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Lehrstuhl Energietechnik

Ministry of Culture and Science of the German State of North Rhine-Westphalia

NEQ Graduate School for Sustainable Energy Systems in Neighbourhoods

An innovative concept to increase the efficiency of existing combined heat and power plants in developing district heating systems

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5TH INTERNATIONAL CONFERENCE ON SMART ENERGY SYSTEMS
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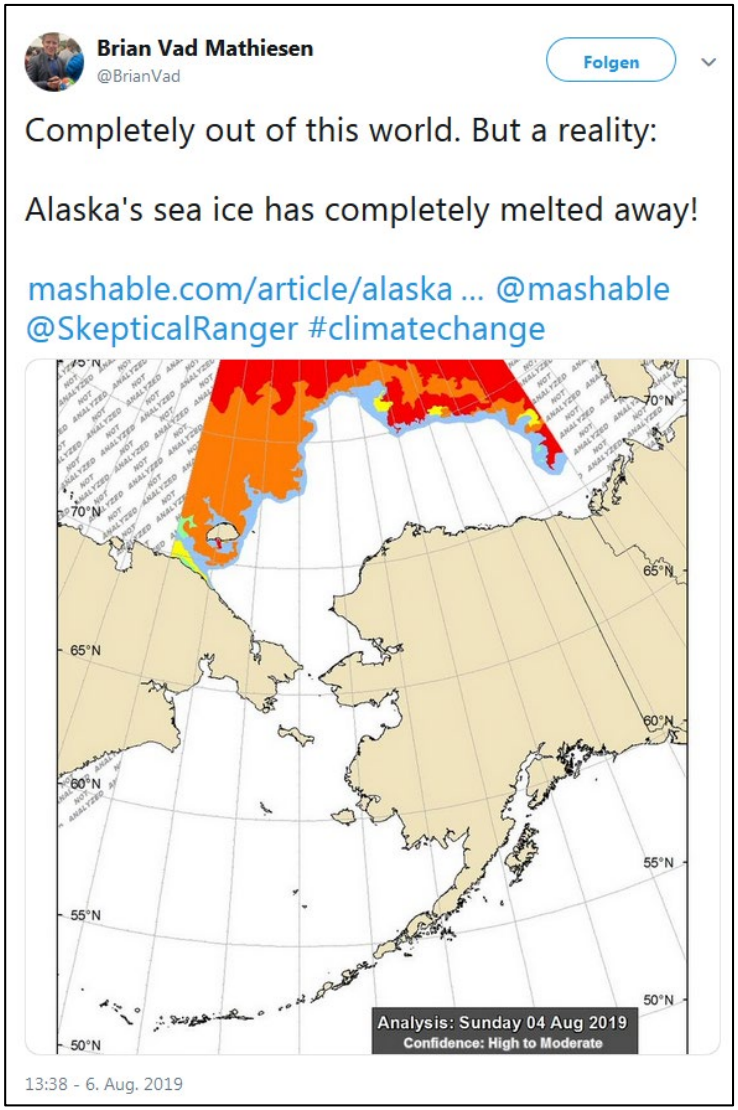
DISTRICT ENERGY IN CITIES INITIATIVE

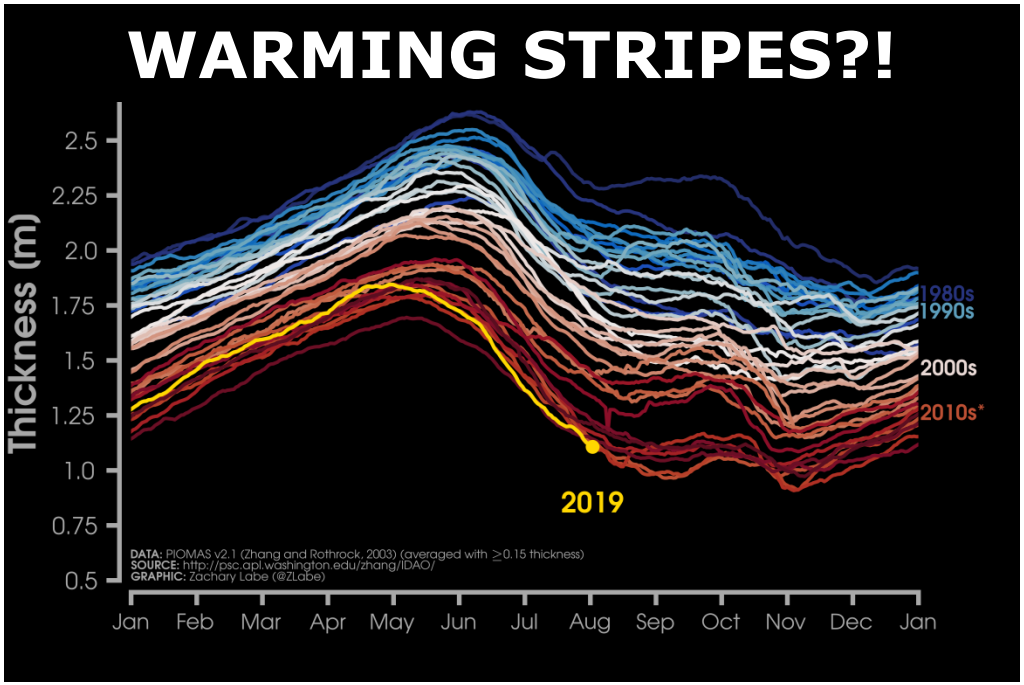
Innovation Fund Denmark

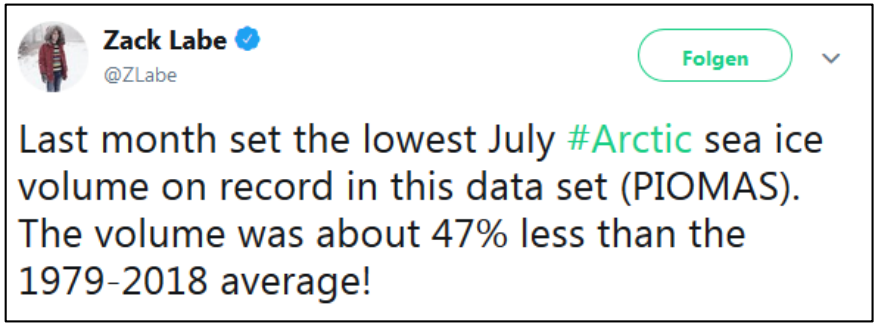
Polar bear (Ursus maritimus)

Source: [1]

Motivation – a current example



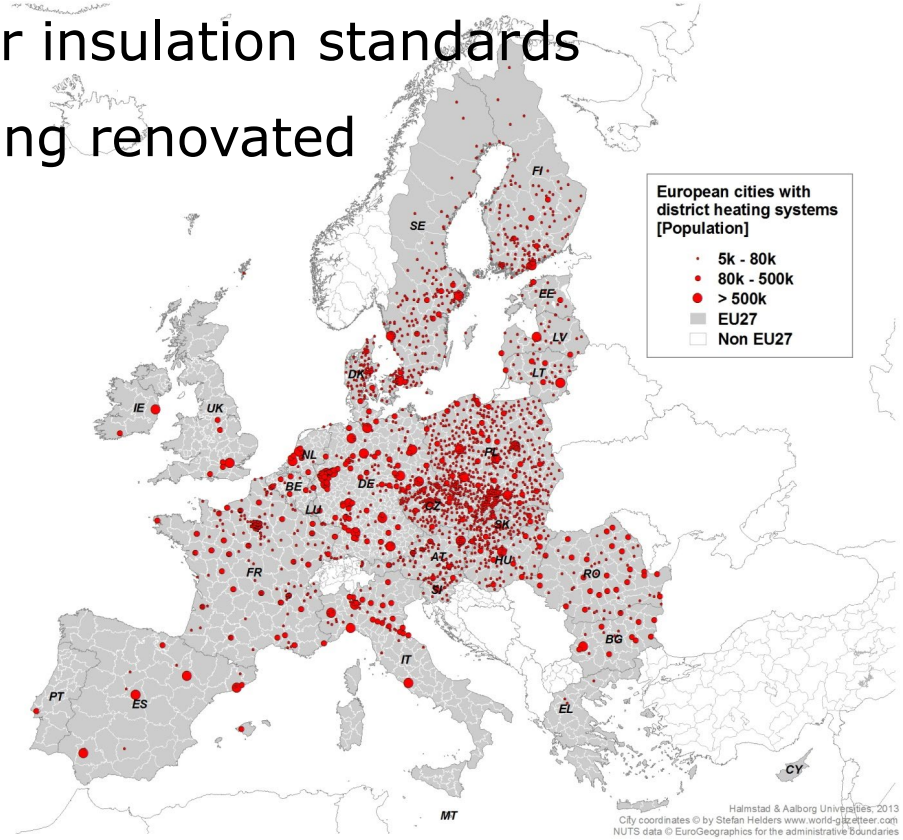




Sources: [2], [3], [4]

Urban district heating

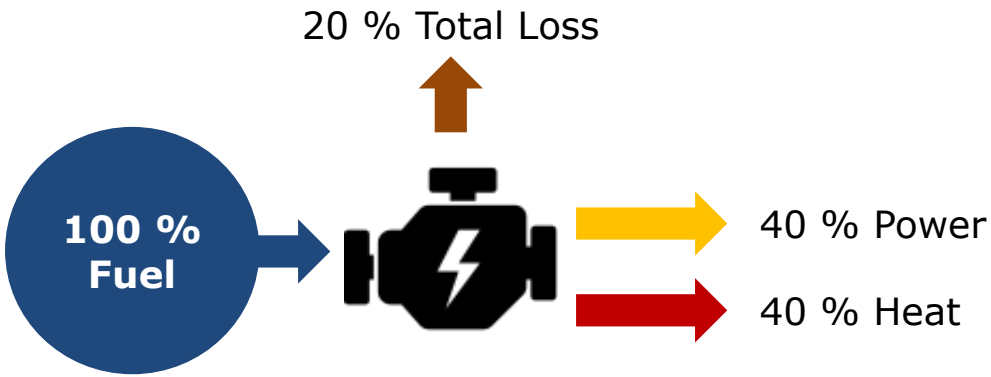
- System operators → increase the number of customers!
- Changes → infrastructure and heat loads
- New demand patterns
  - new buildings fulfil higher insulation standards
  - existing buildings are being renovated



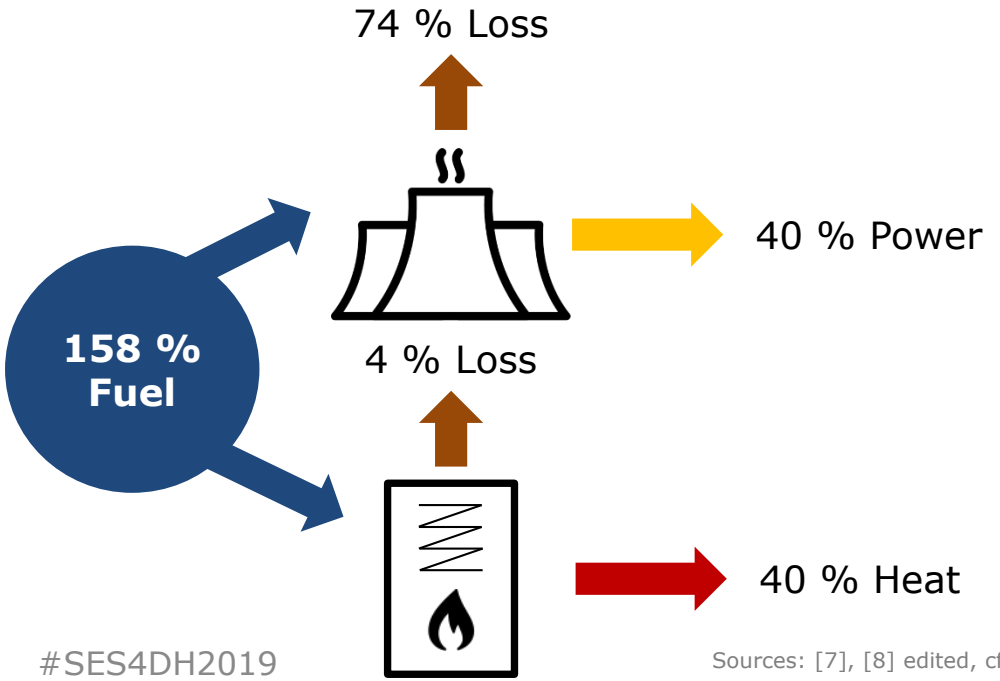
Sources: [5], [6]

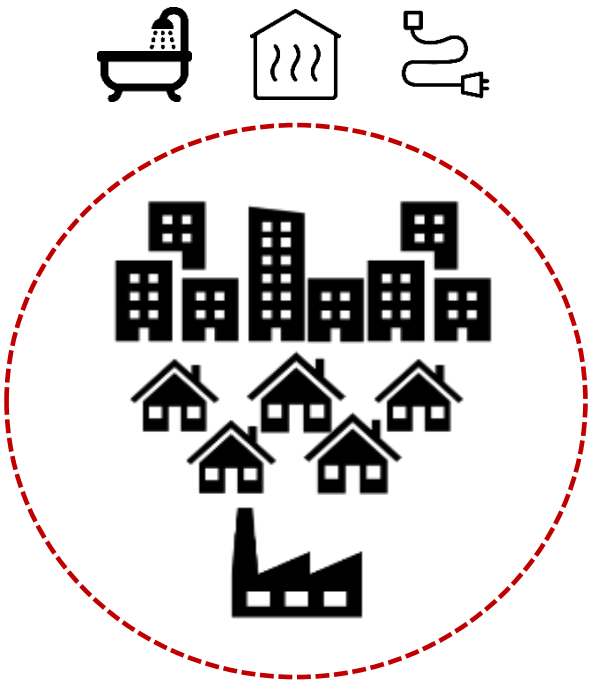
District heating production

Cogeneration



Separate generation (traditional)



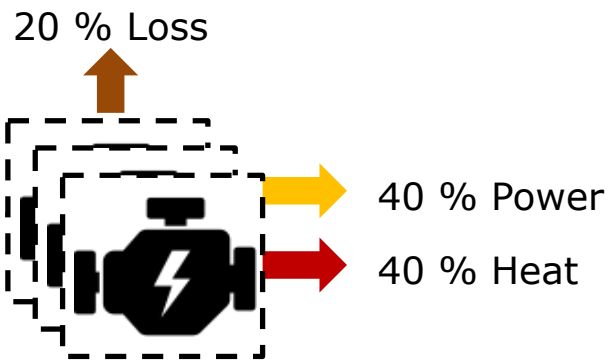


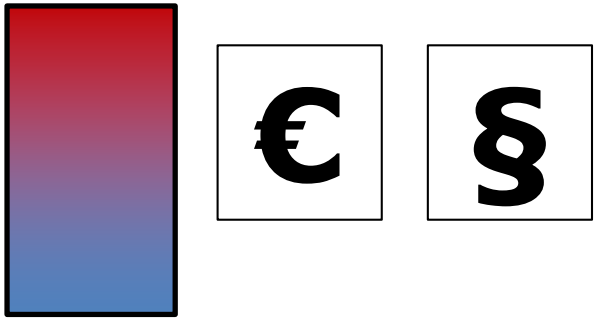
District heating
Use case

Sources: [7], [8] edited, cf. [9]

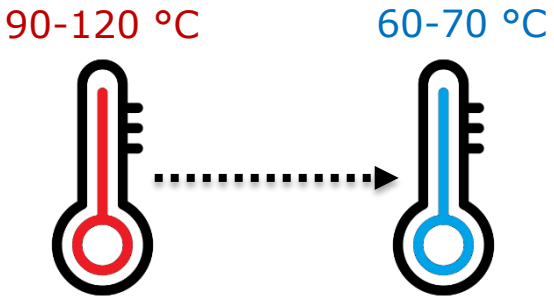
Developing district heating systems

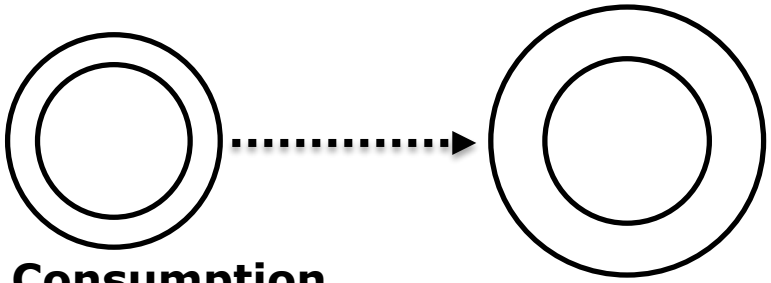
Supply



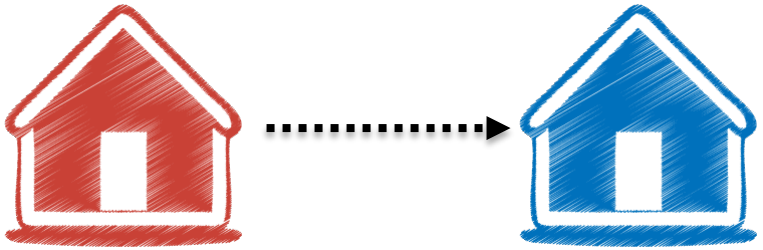


Distribution



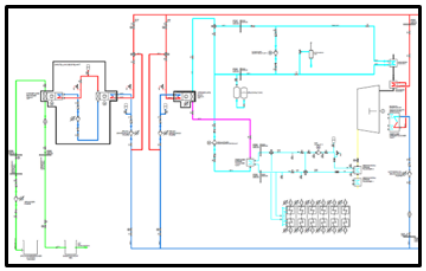


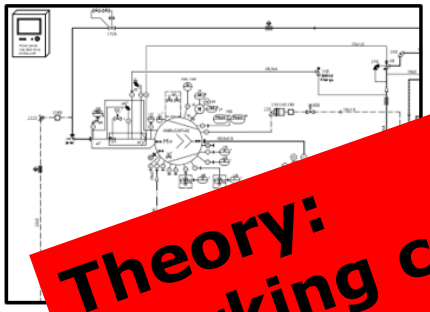
Consumption

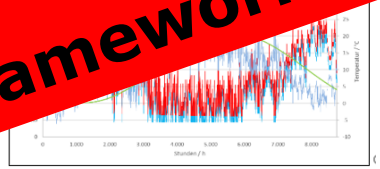


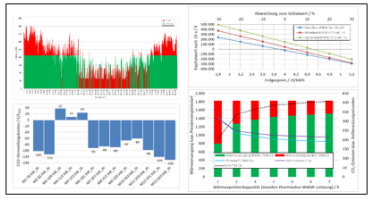
Sources: [7], [8] edited

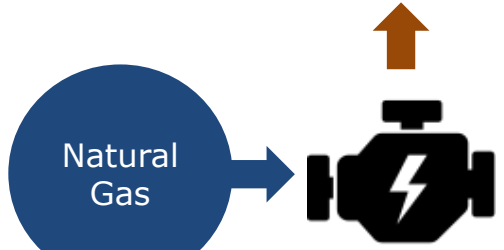
Use Case





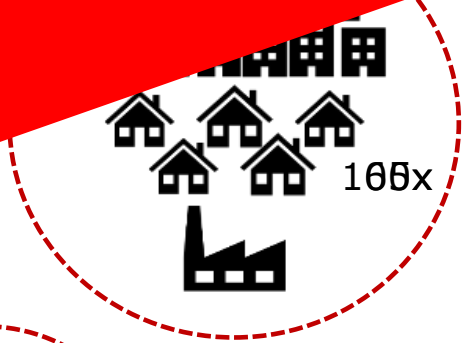


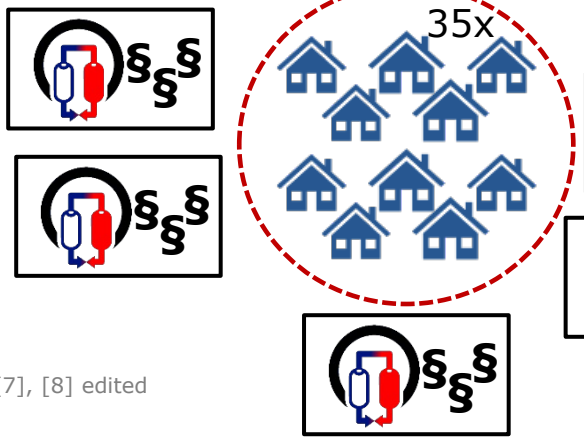




Theory:
Working concept, energy efficient, SES + 4DH.

Reality:
Legal framework = problems!

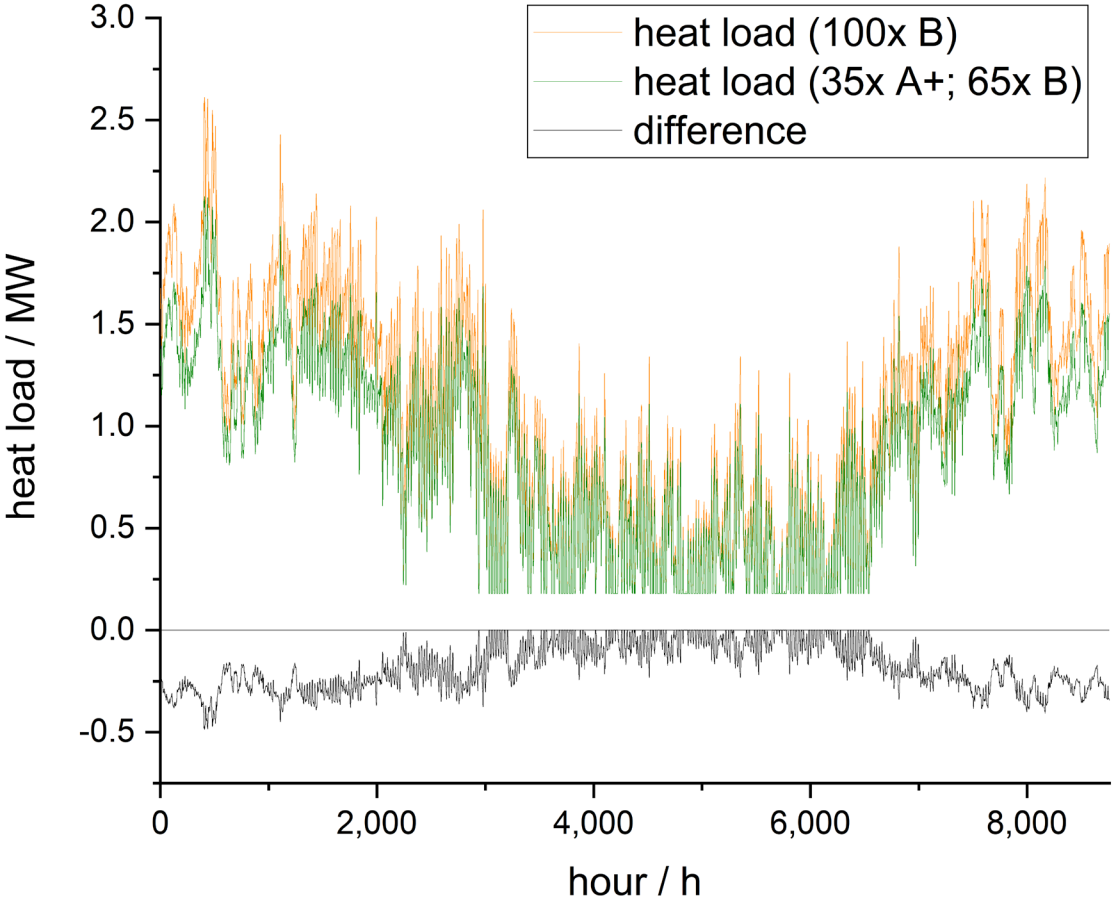


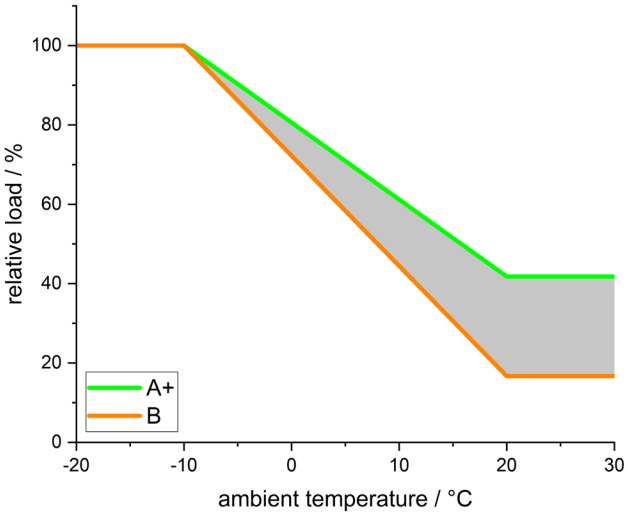


Sources: [7], [8] edited

Energetic evaluation of the results

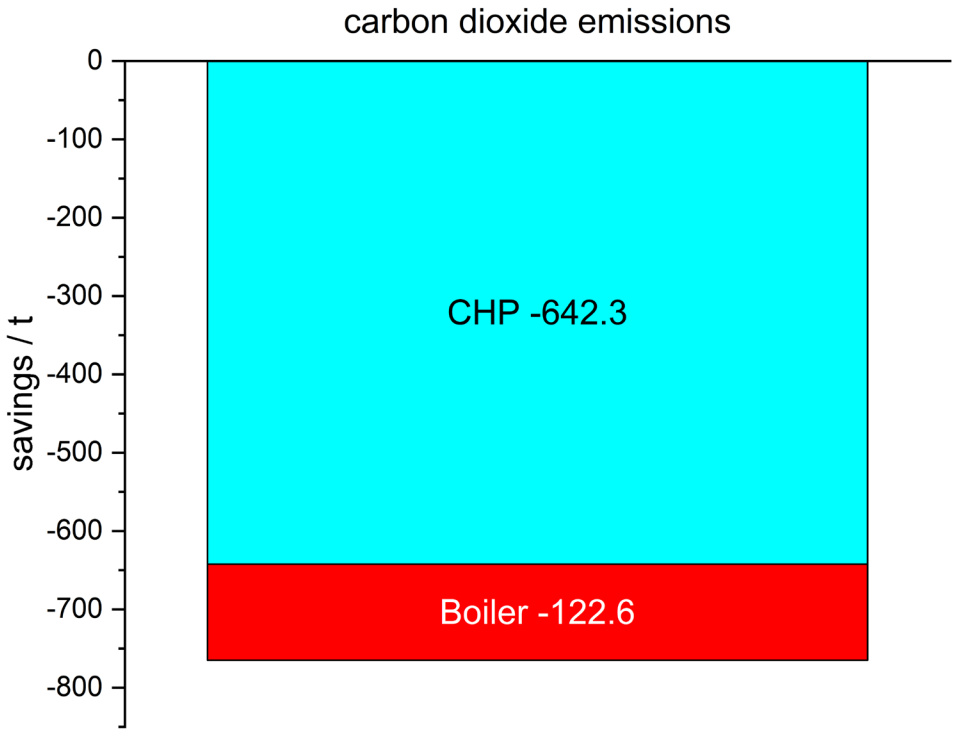
- Savings (buildings): 1,6 GWh/a
- Savings (distribution): 150 MWh/a





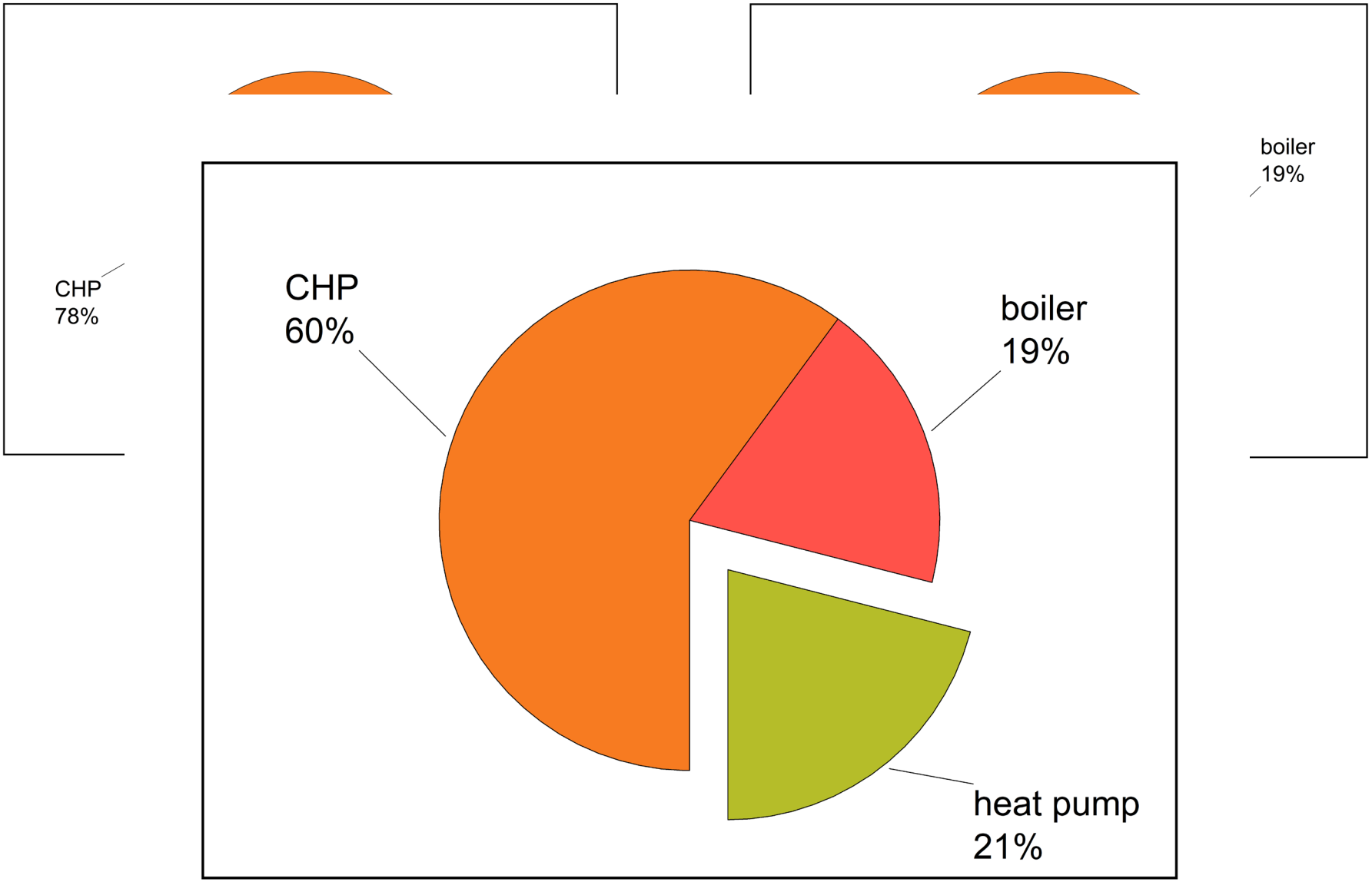
Energetic evaluation of the results

- Runtime reduction (peak load boiler): 135 h/a
- Thermal storage compensates peaks: 1.500 cycles
- CHP operates profitable and more efficient (residual load)



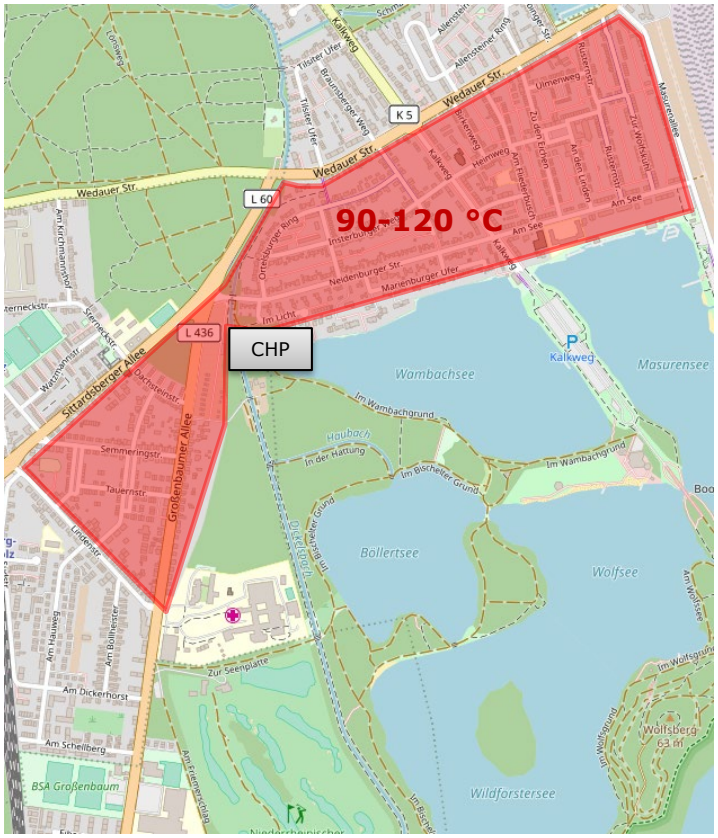
Sources: cf. [10], cf. [11]

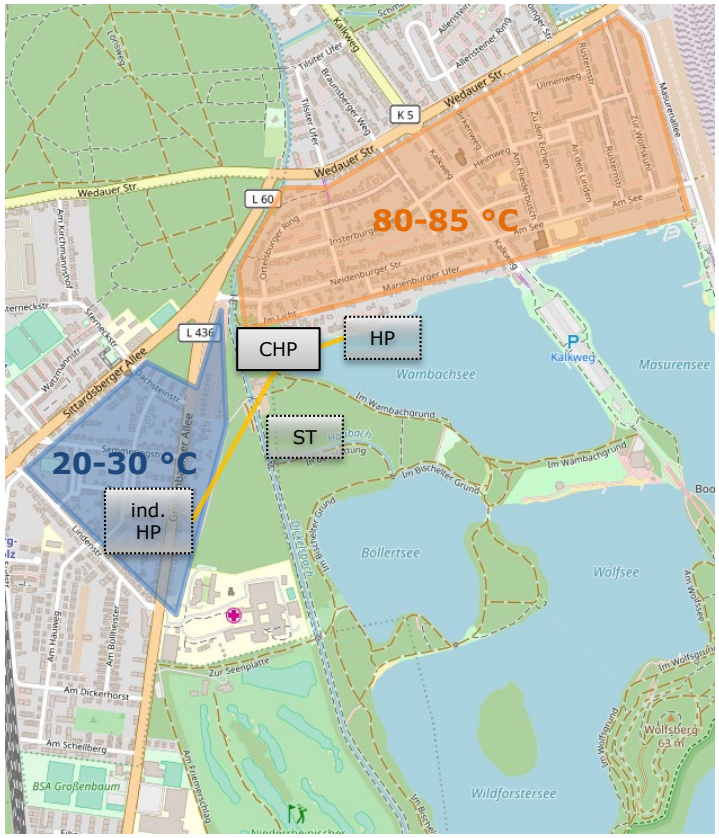
Energetic evaluation of the results



Visualization of the concept (example)

- Simulations: two separated networks, low temperatures
- Usage of more CHP waste heat, heat pumps possible
- Thermal solar collectors with seasonal storage





Source: [12] edited

Lessons learned

- Energy supply must be modified cross-sectoral to satisfy upcoming challenges (e.g. new consumption pattern)
- District heating systems as separated infrastructures with different supply temperatures 
  - "LowEx"-part with temperatures around 20 to 30 °C
  - "Conventional"-part: operation at around 80 °C 
- Integration of renewable sources
- Existing CHP-plants: more flexible and efficient
- transferable to urban areas, but very much dependent on the actual use case
  - Difficult legal conditions regarding heat pumps 
  - Non-profit concepts will not be realized

Source: [8] edited

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Thank you for your attention!

Questions? Remarks? Criticism?
→ *christian.thommessen@uni-due.de*

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Sources

[1] Pixabay, skeeze, Online: https://pixabay.com/de/photos/eisb%C3%A4r-mutter-jungen-wei%C3%9F-arktis-1509103/

[2] Twitter, @BrianVad, Online: https://twitter.com/BrianVad/status/1158839778160402432

[3] Zachary Labe, Simulated sea ice thickness across the Arctic, Online: https://sites.uci.edu/zlabe/arctic-sea-ice-volumethickness/

[4] Twitter, @ZLabe, Online: https://twitter.com/ZLabe/status/1158445047064358912

[5] Werner, Persson. Halmstad University District heating and Cooling Database. Halmstad University, 2013.

[6] Photo taken by Nicolas Witte, renovation work on an apartment building with district heating in the Ruhr area, 2018.

[7] Bundesverband Kraft-Wärme-Kopplung e.V., Online: https://www.bkwk.de/kraft-waerme-kopplung/

[8] IconArchive.com, 2019.

[9] Mathiesen et al., 2015. „Smart Energy Systems for coherent 100% […]" Applied Energy 145, pp. 139-154.

[10] Thommessen et al. „Significance of Cogeneration for Germany's Future Energy Supply" (upcoming IEEE ISGT Europe 2019)

[11] Fette. „The development of the residual load in a future scenario with a high share of renewable energy". Fraunhofer IFAM, 2018.

[12] OpenStreetMap - published via ODbL, Online: http://www.openstreetmap.org/ http://opendatacommons.org/licenses/odbl/

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BACKUP

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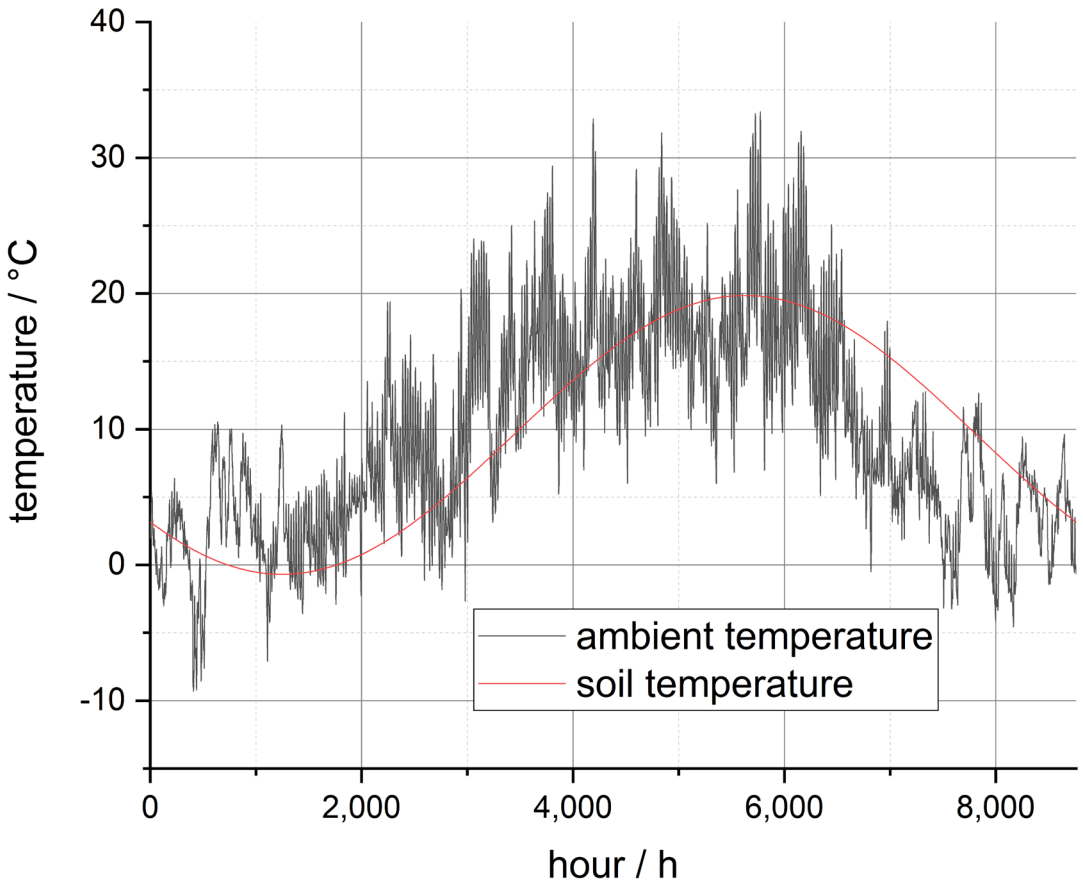
Ambient and soil temperature



Heat pump operation

- Cannibalizes with solar thermal
- Storage needed!