Is Efficient Efficient?

Or: How to Define Efficient District Heating in a Renewable World?

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Agenda

- Introduction and Background
- Methodology
  - Literature Review and Interviews
  - Modelling of two Exemplary District Heating Systems
  - Systemic Efficiency Evaluation
- Key Results
- Conclusion

Introduction – Background

- **DH plays an important role** for decarbonizing heat
- Scenarios often focus on absolute amount of energy delivered to customers and on decarbonization of the supply side
- **Efficiency** of the network itself is **often not assessed in detail** → heat losses are frequently considered only through flat-rate percentage values
- The **definition of "efficient district heating"** in Article 26 of the EED does not capture all relevant effects and has **weaknesses** in its valuation of efficiency in a renewable energy system

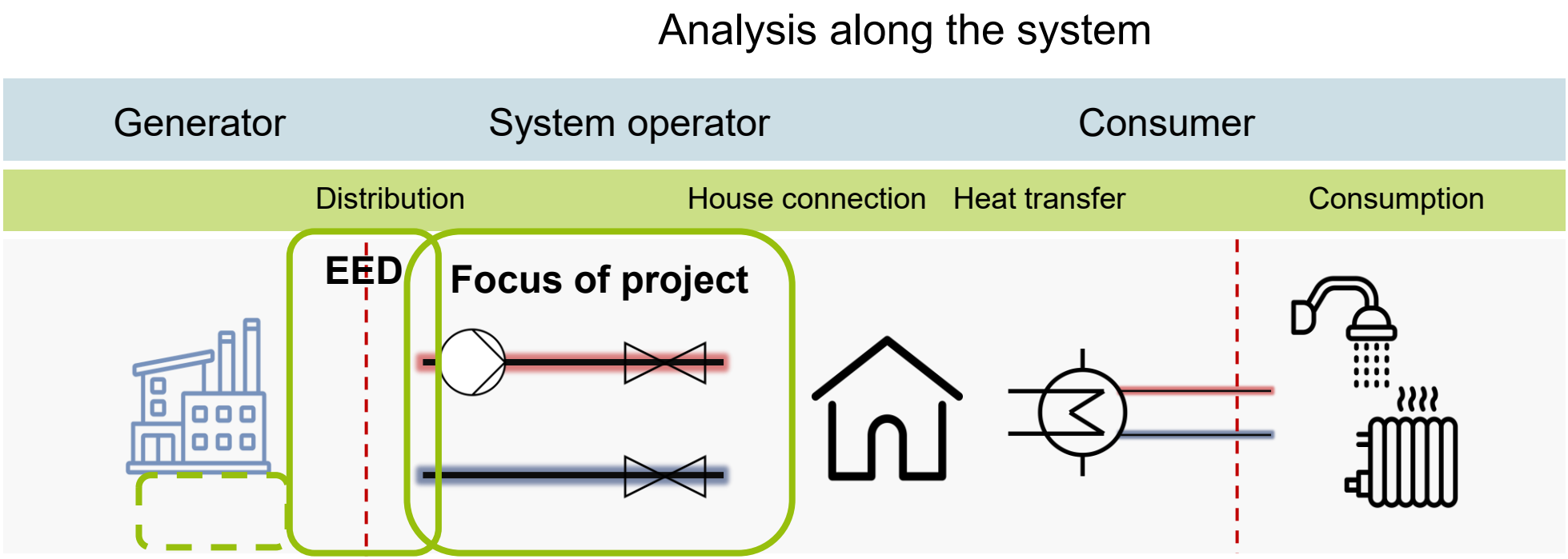
➢ Aim of the study: analyse and compare three possible efficiency criteria for DH, with a focus on their **future viability**

Introduction

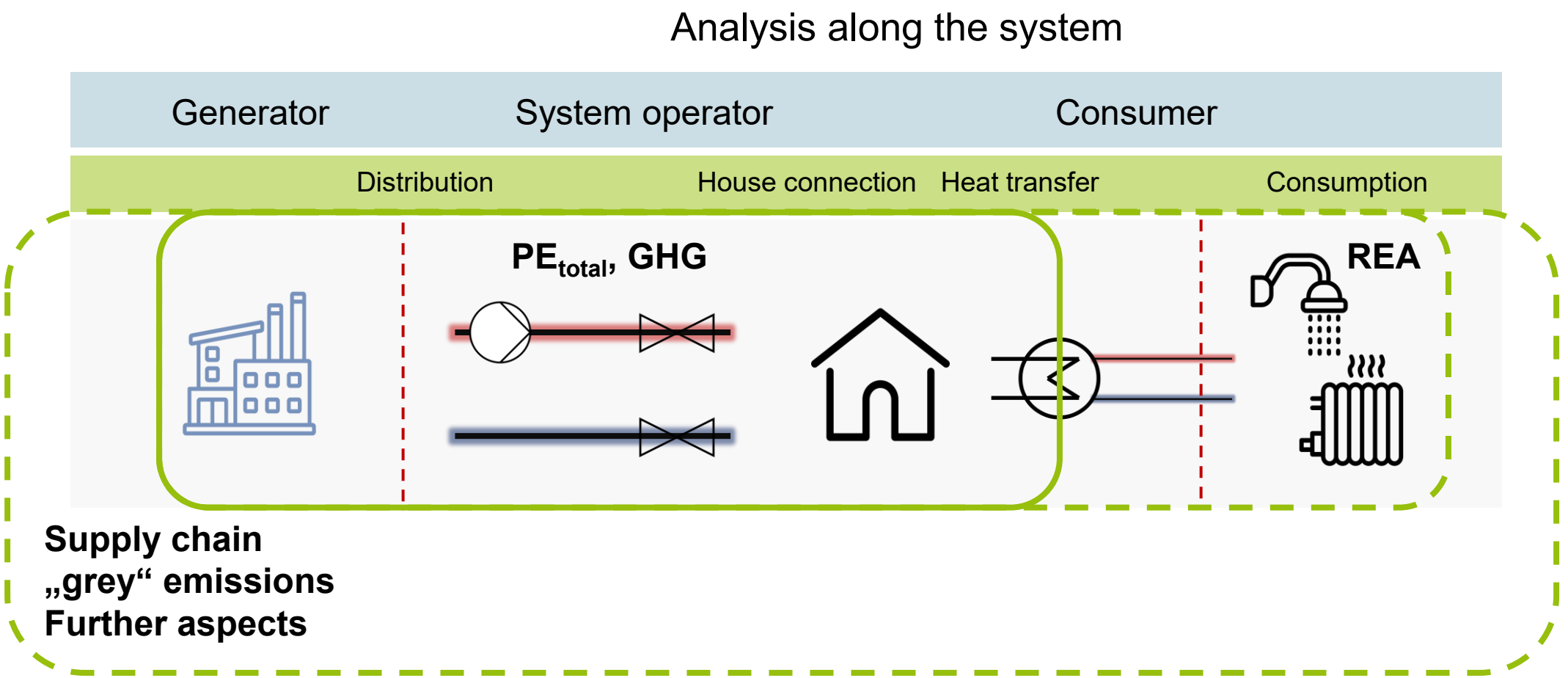
What is efficiency in the context of DHC?

- Technical efficiency?
  - Meaning: deliver heat to customers with minimal losses!
  - ➢ generation, distribution, supply chain, all?
- Economic efficiency?
  - Meaning: deliver heat at minimum costs!
  - ➢ for companies, customers, the society?
- ➢ Something different comprising all relevant aspects (societal, economic, environmental…)?

Introduction – balance boundaries



Introduction – balance boundaries systemic efficiency



Results – Systemic Aspects: balance boundaries and indicators

Relevant aspects:

- Increasing share RES, waste heat
- Sector coupling
- Limited availability of some energy carriers (e.g. biomass)
- Security of supply
- Utilization rate local potentials
- Space availability in urban areas
- …

Results – Systemic Aspects: qualitative comparison of indicators

Factor	GHG	PE_{tot}	REA
Share of renewable energy and unavoidable waste heat	Partly	Yes (important to determine how renewable energy used on site is evaluated (PEF=0 or PEF=1))	Yes
Transport routes and methods	Yes	Partly: PEF supply chains	Yes
Supply chains	Yes	Yes	Yes
Resource consumption	Yes, as part of a life cycle assessment (LCA)	Yes, as part of a life cycle assessment (LCA)	Yes

Results – Systemic Aspects: qualitative comparison of indicators

Factor	Pros	Cons
GHG	• Direct link to **climate targets** • High **public and political recognition** • **Established accounting** methods • Easily **understood by customers** • Likely to remain relevant in the future	• **Allocation methods** are debatable • **Significance decreases** as electricity sector emissions decline • **Risk of shifting emissions** unless clear accounting rules are defined
PE_{tot}	• **Linked to EU regulatory framework** • **Well-known indicator**, although less intuitive for customers than GHG emissions • **Established accounting** methods	• **System boundary definition** unclear (e.g. inclusion of embodied energy) • **Risk of treating heat differently** from other sectors • **Allocation methods** are debatable
REA	• **Physically sound scientific approach** • **Exergy losses better reflect resource quality** • **Embodied energy** can be included	• **Complex and data-intensive** • **Not yet widely established** • Very **low public and customer understanding** • **Long timeframe** likely required for widespread adoption

Results – Systemic Aspects: Exemplary DHC systems

Test case definition:

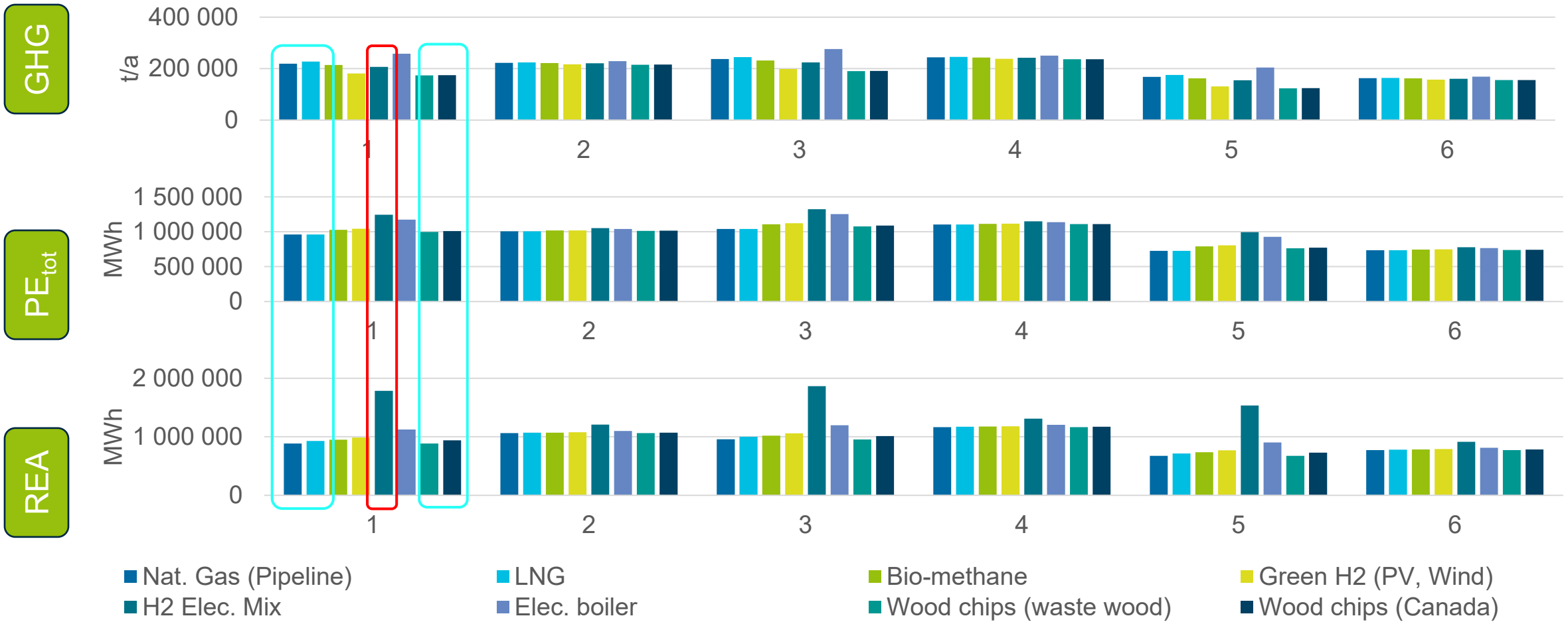
Parameter	Size
Peak heat load coverd by heat pump	40 % or 60 %
Temperature range	• Average • High • Low

- **6 cases**
  - Case 1 and 2: 918 GWh/a
  - Case 3 and 4: 929 GWh/a
  - Case 5 and 6: 877 GWh/a
- Difference in heat supply: Grid losses rise with higher temperatures

HP supplemented by:

- Natural gas boilers (natural gas pipeline, liquefied natural gas (LNG));
- Bio-methane boilers;
- Wood chip boilers (wood waste, cultivation and import from Canada);
- Hydrogen boilers (H2 supply with current electricity mix vs. generation with renewable surplus electricity (green hydrogen));
- Electrode boilers (direct electricity).

Results – Systemic Aspects: Exemplary DHC systems

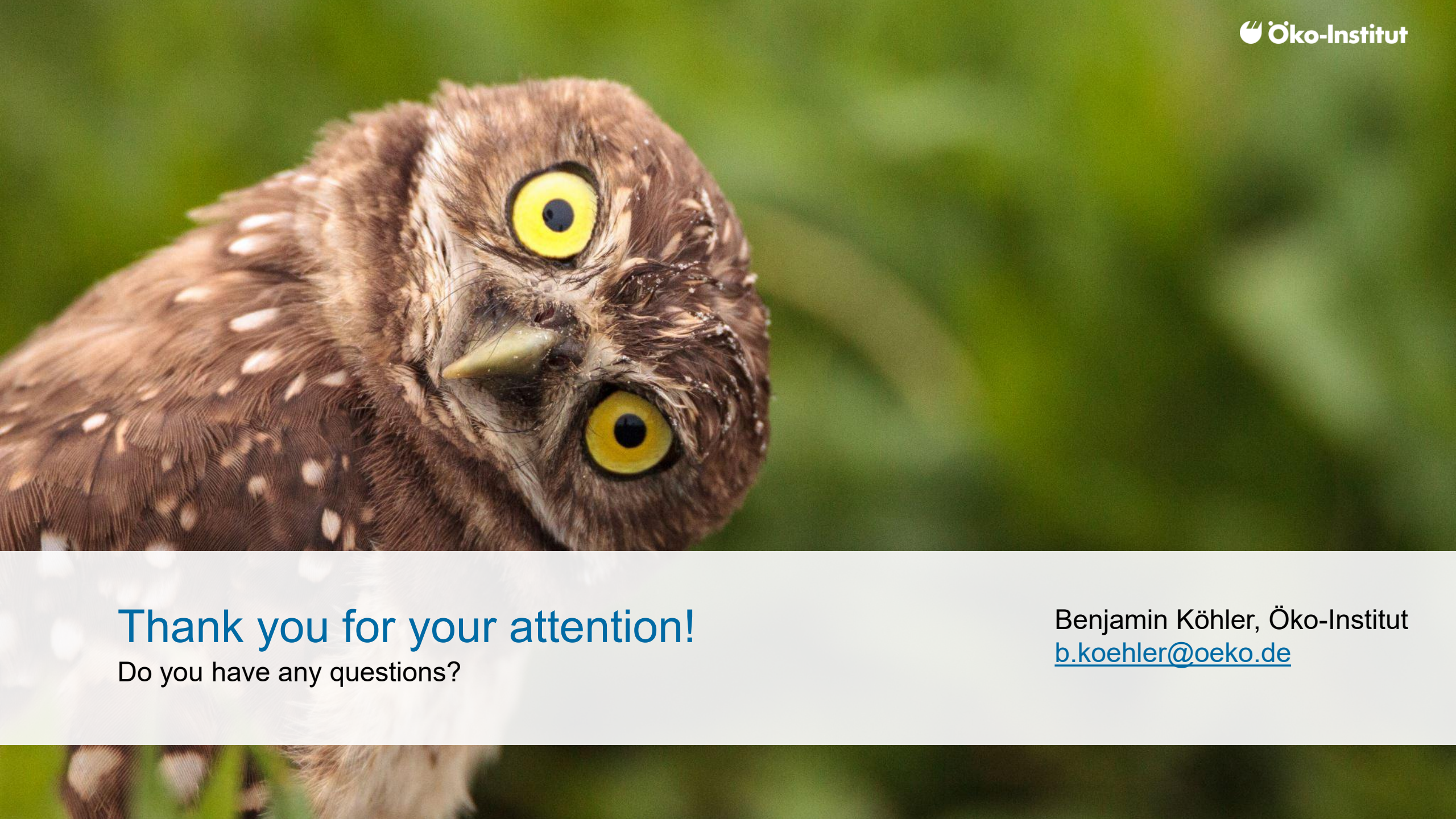


Conclusion – What do the results tell us?

- Many different options exist for reducing heat losses in DHC
- All 3 assessment strategies have advantages and disadvantages
  - For rapid implementation and ease of understanding, PE_{tot} and GHG are appropriate indicators
- For all strategies, clearly defined system boundaries essential
- At a minimum, assessment should cover all elements of the supply chain
  - From fuel input to heat delivery to consumers

Conclusion – What do the results tell us?

- Central challenge: none of the 3 assessment strategies captures all relevant aspects
- Broad system boundaries do not allow for specific analysis of individual elements such as heat distribution efficiency
  - But: broad definition offers DHC-operators flexibility in implementing different measures to improve overall system efficiency
- Remaining challenges include: detailed assessment of supply chains, embodied energy and emissions, use of local heat supply potentials, security of supply
  - These aspects cannot be fully captured by the assessment strategies
- Holistic assessment may therefore require several indicators, even though this increases complexity



Thank you for your attention!

Do you have any questions?

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Results – Technical Aspects for Improved Network Efficiency

Network design

- Pipe dimension
- Insulation thickness
- Pipe length
- Grid temperature
- Temperature spread
- No. of connected buildings
- Pipe system and design

Laying system

- Underground pipes
- Above ground pipes
- Basement laid pipes

Operating mode

- Sliding
- Constant
- Summer shutdown

Ageing effects and water losses

- Ageing insulation
- Leakages

Consumers

- Diff. operating states of connected systems