# HEAT HIGHWAY

## Lessons learnt from European examples

Innovation Workshops; March 3rd; Wels, Austria

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TOMORROW TODAY

# BEST PRACTISE EXAMPLES*

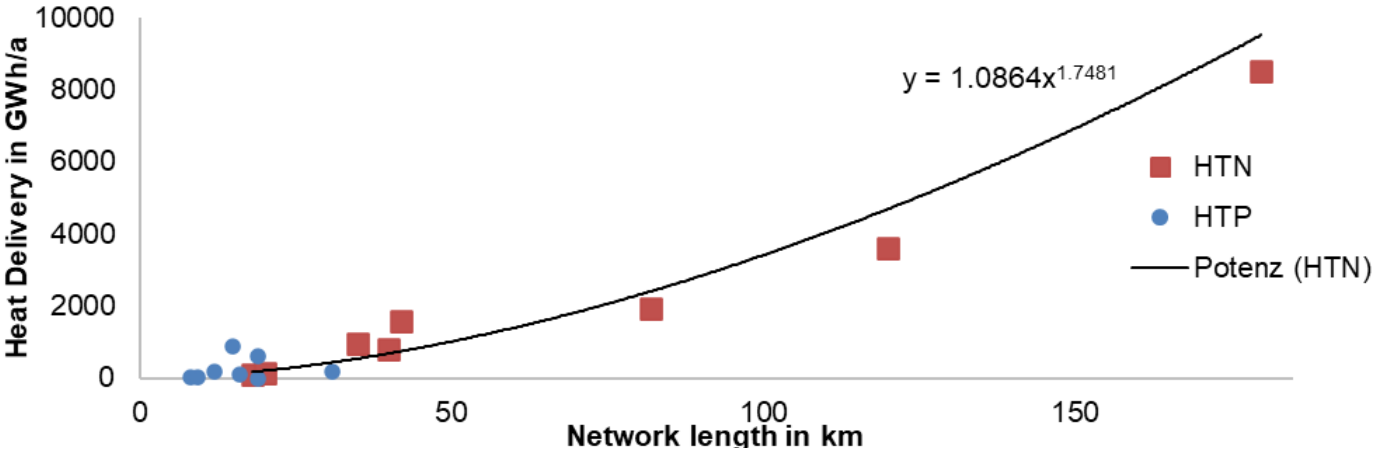

Source: Google - MyMaps

Long heat transfer network

Heat transfer pipe
Unidirectional transport
(one source/one sink)

**Non-exhaustive list*

# QUANTITATIVE ANALYSIS




| Parameter | Average | HTN | HTP |
|---|---|---|---|
| Distance in km | 32 | 62 | 22 |
| Capacity in $MW_{th}$ | 221 | 482 | 164 |
| Heat delivery in $GWh_{th}/a$ | 1422 | 2302 | 264 |
| Specific investment cost in €/m | 725 | 816 | 699 |
| Linear power density in MW/km | 8.8 | 11 | 8.4 |
| Linear heat density in MWh/m×a | 21 | 24 | 16 |

# QUALITATIVE ANALYSIS
## LEARNINGS FROM DANISH INTERVIEWS

- Financing and business models based on:
  - Tax increase on other fuels
  - Lack of profit motive of operators
  - Interconnection of individual networks to increase cost-optimized heat production
- Attract financing
  - Company formed by municipalities liable for entire debt
  - Adjust heat price annually to guarantee repayment <20y
- 3-phase integration of industrial waste heat
- Financial incentives for lower return temperatures
- Establishment of a heating market in Copenhagen

# QUALITATIVE ANALYSIS*
## SWOT ANALYSIS

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### Strengths

- Optimal integration of regionally available heat sources
- Heat delivery to remote customers
- Reduced dependencies, increased system resilience

### Weaknesses

- High CAPEX
- High complexity
- High system inertia  (e.g. temperature changes)

### Opportunities

- Suitable land for (seasonal) heat storage
- Establishment of heat market
- Increased large-scale utilization of alternative heat sources

### Threats

- Challenging investment decisions
- Utilization rates as a key parameter may vary greatly
- Changed conditions

**Only key aspects are shown*

# HEAT TRANSFER NETWORK RHEIN-RUHR

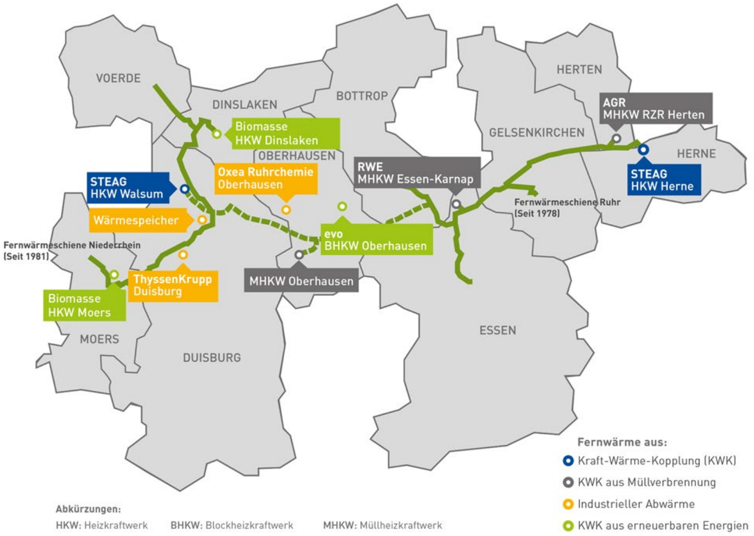
- Planned: 25 km interconnection between existing HTNs
- 100 000 tons $CO_2$-savings per year
- Reasons for non-implementation:
  - Lenghty planning and appproval phase→ Changed framework conditions (coal phase-out)
  - Measures needed to secure supply→ Focus on local heat sources
  - No additional benefit of the planned connection with new heat sources

02.09.2021 – 15:08

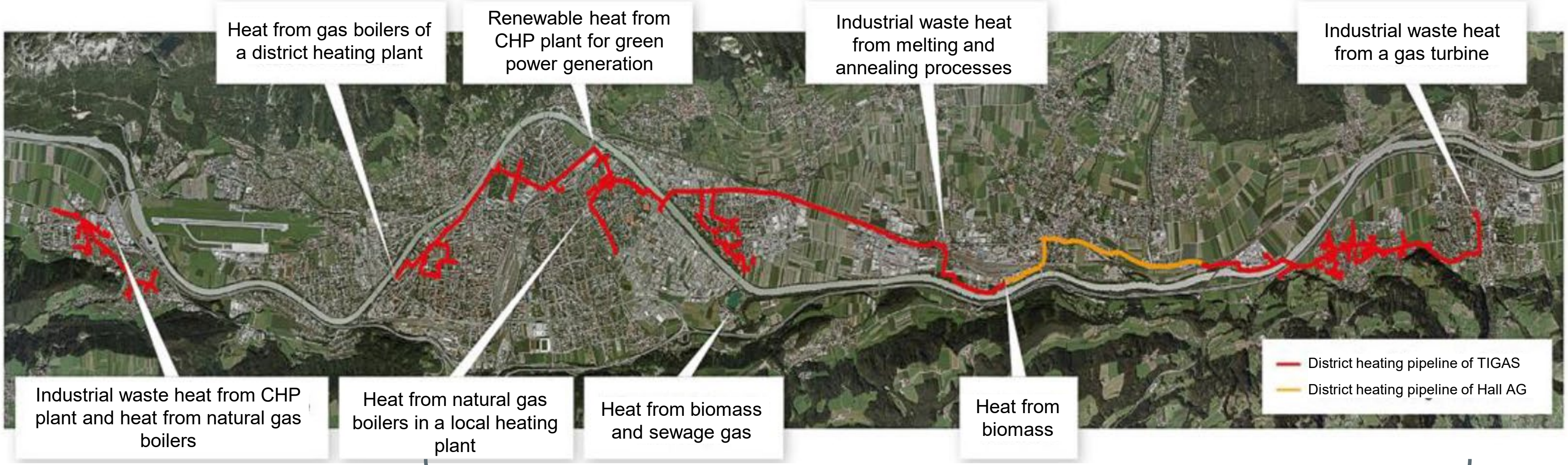
Westdeutsche Allgemeine Zeitung

**Fernwärmeschiene Rhein-Ruhr hat keine Zukunft**

https://www.presseportal.de/pm/55903/5010041



# EXISTING HTN: INNSBRUCK – WATTENS



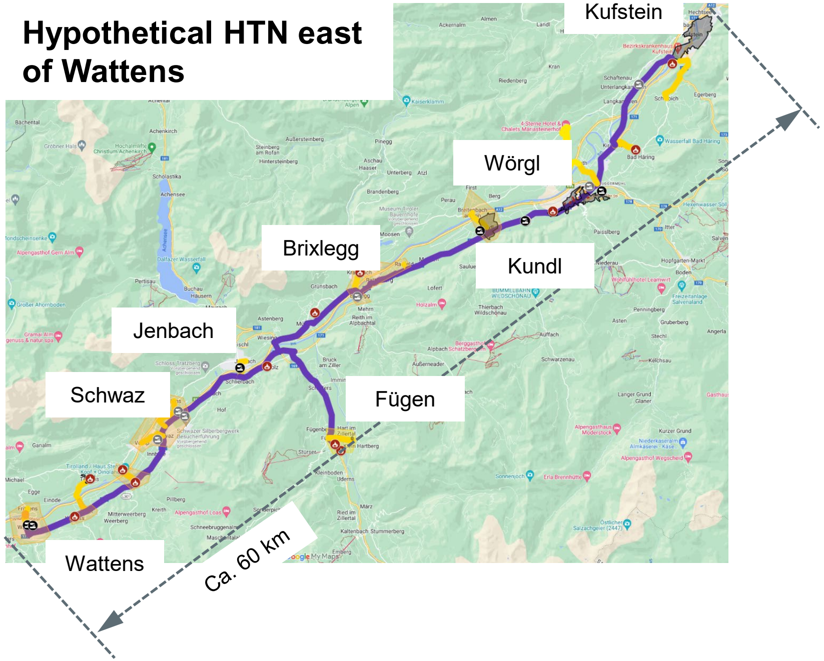

Ca. 16 km


* with Partner IKB

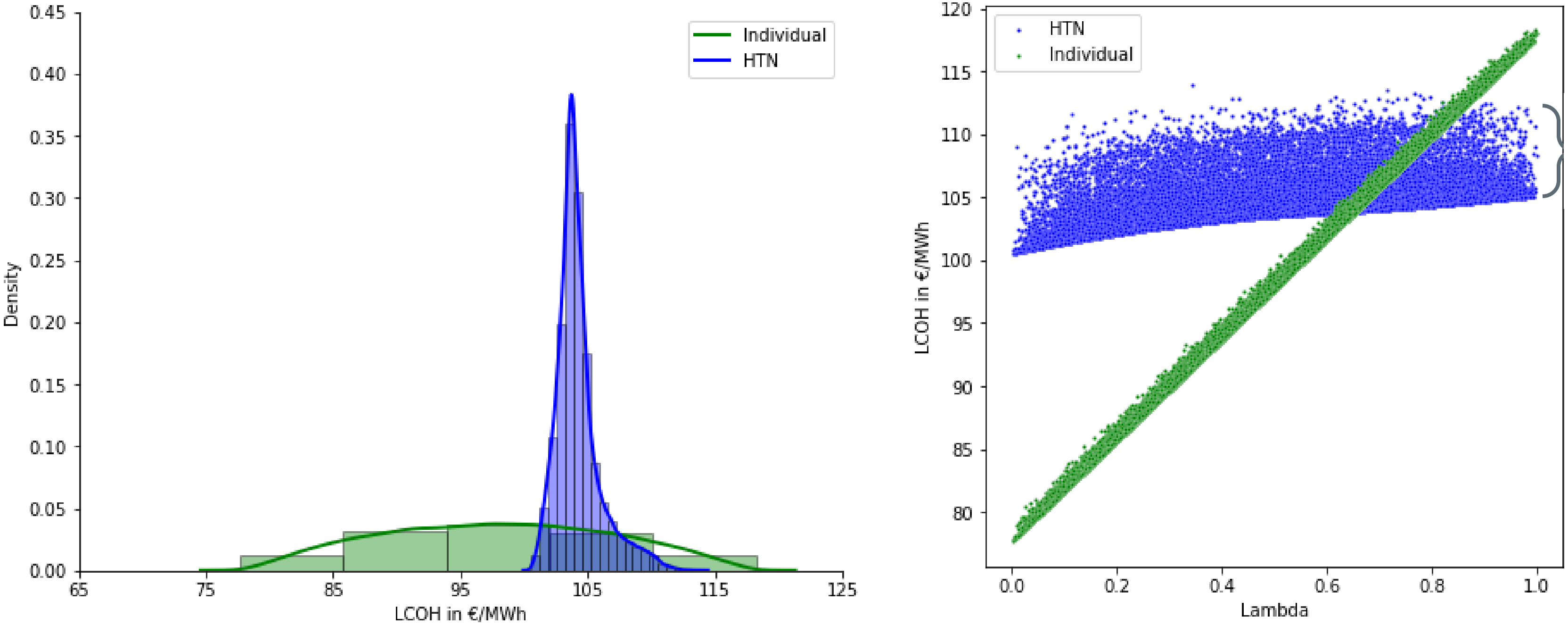
Source: https://eventmaker.at/uploads/16600/downloads/11_hilber_vortrag.pdf
Translated to English

# CASE STUDY: INTER-REGIONAL HEAT TRANSFER NETWORK EASTERN INN VALLEY

- Identify the most promising **heat sinks and sources** (8 industrial waste heat suppliers + existing biomass heating plants
- Elaboration of a **basic pipeline route** + costs
- Calculation of **profitability** via seasonal balances (no optimisation)
- Carry out a risk analysis in comparison to "individual" supply with the help of Monte Carlo simulation
  - Energy price forecasts
  - Availability of waste heat



# RESULTS (PRELIMINARY)




Scattering due to disappearance of waste heat

# CONCLUSION AND NEXT STEPS

HTNs can

- …include seasonal storages, backup boilers…
- …reduce supply risks
- …lead to price stability

Interest in HTN is increasing

- Rising and volatile energy prices
- Best-practise examples

Further investigation the case study “Inn Valley”*

*see also: Nicolas Marx, Stefan Reuter, Ralf-Roman Schmidt: Decarbonizing the heating supply via regional district heating networks - Status-Quo for a case study in Tyrol; 8th International Conference on Smart Energy Systems, 13th – 14th of September 2022, Aalborg, Denmark

# ERKENNTNISSE AUS VORPROJEKT VON EI JKU ZU HEAT TRANSMISSION NETWORKS

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- Technische Möglichkeiten
  - Integration von (neuen) Wärmesenken im Sommer
  - Höhere Netzwerktemperatur im Sommer
  - Niedrigere Netztemperatur im Winter

- Ökonomische und organisatorische Betrachtung
  - Organisation: Network Codes & zentrale Ansprechstelle (Netzbetreiber)
  - Finanzierung: keine generalisierbaren Erkenntnisse
  - Infrastrukturkosten: ca. 1000 €/m Rohrleitung
  - Betriebseinnahmen: Einsparungen der Abnehmer im Vgl. zu aktuellem Benchmark
  - Risikominderung: Einbindung mehrerer Abwärmequellen möglich

Moser, S., & Puschnigg, S. (2021). Supra-Regional District Heating Networks: A Missing Infrastructure for a Sustainable Energy System. Energies, 14(12), 3380. https://doi.org/10.3390/en14123380

# EINFLUSSFAKTOREN AUF WIRTSCHAFTLICHKEIT

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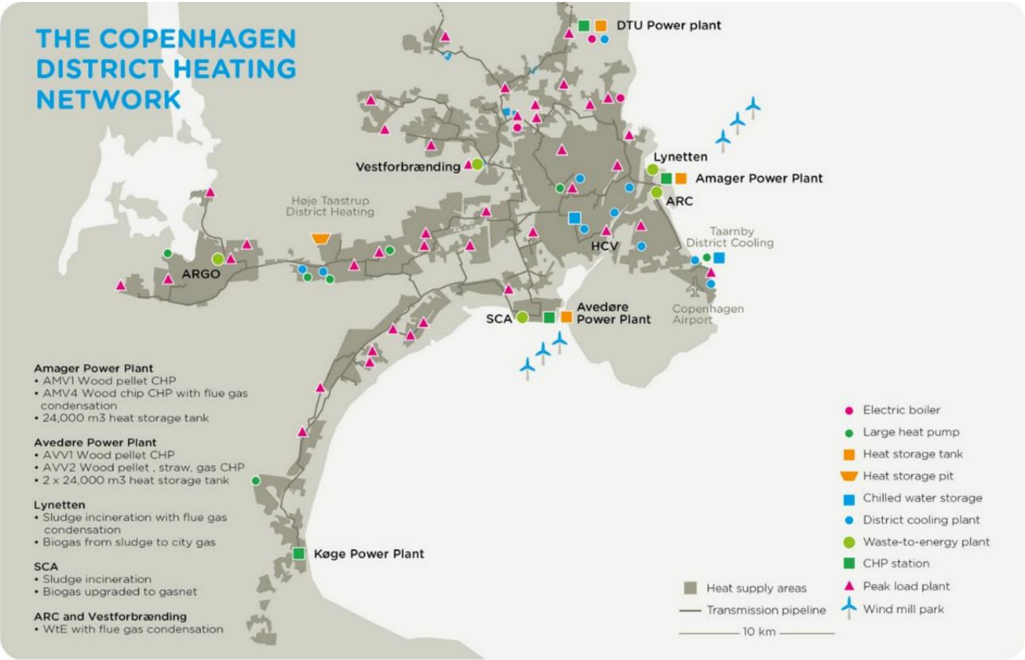
- Kostengünstige Erzeugungskapazitäten entlang der Trasse
- Etablierte Wärmeabnehmerstruktur
- Möglichkeit der Einbindung weiterer neuer Wärmesenken
- Topographie der Trassenführung
- Wegfall nahegelegener relevanter Erzeugungskapazitäten
- Politische Rahmenbedingungen und Förderungen

# EXAMPLE
# GREATER COPENHAGEN DHN

- 180 km transmission network
- 3 operators
- 21 connected DHN
- Heat supply: ~ 8500 GWh/a
  - Biomass CHP
  - Waste incineration
  - Peak load boiler
  - Industrial waste heat
  - Thermal storages
- Targets
  - CO2-neutral by 2025
  - Realization of 4GDH

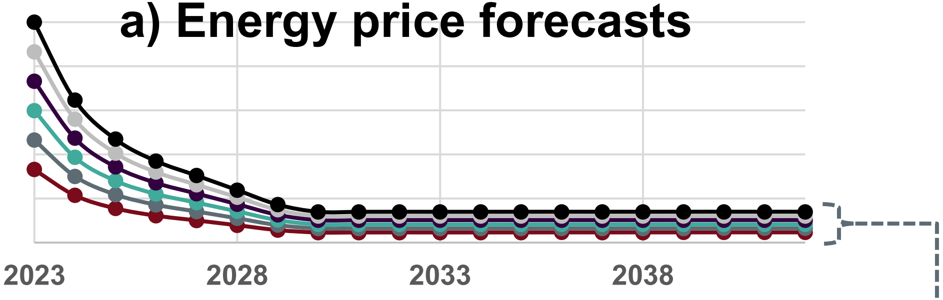



https://dbdh.dk/wp-content/uploads/SoG_WhitePaper_DistrictEnergy_210x297_DE_V03_WEB.pdf
https://www.cibsejournal.com/technical/europes-hottest-city/

Gudmundsson, O. und Dyrelund, A.: District Energy – the resilient energy infrastructure. URL: https://www.iea-ebc.org/Data/Sites/4/media/events/2020-10/presentations/2.4--gudmundsson--district-energy-resilience.pdf

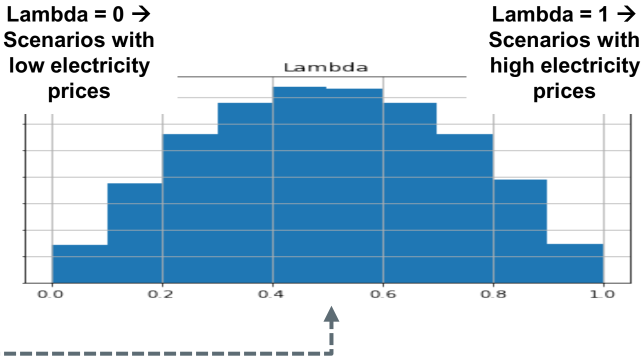
# DEFINITION OF THE UNCERTAINTY FACTORS

## a) Energy price forecasts




- Hourly electricity prices
- Monthly biomass prices
- Annual biomethane prices (= gas price + premium)

Quellen: Gaspreise: EU Energy Outlook 2060, Strompreise: öffentlich verfügbare Studien, Schwankungen: VAR-Model, Biomassepreise: Biomasseverband




Lambda Ziehung

- The distribution of the energy price scenarios is described by a beta distribution
- $Price = Lambda \cdot Price_{max} + (1 - Lambda) \cdot Price_{min}$

## b) Availability of waste heat

- Little data available when and under which conditions the supply of waste heat fails
- Here: Use of WKO statistics on corporate insolvencies, calculation of the average probability per year