HEAT HIGHWAY

Heat Highway

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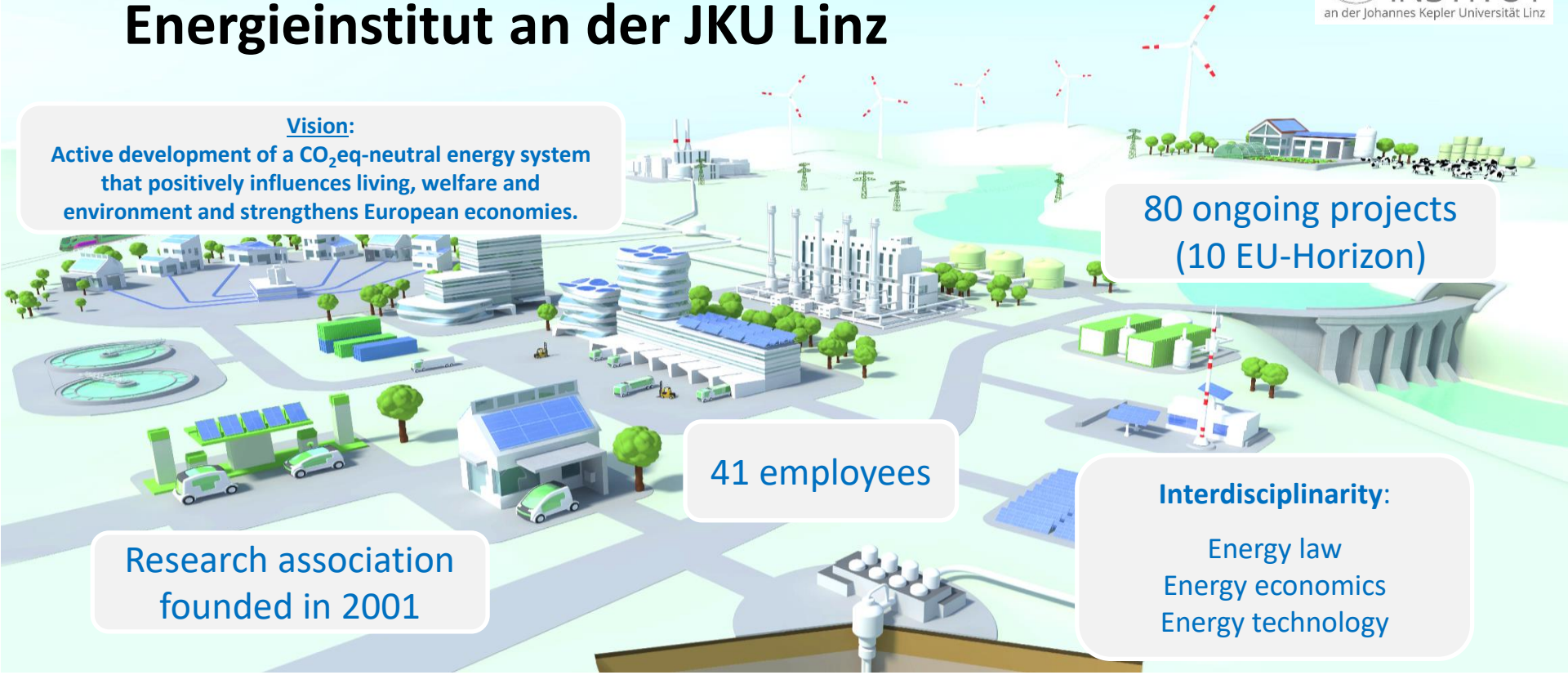
Energieinstitut an der JKU Linz

powered by klima+ energie fonds
LAND OBERÖSTERREICH
NEFI NEW ENERGY FOR INDUSTRY

Energieinstitut an der JKU Linz

Vision:
Active development of a CO_2eq-neutral energy system that positively influences living, welfare and environment and strengthens European economies.



80 ongoing projects
(10 EU-Horizon)

41 employees

Research association
founded in 2001

Interdisciplinarity:

Energy law
Energy economics
Energy technology

Heat Highway project partners

1. Energieinstitut an der Johannes Kepler Universität Linz
2. Allplan GmbH
3. Ars Electronica Linz GmbH & Co KG
4. Austrian Institute of Technology
5. LAT Nitrogen Linz GmbH
6. Business Upper Austria
7. Energie AG OÖ Erzeugung GmbH
8. Energie AG OÖ Umwelt Service GmbH
9. eww AG
10. FH Oberösterreich F&E GmbH
11. Kremsmüller Industrieanlagenbau KG
12. Linz Strom Gas Wärme GmbH
13. MU Leoben – Lehrstuhl für Energieverbundtechnik
14. OÖ Energiesparverband
15. Primetals Technologies Austria GmbH
16. voestalpine Stahl Donawitz GmbH
17. voestalpine Stahl GmbH

Basic data of the project „Heat Highway“

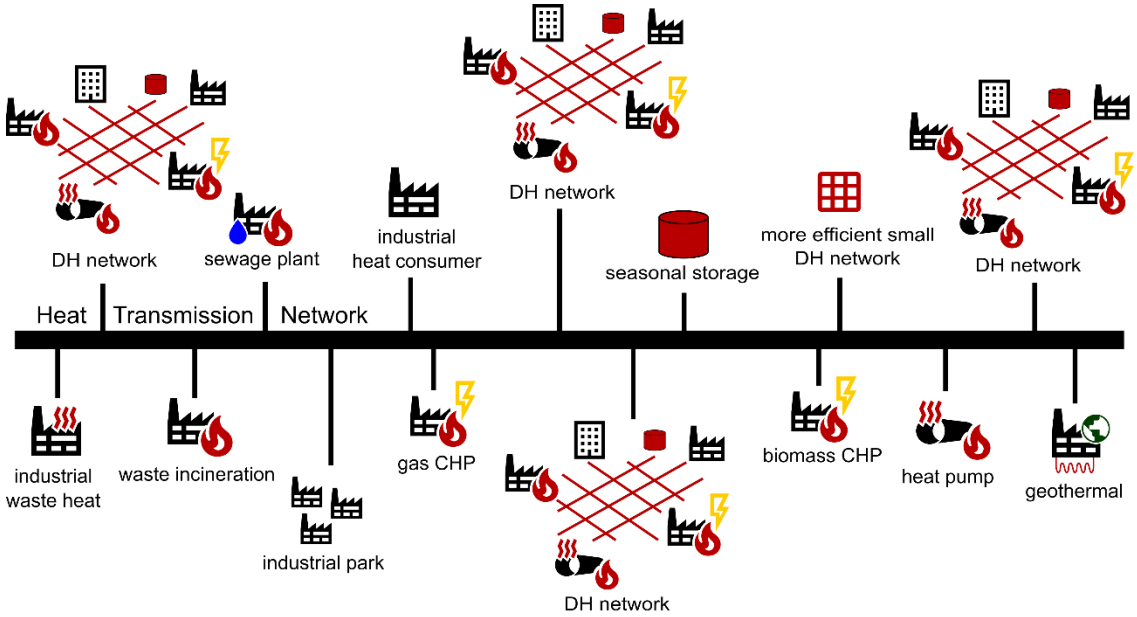
- Short title: Heat Highway
- Long title: „Interregional **heat transmission networks** to enable **industrial waste heat usage** and fossil-free industry”

- Duration: March 2021 – August 2024
- Budget: 2.5 M Euro total costs
- Funding: 49% Climate and Energy Funds
  6% State of Upper Austria

Programme: 3rd Call „Vorzeigeregion Energie” by Climate and Energy Fund

The idea

"Replicating the power grid in the heat sector?"



The supra-regional power grid enables a secure supply, efficient use of electricity and also the feeding of surpluses (e.g. from PV) into the power grid.

Would these advantages also apply to a superior heat network?

The starting point of the approach is a backcasting of this vision. Economic efficiency, heat losses, legal aspects, hydraulics, etc. are the subject of the project.

Source: Moser, Puschnigg (2021): Supra-Regional District Heating Networks: A Missing Infrastructure for a Sustainable Energy System https://doi.org/10.3390/en14123380

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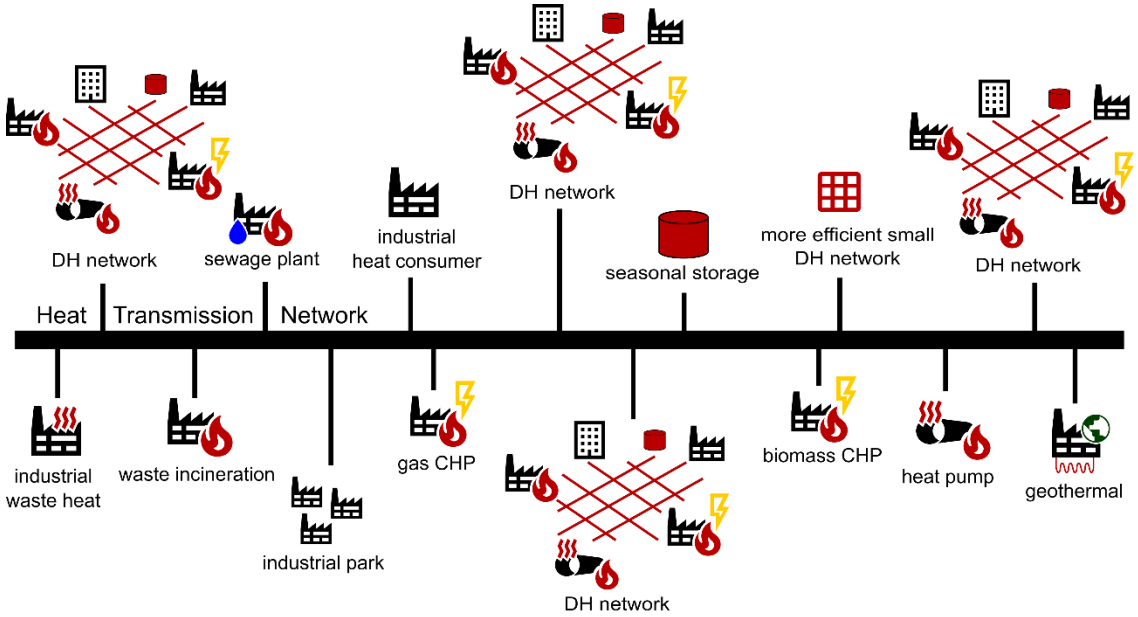

Heat transmission networks

- Connect centers of demand and supply,
- Make use of the most inexpensive and clean heat sources,
- Elevate the potential of waste heat and geothermal,
- Take advantage of the inexpensive ground they pass, for seasonal heat storages and solar thermal energy,
- Supply district heating to areas they pass
- Increase the security of supply

Source: Moser, Puschnigg (2021): Supra-Regional District Heating Networks: A Missing Infrastructure for a Sustainable Energy System https://doi.org/10.3390/en14123380

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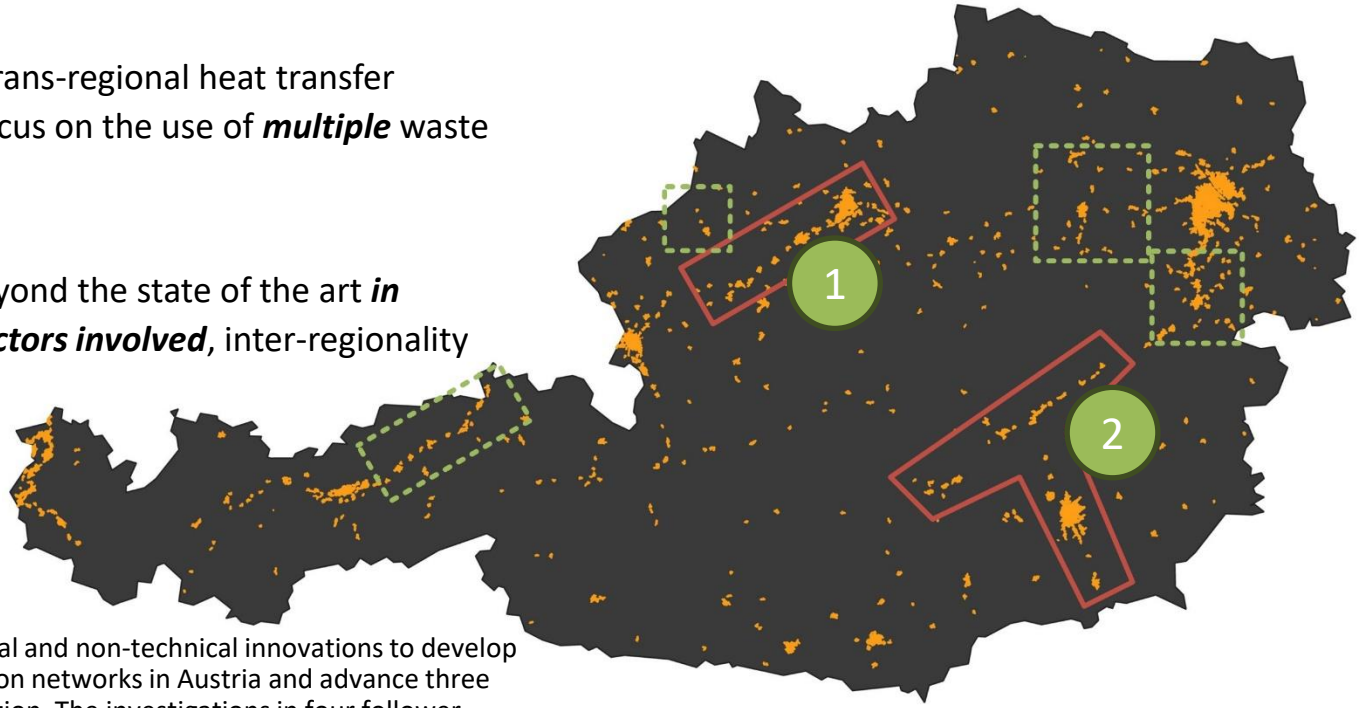
Objective

Heat Highway examines trans-regional heat transfer networks (HTN), with a focus on the use of ***multiple*** waste heat sources.

Heat Highway goes far beyond the state of the art ***in terms of the number of actors involved***, inter-regionality and interaction.



Heat Highway will use its technical and non-technical innovations to develop two 100 km long heat transmission networks in Austria and advance three sections of them towards realization. The investigations in four follower regions ensure reproducibility.

Figure based on source: Fallahnejad et al (2022): The economic potential of district heating under climate neutrality: The case of Austria https://doi.org/10.1016/j.energy.2022.124920

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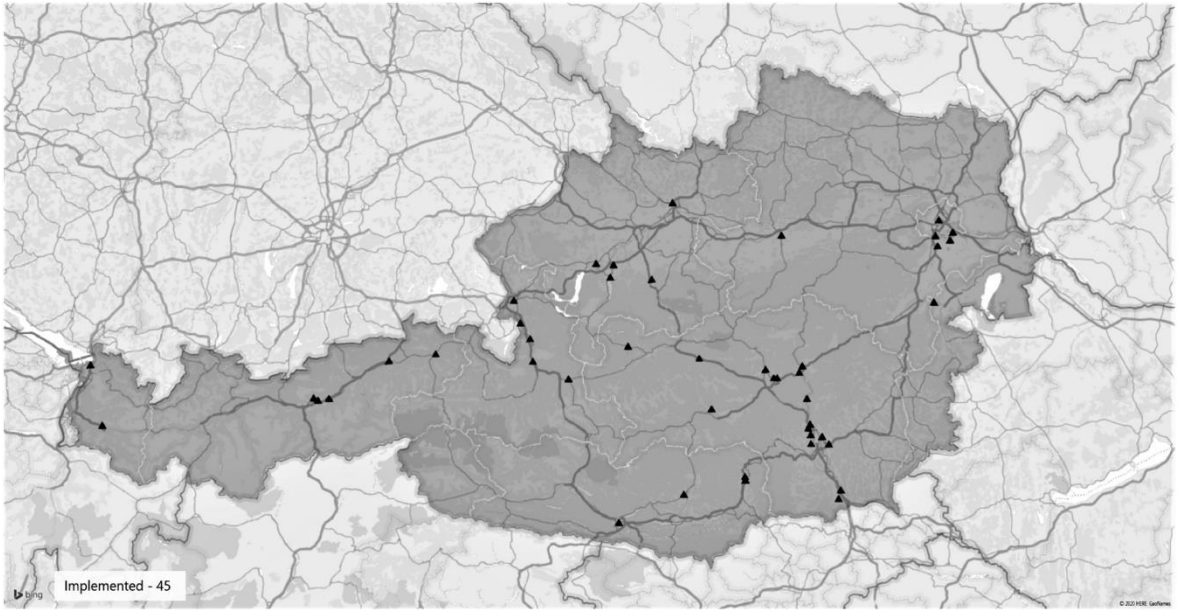
Best practice examples

- External use of industrial waste heat
  - 42 existing projects
  - Re-utilization in district heating networks

→ Learn from existing implementations

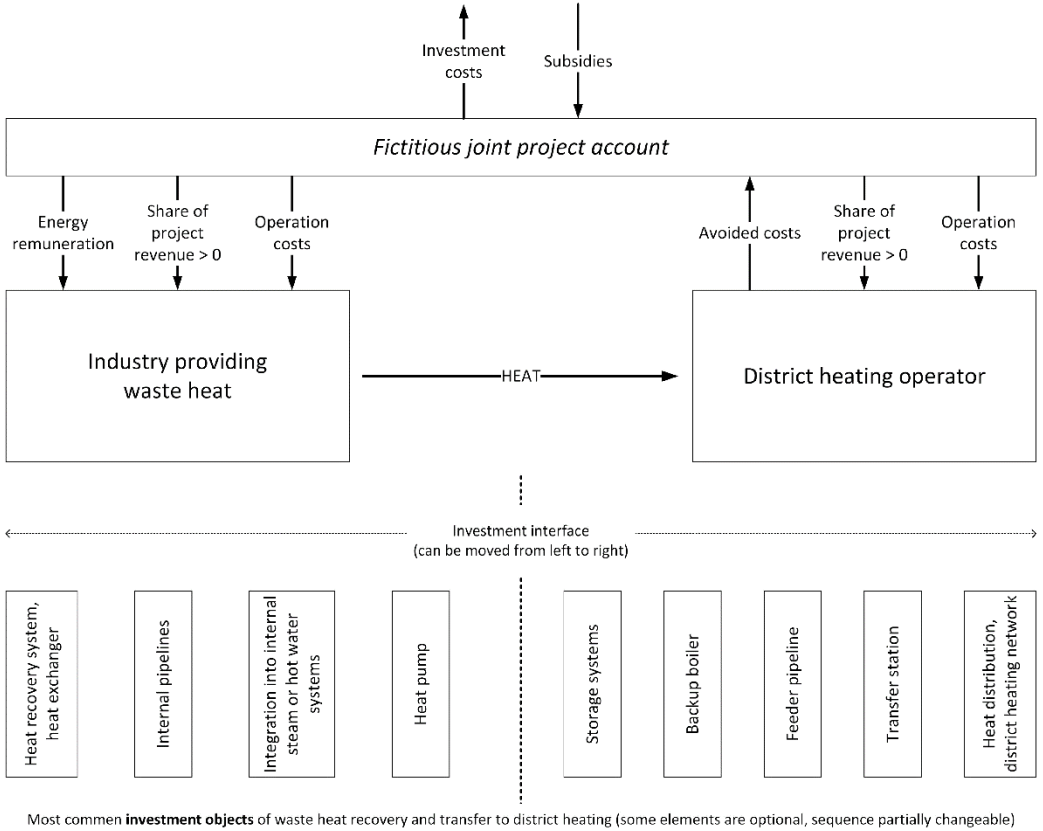
→ FACILITATE.



Source: Moser, Lassacher (2020): External use of industrial waste heat - An analysis of existing implementations in Austria https://doi.org/10.1016/j.jclepro.2020.121531

Business models

- First, overall profitability is a joint issue.
  - Costs can be covered together.
  - Each partner needs to cover her costs.
  - Then, profits must be distributed in a fair manner.



Most commen **investment objects** of waste heat recovery and transfer to district heating (some elements are optional, sequence partially changeable)

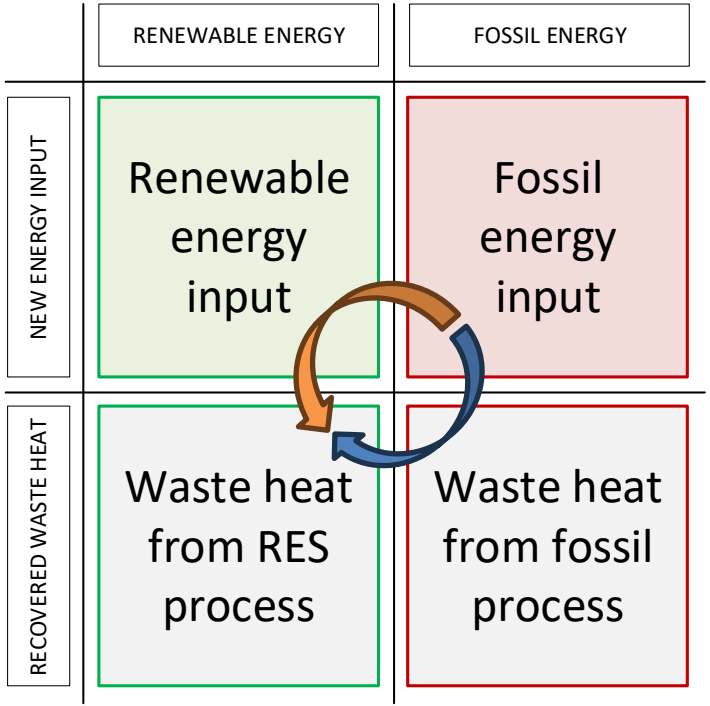
Source: Moser, Jauschnik (2023): Using Industrial Waste Heat in District Heating: Insights on Effective Project Initiation and Business Models https://doi.org/10.3390/su151310559

Legal issues: *waste heat* definition

→ Transformation of the heat supply:
- Substitute fossil fuels
- Use clean energy

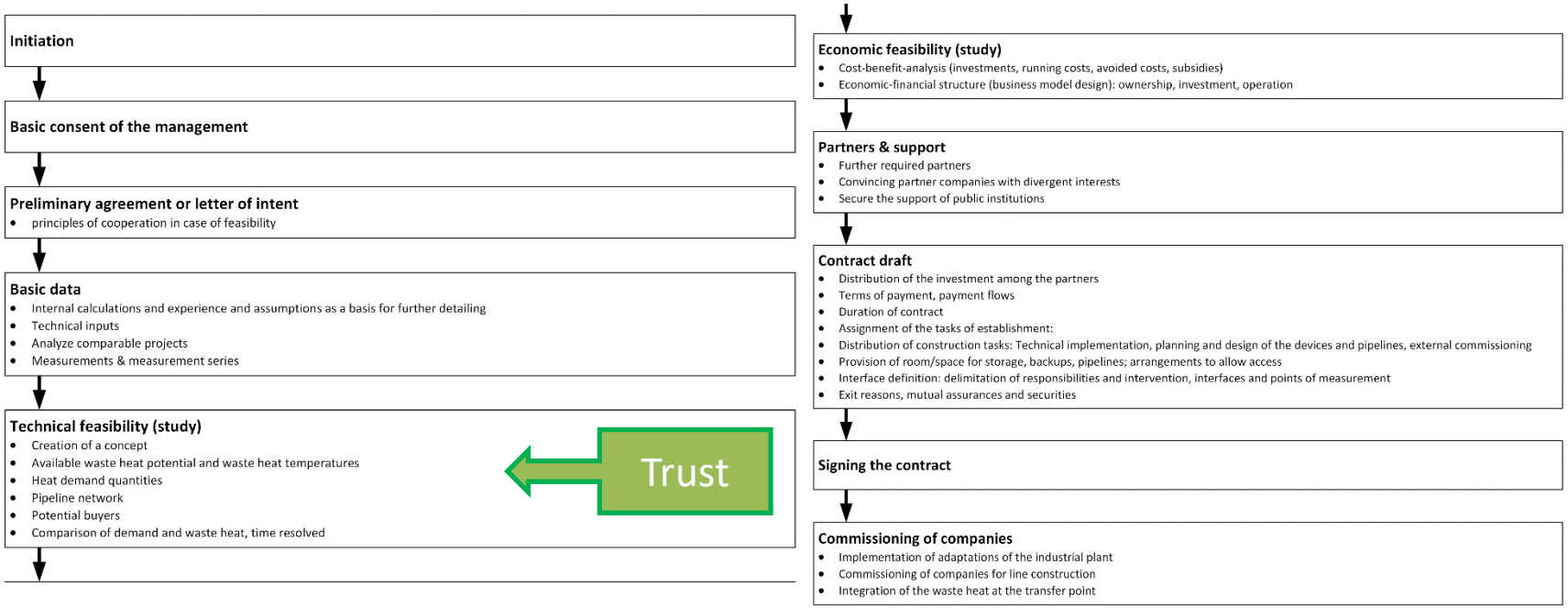
→ Comply with RED II and RED III
- Definition of waste heat
- Preference for Renewables?
- Waste heat is treated equal for DH networks.

→ Proposal for a clarification of the definition



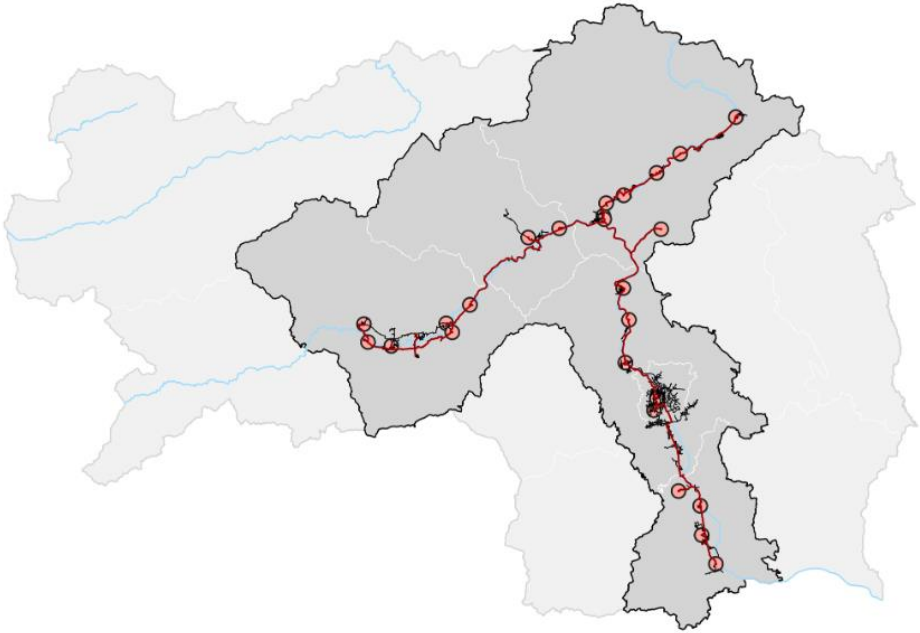
Source: Holzleitner et al. (2025): Waste heat inconsistencies in the EU's energy legislation. https://doi.org/10.1016/j.jup.2024.101880.

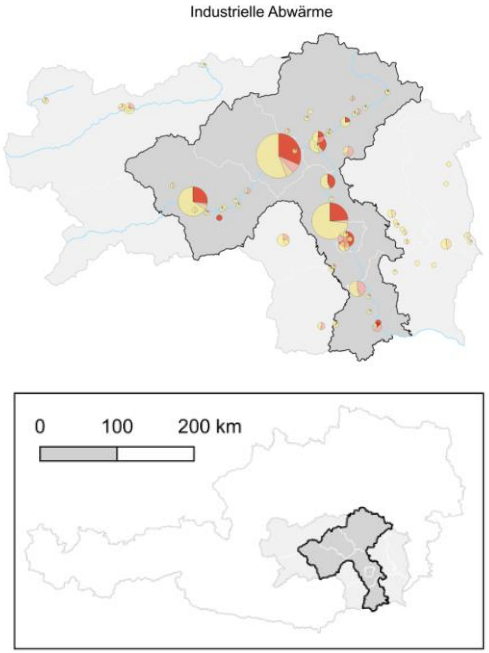
Implementation process



Source: Moser, Jauschnik (2023): Using Industrial Waste Heat in District Heating: Insights on Effective Project Initiation and Business Models https://doi.org/10.3390/su151310559

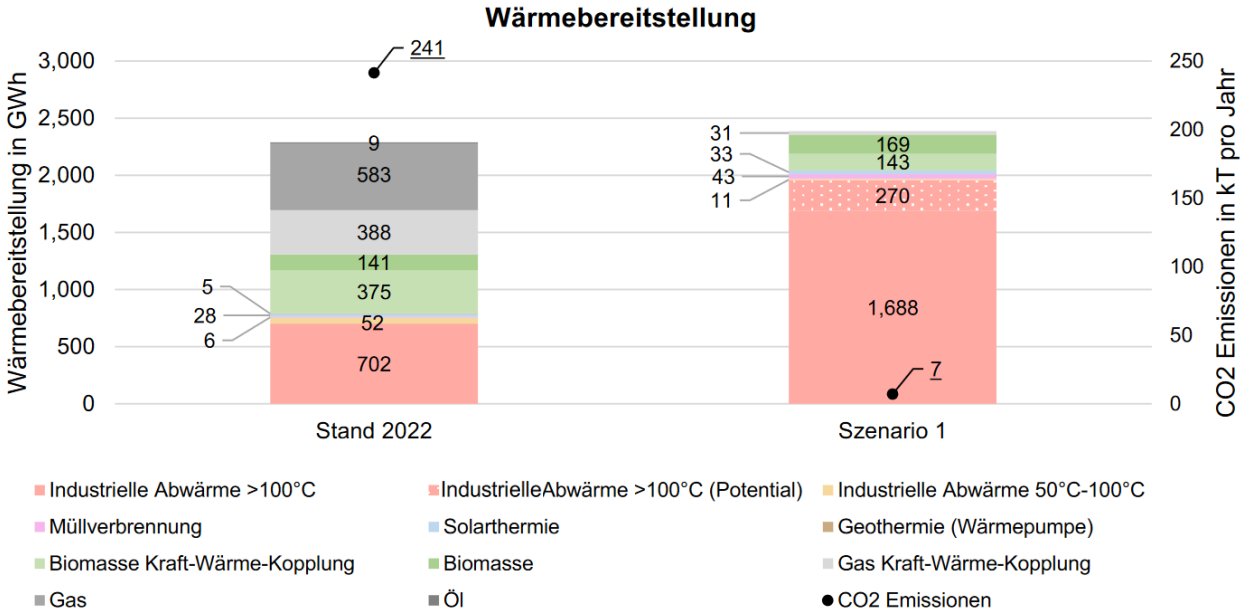
Heat Transmission Network „Styria“ 1/2





Quelle: Steinegger, Hammer, Kienberger (2024) Nachhaltige Fernwärme für den Großraum Graz 18. Symposium Energieinnovation, 14.-16.02.2024, Graz/Austria

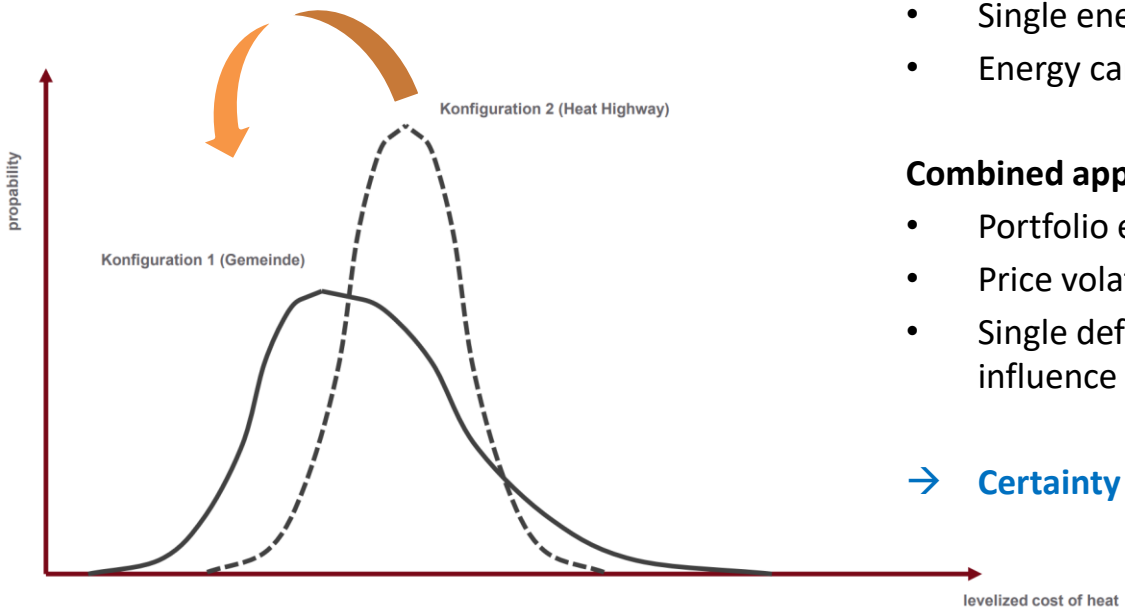
Heat Transmission Network „Styria“ 2/2



- 269 kilometers
- Capitalize the use of *existing* waste heat sources.
- Heat losses of approx. 5%
- Emissions reduction from **241 to 7 kt CO2** per year

Quelle: Steinegger, Hammer, Kienberger (2024) Nachhaltige Fernwärme für den Großraum Graz 18. Symposium Energieinnovation, 14.-16.02.2024, Graz/Austria

Increase of price stability and resilience



Individual approach:

- Single energy carriers
- Energy carrier supply

Combined approach

- Portfolio effect → diversification
- Price volatility with less influence
- Single defaults of waste heat show less influence

→ **Certainty as success factor for Heat Highways**

Quelle: Marx et al (2023) Risk assessment in district heating: Evaluating the economic risks of inter-regional heat transfer networks with regards to uncertainties of energy prices and waste heat availability using Monte Carlo simulations. https://doi.org/10.1016/j.segy.2023.100119

AUSTRIAN INSTITUTE OF TECHNOLOGY

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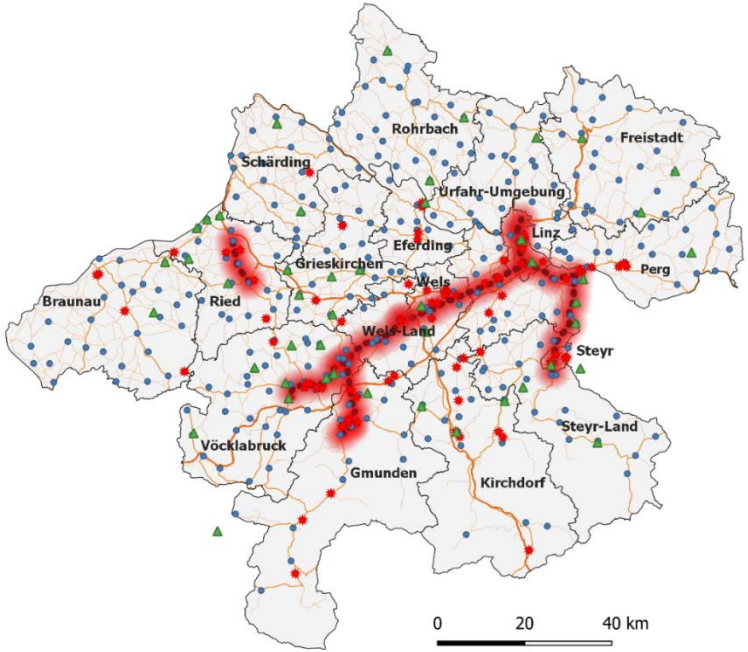
Heat Transmission Network „Upper Austria“

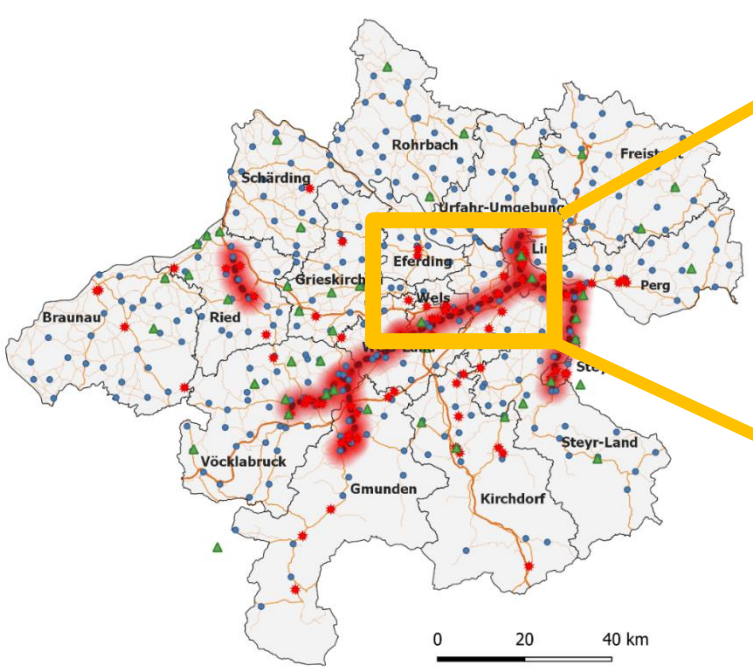


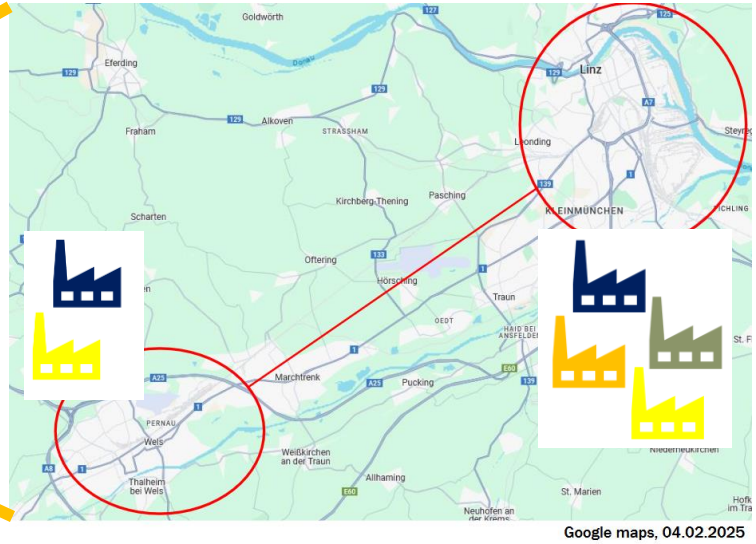
- First estimates from 2020
  - Pipeline cost 2020: 130 M Euro
  - Revenue 2020: 1.5 - 20 M Euro/a
  - Significant uncertainty
  - Calculations ongoing
  - *Technical* waste heat potential is estimated at around 230 MW in summer and 130 MW in winter

- Today, the project Heat Highway **triggers concrete actions**:
  - Linz #1
  - Linz #2
  - Wels
  - Enns
  - Gmunden
  - Vöcklabruck

Source: Moser, Puschnigg (2021): Supra-Regional District Heating Networks: A Missing Infrastructure for a Sustainable Energy System https://doi.org/10.3390/en14123380

Heat Transmission Network „Upper Austria“





Google maps, 04.02.2025

Wels

Waste incineration CHP

Gas boilers

Linz

Waste incineration CHP

Biomass CHP

Gas CHP

Gas boilers

Source: Moser, Puschnigg (2021): Supra-Regional District Heating Networks: A Missing Infrastructure for a Sustainable Energy System https://doi.org/10.3390/en14123380

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Heat Merit Order

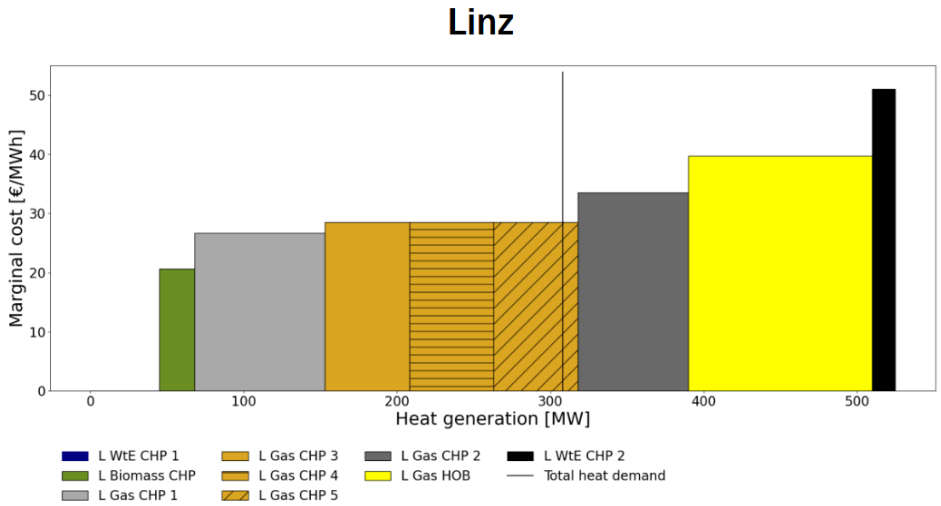
- Compare variable/marginal costs
- Assume that connection and plants are built → calculate savings
- I.e. using the Heat Merit Order model here is a back-casting method:
  - What CAPEX can be invested and what income remains?
  - The fact that there is a saving and this entails reduced costs does not imply that an investment in a connecting line is economic.

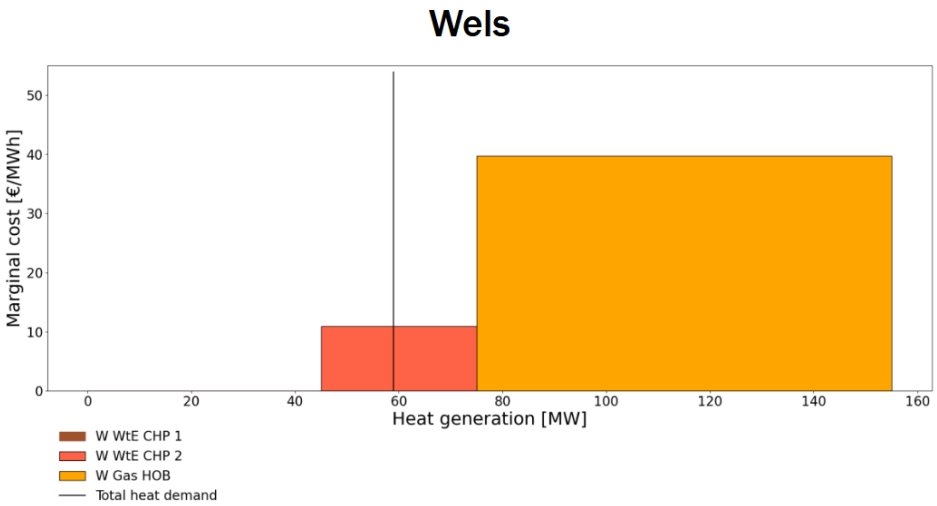
- Heat costs
  - Transparent prices
  - Wholesale market prices for gas and electricity
  - CHP plants are sector-coupled, i.e. consider 1h electricity spot market

Source: Rusch, Moser (2025): Ökonomische Bewertung eines Heat Highways zwischen existierenden Fernwärmenetzen. Präsentation, IEWT Conference Vienna 2025.

Heat Merit Order

- The heat merit order may change hourly,
  primarily due to electricity market prices (day-ahead spot market)
- Examplary heat merit order in hour 109, 2019





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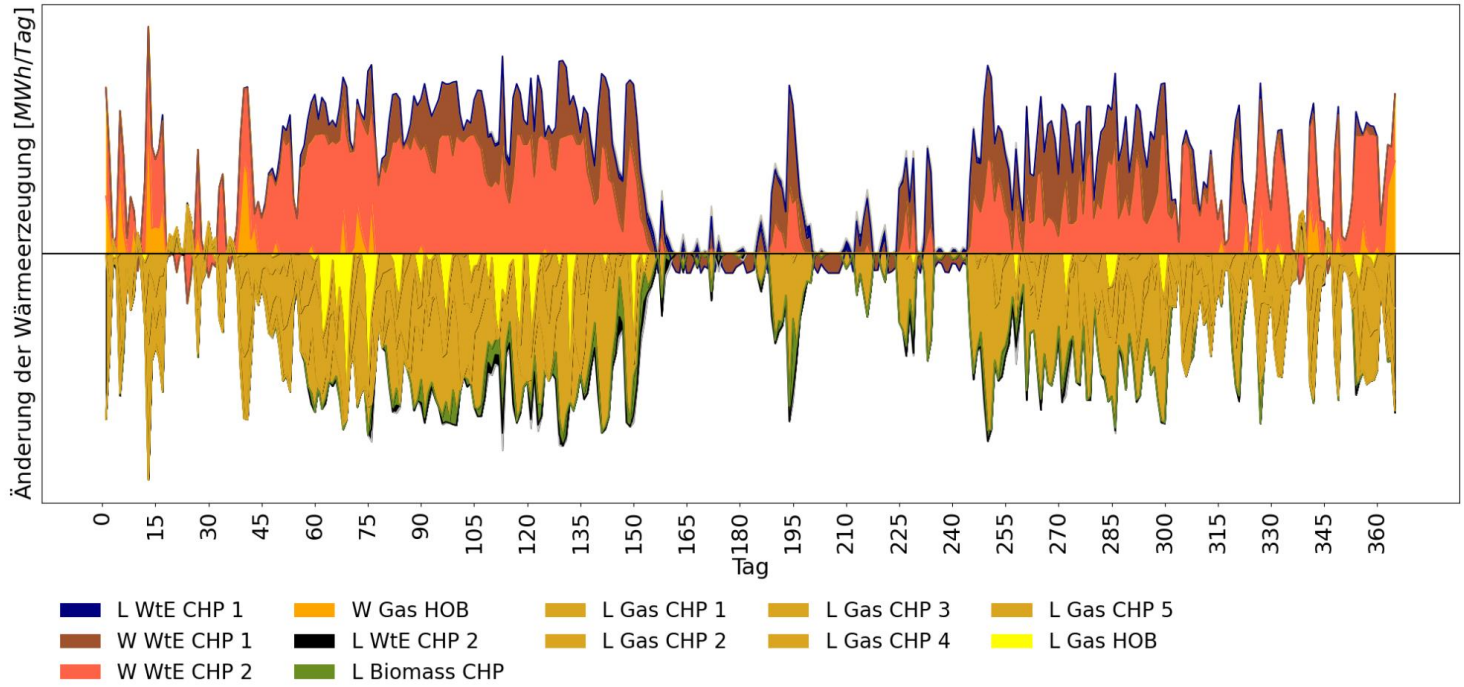
Linz-Wels: Daily change in generation



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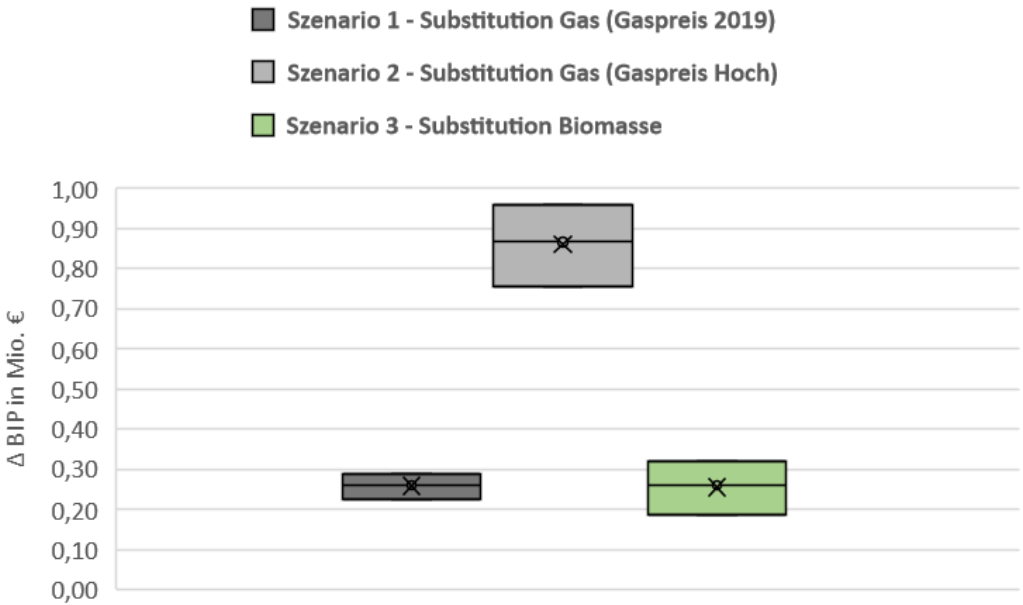
Macroeconomic benefit



Macroeconomic evaluation

- Basic size: 1 GWh/a of recovered and used waste heat
- High-price gas scenario:
  - 0.9 Mio GDP growth
  - 8 additional people employed
- Benefits also appear for the scenario with biomass substitution.

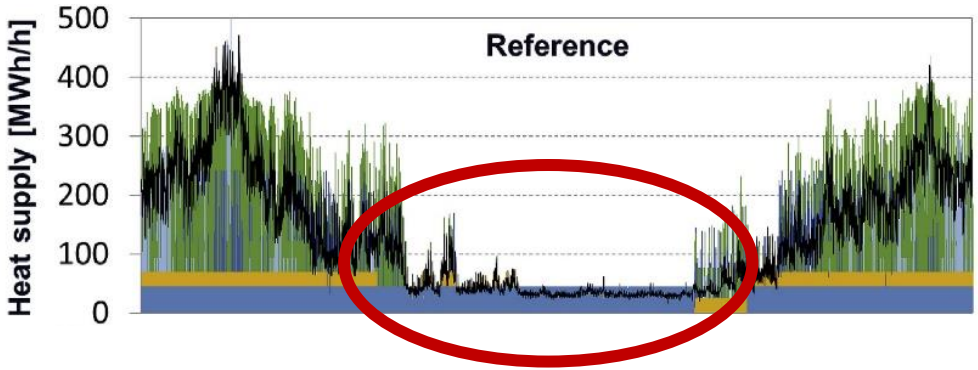
Quelle: Hammer et al (2023) Industrial Excess Heat – INXS. Erhebung industrieller Abwärmepotenziale in Österreich. Final report, accepted, forthcoming.

To do: Enhance economic feasibility

- Summer heat
  - Waste heat potential
  - Geothermal potential

No payback for ½ year

- Future sinks to investigate:
  - Process heat
  - Heat-to-Cold
  - Hot water preparation
  - Seasonal storage



Source: Köfinger et al. (2018) Simulation based evaluation of large scale waste heat utilization in urban district heating networks: Optimized integration and operation of a seasonal storage https://www.sciencedirect.com/science/article/pii/S036054421831257X

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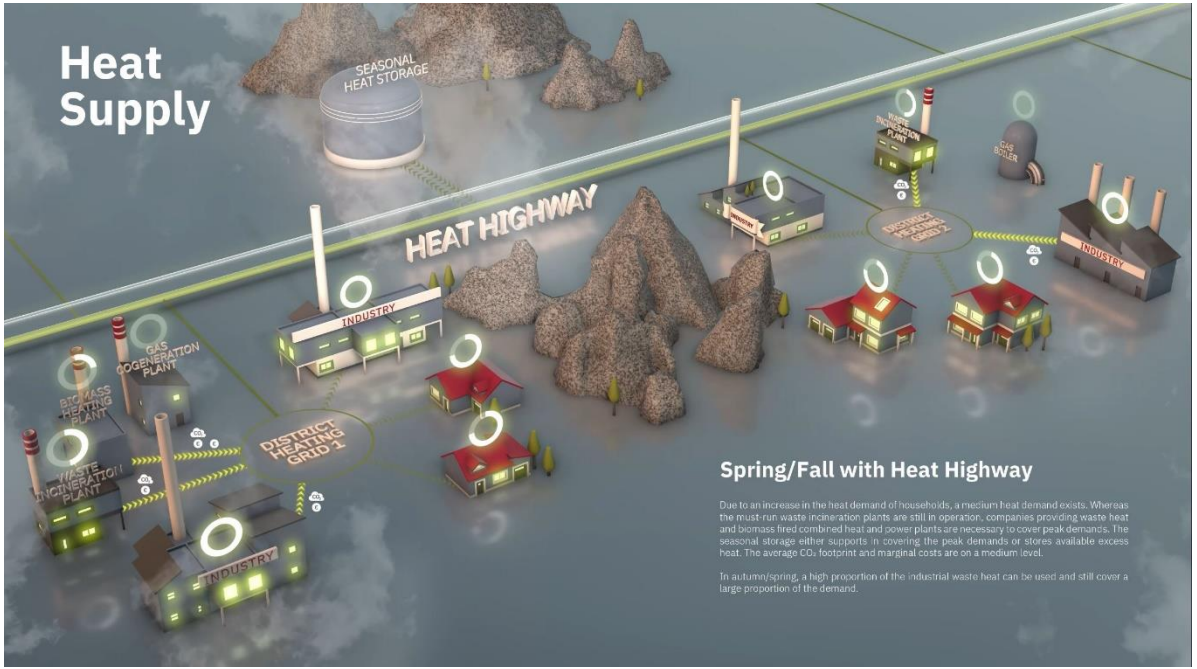
Showcase the feasibility

- "Museum of the future"
  - Ars Electronica Center Linz
- Popular showcasing of a "virtual demonstrator"
  - Guided tours
  - 1000s of visitors



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ARS ELECTRONICA

HEAT HIGHWAY

Showcase the feasibility

- Popular showcasing of a “prototype”
  - 1000s of visitors
- “Museum of the future”
  - Ars Electronica Center Linz

ARS ELECTRONICA

United Skills of KREMSMUELLER

HEAT HIGHWAY

Thank you!

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