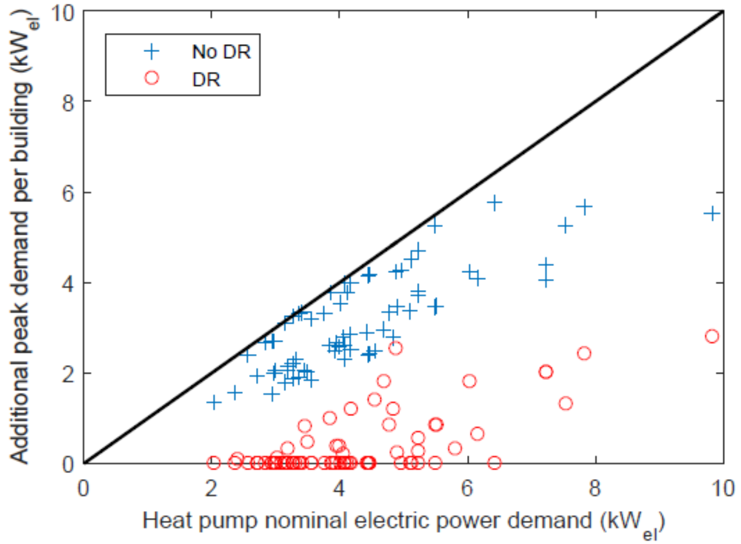
Belgian case study: peak load







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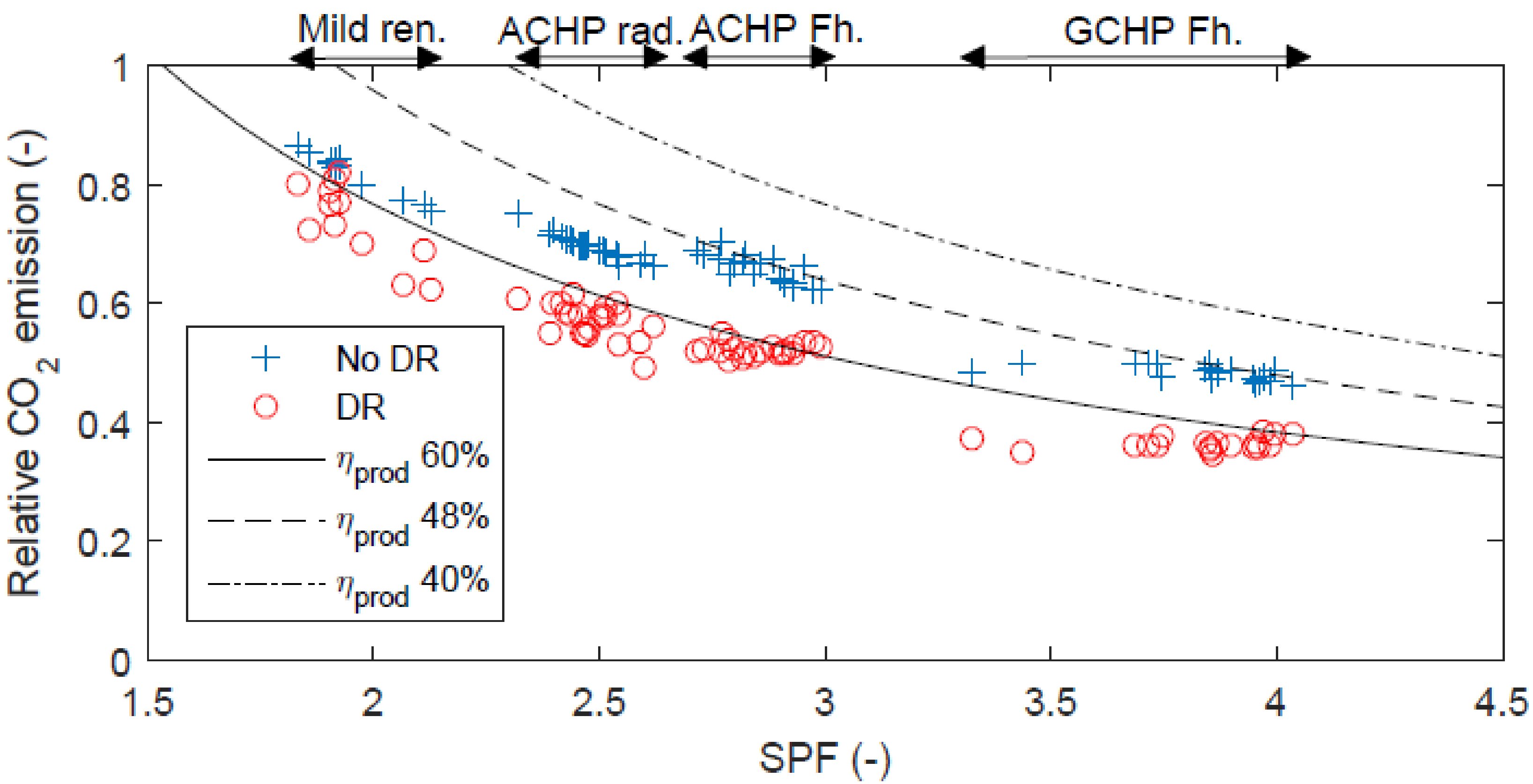
Belgian case study: CO_2

Lower CO_2 compared to a condensing gas boiler



Belgian case study: CO_2 How?

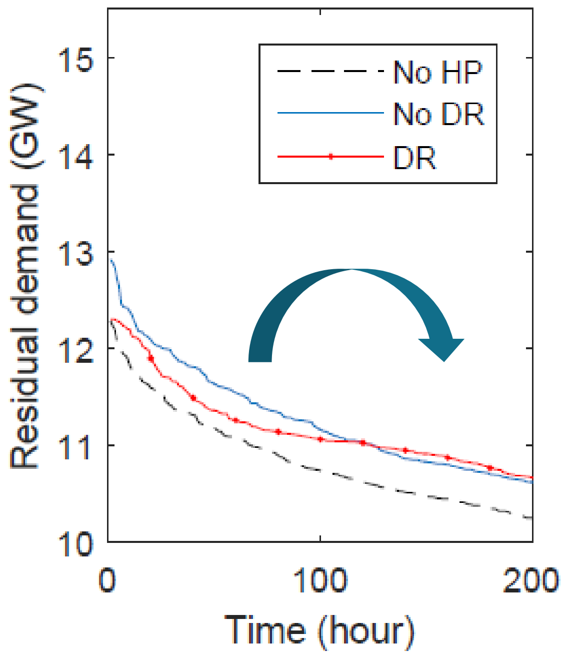
<u>Efficiency</u>

Gas -> CCGT -> Heat pump

1 * 0,5 * 3 - 4

<u>Demand response</u>

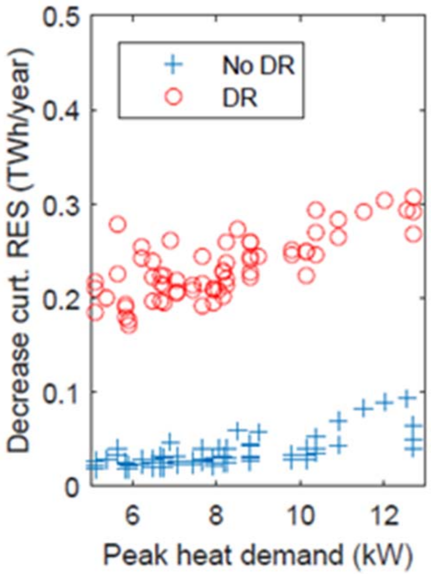
More efficient power plants

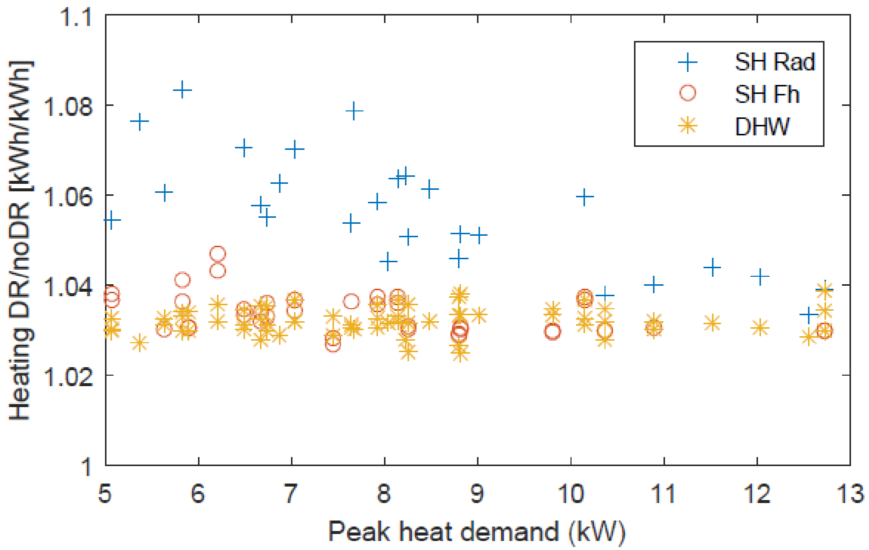


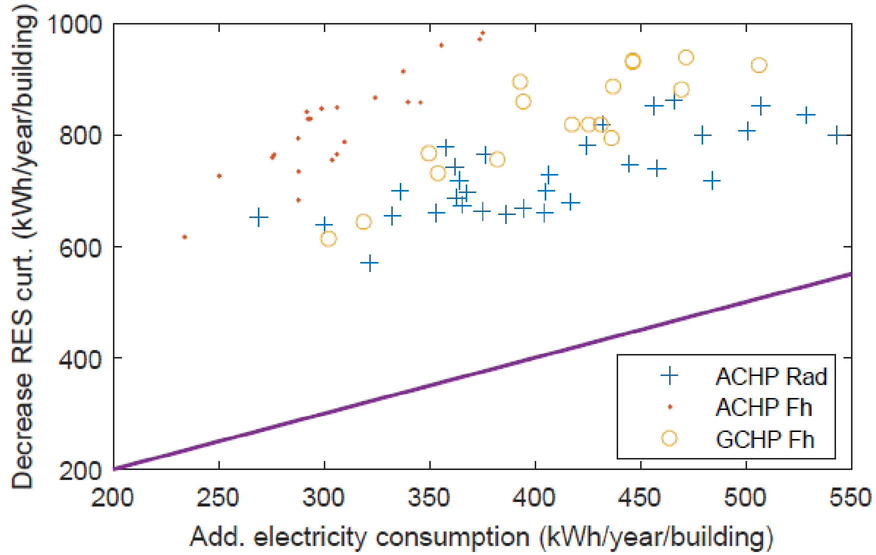
Belgian case study: CO_2 How?

Demand response:

less RES curtailment







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Study: market effects

- Same mix as Belgian case study
- 1 million well-insulated buildings
  - 5 to 100% participation

- Results
  - Max. 150 EUR/a/part. operational
  - Max. 300 EUR/a/part. peak shaving
  - Unnecessary: Larger ΔT , larger hot water tank

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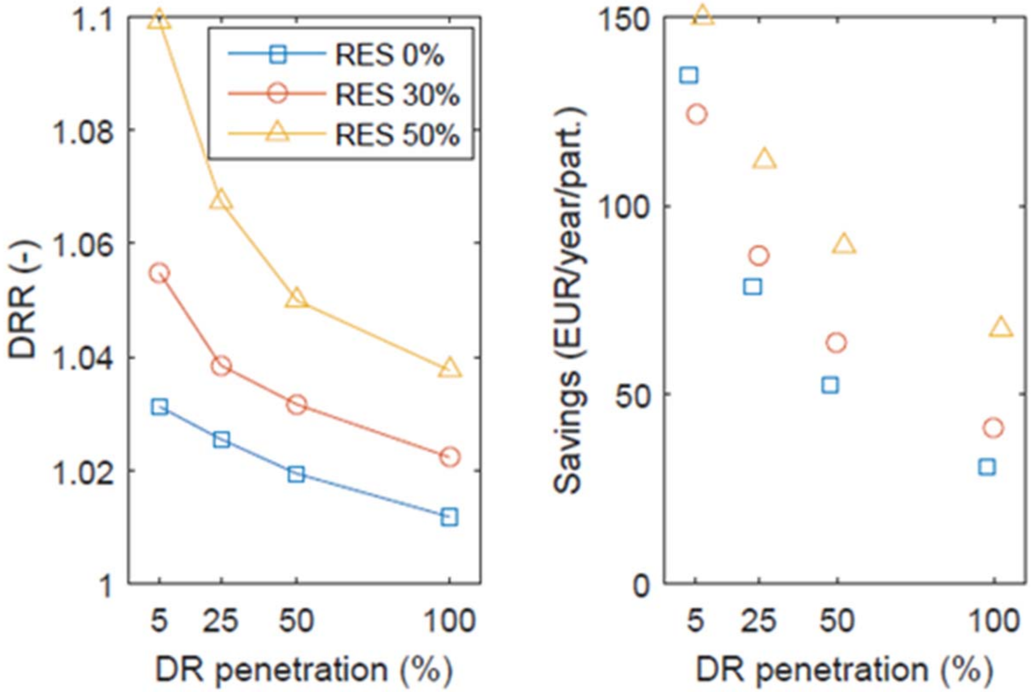
Study: market effects

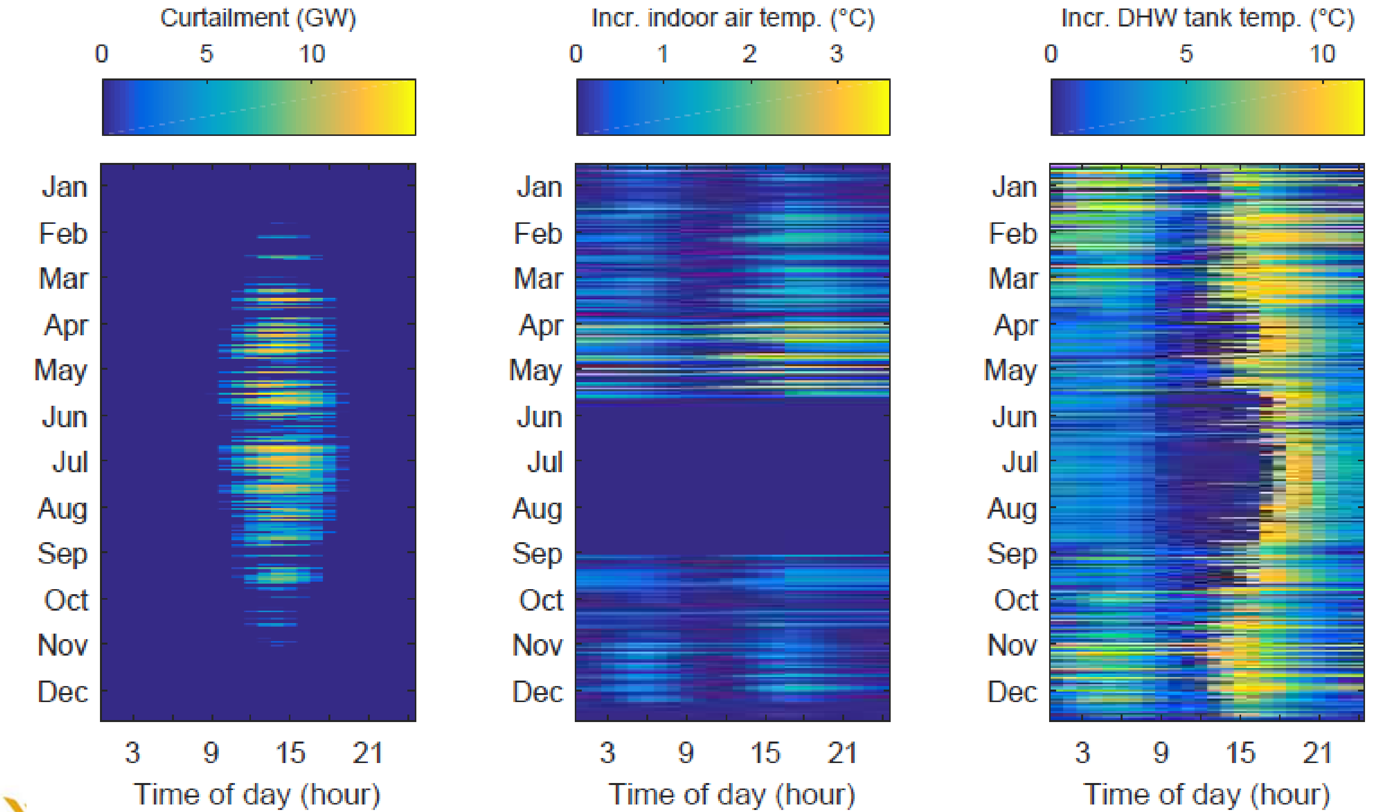
Higher participation rates

-> Lower gains per participant



Study: market effects

- 30% solar



(a) Curtailment 0% DR. (b) Zone temperature. (c) DHW tank temperature.

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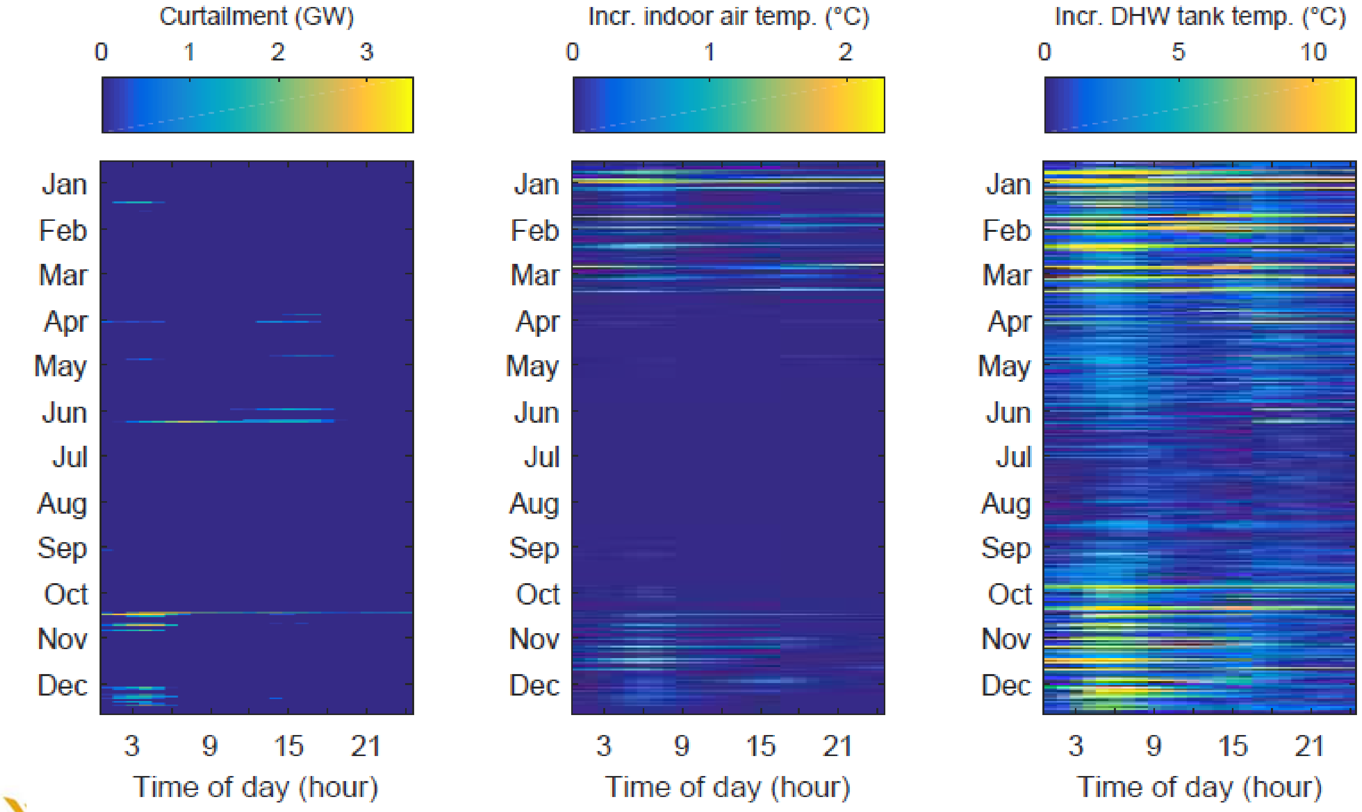
Study: market effects

- 30% wind



(a) Curtailment 0% DR. (b) Zone temperature. (c) DHW tank temperature.

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Conclusion

- Exploration value demand response heat pumps
  - CO_2 reduction 10-20%
  - Reduce peak demand
  - Value 50-400 EUR/part/year
  - 1 to 10% higher electricity use

- PhD text
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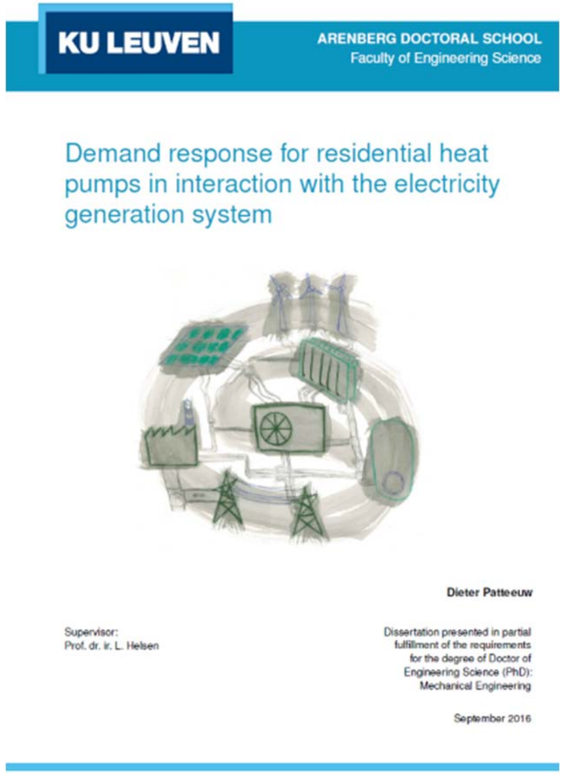
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Faculty of Engineering Science

Demand response for residential heat pumps in interaction with the electricity generation system

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Supervisor:
Prof. dr. ir. L. Helsen

Dissertation presented in partial fulfillment of the requirements for the degree of Doctor of Engineering Science (PhD): Mechanical Engineering

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