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OptHySys

Optimisation of Hybrid Energy Systems

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4DH
4th Generation District Heating Technologies and Systems

Content

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- Goal
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- Conclusions

Background

Why hybrid energy grids?

Increase integration of renewable sources

Improve supply-demand balance

Increase energy savings

Reduce CO_2 emissions

Challenges

- Thorough investigation needed on the real impact and benefits of hybridisation
- Absence of tools for the cooperative simulation of multiple grids

Background

OptHySys - Optimisation of Hybrid Energy Systems

- **Objective**

  Assessment of synergy potentials in the operation of electric distribution grids and district heating networks, on the basis of a relevant scenario in Austria.

- **Period**

  From 01.06.2015 to 31.05.2016

- **Funds**

  Climate and Energy Funds

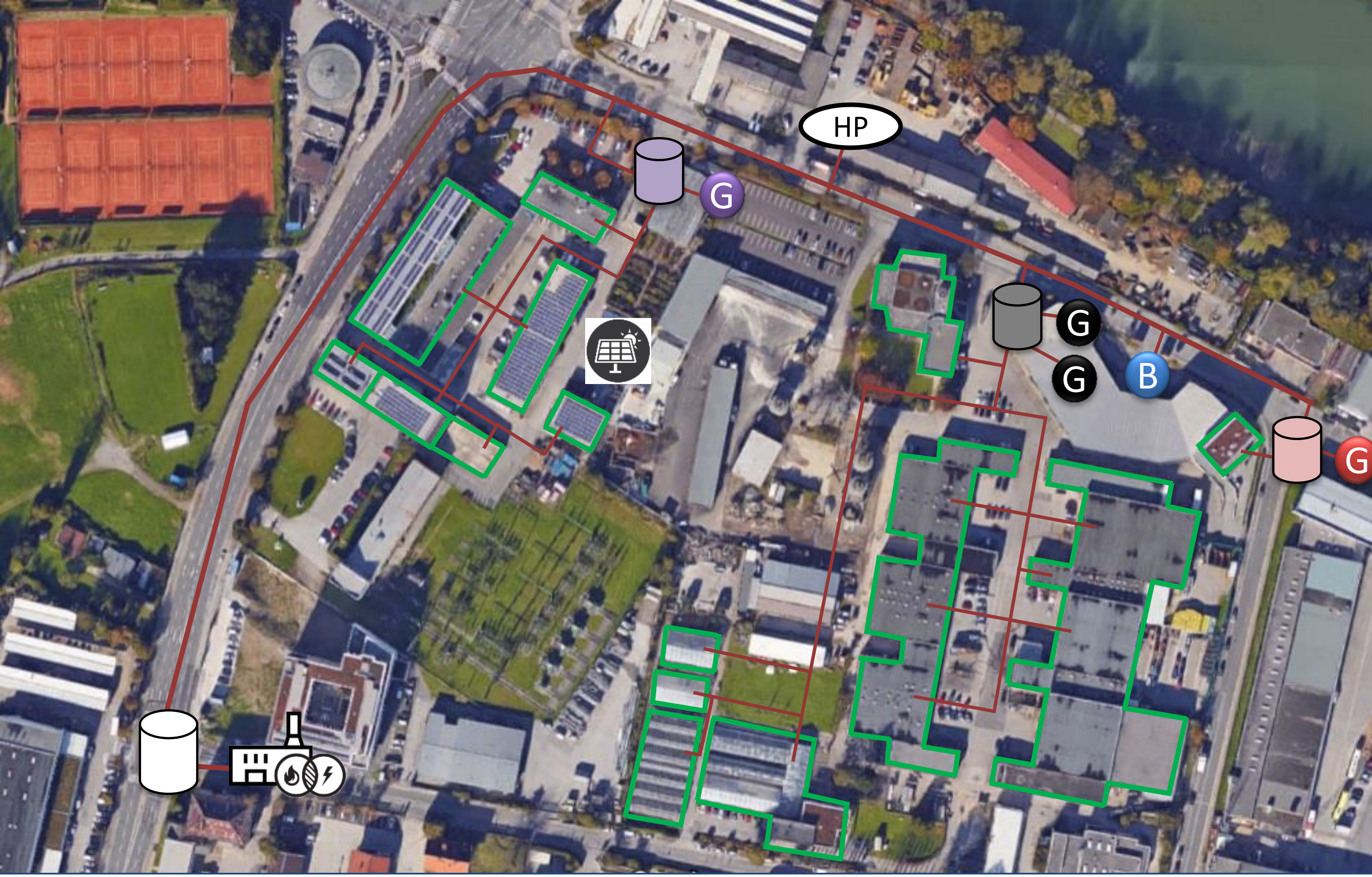
- **Programme**

  Energieforschungsprogramm 2014

Case study

Case study

Case study



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- Gas boiler 630 kW
- Gas boiler 865 kW
- Gas boiler 80 kW
- Biomass boiler 950 kW
- PV system 160MWh/year
- CHP 257 kW th./ 200 kW el.
- HP Heat pumps

Goal

- Design and operational optimisation of a hybrid energy system in Innsbruck.
- The following goals have guided the optimisation process:
  - maximisation of the local consumption of on-site PV generation for thermal production
  - minimisation of on-site CO_2 production
  - minimisation of electricity imported from the external grid
- Methodology:
  1. Development of the controller.
  2. Modelling of the thermal and electric grid.
  3. Coupling of the thermal, electric grid and controller (co-simulation)

Controller

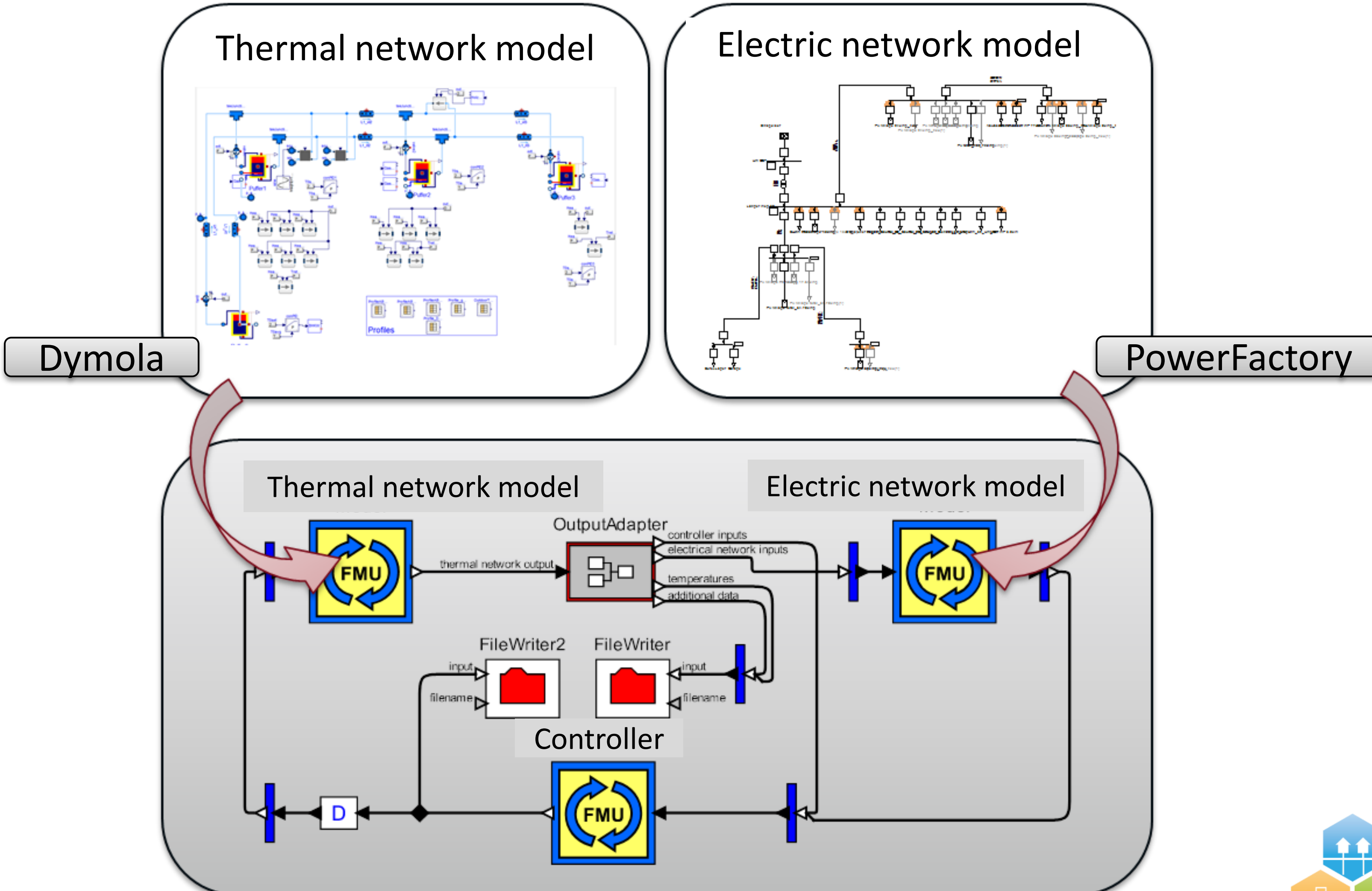
Operational strategy

- Sufficient PV production?
  (1) Run heat pumps with the highest priority.
- Heat pumps cannot cover the demand?
  (2) Run biomass boiler.
- Demand still cannot be covered entirely?
  (3) Run the CHP.

Implementation

- The formulation of the goals from above is programed as a linear optimisation problem.
- Optimal heat flows are calculated in real-time.
- System operational constraints are taken into account.

Co-simulation setup



Design optimisation

Design optimisation variations

- Storage volume

Address	Variation 1	Variation 2
Rossaugasse 2	15 m^3	20 m^3
Rossaugasse 4	25 m^3	30 m^3

Assessment of the potential of HP integration

- Heat pump size

Address	Variation 1	Variation 2	Variation 3
Waste water	100 kW	150 kW	200 kW
Ground water	50 kW	50 kW	50 kW

The ground water HP is used as backup due to its lower efficiency compared to waste water HP.

Design optimisation

System configurations

heat pumps

maximize usage of local PV generation

thermal storages

assessment of the potential for heat pump integration

- basically same performance w.r.t. thermal KPIs
- slighltly worse performance w.r.t. electrical KPIs
- needs more actuation of production plants

config4 | **config5** | **config6**

Design optimisation

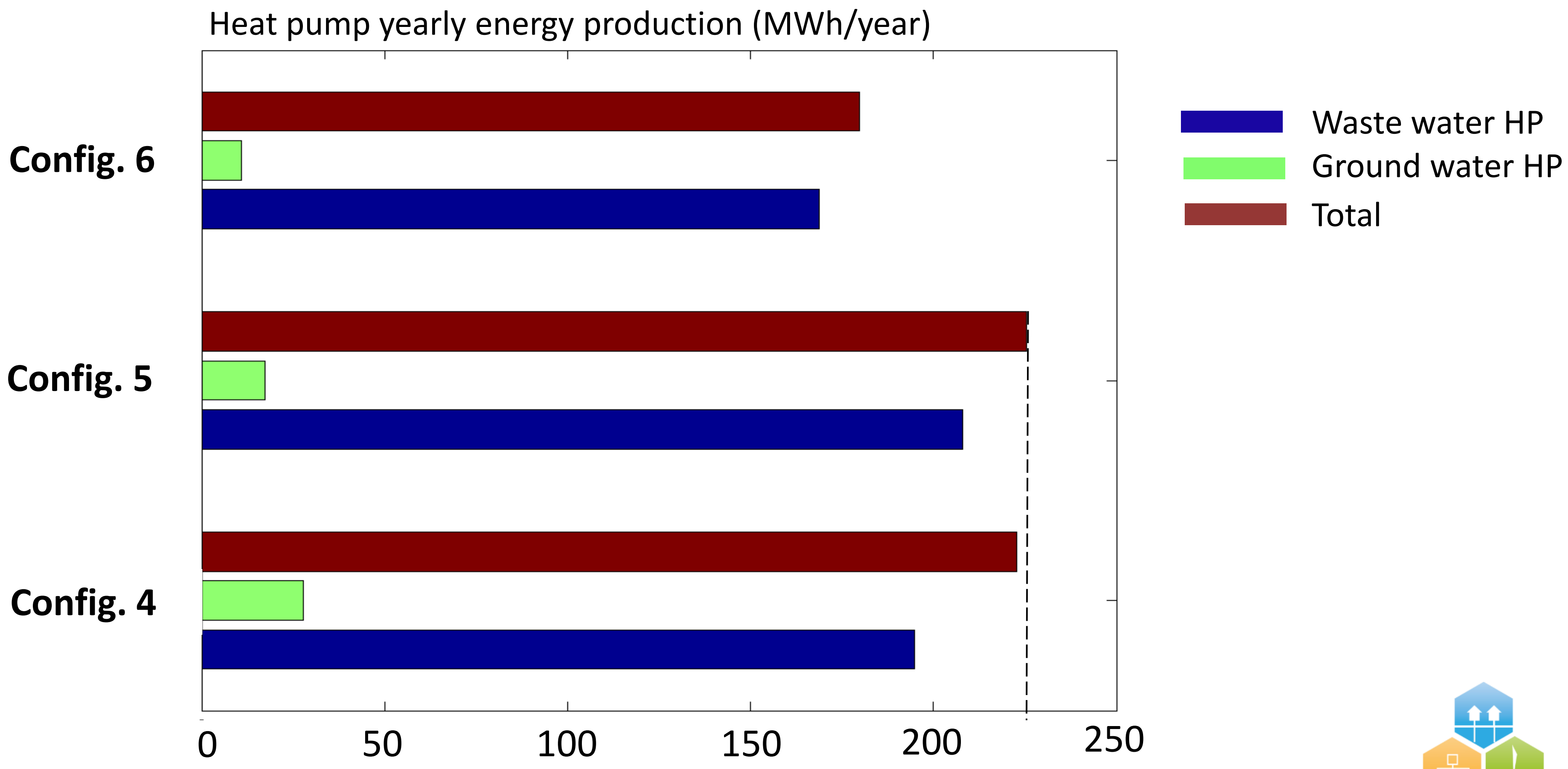
Sizing of the heat pumps

Explotation of local production from PV:

- *small size* heat pump configuration (*config4*) → limited by **maximal electrical consumption**
- *large size* heat pump configuration (*config6*) → limited due to high **operational production threshold**
- *medium size* heat pump configuration (*config5*) → **optimal compromise** between *config4* and *config6*

Design optimisation

Sizing of the heat pumps



Design optimisation

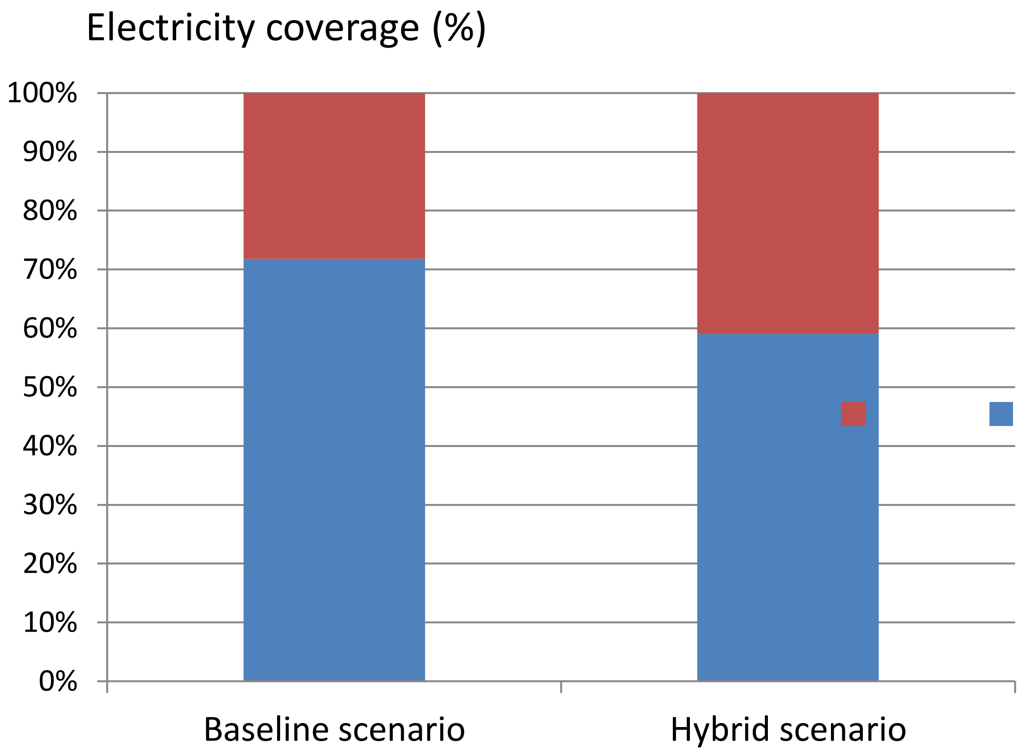
Sizing of the heat pumps

heat pumps

Thermal storages		small size configuration WWHP: 100 kW GWHP: 50 kW	medium size configuration WWHP: 150 kW GWHP: 50 kW	large size configuration WWHP: 200 kW GWHP: 50 kW
	small size configuration RG 2: 15 m^3, RG 4: 25 m^3	**config1**	**config2**	**config3**
	large size configuration RG 2: 20 m^3, RG 4: 30 m^3	**config4**	**config5**	**config6**

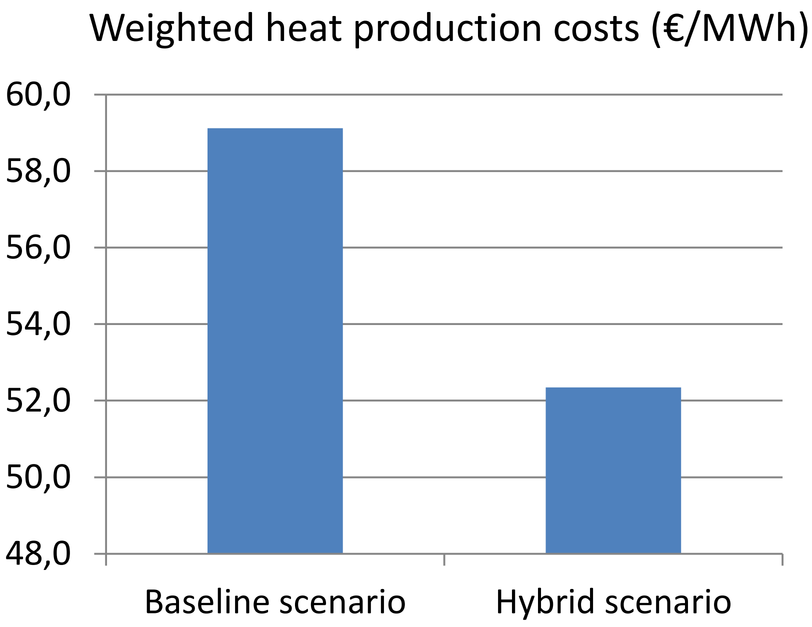
Goals achieved?

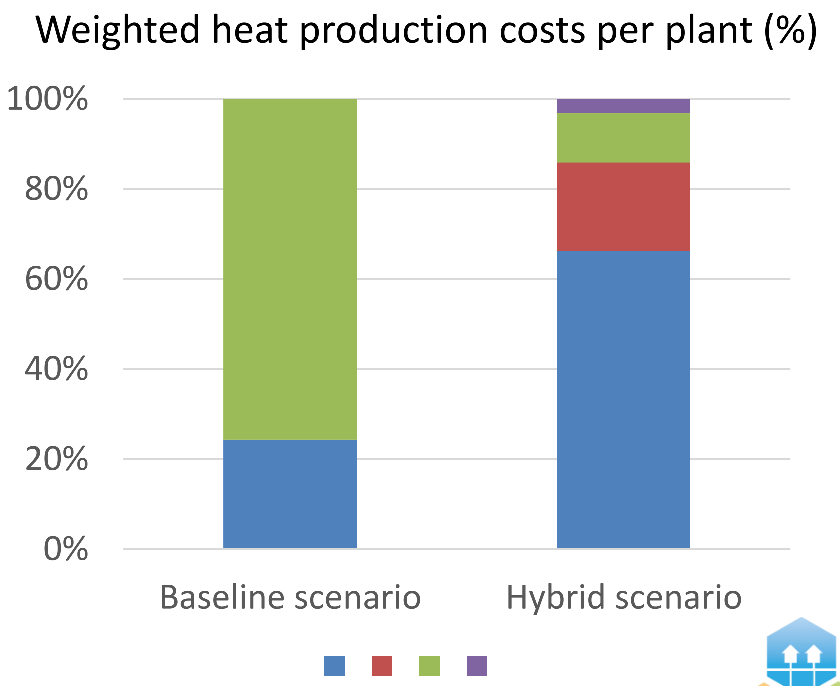
Integration of renewable sources increased?



Goals achieved?

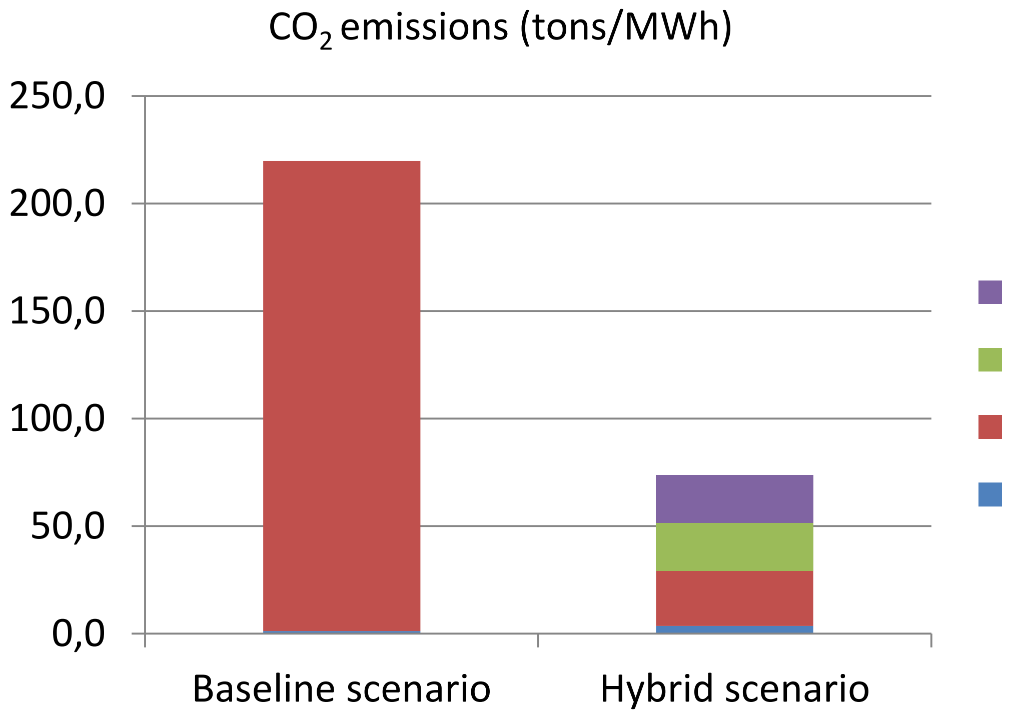
Energy savings increased?





Goals achieved?

CO_2 emissions decreased?



Conclusions

- The methodology presented enables the evaluation of the sinergies between multiple energy grids.
- Development of a cosimulation environment to simulate multiple grids
- Increase of PV integration (13%)
- Reduction of CO_2 emissions (60%)
- Further demonstration projects would allow to verify the potential of hybridisation

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Thank you for your attention.

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