Digitalisation technology for district heating

4th workshop on district heating Antwerp
28 November 2023

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Digitalisation in DHC

Definition: What makes a heat network a digital heat network?

No univocal definition yet…

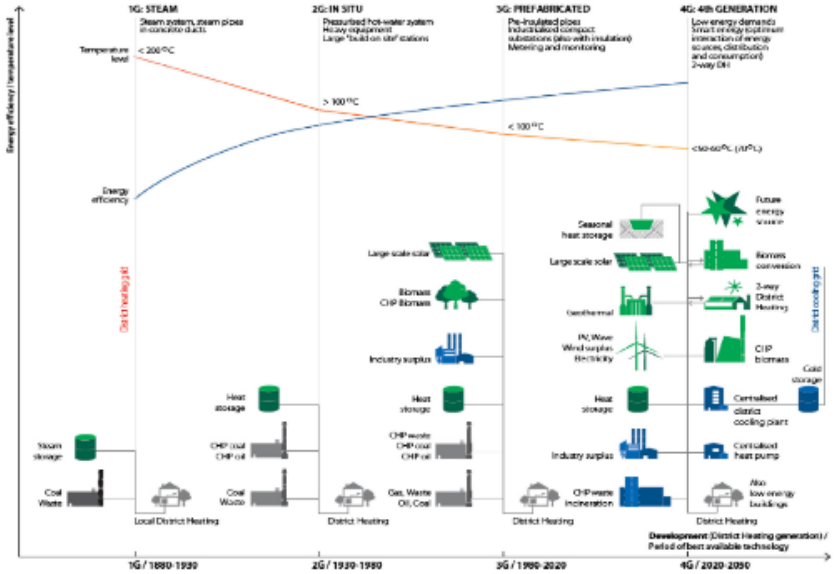
…but some criteria:

- Large number of sensors present in the network
- Automated recording, transfer and storage of data
- Automated analyses of data
- The analyses are used:
  - Not only automated billing
  - But to optimize the network operation

Digitalisation in DHC

The importance of digitalisation

- Digitalisation is a prerequisite in 4th generation heat networks
- Digitalisation makes heat networks
  - More sustainable
    - More renewable energy, more excess heat, lower temperature levels
  - More reliable
    - Safe guarding systems for heat networks
  - More profitable
    - Lower losses
    - Reduction of expensive fossil fuel consumption
    - Optimal usage of CHP, heat pumps,…



Source: Lund H. Werner S. et al. 4th Generation District Heating (4GDH) Integrating smart thermal grids into future sustainable energy systems. Energy 68 (2014) 1-11

Digitalisation in DHC

From data…

Machine
(e.g. control systems and optimisation models)

Data

Digitalisation in DHC

From data…

to information…

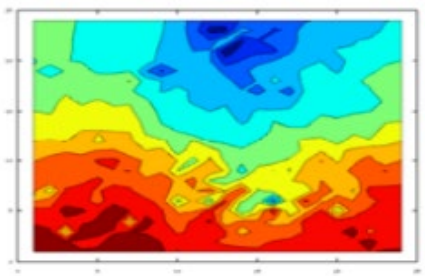
Machine
(e.g. control systems and optimisation models)

Human, expert
(e.g. utilities, energy system operators and certain building owners)

Data

Information

Technology example: Machine Learning and data mining



Digitalisation in DHC

From data…

to information…

to knowledge…

Machine
(e.g. control systems and optimisation models)

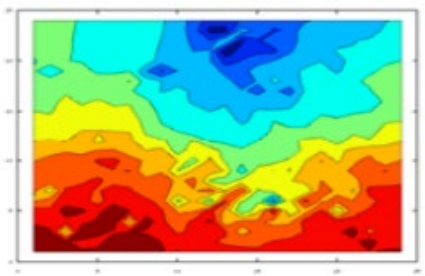
Human, expert
(e.g. utilities, energy system operators and certain building owners)

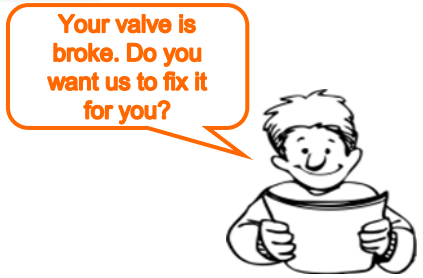
Human, non-expert
(e.g. end customers and most building owners)

Data → Information → Knowledge

Technology example: Machine Learning and data mining

Technology example: Natural language generation





Digitalisation in DHC

From data… to information… to knowledge… to wisdom

Machine
(e.g. control systems and optimisation models)

Human, expert
(e.g. utilities, energy system operators and certain building owners)

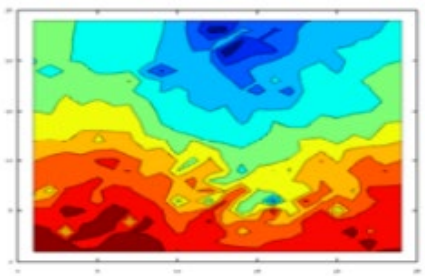
Human, non-expert
(e.g. end customers and most building owners)

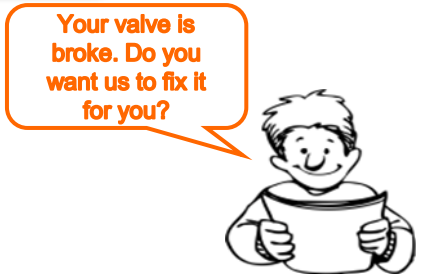
Human, policy makers
(e.g. basis for long-term strategy and policy)

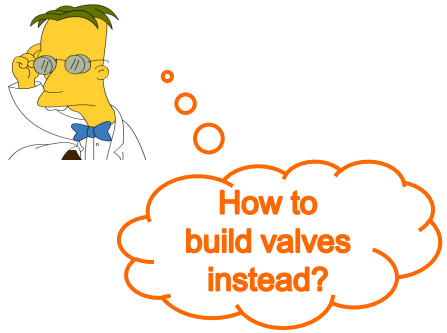
Data → Information → Knowledge → Wisdom

Technology example: Machine Learning and data mining

Technology example: Natural language generation







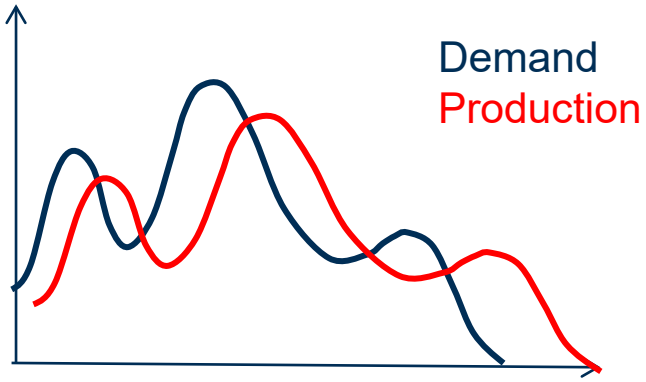
Digitalisation solutions for the entire supply chain

Production level

The challenge: Integration of highly fluctuating sources (e.g. solar heat, excess heat), peak shaving

The solution: smart network controllers

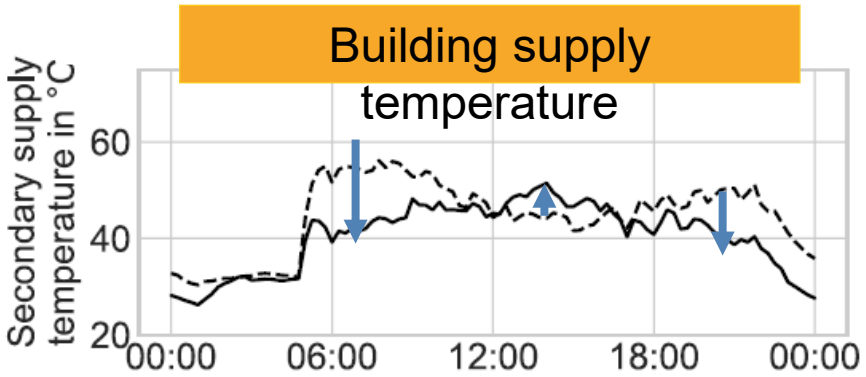
- Influencing the demand profile by ‘activation’ of available flexibility in the network
  - Thermal storage buffers
  - ‘Intrinsic’ flexibility (buildings, water in network)
- Aim:
  - Peak shaving
  - Support of the electric grid (CHP, HP, ORC)
  - Maximisation of profits (CHP) / minimisation of costs (HP)
  - Plant scheduling



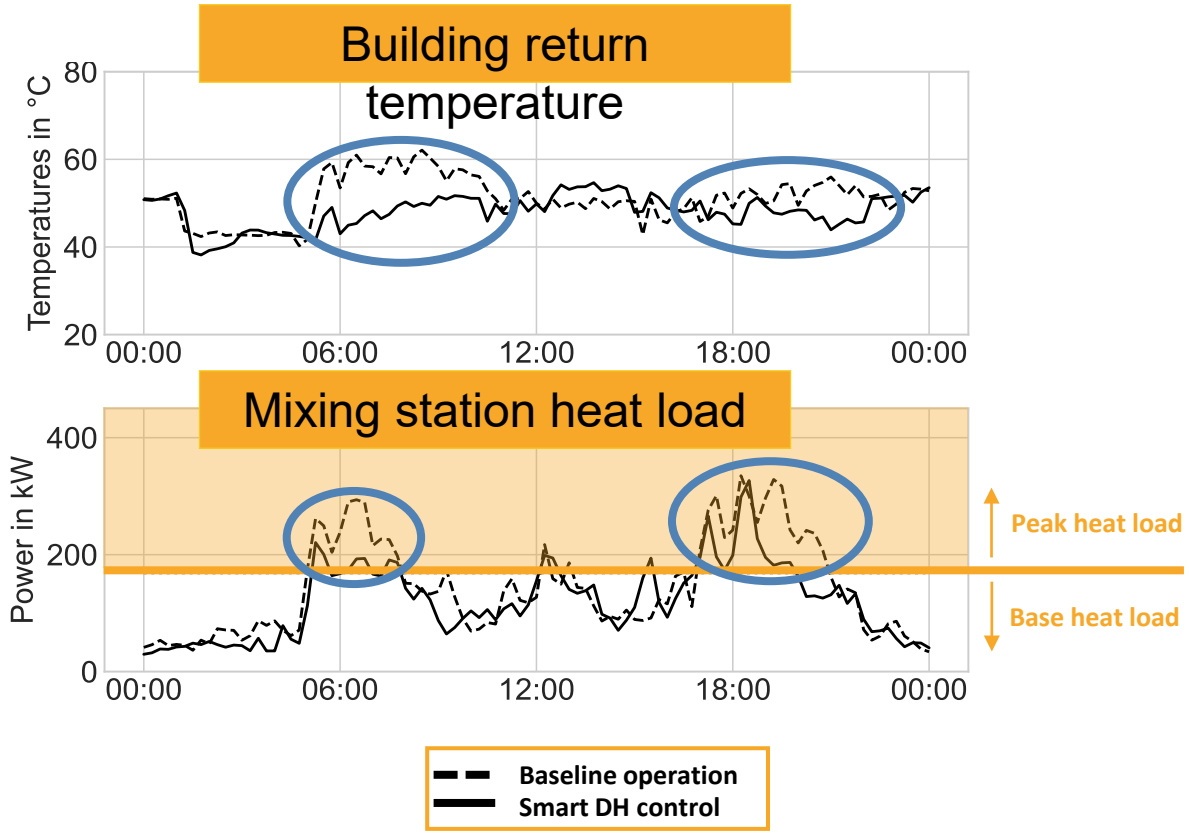
Digitalisation solutions for the entire supply chain

Results from a case study in Brescia, Italy

- Example:
  - Automated building demand response
  - Temporary load reductions during morning and evening peak times



November 5th, 2021 (test) compared with November 9th, 2021 (baseline)



Digitalisation solutions for the entire supply chain

Distribution level

Additional digital functionalities:

- Operational analysis and predictive maintenance
  - Identify bottle necks in the network
  - Leakage detection
- Management of under-dimensioned piping systems
- Pressure optimization
  - Dynamic instead of static pressure head
- Operational thermal optimization
  - Dynamic supply temperature control
  - The network pipes as thermal storage

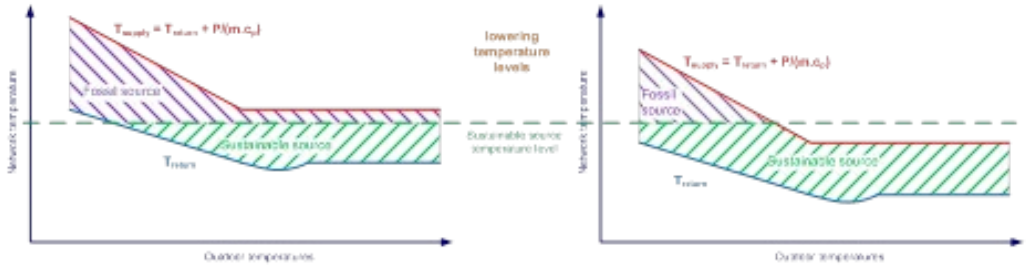
Digitalisation solutions for the entire supply chain

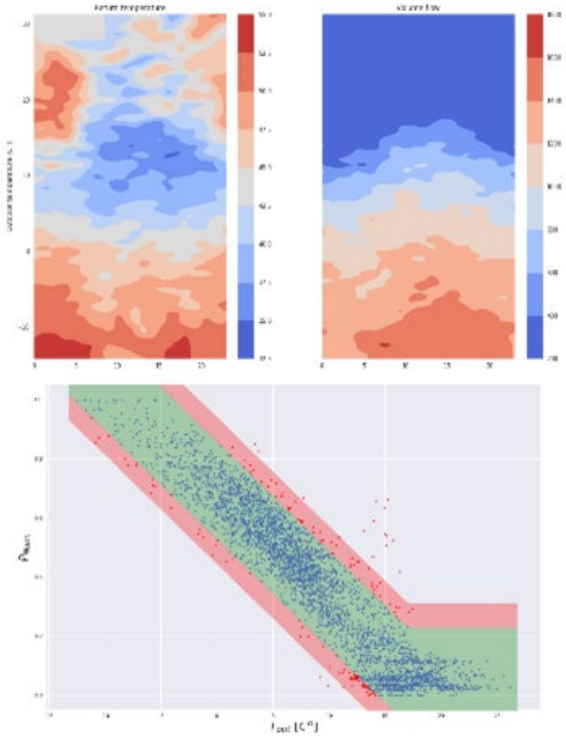
Building level

Since heat networks are demand driven, the building level is crucial for the whole network.

Smart meters for:

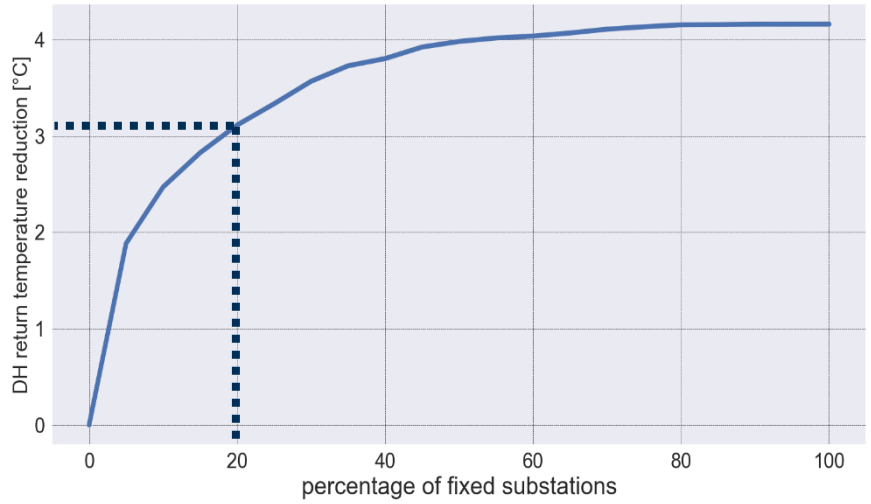
- Detection of faulty installations
  - Poorly performing substations
  - Faults in HVAC systems, i.e. leakages, anomalous consumption
- Inefficient use of resources
  - Peak loads
- Minimization of return temperature to promote LT sources

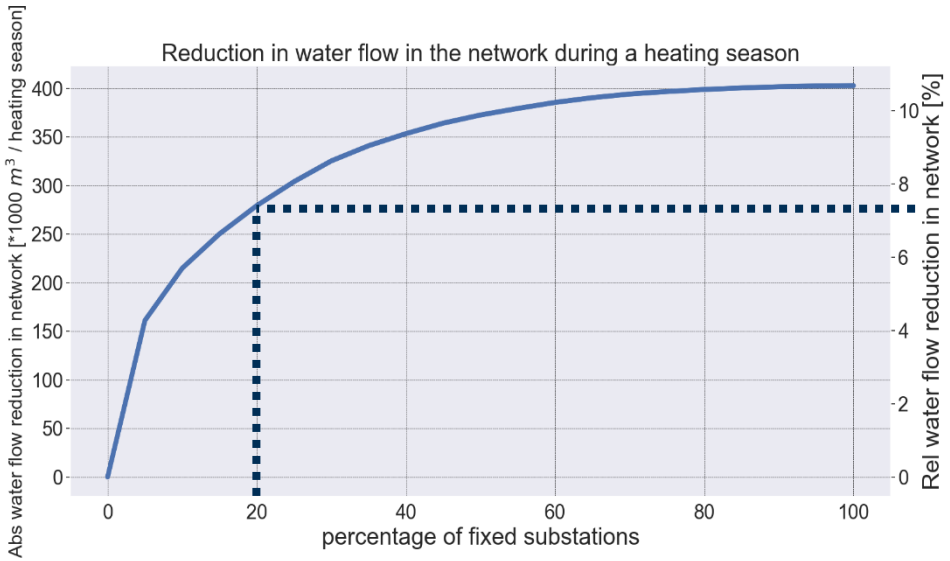


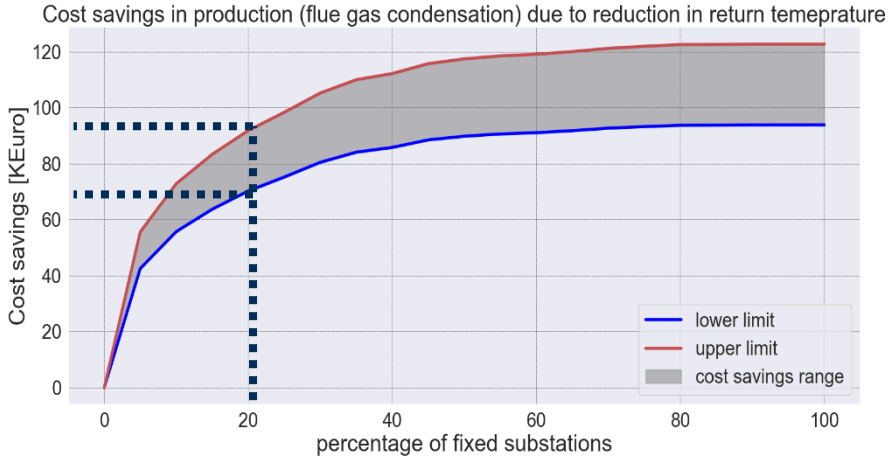


Digitalisation solutions for the entire supply chain

Result of a case study of 60 buildings







If 20% of building installations fixed:

- Return temperature reduced by 3 ºC
- Total volume flow reduced by 7.5% → Electricity consumption of pumps reduced
- k€ 70-90 operational cost savings

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Digitalisation solutions for the entire supply chain

Consumption level

Visualisation tools for end-users

- Increasing awareness of end-users' energy consumption
- Suggestions of energy savings
- Optimize behaviour of optimal het network operation
  - Night setback issue

Digitalisation solution for the entire supply chain

Design and planning

Source: EM Magazine

Planning of DH networks is not straightforward, since it depends on many technical and non-technical conditions. Therefore, optimum planning is challenging.

Digitalisation can support the decision making process by:

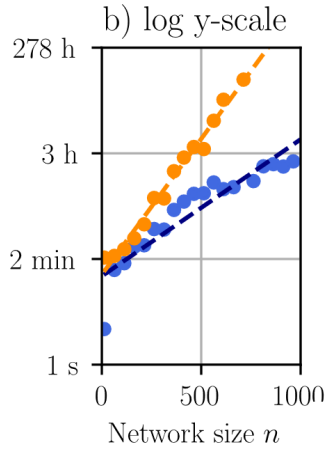
- Tools to dynamically simulate the network behaviour
- Tools to provide optimal type, routing and dimensioning of the network, and the temperature levels
- Tools to support the design of hybrid solutions:
  - DH in combination with PV, solar thermal, (micro-)CHP, batteries, heat pumps, storages on central or decentralised level

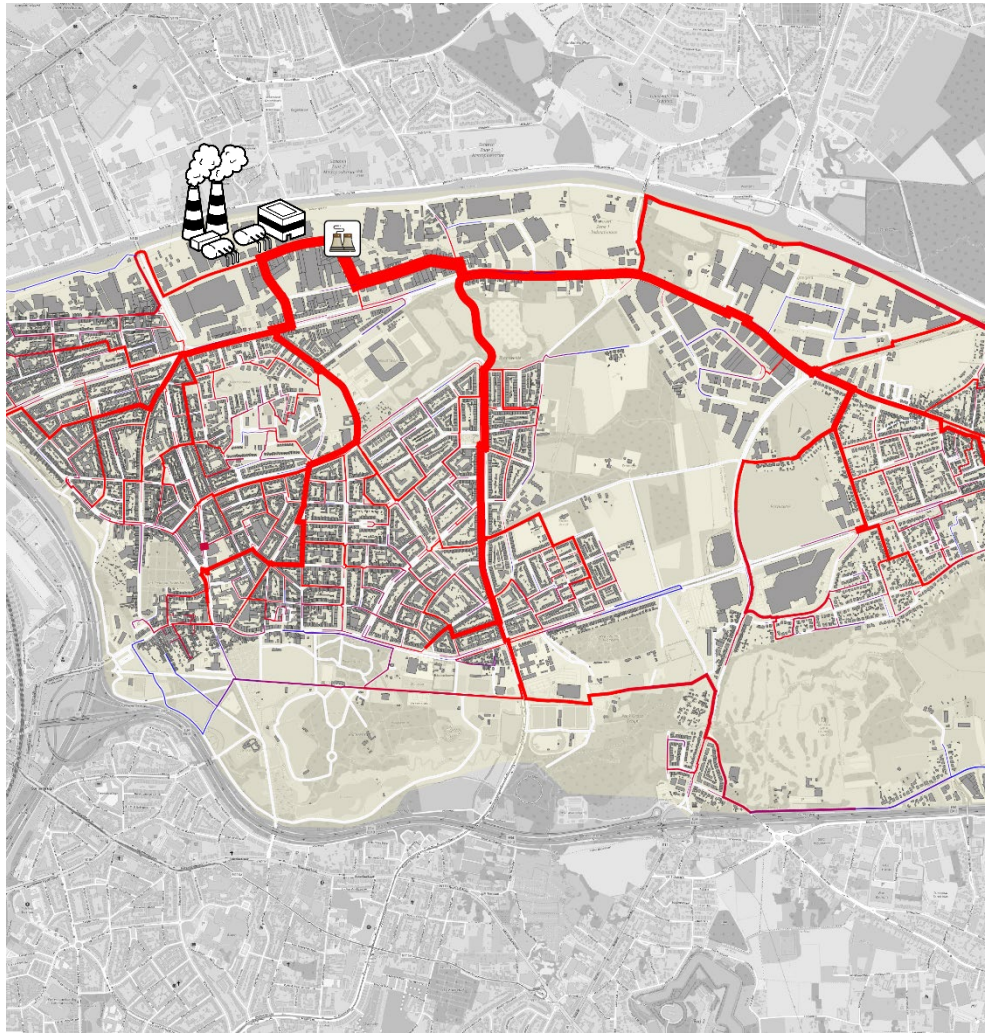
Digitalisation solution for the entire supply chain

Design and planning

PathOpt:

- Optimized network layout and pipe dimensioning
- Optimized heat capacity sizing
- Detailed thermo-hydraulic information
  - Temperatures, flows and pressures at any location
- Project economics CAPEX, OPEX, LCOH
- Way faster can other solvers





More information on digital solutions in DHC

- DHC+ Digital Roadmap on District Heating and cooling (Jul 2019)
  - https://www.euroheat.org/resource/digital-roadmap-for-district-heating-and-cooling.html
- DHC+ Report on Digitalization in DHC systems (May 2023)
  - https://www.euroheat.org/resource-report/digitalisation-in-dhc-systems.html
- IEA-DHC TS4 Guidebook (Nov 2023)
  - TS4 Guidebook (iea-dhc.org)

Conclusions

- Digital technologies will become very important in new and existing DHC networks
- Digital technologies are available in the entire DHC supply chain
- Results of pilot projects show very promising results
  - 70-90 kEuro per year in 60 buildings case study
  - Daily peak energy reduction: 60%-70% of baseline peak energy

Thank you!
Questions?

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