PARALLEL SESSION 8: HYBRID ENERGY NETWORKS – IEA DHC ANNEX TS3

Ralf-Roman Schmidt

17th Symposium of DHC, Nottingham, 7th - 8th of September 2021

This presentation has been created in the framework of the international cooperation program IEA DHC Annex TS3 „Hybrid Energy Networks“. More information at www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3
The Austrian participation in the IEA DHC Annex TS3 is financed by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) in the framework of the IEA-Forschungskooperation.

MOTIVATION:

- **Coupling the electricity and gas sector together with a closer integration with other sectors, i.e., transport, heating & cooling and industry, is considered one of the key measures for decarbonizing the energy system.**

- District heating and cooling (DHC) networks are **traditionally linking the heating & cooling and electricity sector** (and often also the gas sector) through combined heat and power (CHP) plants. However, **the role of CHP plants will significantly change**
  - competition for renewable fuels with hard-to-decarbonise sectors
  - increasing share hydro, wind and PV, less CHP electricity required

→ **We will need other heat (and cold) sources**
→ **We will need other coupling points to provide flexibility**

RELEVANT SECTOR COUPLING TECHNOLOGIES

- Waste and ambient heat, solar and geothermal energy often require **heat pumps (HPs)** for upgrading their temperature level;

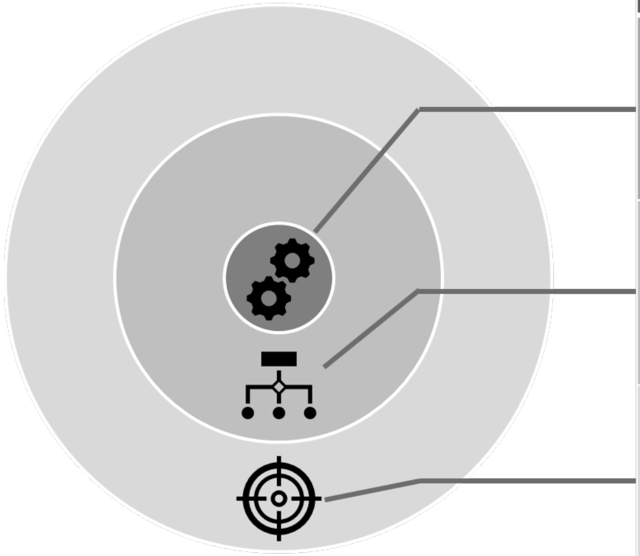
- **electric boilers (eBs)** enable high temp. heat generation at fast gradients and low costs;

- **power-to-gas (PtG)**[1] processes generate fuels, that can be used in

- **CHP plants** for generating electricity and heat.

[1] *PtG process itself generate significant amounts of waste heat, so a proper term would be power-to-gas&heat (**PtG&H**) or combined heat and gas (**CHG**) plants*

A CLASSIFICATION APPROCH*



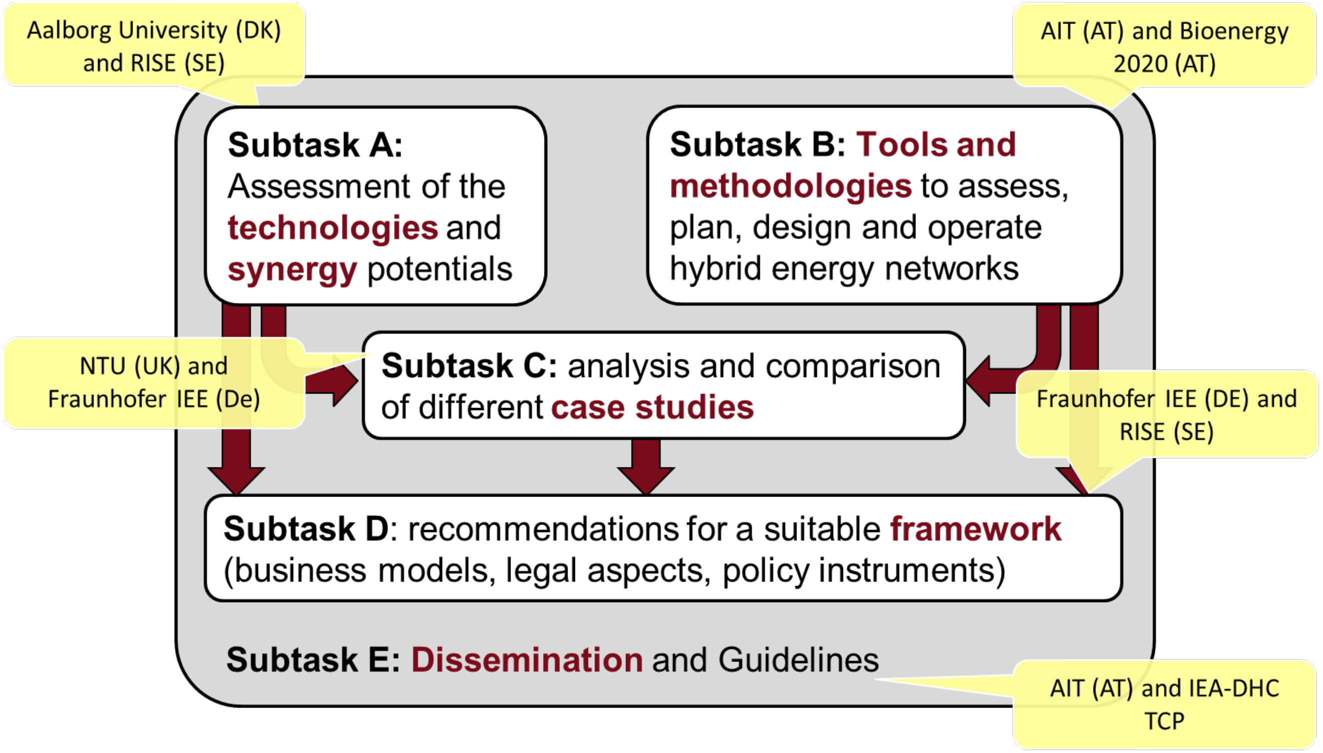
Layer	Minimum	Maximum
Technology	Single coupling points, central controls of network and coupling points	Multiple and diverse coupling points, high operational flexibility, advanced controls, automation and analytics
Organization	Minimum permissible ownership of coupling points, traditional business models and services offered	Diverse ownership, high share of prosumers, innovative business models and services offered
Strategic	Central structures, integration of coupling points as a reaction to market pressure	Decentralized structures, integrated planning and design, optimized interaction and decarbonization

*This classification differs from the 4G DHC networks concept (Lund et. al=) → the main characteristic of a HEN is the integration between the different networks, and not the supply temperature or the time period where the different generations were dominating.

BACKGROUND: IEA DHC ANNEX TS3: HYBRID ENERGY NETWORKS

- **An international cooperation program with the aim**:
  - To promote the opportunities and to overcome the challenges for district heating and cooling (DHC) networks in an integrated energy system context
- **Funded**
  - through a task-sharing approach (participants contribute resources in-kind)
- **Lead**:
  - Ralf-Roman Schmidt (AIT); ralf-roman.schmidt@ait.ac.at
- **Runtime**:
  - Fall 2017 – March 2022
- **More information at**
  https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft

BACKGROUND: IEA DHC ANNEX TS3: HYBRID ENERGY NETWORKS - STRUCTURE



BACKGROUND: IEA DHC ANNEX TS3: HYBRID ENERGY NETWORKS - SCHEDULE

Definition phase	Preparation phase		Working phase					
2017 /Fall	**2018 /Spring**	**2018 /Fall**	**2019 /Spring**	**2019 /Fall**	**2020 /Spring**	**2020 /Fall**	**2021 /Spring**	**2021 /Fall**
Austria	Stockholm	Berlin with Industry WS	Stockholm shared WS with ISGAN	France – on invitation by CEA	Online TelCo and public Webinar	Online TelCo and public Webinar	Online a side event to the https://missioninnovationaustriaweek.at	Nottingham/ Denmark – part of the symposium/ SES

reporting phase
2022 /Spring
tbd

Please find more information (previous webinars, presentations, publications …) at https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3

OUTLOOK

- publication of the results in different journals
- publication of a Guidebook
- Development of short fact sheets/ summary for policy makers + recommendations
- Final workshop on the TS3 results in Spring 2022 (ISEC conference?)
- **Save the date**: IEA DHC Annex TS3&4 Industry Workshop:
  - November 3rd, 2021 as a web meeting

PARALLEL SESSION 8 - OVERVIEW

14:00 - 14:25	**P50 - Svensson, Inger-Lisa (RISE, Sweden)**	Drivers and barriers for prosumer integration in the Swedish district heating sector
14:25 - 14:50	**P22 - Anna Kallert (Fraunhofer)**	A Multivalent Supply Concept: 4th Generation District Heating in Moosburg an der Isar
14:50 - 15:15	**P65 - Sorknes, Peter (AAU)**	Hybrid energy networks and electrification of district heating under different energy system conditions
15:15 - 15:40	**P52 - Svensson, Inger-Lisa (RISE, Sweden)**	How are business models capturing flexibility in the district energy (DE) grid
15:40 - 16:00	**P49 - Schmidt, Ralf-Roman (AIT)**	Analyses of strength, weaknesses, opportunities and threats of hybrid energy networks

Should I stay or should I go?

Drivers and barriers for prosumer integration in the District Energy sector of Sweden

Inger-Lise Svensson,
Lovisa Axelsson,
Sujeetha Selvakkumaran

RISE Research Institutes of Sweden, Gothenburg, Sweden

Eye of the Tiger

- Despite the benefits prosumers bring, prosumers are not so common in Sweden
- Some of the reasons for this are:
  - Technically difficult to incorporate low-temperature sources
  - Don't really know who is going to bear the cost
  - The benefits of prosumers in the DHC grid are not commonly known
  - The problem of third-party access
  - No proper business models for the inclusion of prosumers

Take a chance on me!

We want to investigate the drivers and barriers related to prosumer integration in the District Energy sector in Sweden

We carried out a literature search and analysed the contents using Content Analysis

Altogether, ten articles were read and analysed

Don’t stop me now

We analysed the Drivers under the following three categories:

- Drivers from the DE’s side
- Drivers from Prosumers’ side
- Macro-trends as drivers

We analysed the Barriers under the following three categories:

- Barriers from the DE’s side
- Barriers from Prosumers’ side
- Other barriers


Look what I found
RI.
SE

Here comes the sun
- Drivers from the DE's side

- Cost saving
- Enhancing the environmental and commercial profile of the DH company
- Increasing the effective use of energy
- Enabling flexibility

Money, Money, Money

For the DE, cost savings through prosumer integration are the biggest motivator!

This is done in many ways:

- The cost of heat from a prosumer may have a lower marginal cost of heat than their own production units
- Also, delaying investments into new heat units, saving them money and resources in the long-run

I want to break free

Drivers from the prosumers' side

The factors driving prosumer integration from the prosumers' side are:

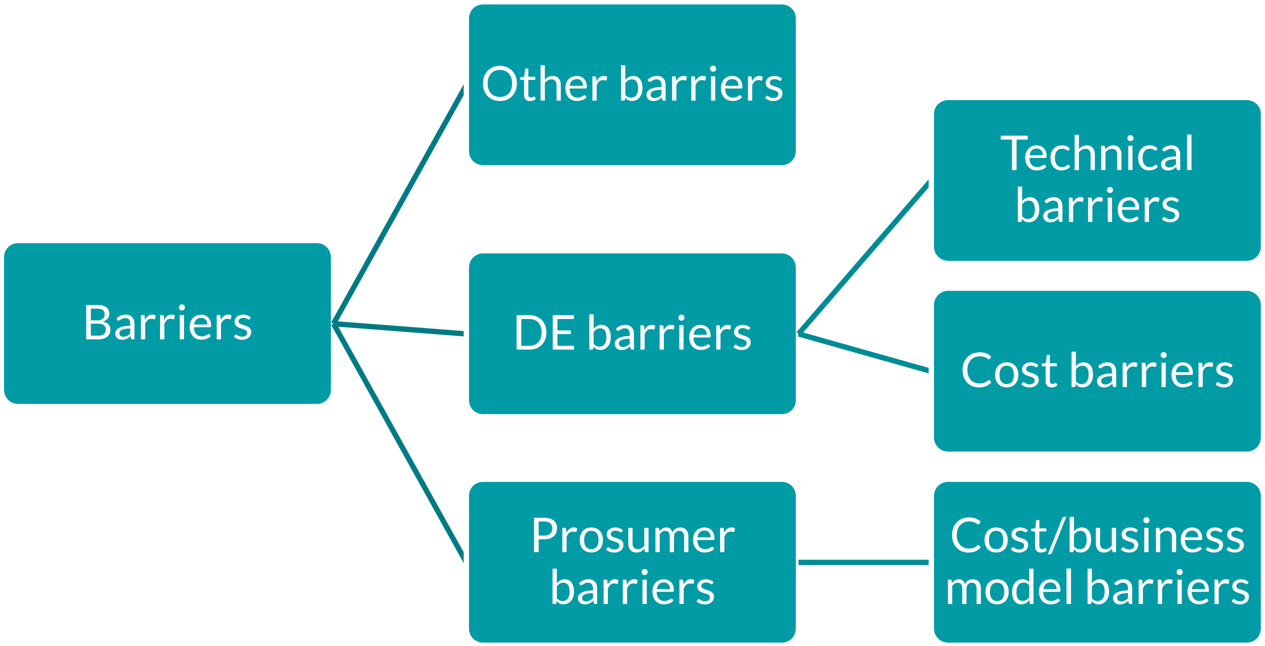
- Need for self-sufficiency
- Financial benefits
- Raising the environmental profile of the prosumer

High Hopes
Macro-trend related drivers

- The development of low-temperature, 4th generation DH networks
- High energy effectiveness in building energy use

Bottom of the deep blue sea

Barriers against prosumer integration



Take the power back
Technical barriers for DE firms

Some of the technical barriers are:

- Asynchronous heat supply by prosumers and actual demand
- Quality of heat being low
- *‘Bottlenecks’* or low-pressure areas in the DH grid, by prosumer integration

We used to be friends

Prosumer barriers

Lack of generalized and standardized business models lead to uncertainty about investing in prosumer technologies, on the prosumers' side.

This also leads to cost-related uncertainties.

Under pressure
Other barriers

- Lack of policies promoting recycled heat, in Sweden, is a barrier against prosumer integration
- Similarly, the metrics in place to measure energy efficiency does not include a system perspective, but rather only on the consumer or producer perspective

Bring me to life

- Building certifications could impact the prosumer integration positively, if designed to incentivize use of excess heat
- Similarly, if DH's energy effectiveness may increase with prosumer integration, this gives DH an edge over other individual heating technologies such as Heat Pumps. This would also mitigate the system-level impacts Heat Pumps may have in the power grid.
- Standardized business models

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A Multivalent Supply Concept: 4th Generation District Heating in Moosburg an der Isar

17th International Symposium on District Heating and Cooling / Nottingham (online)

6-9th September 2021

Authors: Robert Egelkamp, **Anna Kallert** , Ulrich Bader, Dietmar Münnich, Lisa Staudacher, Hannes Doderer,

BADER ENERGIE WÄRME NATÜRLICH   dme consult   Fraunhofer IEE   IKEM

Local Heating in Moosburg – Status Quo

- Moosburg: small city close to Munich / Germany
- Population: approx. 19.000
- Heat supply mostly decentralised based on fossil fuels

➢ Heating network is run by local utility „Bader Energie“

BADER ENERGIE
WÄRME NATÜRLICH

Network data (status quo):

- Total annual demand: 2,5 GWh/a (approx. 30 buildings)
- Grid length: approx. 2,5 km
- Heat sources:
    - Biomass-boiler operated by woodchips
    - Waste heat from local sewage treatment plant (CHP)

Project: "District Heating 4.0" in Moosburg

Objectives:

- Expansion of the local heating grid within the „District Heating 4.0" funding programme
- Development of economically sustainable supply concept with 100% renewable energies

Project team:

Bader Energie	DME-Consult	Fraunhofer IEE	Institute for Climate Protection, Energy and Mobility

Actions:

- Detailed analysis of heat demand and renewable energy potentials in supply area
- Development and assessment of varying supply scenarios
- Development of an optimal supply concept and investigation of technical parameters
- Economical and legal assessment of supply concept

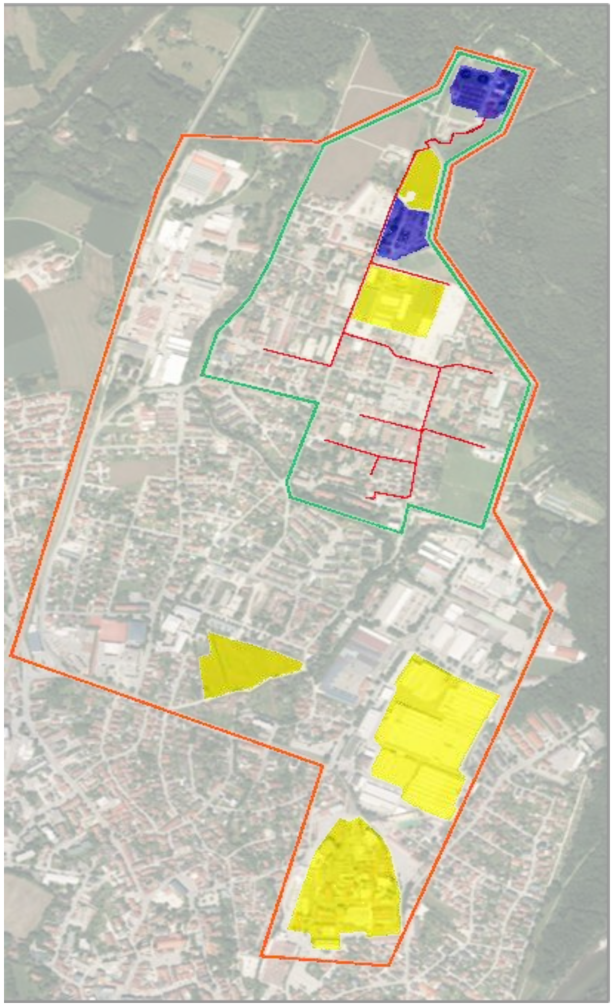
Supply Area – Heat Demand and Sources

Heat demand:

- Total heat demand in area: approx. 15 GWh/a
- School and big development area as main consumer

Heat sources:

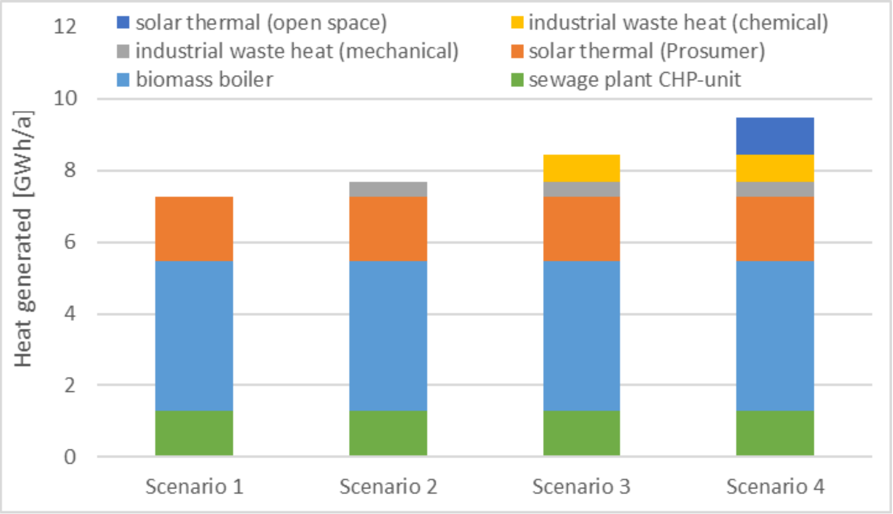
- Biomass boiler (existing)
- Waste heat of sewage plant CHP-unit (existing)
- Solar thermal systems on roofs and open spaces (new)
- Waste heat from mechanical and chemical industry (new)



- Range of existing grid
- New Range due to planned extension of the grid
- Existing grid
- Existing heat sources
- New heat sources

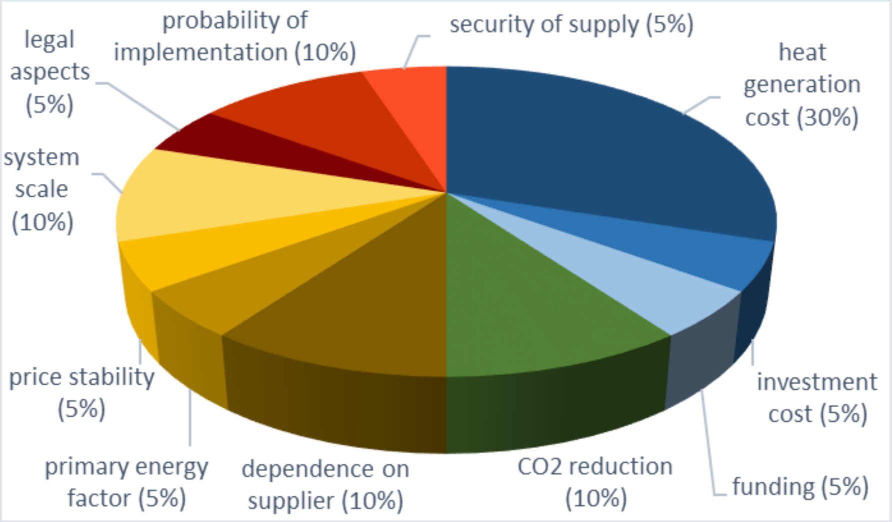
Development and Assessment of Supply Scenarios

- Definition of 4 supply scenarios differentiated by the heat sources used

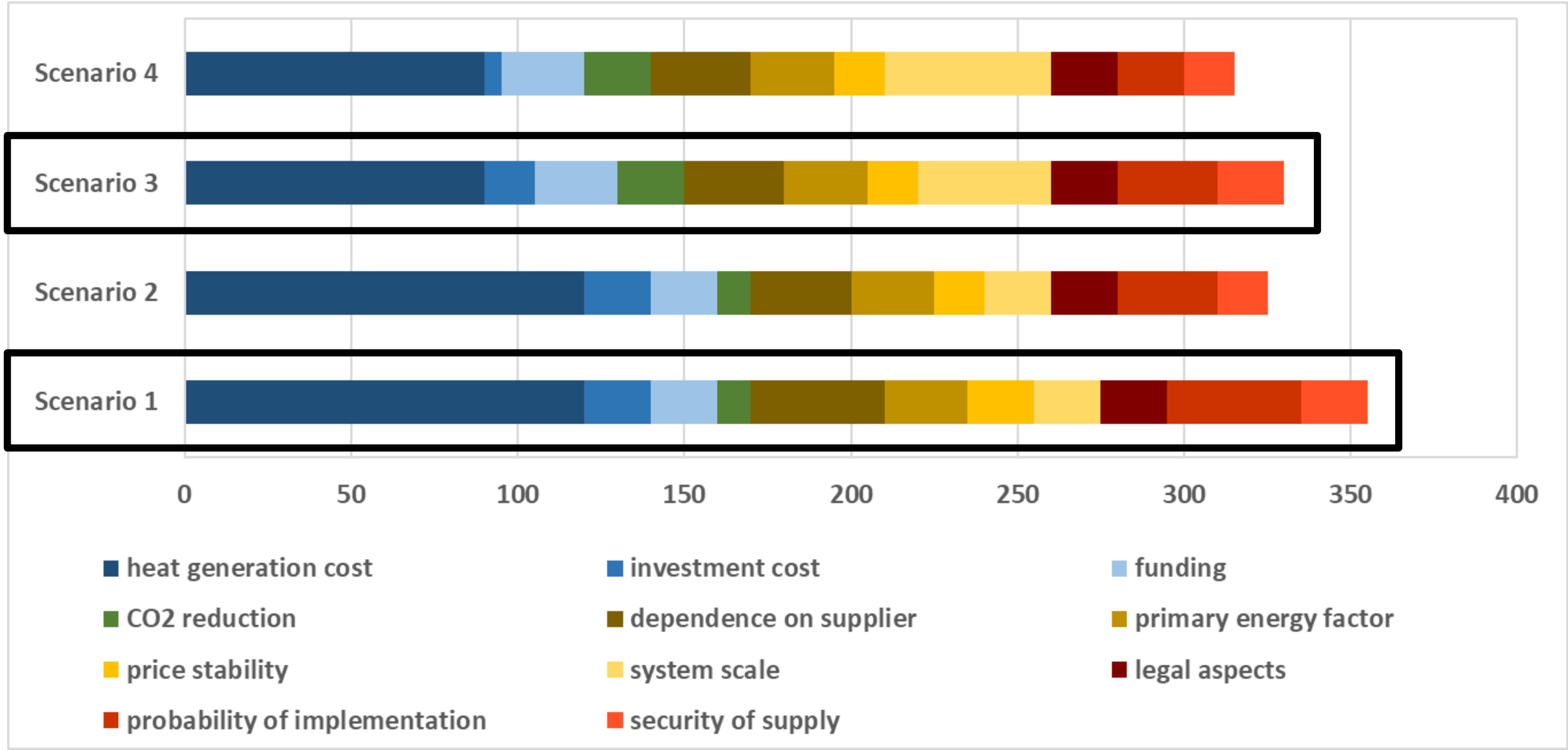


Identification of optimal supply scenario through Multi-Criteria-Analysis:

1. Define and weight technical and economical evaluation criteria
2. Investigate scenarios and determine KPI according to the criteria defined
3. Evaluate the scenarios based on the investigation



Results of Multi-Criteria-Analysis



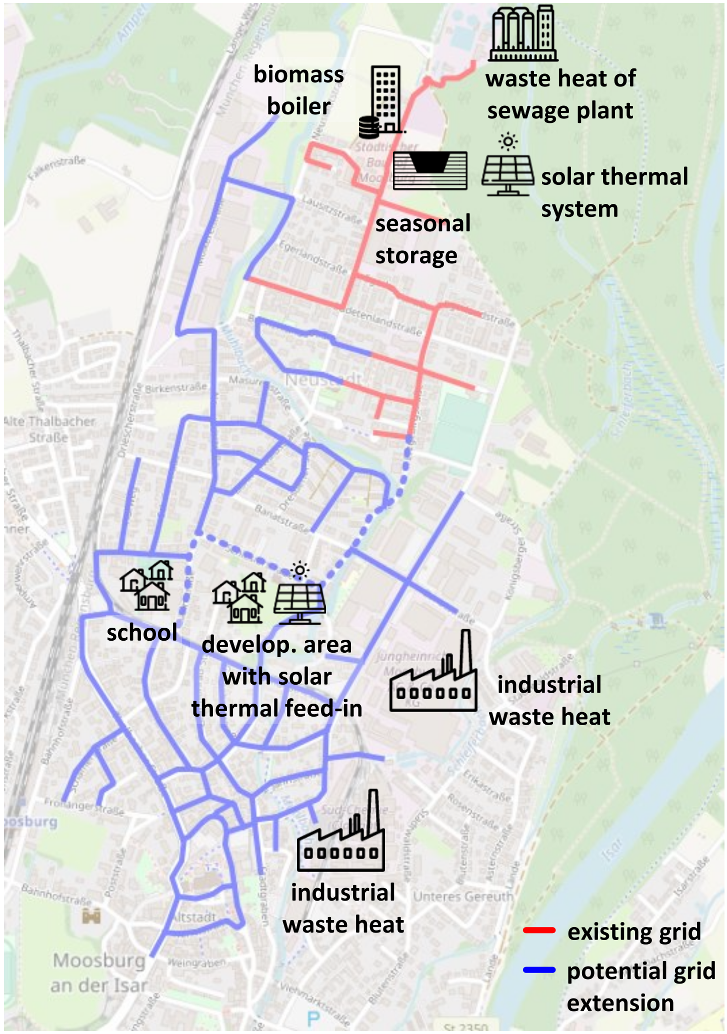
- Scenarios 1 and 3 are chosen for a more detailed investigation on technical, economical and legal aspects.

Supply Concept

- Grid operated on lowest temperature possible (70…80 °C)
- Integration of low-temperature industrial waste heat by heat pump
- High share of solar thermal feed-in generated by collectors on roofs (prosumer) and open space systems
- Storage (1 000 m³) provides load shifting and maximum efficiency of renewables

➢ Multivalent energy system integrates decentralised heat sources

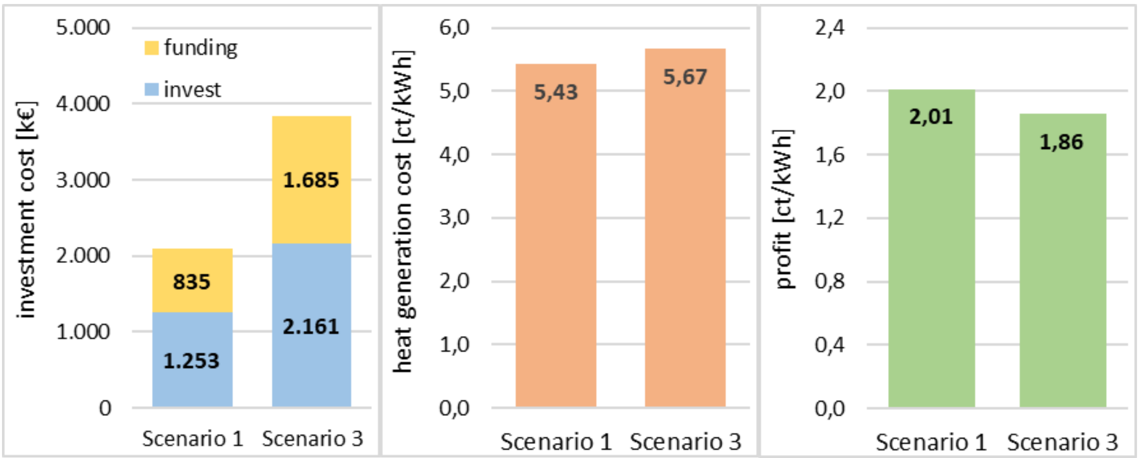
➢ 100% renewables and waste heat sources supply up to 300 buildings with total heat demand of approx. 7,5 GWh/a



Economic and Legal Evaluation

Balance of costs and revenues for 20 years taking into account investments, funding, maintenance and energy costs:

➢ Both scenarios are profitable due to funding and low heat generation costs of renewables



A legal assessment has been carried out to verify the concept's suitability for approval:

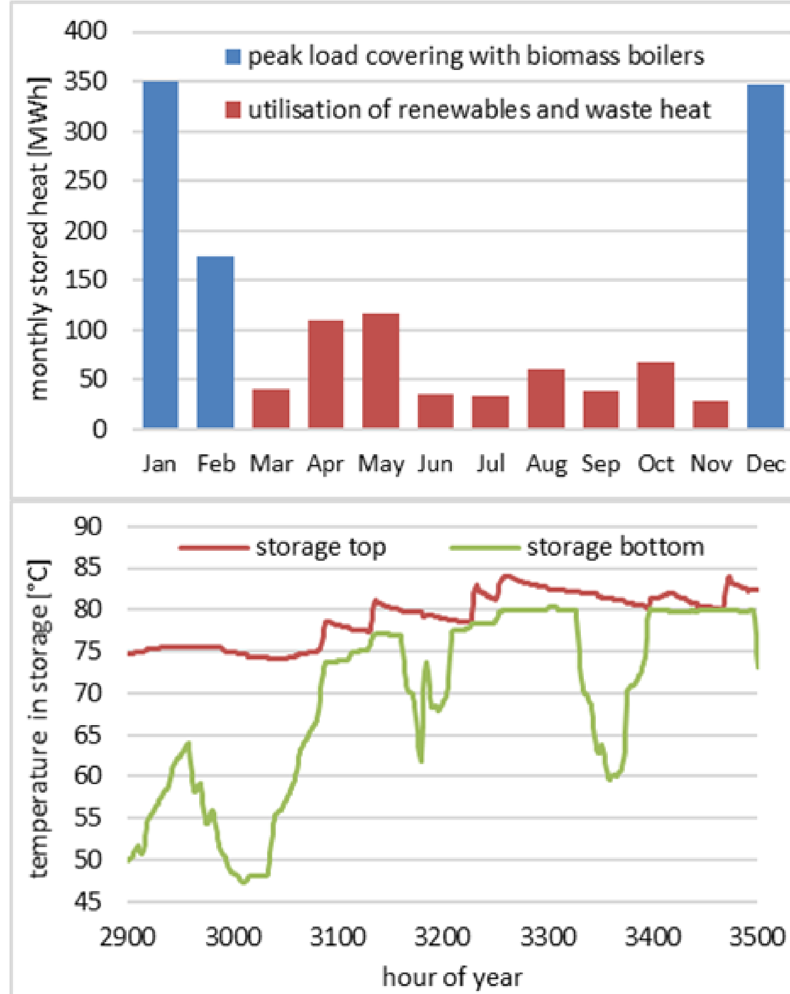
➢ No regulatory barriers for the implementation and operation of the supply concept

➢ Contract formation with waste heat suppliers must be evaluated in detail regarding business model (pricing, sharing of investment costs) and legal aspects

Heat Storage Operation

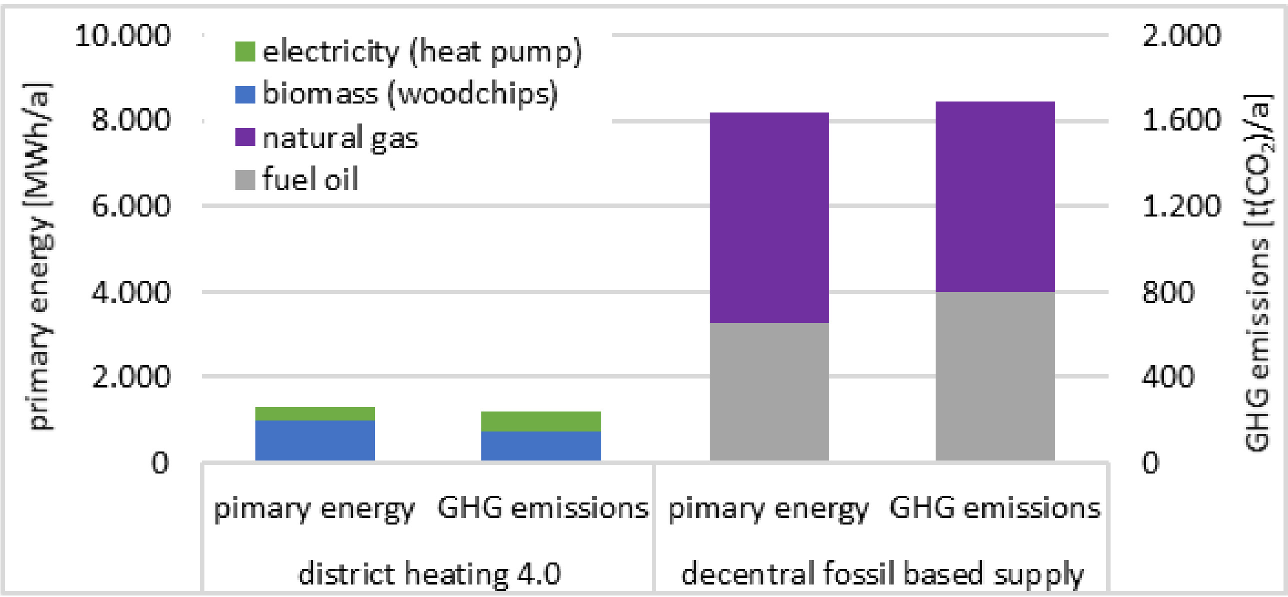
- Heat storage is a key component in the supply concept
- Operation mode changes over the year:
  - Summer: utilisation of renewables
  - Winter: coverage of peak loads
- Utilising solar and waste heat by high amount of charging cycles and efficient use of temperature stratification
- Storage capacity of approx. 35 000 kWh (V = 1000m³ / ΔT = 30K)

➢ Through intelligent operation, a multiple of the storage capacity can be used efficiently



Energy Saving Potential

- Savings of primary energy and GHG emissions is main objective of "district heating 4.0"
- Current decentral heat supply: 60% natural gas, 40% heating oil
- Renewable supply concept will reduce primary energy demand by 84% and GHG emissions by 86%



➢ Supply concept leads to great savings and enables carbon neutrality in the area!

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Summary and Outlook

- Development and investigation of a concept for the transformation and extension of a local heating grid based on 100% renewable energies
- Significant CO_2 reduction in the supplied area due to efficient use of local heat sources and waste heat

➢ The concept proofs that heating networks based on 100% renewables are technically and economically feasible!

➢ The German „District Heating 4.0" funding programme is a big incentive for the implementation!

Next steps:

➢ Approval of funding for the implementation of the planned concept in 2021

➢ Start of construction in 2021 / 2022

➢ Finalisation of the grid extension expected in 2025

Thank you for your attention!

Fraunhofer IEE

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IKEM

HYBRID ENERGY NETWORKS AND ELECTRIFICATION OF DISTRICT HEATING UNDER DIFFERENT ENERGY SYSTEM CONDITIONS

PETER SORKNÆS

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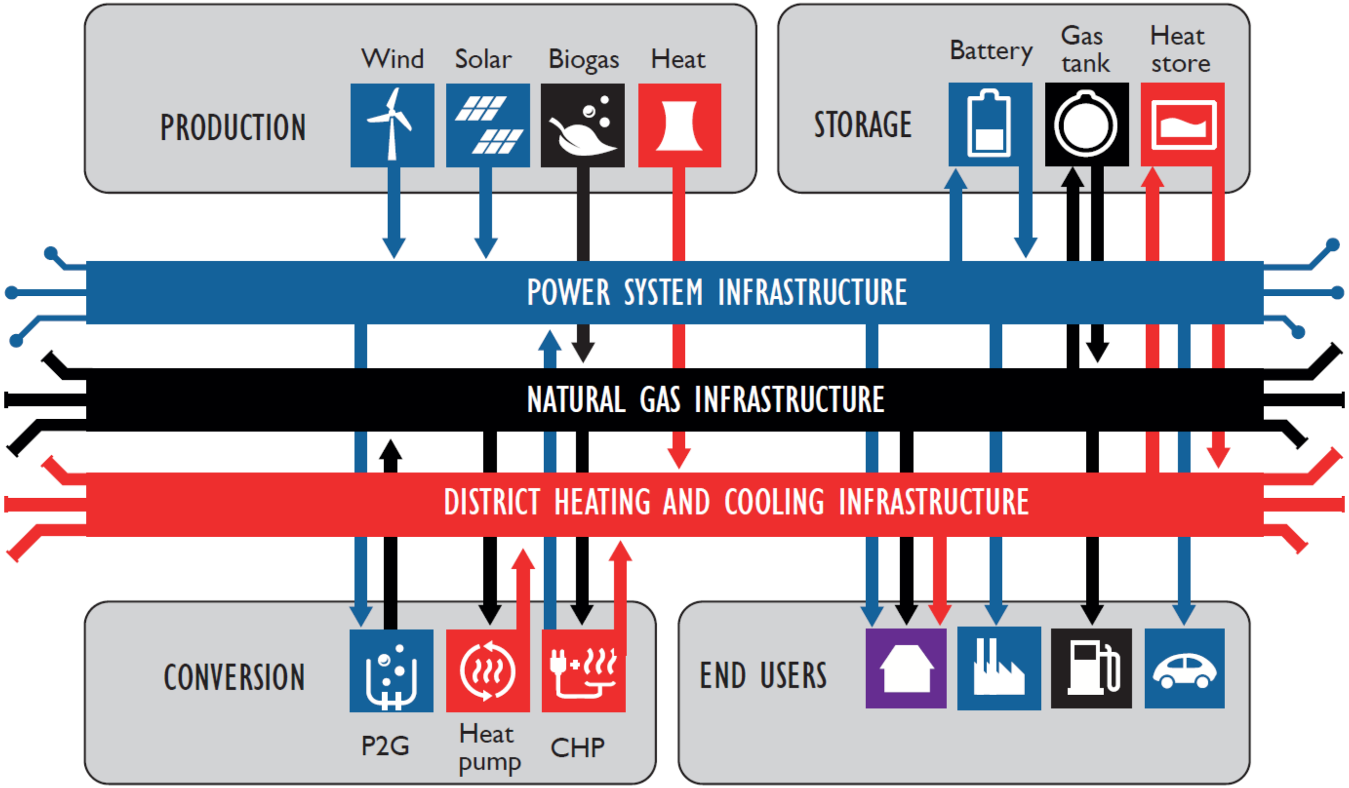
Principle scheme of a possible hybrid energy network



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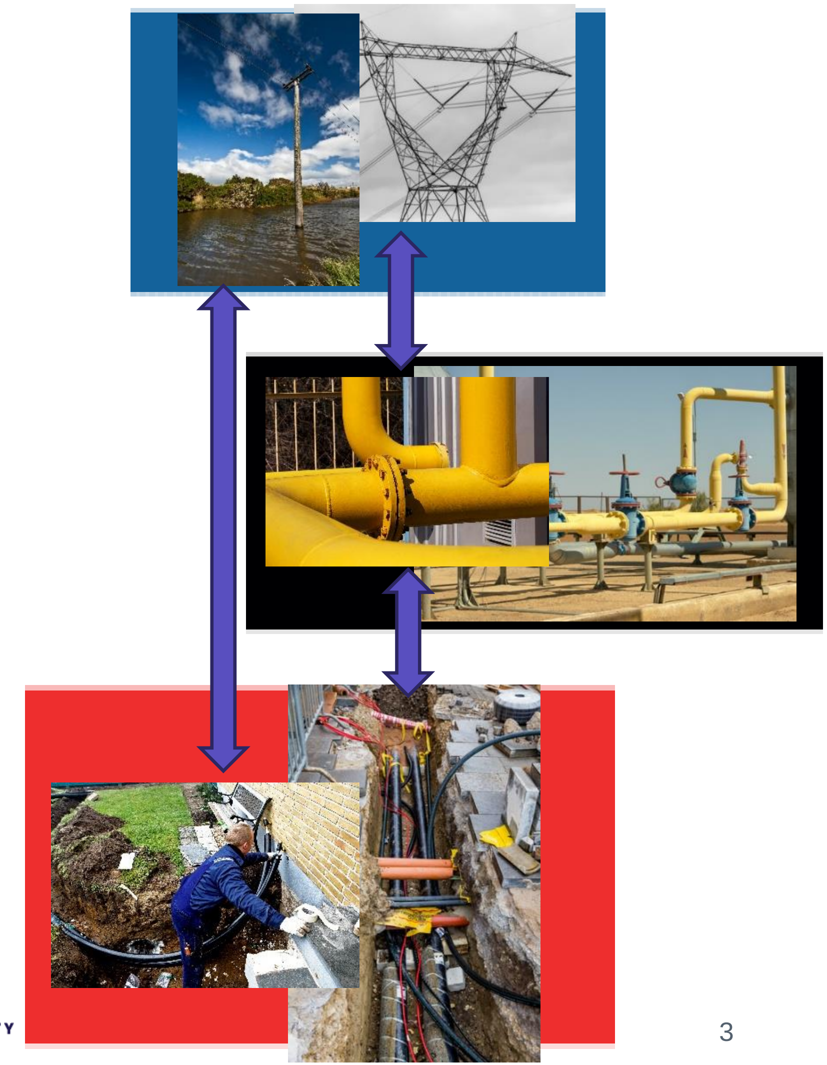
https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3

Networks

- Electricity
- Gas
- Heating and Cooling

Direct electrification



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Technologies tested for direct electrification of district heating

Electric boilers

- Less energy efficient conversion from power to heat compared to heat pumps (<100%).
- Relatively low investment costs (~0.1 M EUR/MW-e*).

Electric heat pumps

- Energy efficient conversion from power to heat (COP) by use of low temperature heat sources (COP 2.8-5.4*).
- Relatively high investment costs (~0.4-1.3 M EUR/MW-th*).

*Projected for 2050 by the Danish Energy Agency, https://ens.dk/sites/ens.dk/files/Analyser/technology_data_catalogue_for_el_and_dh.pdf

National energy system scenarios used

<u>Baseline scenarios:</u>

- Baseline scenarios (2015) for the energy systems of Austria and Denmark.

<u>Future scenarios:</u>

- Future scenarios with high shares of renewable energy for both Austria and Denmark. High district heating utilisation scenarios from:
  - Austria: ”Heat Roadmap Europe 4” (HRE4)
  - Denmark: ” IDA’s Energy Vision 2050”
- For each country two different future scenarios topologies are investigated:
  - A system with (relative) **low district heating utilisation** (developed based on high district heating utilisation scenarios)
  - A system with (relative) **high district heating utilisation**

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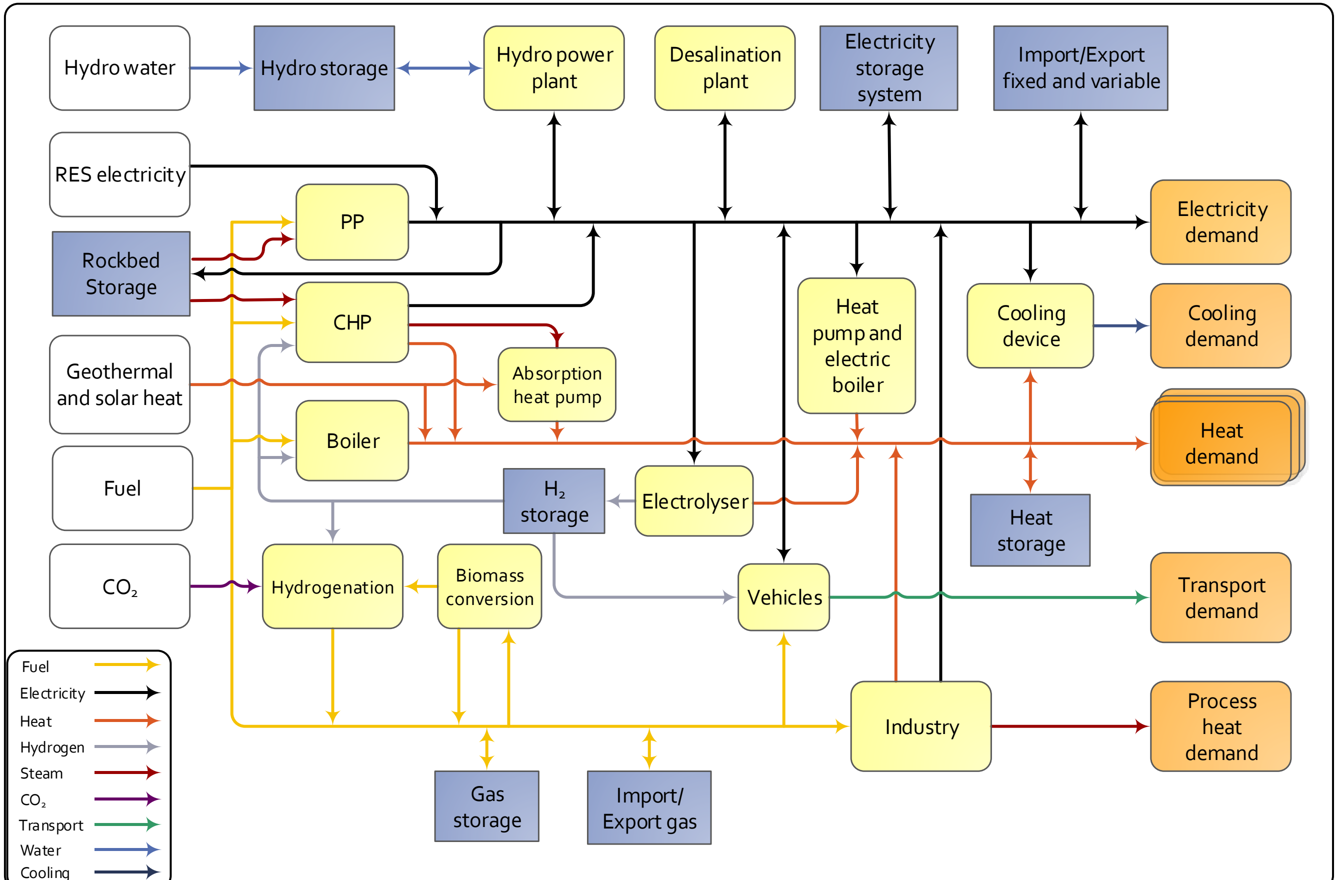
Energy system simulation tool - EnergyPLAN v16



www.energyPLAN.eu

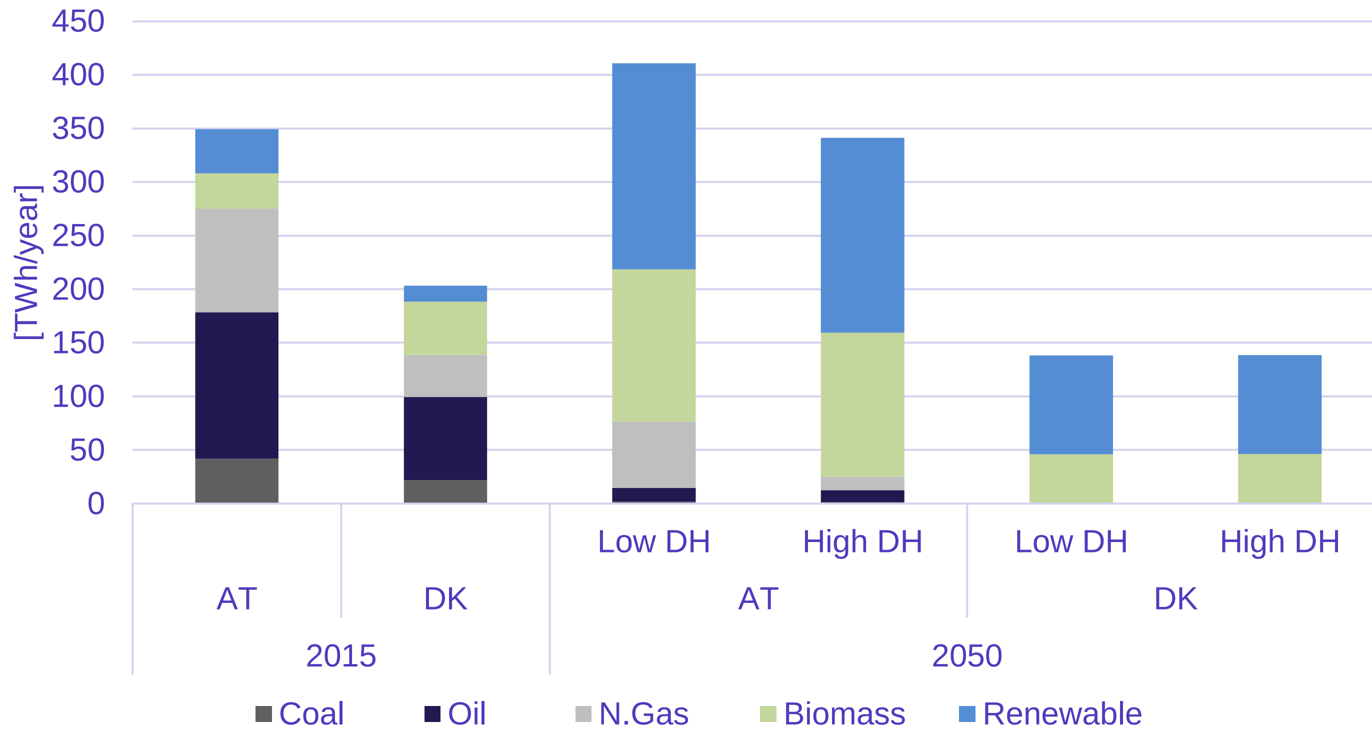
Simulation approach

- Costs have been updated so that the costs are comparable.
- All scenarios are simulated without electricity transmission capacity
- Sufficient energy supply has been ensured that is available for the energy systems simulated by adjusting the marginal variable renewable electricity source, so that the yearly production of unusable electricity is unchanged*.
  - The marginal variable renewable electricity source is assumed to be photovoltaic for Austria and offshore wind power for Denmark

- IDA2050 scenario is developed on the principle that on a yearly basis the domestic production of gas must equal the gas consumed in Denmark.
  - Maintained by adjusting the capacity and biomass input to the biomass gasification plants.

**In a real-world situation this production would either be exported or result in reduced production from variable renewables*

Primary energy supply of the different scenarios as simulated in EnergyPLAN



(All energy sectors)

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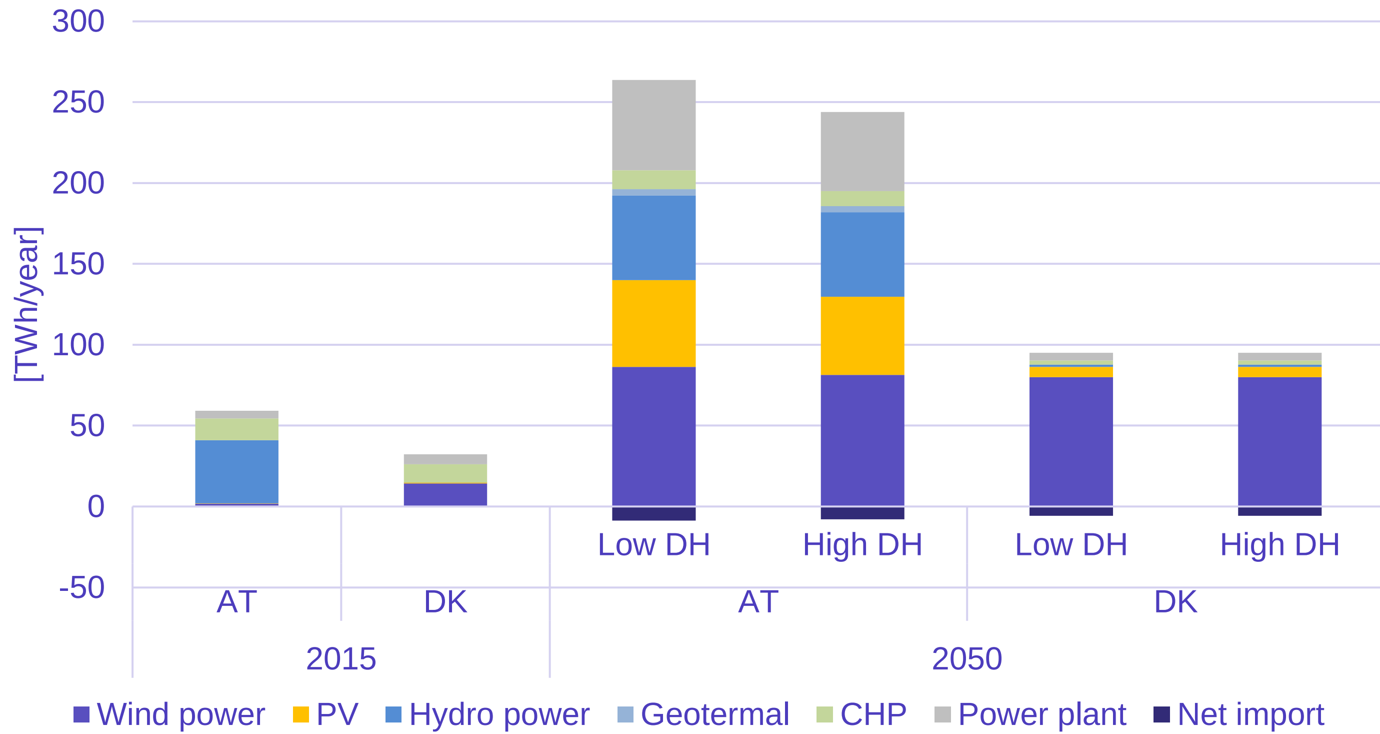
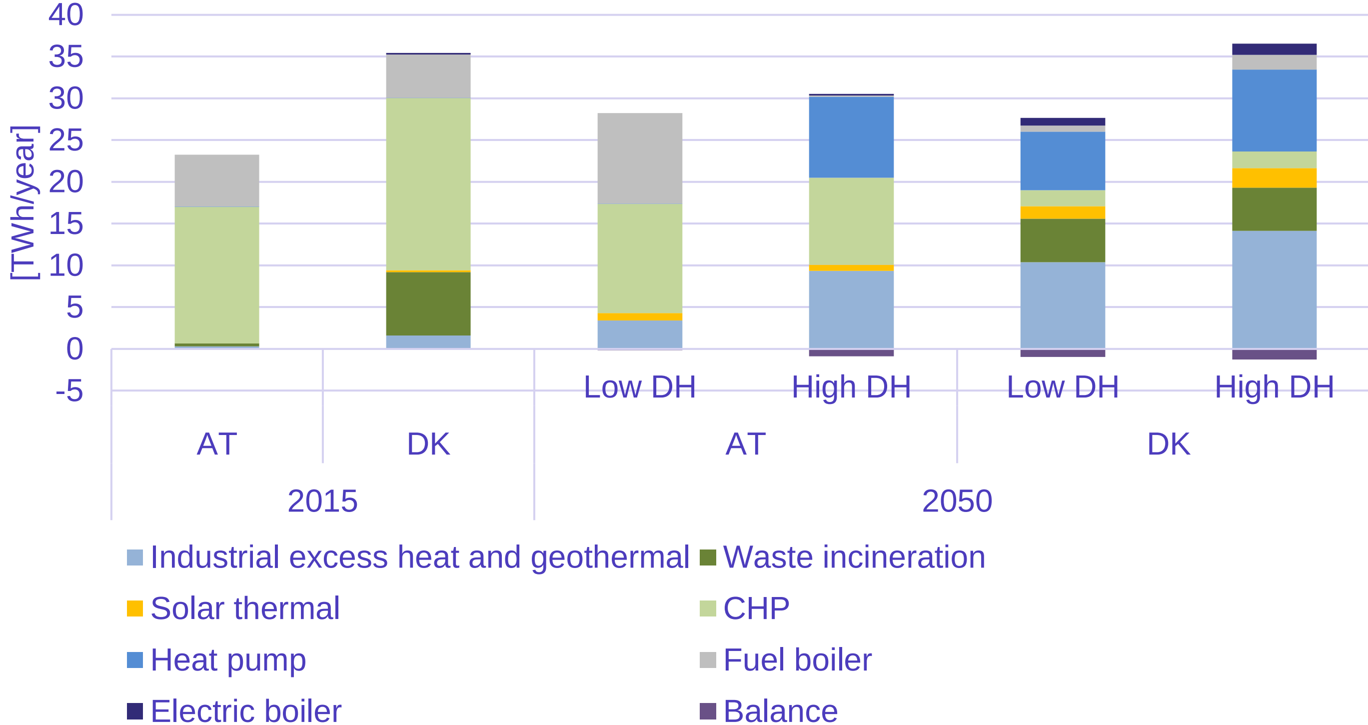
Electricity supply of the different scenarios as simulated in EnergyPLAN



District heating supply of the different scenarios as simulated in EnergyPLAN



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Adjustments tested

- Change to electric boiler capacity
- Change to heat pump capacity
- Change to heat pump capacity with electric boiler capacity as replacement

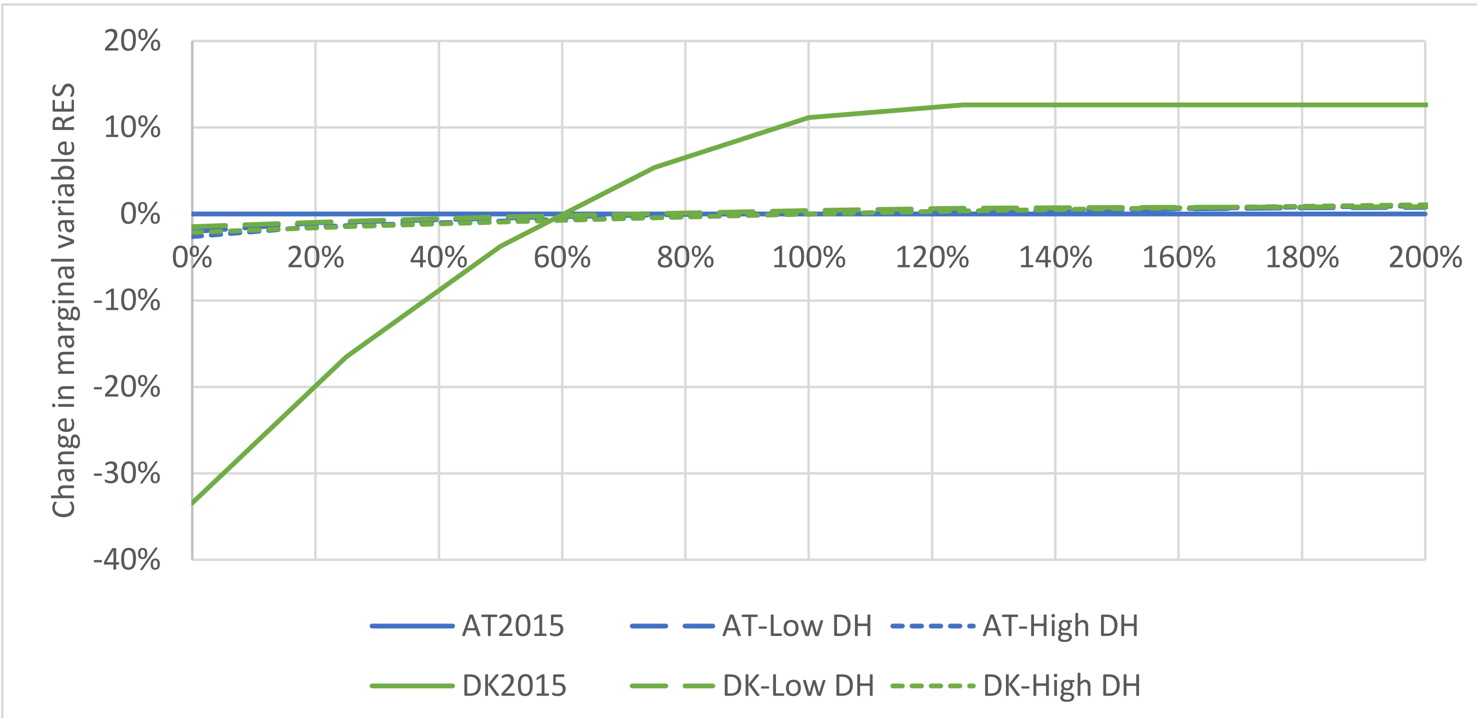
- To make the results easier to compare, the ranges of capacities are set as 0-200% of the starting capacities in the future high DH market share scenarios for each country.

- Focus on change in energy system wide use of biomass and total annual cost of the energy system.

Starting capacities for relevant technologies

Scenario	Electric boiler capacity [MW-e]	Heat pump capacity [MW-e]	Marginal variable RES capacity [MW-e]
AT2015	0	0.7	103
AT-Low DH	1,027	1,027	47,000
AT-High DH	**1,200**	**1,200**	47,000
DK2015	522	3.8	1,271
DK-Low DH	692	516	14,000
DK-High DH	**900**	**700**	14,000

Change to electric boiler capacity – Change in marginal variable renewable



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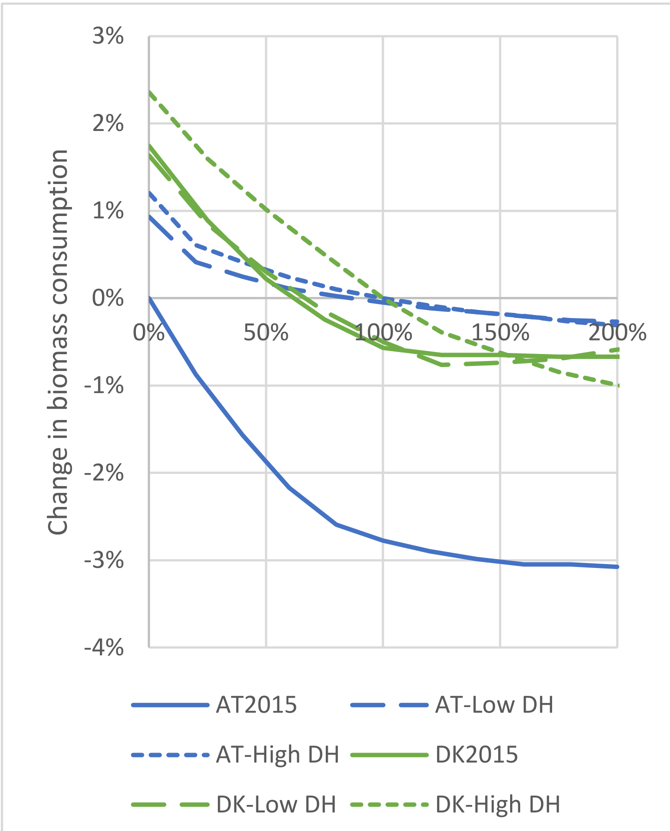
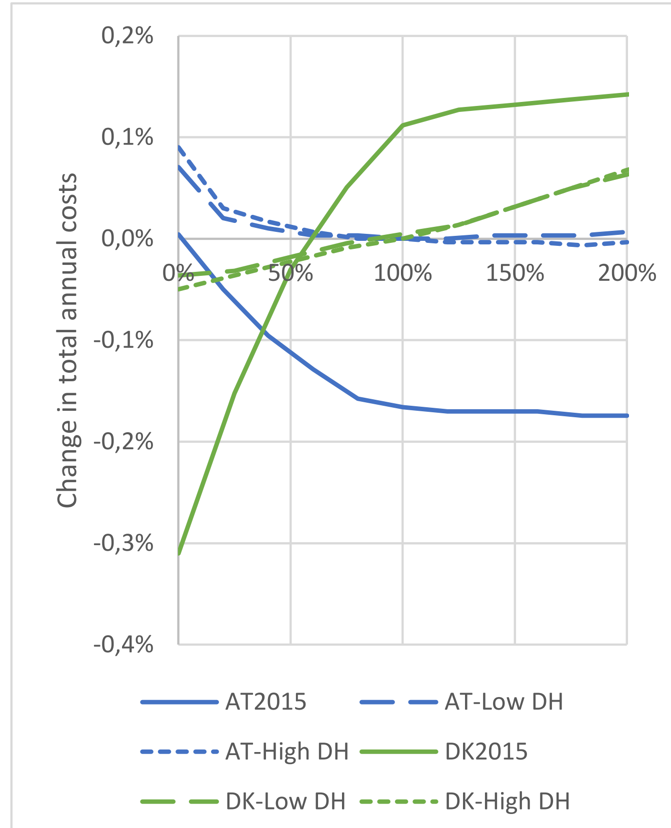
Change to electric boiler capacity – Biomass and total annual costs





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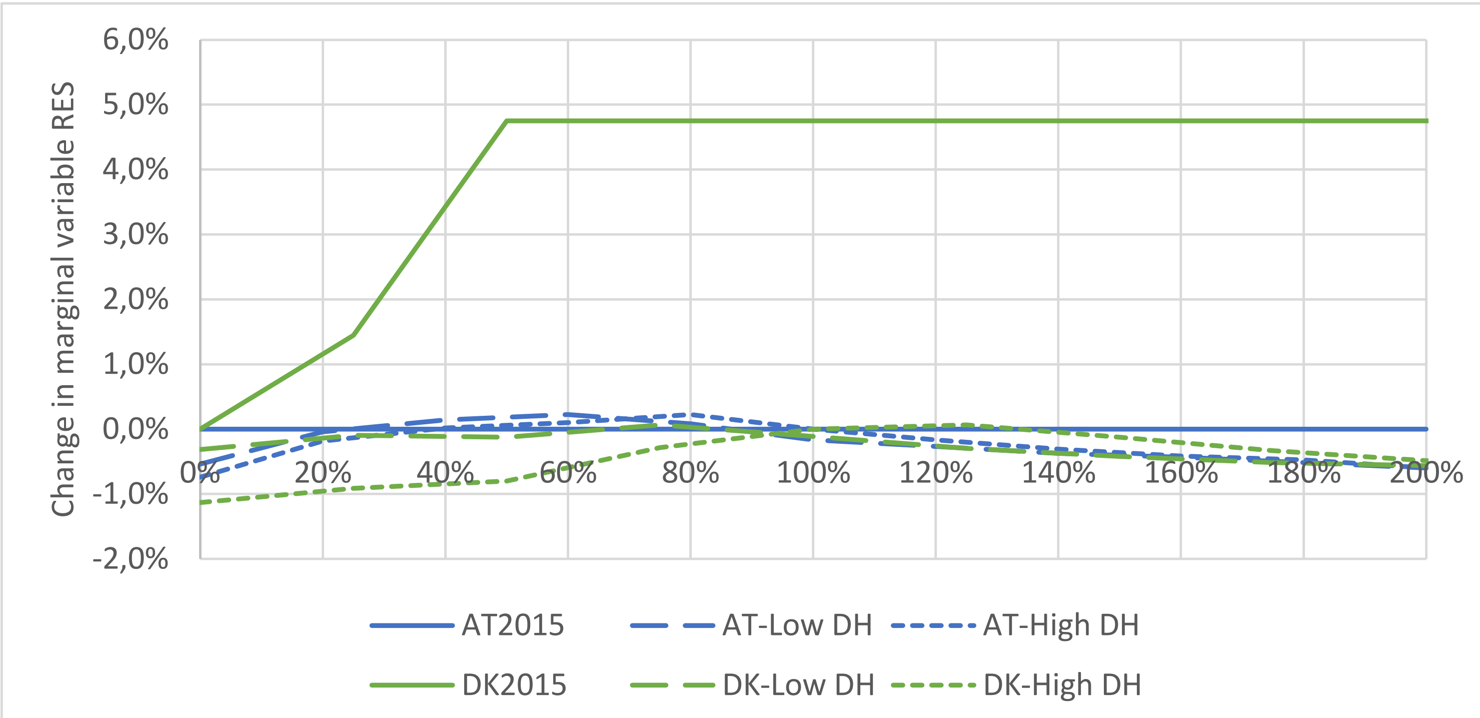
Change to heat pump capacity – Change in marginal variable renewable



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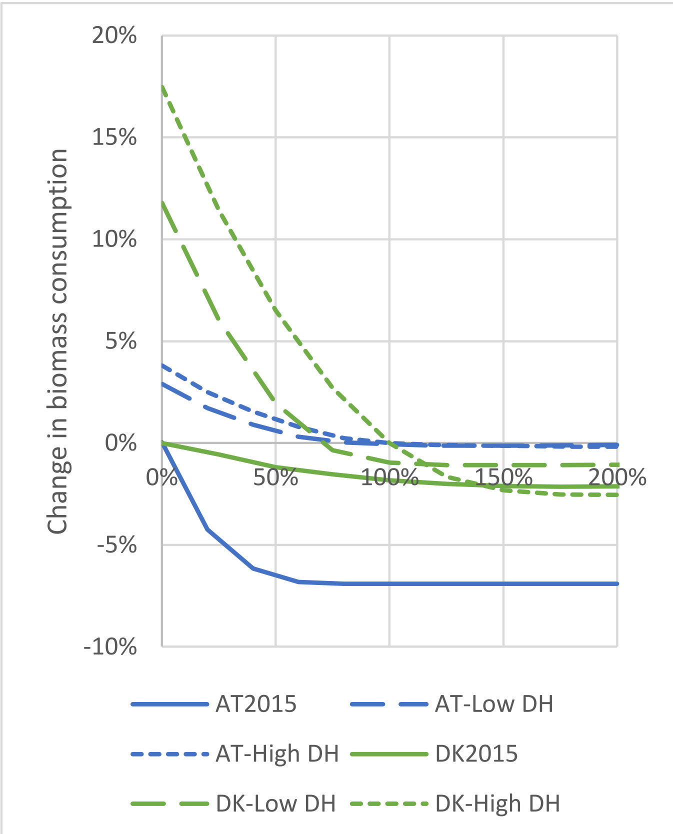
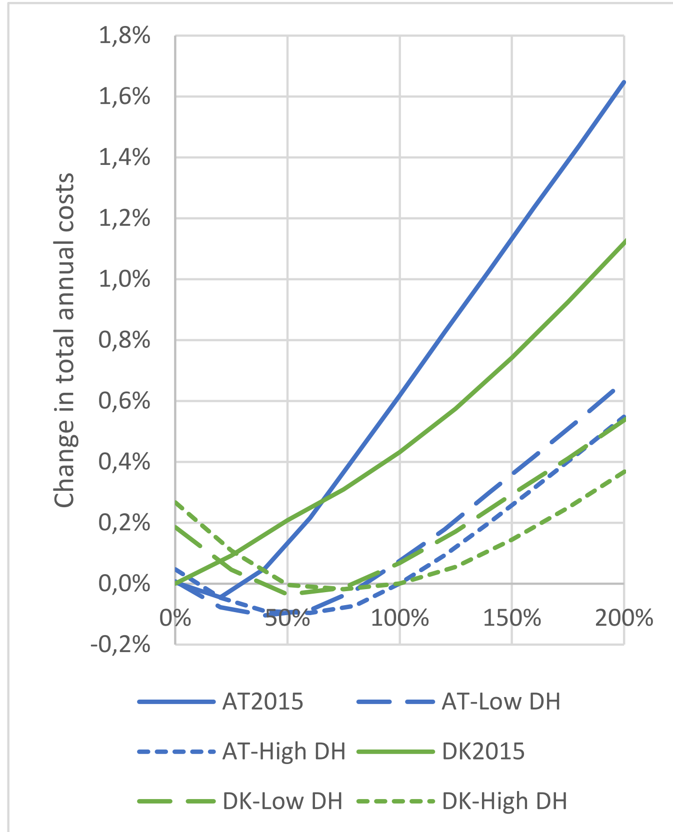
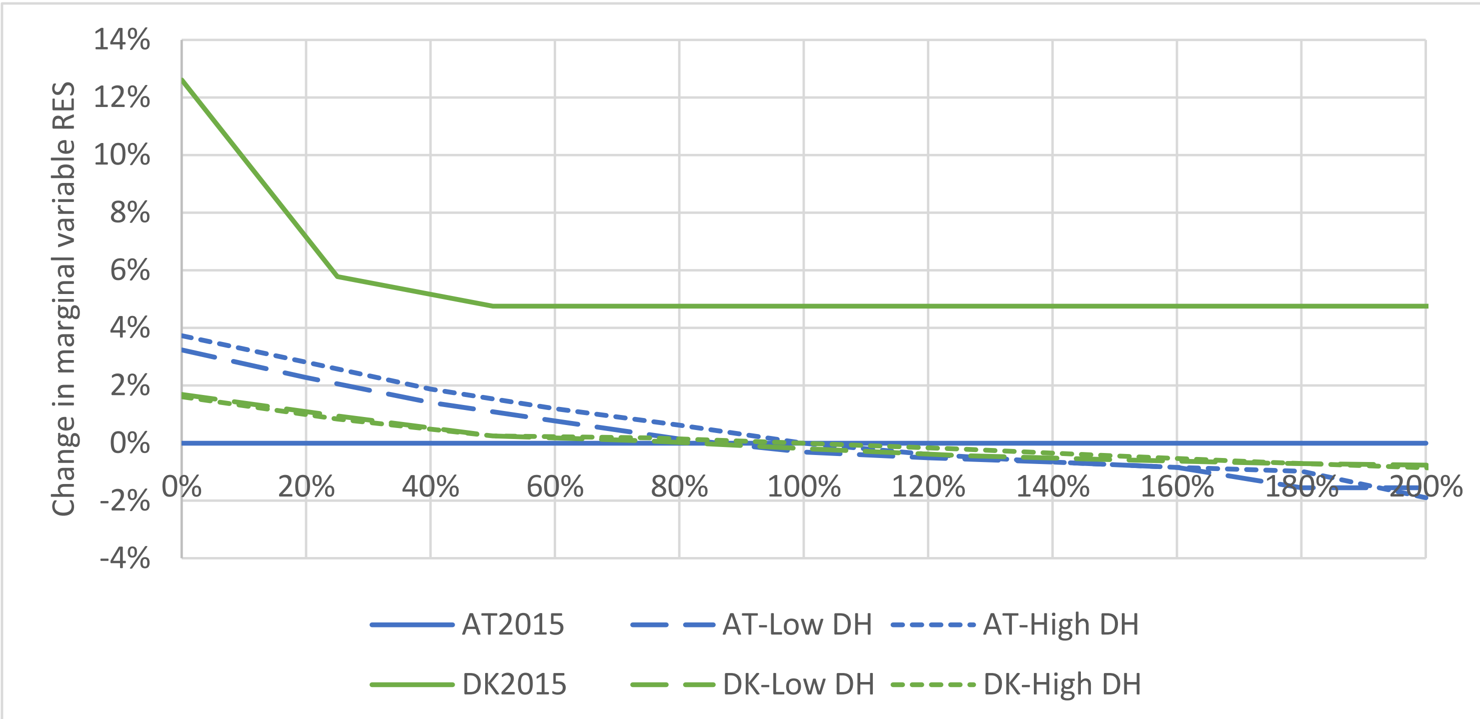
Change to heat pump capacity – Biomass and total annual costs





Change to heat pump capacity with electric boiler capacity as replacement – Change in marginal variable renewable



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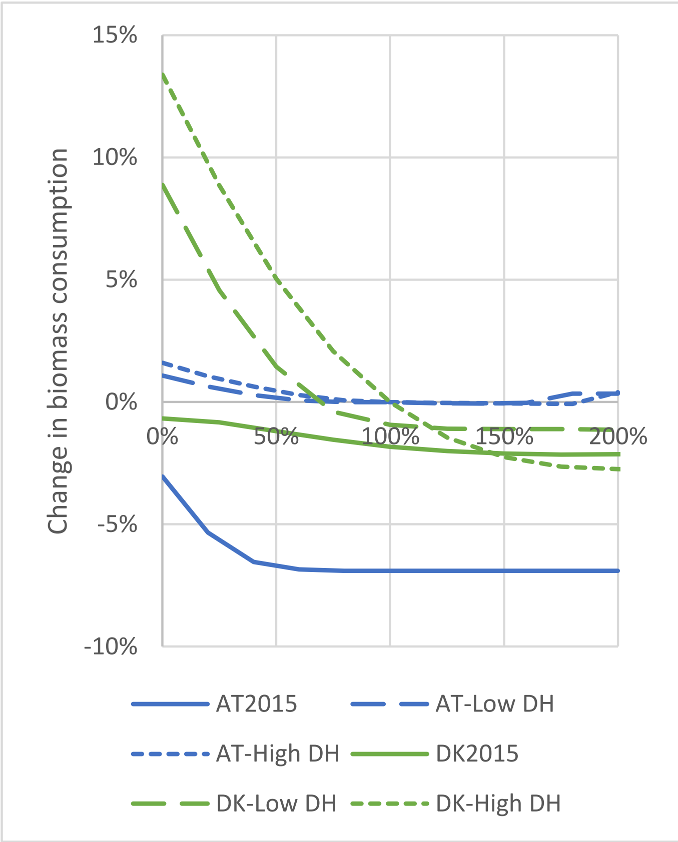
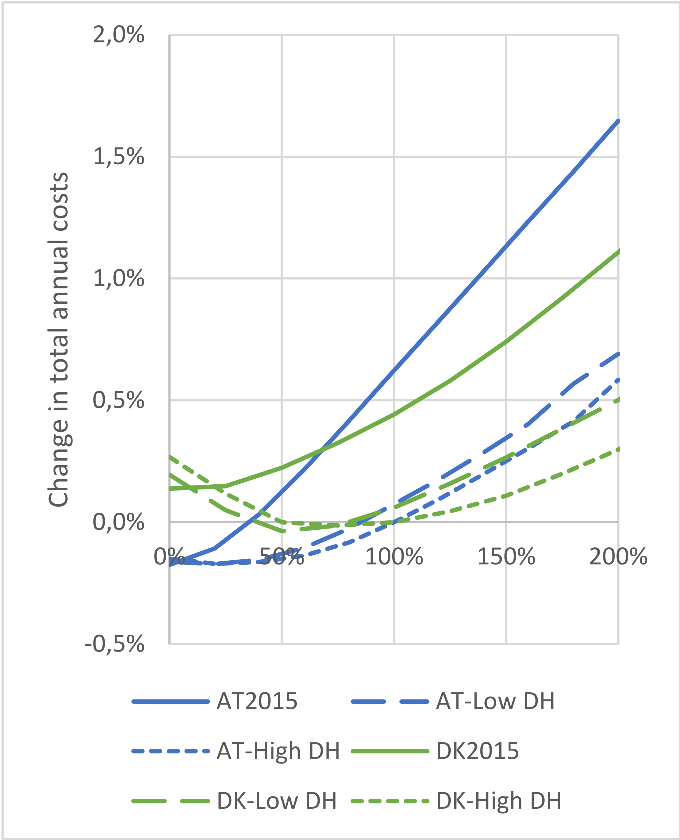
Change to heat pump capacity with electric boiler capacity as replacement – Biomass and total annual costs





Conclusions

- Due to electric boilers' less efficient conversion of electricity to heat, electric boilers allow for larger integration of variable renewables without creating increased levels of unusable electricity production.

- Heat pumps have a larger potential to reduce the biomass consumption compared with electric boilers, even when accounting for the potential to integrate more variable renewables with electric boilers.
  - Only until the operation of the heat pumps is limited by the district heating demand.
  - The biomass reduction is especially in relation to reduced use of biomass-fired boilers.

- The total annual costs of the energy system are mostly affected by the capacity of heat pumps, compared with the electric boilers.
  - For electric boilers, the effect on the total annual costs is mostly related to the potential to integrate more variable renewables into the energy system.
  - However, the change in total annual costs is relatively low compared with the total cost of the entire energy system, as this also includes costs for the transport sector, etc.

Drop it like its hot ?!

How do business models capture the flexibility of prosumers?

Inger-Lise Svensson,
Lina Eriksson,
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RISE Research Institutes of Sweden, Gothenburg, Sweden

Prosumers in DHC: Yay! or Nay?

- Prosumers in the electricity sector are pretty common
- But, not so common in the DHC sector !
- Some of the reasons for this are:
  - Technically difficult to incorporate low-temperature sources
  - Don’t really know who is going to bear the cost
  - The benefits of prosumers in the DHC grid are not commonly known
  - The problem of *third-party access*
  - **No proper business models for the inclusion of prosumers!**

But, but, but…

- Given the shift to 4th generation DH, low temperature sources are technically feasible
- The prosumers can provide flexibility in the DHC grid
- Prosumer inclusion can lead to monetary and environmental benefits

So…look at what Business Models are out there for prosumers?

- What are the Business Models (BM) for prosumers in the heating sector?
- Do they capture flexibility?
- If so, how do they capture flexibility?

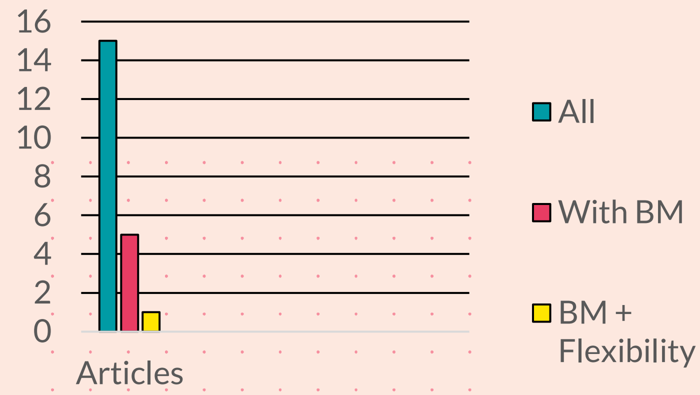
Don’t worry, we did the ‘science‘!

- We read and analysed the contents of 15 peer-reviewed articles and reports dealing with prosumers and flexibility in the DHC sector.

What did we find?

<u>Five</u> of the 15 articles focused on the Business Model development for prosumer integration in the DHC business.

Of these five, **<u>only one</u>** looks at how prosumers can provide flexibility!



Capturing flexibility through business models for prosumers

Pricing logic of heat – Show me the money!
Flexibility consideration
Control of prosumer technologies
Benefits sharing – Help me help you!

Show me the money!

Five different pricing logics for prosumer heat emerged

- Operational parameter-based pricing (1 out of 15)
- Marginal cost (MC) pricing (7 out of 15)
- Seasonal pricing (2 out of 15)
- Levelized cost of heat (LCOH) pricing (2 out of 15), and
- Combination with other price logics (3 out of 15)

Show me the money!

Marginal cost pricing

Pros

Easy to calculate and make a decision about prosumer heat integration

Cons

The investment and other long-run costs are not considered, thus leading to uncertainty

Levelized Cost of Heat

Pros

Long-term investment costs are included in the cost/benefit analysis

Cons

Not so easy to calculate and make short-term decisions

Flexibility consideration

Availability of heat

Heat is available when it is needed, this is irrespective of the quality of heat, and whether it is peak heat or not

Connected to Seasonal Pricing and/or Levelized Cost of Heat pricing

Quality of heat

This is connected to the operational parameters of the grid, and provides monetary benefits or disbenefits (if quality goes down)

Connected to Operational Parameter based pricing

Peak heat

This is connected to the ability of the prosumer to reduce peak heat

Connected to Marginal Cost pricing

Control of prosumer technologies

Who controls the prosumer technologies is important, especially in the design of the business model for prosumer integration

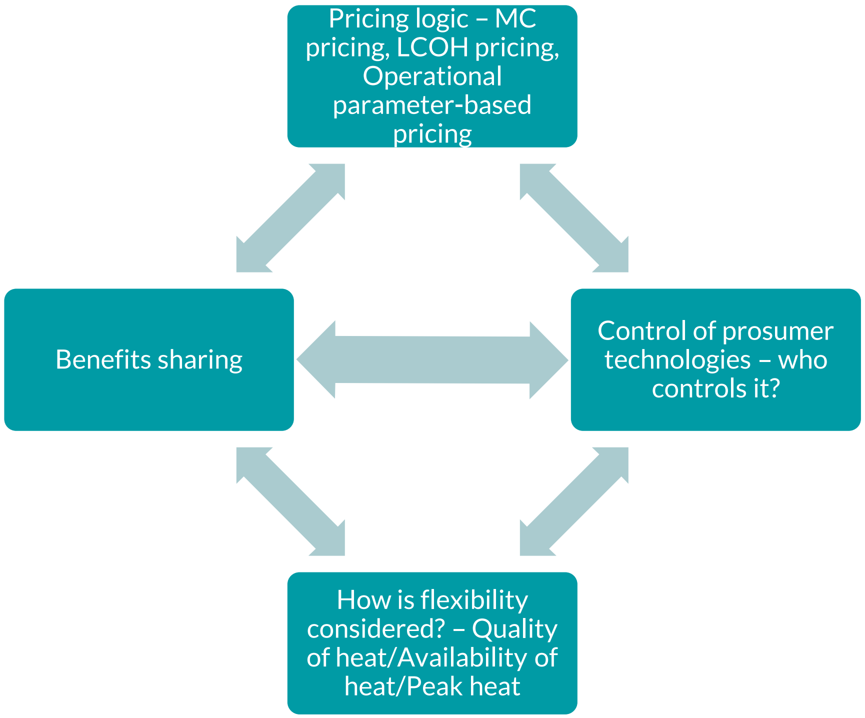
Mostly, in literature, the prosumers themselves control the technologies

But the price acts as a signal to the prosumers.

Benefits sharing

Article	Who has control	What determines the control	Computation of benefits
Art. 3	Total system	The marginal cost of heat of the total system	**The benefit is the difference between the marginal cost of heat of the DE grid and the marginal cost of heat of the prosumer**
Art. 8	Prosumer	The price communicated to the prosumer for prosumer supplied heat which is the marginal cost of the main heat supply, determines the operation and control of the system	**The benefit is the difference between the price offered by the DE and the marginal cost of heat from the prosumers side**
Art. 9	Prosumer or aggregator	The Reference price, and the marginal cost of heat from the prosumer	**The benefit is the accrued profit for different prices of electricity, heating and cooling**
Art. 12	DE company	Technical parameters such as supply and return temperatures of the prosumer heat units	**Price offered for prosumer heat is a function of the external ambient temperature, and the difference in the price offered and the marginal cost of prosumer heat is the benefit**
Art. 13	**Prosumer**	**The control over the system is dependent on the marginal cost of supplying heat to the DE grid**	**Price offered is the marginal cost of heat production from the DH side**


What did we learn?



We see a nexus between pricing logic, flexibility consideration and control, and eventually how the benefits of prosumer integration are shared

Depending on the decisions about the factors in the graphics, business models may need to be tailored for different prosumers

But, currently, not many studies actually look at the different business models for prosumer integration, especially considering the flexibility benefits

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ANALYSES OF STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS OF HYBRID ENERGY NETWORKS

Benedikt Leitner, Ralf-Roman Schmidt

17th Symposium of DHC, Nottingham, 7th - 8th of September 2021

This presentation has been created in the framework of the international cooperation program IEA DHC Annex TS3 „Hybrid Energy Networks". More information at www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3
The Austrian participation in the IEA DHC Annex TS3 is financed by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) in the framework of the IEA-Forschungskooperation.

BACKGROUND: IEA DHC ANNEX TS3: HYBRID ENERGY NETWORKS

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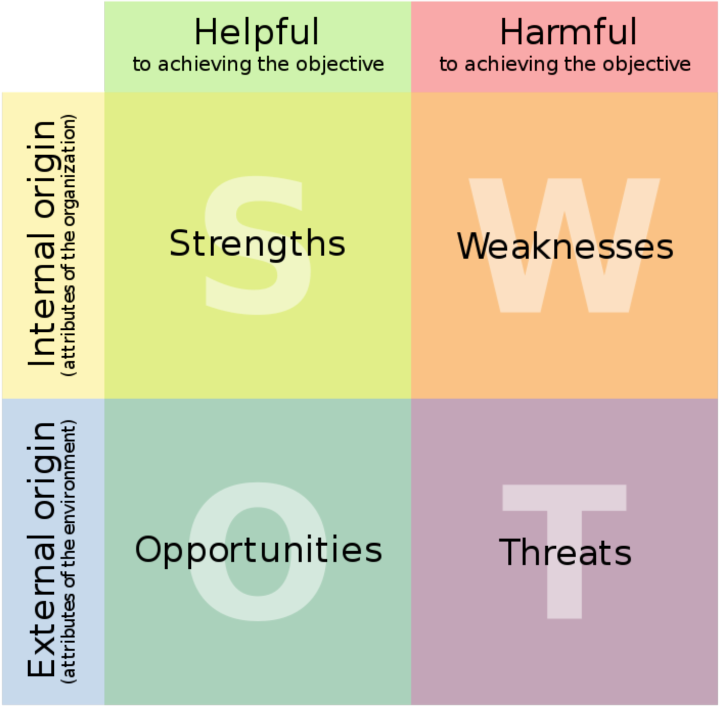
- **An international cooperation program with the aim**:
  - to promote the opportunities and to overcome the challenges for district heating and cooling (DHC) networks in an integrated energy system context
- **Funded**
  - through a task-sharing approach (participants contribute resources in-kind)
- **Lead**:
  - Ralf-Roman Schmidt (AIT); ralf-roman.schmidt@ait.ac.at
- **Runtime**:
  - Fall 2017 – March 2022
- **More information at**
  https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft

SWOT ANALYSIS

- In 2018, a **cooperation between IEA ISGAN Annex 6 and IEA DHC Annex TS3** started. A first shared document is a SWOT analysis.

- **The SWOT analysis aims at supporting the general understanding of the properties and characteristics of a Hybrid Energy Network**

- **Method**: a structured expert involvement:
  - <u>First</u>**:** collection of SWOT factors
  - <u>Second</u>**:** comprehensive discussion phase
  - *<u>Third</u>***:** *(not yet carried out): survey*



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RESULTS

STRENGTHS

- **multiple / distributed supply, transformation and storage** options lead to a higher
  - degree of freedom for planning and operation
  - security of supply, resilience and system flexibility
  - The options to counteract limitations of the electricity network transfer capacity and/ or reduce electricity grid losses by maximizing local consumption
- New **business models** (e.g. ancillary services, energy markets revenues)
- An increased **economic added value** due to the investment in coupling points
- A **decarbonization / diversification of DHC network** heat (and cold) supply
- Integrate **low temperature heat sources** by using (booster) HPs and/ or eBs

WEAKNESSES

- **increasing level of complexity + interdependencies** of the different sub-systems
  - multiple gateways are resulting in a threat to cybersecurity
- The requirement of **additional investments** into coupling points
- Present **electricity tariffs and taxes** are a barrier
- **regulatory restrictions** for electricity grid operators (co-optimizing the distribution and generation of energy; investment and ownership; accessing the flexibility)
- the **seasonality of the heat demand** → price surges on the electricity market?
- Additional heat (and cold) sources in DHC result in a **supply competition**
- Only renewable if **fossil-free electricity** is used (many countries have a fossil fuel dominated el. mix; the heating peak demand coincide with low availability of solar)
- **re-conversion of heat into electricity** has a very low round trip efficiency

OPPORTUNITIES

- An **increased focus on sector integration in research, industry and policy**
  - future decarbonization incentives, supporting regulatory framework
  - More research, products, demo projects, trainings etc.
  - improved performance of coupling points, smart controls etc.
  - Digitalization supports handling of the complexity
- higher shares of PV and wind → **incentives for more flexibility services**
- **Green financing options** + acceptance of long-term amortization periods
- tendency for the **reduction of DHC temperature** → support the integration of HPs

THREATS

- Silo thinking of many actors / a **possible disruptions of existing business models**;
- PtH and PtG units can lead to an **overall higher electricity demand**
- **uncertainties of the future development** of key enabling factors such as
  - Political situation, regulatory framework and market design: e.g. subsidies/ CO2 pricing; allowed ownership of coupling points; the options to participate in the different electricity markets / the availability of suitable network tariffs;
  - The market development in terms of electricity prices as well as the number of alternative flexibility providers (e.g. electric vehicles) / degree of diffusion of coupling points and resulting competition
  - medium- and long-term availability of waste heat as a source for HPs
- **suitable DHC infrastructures** might not be available or be in a bad condition

OUTLOOK

- publication of preliminary results in “**Elsevier Energy Reports**” + Presentation of final results in a **peer reviewed journal paper**
- **Finalizing the review process** within IEA DHC and ISGAN over fall/ winter (including a “public consultation”)
- Development of a short **fact sheet/ summary for policy makers** + recommendations
- **(national) workshop** on the TS3 results in Spring 2022 (ISEC conference?)
- **Save the date:** IEA DHC Annex TS3&4 Industry Workshop:
    - November 3rd, 2021 as a web meeting

WE ARE HIRING!

- *AIT has a job position open*
- ***„research engineer for renewable heating technologies“***
  https://jobs.ait.ac.at/Job/149763
- *Focussing on modelling, simulation and optimization of district heating networks*
- *Currently the job position is in German, but we can discuss this ☺*

THANKS FOR YOUR ATTENTION!

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