

**energy resources:**

solar
geothermal
oil and gas
wood
grid electricity



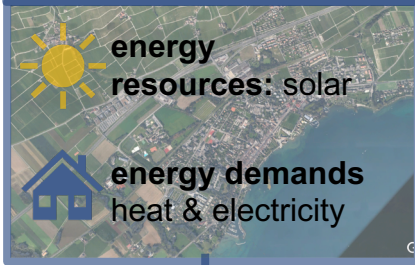
energy demands
heat & electricity

Simultaneous optimization of distributed energy systems connected to thermal network considering robust operation

Muriel Beaud, Amarasinghage Tharindu Dasun Perera, Hanmin Cai, Andrew Bollinger, Kristina Orehounig

Methodology

Rolle case data:



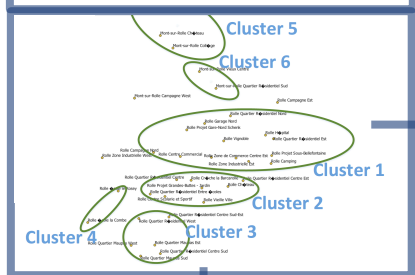
Technology data:

Technical parameters of conversion, storage and network technologies

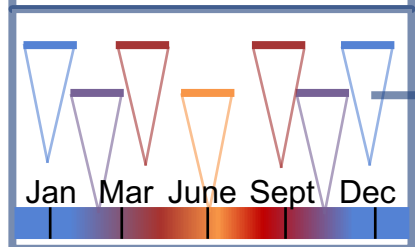
Parameter specifications:

Economical parameters of conversion, storage and network technologies

Spatial Aggregation:



Temporal Aggregation:



Ehub Tool

Individual Hub Analysis

3 typical clusters



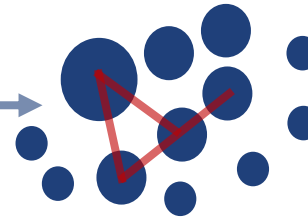
• *The following slides will show the results & conclusion of the Individual Hub Analysis with 3 different urban densities*

12 clusters



Thermal Network Design

4 clusters



Demand Resilience

4 clusters heat demand



Grid-Dependency with different hub densities

Hub 1



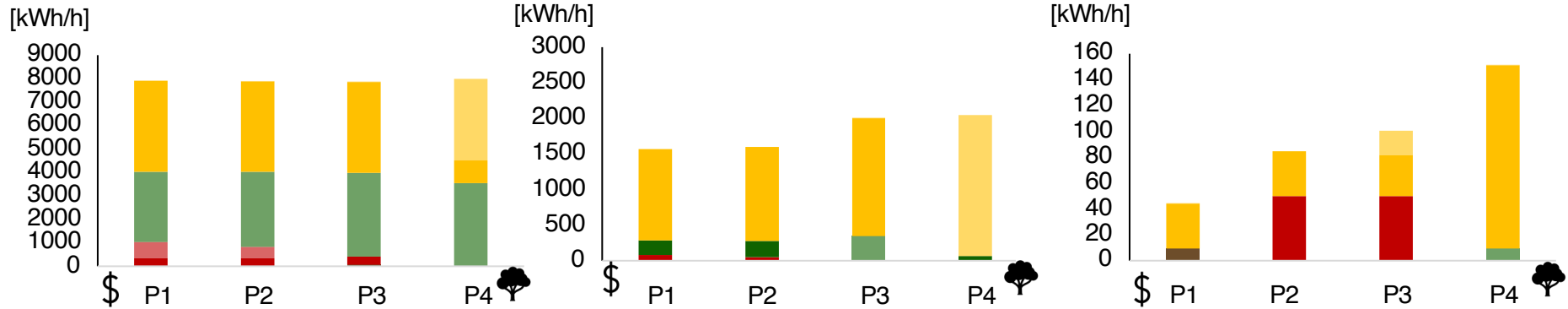
Hub 4



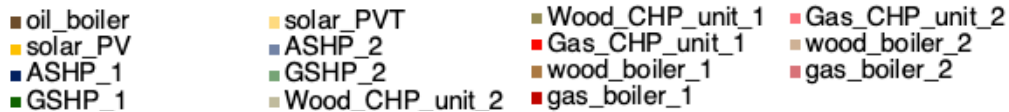
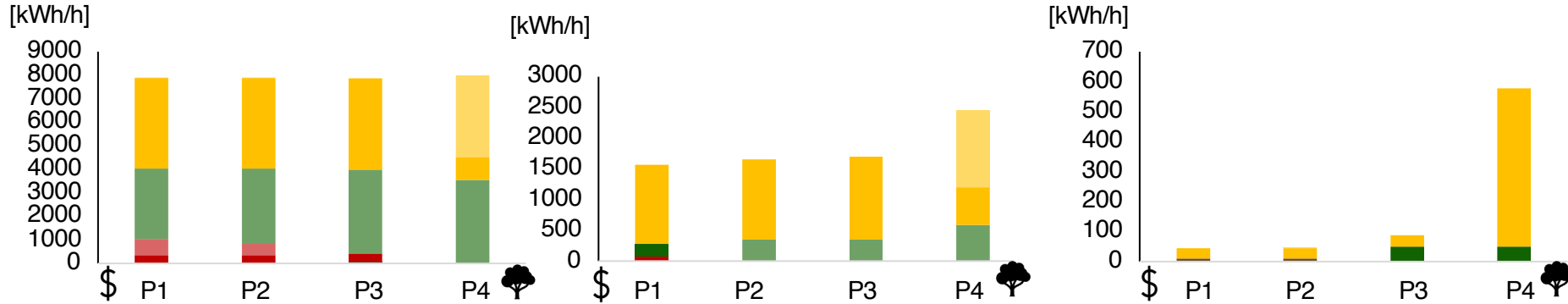
Hub 8



Standalone



Interconnected

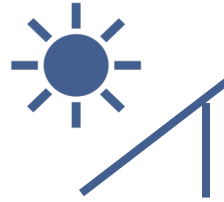


Economic Sensitivities of overall system

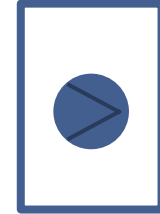
Smaller system (3 out of 12 clusters)



electricity export price
 [0.05 CHF/kWh]
 [0.15 CHF/kWh]



PV-investment cost
 15 % and 30% reduced



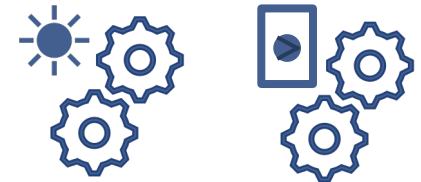
HP-investment cost
 10% and 20% reduced



reduced storage cost
 12.5% and 30%



red. and incr. fuel costs
 15%

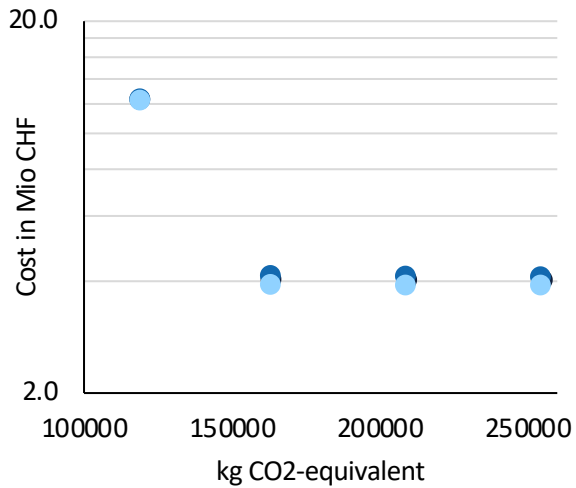


increased efficiency
 HP and PV
 15%

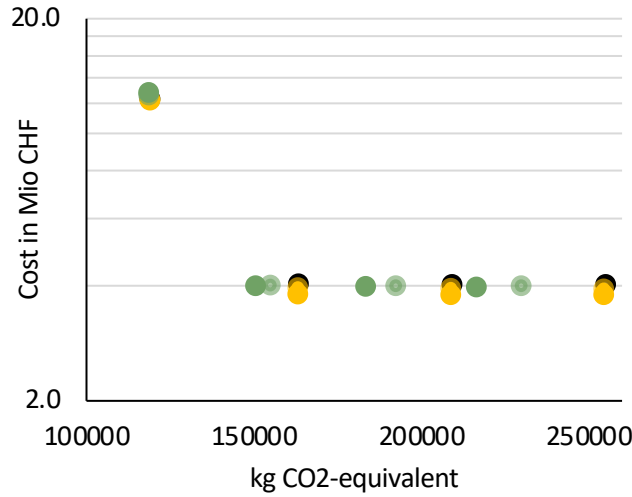
One Combination of several scenarios

- 30% reduced PV-investment costs
- 30% reduced storage costs
- 15% increase in grid injection & fuel costs
- 20% reduced HP-investment costs
- 15% increase in HP and PV efficiencies

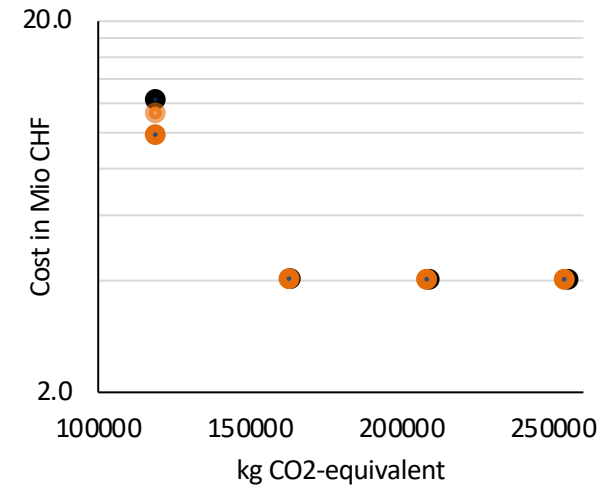
Pareto fronts: economic sensitivities



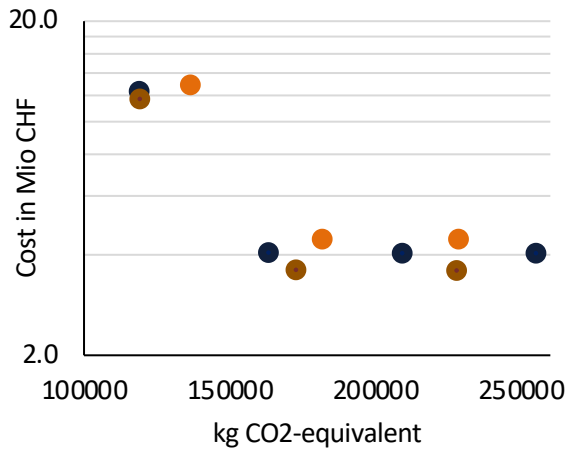
- [0.12 CHF/kWh]
- [0.15 CHF/kWh]
- [0.05 CHF/kWh]



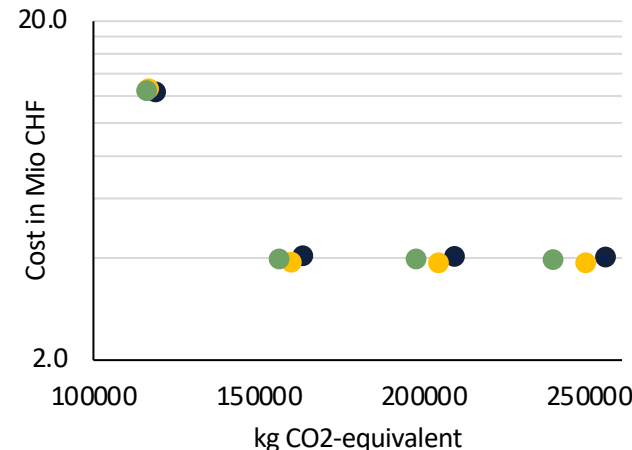
- Base case
- -10% HP-invest
- -20% HP-invest
- -15% PV-invest
- -30% PV-invest



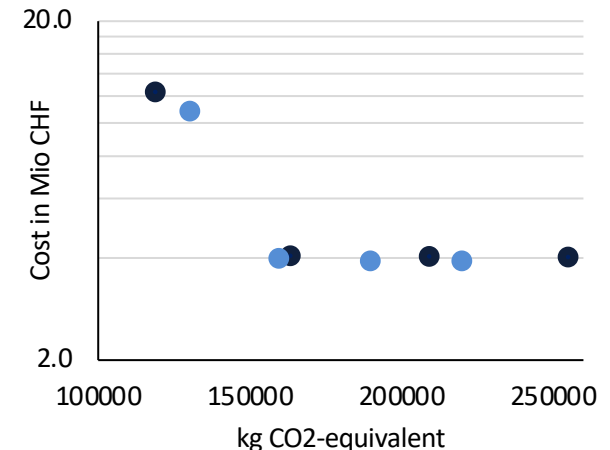
- Base case
- -12.5% storage costs
- -30% storage costs



- Base case
- -15% fuel costs
- +15% fuel costs



- Base case
- +15% PV efficiency
- +15% HP efficiency



- Base case
- combination of scenarios

Economic sensitivities of different hub densities

Hub 1



Hub 4

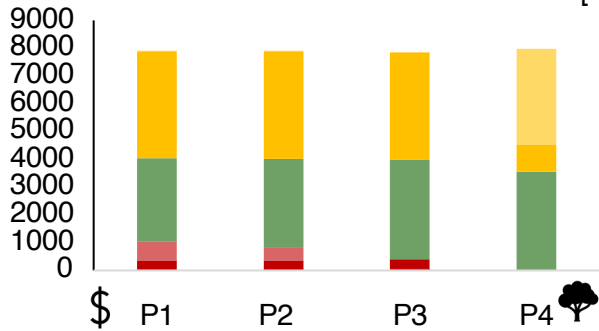


Hub 8

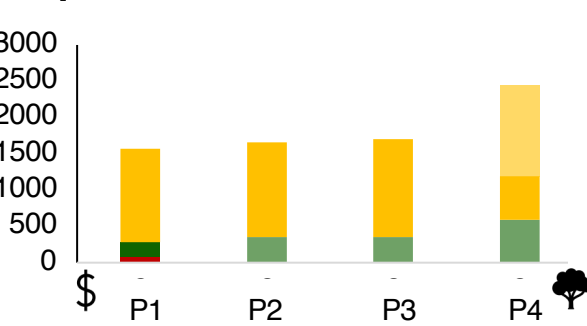


Base case

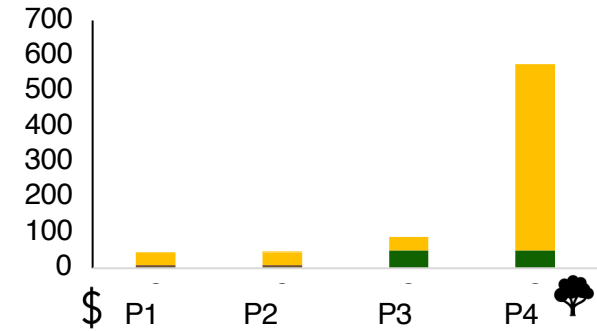
[kWh/h]



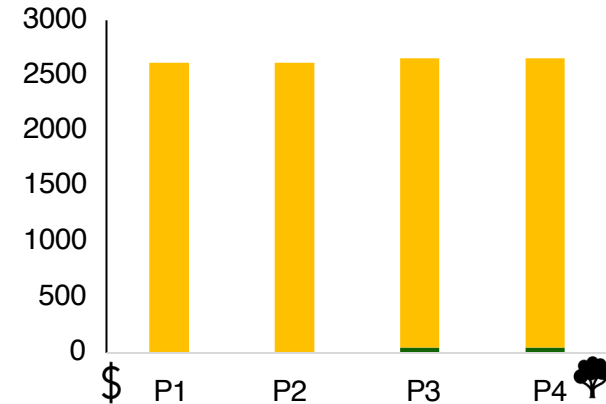
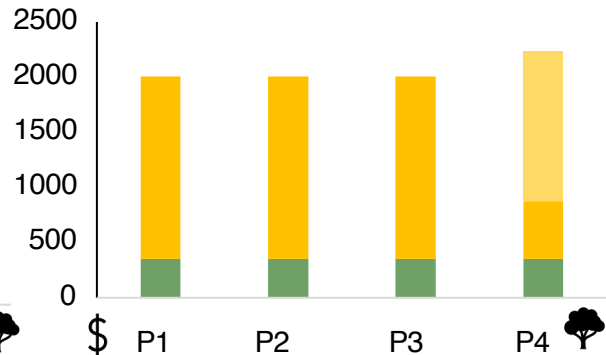
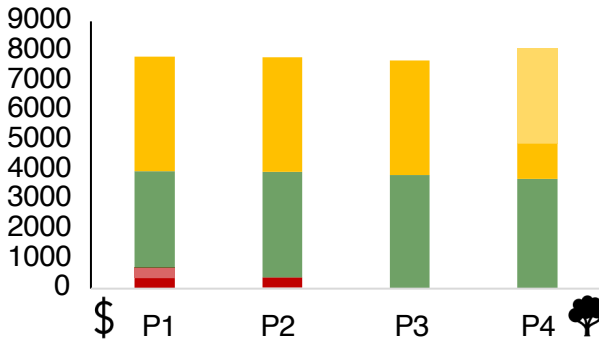
[kWh/h]



[kWh/h]



Combination of scenarios



- oil_boiler
- solar_PVT
- Wood_CHP_unit_1
- Gas_CHP_unit_2
- solar_PV
- ASHP_2
- Gas_CHP_unit_1
- wood_boiler_2
- ASHP_1
- GSHP_2
- wood_boiler_1
- gas_boiler_2
- GSHP_1
- Wood_CHP_unit_2
- gas_boiler_1

Conclusion

- Novel approach in suburban areas to estimate impact of different urban densities
- The study reveals that the energy technologies used for each energy hub are notably influenced by the density of the sub urban area.
- The energy hubs that are larger in capacity are less vulnerable to the market changes when compared to the systems that are to be installed in the periphery which are having lower capacity.

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