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Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT

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load shifting of distributed cross-sectoral energy systems in economic optimised flexible operation

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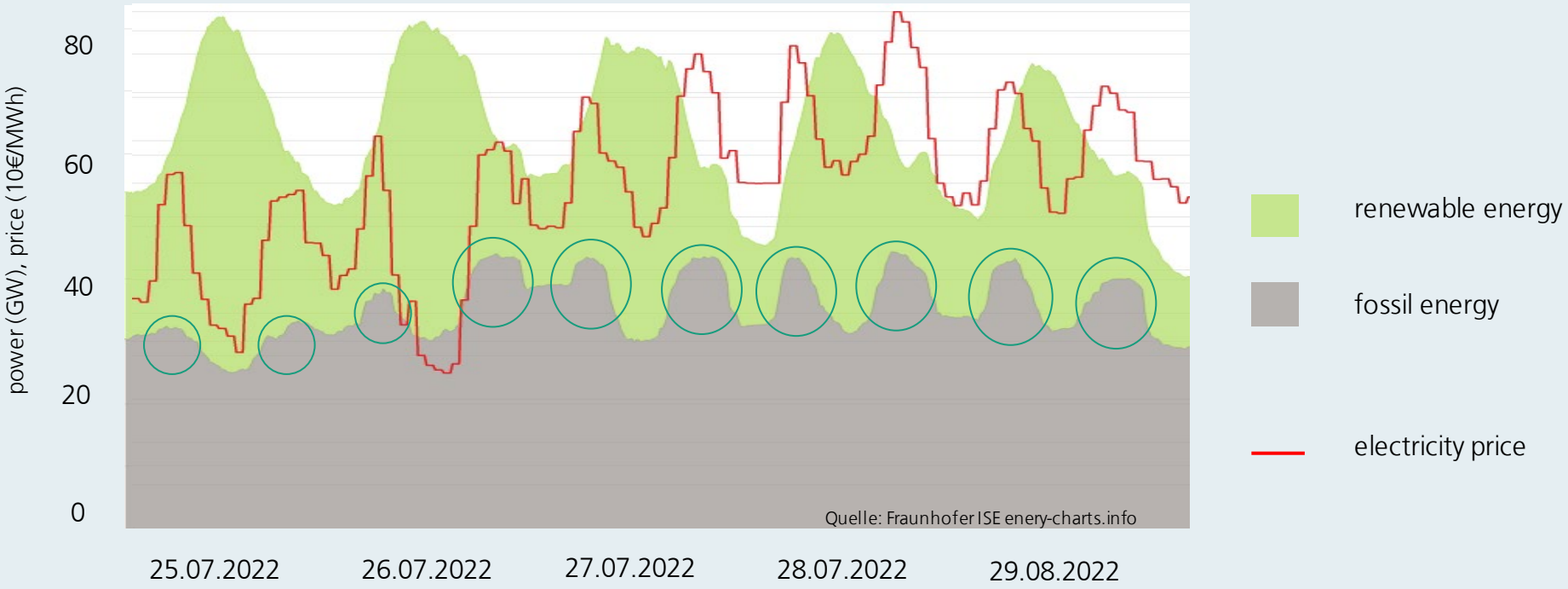
motivation

substitution of fossil energy and integration of renewable energy by optimised operation

German electicity generation and electricity stock market price



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introduction

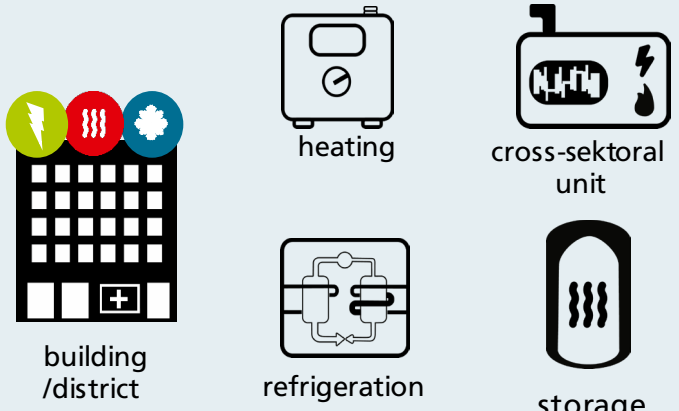
distributed cross-sectoral energy system

properties DCE

- connection with public electricity grid
- cross-sektoral energy units
- storage

-> load shifting potential

distributed cross-sectoral energy system (DCE)



assumption

optimised flexible operation:

- adjustable generation
- demand orientated
- utilise price volatility

-> substitution of conventional fossil powered energy generation and integration of renewable energy

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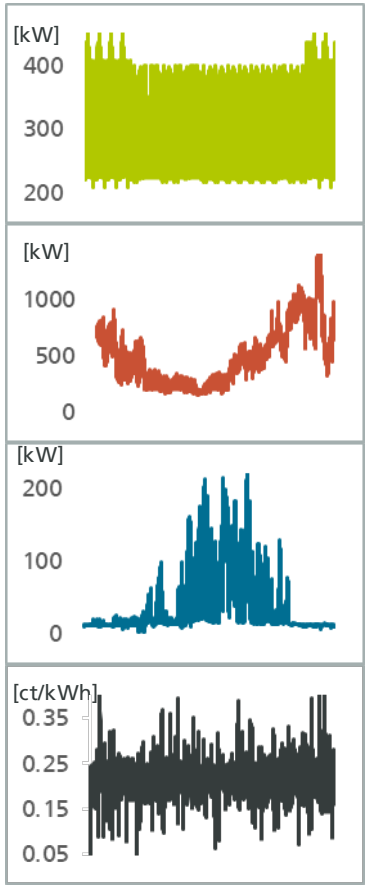
case Study – hospital

optimisation model

input data



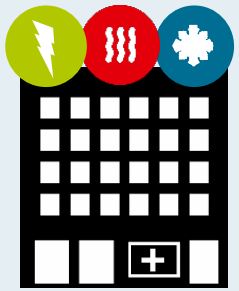
electricity demand

heating demand

cooling demand

electricity price

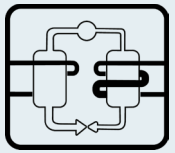
optimisation model



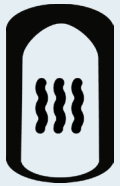
hospital

gas boiler

combined heat and power plant (CHP)



vapor-compression refrigeration



thermal storage

output data

electricity_purchase
electricity_feed-in

electricity grid

natural_gas_purchase_

natural gas grid

optimised operation

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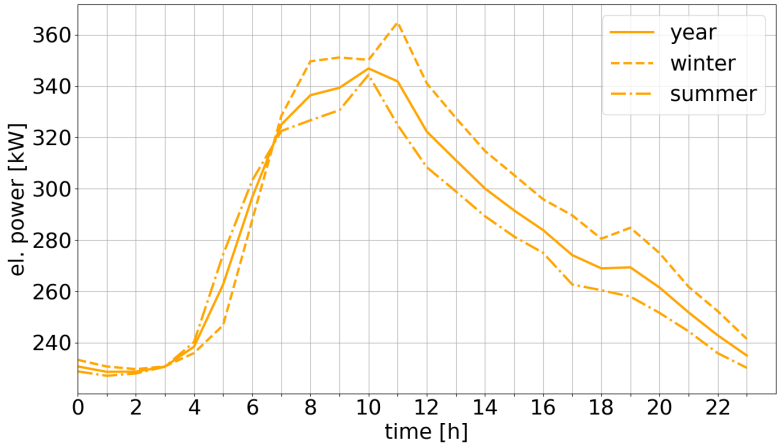
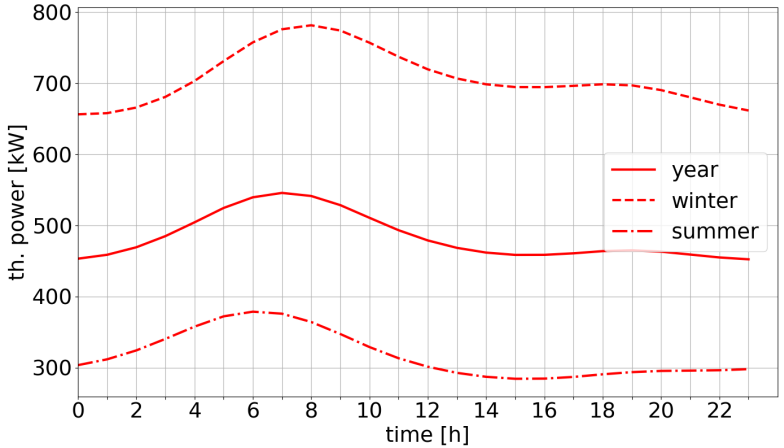
case study – hospital

demand



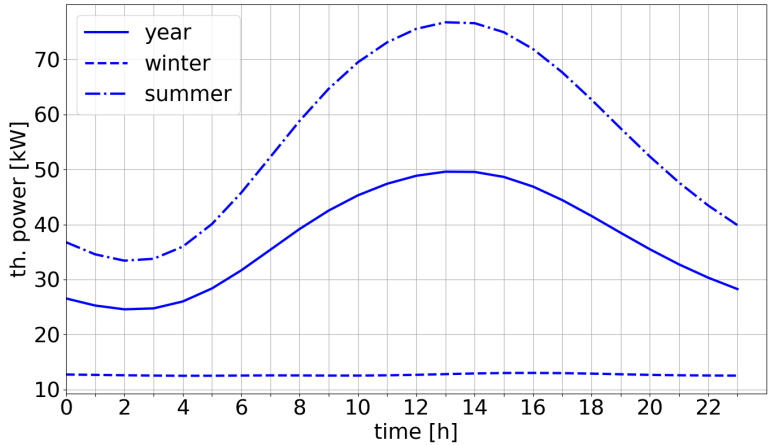
average electricity demand

- base load: 230 kW
- from 4 – 8 am rise to 340 kW
- lunchtime peak of 10 kW
- base load at midnight
- demand in winter 30 kW higher than in summer



average heating demand

- base load: 300 kW summer; 650 kW winter
- from base load at midnight to highest peak at 7 am rise by 20 %
- back at base load at 3 pm



average cooling demand

- high cooling demand in summer
- lowest point at 3 am of 35 kW
- highest point at 1 pm of 78 kW
- base load of 13 kW in winter

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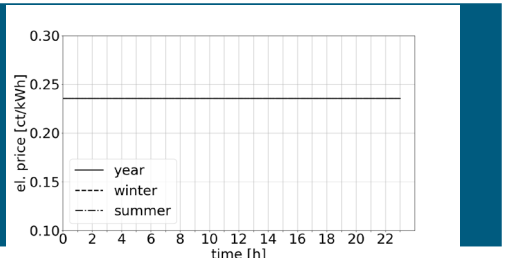
scenarios

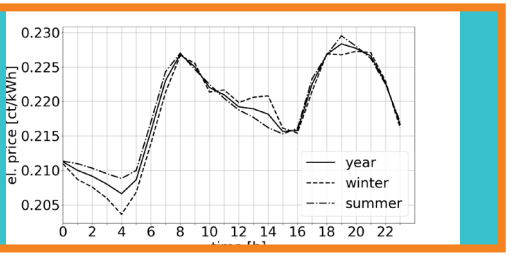
fixed tariff
based on 2019

no volatility, low price level
electricity purchase: 23,57 ct/kWh, electrcity feed-in: 3,6 ct/kWh,
volatility in electricity price: 0 ct/kWh,
natural gas price: 3,77 ct/kWh



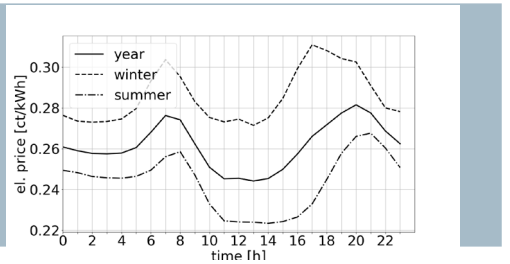
dynamic tariff
based on 2019

medium volatility, low price level
electricity purchase: 21,86 ct/kWh, electrcity feed-in: 3,71 ct/kWh,
volatility in electricity price: 2,03 ct/kWh,
natural gas price: 3,77 ct/kWh



dynamic future tariff
based on 2030

high volatility, high price level
electricity purchase: 26,02 ct/kWh, electrcity feed-in: 7,21 ct/kWh,
volatility in electricity price: 6,67 ct/kWh,
natural gas price: 5,31 ct/kWh



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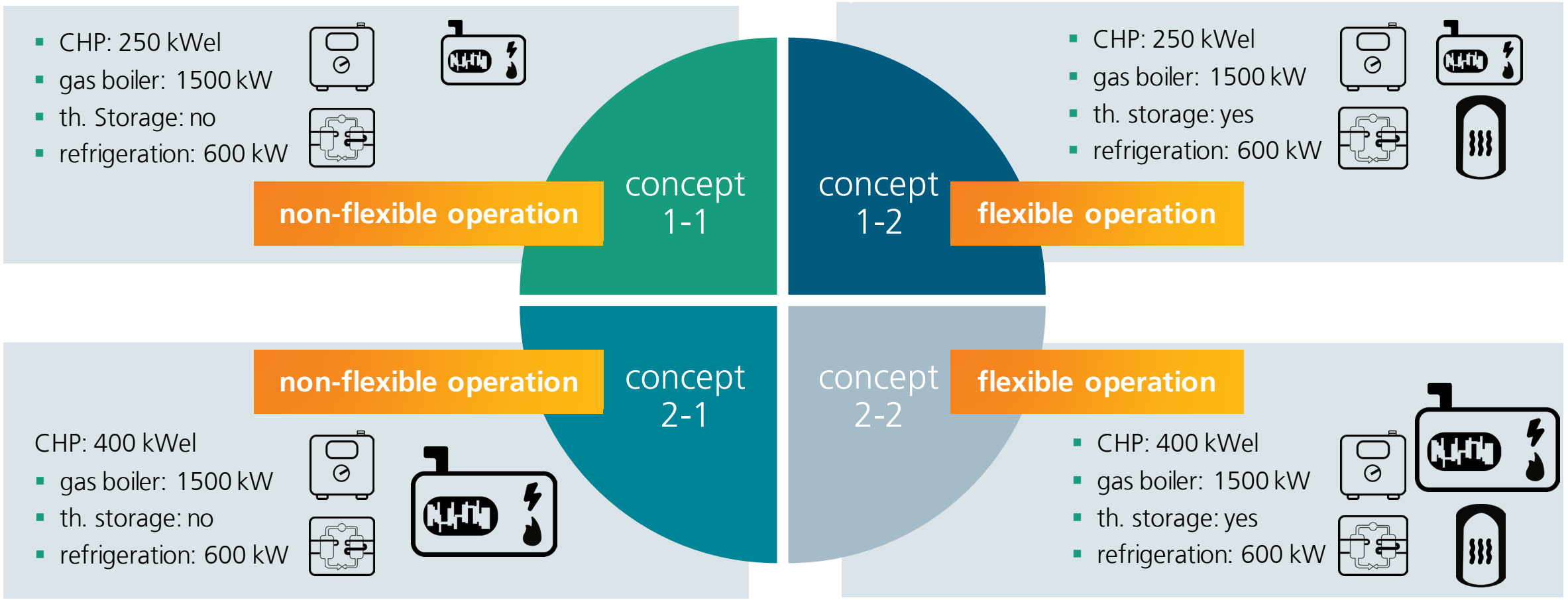
case study
concepts



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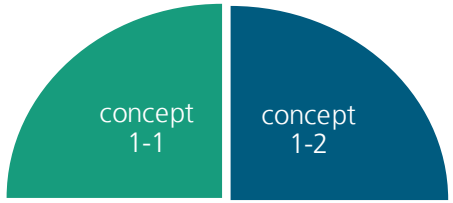
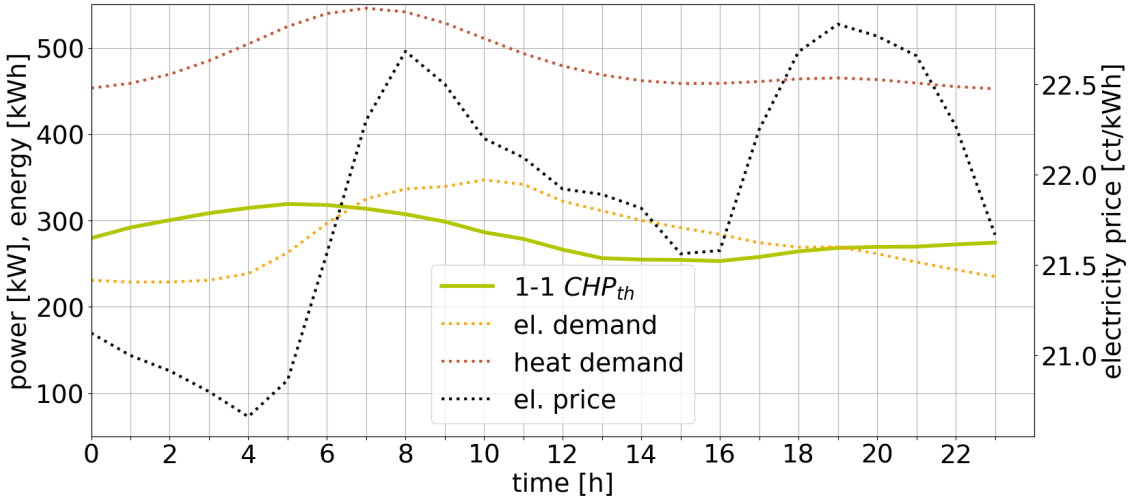
case study – results: load shifting

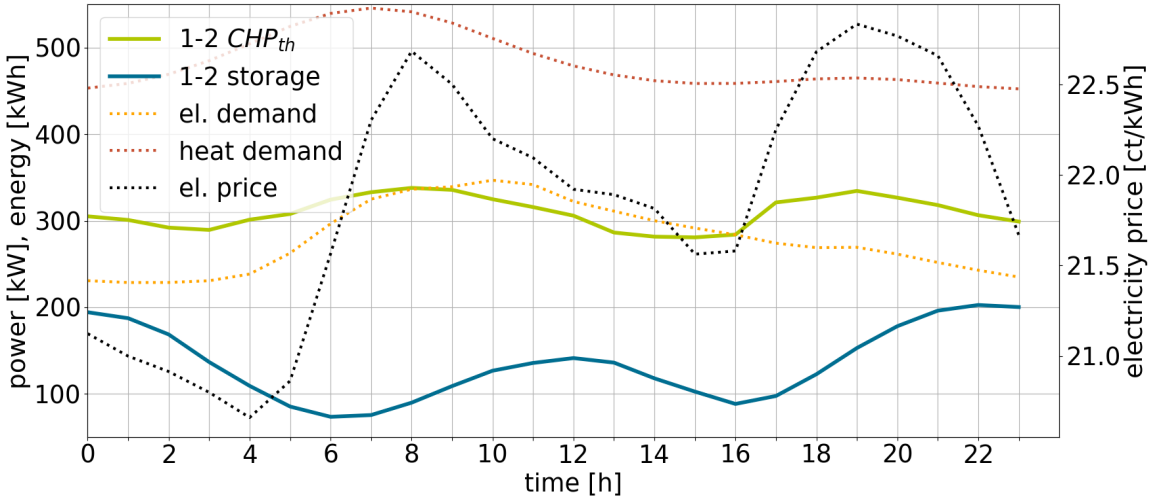
average heat generation of small CHP





concept 1-1

- CHP follows heat demand roughly



concept 1-2

- CHP operation follows price signal
- CHP utilisation rate increases by using storage
- low utilisation of storage capacity

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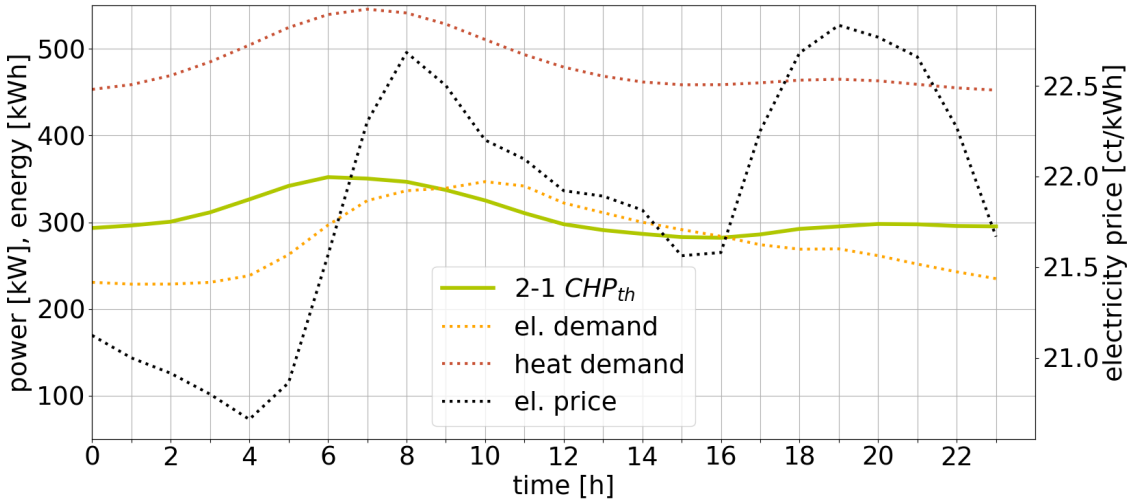
case study – results: load shifting

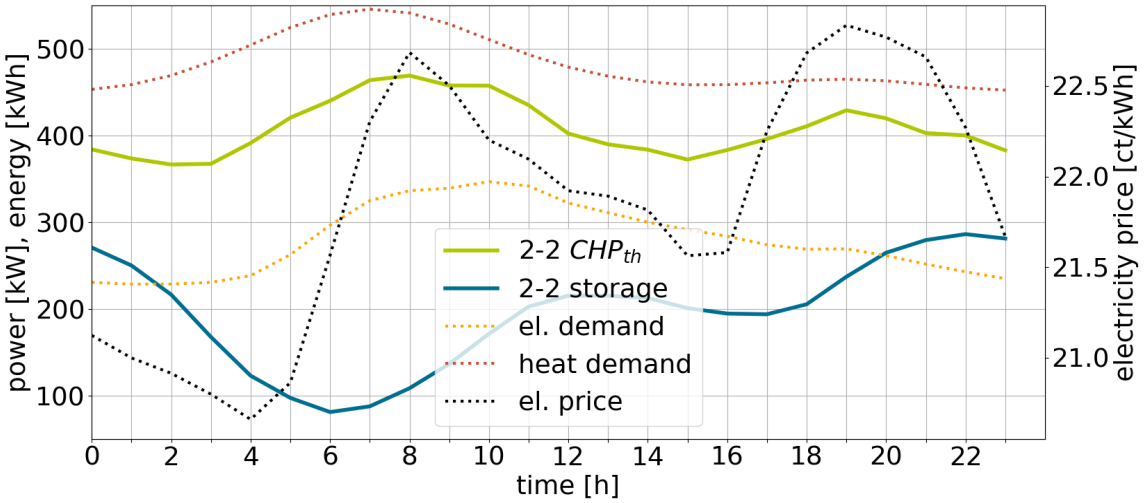
average heat generation of big CHP

concept 2-1 | concept 2-2



concept 2-1

- little increase in CHP utilisation rate
- CHP operation follows heat demand



concept 2-2

- CHP operation-shift from night and afternoon (low electricity price) to morning and evening (high electricity price).
- high increase in CHP utilisation rate
- high utilisation of storage capacity

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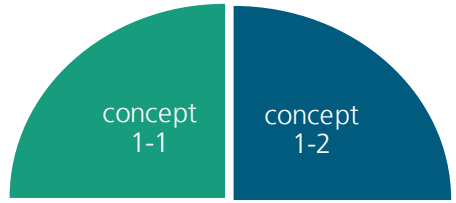
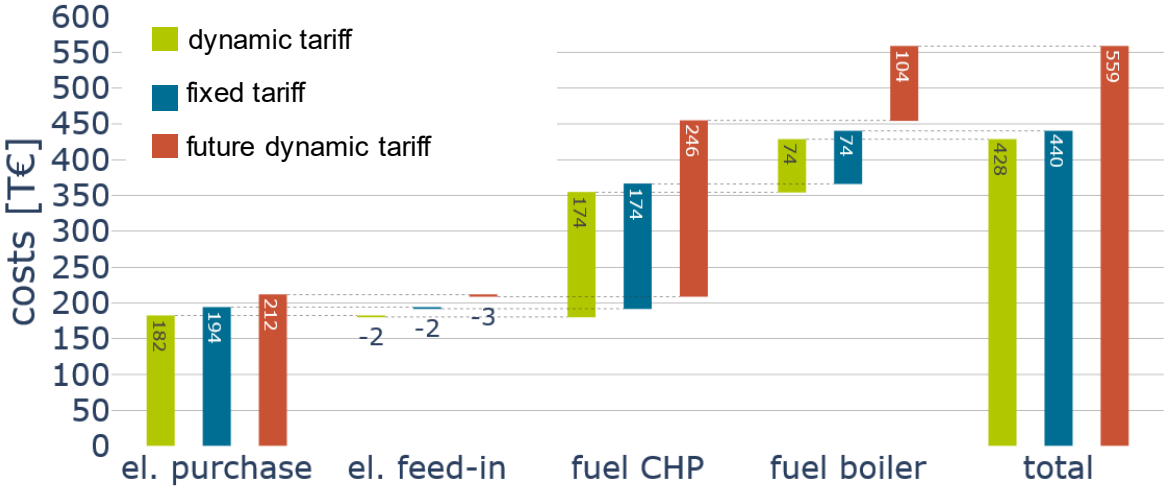
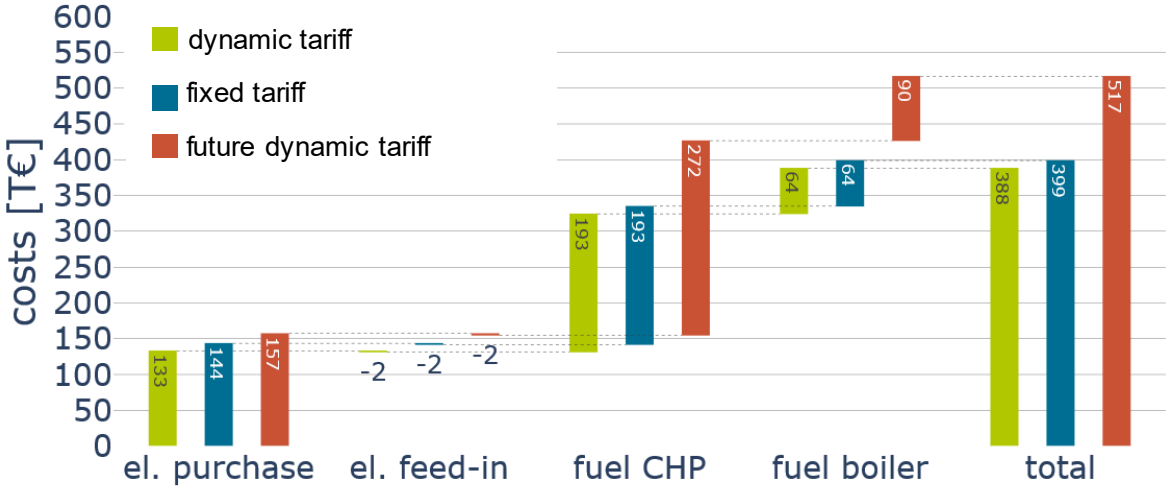
case study – results: costs

operating costs with small CHP







concept 1-1

- highest costs in electricity purchase in dynamic and fixed tariff
- highest costs for natural gas of CHP operation in future dynamic tariff
- almost no return from el. feed-in

concept 1-2

- highest costs gas of CHP operation in all tariffs
- less costs for natural gas boiler operation and electricity purchase
- total savings of 10% by using storage

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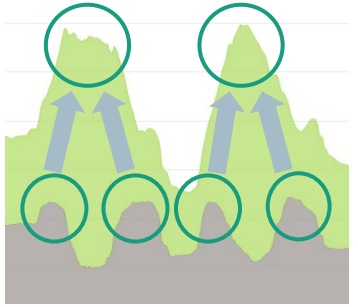
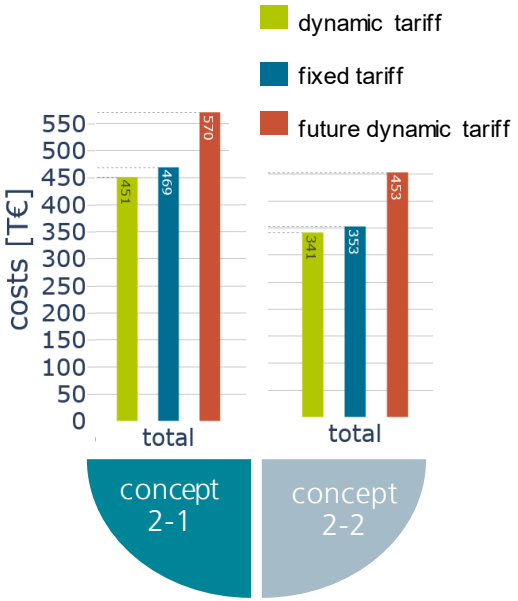
summary and conclusion

Economic optimised operation of distributed cross-sectoral energy systems provides …

1. … load shifting and therefore substitution of conventional fossil powered energy generation.
2. … higher benefits by using bigger units, …
3. … but only when using storage.
4. … even higher benefits by using dynamic electricity tariffs.





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outlook and discussion

Economic optimised operation of distributed cross-sectoral energy systems…

1. … reduces operation costs, …
2. … without installing new costly energy units.
3. … requires smart remote control …
4. … and smart measurement technology.

contact

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