IEA-Cross-TCP-Workshop:

Towards a flexible, cross-sectoral energy supply

CEBC 2023, 18.01.2023

Markus Gölles

Introduction

- **Future sustainable energy and resource supply**
  can only be achieved by
  - a flexible, cross-sectoral energy and resource system
  - utilizing the specific advantages of various technologies and resources

- **Workshop**
  - discussion of possible roles of different technologies
  - based on users' needs among the different sectors
  - special focus on flexibility provision via the heating sector
  - holistic view by bringing together users and technological experts

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

Block A Future needs of users and the specific role of biomass

09:10 **Wien Energie‘s vision of a sustainable energy and ressource supply of Vienna**
Teresa Schubert, Wien Energie, Austria

09:30 **Digitalization of energy management systems – optimization of internal energy use as an industrial company**
Maria Lechner, INNIO Jenbacher, Austria

09:50 **Flexible Bioenergy and System Integration**
Elina Mäki, VTT Technical Research Centre of Finland, Finland
Task Leader – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration

10:10 **Use Case: Syngas platform Vienna for utilization of biogenic residues**
Matthias Kuba, BEST – Bioenergy and Sustainable Technologies, Austria

Block A Future needs of users and the specific role of biomass

09:10 **Wien Energie‘s vision of a sustainable energy and ressource supply of Vienna**
Teresa Schubert, Wien Energie, Austria

09:30 **Digitalization of energy management systems – optimization of internal energy use as an industrial company**
Maria Lechner, INNIO Jenbacher, Austria

09:50 **Flexible Bioenergy and System Integration**
Elina Mäki, VTT Technical Research Centre of Finland, Finland
Task Leader – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration

10:10 **Use Case: Syngas platform Vienna for utilization of biogenic residues**
Matthias Kuba, BEST – Bioenergy and Sustainable Technologies, Austria

Wien Energie | Teresa SCHUBERT | 18 January 2023

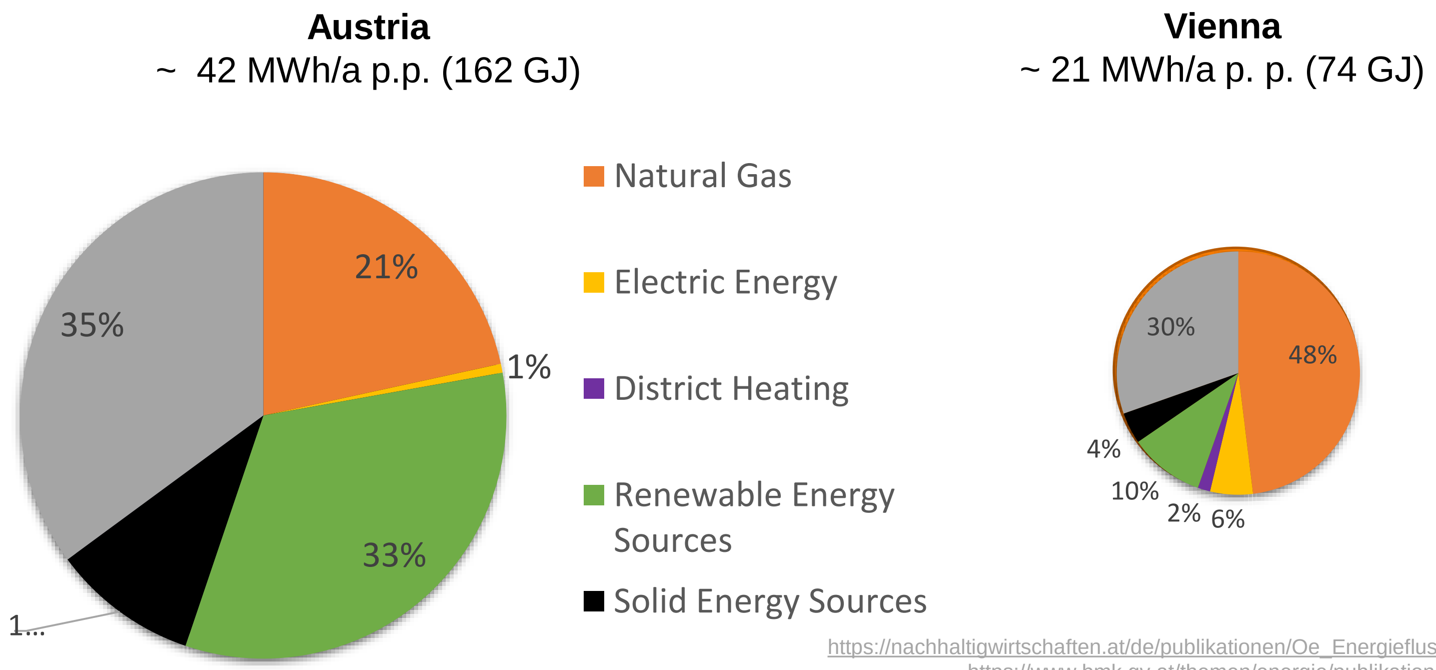
Wien Energie‘s vision of a sustainable energy and resource supply of Vienna

Agenda

- Energy consumption– Austria and Vienna
- Wien Energie
- Decarb 2040
- Gasification – Waste2Value

Gross inland energy consumption 2020

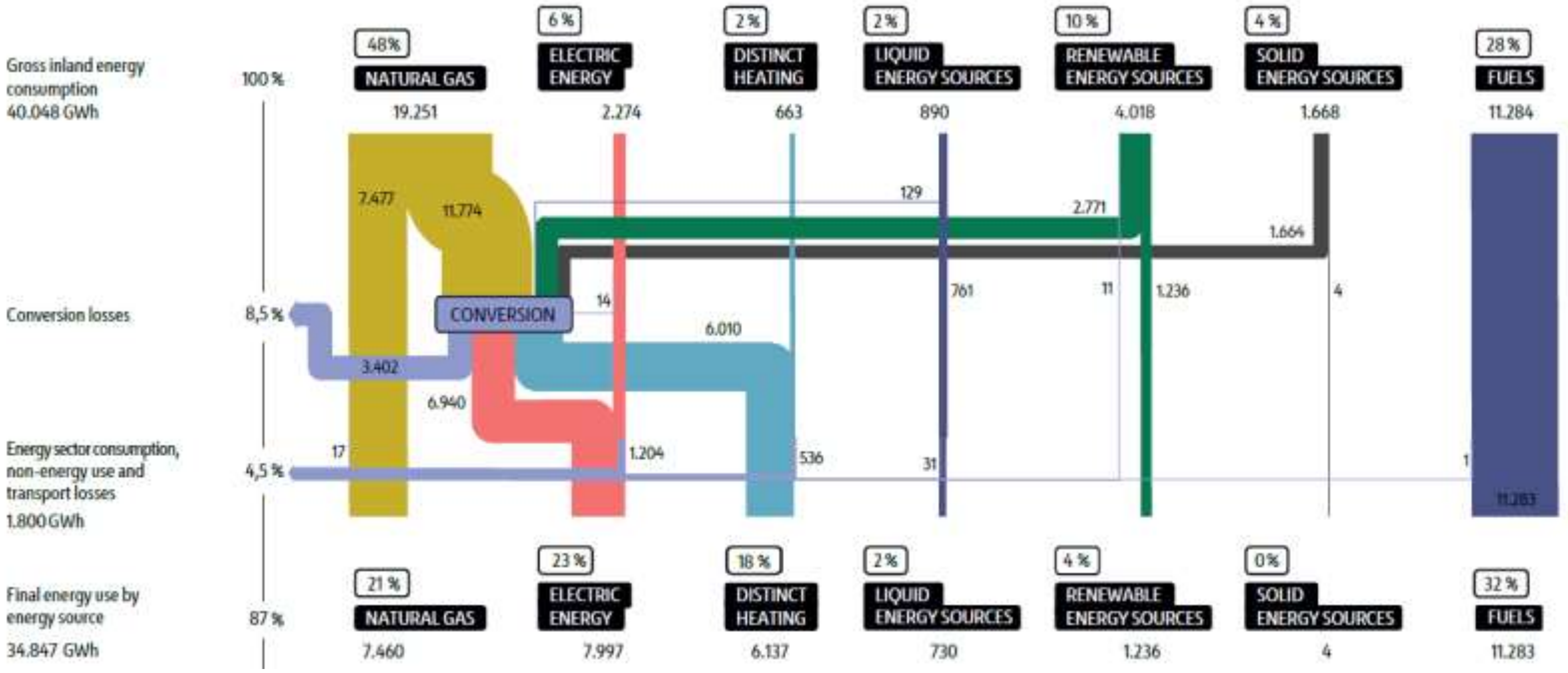
Austria and Vienna



Data sources:
https://nachhaltigwirtschaften.at/de/publikationen/Oe_Energieflussbild_2020.pdf
https://www.bmk.gv.at/themen/energie/publikationen/zahlen.html
http://ma20.23degrees.io/#/sankey/00

Energy demand and supply today

Vienna 2020



Sources: http://ma20.23degrees.io/#/sankey/00

Wien Energie

Austria‘s larges energy supplier

climate neutral by 2040

We provide 2 million people with power, gas, heating and cooling

€1.29bn investments in the period to 2027

Our power stations stabilise the grid

Energy from 1 million tonnes of waste

Austria’s leading energy provider

2,179 employees
49 apprentices

Austria’s largest producer of solar power

District heating for 440,000 households

A new photovoltaic system the size of a football field goes online every week

Wien Energie

Operational KPIs 2021

		2021	+/- % change to prior year
Power production in GWh **Total 6,3 TWh**	Thermal generation	5,020.4	-10.7
	Biomass	80.1	-5.2
	Hydro power	776.3	-4.9
	Wind power	326.5	+10.6
	Photovoltaic power	77.5	+149.1
Heat production in GWh **Total 7,0 TWh**	Cogeneration (CHP)	3,626.8	+4.4
	Waste incineration	1,388.5	+1.0
	Biomass	105.1	+6.8
	Geothermal and ambient energy	191.9	+73.0
	Waste heat sourced	1,150.4	0.0
	Peak load boiler	275.5	+159.4
	Heating plant	248.2	+8.2

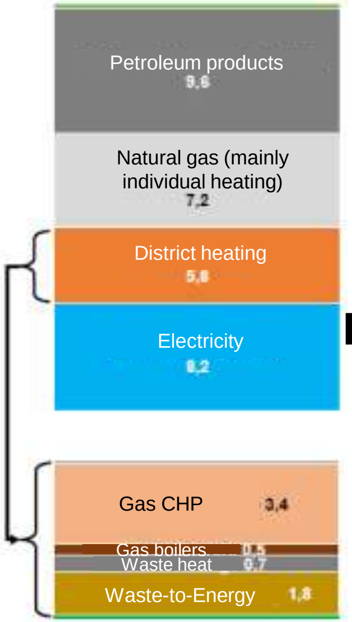
Energy demand and supply 2040

How to decarbonize?

2019

Final energy consumption [TWh]

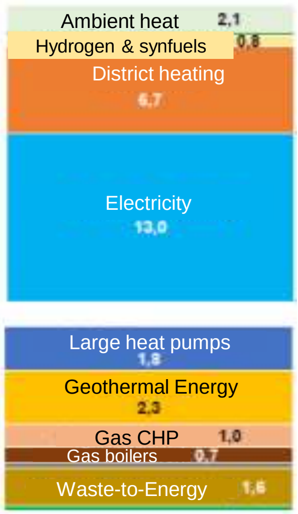
District heating production (incl. losses) [TWh]



Decarb Vienna 2040

- Mobility based on electricity
- Heating and cooling: **Electricity** and **district heating** (geothermal and heat pumps)
- Increase of renewable electricity **production** and **import**

2040



Sources: Compass Lexecon (2021) *Wärme & Kälte, Mobilität, Strom: Szenarien für die Dekarbonisierung des Wiener Energiesystems bis 2040*

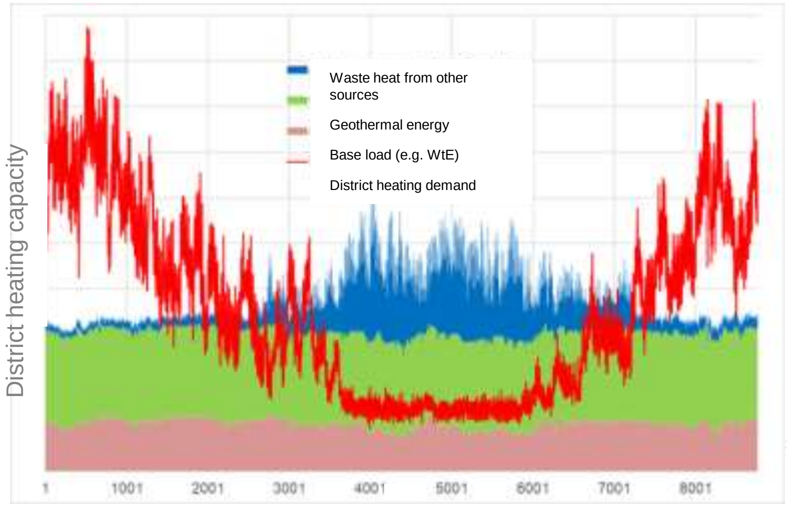
Energy demand and supply 2040

Several technologies needed

Peak load coverage in winter times

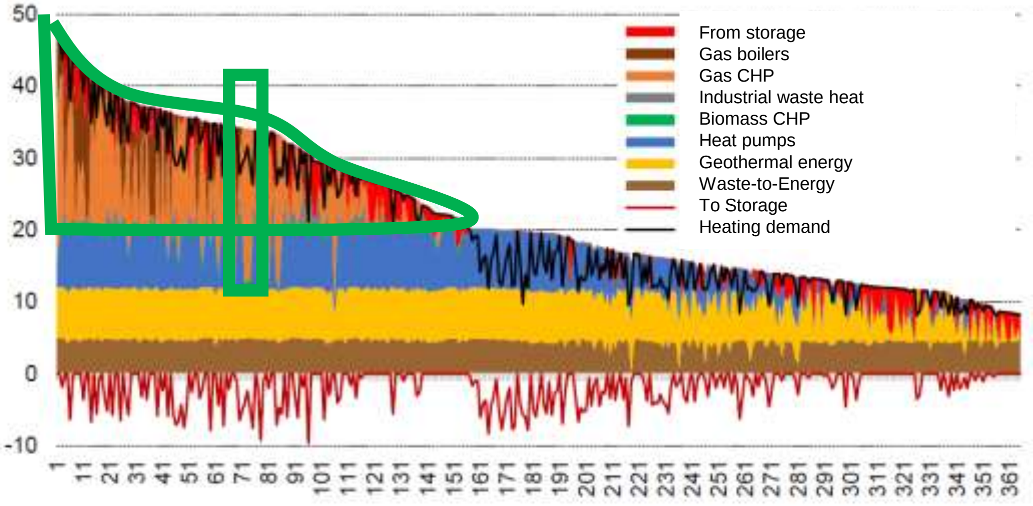
Renewable disctrict heating mainly via geothermal energy and heat pumps BUT…

District heating annual distribution of demand and supply



hours

District heating load duration curve [GWh/d]

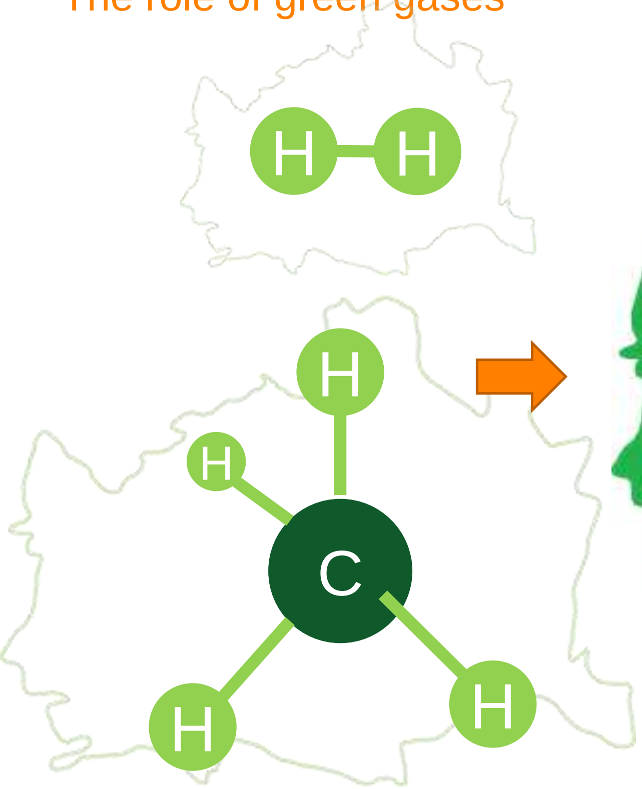


Economic optimization potential

Sources: Compass Lexecon (2021) *Wärme & Kälte, Mobilität, Strom: Szenarien für die Dekarbonisierung des Wiener Energiesystems bis 2040*
Mooslechner, H. Gadermeier, G. „Erforschung von Aquiferwärmespeichern im Großraum Wien (ATES Vienna)“ (2022). Geothermische Energie 103.

Energy demand and supply 2040

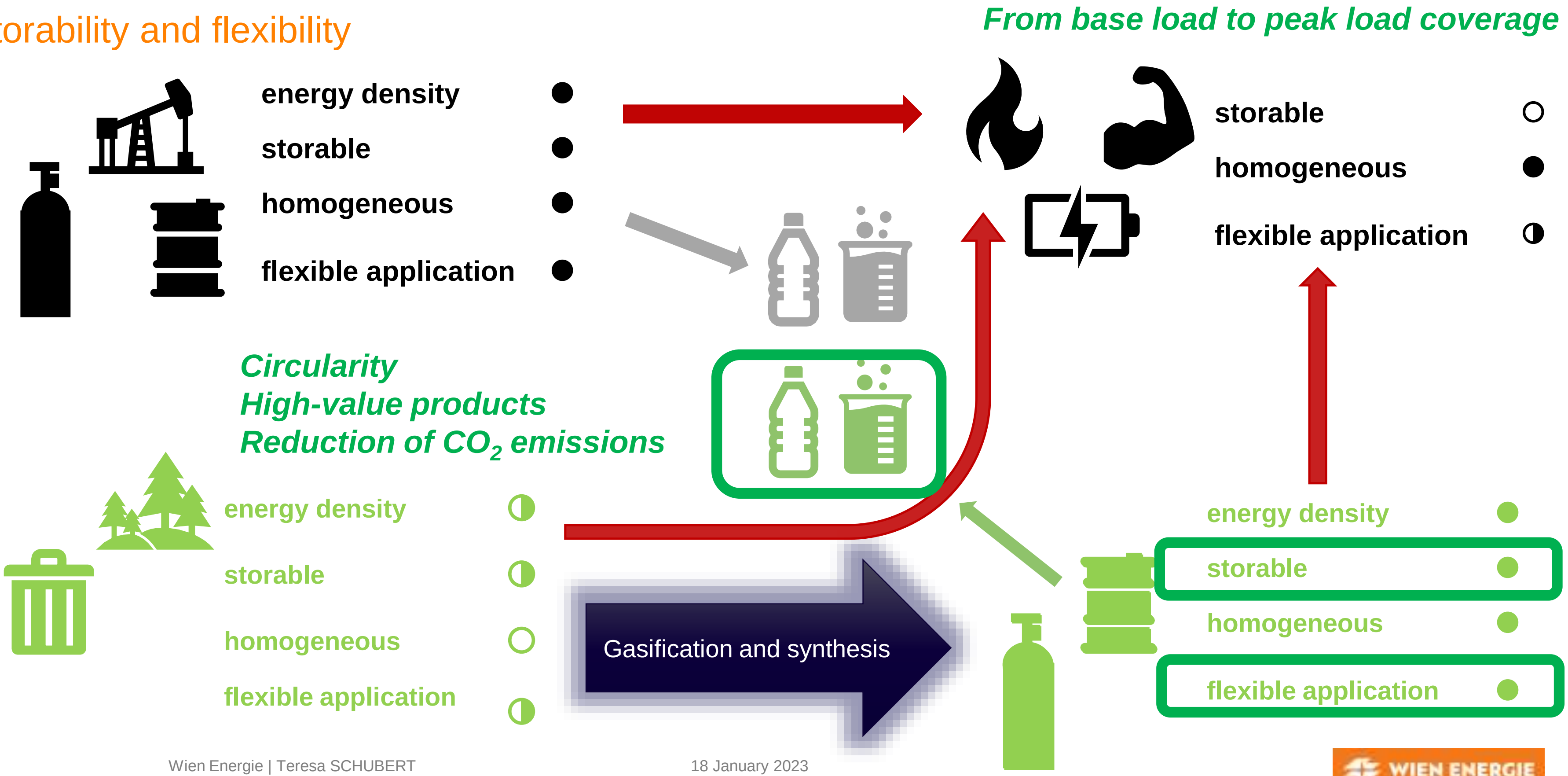
The role of green gases



WIEN ENERGIE

Gasification

Storability and flexibility



Gasification

Waste2Value – research to answer these questions

Technical data of the demo plant	
Fuel input gasification	1000 kW
Syngas input Fischer-Tropsch synthesis	300 kW
Overall efficiency	~ 55%
Input materials	Woody biomass and residues, rejects, sewage sludge and other urban waste fractions

Unsere
Forschungsenergie
dekarbonisiert.
Für Wien.

Teresa SCHUBERT

teresa.schubert@wienenergie.at
+43 664 884 80235

Block A Future needs of users and the specific role of biomass

09:10 **Wien Energie‘s vision of a sustainable energy and ressource supply of Vienna**
Teresa Schubert, Wien Energie, Austria

09:30 **Digitalization of energy management systems – optimization of internal energy use as an industrial company**
Maria Lechner, INNIO Jenbacher, Austria

09:50 **Flexible Bioenergy and System Integration**
Elina Mäki, VTT Technical Research Centre of Finland, Finland
Task Leader – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration

10:10 **Use Case: Syngas platform Vienna for utilization of biogenic residues**
Matthias Kuba, BEST – Bioenergy and Sustainable Technologies, Austria

Digitalization of EMS

Optimization of internal energy use as an industrial company

Maria Lechner

Graz, 18th Jan 23

INNIO Digital Training

Agenda

- Intro
- General Approach for Energy Management Systems
- Overview of Energy Supply
- Platform Concept
- Q&A

INNIO Jenbach

Company presentation

INNIO* is...

- A leading provider of renewable gas and hydrogen-rich solutions and services for power generation
- With our Jenbacher* products, INNIO* helps to provide communities, industry and the public access to sustainable, reliable and economical power ranging from 250 kW to 10.4 MW.
- Headquartered in Jenbach, Austria

*Indicates a trademark

Personal Data

Ing. Maria Lechner MSc Ba

Education

- HTL Industrial Engineering
- Study Energy Engineering
- Study Management and Law
- Continuing Education (Leadership, Hydrogen, Auditor,..)

Job

- Project Lead Energy > 2016
    - Projects (CHP Plants, Smart Meter, Battery storage, Microgrid, H2,..)
- Global Supply Chain Management 2012- 2016

INNIO Jenbach

Energy Infrastructure

On-site energy landscape

- Local electricity and heat supply
- Site-specific energy supply
- Volatile electronical output from local testbenches
- Energy cost optimization with our digital platform

Goal: “Analyze and optimize in-house energy balance”

Energy Management Systems

Energy Management System

Challenges of today

Operational Optimization

- ✓ Energy costs
- ✓ Increasing volatility of renewable systems (e.g., solar)
- ✓ Efficient use of recovered heat
- ✓ Flexibility in power generation with optimal dimensions for energy storage and heat grids

Solution:
Optimize internal energy use with digital platform

Connectivity

- ✓ Visualization and diagnostic
- ✓ Forecast and operational timetable
- ✓ Analysis of continually updated information (e.g., machine data, process data, electricity prices, weather data and calculated prognoses)
- ✓ Precise electricity supply when the grid demands

Solution:
CHP technology - combined heat and power generation

Costumer Perspective

- ✓ Showcase Jenbacher product portfolio
- ✓ Machine connectivity
- ✓ Amount and complexity of data requires to use of artificial intelligence (AI) and self-teaching algorithms
- ✓ Microgrid CHP+

Solution:
Scalable digital platform

Energy Management System

Adding value through digitalization

Traditional solution

- ✓ Historical information/ afterwards
- ✓ Focus on electricity grid
- ✓ Unused potential for optimizing energy storage and heating demands
- ✓ Manual adjustment of operating schedules and limited overall efficiency

Digitalization of EMS

Holistic approach:
Optimization of plant, energy storage, heat and electricity trading

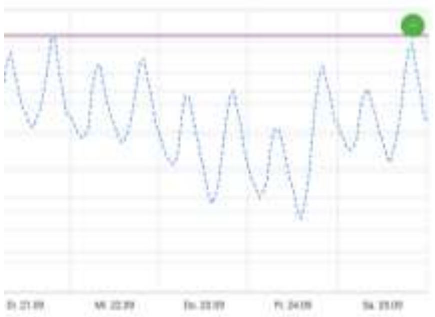
Creating opportunities for additional revenue through flexible profiles and forecasts

myPlant* Optimization all-in-one solution:

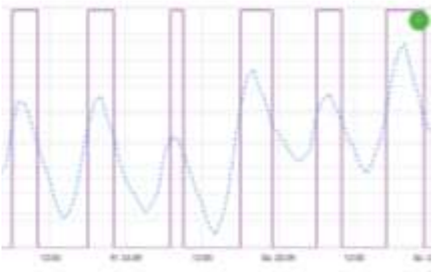
myPlant OPTIMIZATION

Energy Management System
Optimization

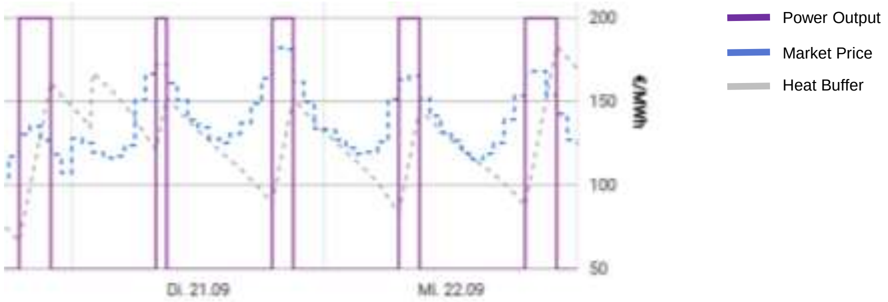
Base Load Operation



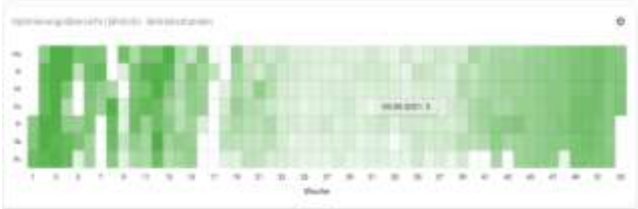
Electricity Optimization



myPlant* Optimization Operation



Daily Optimization



Yearly Optimization

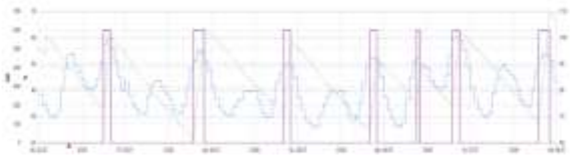
Energy Management System

Optimizing on multiple time horizons

Annual optimization

Annual operation profile for optimized operation of the entire plant to **achieve annual targets**.

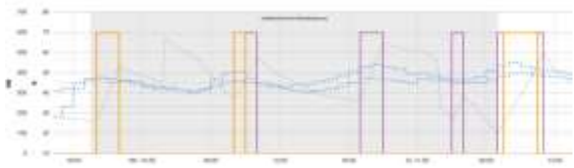
Prognosis: once a week



Day-ahead optimization

Based on **short-term weather forecasts** and other **plant-related data**, our solution optimizes operation for the day-ahead market.

Prognosis: twice a day



Intraday optimization

On **short-term variations** such as unscheduled maintenance, manual operations or extreme **unforeseeable** weather **changes**, operation is adjusted to the 15min based intraday market.

Prognosis: every 5 minutes

myPlant OPTIMIZATION

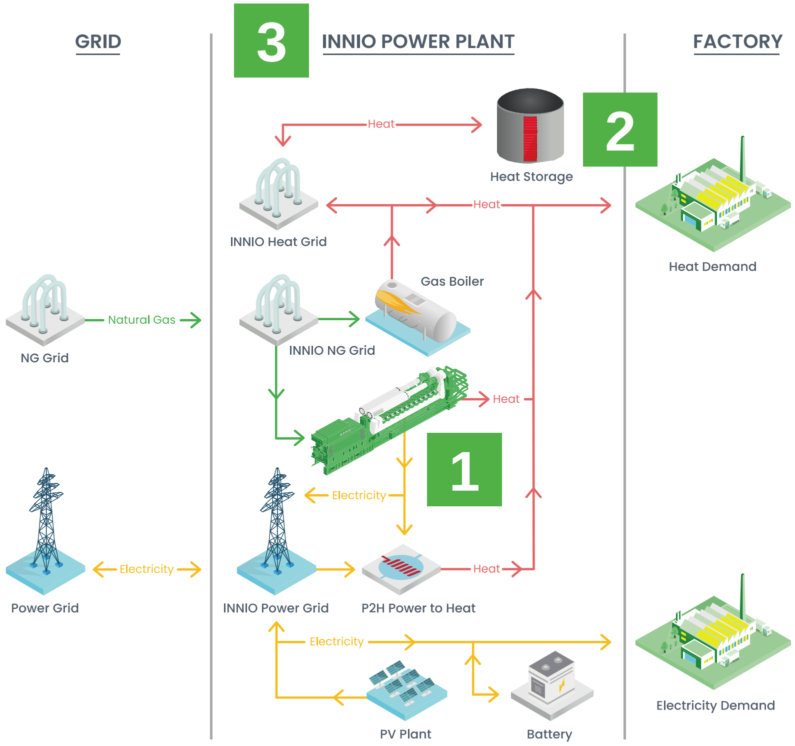
JENBACHER
INNIO

Energy Supply

Energy Supply
Infrastructure

	Electrical Output	Thermal Output
1 x CHP J420	1.56 MW	1.62 MW
1 x CHP J612	2.01 MW	1.94 MW
2 x Heat Storage		2 x 10 MWh
2 x Thermal Boiler		2 x 8 MW
1 x Power to Heat		4.8 MW
1 x Battery	1.2 MW	
PV	350 KWp	
Water Turbine	60 KW	

Energy Supply
System Overview



1 **Fast and flexible CHP plant**
- ✓ Technology, production and training center
- ✓ Wide load range

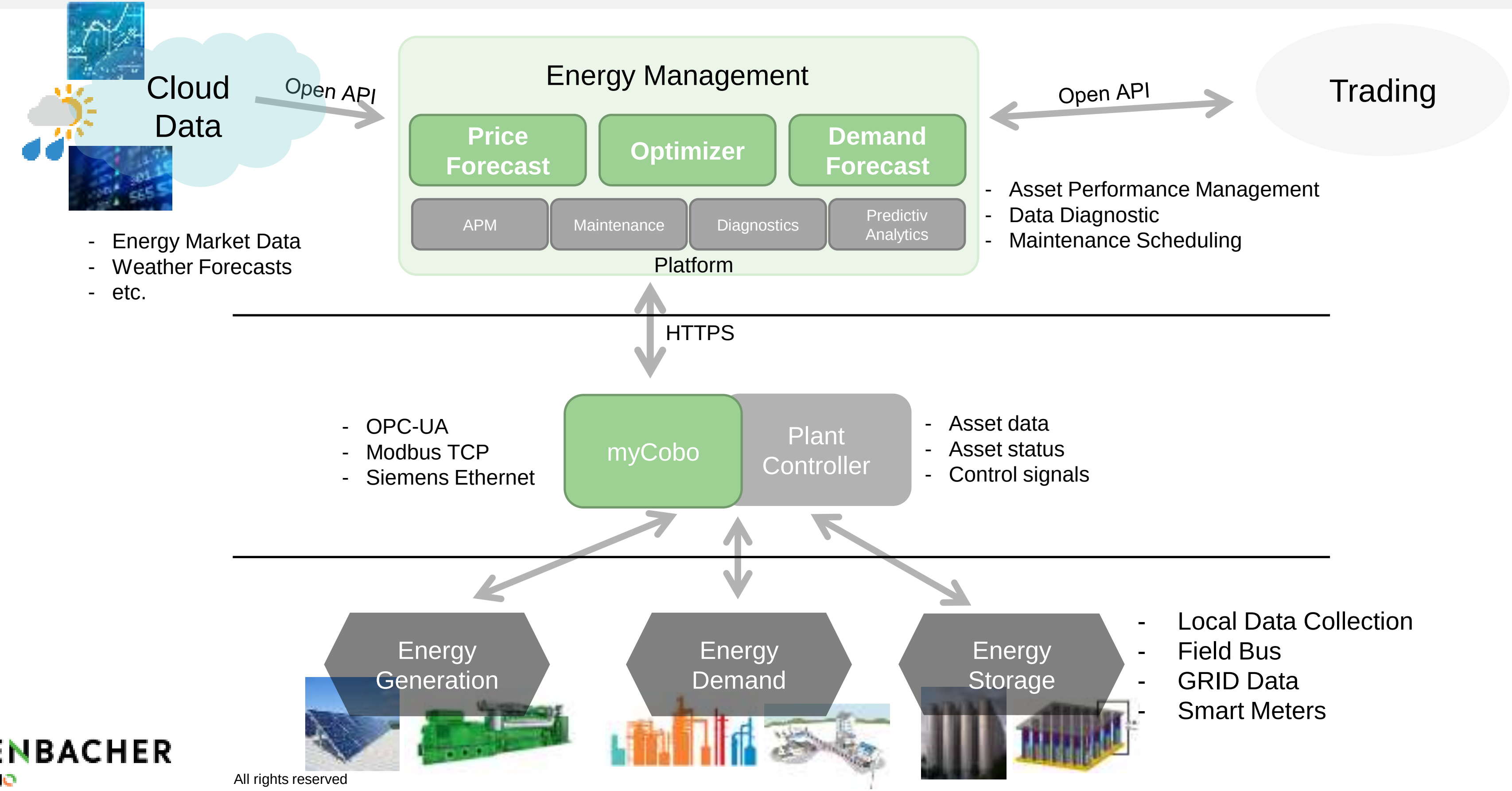
2 **Flexible power for heating and heat storage**
- ✓ Use excess electricity
- ✓ Store heat for use when needed

3 **Energy Management with myPlant* Optimizer**
- ✓ Fully integrated solution
- ✓ Operation optimization
- ✓ System forecasting

JENBACHER
INNIO

Platform Concept

Energy Management
Platform Concept



Conclusion

Conclusion

Digitalization of EMS

BENEFITS

- Higher Potential for optimization
- Utilization of **existing myPlant infrastructure**
- **Digital platform** with wide range of possibilities
- High **flexibility and reaction speed**
- Self-hold **IT Security**

ECONOMICS

- **10% energy cost saving**
  - ✓ energy flow optimization
- **myPlant infrastructure**
  - ✓ cost saving
- **Revenue generation**
  - ✓ Forecast
  - ✓ Intraday spot market
  - ✓ balance energy

Block A Future needs of users and the specific role of biomass

09:10 **Wien Energie‘s vision of a sustainable energy and ressource supply of Vienna**
Teresa Schubert, Wien Energie, Austria

09:30 **Digitalization of energy management systems – optimization of internal energy use as an industrial company**
Maria Lechner, INNIO Jenbacher, Austria

09:50 **Flexible Bioenergy and System Integration**
Elina Mäki, VTT Technical Research Centre of Finland, Finland
Task Leader – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration

10:10 **Use Case: Syngas platform Vienna for utilization of biogenic residues**
Matthias Kuba, BEST – Bioenergy and Sustainable Technologies, Austria

Flexible Bioenergy and System Integration

IEA-Cross-TCP Workshop: Towards a flexible, cross-sectoral energy supply

Elina Mäki, VTT, Task 44 Leader
- with contribution from Task 44 members

Graz, Austria, 18/1/2023

IEA Bioenergy Task 44 – Flexible Bioenergy and System Integration

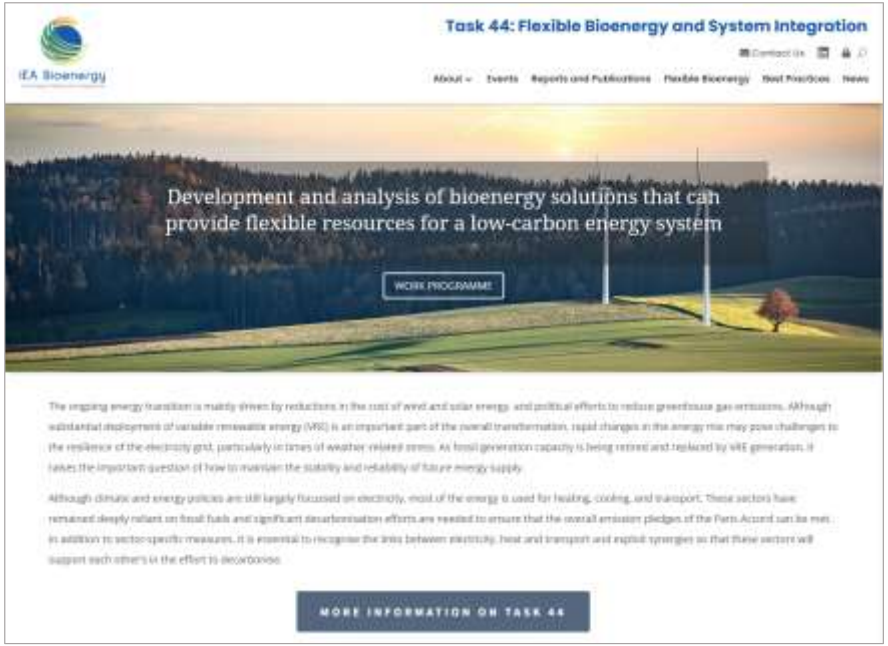
The objective is to improve understanding on flexible bioenergy and its future role, and identification of barriers and future development needs in the context of the entire energy system.

Our key topics (2022-2024)

- Flexible bioenergy **concepts** for supporting low-carbon energy systems
- Flexible bioenergy **integration in energy systems**
- Acceleration of **implementation**
- **Synergies** with green hydrogen and BECCUS value chains

Members

- Austria, European Commission, Finland, Germany, Ireland, The Netherlands, Sweden, Switzerland, USA



Find more information: https://task44.ieabioenergy.com/

Discuss about flexible bioenergy: https://www.linkedin.com/groups/13682476/

What is flexible bioenergy?

Task 44 definition

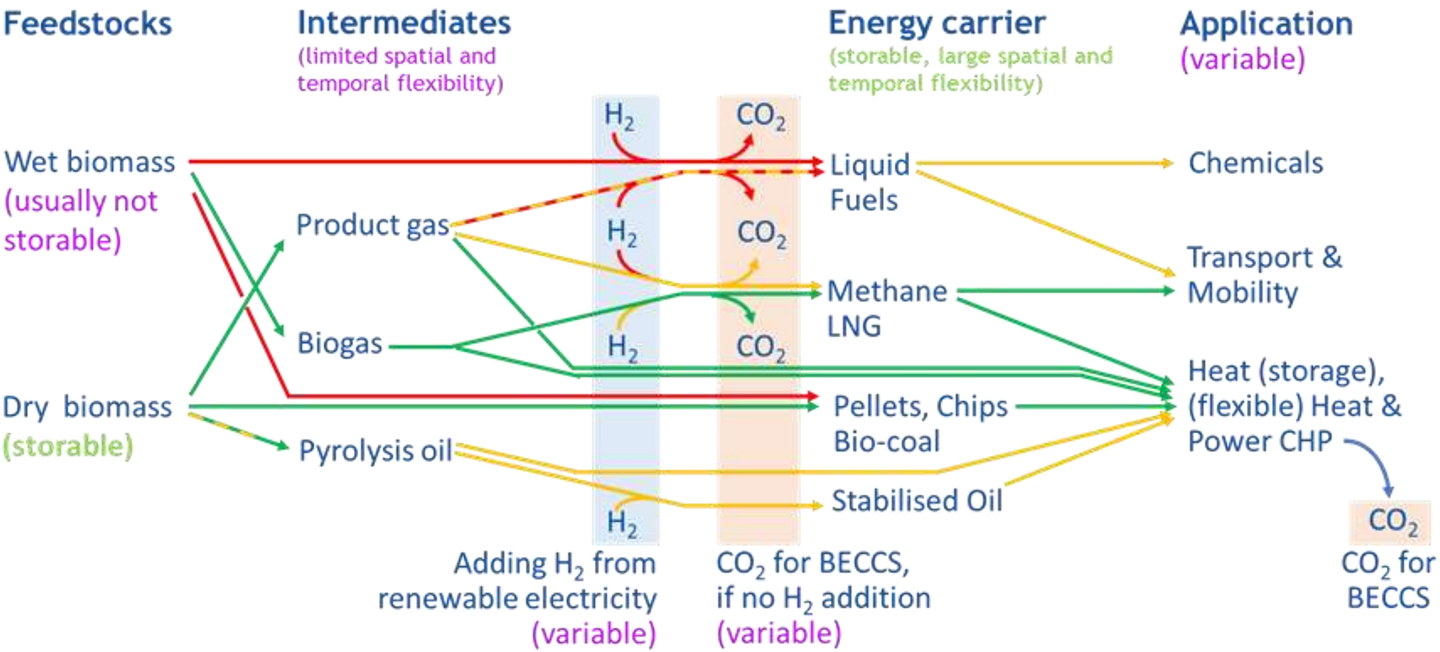
"Flexible bioenergy is defined as a bioenergy system than can provide multiple services and benefits to the energy system under varying operating conditions and/or loads."

"Examples of flexible bioenergy include:

- technologies and concepts providing grid stability for a power system with large amounts of variable wind and solar energy;
- dispatchable production of energy and other products according to market demand;
- integrated polygeneration systems combining the production of heat, power, fuels and/or chemicals;
- long-term storage options such as biofuels and biochemicals; or
- ancillary services to support system reliability."

Source: IEA Bioenergy Task 44 – Flexible Bioenergy and System Integration

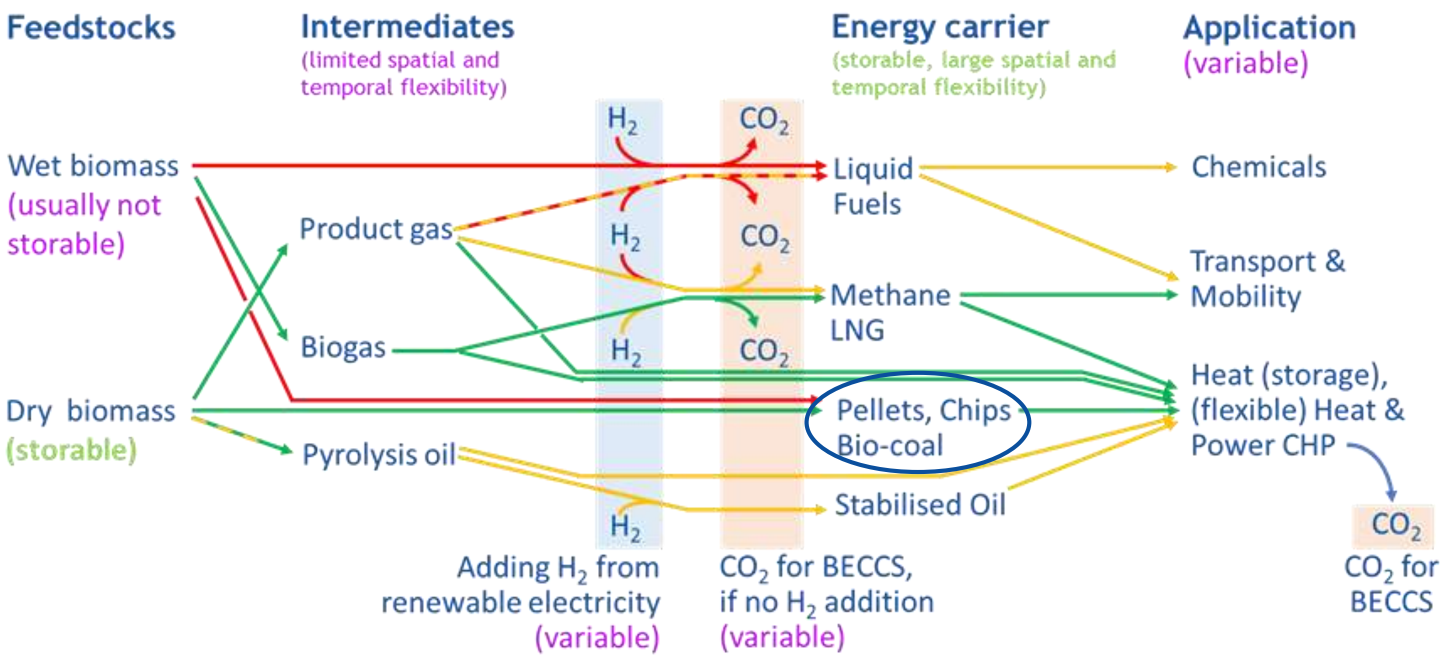
The network of flexible technologies in biomass related energy conversions



Technology already applied
Technology demonstrated technically, but does not yet have a working business case
Technology under development

Schildhauer, T. et al. (2021.) *Technologies for Flexible Bioenergy.* Available at: https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2021/08/IEA-Task-44-report-Technologies-for-Flexible-Bioenergy.pdf

The network of flexible technologies in biomass related energy conversions



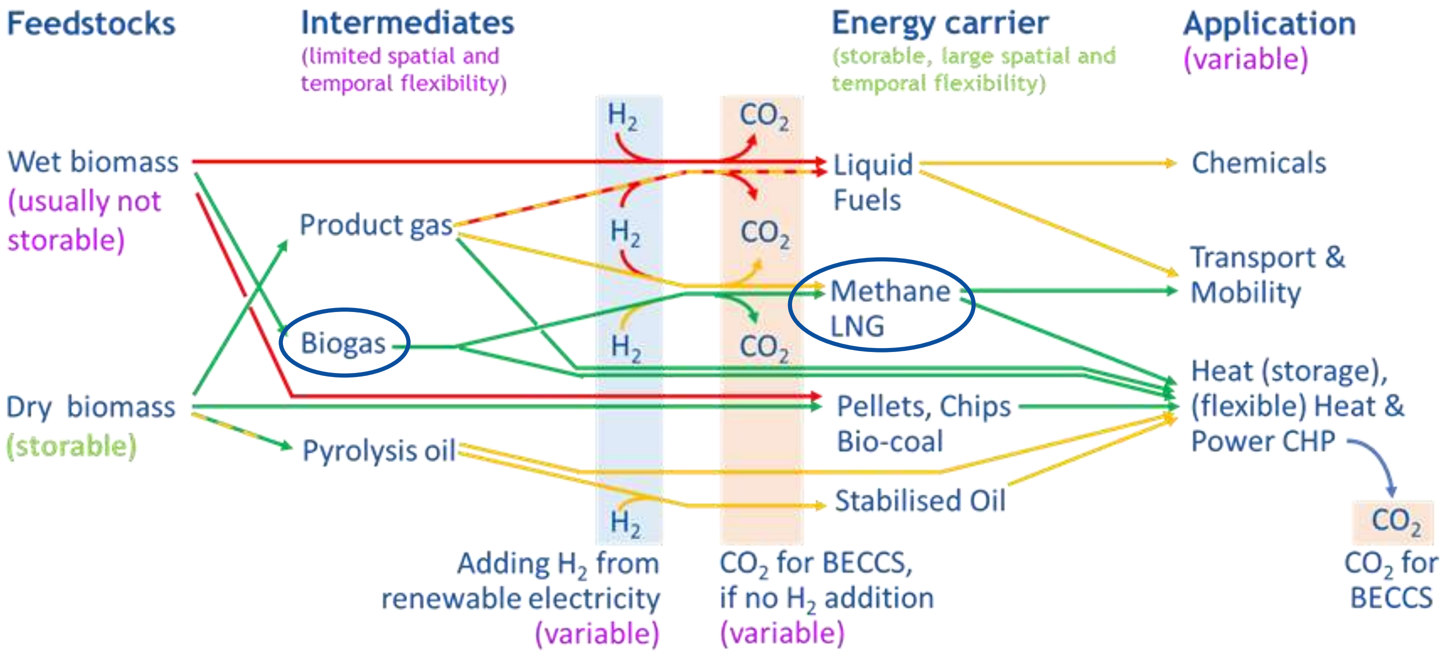
Technology already applied

Technology demonstrated technically, but does not yet have a working business case

Technology under development

Schildhauer, T. et al. (2021.) *Technologies for Flexible Bioenergy.* Available at: https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2021/08/IEA-Task-44-report-Technologies-for-Flexible-Bioenergy.pdf

The network of flexible technologies in biomass related energy conversions



Technology already applied

Technology demonstrated technically, but does not yet have a working business case

Technology under development

Schildhauer, T. et al. (2021.) *Technologies for Flexible Bioenergy.* Available at: https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2021/08/IEA-Task-44-report-Technologies-for-Flexible-Bioenergy.pdf

Specific possibilities for flexible bioenergy

Extensive technical and cost data for flexible bioenergy technologies included

- Long and complex supply chains, with multiple options for flexibility, not only for energy but for the broader bioeconomy.
- Many high TRL options already implemented, but are not making use of the flexibility.
- The broad use of bioenergy flexibility will depend on a suitable market design and for some period also support schemes.
- Multiple options to include renewable hydrogen in bio-based value chains.
- In an energy mix dominated by wind and solar, sustainable bioenergy plays an important role in flexible energy generation, industry and transport, and is increasingly used in connection with CCUS.


IEA Bioenergy

Technologies for Flexible Bioenergy

IEA Bioenergy: Task 44

August 2021

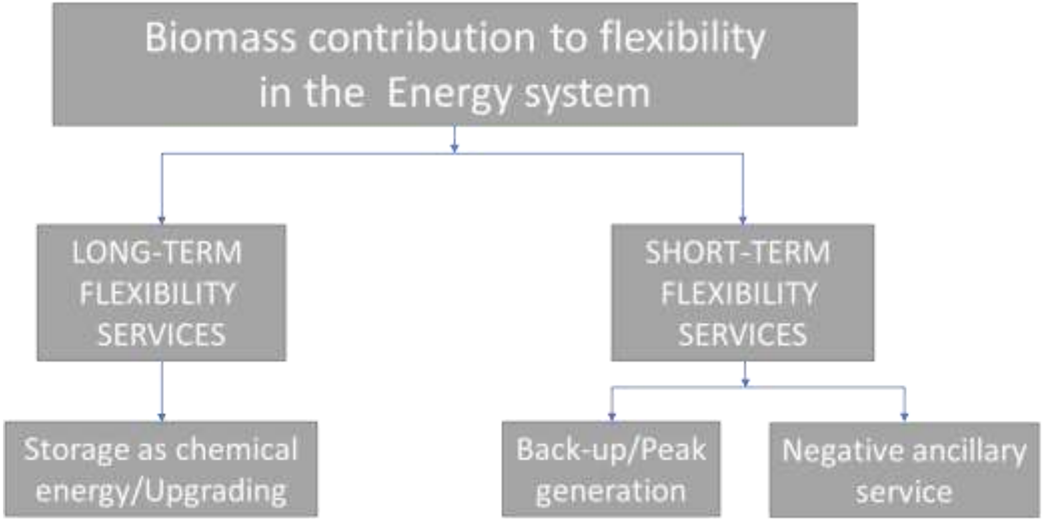
Flexibility in biomass related energy conversions

Technology Collaboration Programme

Schildhauer, T. et al. (2021.) *Technologies for Flexible Bioenergy.* Available at: https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2021/08/IEA-Task-44-report-Technologies-for-Flexible-Bioenergy.pdf

Expectations on the role of flexible bioenergy

Categories for flexible bioenergy



Flexible bioenergy options go beyond short- and mid-term flexibility provision and services for the power grid.

→ Shifting resources in place and time even seasonally

→ Supporting integration of variable renewables

Synergies with other renewables

Best Practice examples show the variety of options

Best Practice collection: https://task44.ieabioenergy.com/best-practices/

E-gas plant in Werlte, Germany
(Source: e-gas GmbH)

Liquid Wind's production facility, Sweden
(Source: Övik Energi)

Vantaa Energy's Power-to-Gas integrated with Waste-to-Energy, Finland
(Source: Vantaa Energy)

The Ethtec Lignocellulosic Bioethanol Pilot Plant, Australia
(Source: Ethtec)

Siemens Energy's Zero Emission Hydrogen Turbine Center
(Source: Siemens Energy)

Expectations on the role of bioenergy in the energy system

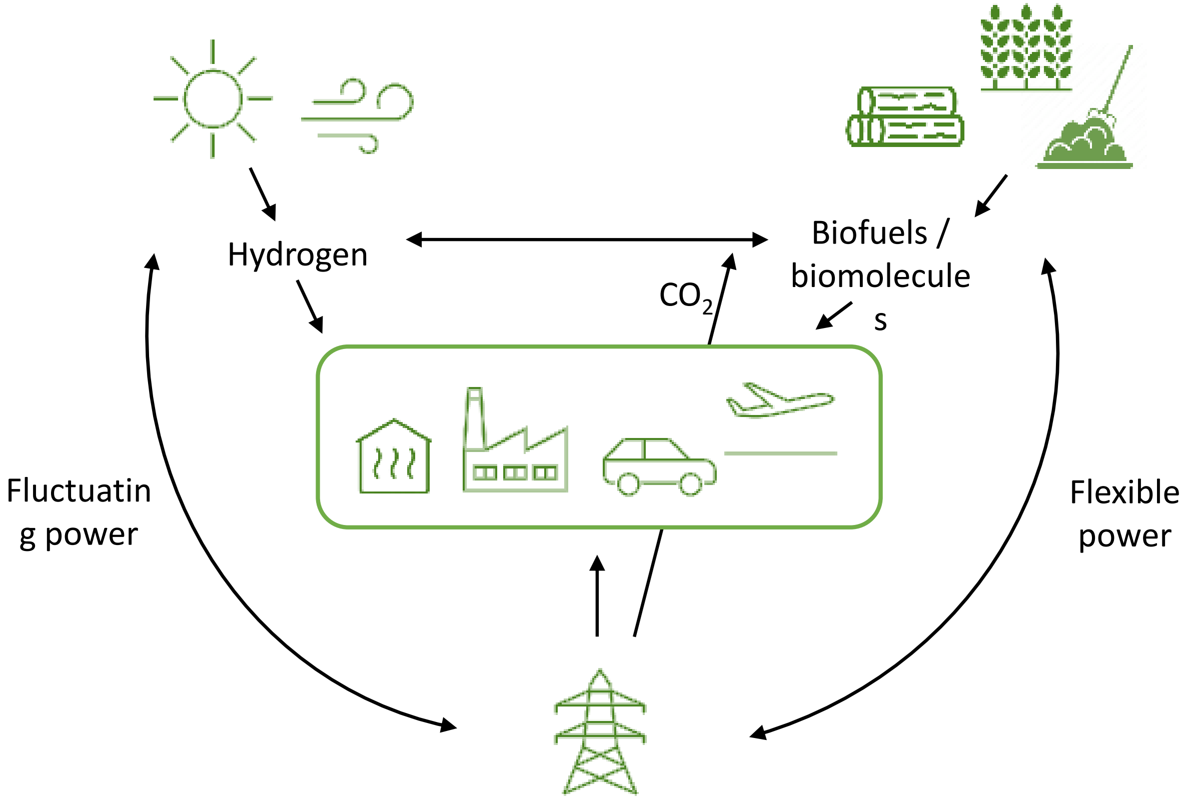
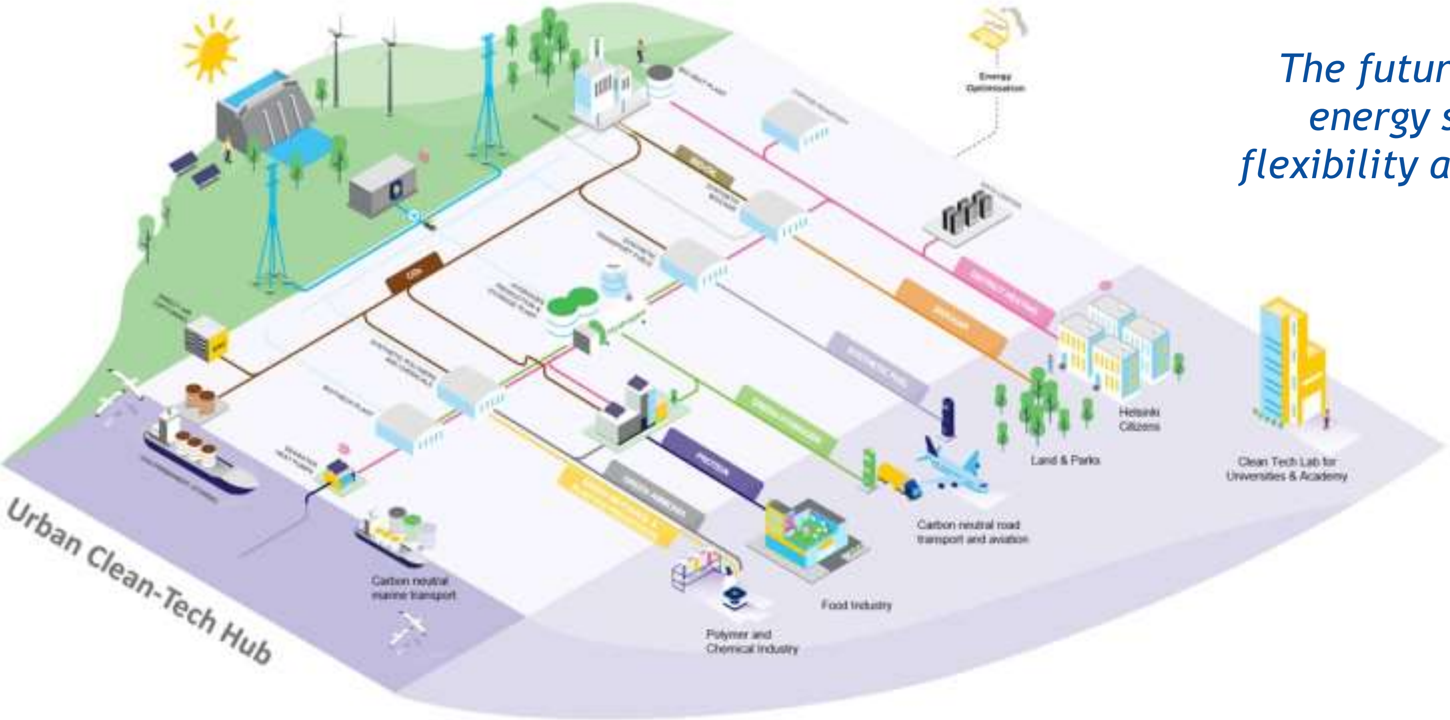


Figure modified from Thrän, D. Presentation at IEA Bioenergy triannual conference (Task 44 session), 2021.

Expectations on the role of flexible bioenergy

Toward carbon-neutral Helsinki



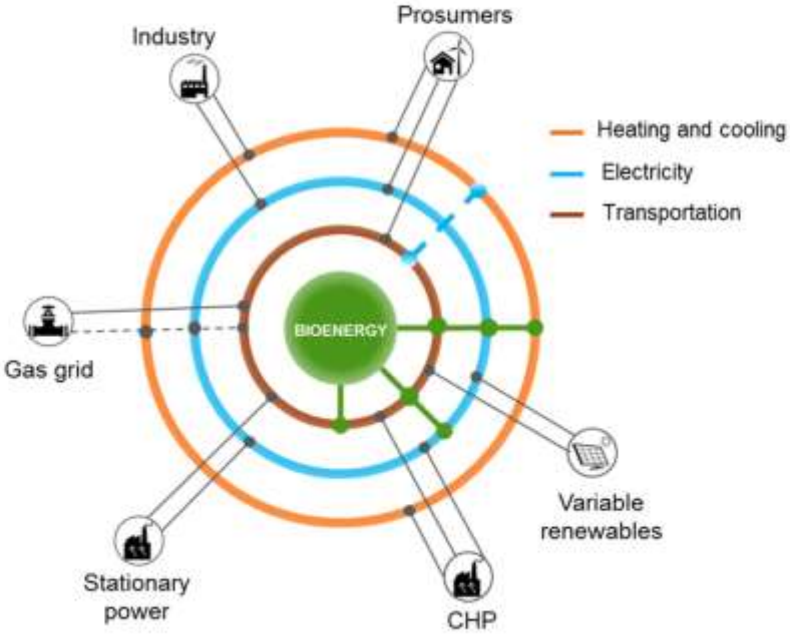
The future interconnected energy system requires flexibility and sector coupling.

Courtesy of Helen Ltd.

Expectations on the role of flexible bioenergy

Bioenergy can play a central role in balancing

- The applied flexibility options depend on local conditions
- Gas and heat networks are expected to play a bigger role in balancing the electrical grid
- Bioenergy can play a central role across the different sectors



Arasto, a. et al. (2017.) *Bioenergy's role in balancing the electricity grid and providing storage options – an EU perspective.*
Available at: https://www.ieabioenergy.com/wp-content/uploads/2017/02/IEA-Bioenergy-Bioenergy-in-balancing-the-grid_master_FINAL-Revised-16.02.17.pdf

The way forward to realize the flexibility potential

Five cornerstones are necessary

1. Clear definition
2. Multiplication of Best Practices
3. Technology development, incl.:
   - Automation and control
   - Integration of green hydrogen and CO_2 value chains
   - Fuel flexibility, low-quality feedstocks
4. Policy and market conditions
5. Appropriate consideration in long-term energy system planning


IEA Bioenergy
Summary Series
Five cornerstones to unlock the potential of flexible bioenergy
Introduction

Thrän, D. et al. (2021.) *Five cornerstones to unlock the potential of flexible bioenergy*. Available at: https://task44.ieabioenergy.com/publications/five-cornerstones-to-unlock-the-potential-of-flexible-bioenergy-2021/

Thank you

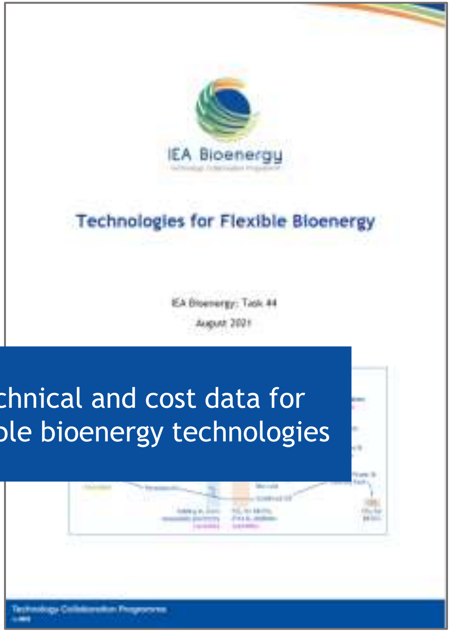
Elina Mäki
Elina.Maki@vtt.fi

IEA Bioenergy Task 44:
https://task44.ieabioenergy.com/

IEA Bioenergy
Technology Collaboration Programme

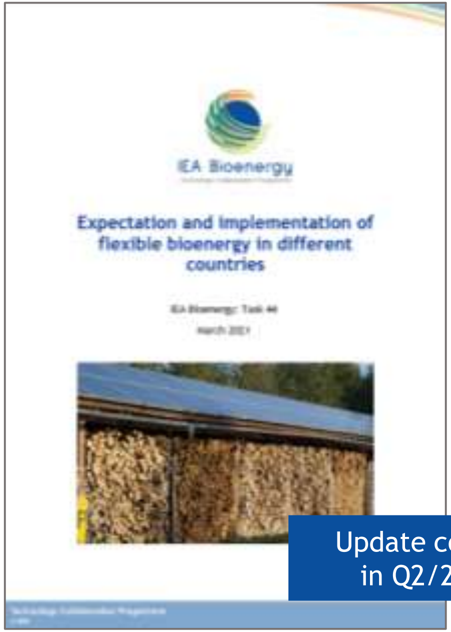
www.ieabioenergy.com

Publications



Technical and cost data for flexible bioenergy technologies

Technologies for Flexible Bioenergy, 2021



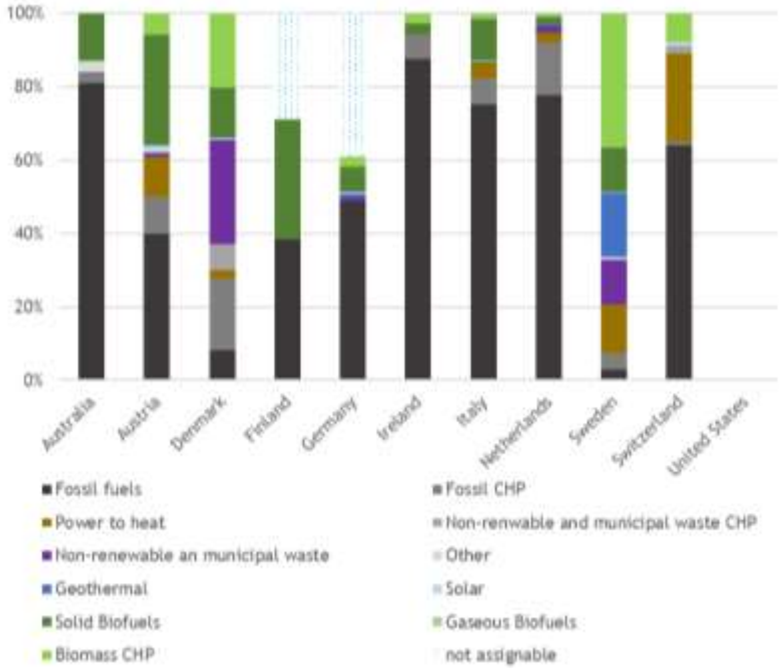
Update coming in Q2/2023

Expectation and implementation of flexible bioenergy in different countries, 2021

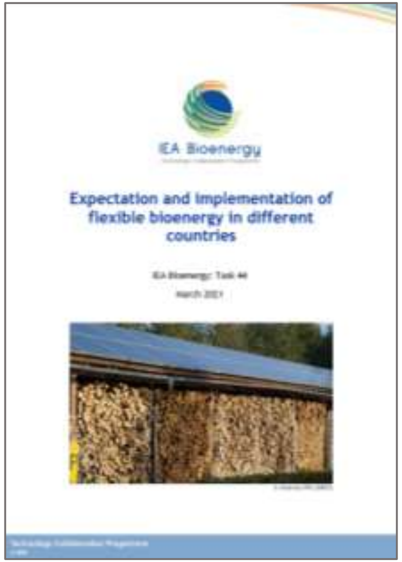
Five cornerstones to unlock the potential of flexible bioenergy, 2021

Heating and cooling provision by source in selected countries

The role of bioenergy is system dependent

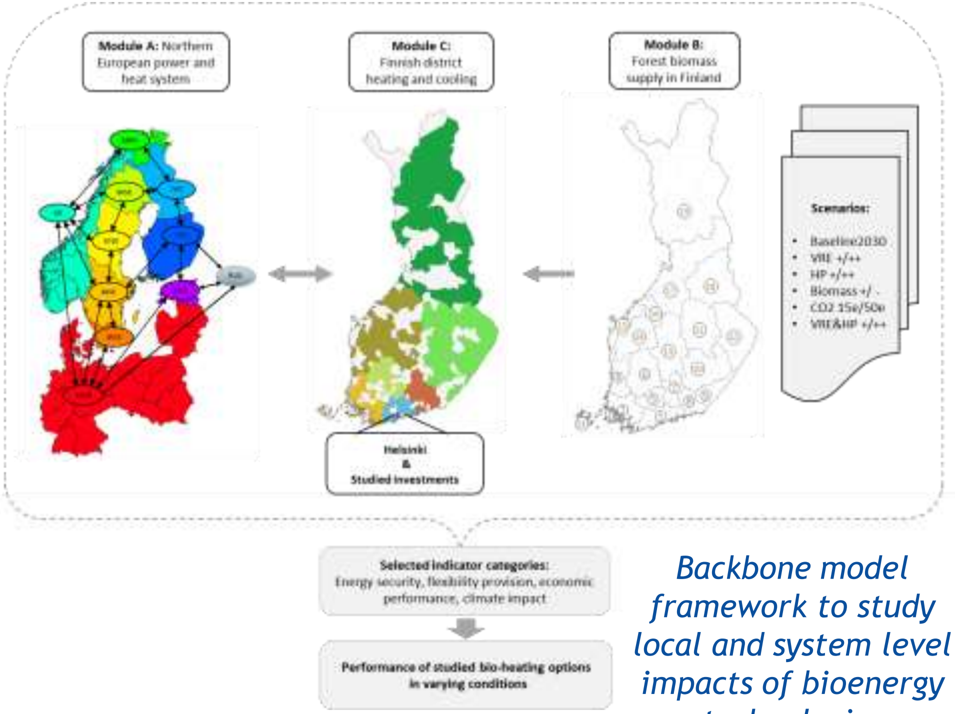


Data from 2018



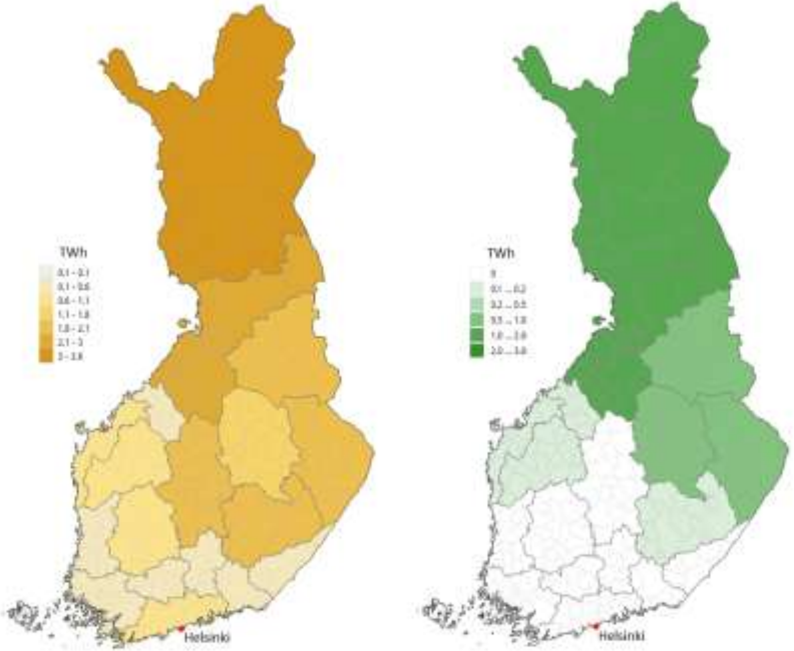
Thrän, D. et al. (2021.) *Expectation and implementation of flexible bioenergy in different countries.* Available at: https://task44.ieabioenergy.com/publications/bioenergexpectation-and-implementation-of-flexible-y-in-different-countries-2021/

Decarbonization of district heating in Finnish capital area



Backbone model framework to study local and system level impacts of bioenergy technologies

Available (left) and unused (right) forest energy wood in the baseline 2030 scenario

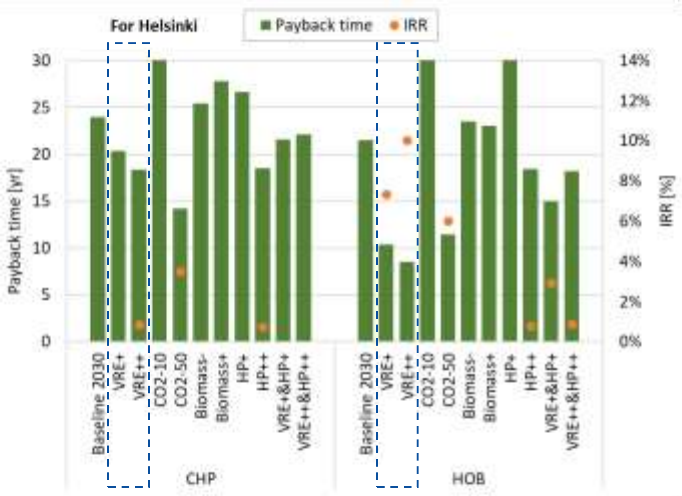


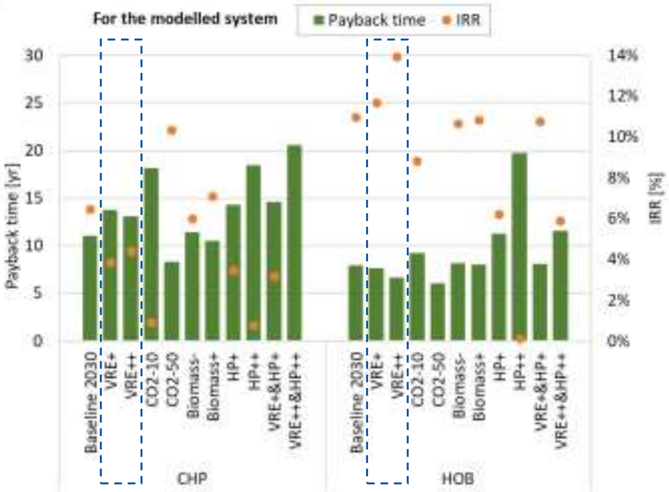
Lindroos, T.J., Mäki, E., Koponen, K. et al. *Replacing fossil fuels with bioenergy in district heating – Comparison of technology options.* Energy 2021;231:120799. https://doi.org/10.1016/j.energy.2021.120799

Decarbonization of district heating in Finnish capital area

Local and systemic impacts of bioenergy investments

- **Technology options:** heat-only boiler (HOB), CHP, biorefinery, biorefinery with hydrogen enhancement
- Investment decisions are done based on local interests, which might lead to outcomes that are less optimal from the whole system perspective and lock-in effects **>> Systemic view and consideration on required system services are needed**
- Availability of domestic biomass in Southern Finland is a limiting factor **>> The value of biomass in different uses!**





Block A Future needs of users and the specific role of biomass

09:10 **Wien Energie‘s vision of a sustainable energy and ressource supply of Vienna**
Teresa Schubert, Wien Energie, Austria

09:30 **Digitalization of energy management systems – optimization of internal energy use as an industrial company**
Maria Lechner, INNIO Jenbacher, Austria

09:50 **Flexible Bioenergy and System Integration**
Elina Mäki, VTT Technical Research Centre of Finland, Finland
Task Leader – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration

10:10 **Use Case: Syngas platform Vienna for utilization of biogenic residues**
Matthias Kuba, BEST – Bioenergy and Sustainable Technologies, Austria

Use Case: Syngas Platform Vienna for the use of biogenic residues and waste

Matthias Kuba

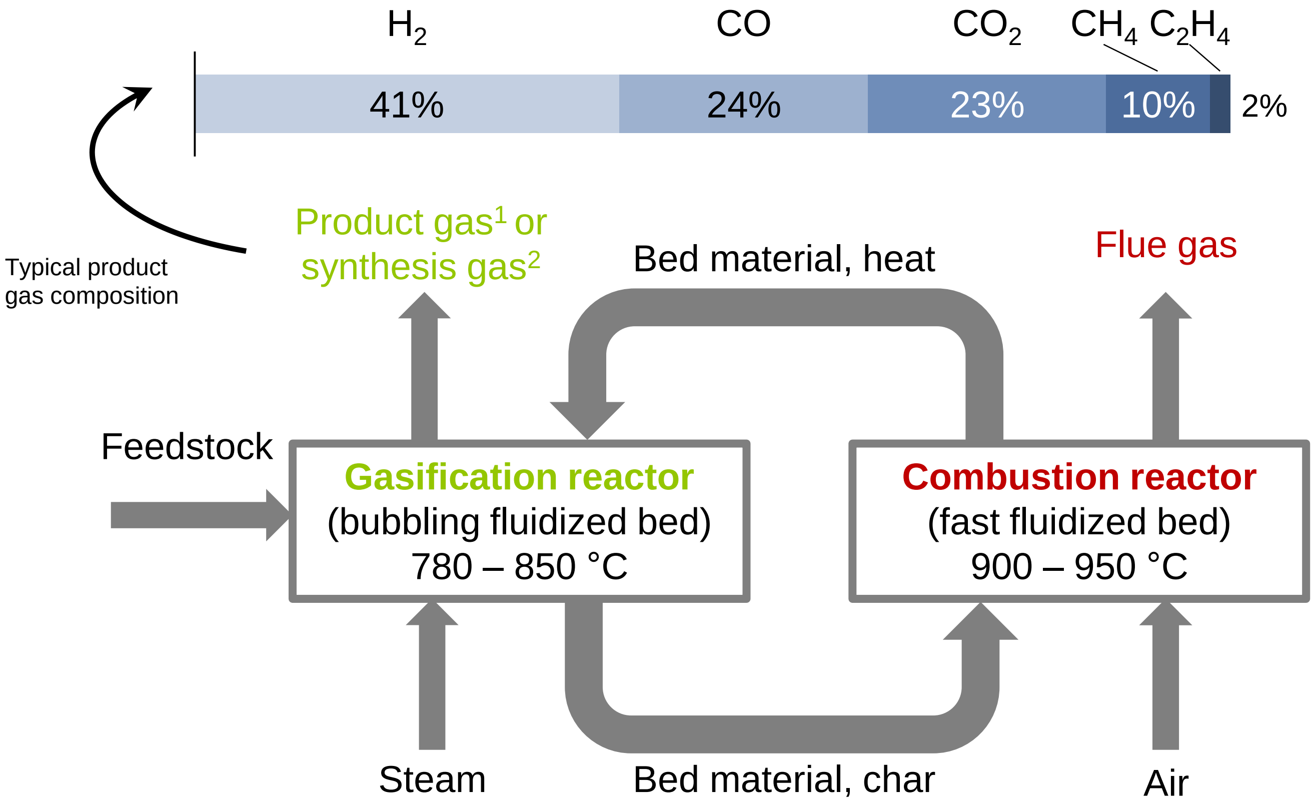
BEST Bioenergy and Sustainable Technologies

FFG Forschung wirkt. · Bundesministerium Arbeit und Wirtschaft · Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie · wirtschafts agentur wien · Für die Stadt Wien · Das Land Steiermark – Wirtschaft, Tourismus, Regionen, Wissenschaft und Forschung · SFG

BEST

Target	Production of syngas from biomass and waste and downstream synthesis
Scale	1 MW **DUAL FLUID** gasification 250 kW Fischer-Tropsch synthesis
Operation	Campaigns for research operation
Fuel	wood chips, sewage sludge, plastic waste, sorted waste, agricultural residues

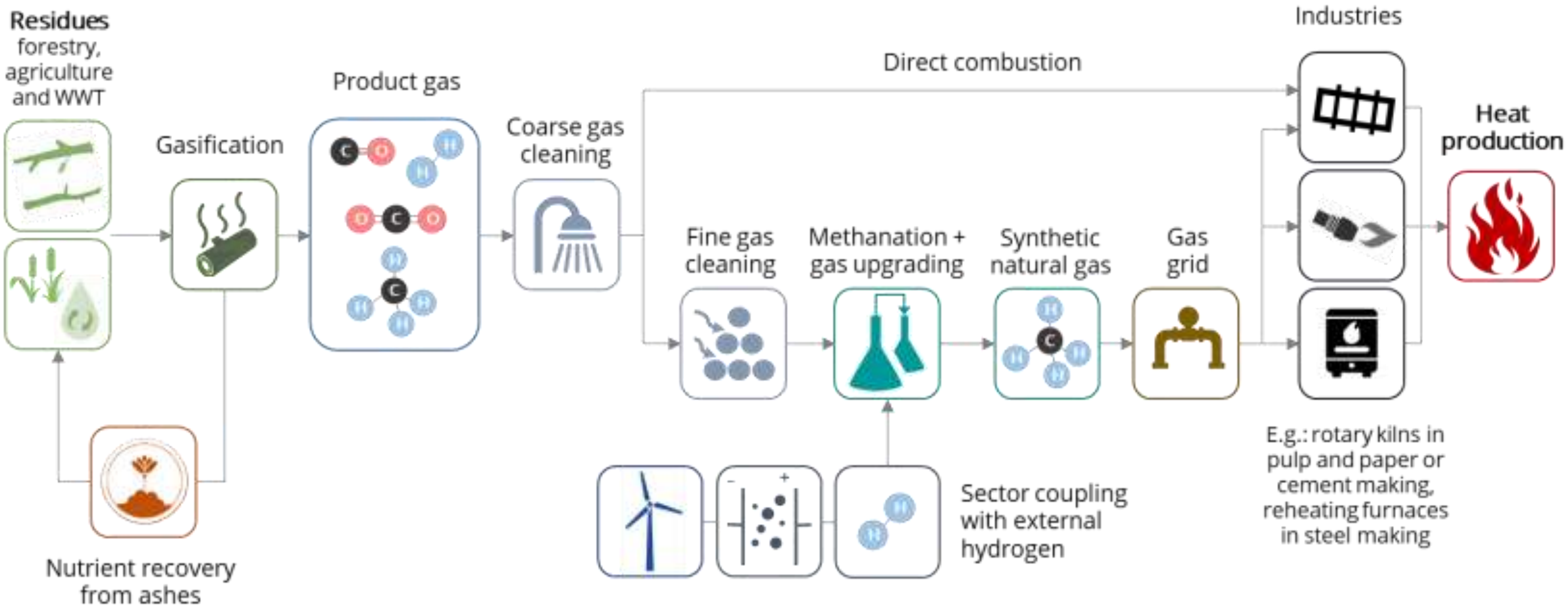
Syngas from DFB gasification



1 e.g. tar (incl. BTEX): 20-30g/m³, H_2S ~100 ppm for biomass fuel before any gas cleaning for downstream processing

2 Synthesis gas = cleaned from impurities

Gasification for heat production – heat as main product



Syngas Platform Vienna: Different end products – heat as a side product

Shifting Research Focus

Syngas Platform Technologies

Residues and waste
forestry, agriculture, industry and WWT

Optional: Peak-wind energy

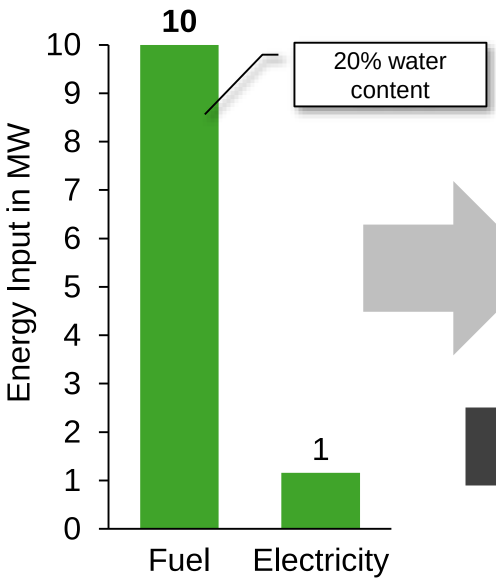
Refinery products
- Wax
- Jet Fuel
- Alcohols
- Diesel

Gases
- Hydrogen
- SNG
- Syngas combustion

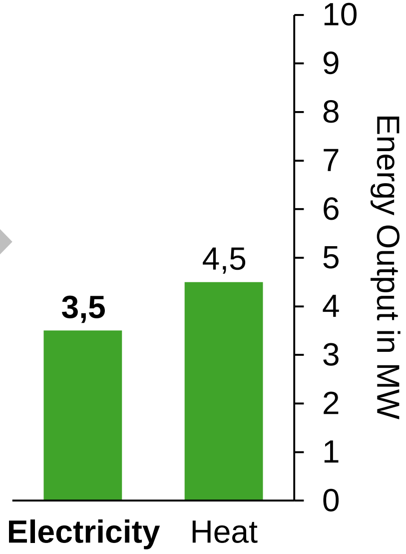
CHP
- Electrical
- Thermal

Shifting Research Focus

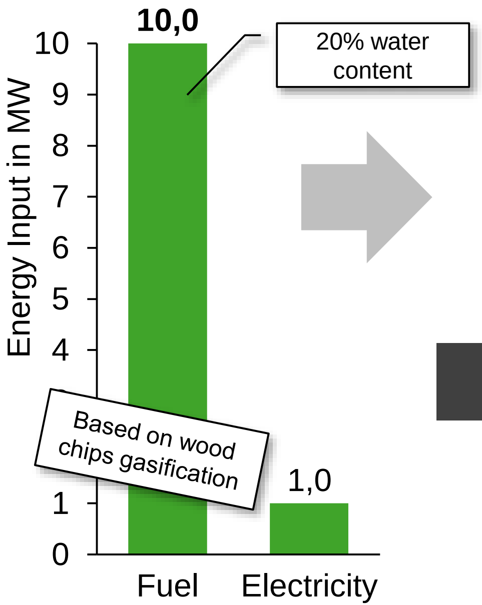
CHP: Efficiency (of electricity orientated process)



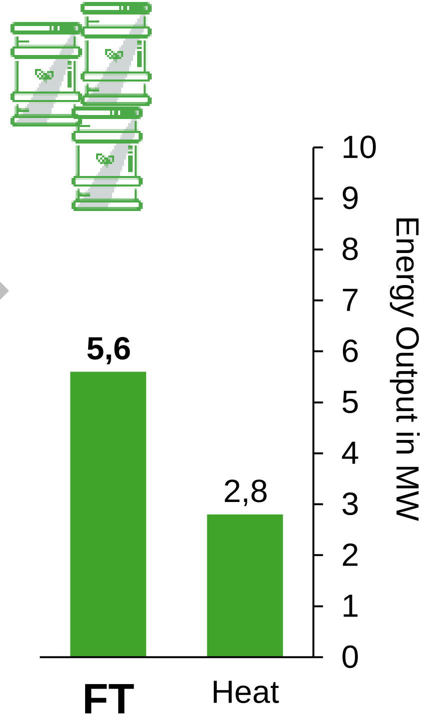
Gasification + gas engine



BtL: Efficiency (of fuel orientated process)



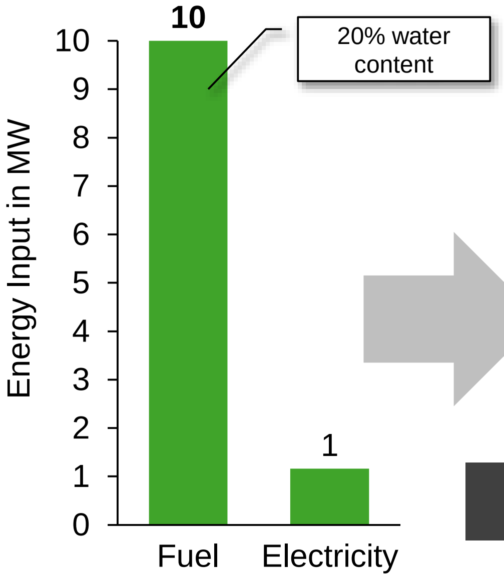
Gasification + FTS

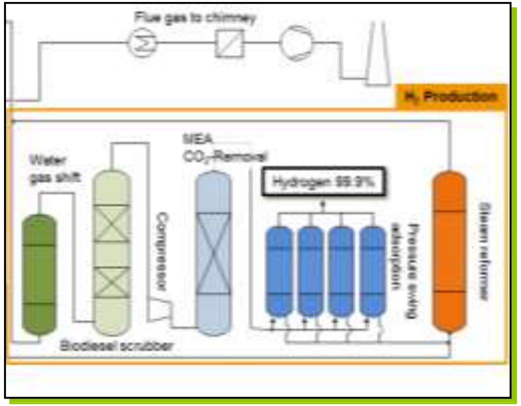


Production cost estimates

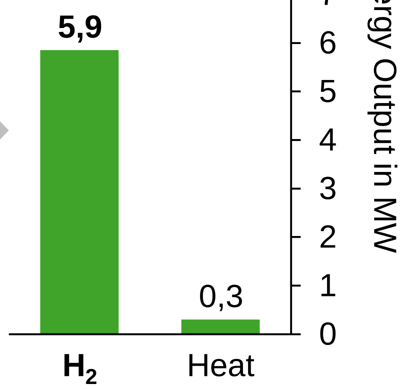
75-144 EUR/MWh (based on results of IEA study)

Bio-H_2: Efficiency (of H_2 orientated process)





Gasification + gas separation



Concluding thoughts

- Gasification can be a key technology in different process chains
- Gasification can be a used for heat production, e.g. in industrial applications (pulp and paper, cement making, etc.)
- The main end product determines how much heat is available as side product
- Even if heat is not the main product, it is often not negligible!

BEST

Target	Production of syngas from biomass and waste and downstream synthesis
Scale	1 MW **DUAL FLUID** gasification 250 kW Fischer-Tropsch synthesis
Operation	Campaigns for research operation
Fuel	wood chips, sewage sludge, plastic waste, sorted waste, agricultural residues

Matthias Kuba
Area Manager
matthias.kuba@best-research.eu

Area 2
Fluidized Bed Conversion Systems
Mariahilferstraße 51/1/15a
1060 Vienna
AUSTRIA

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

Block B Flexibility provision via the heating sector

11:00 **Transformation of District Heating and Cooling Systems towards high share of renewables**

Ingo Leusbrock, AEE INTEC, Austria
Austria Lead of Austrian delegation – IEA DHC Annex TS5 Integration of Renewable Energy Sources into existing District Heating and Cooling Systems

11:20 **Opportunities offered by long-term heat storages and large-scale solar thermal systems**

Viktor Unterberger, BEST – Bioenergy and Sustainable Technologies, Austria
Task Manager – IEA SHC Task 68 Efficient Solar District Heating Systems

11:40 **Possibilities through digitalization on the example of District Heating and Cooling**

Dietrich Schmidt, Fraunhofer Inst. f. Energy Economics a. Energy System Technology, Germany
Operating Agent – IEA DHC Annex TS4 Digitalisation of District Heating and Cooling

Block B Flexibility provision via the heating sector

11:00 **Transformation of District Heating and Cooling Systems towards high share of renewables**

Ingo Leusbrock, AEE INTEC, Austria
Austria Lead of Austrian delegation – IEA DHC Annex TS5 Integration of Renewable Energy Sources into existing District Heating and Cooling Systems

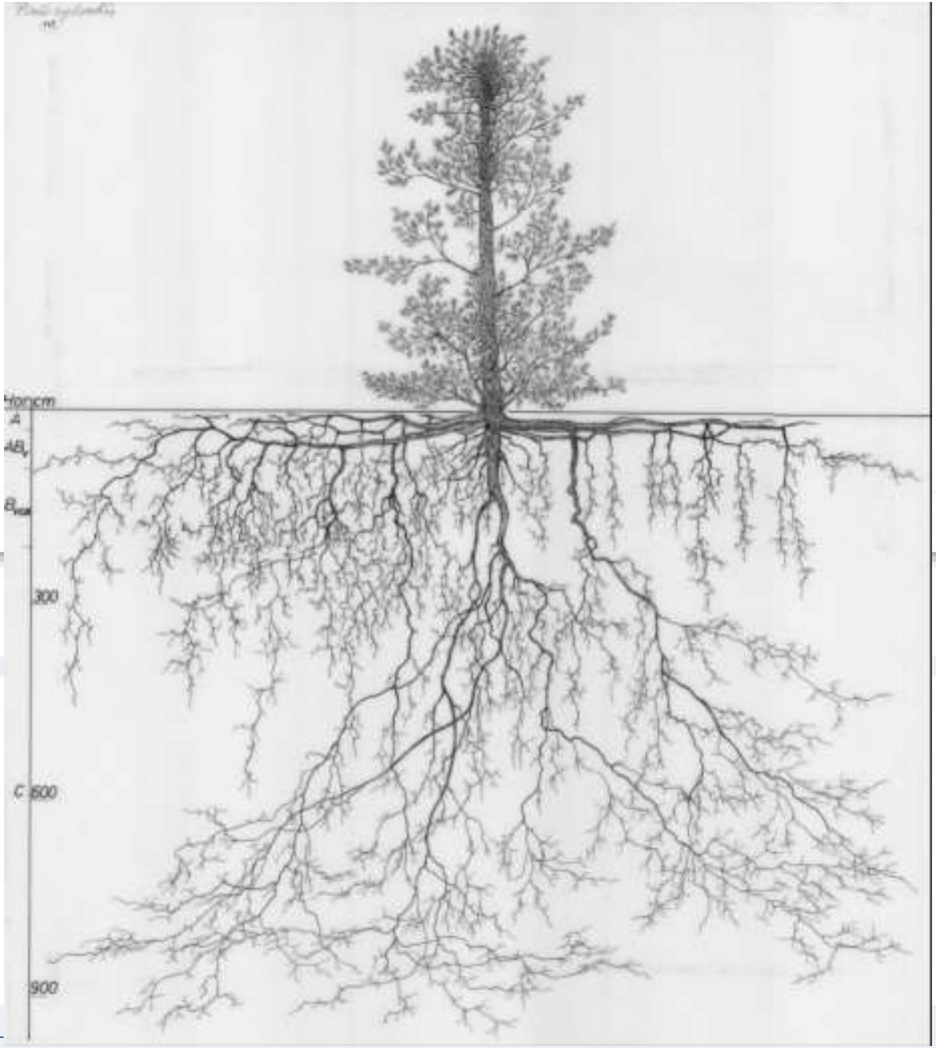
11:20 **Opportunities offered by long-term heat storages and large-scale solar thermal systems**

Viktor Unterberger, BEST – Bioenergy and Sustainable Technologies, Austria
Task Manager – IEA SHC Task 68 Efficient Solar District Heating Systems

11:40 **Possibilities through digitalization on the example of District Heating and Cooling**

Dietrich Schmidt, Fraunhofer Inst. f. Energy Economics a. Energy System Technology, Germany
Operating Agent – IEA DHC Annex TS4 Digitalisation of District Heating and Cooling

AEE INTEC



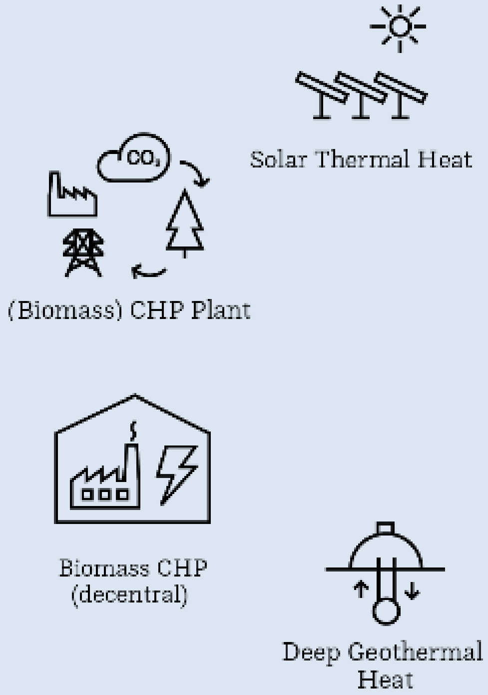
AEE INTEC

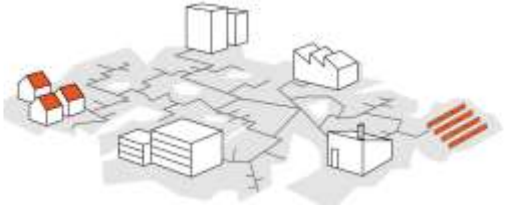
Transformation of District Heating and Cooling Systems towards high share of renewables

Thomas Pauschinger, Heiko Huther (AGFW, GER)
Alice Dénarié (Politecnico di Milano, IT)
Per-Alex Sörensen (Planenergi, DK)
Michael Salzmann, Ingo Leusbrock (AEE INTEC, AUT)

District heating as energy hub

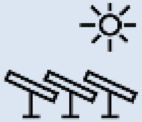
Renewable heat sources



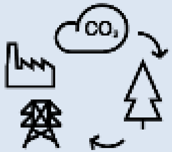


District heating as energy hub as part of a larger and integrated energy system

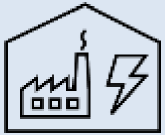
Renewable heat sources



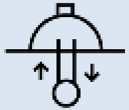
Solar Thermal Heat



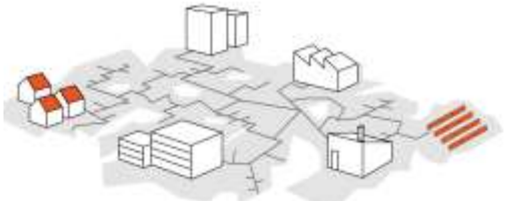
(Biomass) CHP Plant



Biomass CHP (decentral)

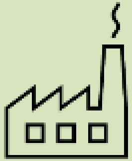


Deep Geothermal Heat

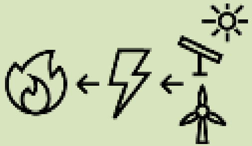


Large Thermal Energy Storage

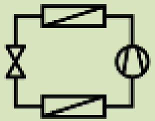
Sector coupling



Industrial Waste Heat

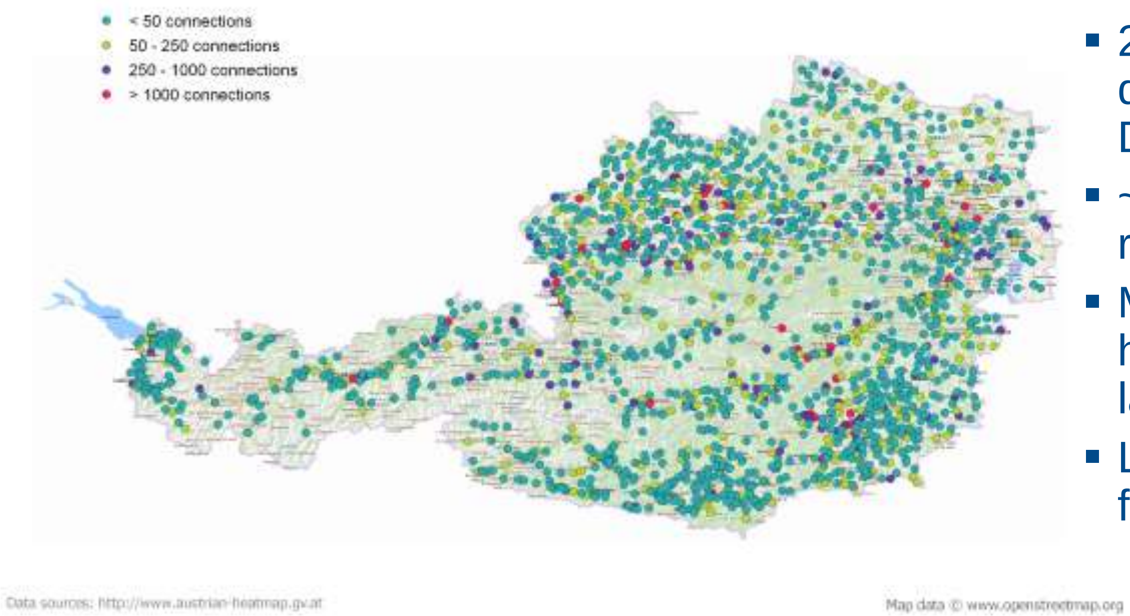


Power2Heat



Large Heat Pumps

Current role of district heating in Austria



- 20% of total heating demand covered by DH
- ~50% share of renewables in DH
- Many smaller district heating systems → largely biomass-based
- Larger systems mainly fossil → gas CHP

Vision >2030: Harder, Better, Faster, Stronger

Challenges for sustainable district heating as part of a larger energy system?

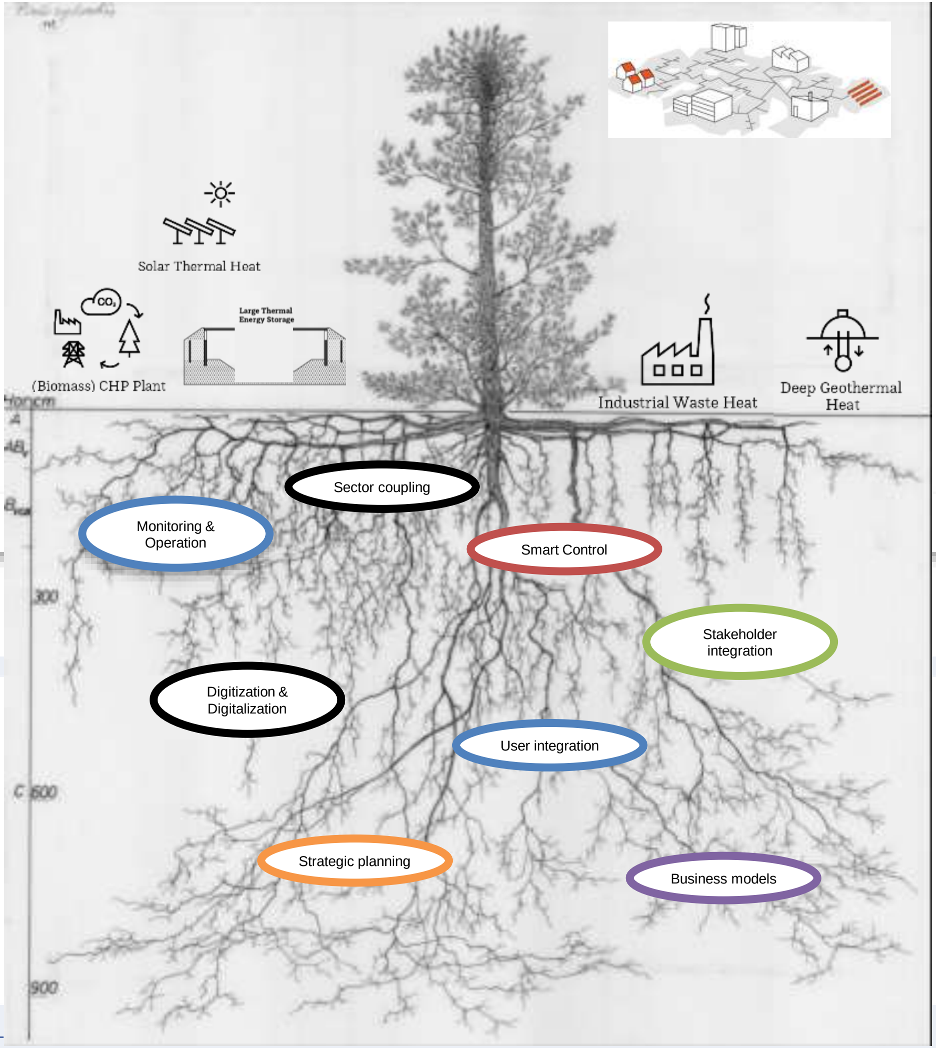
- Renewables: Where, when, how much?
- Dynamics: How to deal with daily patterns and seasonality?
- How to provide flexibility & resilience & cost-efficiency?
- How to tackle increased complexity?
- How to develop long-term strategies?
- Which role in an overall energy system?
- Knowledge transfer and capacity building
- Stakeholder and user integration

Future district heating: More than just one thing

AEE INTEC

Regulatory framework

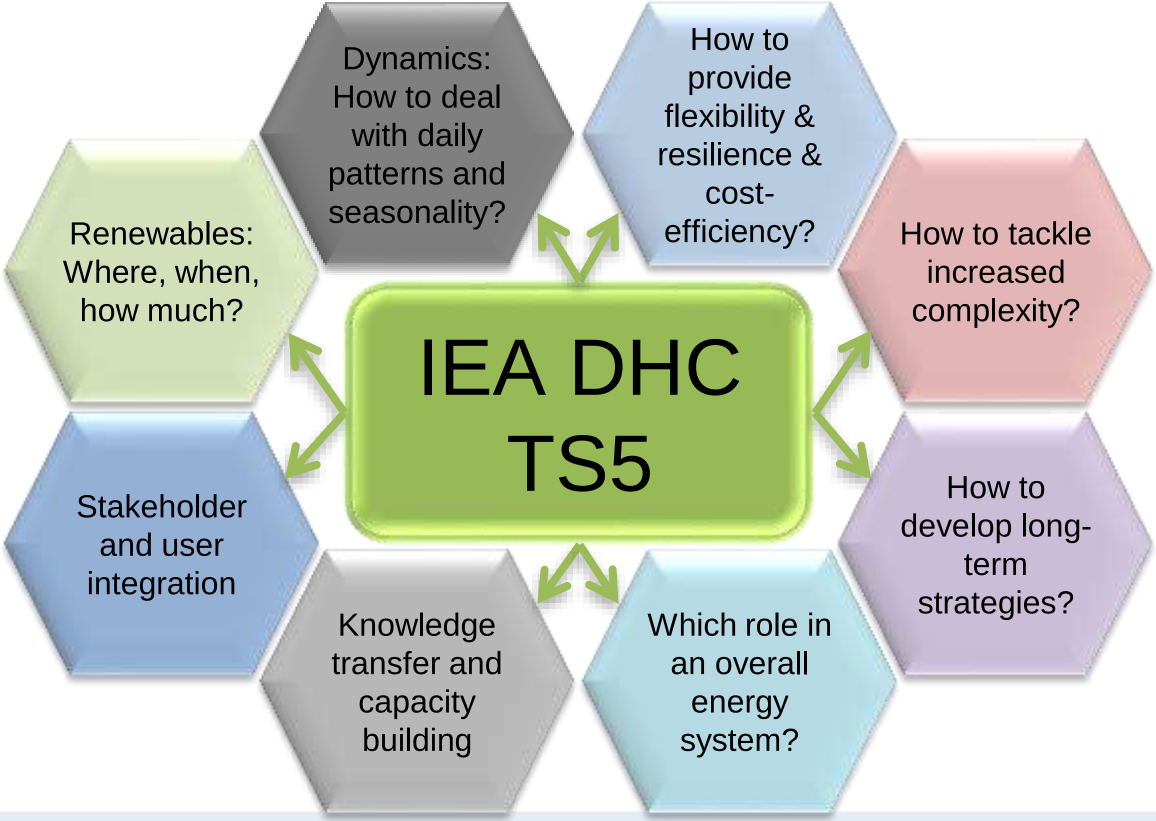
Financial incentives



Long-term security for planning

Level playing field for everyone

IEA DHC TS5: Integration of Renewable Energy Sources into existing District Heating and Cooling Systems



IEA DHC TS5: Integration of Renewable Energy Sources into existing District Heating and Cooling Systems

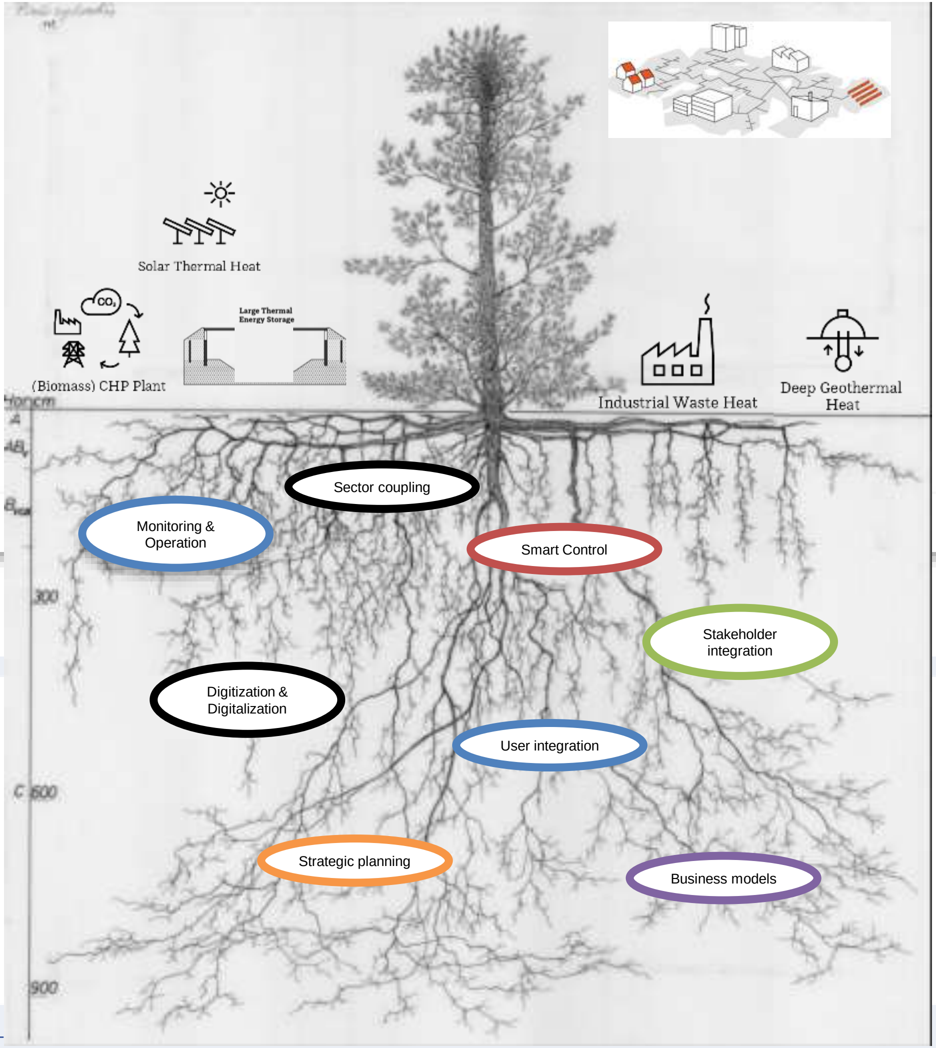
- Subtasks
  - Subtask A: RES technologies for DHC
  - Subtask B: Transformation of large DHC systems to high shares of RES
  - Subtask C: Decentral integration of RES into DHC systems
  - Subtask D: Non-technical framework: economics, life cycle analyses, legal framework, business models, area availability for RES

- Participating countries
  - GER, DK, IT, AT, SWE, UK, ROC, CN, FIN
- Operating agent
  - Thomas Pauschinger, AGFW, GER (t.Pauschinger@agfw.de)
- Website: https://www.iea-dhc.org/2019-2024-annex-ts5

AEE INTEC

Regulatory framework

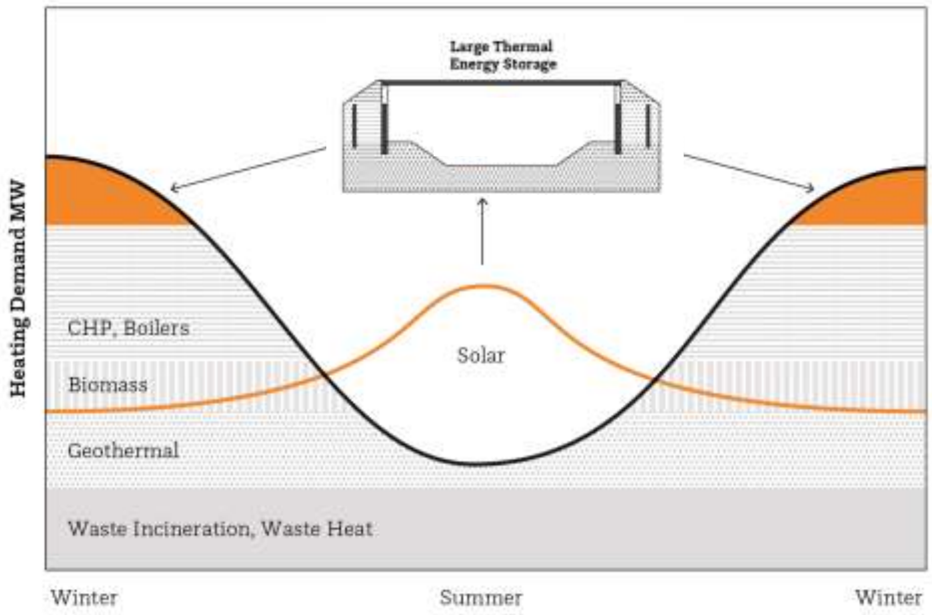
Financial incentives



Long-term security for planning

Level playing field for everyone

Large-scale Storage

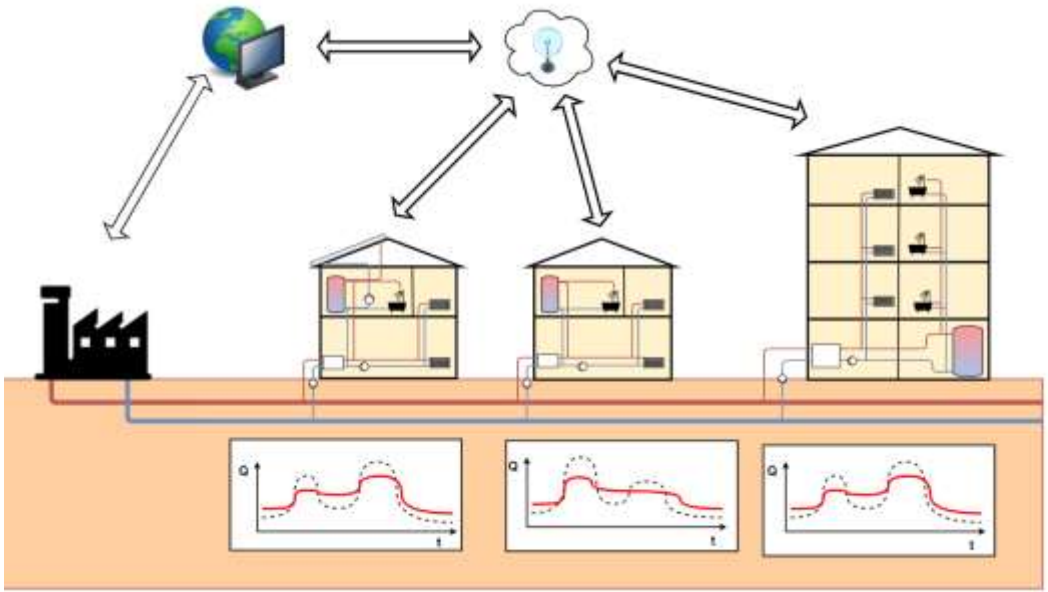


- DK storage as frontrunners for Pit Thermal Energy Storage
- First follow – ups in Germany
- Demonstrator to be built in Vienna, AUT

- More R&D and demonstration necessary, also for
  - Cavern storage
  - Aquifer thermal energy storage
  - …

Flexibility by Demand Side Management

- Monitoring & Operation
- Smart Control
- Digitization & Digitalization
- Business models



- Requirements
  - „Smart thermal grid ready“ buildings
  - Digitized + digitalized DH system + buildings
  - Sophisticated monitoring & control scheme
  - Suitable business models

https://annex84.iea-ebc.org/

Strategic planning of heat and cold supply

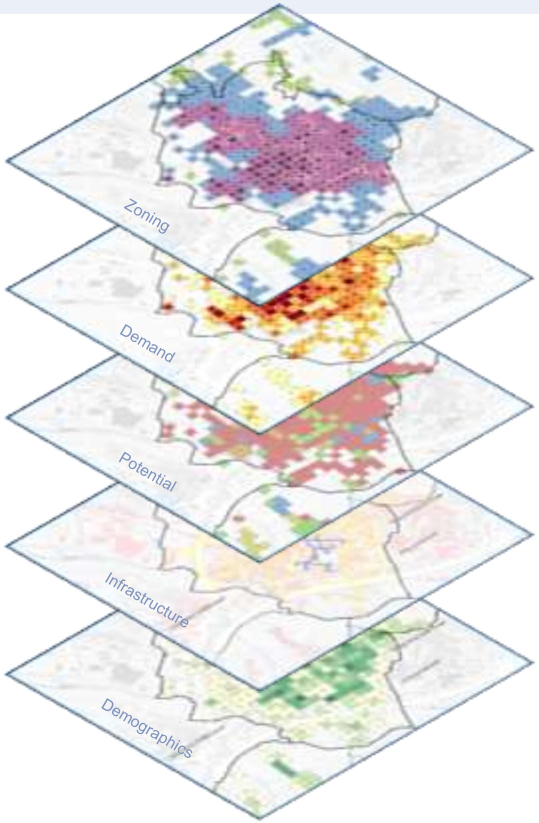
Long-term security for planning

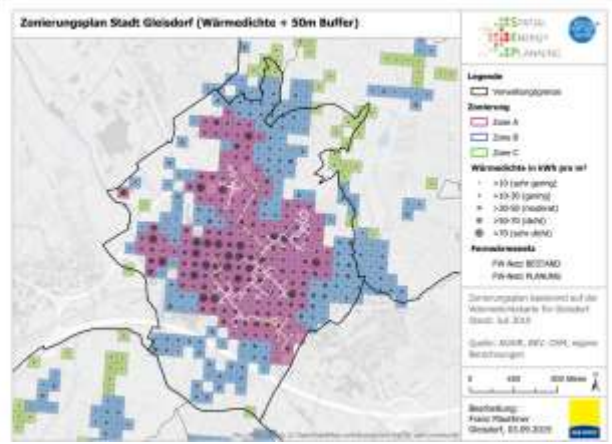
Regulatory framework

Stakeholder integration

User integration

Strategic planning





Integration of WWTPs: Potential & opportunities

Sector coupling

Energy in

COD

Temperature influent
10 – 25 °C

Energy out

Biogas

Temperature effluent
10 – 25 °C
e.g. via heat pump

Heat from
- *Combustion*
- *CHP*

Internal processes
- *Optimization e.g. AD*
- *Aeration & pumping*
- *Buildings*

Resource cycles
- *Nutrient recovery (N,P,K)*
- *High value products (lipids, proteins,…)*

Opportunities
- *Resource, bioeconomy and energy hub*
- *Surface area in surrounding*

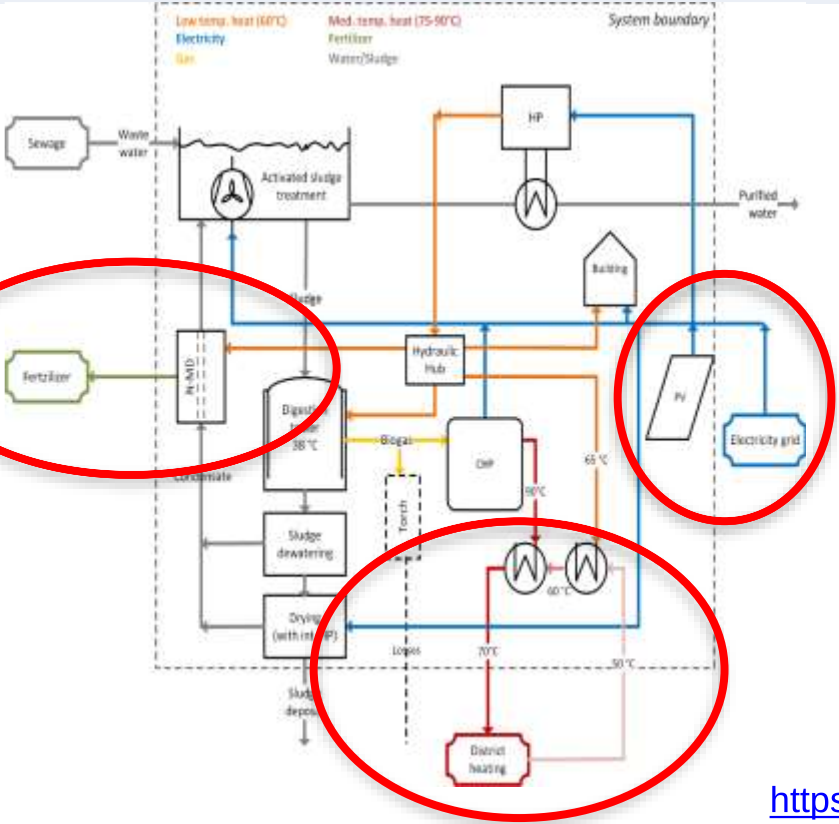
Sector coupling and hybrid network at waste water treatment plant

Regulatory framework

Sector coupling

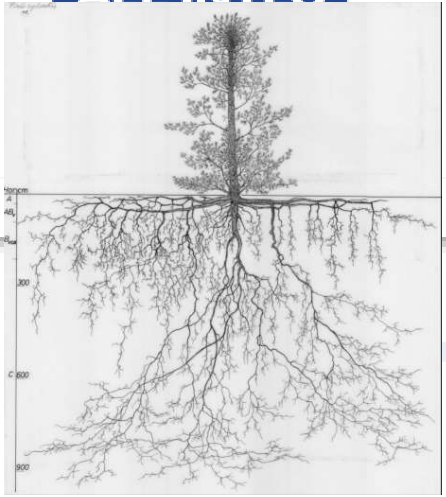
Strategic planning

Business models



- Connection to district heating
- Connection to electricity grid
- Nutrient recovery via Membrane Distillation

https://thermaflex.greenenergylab.at/



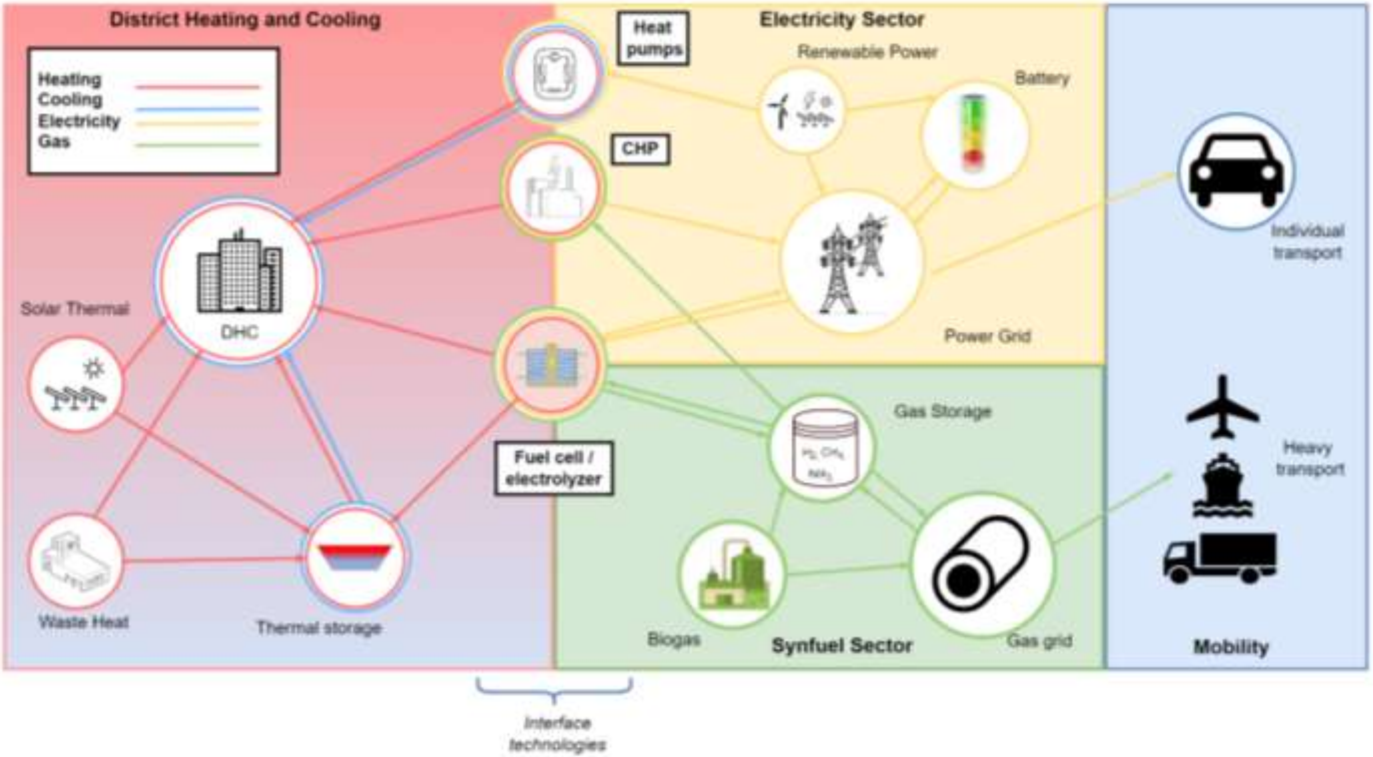
Source: https://www.publicdomainpictures.net/en/view-image.php?image=175863&picture=forest

Sector coupling: towards an integrated enery system

Sector coupling

Strategic planning

Business models

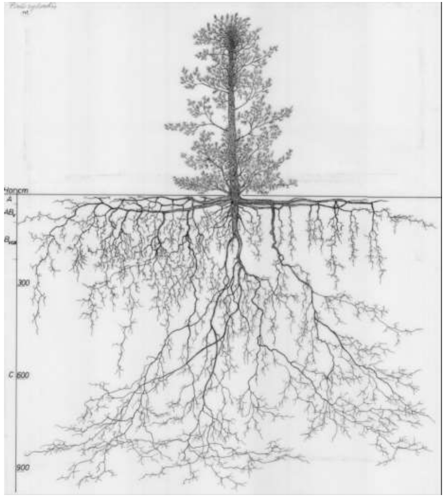


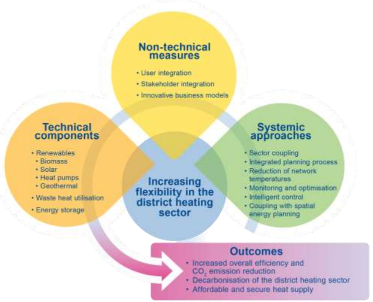
Stakeholder integration

- Talk early
- Talk with all stakeholders
- Talk often
- Be proactive
- Engage and involve

Source: https://www.flickr.com/photos/tom-margie/2085155209

Future district heating: More than just one thing





AEE INTEC

IDEA TO ACTION

AEE – Institute for Sustainable Technologies (AEE INTEC)
8200 Gleisdorf, Feldgasse 19, AUSTRIA

Website: www.aee-intec.at
Twitter: @AEE_INTEC

Ingo Leusbrock
i.leusbrock@aee.at

Block B Flexibility provision via the heating sector

11:00 **Transformation of District Heating and Cooling Systems towards high share of renewables**

Ingo Leusbrock, AEE INTEC, Austria
Austria Lead of Austrian delegation – IEA DHC Annex TS5 Integration of Renewable Energy Sources into existing District Heating and Cooling Systems

11:20 **Opportunities offered by long-term heat storages and large-scale solar thermal systems**

Viktor Unterberger, BEST – Bioenergy and Sustainable Technologies, Austria
Task Manager – IEA SHC Task 68 Efficient Solar District Heating Systems

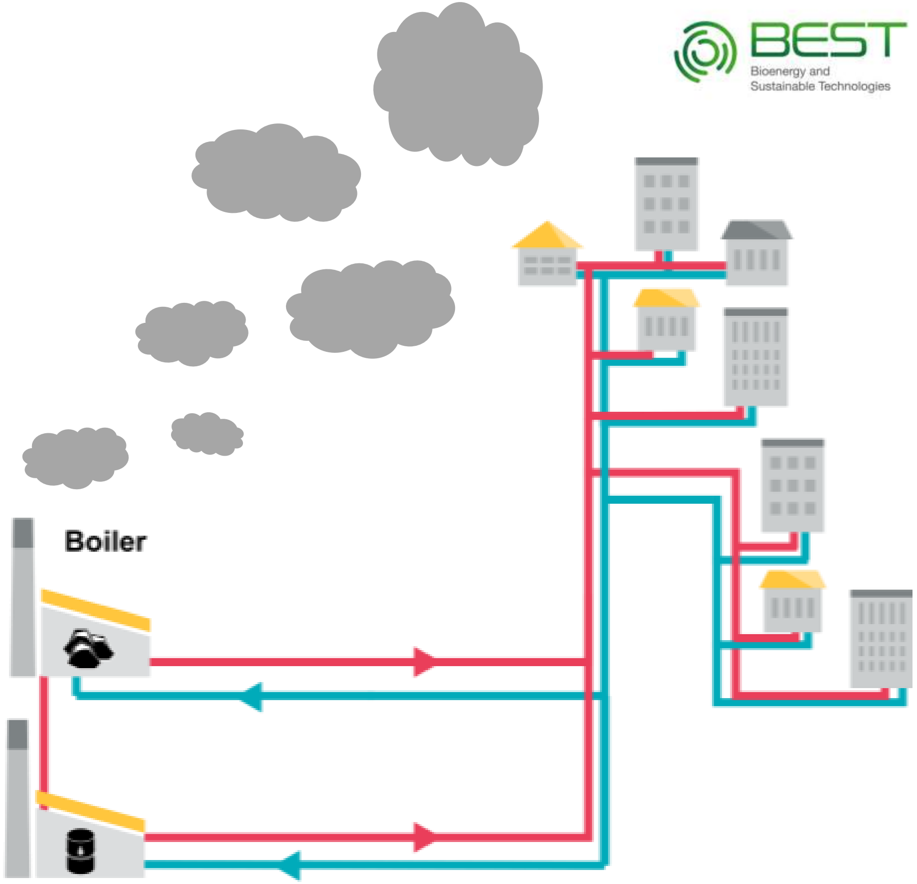
11:40 **Possibilities through digitalization on the example of District Heating and Cooling**

Dietrich Schmidt, Fraunhofer Inst. f. Energy Economics a. Energy System Technology, Germany
Operating Agent – IEA DHC Annex TS4 Digitalisation of District Heating and Cooling

Opportunities offered by long-term heat storages and large-scale solar thermal systems

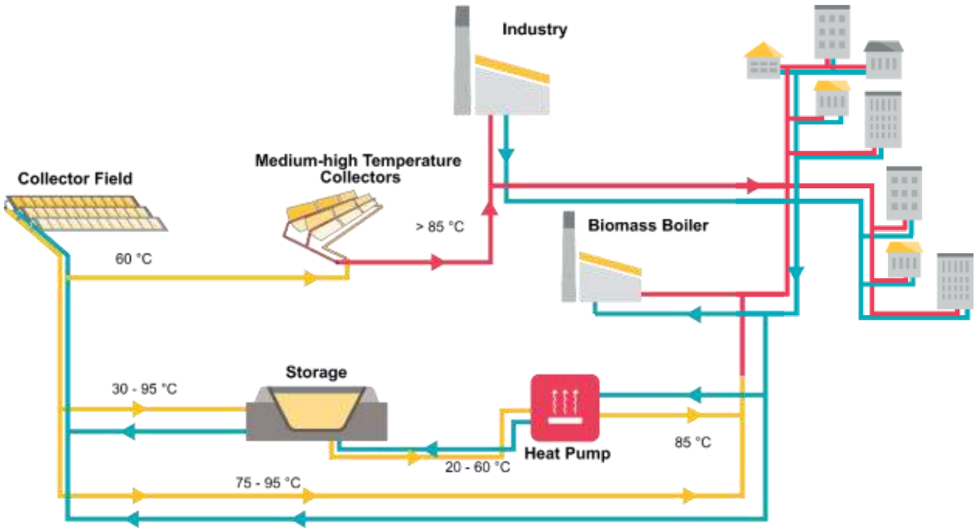
CEBC 2023 – IEA Cross-TCP WS

DI Dr. Viktor Unterberger, Task Manager of IEA SHC Task 68
+43 5 02378-9245
viktor.unterberger@best-research.eu



< 10% Renewables

https://www.iea.org/reports/district-heating



Solar District Heating Systems

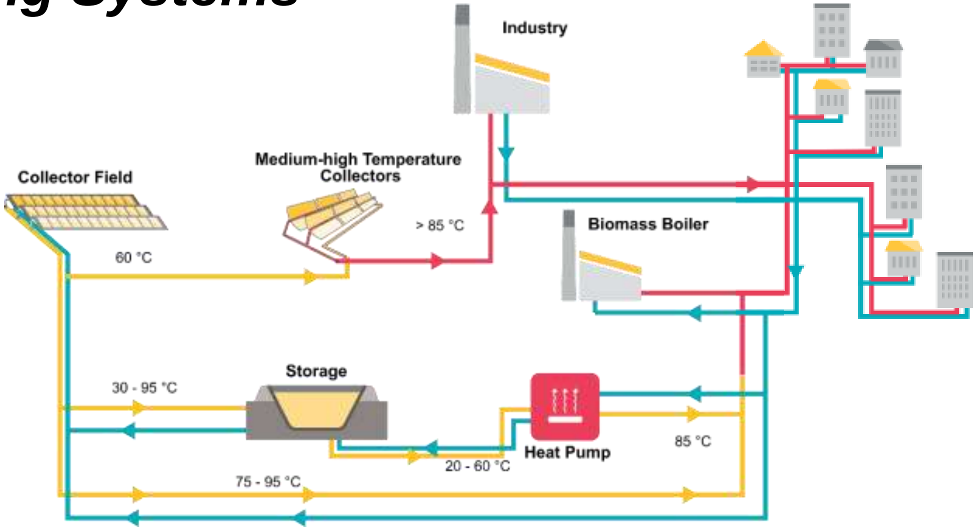
Goals of the IEA SHC Task 68 –
Efficient Solar District Heating Systems

Provide the **heat most efficiently at** the **desired temperature level**

Increase digitalization level for a more **efficient data preparation** and **utilization**

Make SDH systems more cost-efficient and explore **new business models**

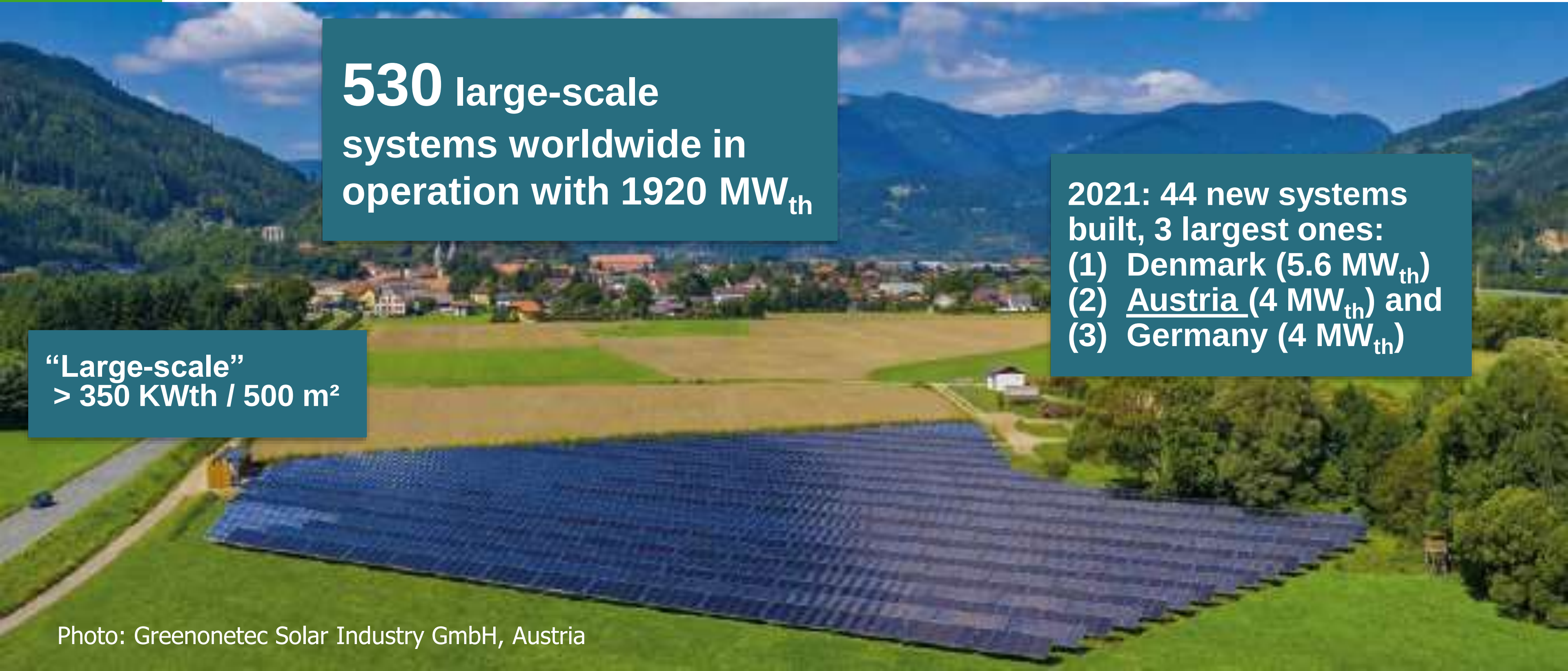
Raise awareness for solar technologies and **efficiently disseminate the results**



Participating Countries:

Austria / Germany / UK / Spain / Sweden / Denmark / Finland / Swiss / Italy / China / Netherlands.

Solar thermal large-scale systems



530 large-scale systems worldwide in operation with 1920 MW_{th}

2021: 44 new systems built, 3 largest ones:

1. **Denmark (5.6 MW_{th})**
2. **Austria (4 MW_{th}) and**
3. **Germany (4 MW_{th})**

“Large-scale”
> 350 KWth / 500 m²

Photo: Greenonetec Solar Industry GmbH, Austria

Solar thermal large-scale systems – technologies

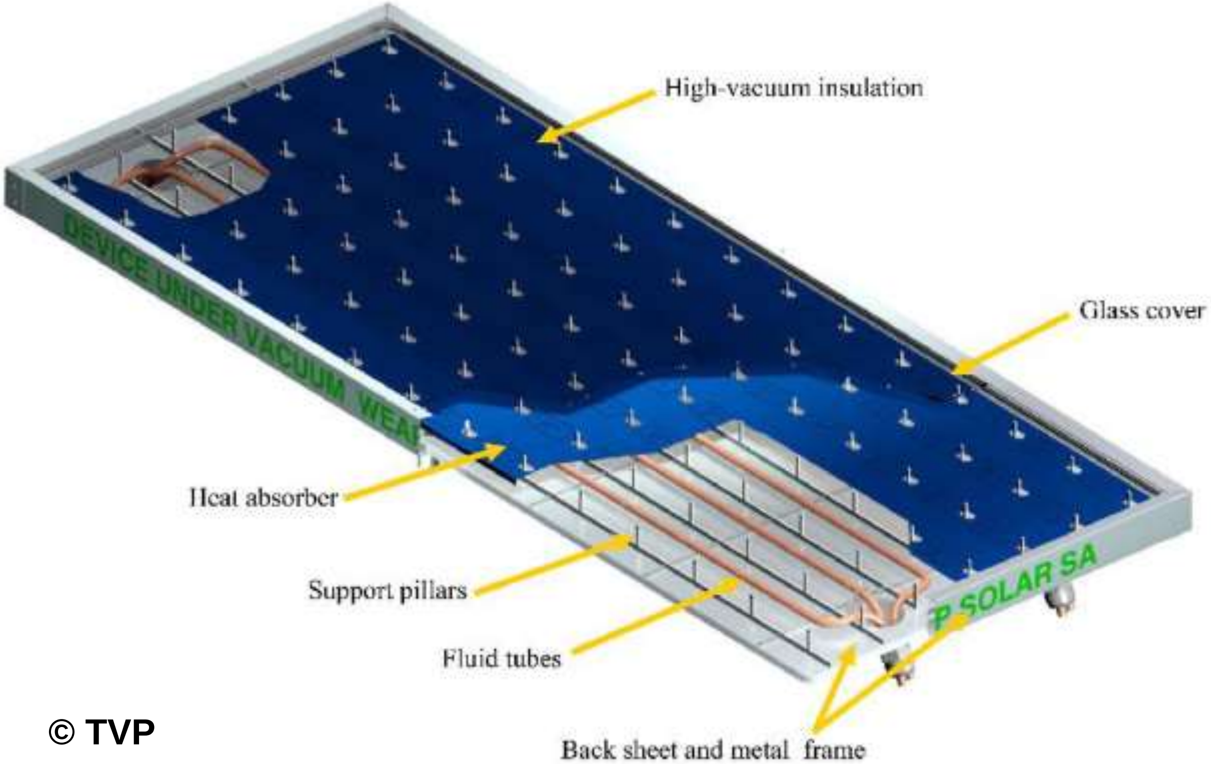
„Classical“ technologies

- **Flat plate collectors** (~30% worldwide) ➔ mostly Europe
- **Evacuated tube collectors** (~70% worldwide) ➔ mostly Asia/China

Concentrating and modern technologies

- **PVT**
- **Vacuum flat plate collector**
- **Parabolic trough**
- **Heliac solution**
- and others …

Vacuum flat plate collector by TVP



- High-Vacuum / High Performance
- Little cleaning efforts
- Works also with diffuse radiation not only direct one
- Temperatures of **> 80°C all year around**
- Exemplarily plant, e.g. in the Netherlands, 37 MW, 48.000 m²

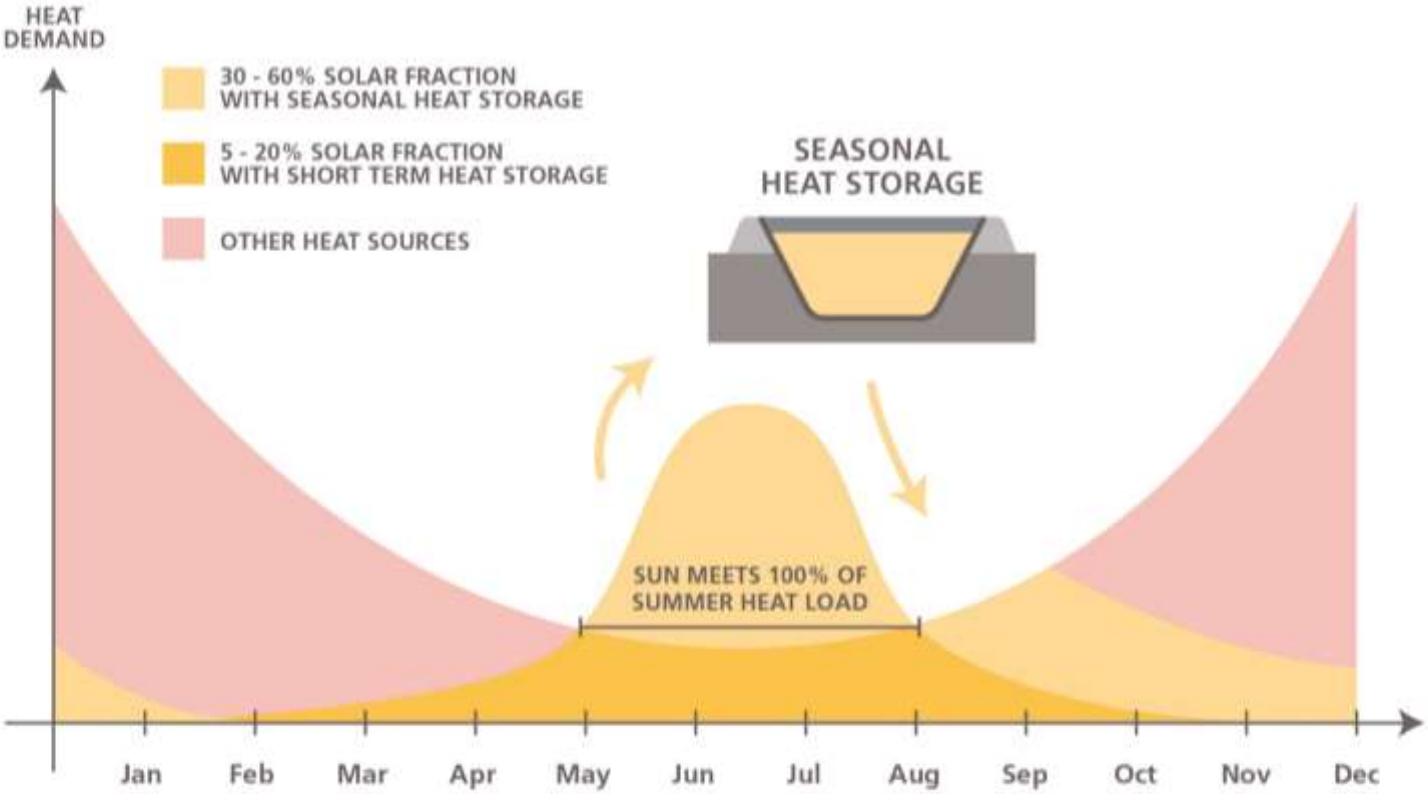
Parabolic trough

- Concentrating solar technology
- Small scale little weight
- Combinable with flat-plate collectors to reach higher temperatures by increased efficiency.
- **Temperatures up to 160°C**
- Exemplarily plant e.g. in Graz Austria.

HELIAC solution

- Concentrating solar technology
- Cheap, high-efficiency lenses
- Higher wind load
- **High temperature solar heat possible up to 350°C**
- Example Plant, e.g. in Denmark.

Storing solar energy in summer for heating in winter ➔ long-term storage



Long-term storage technologies

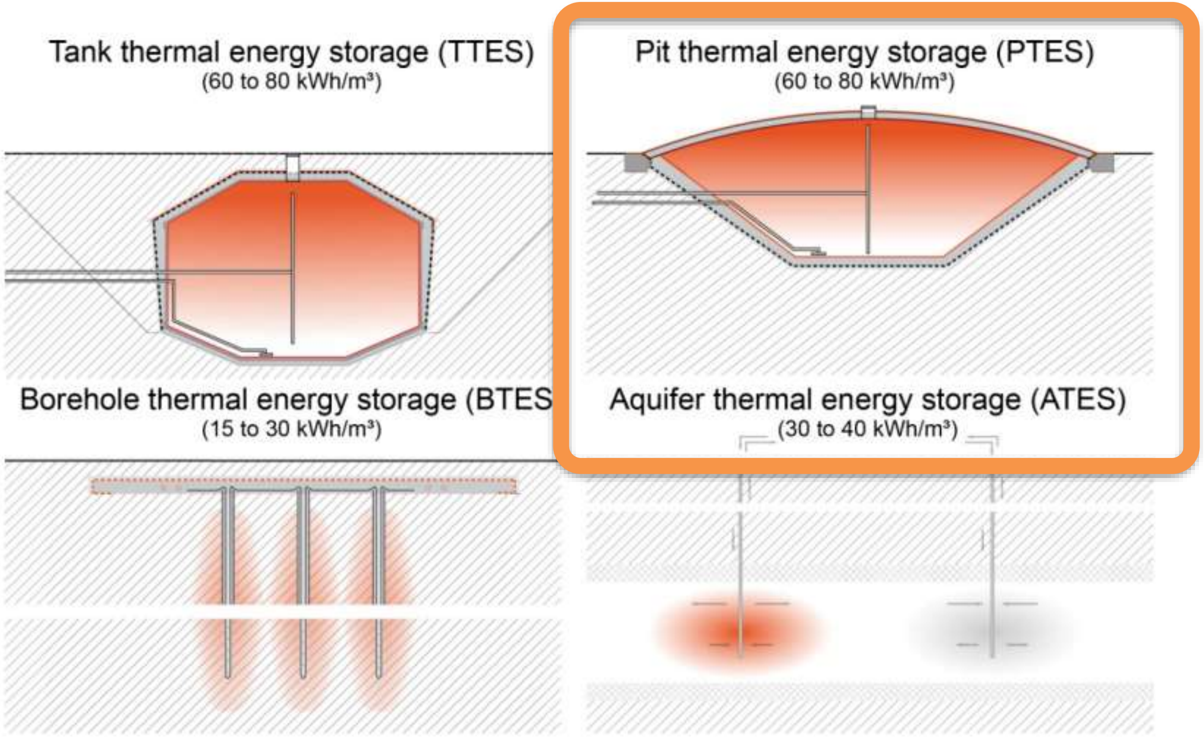
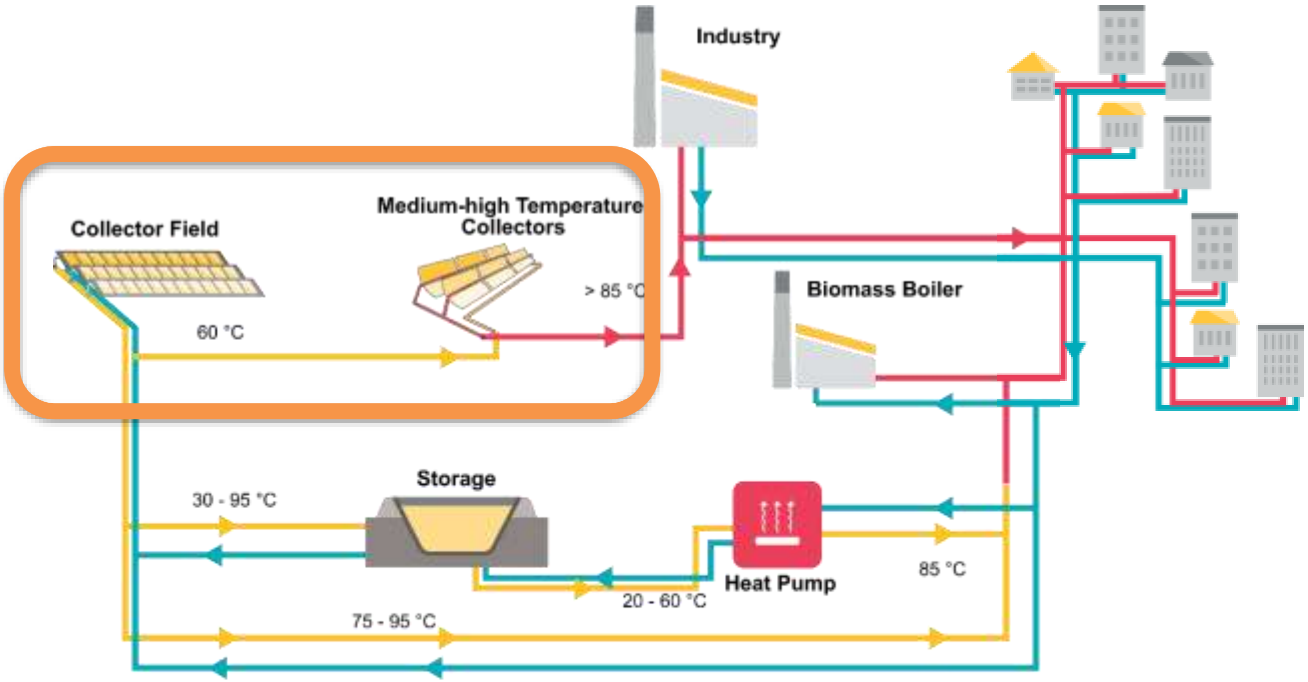


Chart: Solites

Use Case – large-scale solar thermal and long-term storage (Vojens, Denmark 2016)

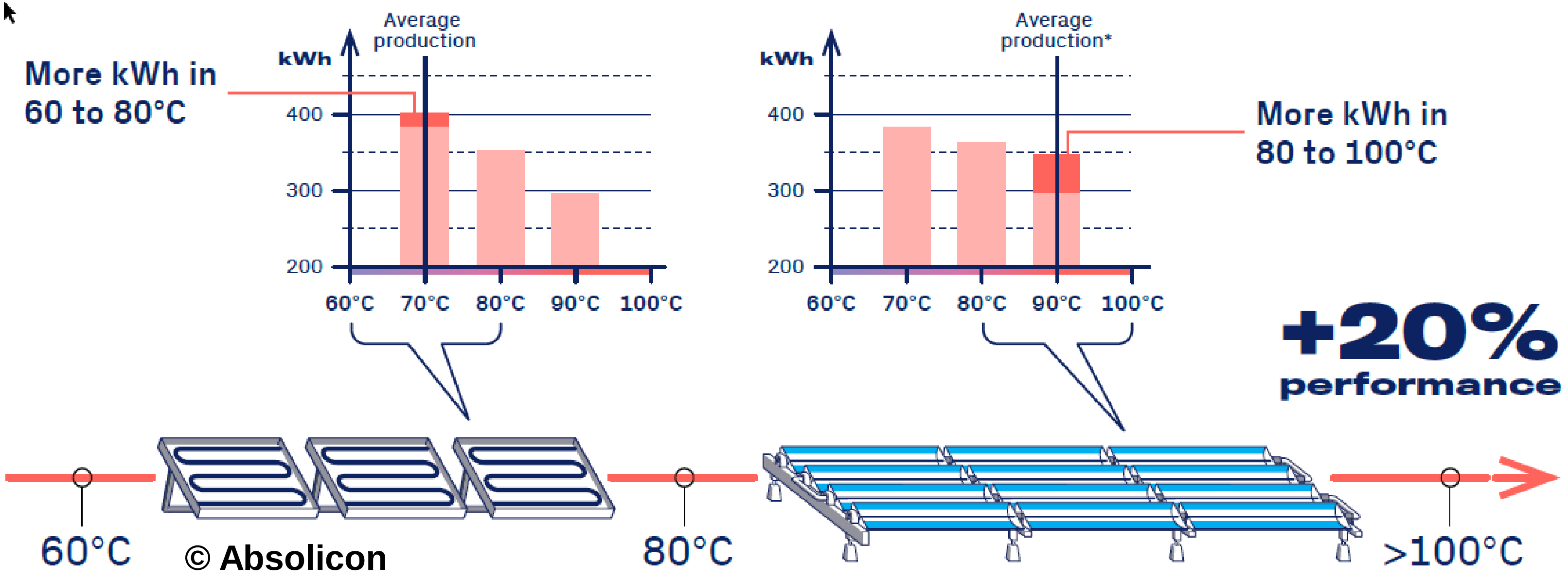
- Collector area: 70.000 m²
- Storage: 200.000 m³
- Depth: 13 m
- Solar share 45%
- 7500 Inhabitants
- District Heating demand 7 GWh ➔ Vienna **~6500 GWh**

Opportunities regarding interaction of solar thermal with other technologies

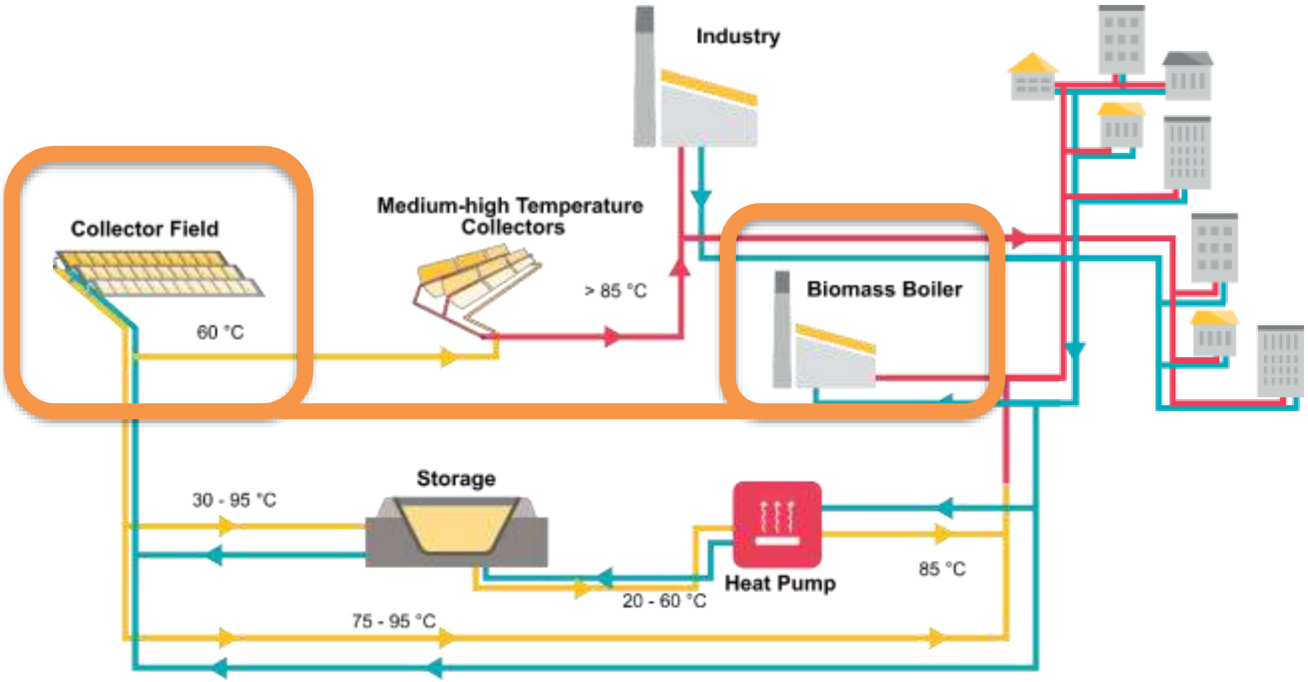


Opportunities regarding interaction of solar thermal with other technologies

Solarthermal + solarthermal: more performance at higher temperatures



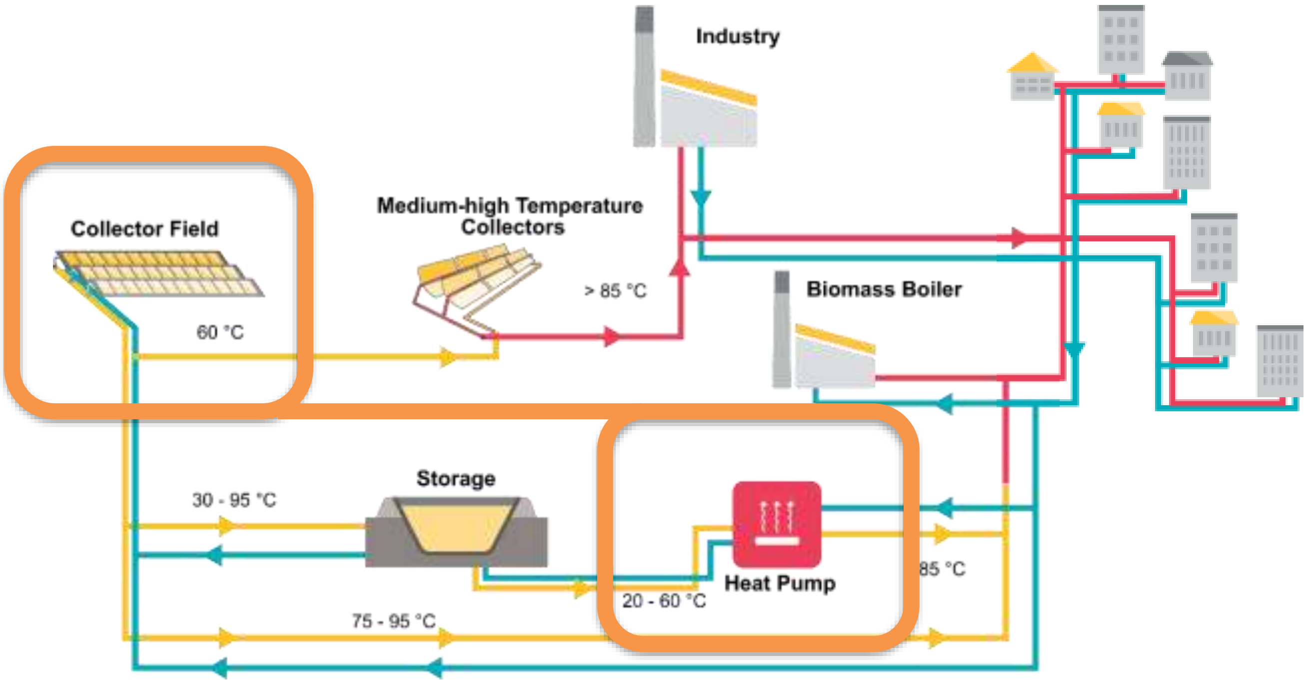
Opportunities regarding interaction of solar thermal with other technologies



Opportunities regarding interaction of solar thermal with other technologies

Solarthermal + biomass: solar system takes over summer operation. Boiler is less stressed ➔ service life is extended

Opportunities regarding interaction of solar thermal with other technologies



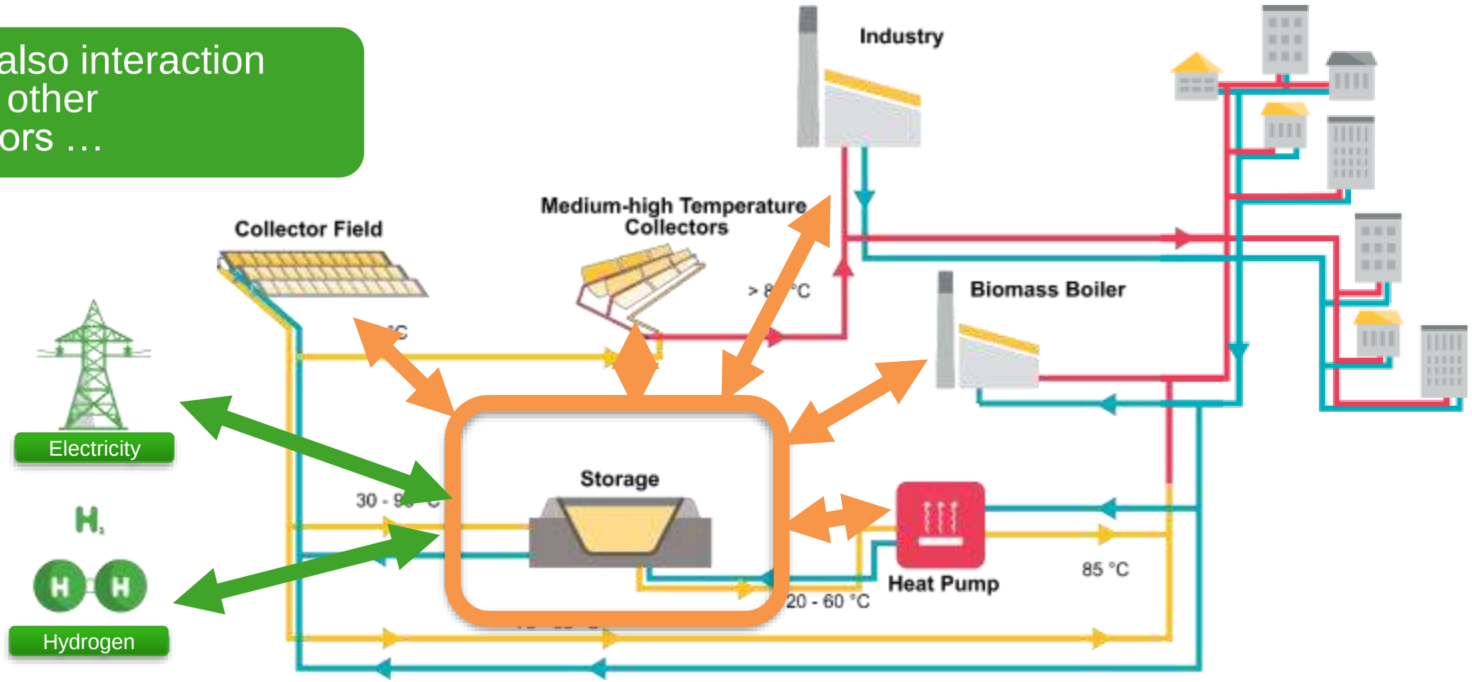
Opportunities regarding interaction of solar thermal with other technologies

Solar thermal + heat pump: depending on grid needs different operating modes possible (parallel, preheat/boost, re-heats storage)

New TTES New building with HP Evaporators (air cooling) Solar collectors

Opportunities regarding interaction of long-term storage with other technologies

But also interaction with other sectors …



Challenges and Barriers

- Never had been so many single technologies and combinations available
- Low level of digitalization
- Technological barriers
- Access to land for rolling out renewables
- Long permission procedures
- No one fits all solution

Conclusion

- **Many large-scale systems world-wide installed** even in countries with medium solar radiation (e.g. Denmark)
- Many **mature solar technologies available** which are proven to work and capable of efficiently providing heat at the desired temperatures
- **Combination of technologies** has to put in the focus and instead of playing them off against each other.
- **Research have to be done** to solve open issues for the sustainable energy system of the future
- **International exchange and dissemination** is important to learn from successful transformations (e.g. Denmark) and to find optimal strategies on national level
- **Heat (also often as a by-product) must always be used** in future sustainable energy systems

Opportunities offered by long-term heat storages and large-scale solar thermal systems

CEBC 2023 – IEA Cross-TCP WS

DI Dr. Viktor Unterberger, Task Manager of IEA SHC Task 68
+43 5 02378-9245
viktor.unterberger@best-research.eu

Block B Flexibility provision via the heating sector

11:00 **Transformation of District Heating and Cooling Systems towards high share of renewables**

Ingo Leusbrock, AEE INTEC, Austria
Austria Lead of Austrian delegation – IEA DHC Annex TS5 Integration of Renewable Energy Sources into existing District Heating and Cooling Systems

11:20 **Opportunities offered by long-term heat storages and large-scale solar thermal systems**

Viktor Unterberger, BEST – Bioenergy and Sustainable Technologies, Austria
Task Manager – IEA SHC Task 68 Efficient Solar District Heating Systems

11:40 **Possibilities through digitalization on the example of District Heating and Cooling**

Dietrich Schmidt, Fraunhofer Inst. f. Energy Economics a. Energy System Technology, Germany
Operating Agent – IEA DHC Annex TS4 Digitalisation of District Heating and Cooling

Possibilities through Digitalisation on the example of District Heating and Colling

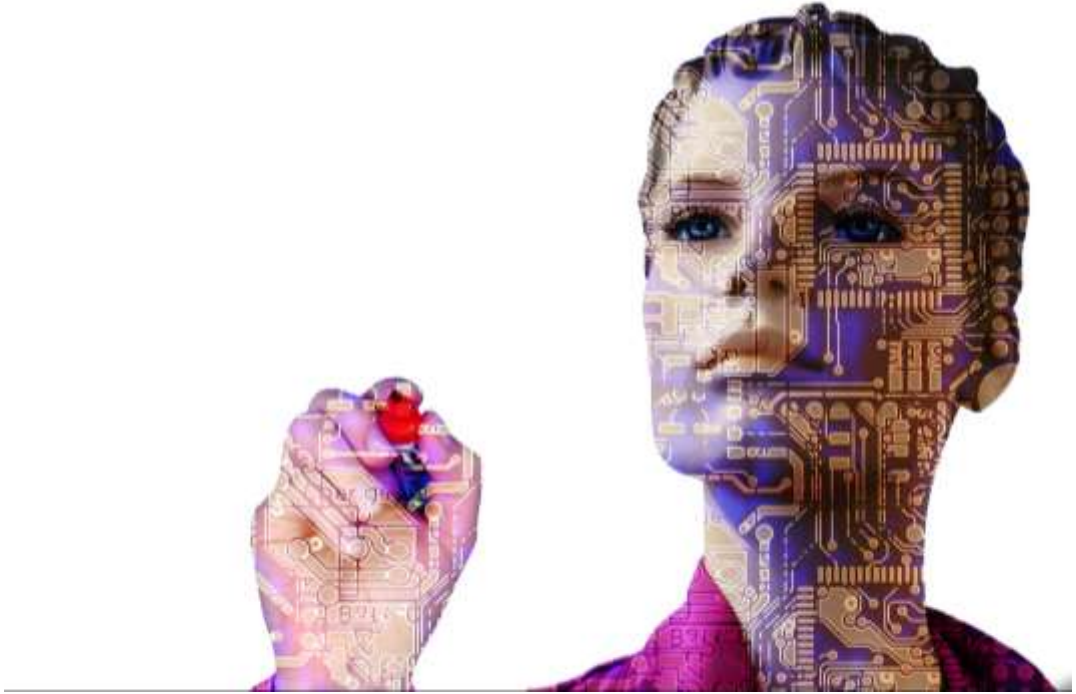
IEA Cross-TCP Workshop within CEBC 2023

Graz/AT, 18th January 2023

Dr. Dietrich Schmidt – Operating Agent IEA DHC Annex TS4

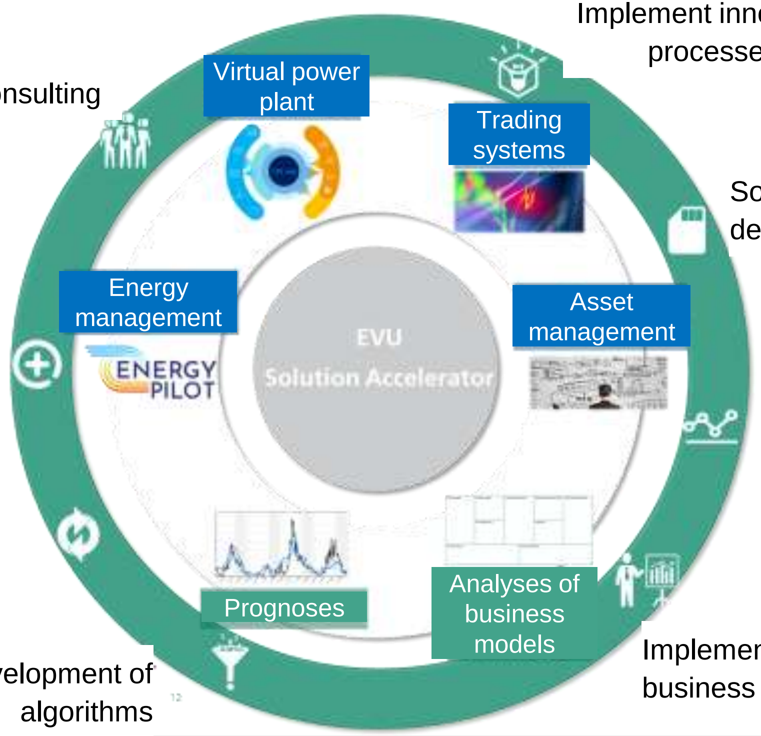
Fraunhofer
IEE

Our future Energy system will be digital!



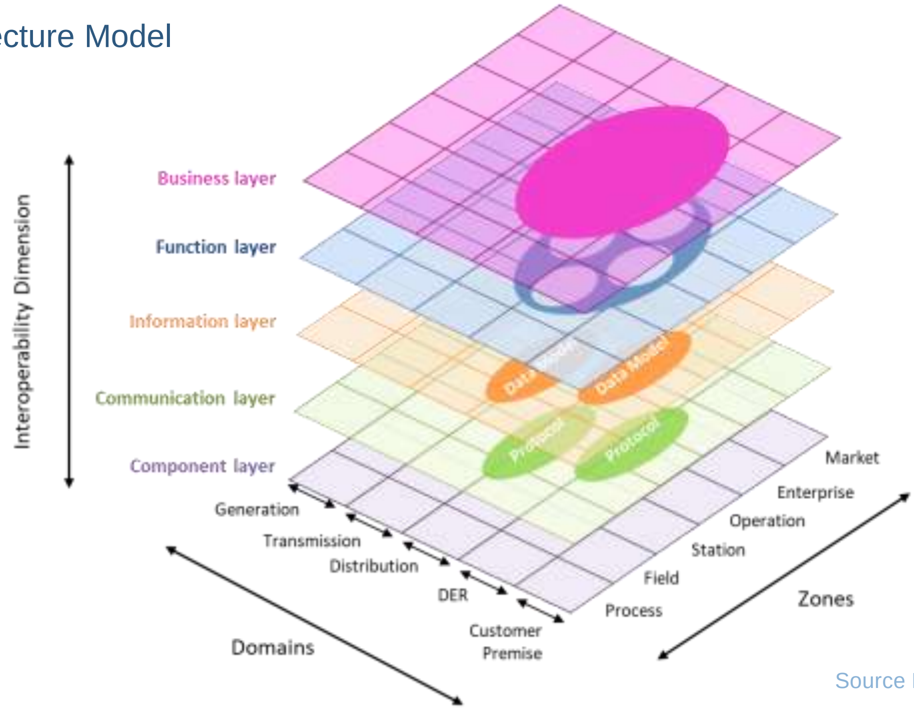
Digital Transformation towards Energy Supplier 4.0

Digitization has so far primarily focused on the electricity sector



The perspective of research - digitization concepts

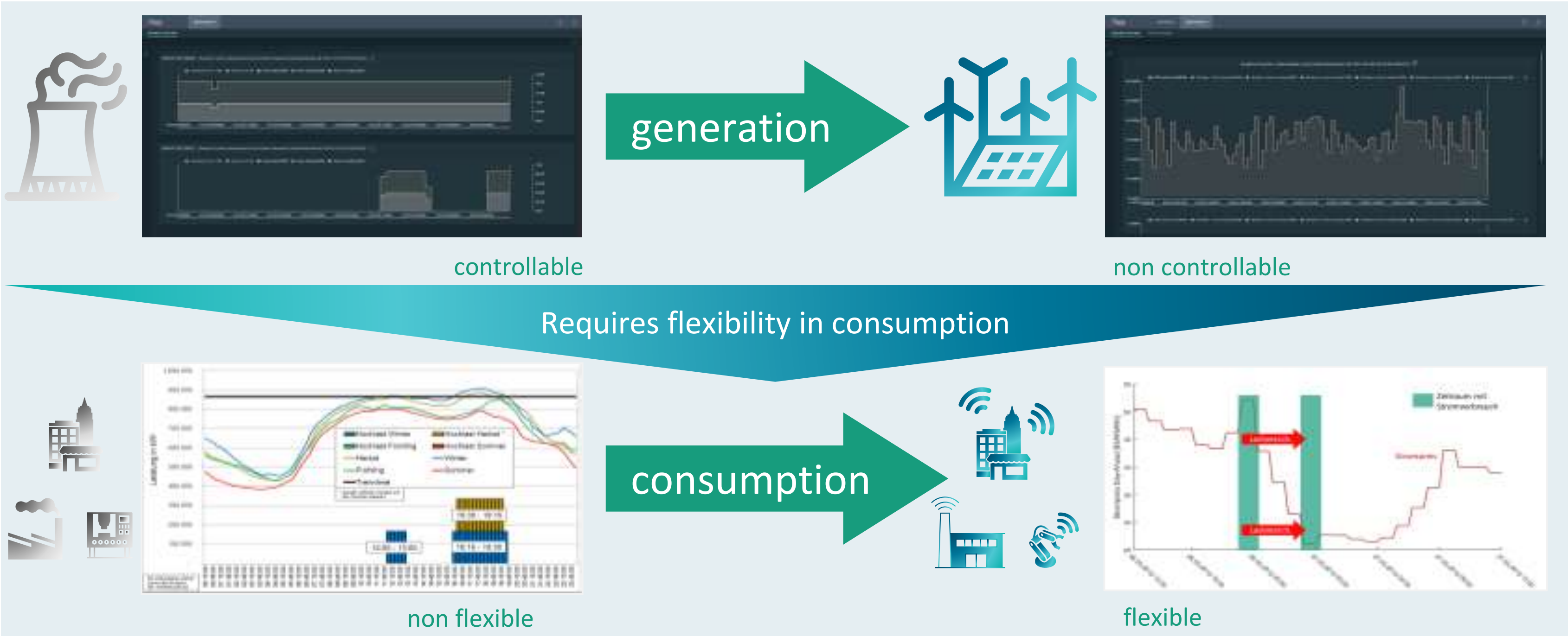
SGAM: Smart Grid Architecture Model



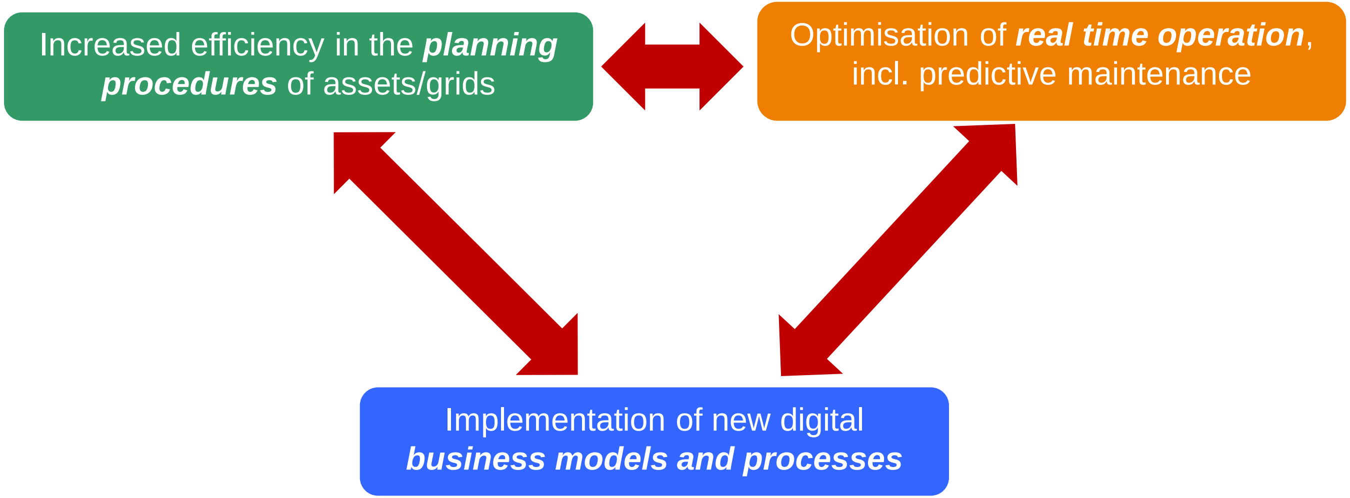
Source Fraunhofer CINES Cluster

Necessary for the next phase of the energy transition: flexibility

From controllable producers to controllable consumers



Focus on the digitization of district heating



- Digitization so far primarily focused on power grids etc
- The integration of high proportions of renewable energies into district heating networks requires further digitization
- Optimized operational management through digital processes

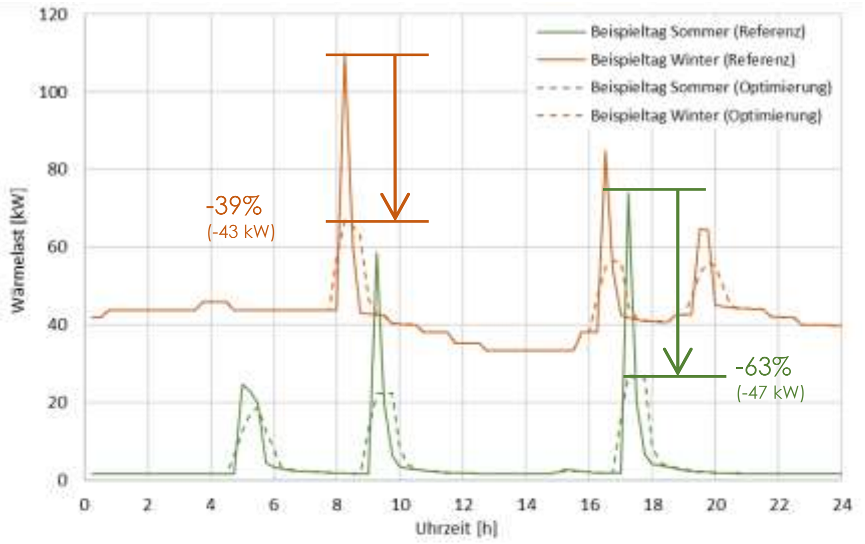
Digitization of energy use

Flexibility potential of DHW storage in the district heating supply

Loading the DHW storage tank:

- Reference / initial situation: High, short-term heat input (peak load)
- Optimization: Memory loading stretched over a longer period (here: 30 minutes)

➔ High flexibility potential through DHW storage!



Focus on the digitization of district heating

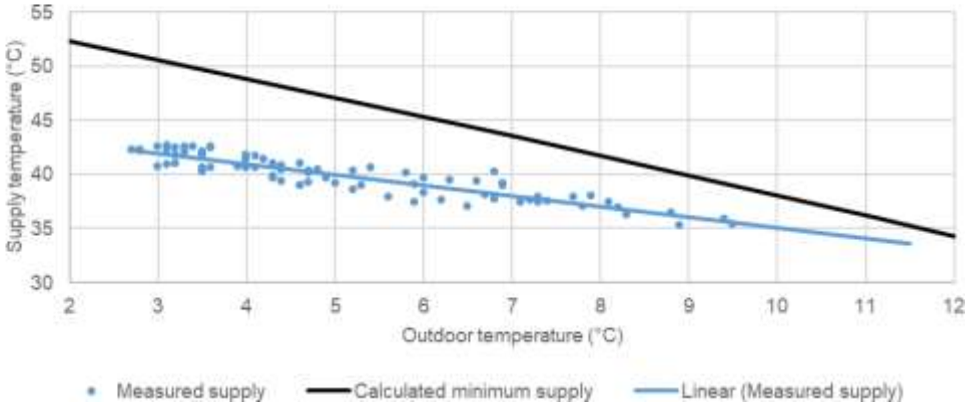
Potential for reducing system temperatures

Improved control of heating systems with a focus on reducing:

- flow temperature
- return temperature
- peak load

➔ Greater potential identified as the actual heating loads are lower than the calculated ones.

➔ Data acquisition / system monitoring necessary



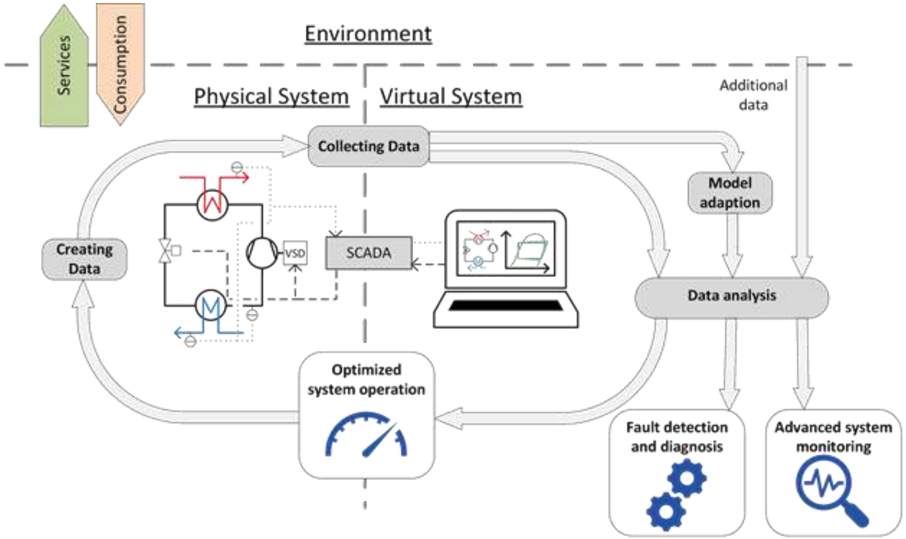
DTU

Digitization of the heating network infrastructure

Use of digital twins

areas of application

- Optimization of operation and control
- Error identification and diagnosis
- Scenario evaluation / if-then analysis
- Predictive Maintenance / Asset Management
- Visualization / Virtualization



„Digital twins for large-scale heat pump and refrigeration systems" http://digitaltwins4hprs.dk/

Example of innovative heating networks

initial conditions

- Heterogeneous development: 70% new construction, 30% existing buildings, some listed buildings
- Heterogeneous use: 59% residential, 34% commercial office, 4% retail, 3% culture
- Various construction standards (KfW40 – EnEV16)
- Heat requirement 10 GWh
- -> 3.5 GWh in the current supply area "Lagarde-West"
- Partly high-temperature supply necessary
- LT supply alone using geothermal energy is not sufficient

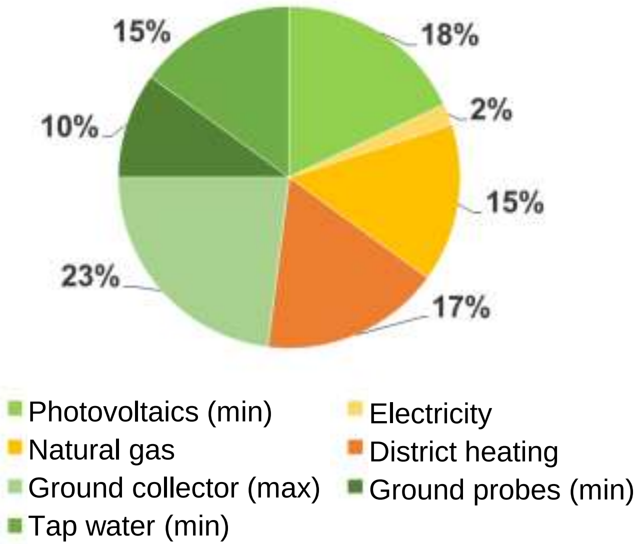
Conversion of the Lagarde Campus Bamberg

Example of innovative heating networks

Resulting network infrastructure for Lagarde Campus Bamberg

- Cold local heating (10°C) for new buildings and existing buildings (>90°C)
- Geothermal collectors, heat mains and cold water
- Dec. Heat pumps and PV for space heating and domestic hot water
- Electrical operating network couples heat generation systems

➔ Digitization measures necessary for optimized operational management!



Wärmenetze 4.0

https://s.fhg.de/lagarde

Conclusions

Digital technologies are **believed to make** the whole energy system:

- smarter,
- more efficient, and
- reliable and
- to boost the efficiency and
- the integration of more renewables into the system.

Conclusions

- Future district energy systems might be able to **fully optimize their plant and network functioning while empowering the end user** thanks to digital applications..
- The difficulties of **data security and privacy**, as well as concerns about **data ownership**, must be addressed, and solutions must be developed, in order for digital processes to be more widely integrated.
- Where to go from the trendy term "digitalization" **to actual business models, products, and services** that are ready for the market is a crucial question.
- The strong **communication between the scientific community and system makers, utilities, and service providers** is the project's main strength..


Digitization is an essential key technology for the transformation and decarbonization of district heating

Contact us!

Join us on Friday:
Annex TS4 special session at
CEBC 2023: 13:30 – 15:00

Contact:

Dr. Dietrich SCHMIDT
Fraunhofer Institute for Energy Economics and Energy Technology / Germany
+49 561 7294 1517
dietrich.schmidt@iee.fraunhofer.de

www.iea-dhc.org/the-research/annexes/2018-2024-annex-ts4/

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

Questions / comments from the audience?

Flexibility

- **Where will we need short- / long-term flexibility and how will it be provided?**
  - Which technologies will be modulated and according to which demand?
  - Which storages will thus be needed?

- **A lot of theoretical potential for flexibility lies in the producing industry**
  - What will they actively on their own and what will needed to be provided as service?
  - What will be the main barriers?

- **So many economic feasibilities base on full-load operation – is this possible?**
  - Where will this be really necessary?
  - Who will then do the flexibility?

Role of different technologies

- **What will be the role of biomass (biogenic residues)?**
  - Which biomass (biogenic residues) will be used for which applications?
  - What will happen to the many biomass-based DH systems?

- **Where will all the electricity come from?**
  - in particular for all the base-load technologies?

- **What will be the role of solar thermal systems?**
  - Which technological combinations will be beneficial?

Specific role of heating sector

- **How much heat will be produced by sector-coupling technologies?**
  - CHP / electrolysis / gasification + synthesis / …
  - How much of the (indirectly) produced heat will be used?

- **What is necessary to support the provision of flexibility to other sectors via the heating sector?**

How important will digitalization really be?

What are the main aspects requiring new legal regulations / funding schemes / business models / …?

Final statement of the presenters

Which innovations / technologies / solutions / … are most important to achieve a sustainable energy and resource system?

Please vote!

OR

https://www.menti.com/

Code: 1867 2754

Which innovations/ technologies/ solutions/ ... are most important to achieve a sustainable energy and resource system?

Mentimeter

20

Agenda

09:00	**Opening**
09:10	**Block A – Future needs of users and the specific role of biomass**
10:30	**Coffee break**
11:00	**Block B – Flexibility provision via the heating sector**
12:00	**Interactive discussion of audience and presenters**
12:30	**Lunch break**

BEST-Day: Sustainable biorefineries and digitalization, Room 6, 13:30 – 17:00

Language English

Wednesday 18. January

„BEST has continuously developed from mostly technology related research towards a strong focus on full process chains and system integration. Today, digital methods and tools are our valuable companions for supporting industrial implementation of sustainable biorefineries and renewable energy technologies."

Chair: Walter Haslinger, *BEST, AUT*

The BEST day provides highlights of industry relevant research activities of BEST and focusses on sustainable biorefineries and digitalization as enabler for successful technology development and technology implementation.

13:30 **Session 1: Biorefineries**

Learnings from biomass combustion towards future bioenergy applications
Manuel Schwabl, *Fixed Bed Conversion Systems*

Green Carbon perspectives for regional sourcing and decarbonization
Elisabeth Wopienka, *Fixed Bed Conversion Systems*

Bioconversion processes for renewable energy and/or biological carbon capture and utilisation
Bernhard Drosg, *Bioconversion Systems*

Second generation biomass gasification: The Syngas Platform Vienna – current status and outlook
Matthias Kuba, *Fluidized Bed Conversion Systems*

Utilization of syngas for the production of fuel and chemicals – recent developments and outlook
Gerald Weber, *Fluidized Bed Conversion Systems*

15:00 **Coffee break**

11:00 **Session 2: Digital methods, tools and sustainability**

Evaluation of different numerical models for the prediction of NOx emissions of small-scale biomass boilers
Michael Essl, Modelling & Simulation

Digitalization as the basis for the efficient and flexible operation of renewable energy technologies
Markus Gölles, *Automation & Control*

Smart Control for Coupled District Heating Networks
Valentin Kaisermayer, *Automation & Control*

Integrated energy solutions for a decentral energy future – challenges and solutions
Michael Zellinger, *Smart- & Microgrids*

Wood-Value-Tool: Techno-economic assessment of the forest-based sector in Austria
Marilene Fuhrmann, *Sustainable Supply & Value Chains*

17:00 **End**

IEA-Cross-TCP-Workshop:

Towards a flexible, cross-sectoral energy supply

CEBC 2023, 18.01.2023

Markus Gölles