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AIT AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

TS3 Webinar on "Hybrid Energy Networks"

Integrating district heating and cooling networks with the electricity and gas grid

Tuesday, 27th April 2021, 9:00 to 17:00 (CET)

A side event of the Mission Innovation Austria Online Conference
https://missioninnovationaustriaweek.at/

Contact: Ralf-Roman Schmidt (AIT); ralf-roman.schmidt@ait.ac.at

This Webinar is held in the framework of the international cooperation program IEA DHC Annex TS3 „Hybrid Energy Networks". More information at http://www.iea-dhc.org/the-research/annexes/2017-2020-annex-ts3-draft.html 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)

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

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AIT AUSTRIAN INSTITUTE OF TECHNOLOGY TOMORROW TODAY

TS3 Webinar on “Hybrid Energy Networks”

Block I: Integrated district heating and cooling networks: introduction and best practices

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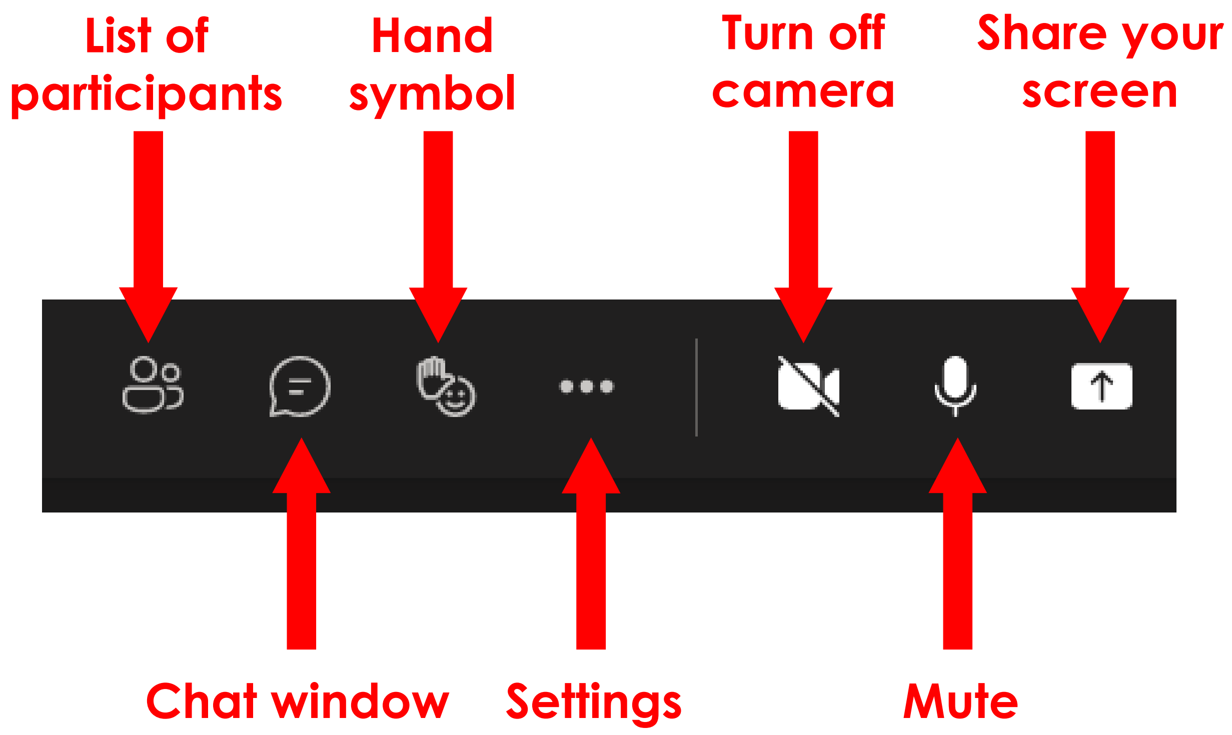
Webinar Etiquette

- The **microphone should be muted** by default
- Requests to speak are reported via the **hand symbol**
- Please **state your name** and institution before you speak
- Please **turn off your webcam**!
  The camera can be used at short notice for spoken contributions.
- We will make a "**group-photo**" at the end of each block



IEA DHC Annex TS3: Hybrid Energy Networks

- **Aim: To promote the opportunities and to overcome the challenges for district heating and cooling networks in an integrated energy system context**
- **Funded** through a task-sharing approach (the participants contribute resources in-kind for connecting existing national and international projects)
- **Lead:** Ralf-Roman Schmidt (AIT); ralf-roman.schmidt@ait.ac.at
- **Runtime**: Fall 2017 – March 2022
- **Expected results**: An assessment of suitable technologies and concepts; country reports; collection and assessment of international case studies; a review of existing methods and tools; best practice guidelines; a final guidebook
- **More information** at https://www.iea-dhc.org/the-research/annexes/2017-2021-annex-ts3-draft

Agenda

Time	Item
09:15 – 11:00 CET	**Block I** – Integrated district heating and cooling networks: introduction and best practices
11:15 – 12:45 CET	**Block II** – Barriers, trends and solutions for the creation of an integrated energy market
13:30 – 15:00 CET	**Block III** – country-based constraints and synergies on a national level
15:30 – 17:00 CET	**Block IV** – handling the complexity: Advanced tools and methods for planning and operation

Agenda *Block I - Integrated district heating and cooling networks: introduction and best practices*

9:00	***Testing of technical connections***
9:15	Welcome and introduction to the webinar (Ralf-Roman Schmidt, AIT)
	DHC as local sector integration hubs – EU policy perspectives (Eva Hoss, European Commission/ Renewables and Energy System Integration Policy)
	Trends and opportunities in district energy (Chiara Delmastro, IEA)
	IKB-Smart-City-Lab – A prototype for hybrid energy provision (Reinhard Fohringer, IKB Innsbruck (Austria))
	Sector integration and the role of DHC from a TSO point of view (Gregor Goričar ELES, d.o.o (the Slovenian TSO))
	Overview on best practises examples for DHC and sector integration (Anna Kallert, Fraunhofer IEE)
	2050 Homes, a hybrid energy network in Nottingham (Anton Ianakiev NTU, UK)
11:00	***End of Block I***

DHC as local sector integration hubs – EU policy perspectives
(Eva Hoss, European Commission/ Renewables and Energy System Integration Policy)

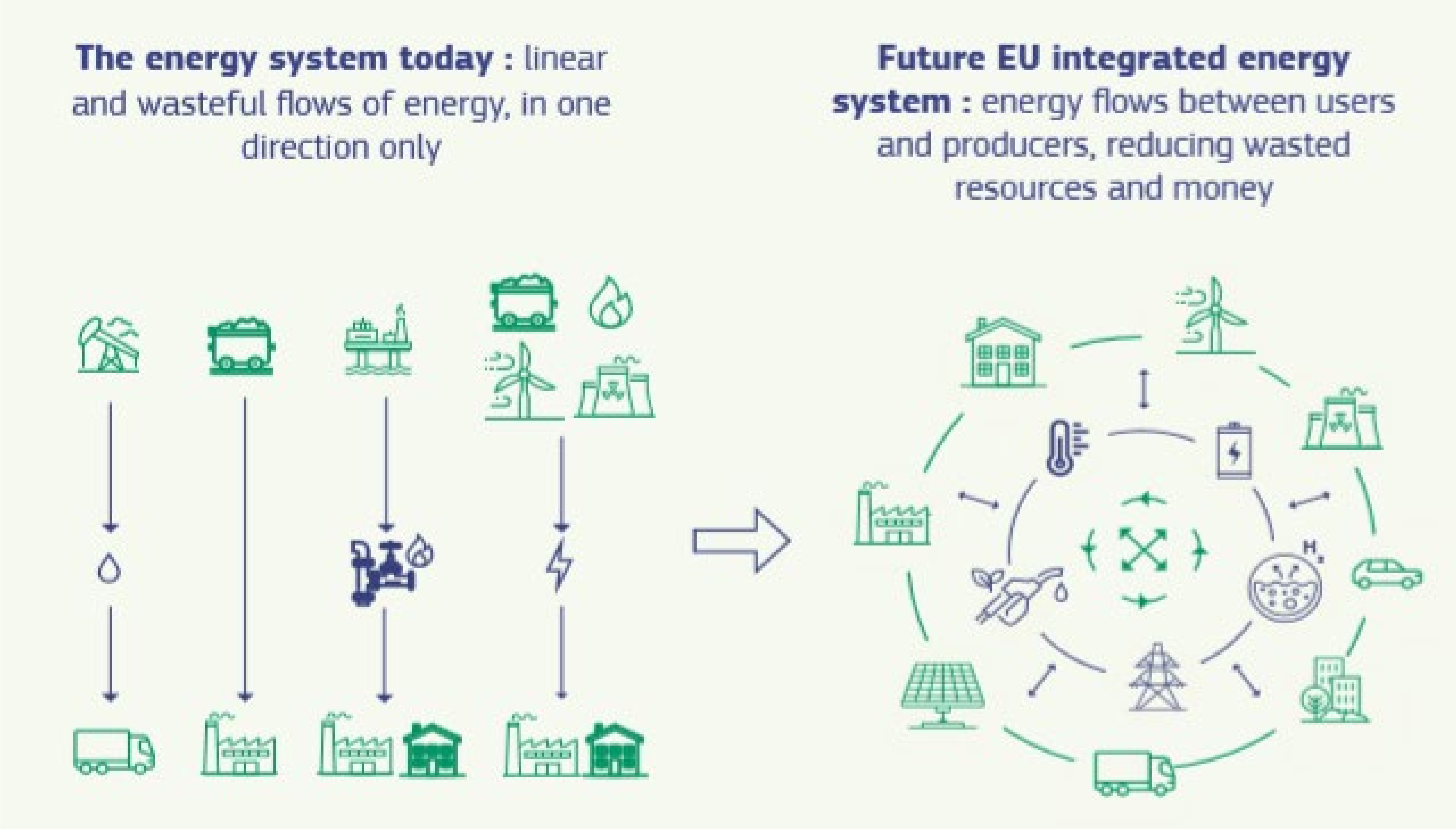
DHC as a local sector integration hub

EU Policy Perspective

TSR3 Webinar on hybrid energy networks

Eva Hoos
Unit Renewables and CCS Policy
Directorate-General for Energy

What is energy system integration?



Energy System Integration (ESI) is the integrated planning and operation of the energy system 'as a whole', across multiple carriers, infrastructures and consumption sectors

European Commission

Laying the foundation for a climate-neutral energy system

Energy System Integration Strategy

1 A more **circular and energy efficient** energy system

2 A **deep electrification** of consumption, based on **renewable electricity**

3 The use of **renewable and low carbon fuels (incl. hydrogen)** in hard-to-abate sectors

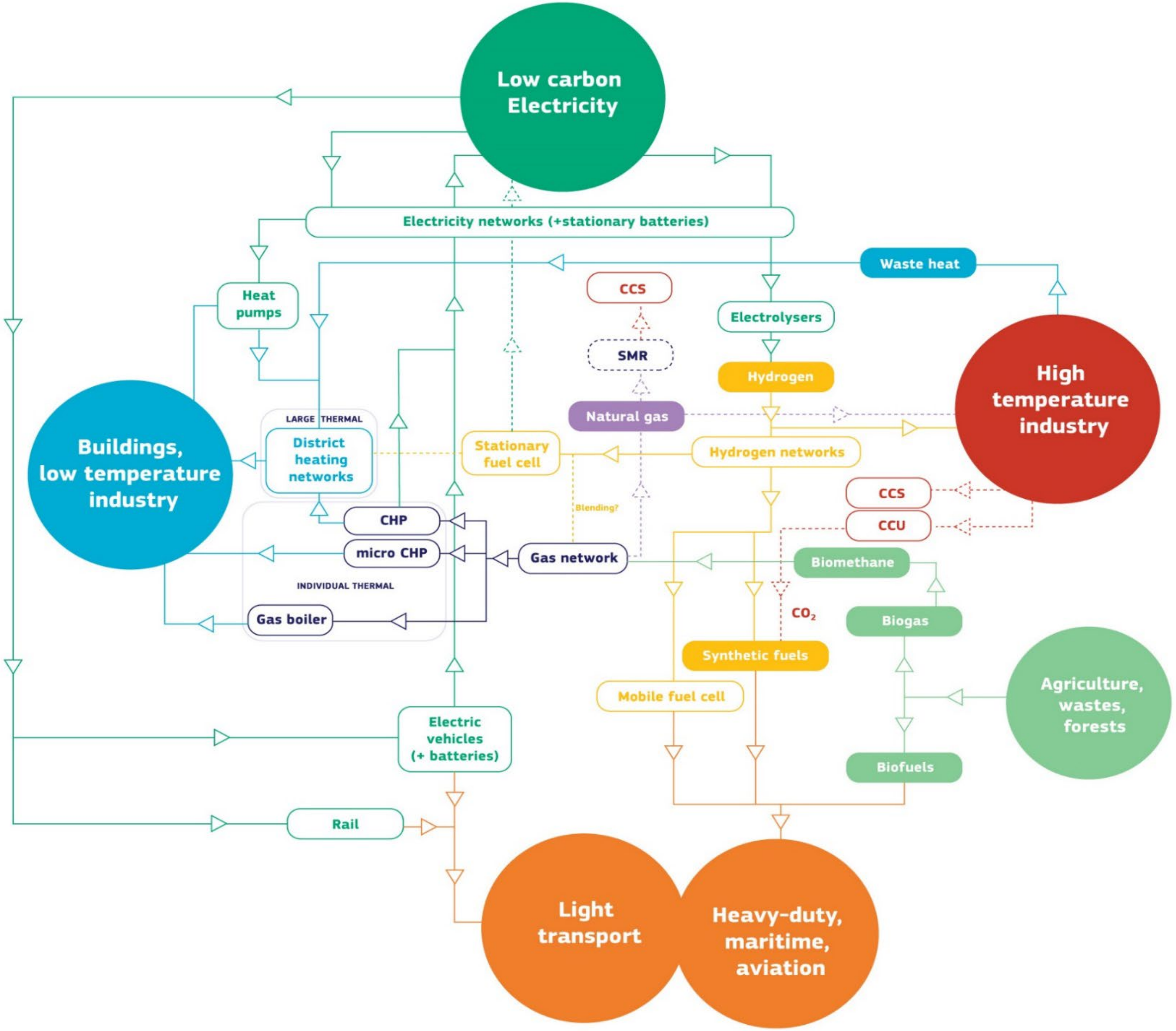
Hydrogen Strategy

A full value chain approach to upscale hydrogen

+

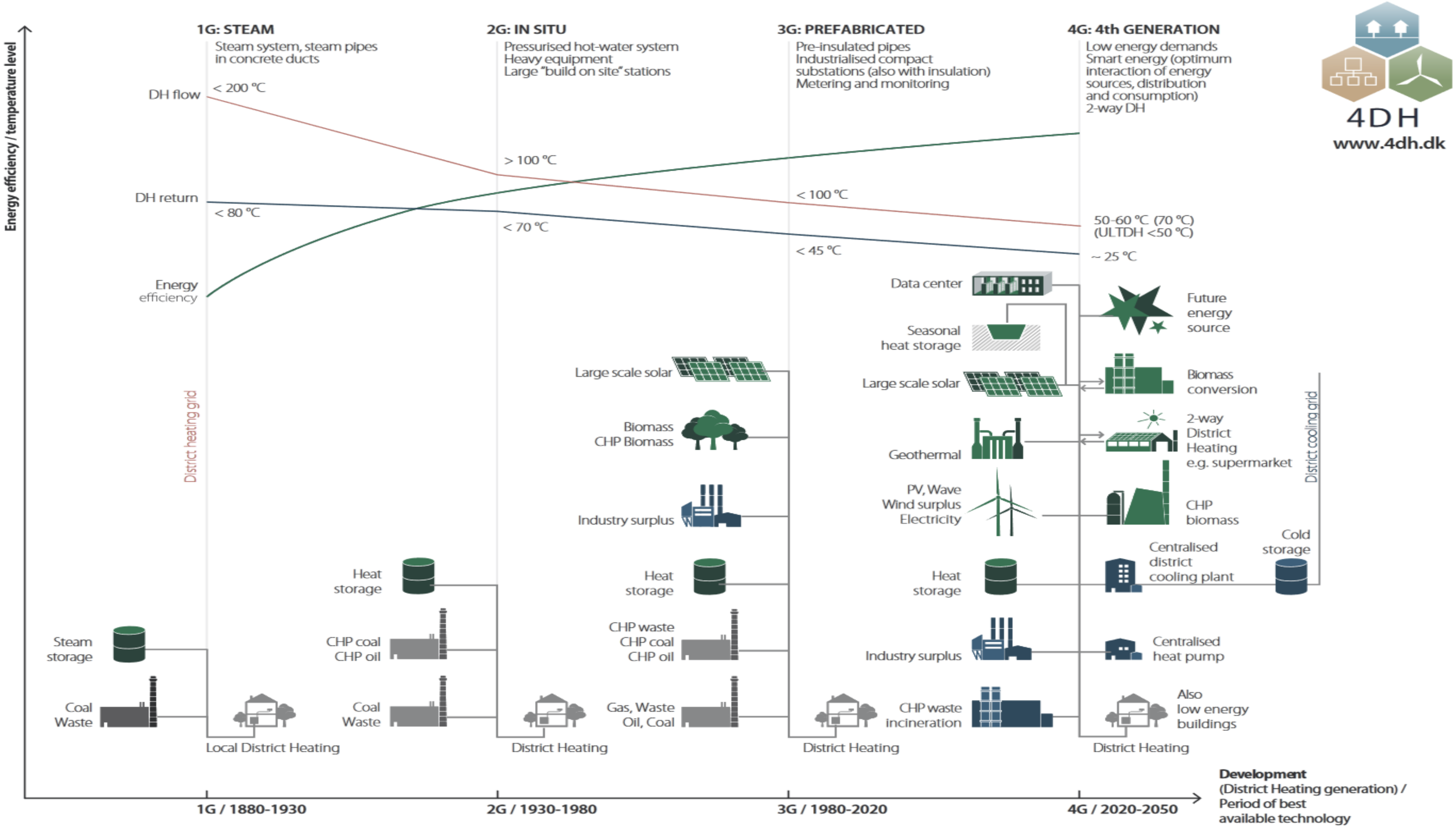
Clean Hydrogen Alliance

The interlinkages of the integrated energy system



European Commission

Evolution of DHC systems: towards energy system integration hubs



European Commission

Key components of DHC as energy system integration hub

- **Multiple sources and technologies in one system**
- **Connection to electricity and gas grids and other grids (hydrogen, CCU)**
- **Heat pumps, electric boilers, CHP, energy storage**
- **Capacity to use waste heat and waste streams based fuels**
- **Primary energy efficiency**
- **Flexibility within the system, flexibility for the larger energy system**
- **Optimisation at local and energy system levels**

⇒*DH can integrate multiple renewable and waste heat sources, highly efficient transformation and thermal storage technologies, connecting prosumers and decentralised energy and using AI-driven flexibility and demand response services through embedded two-way energy and communication flows between production and consumption points.*

European Commission

Making it happen – an action plan for Energy System Integration

Pillar	Actions oriented towards	Main tools involved (*)
A more circular and energy efficient energy system	• Better apply EEF principle & PEF • Build a more circular system	RED, EED, TEN-E
A deep electrification of consumption, based on renewable electricity	• Increased supply RES-E • Faster electrification end-use sectors • Roll out EV infrastructure & new loads integration	RED, IED, AFID, TEN-E, TEN-T, CO2 emissions for cars, EU funding, offshore RES, Renovation wave, NC Flexibility
RES & low carbon fuels for hard-to-abate sectors (incl. hydrogen)	• Promoting RES fuels from biomass • Promoting RES hydrogen • Enabling CCUS incl. for synthetic fuels	RED, Aviation/Maritime initiatives, EU funding + Hydrogen Strategy Follow-up
Energy markets fit for decarbonisation & distributed resources	• Creating a level playing field across carriers • Review gas regulatory framework • Improve customer information	ETD, ETS, State Aid, gas legislation, guidance on non price components
A more integrated energy infrastructure	• More integrated planning at gas, electricity, heat and hydrogen • Better governance	TEN-E, TEN-T, RED, EED, TYNDP
A digitalised energy system & supportive innovation framework	• Ensure digitalisation support energy system integration • Research and innovation as a key enabler	Energy Digitalisation Action Plan, NC cybersecurity, impact oriented research outlook

(*) Non-exhaustive list

Green Deal and 'Fit for 55' package: End goal carbon neutrality

- Review of the relevant regulatory framework: Renewable Energy Directive, Energy Efficiency Directive, ETS and Effort Sharing Regulation, Energy Taxation.
- Later on review of the Energy Performance of Buildings Directive, Gas package, Ecodesign and Energy Labelling
- Energy System Integration is mainstreamed, in particular in REDII and EPBD reviews – heating and cooling: priority sector for action
- Climate spending mainstreamed in new EU budget and Next Generation EU (Recovery and Resilience Facility

⇒Higher focus on heating and cooling in EU energy policy

Thank you for your attention!

Eva.Hoos@ec.europa.eu

Trends and opportunities in district energy (Chiara Delmastro, IEA)

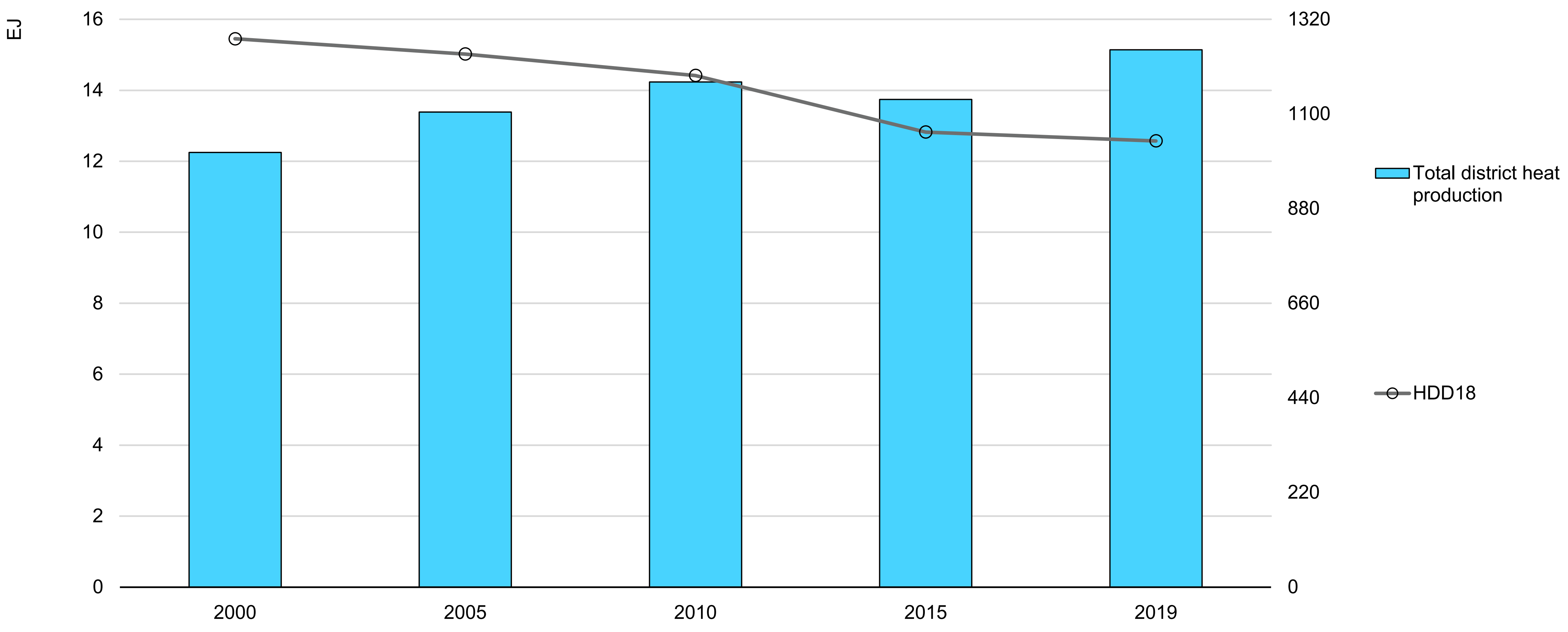
International Energy Agency

Trends and opportunities for district energy

Dr. Chiara Delmastro, International Energy Agency

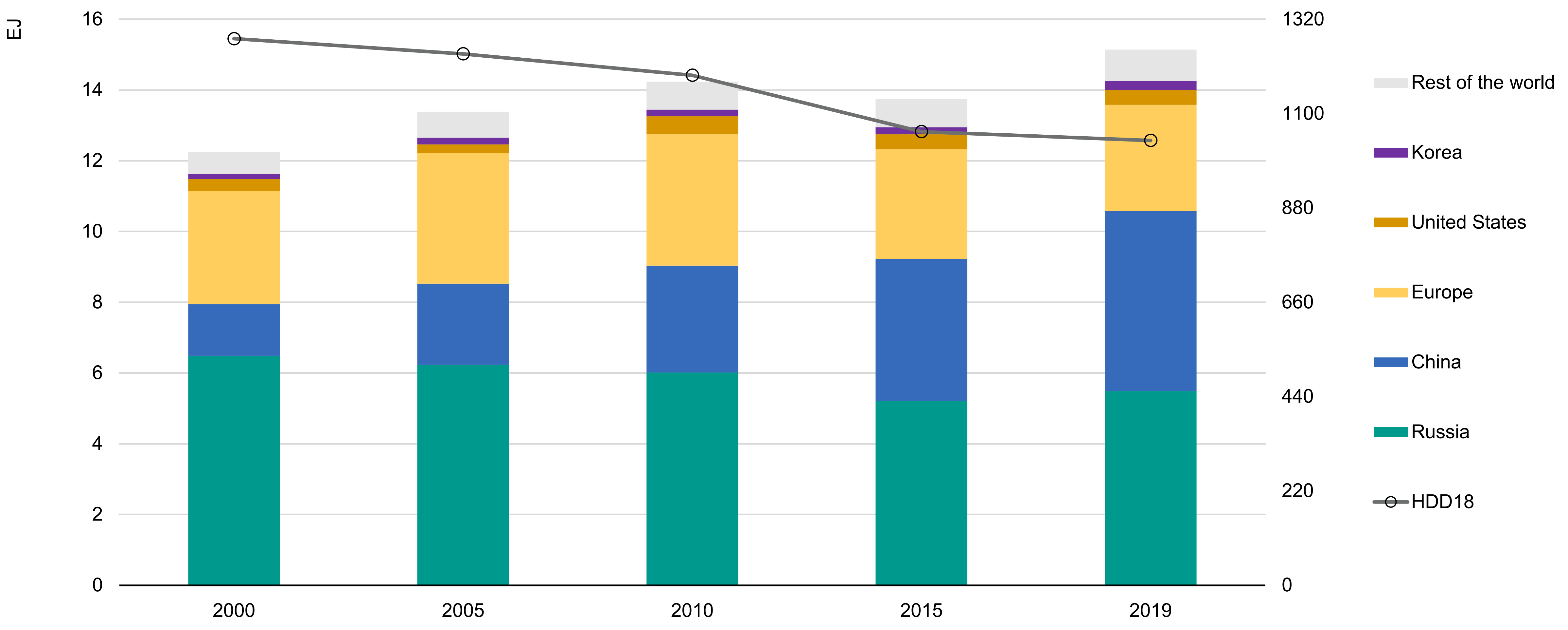
27 April 2021

A steady increase of district heat production



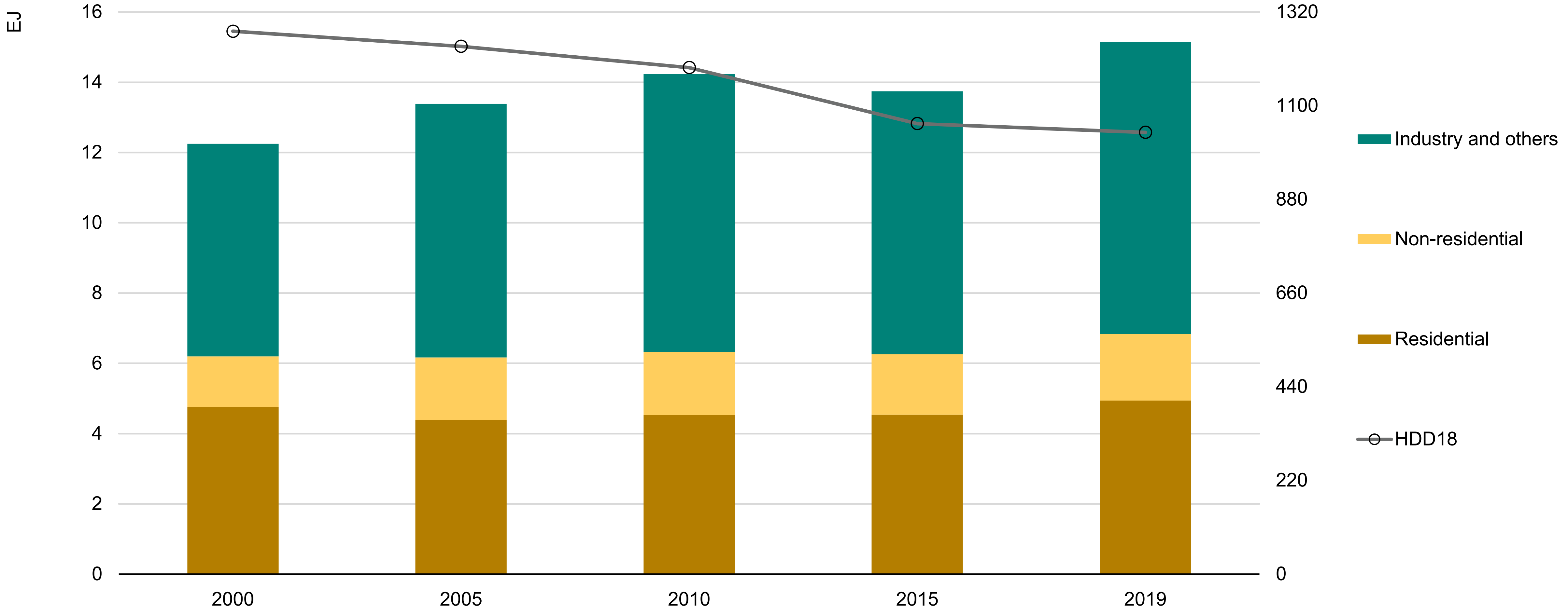
Normalized by climate, district heat production is increasing at an annual compound growth rate of around 1.5%

District heat major markets are Russia, Europe and China



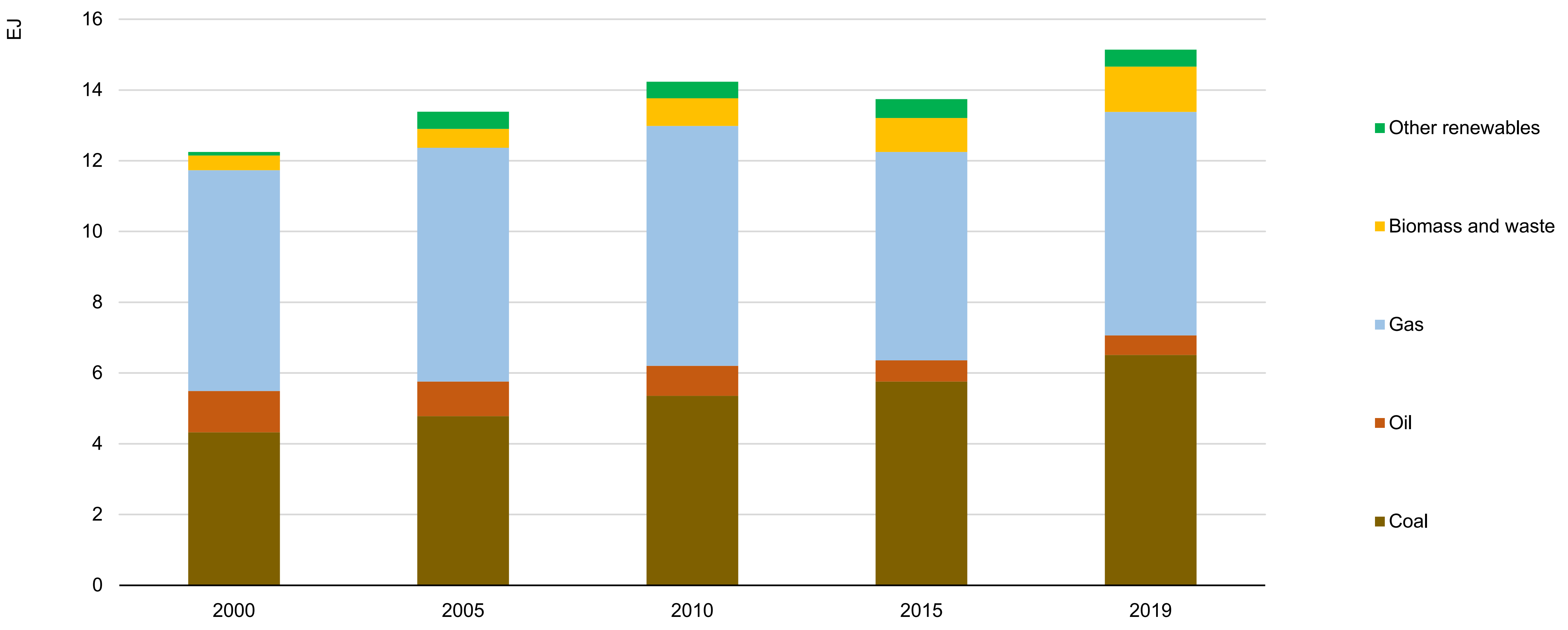
Trends in district heat production change by country, rapid growth observed in China and Korea

The share of heat production for buildings is constant since 2000



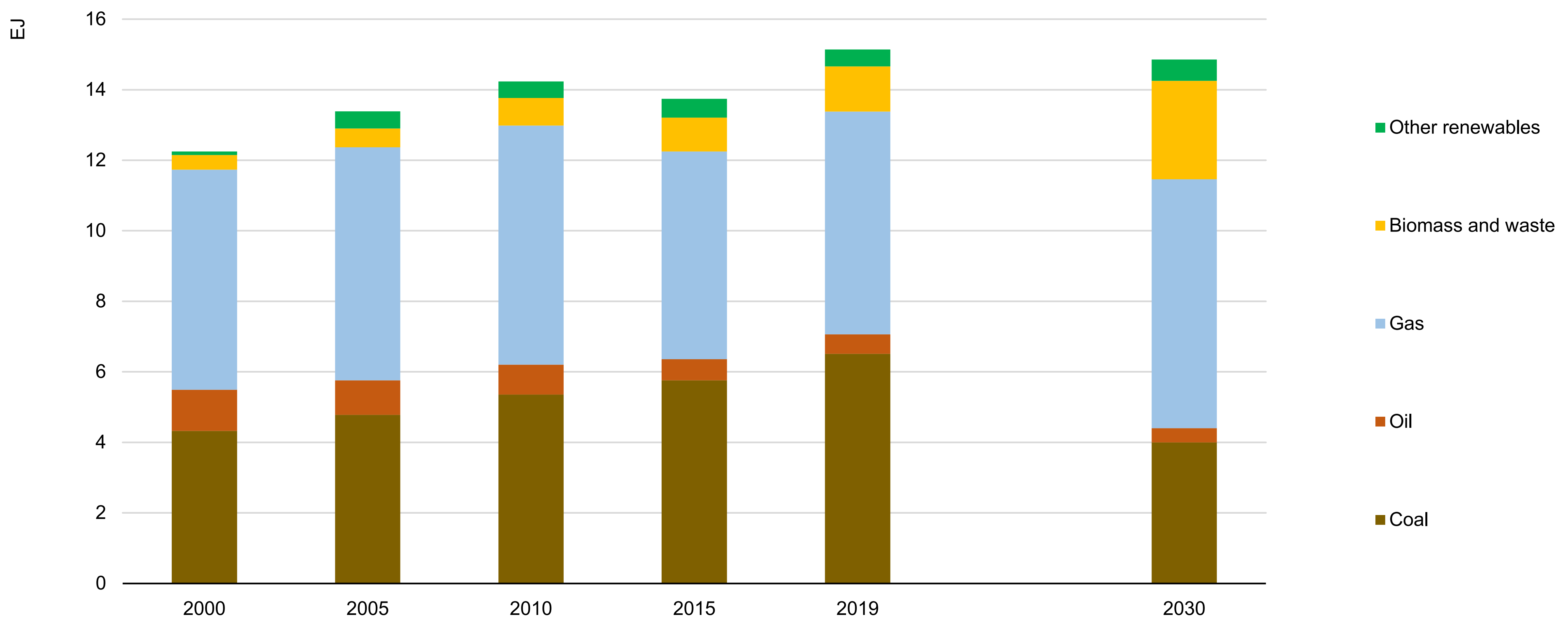
Globally, district heat covers around 9% of global space and water heating demand, as buildings efficiency is increasing and distribution temperatures are decreasing

Fossil fuels are still meeting the bulk of district heat production



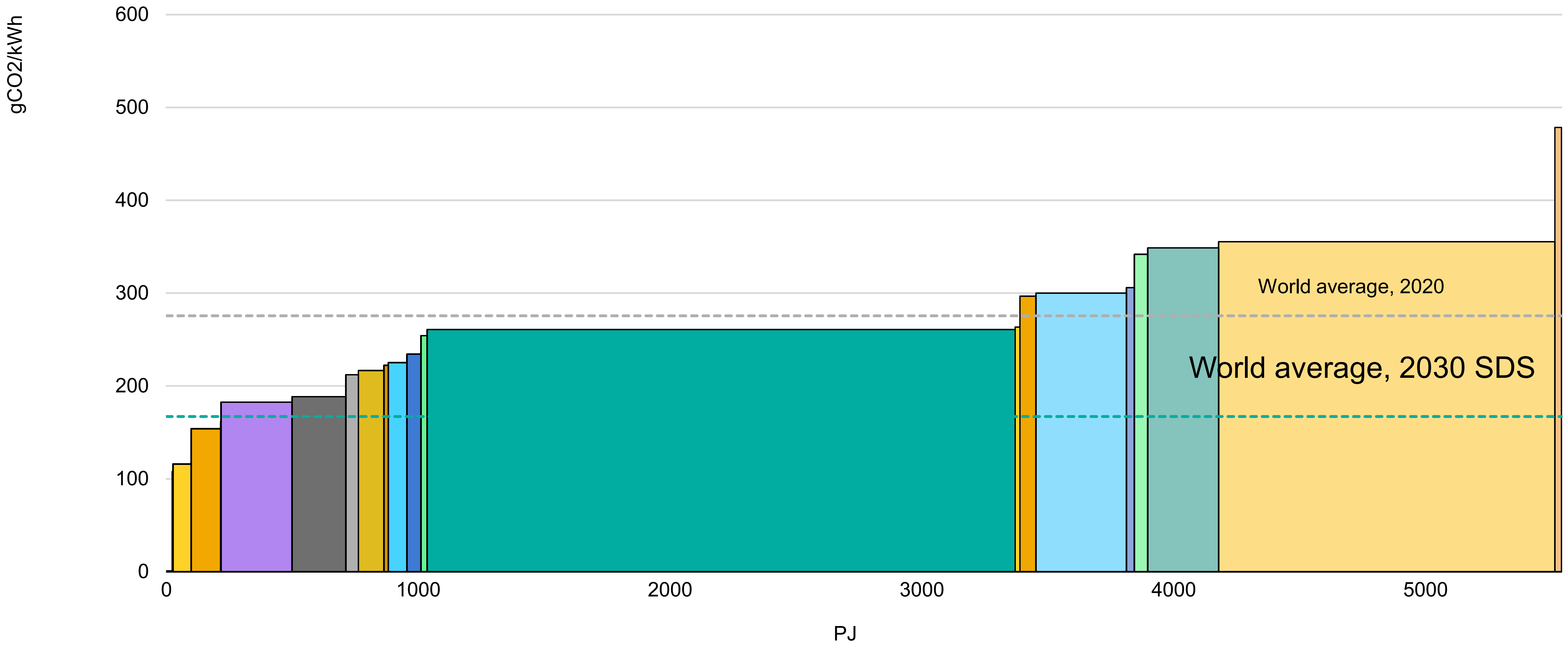
Biomass, waste and other renewables sources covering just more than 10% of global district heat production

Renewables share in district heat production should double to 2030



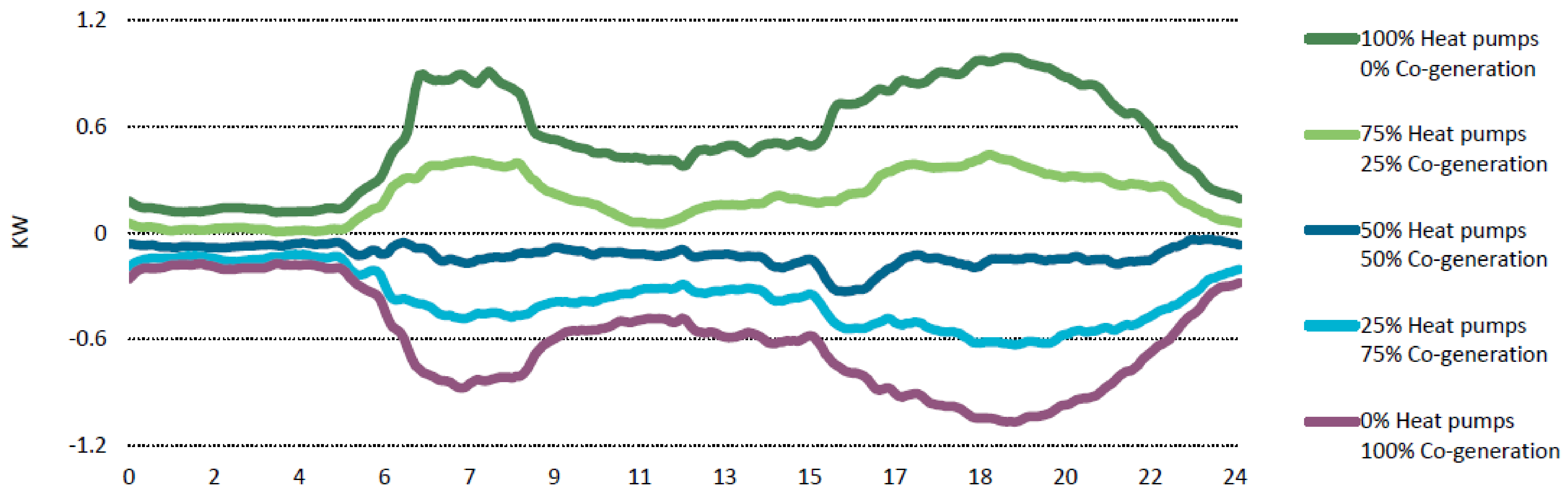
To be aligned with our Sustainable Development Scenario, district heat generation and distribution practices should experience transformation already by 2030

Carbon intensities are too high in almost all heating markets



Only 6% of district heat deliveries to residential and service buildings is produced with carbon intensities lower than 2030 Sustainable Development Scenario target

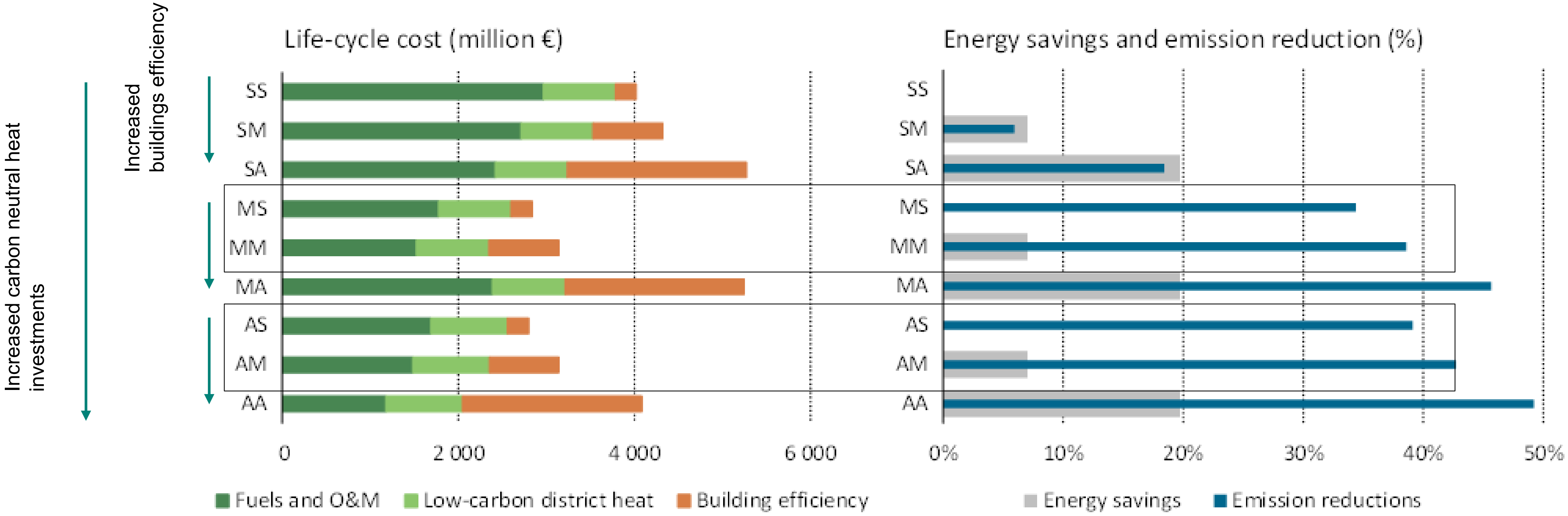
Short-term synergies between co-generation and heat pumps are key



The simultaneous use of co-generation and heat pumps flattens the load profile and reduces the upstream impact of both distributed energy technologies on the electricity system.

 IEA Energy Technology Perspective. All rights reserved.

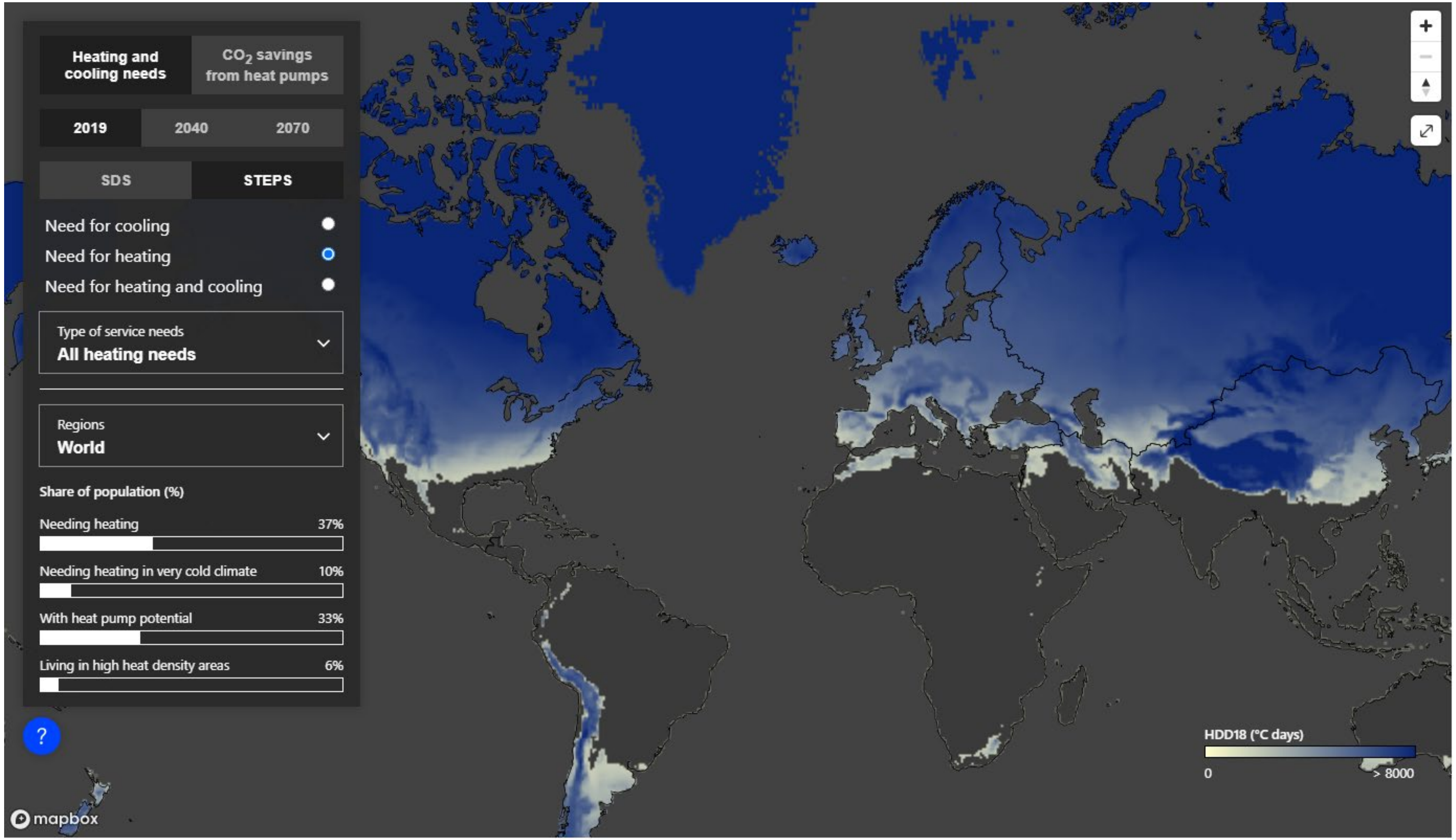
Synergies between buildings heat demand and supply



Case study, city of Stockholm.

Carbon-neutral district heat investments need to be coupled with buildings efficiency measures to achieve the greatest cost-effective emission reductions

Targeted solutions by climate and building stock



Local knowledge to enhance the understanding of heat demand and heat resources is fundamental to asses the cost effectiveness of district heat systems and possible integration with cooling networks

 IEA (2020), Is cooling the future of heating?, https://www.iea.org/commentaries/is-cooling-the-future-of-heating. All rights reserved.

Deploy sustainable policy framework to enable district heat markets

- Decarbonize heat supply and enhance system efficiency.
- Integrate district heating and cooling planning within city planning.
- Improve the understanding of local demand and resources.
- Enhance system integration opportunities.
- Raise cross-service synergies.
- Raise public awareness.

chiara.delmastro@iea.org

IKB-Smart-City-Lab – A prototype for hybrid energy provision
(Reinhard Fohringer, IKB Innsbruck (Austria))

Innsbruck´s prototype for a cross-sectoral energy system – IKB-Smart-City-Lab

Reinhard Fohringer
IEA Industry Session
27.04.2021

Sinfonia

iKB Eins für alle.

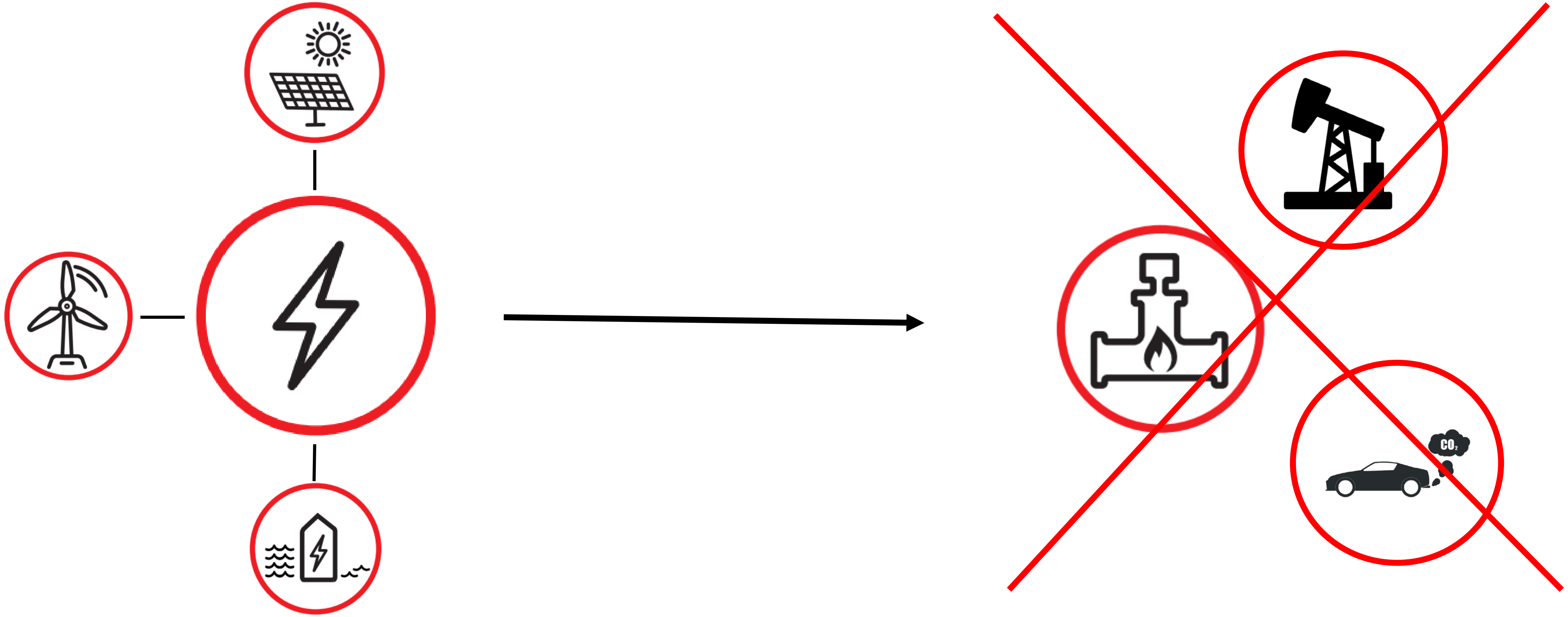
Sector Coupling

=

Holistic approach to the energy system

Sector Coupling

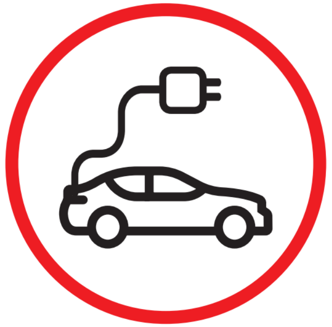
Important role: electrical energy



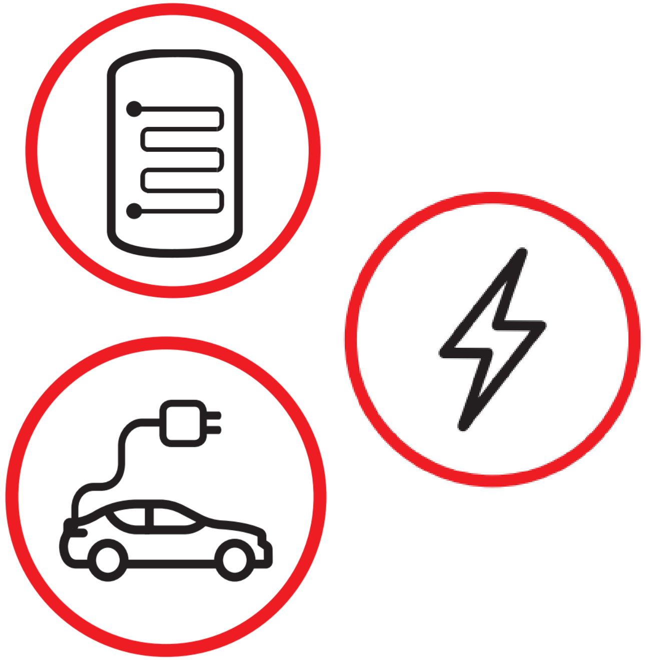
Possibilities of sector coupling

Electricity sector:
- Electricity is a very flexible energy source (convertible)
- Increasing demand for flexibility (renewable energy)
- Electricity storages are complex and therefore expensive

Heating sector:
- Heating systems are slow
- Comparatively low demand for flexibility
- Heat storage is simple and inexpensive



Transportation sector:
- Private cars are not in use for 90 to 95 % of the time
- Transition to electromobility → use of the batteries?

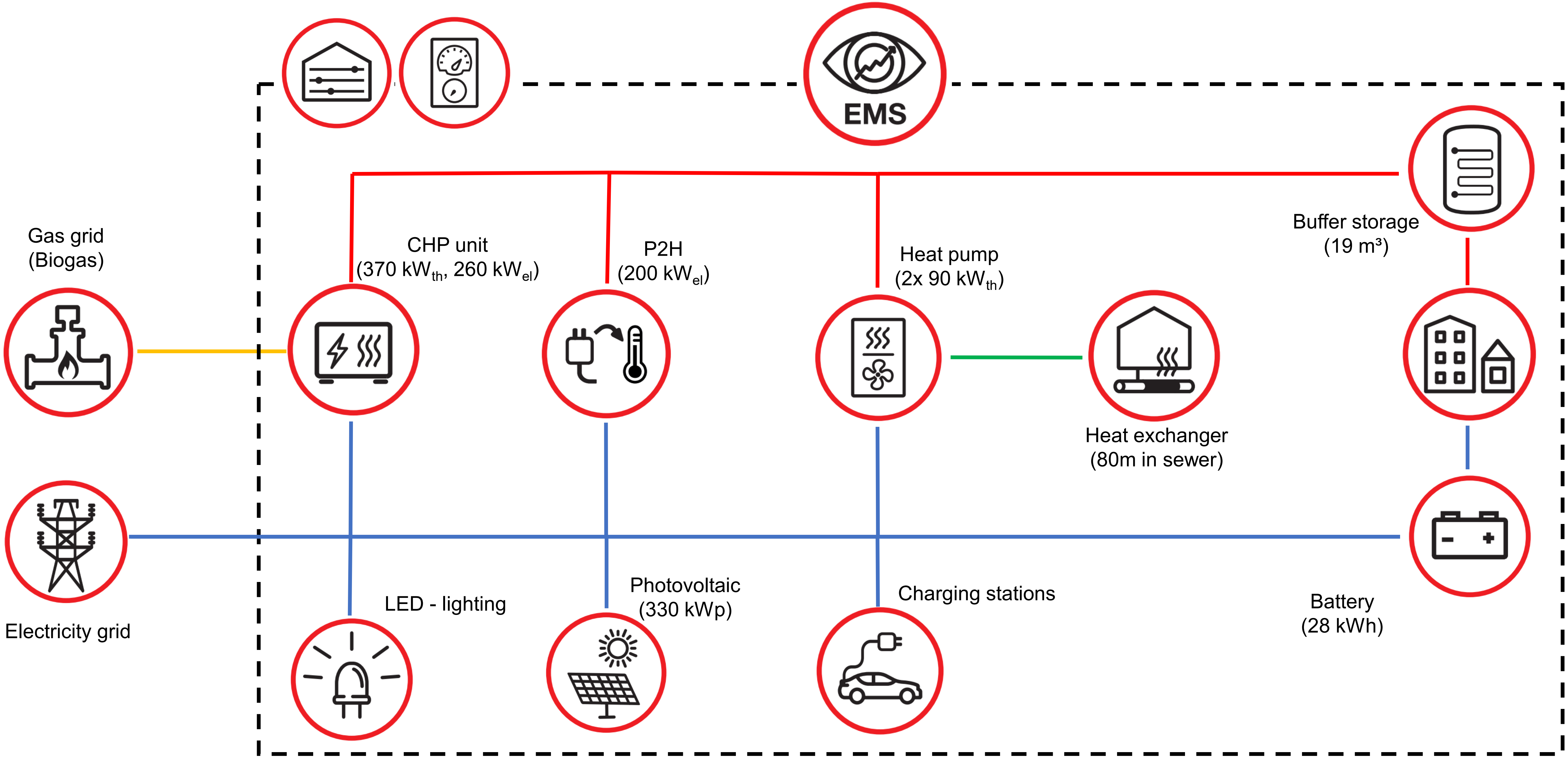


Sector coupling can increase the share of renewable energy in final energy demand, while maintaining system stability in the electricity sector.

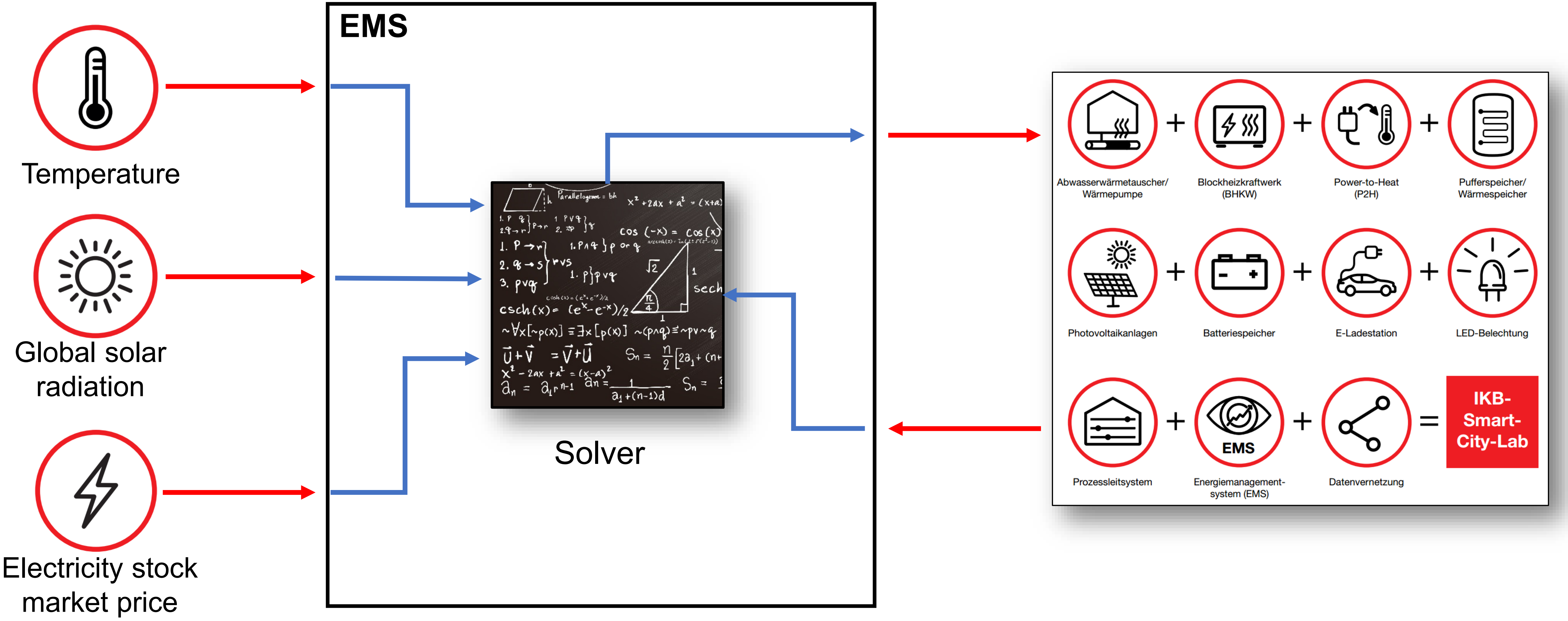
Project objectives – Smart City Lab

- Coupling of the sectors electricity, heat and transportation
- Heat and power supply to 100 % out of renewable sources
- Intelligent control system
- “public energy experience”: build awareness for the topic, differentiated information to target groups (e.g. customers, school kids, universities and research facilities)

Implemented measures



Energy management system



Next steps and challenges

- EMS was ahead of the time (implementation in 2018/19)
- Now in 2021 we see an increasing interest for cross sectoral energy optimization software
- Follow up project with focus on easy replication started in March 2021

Damit Sie
in Innsbruck
IKB Eins für alle.
IKB
Innsbruck
Abwasserwärme
Wärmespeicher
Photovoltaik
Energiemanagementsystem (EMS)
Smart City
Wärmepumpe
Datenvernetzung
Hybridnetz
Power-to-Heat
(P2H)
Europa
Blockheizkraftwerk
(BHKW)
E-Ladestationen
IKB-Smart-City-Lab
Das Netz der Zukunft
Energiemanagement
Lebensqualität
WASSER
ABWASSER

Sector integration and the role of DHC from a TSO point of view (Gregor Goričar ELES, d.o.o (the Slovenian TSO))

Cross Sector Integration Electricity-Heating&Cooling

Gregor Goričar
Strategic innovations department
E-mail: gregor.goricar@eles.si

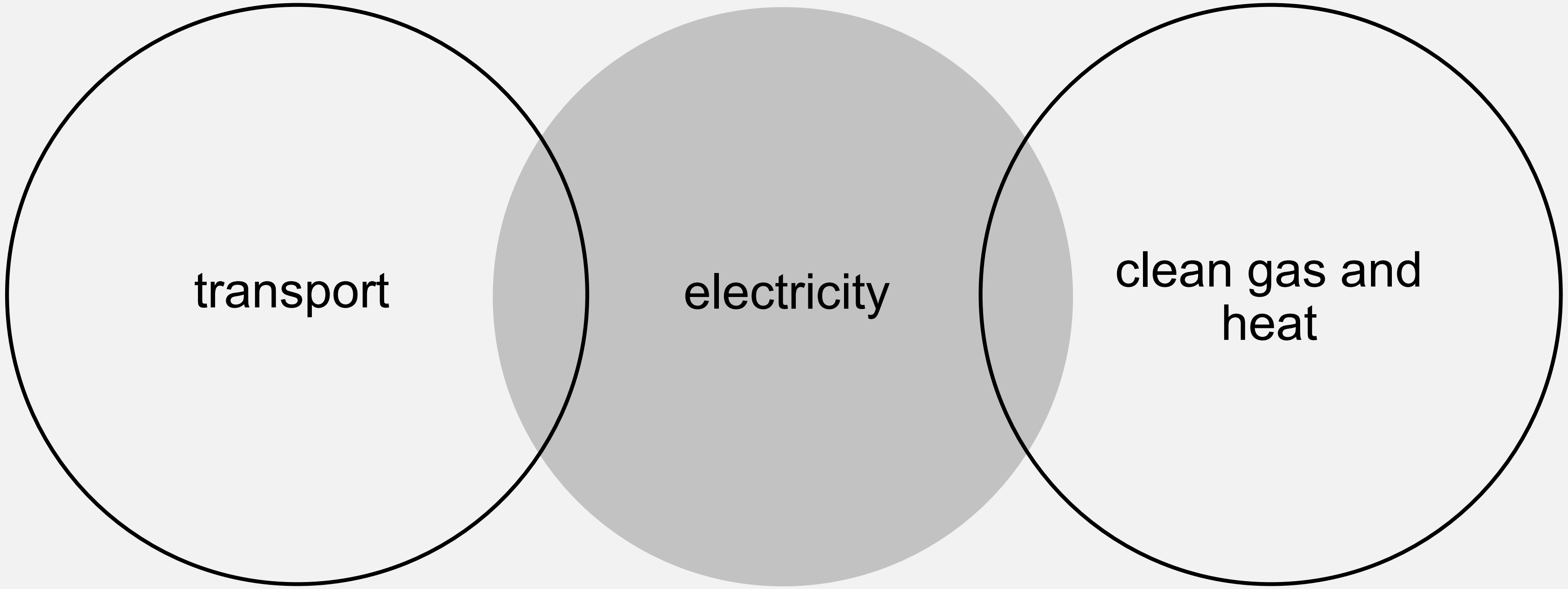
27. 04. 2021

ELES

Cross Sector Integration

2021 | **Separated systems**

- coordinated design and operation of the energy system
- active integration of the consumers



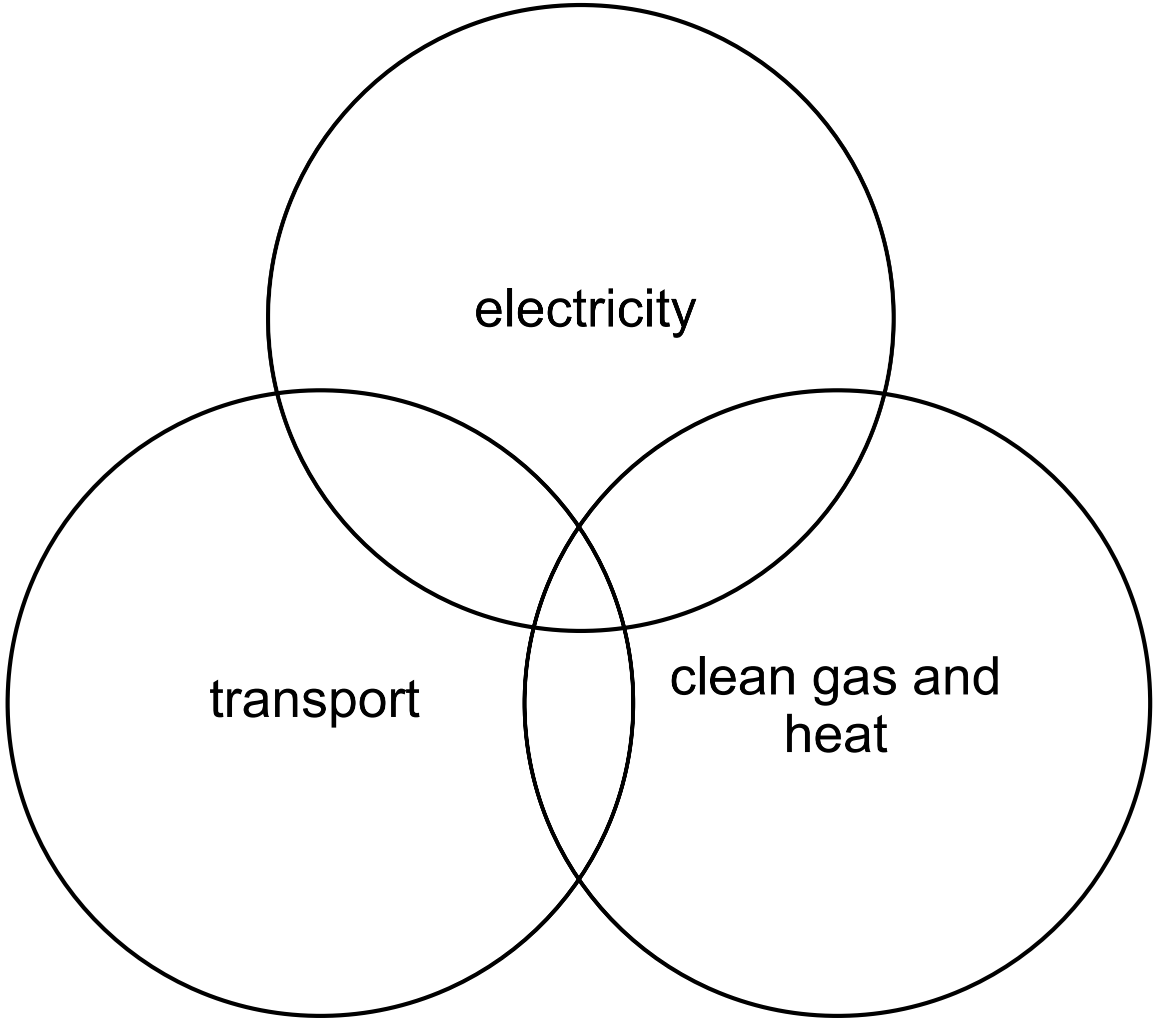
Cross Sector Integration

2050 | One system of integrated systems


European Commission

EU strategy
for Cross Sector
Integration of the
energy system

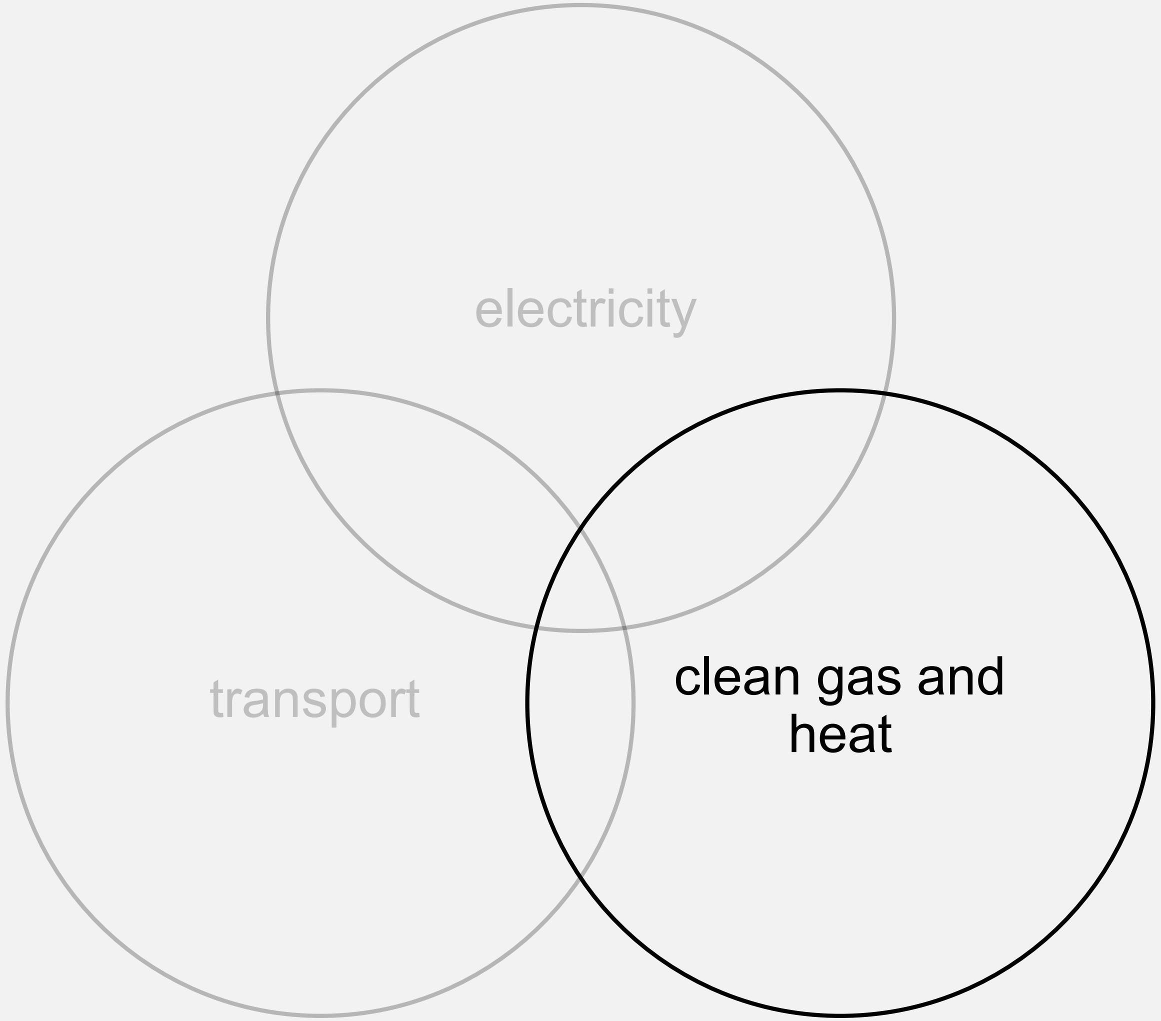
- coordinated design and operation of the energy system
- active integration of the consumers



Cross Sector Integration

2050 | One system of integrated systems

- coordinated design and operation of the energy system
- active integration of the consumers



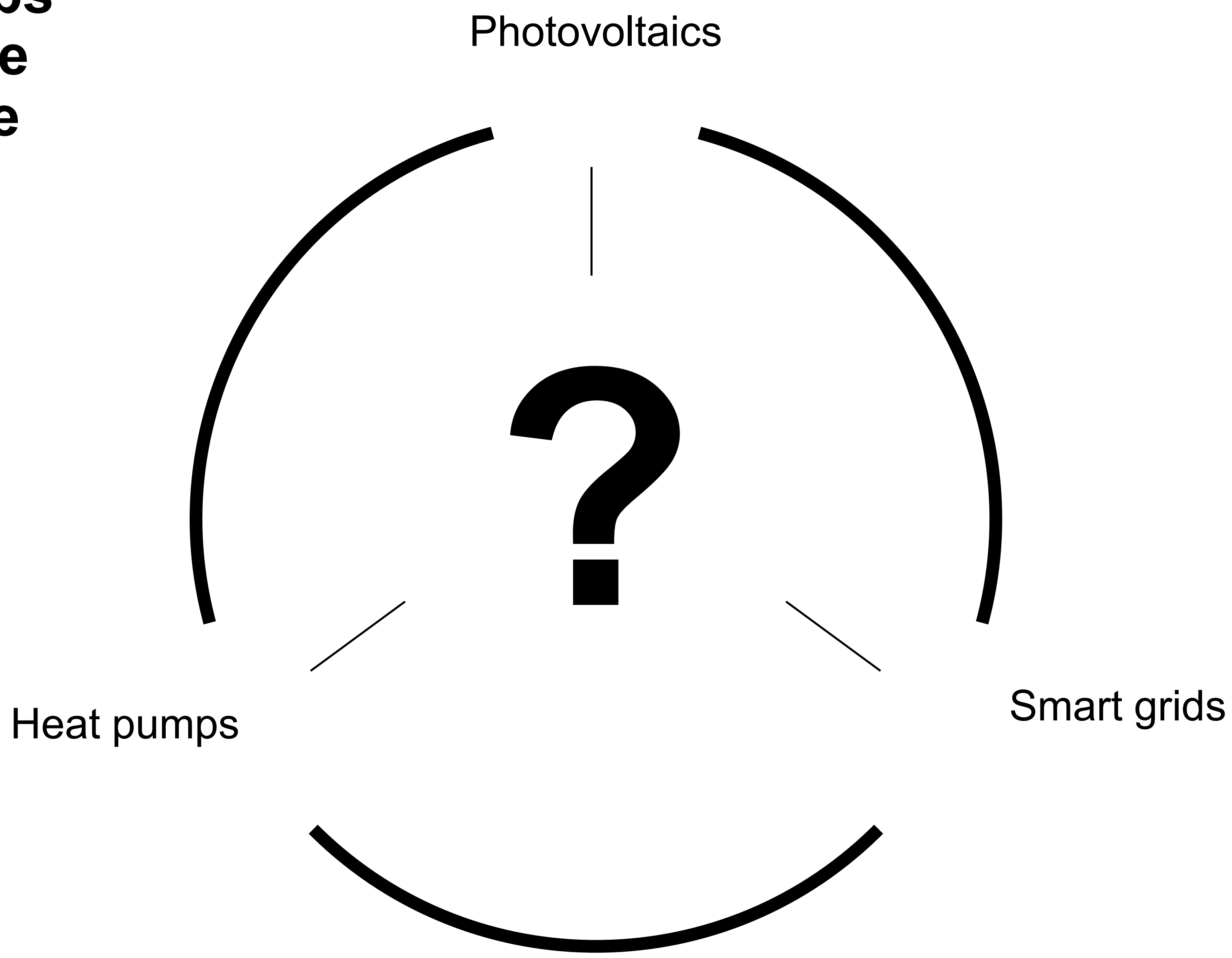
Energy demand for heating 2018
Slovenia [GWh]

Electricity (GWh)	**Gas** (GWh)	**Wood** (GWh)	**Oil** (GWh)
909	1.205	**4.818**	1.118

Source: SURS (2018)

Promotion of the heat pumps is great but…what about the <u>price</u> of the electricity in the future (2050)?

0.9 GW heat pumps by 2030!?



Consideration of an alternative to heat pumps in the direction of Cross Sector Integration

tomorrow

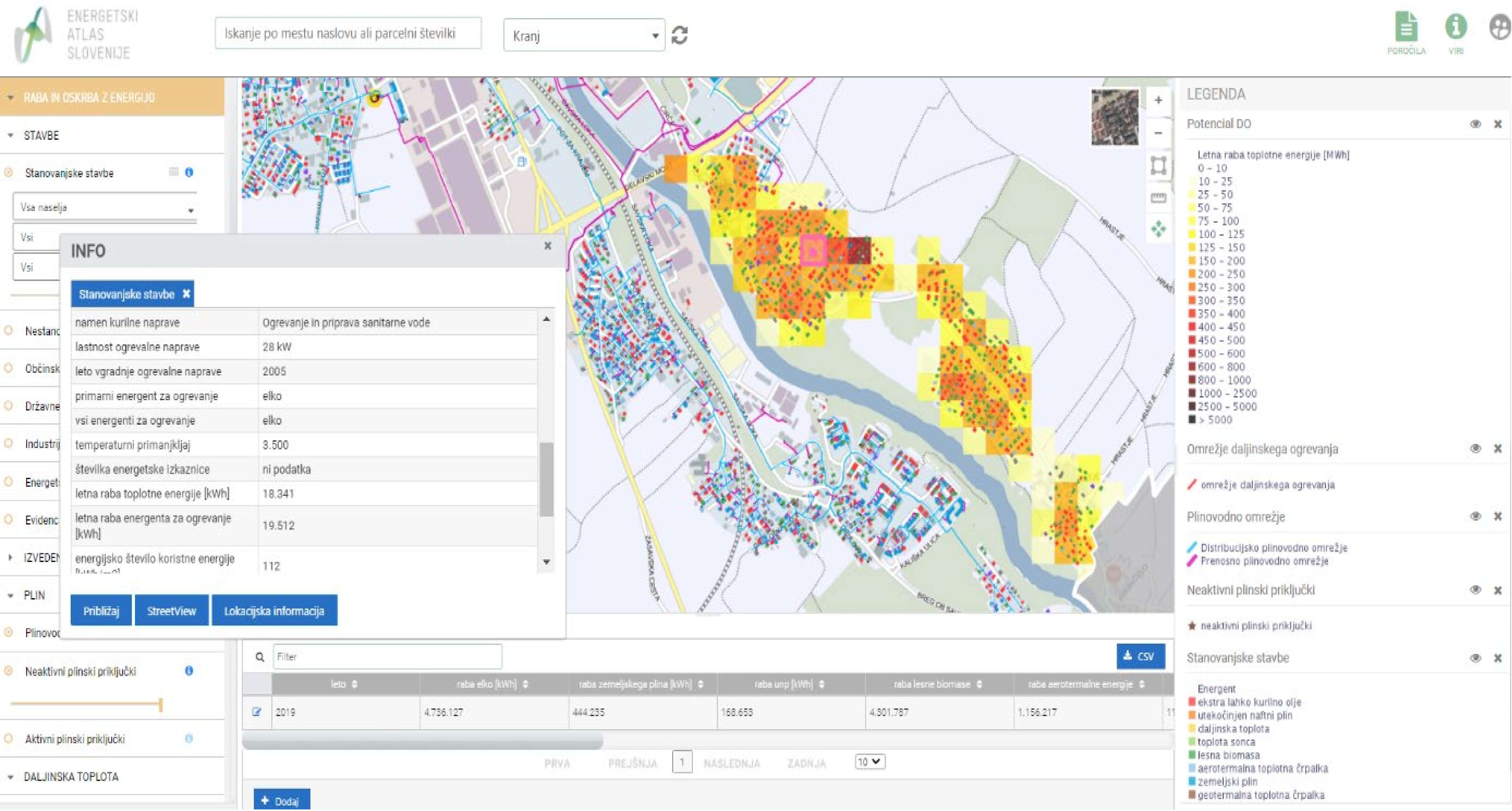
Distributed heating systems: system catalyst for winter use of clean energy for heating

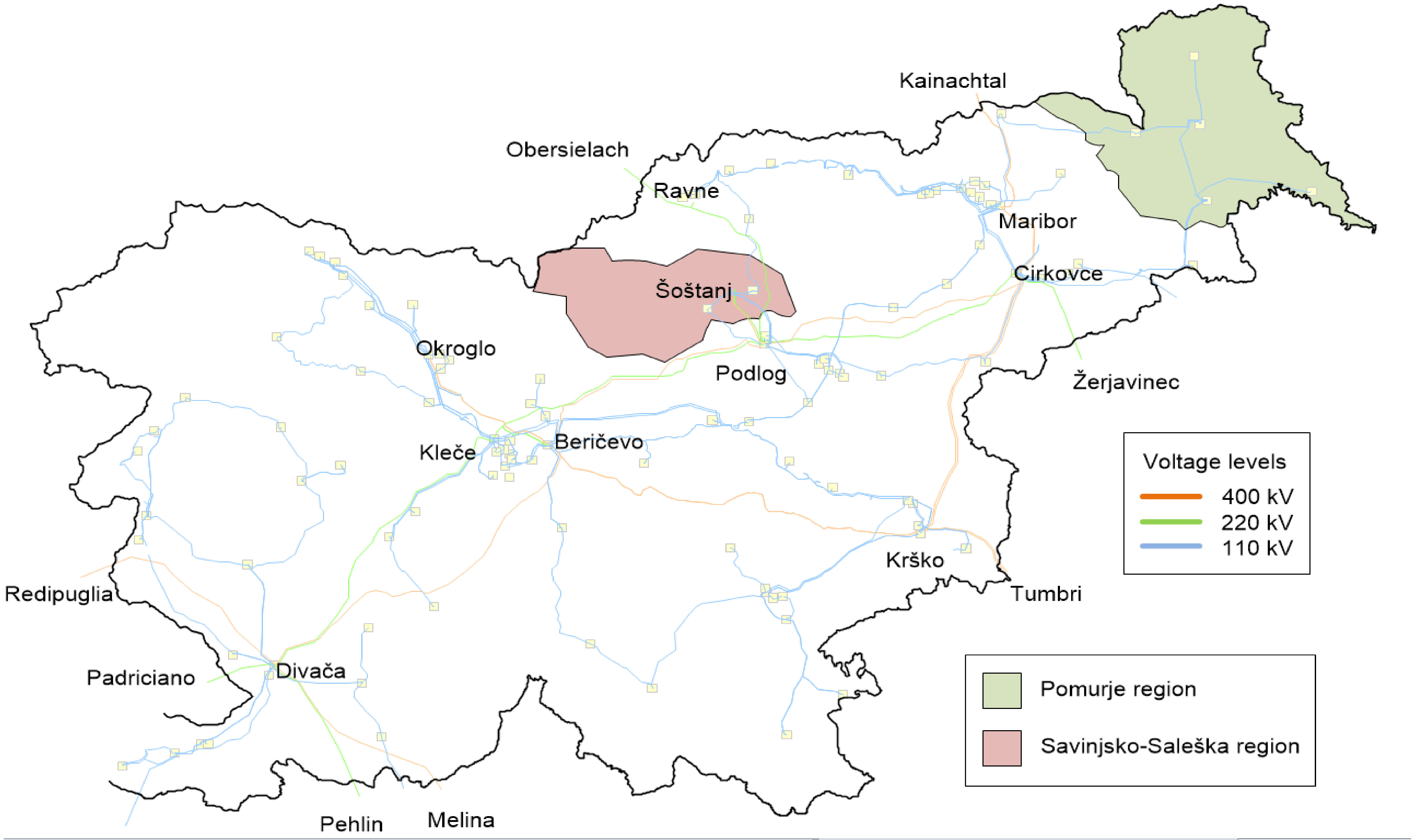
Based on three components:

1.
District heating systems complement electricity systems

2.
Clean energy sources

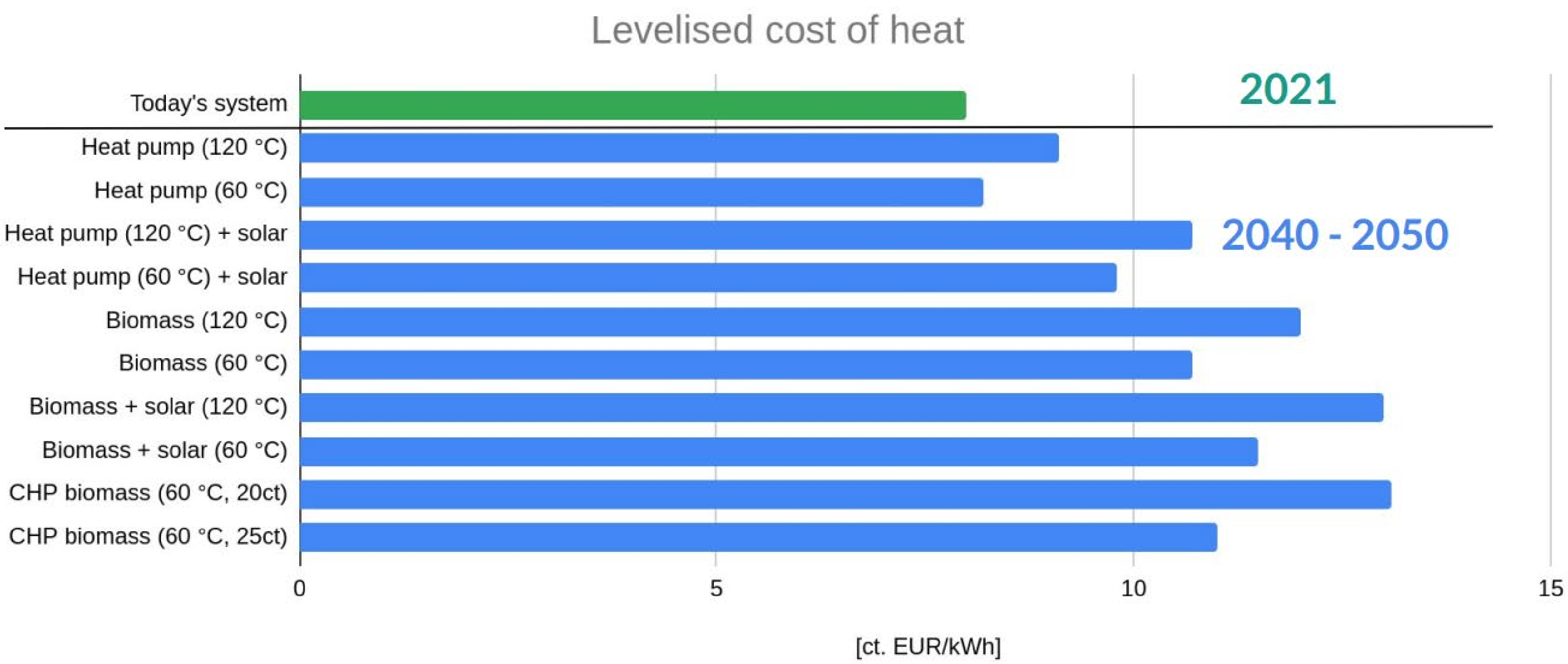
3.
Distributed seasonal heat storage tanks


ENERGETSKI ATLAS SLOVENIJE
Iskanje po mestu naslovu ali parcelni številki
Kranj
POROČILA
VIRI
RABA IN OSKRBA Z ENERGIJO
STAVBE
Stanovanjske stavbe
Vsa naselja
Vsi
Vsi
Nestanc
Občinsk
Državne
Industrij
Energet
Evidenc
IZVEDEN
PLIN
Plinovoc
Neaktivni plinski priključki
Aktivni plinski priključki
DALJINSKA TOPLOTA
INFO
Stanovanjske stavbe
namen kurilne naprave | Ogrevanje in priprava sanitarne vode
lastnost ogrevalne naprave | 28 kW
leto vgradnje ogrevalne naprave | 2005
primarni energent za ogrevanje | elko
vsi energenti za ogrevanje | elko
temperaturni primanjkljaj | 3.500
številka energetske izkaznice | ni podatka
letna raba toplotne energije [kWh] | 18.341
letna raba energenta za ogrevanje [kWh] | 19.512
energijsko število koristne energije | 112
Približaj
StreetView
Lokacijska informacija
Filter
CSV
leto | raba elko [kWh] | raba zemeljskega plina [kWh] | raba unp [kWh] | raba lesne biomase | raba aerotermalne energije
2019 | 4.736.127 | 444.235 | 168.653 | 4.301.787 | 1.156.217
PRVA
PREJŠNJA
1
NASLEDNJA
ZADNJA
10
Dodaj
LEGENDA
Potencial DO
Letna raba toplotne energije [MWh]
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
100 - 125
125 - 150
150 - 200
200 - 250
250 - 300
300 - 350
350 - 400
400 - 450
450 - 500
500 - 600
600 - 800
800 - 1000
1000 - 2500
2500 - 5000
> 5000
Omrežje daljinskega ogrevanja
omrežje daljinskega ogrevanja
Plinovodno omrežje
Distribucijsko plinovodno omrežje
Prenosno plinovodno omrežje
Neaktivni plinski priključki
neaktivni plinski priključki
Stanovanjske stavbe
Energent
ekstra lahko kurilno olje
utekočinjen naftni plin
daljinska toplota
toplota sonca
lesna biomasa
aerotermalna toplotna črpalka
zemeljski plin
geotermalna toplotna črpalka


Kainachtal
Obersielach
Ravne
Maribor
Šoštanj
Cirkovce
Okroglo
Podlog
Žerjavinec
Kleče
Beričevo
Voltage levels
400 kV
220 kV
110 kV
Krško
Redipuglia
Tumbri
Padriciano
Divača
Pomurje region
Savinjsko-Saleška region
Pehlin
Melina


Topolšica
MRP Velenje-sever
Gaberke
Škale
Hrastovec
ZEMELJSKI
PLIN
Metleče
Šoštanj
TEŠ
Pohrastnik
Šembric
Velenje
Konovo
Selo
Lokovica
Pesje
PE ENERGETIKA:
Glavna energetska
razdelilna postaja
CEP
Gorica
HLADILNA POSTAJA
DALJINSKO
OGREVANJE
Podkraj
DALJINSKO
HLAJENJE

System cost comparison



Economic multiplier effects

	Heat pump (120 °C)	Heat pump (60 °C)	Biomass (120 °C)	Biomass + Solar (60 °C)	CHP biomass (60 °C, 20ct)	CHP biomass (60 °C, 25ct)
Output [MEUR]	5.5	6.6	11.5	10.5	19.2	20.6
Earnings [MEUR]	0.8	1.2	3.5	3.1	5.0	5.2
Jobs	30	44	339	283	415	422

The net effect of different systems on GDP can vary significantly.
Heat pump systems depend on imported electricity and technology.
Solar and storage can be provided/constructed by local companies. Values are illustrative.

Thank you.

Overview on best practises examples for DHC and sector integration
(Anna Kallert, Fraunhofer IEE)

IEA DHC Annex TS 3 - Hybrid Energy Networks:

District heating and cooling networks in an integrated energy system context

Analysis and comparison of different case studies (Subtask C)

TS3 Webinar on “Hybrid Energy Networks”, April 27th, 2021

Prof. Anton Ianakiev

School of Architecture Design
and the Built Environment
Nottingham Trent University
England, UK

Dr. Anna Kallert

Head of research group
Urban Heat Systems
Fraunhofer IEE
Germany

Main Targets

The objective is to **illustrate by selected case studies** in which circumstances which **potential and synergies for integrated DHC networks** exists and which technical, economic, organizational and legislative steps, concepts and solutions are necessary and available **for successful implementation** and **avoidance of bottlenecks**.

- Collect best practice examples for realized integrated DHC systems
- Provide examples for integrated DHC systems based on simulation based on simulation etc.
- Criteria for description, analysis and evaluation of best practice examples
- Development practice guidance for transforming existing DHC systems into in integrated ones / developing new integrated DHC systems

Deliverables

- Overview and online **documentation of Best Practice Examples** including a preliminary analysis and evaluation
- **Report on Best Practice Examples** including recommendations for implementation
- **List of criteria and indicators** on technical, economic, organizational and legislative aspects
- **Practical guidance** for archetypal situations and boundary conditions

Currently there are 12 case studies from

- Denmark,
- Great Britain,
- Germany,
- Austria and
- Sweden

recorded and documented!

Lagarde - Bamberg (Germany)

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

- Conversion of military site into residential and business district
- Ultra-low temperature district heating for new buildings (10 °C) and existing network for existing buildings
- Use of geothermal collectors, pipes (heating network) and fresh water for cold district heating
- Decentralized heat pumps and PV collectors for space heating and domestic hot water
- Investigation of sector coupling potentials and concepts for e-mobility

STWB STADTWERKE BAMBERG Fraunhofer IEE BCI BUILD. ING

→ Approach for analysis of hybrid energy networks: Electrical network for coupling the heat supply systems

→ Preparations for the implementation of the energy concept are currently underway!

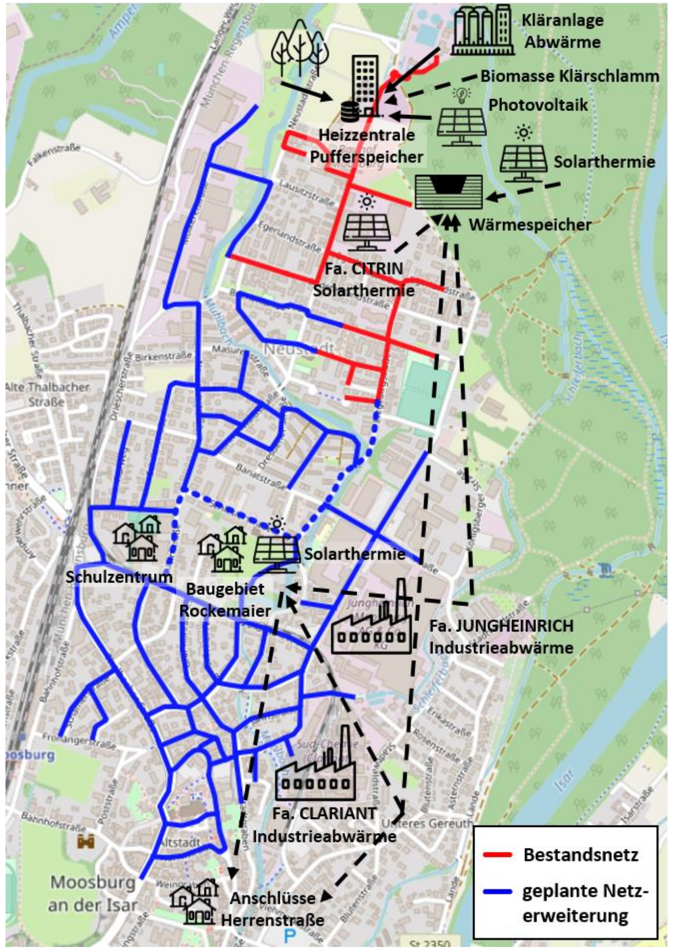
Gefördert durch: Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages

Moosburg an der Isar (Germany)

- Transformation and expansion of an existing heating network
- Utilization of industrial waste heat at rather low-temperature
- Heat supply by solar thermal system and decentralized heat pumps
- Seasonal and short-term thermal energy storage are used for load-shifting
- Cascading for the appropriate reduction of the temperature level

→ Approach for analysis of hybrid energy networks: Electricity market-appropriate feed-in of energy from PV (power-to-heat)

→ Preparations for the implementation of the energy concept are currently underway!



2050 Homes, a hybrid energy network in Nottingham (Anton Ianakiev NTU, UK)

2050 Homes,
a hybrid energy network in Nottingham, UK

(development supported by EU REMOURBAN project)

Professor Dr. Anton Ianakiev

Nottingham Trent University

Hybrid Energy Networks

2050 homes retrofitting innovation activities

As part of the retrofitting programme it is proposed to refurbish terrace blocks of 27 three/two bedroom **William Moss Cross Wall** houses at West Walk, Sneinton to a high standard of energy efficiency, aiming to be as close as reasonably possible to the **EnerPHit** standard.

By integrating Renewable Energy Sources (RES), the energy demand of buildings can be met by local energy microgeneration. This involves upgrading with new outside walls and windows, a solar roof, and state of the art heating system. This will radically change their energy consumption so that these homes generate almost as much energy as they use**.**

Hybrid Energy Networks

2050 homes retrofitting innovation activities

- Development of scalable ‘2050 homes’ concept.
- Properties in the area are (65%) social housing, owned by Nottingham City Council (NCC),
- Interventions include solid wall retrofitting plus **hybrid heating system** (local energy centre)
- In the **hybrid heating systems** the interconnection between PV, electrical and heating networks achieve electrification of the heating.
- Reduced carbon footprint by replacing 27 x 24 kW combi gas boilers with 138 kW GSHP with nine 135m boreholes and 12m^3 thermal storage.
- 27 PV roof plants with electrical storage of 40kW. Space heating at 42°C and DHW supplied at 50°C.

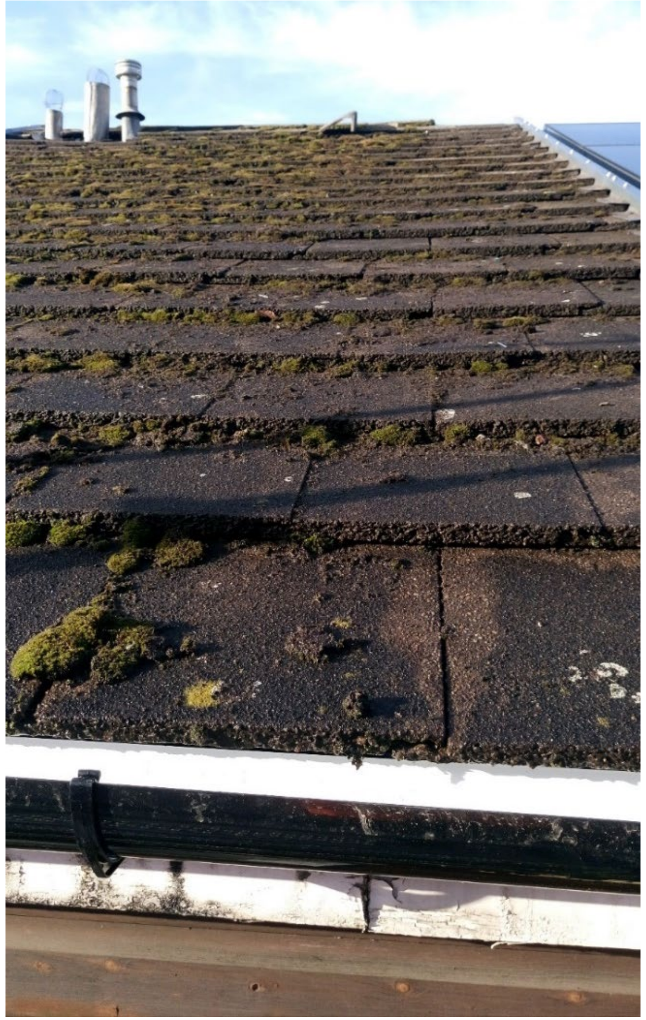
Hybrid Energy Networks

2050 homes retrofitting innovation activities

Installation of insulation panels

Hybrid Energy Networks

2050 homes retrofitting innovation activities



The roof before and after PV panel instalation

Hybrid Energy Networks

2050 homes retrofitting innovation activities

Bore Holes drilling (5 x 135m)

Hybrid Energy Networks

2050 homes retrofitting innovation activities

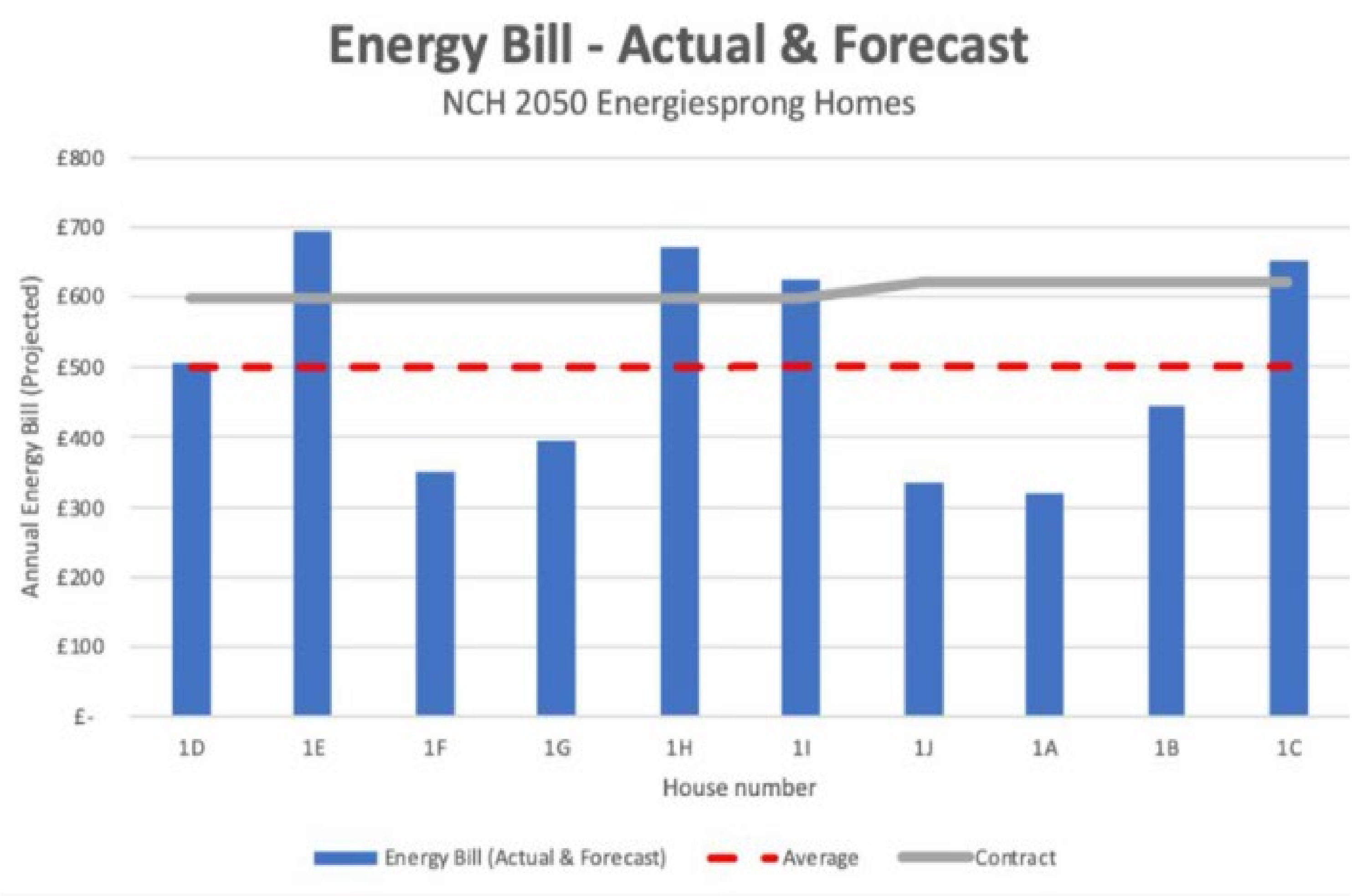
Energy Centre - installation

Hybrid Energy Networks

Energy Centre– 2050 homes

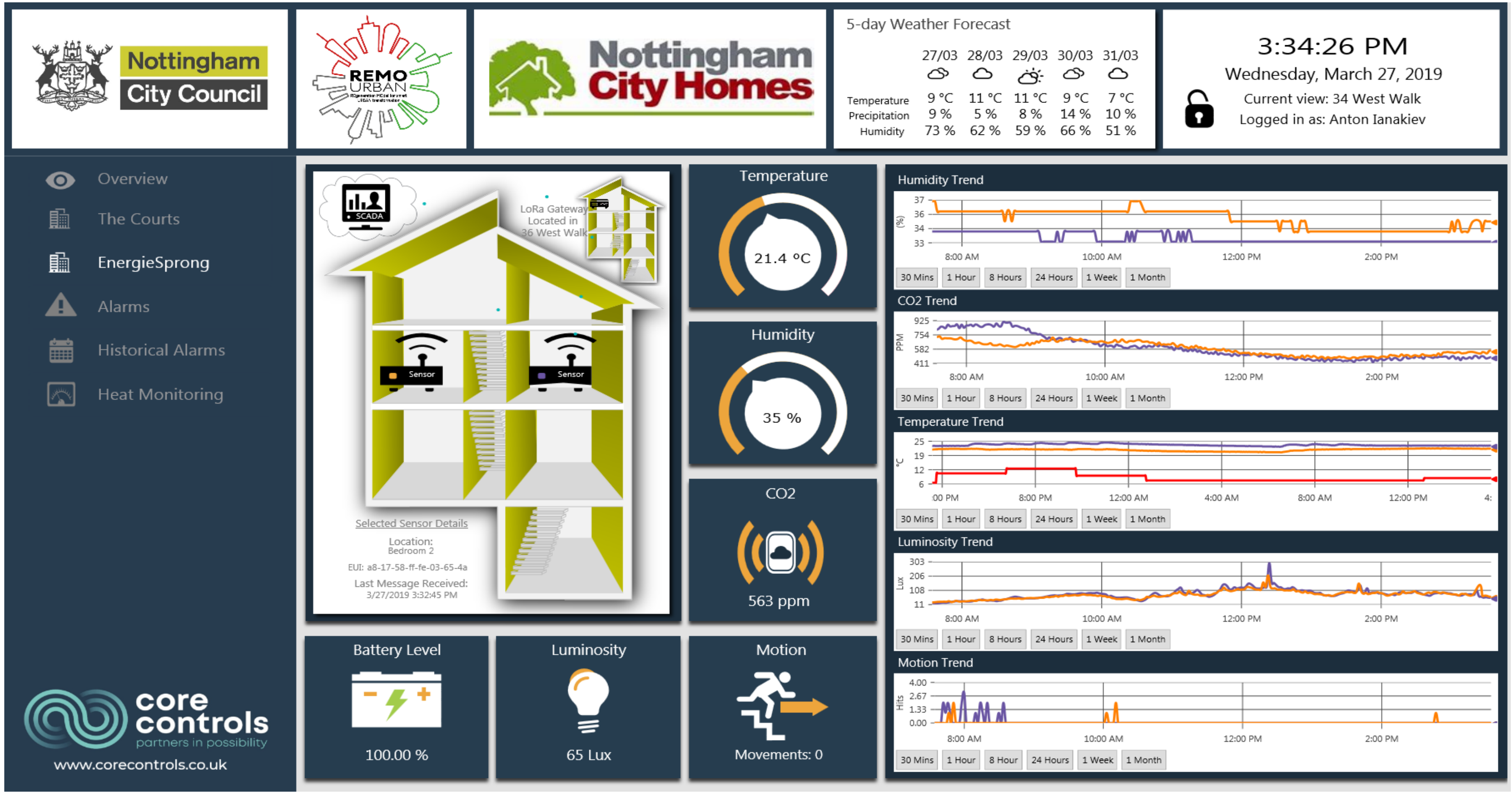
2050 homes 3 ground source heat pumps onto communal network, with 6 large thermal stores, and thermal stores in each property. Fully commissioned and operational. Used as part of strategy to take homes off grid at peak times. Courts LTDH now designed up to 80% efficiency.

2050 Homes Monitoring Programme Definition



Hybrid Energy Networks

2050 Homes Monitoring Programme Definition



Hybrid Energy Networks

Retrofitting the district – 2050 homes

Before

After

Hybrid Energy Networks

2050 homes as Nottingham DEMO Case

- The 2050 homes - low energy buildings can be viewed as self-sufficient approach to transform buildings to be independent from external non-renewable sources. It is economically sustainable and can be develop into a financial model to repay for the intervention by the energy savings.
- The heating and electricity systems and integrated into single hybrid energy system
- The offset the energy consumption by producing energy on the spot and use it in the house in the bigger energy picture will have similar to Passivhaus effect.
- This is not only technical solution but also a financial model. The investment for the retrofitting will be repaid by the energy savings.

Hybrid Energy Networks

The impacts of the hybrid low temperature heating systems:

- reduced energy consumption from the main network
- use of renewable energy sources
- electrification of heating networks
- reduced heat losses and heating bills
- minimum CO_2 impact on environment
- improved living comfort

International Energy Agency – District Heating and Cooling

Task share annex on
HYBRID ENERGY NETWORKS – (2018-2021)
Lead by Austrian Institute of Technology

REMORBAN included as demonstration of Hybrid Energy Networks
NTU as subtask lead

note on other events

IEA DHC | CHP

DHC Industry

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY TOMORROW TODAY

Invitation to the Webinar on

IEA DHC Annex TS7: Industry-DHC Symbiosis

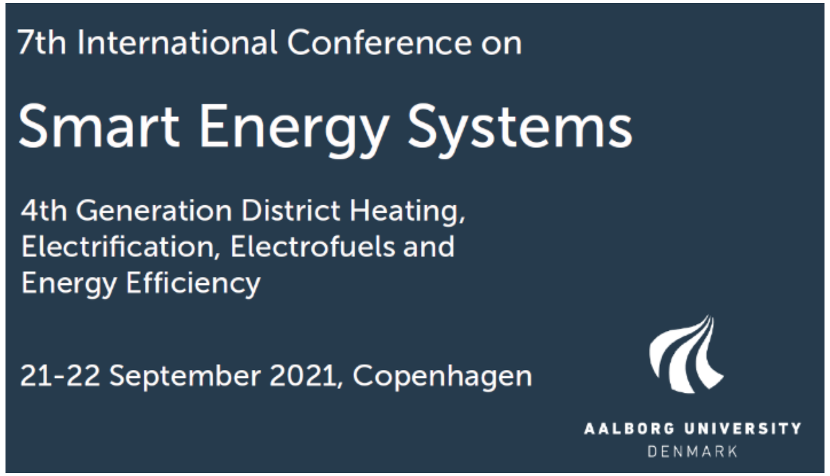
"A systemic approach for highly integrated industrial and thermal energy systems"

Friday, 30th April 2021, 12.30 to 15.30 (CET)

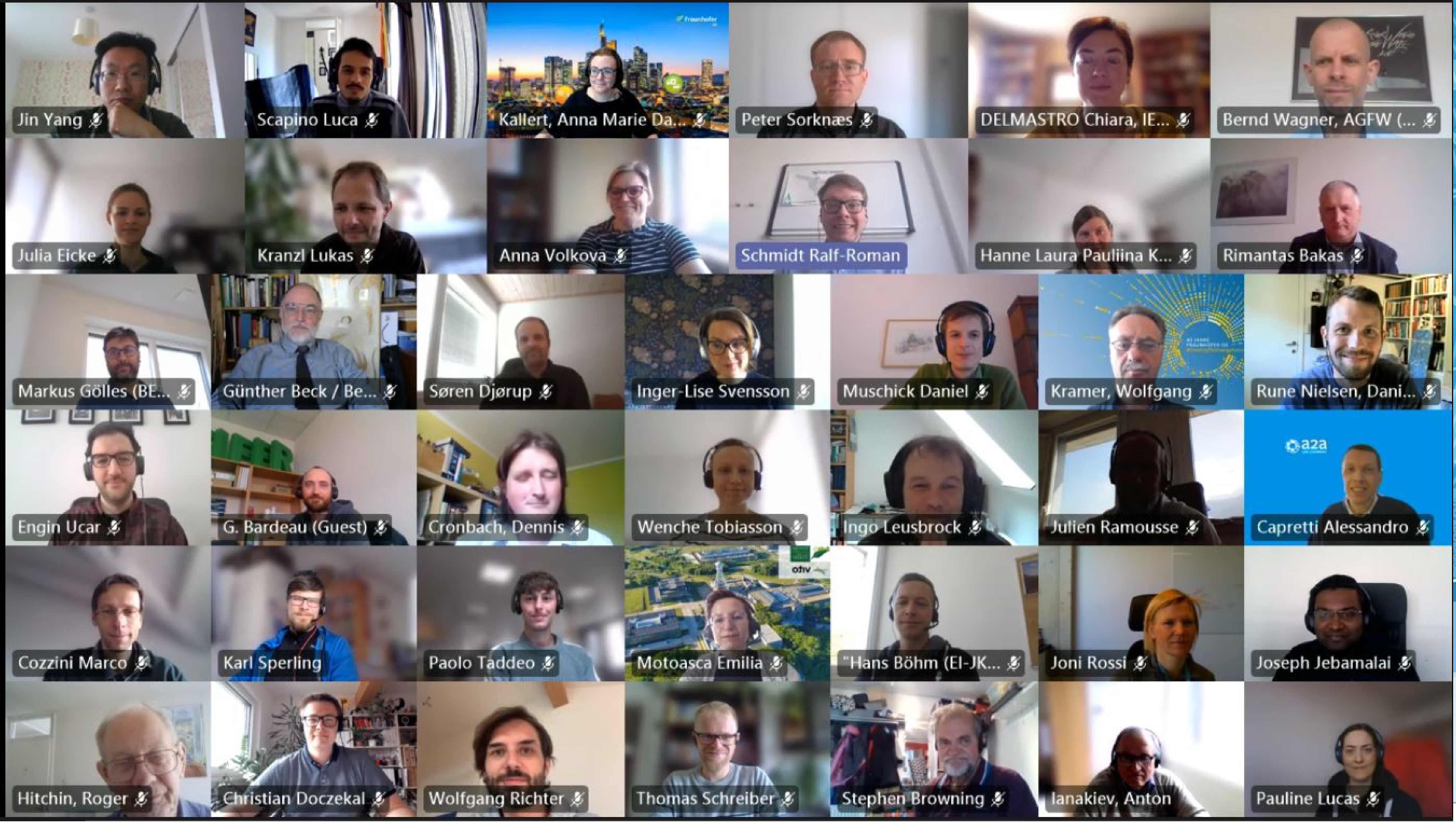
https://missioninnovationaustriaweek.at/events/industry-dhc-symbiosis-a-systemic-approach-for-highly-integrated-industrial-and-thermal-energy-systems/

https://www.nefi.at/new-energy-for-industry-2021/

http://dhc2021.uk/



https://smartenergysystems.eu/



IEA DHC|CHP

INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME ON
DISTRICT HEATING AND COOLING INCLUDING COMBINED HEAT AND POWER

Thanks for your active participation!

- **The slides will be available at http://www.iea-dhc.org/the-research/annexes/2017-2020-annex-ts3-draft.html**
- **Contact: Ralf-Roman Schmidt (AIT); ralf-roman.schmidt@ait.ac.at**