## Webinar Digitalization for optimizing integrated district heating systems

# Block II: Digitalization of district heating systems

This Webinar is held in the framework of two international cooperation programs:

IEA DHC Annex TS3 “Hybrid Energy Networks“

IEA DHC Annex TS4 “Digitalisation of District Heating and Cooling“.

**9. September 2020**

Ralf-Roman Schmidt AIT, Austria, ralf-roman.schmidt@ait.ac.at (leader TS3)

Dietrich Schmidt, Fraunhofer IEE, Germany, dietrich.schmidt@iee.fraunhofer.de (leader TS4)

Fraunhofer IEE

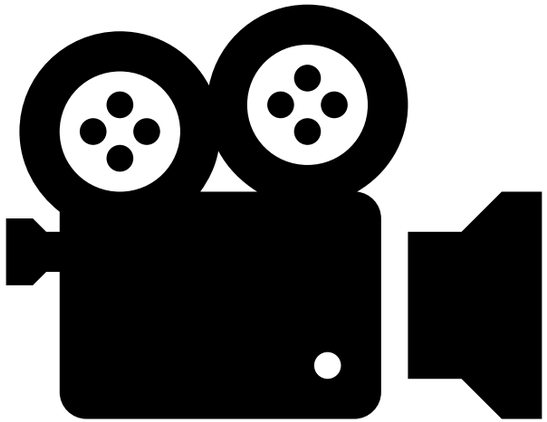
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

*More information at*

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

*http://www.iea-dhc.org/the-research/annexes/2017-2020-annex-ts3-draft.html*

# This webinar is recorded



The video file will be available after the webinar on the IEA DHC YouTube channel
https://www.youtube.com/channel/UCuYcqLjJi8thrUJCjzLBaow

We will have a "group photo" at the end of the webinar, so please be prepared to turn on your webcam (participation voluntarily)

# Webinar Etiquette

- **The microphone should be muted by default**
  - They should only be switched on if you are speaking.
- **Only one person speaks at a time**.
  - Requests to speak are reported via chat ("**rts**"),
  - the moderator will ask then the speakers to speak.
  - Please state your name and institution before you speak
- **Please turn off your webcam**!
  - No general video transmission in order to reduce the bandwidth.
  - The camera can be used at short notice for spoken contributions.
  - We will make a “group-photo” at the end of each block
- **Caution with humor and sarcasm!**
  - much of the original effect between the lines can be lost

# Agenda Block II - Digitalization of district heating systems

| | |
|---|---|
| **12:00** | **Testing of technical connections** |
| **12:30** | Introduction into the IEA DHC Annex TS4 project (Dietrich Schmidt, Fraunhofer IEE) |
| | The era net call on digitalization (Michael Hübner, Austrian ministry BMK) |
| | The utility perspective on digitalisation of district heating (Bernd Rüger & Karina Nold, Stadtwerke München) |
| | Digitalisation solutions for heat infrastructures (Martin Brüssau, SAMSON) |
| | Business opportunities from digitalisation (Steen Schelle Jensen, KAMSTRUP) |
| | Interactive session and Q&A to all presenters |
| **14:00** | **End of Block II** |

# Agenda Block III - Hybrid energy system

| | |
|---|---|
| **15:00** | **Testing of technical connections** |
| **15:30** | Introduction into the IEA DHC Annex TS3 project (Ralf-Roman Schmidt, AIT) |
| | Technologies for Hybridisation (Oddgeir Gudmundsson, Danfoss) |
| | GIS-based automated design of DH networks (Joseph Jebamalai, Comsof) |
| | Sector coupling between hydrogen and district heating (Hans Böhm, EI Linz) |
| | Interactive session and Q&A to all presenters |
| **17:00** | **End of Block III** |

# Introduction into the IEA DHC Annex TS4 project

***(Dietrich Schmidt, Fraunhofer IEE)***

Technology Collaboration Programme
by IEA

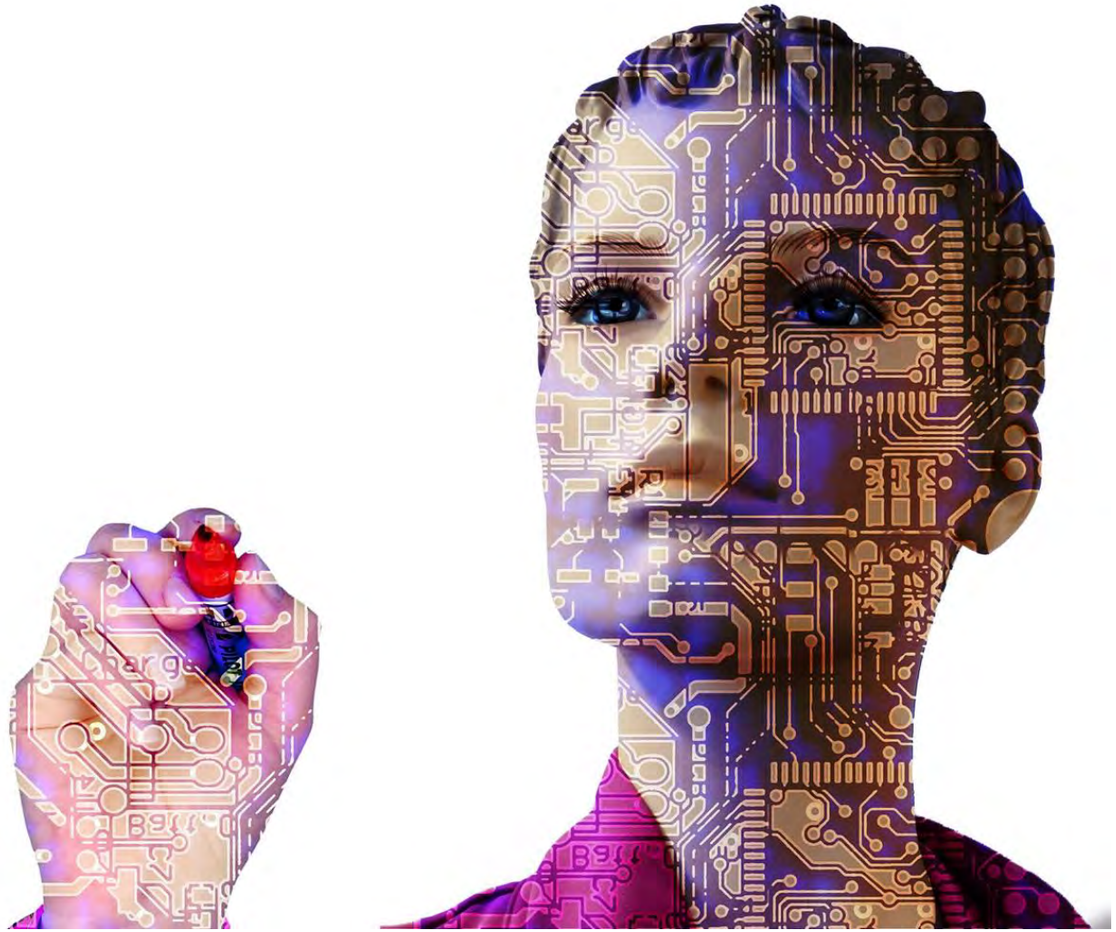
# IEA DHC Annex TS 4:
# Digitalisation of District Heating and Cooling:
## Optimised Operation and Maintenance of District Heating and Cooling Systems via Digital Process Management

**9th of September 2020**

**Dr. Dietrich Schmidt**
Fraunhofer IEE

Fraunhofer IEE

# Our future Energy system will be digital!



# Background: Digitalisation

- District heating and cooling networks are **traditionally** operated with a limited number of controls.
- A wider implementation of information and communication technologies, as in many other industries, opens up for better network management based on real time measurement data.
- **Opportunities**:
  - offering flexibility by integrating digital processes and demand side management (peak shaving)
  - Enabling the integration of fluctuating heat sources (renewables)
  - New business models for district heating provider

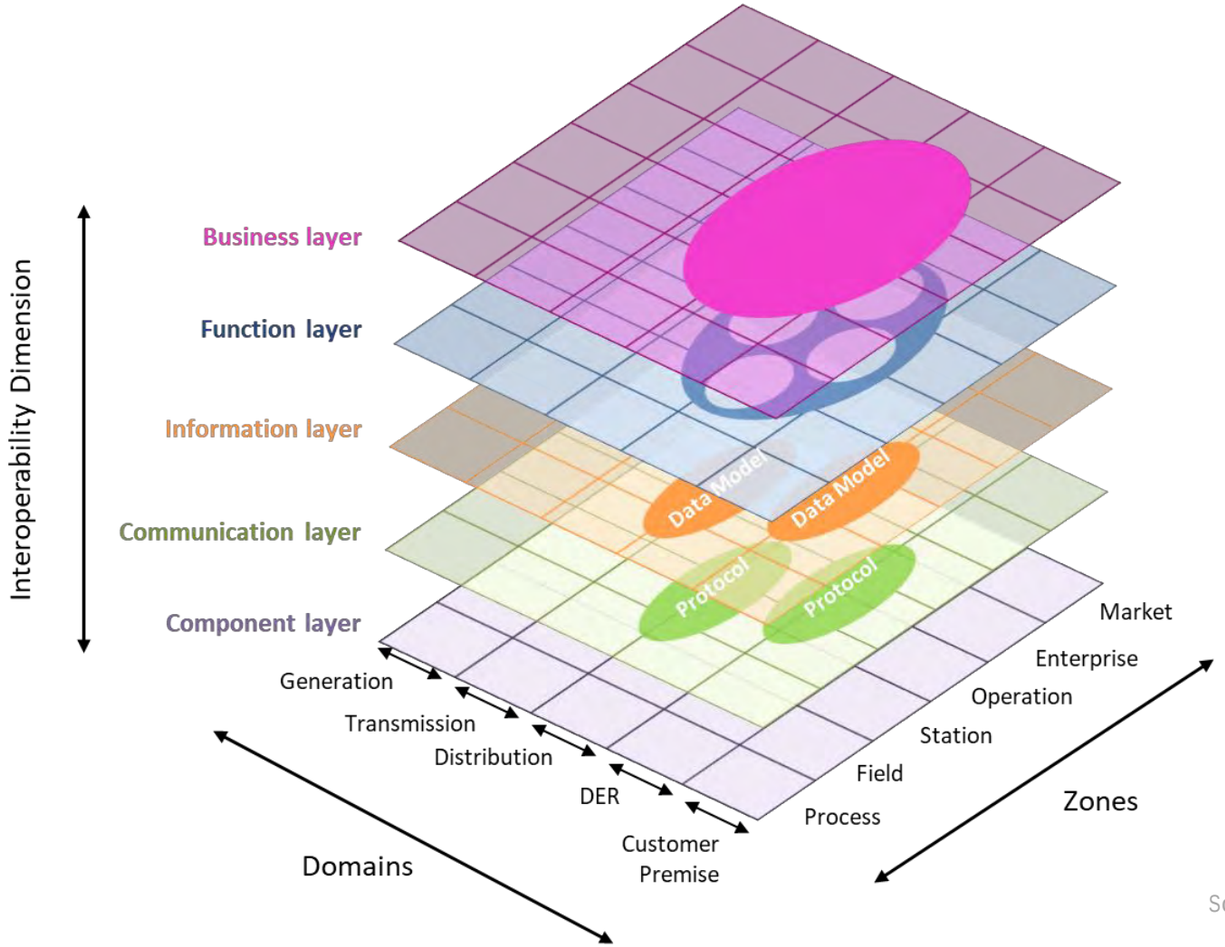
# Aim of the proposed DHC Annex

- The new project aims at **promoting the opportunities** of the integration of digital processes into DHC schemes and to clarify the role of digitalisation for different parts within the operation (and maintenance) of the district heating and cooling system.
- Furthermore, the implementation of these technologies is going to be **demonstrated**.
- On the other hand **new challenges** need to be tackled, such as data security and privacy as well as questions about data ownership.

# principle goals of the task shared Annex

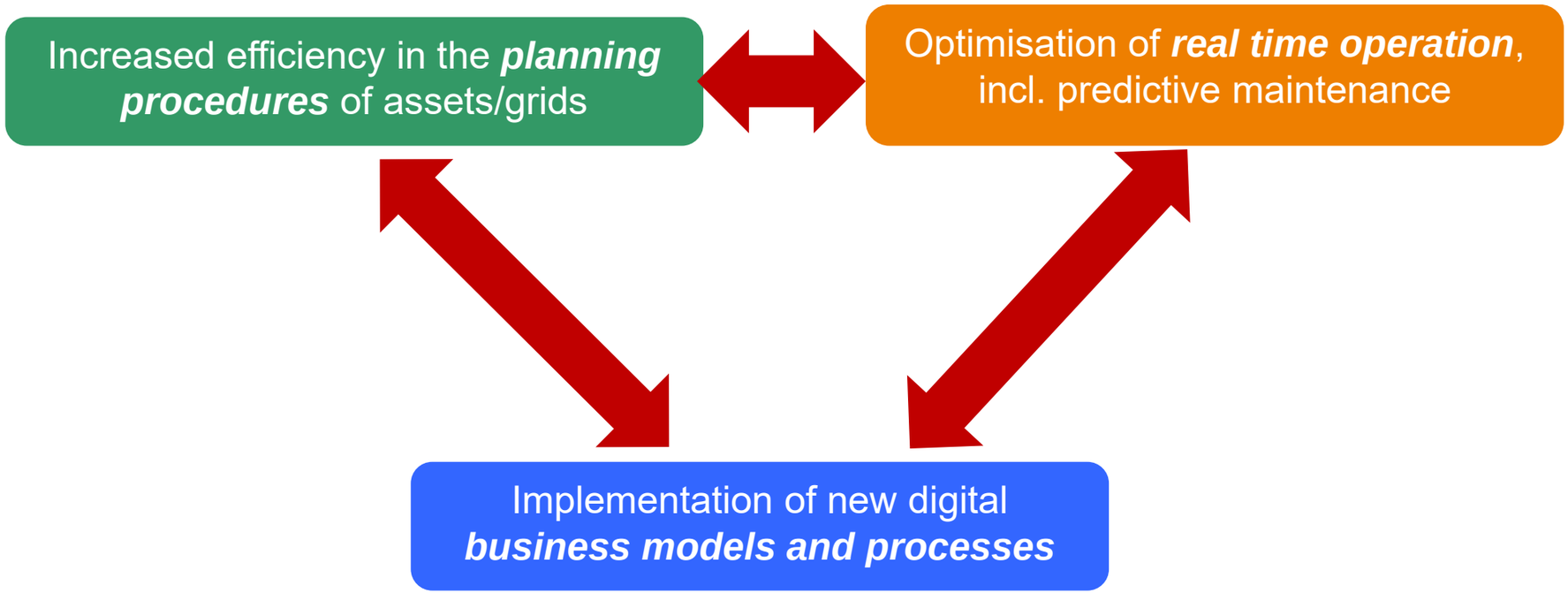
- **Create** awareness for the advantages of the implementation of digital processes to the various stakeholders and users
- **Provide** a state-of-the-art overview of the digitalisation of district heating schemes in terms of R&D projects, demonstrators and case studies
- **Evaluate** non-technical barriers and enablers for digitalisation processes in district heating and cooling schemes such as business models, legal aspects and policy instruments

# Digitalisation concepts

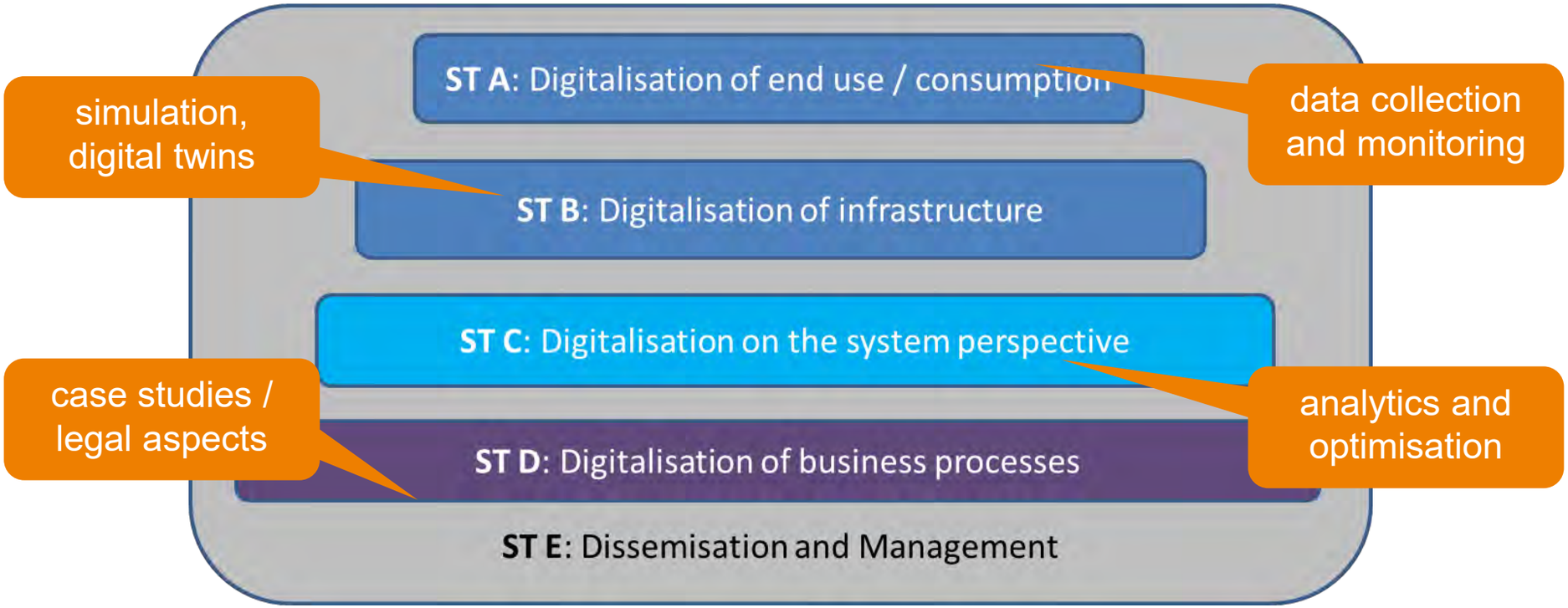



Source Fraunhofer CINES Cluster

# Our focus areas for a digitalisation in DHC



# DHC Annex TS4 working structure



# Annex TS4 1st Preparation Phase meeting

# cooperation with other initiatives

- **German Heat & Power Association (AGFW)**
  - Offer to support the upcoming Annex via different means
  - Strong interest to support the dissemination
- **DHC+**
  - Offer to support the upcoming Annex via different means
  - Strong interest to support the dissemination
- **Danish Board of District Heating (dbdh)**
  - Happy to support the Annex and dissemination
- **IEA EBC Annex proposals on:**
  **“Demand Response of Buildings in DHC networks” &**
  **“Data-Driven Smart Buidlings”**
- And others…

# Thank you for your attention!

**Contact:**

**(Proposed OA:) Dietrich SCHMIDT**

**Fraunhofer Institute for Energy Economics and Energy Technology (IEE) / Germany**

**+49 561 804 1871**

**dietrich.schmidt@iee.fraunhofer.de**

# The era net call on digitalization *(Michael Hübner, Austrian ministry BMK)*

# The utility perspective on digitalisation of district heating *(Bernd Rüger & Karina Nold, Stadtwerke München)*

Stadtwerke München

# The utility perspective on digitalization of district heating
# Leakage localisation[1] and integration of geothermal energy[2]

Dr.-Ing. Bernd Rüger, Dr.-Ing. Karina Nold
09.09.2020, IEA DHC Annex TS3, TS4 Industry Workshop

SWM intern

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

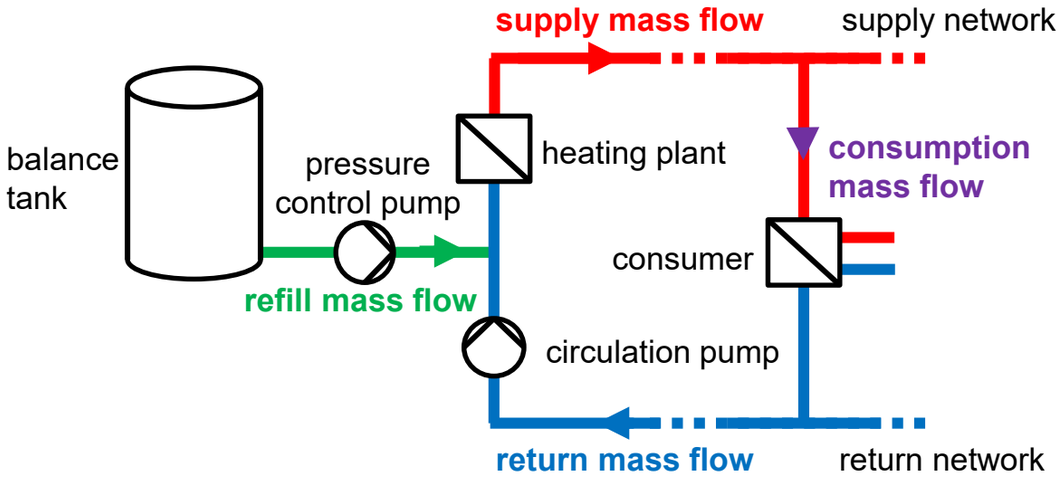
M/Wasser M/Bäder M/Strom M/Wärme M/net MVG

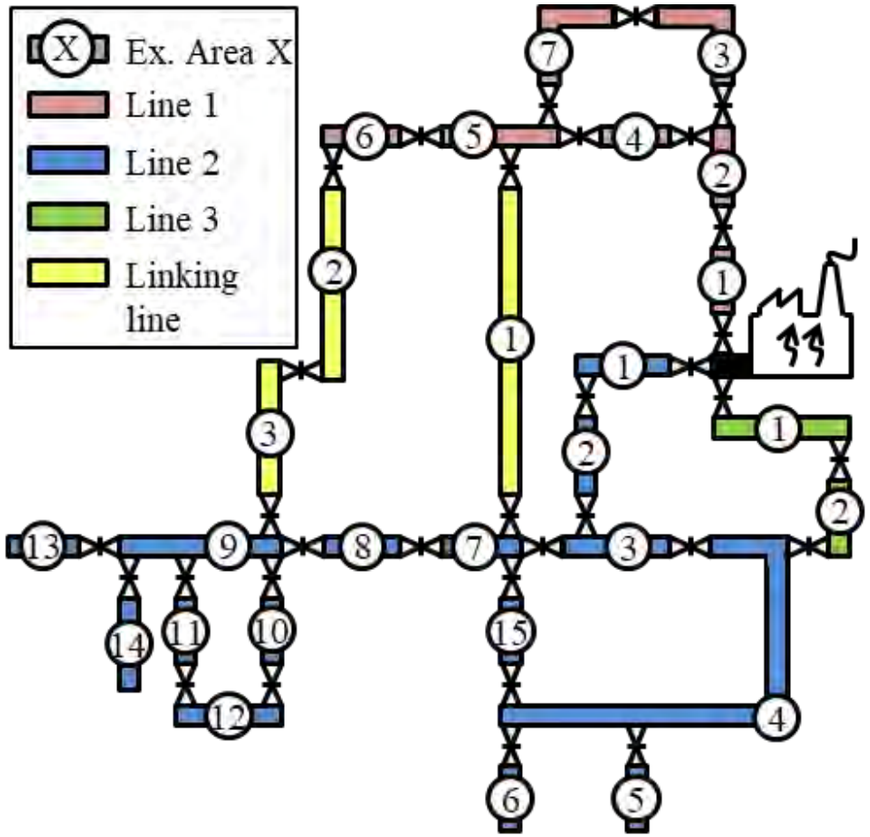
see https://www.enargus.de
[1]FKZ 03ET1624B and 03ET1236B (final report https://doi.org/10.2314/GBV:1027778887)
[2]FKZ 0324332A

# Outline

- Applications
  - Leakage localisation
  - Integration of geothermal energy
- Challenges
- Wish list R&D-projects vs. operational needs

# Fast localisation and reaction is important in case of large spontaneous leakages

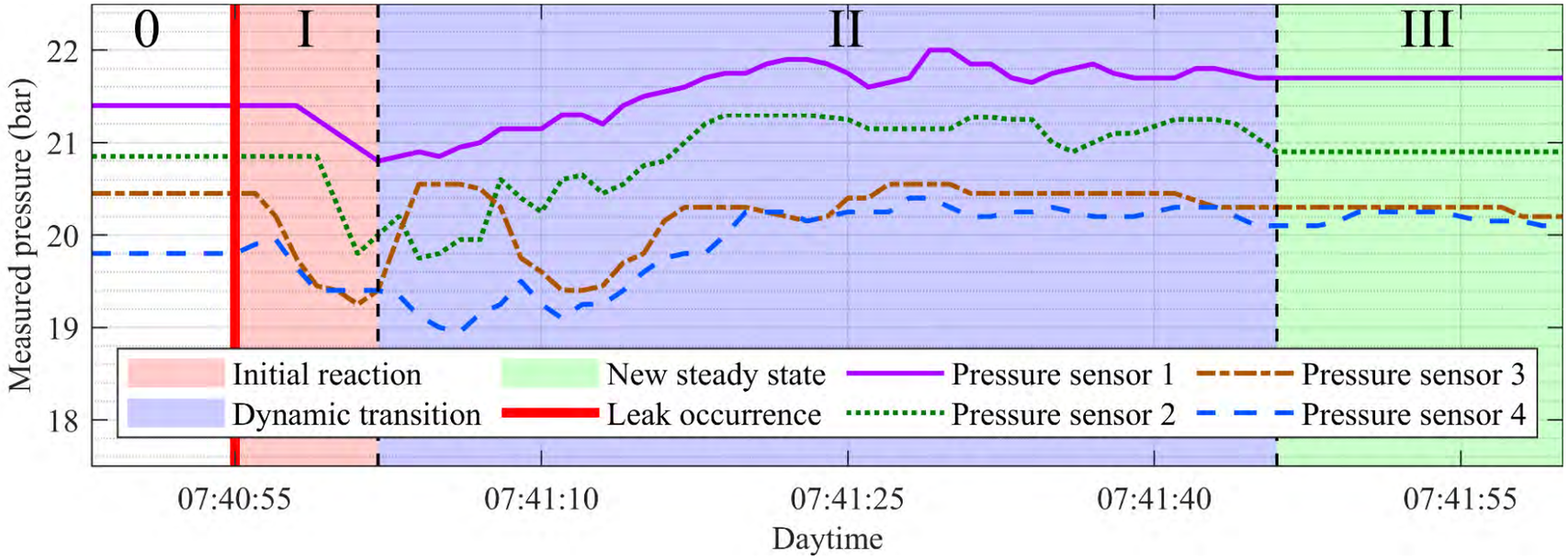



Balance tank can run empty within short time in case of large leakages
➔ imminent shutdown of network

District heating networks equipped with remote controlled motor driven valves ➔ separation is possible

# Phases after occurrence of a leakage




- **Three phases occur:**
  - I. Initial reaction – negative pressure wave travels through the network directly after leakage occurrence
  - II. Dynamic transition – pressures change due to pressure control working
  - III. New steady state – all oscillations declined
- Occurrence of a leakage changes hydraulic state of DHC networks and refill mass flow rises to compensate medium losses.

More details are presented at the
52. Kraftwerkstechnisches Kolloquium
am 06. und 07. October 2020

# Approaches for leakage localisation

Ostfalia Hochschule für angewandte Wissenschaften

iat Institut für Automatisierungstechnik

Otto von Guericke Universität Magdeburg – Fakultät für Informatik

| | Pressure wave evaluation | Numerical approach | Machine learning approach |
|---|---|---|---|
| **Phase** | o I – initial reaction | o III – new steady state | o III – new steady state |
| **Measurement data** | o Time frame with high temporal resolution | o Point in time – values with high resolution | o Point in time – values with high resolution |
| **Classification rates**<br>ideal data*<br>„real“ data* | o $Z = 100\ \%$<br>$Z \sim 71\ \%$ | o $Z \sim 70\ \%$<br>$Z \sim 46\ \%$ | o $Z \sim 89\ \%$<br>$Z \sim 62\ \%$ |
| **Features** | o Identification of pipe possible with ideal data | o Classification result depends on leakage size | o Classification result depends on ML method |
| **Contact information** | o Kai Vahldiek<br>k.vahldiek@ostfalia.de | o Dennis Pierl<br>dpierl@iat.uni-bremen.de | o Julia Koltermann<br>julia.geissler@ovgu.de |

*ideal data = simulated with appropriate models without noise; real = ideal data with noise added (but not measured data!)

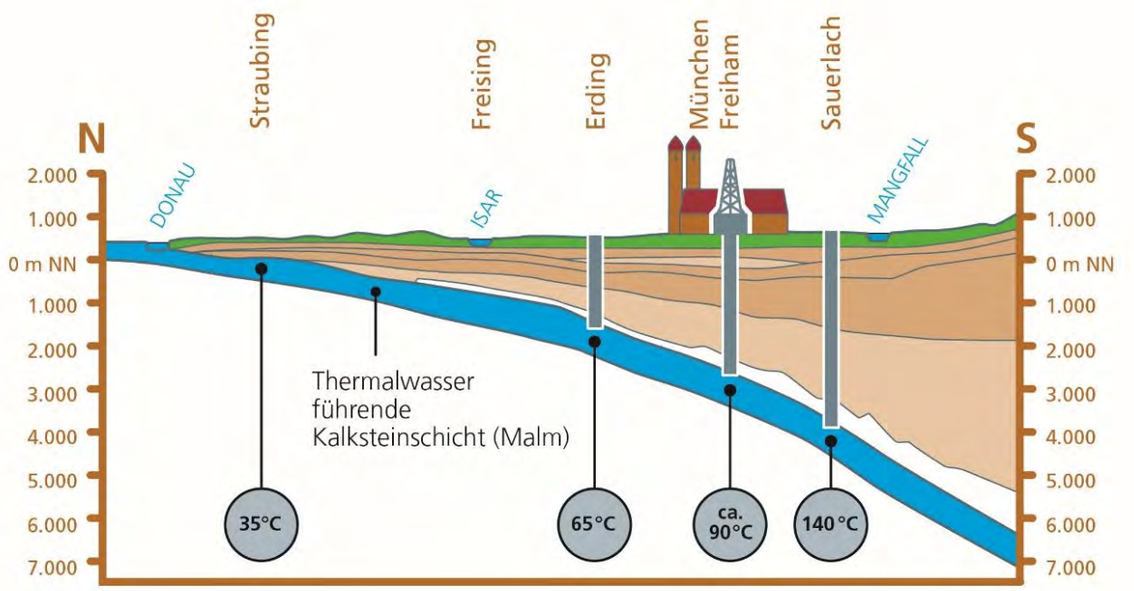


SW//M

# District Heating - Vision 2040

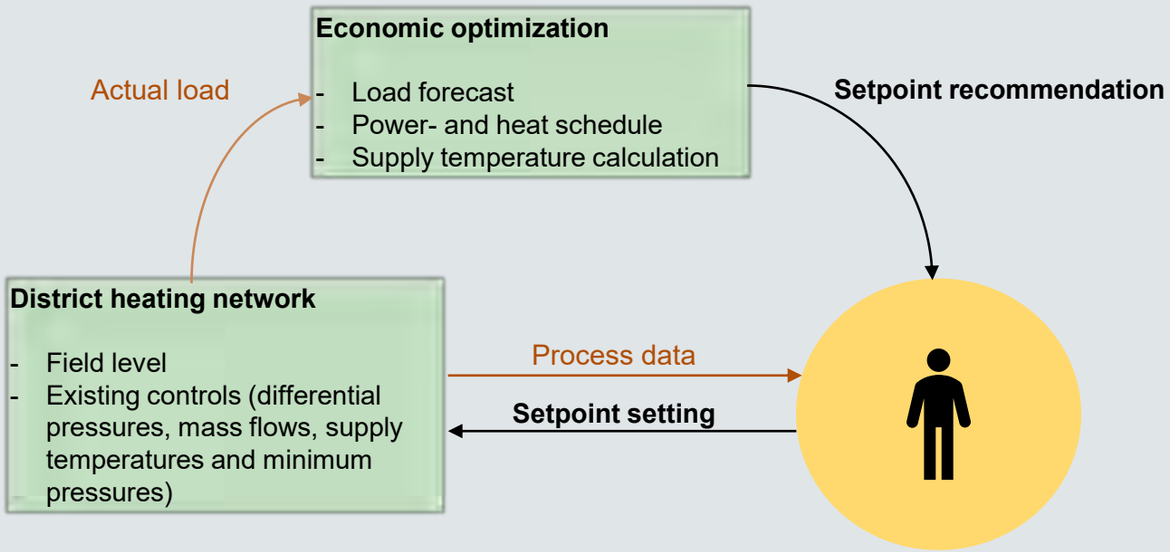
- SWM aims at providing 100% $CO_2$-neutral district heating by the year 2040
- This will be achieved by using predominantly **sustainable heat sources** from deep geothermal energy

**North-south-sectional view of alpine upland**

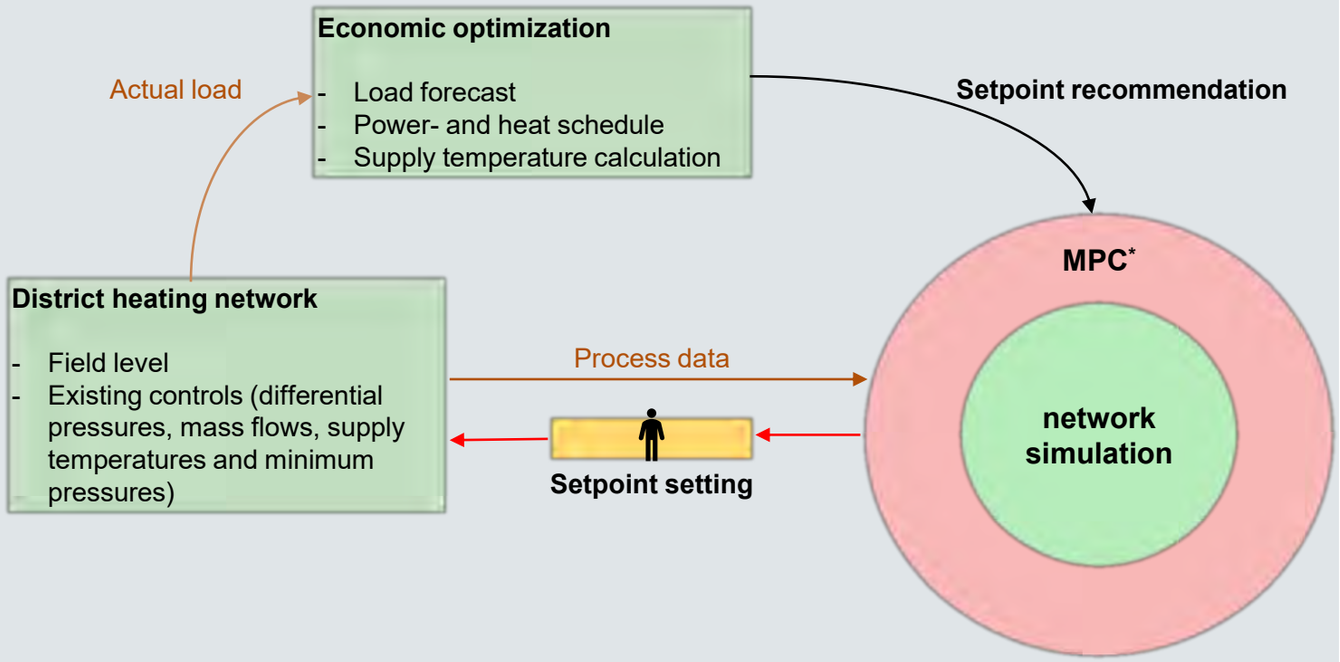


# Integration of geothermal energy

## Current operating scheme




## Future operating scheme




*Model predictive control (MPC) validates hydraulic boundaries and reschedules optimal if necessary.

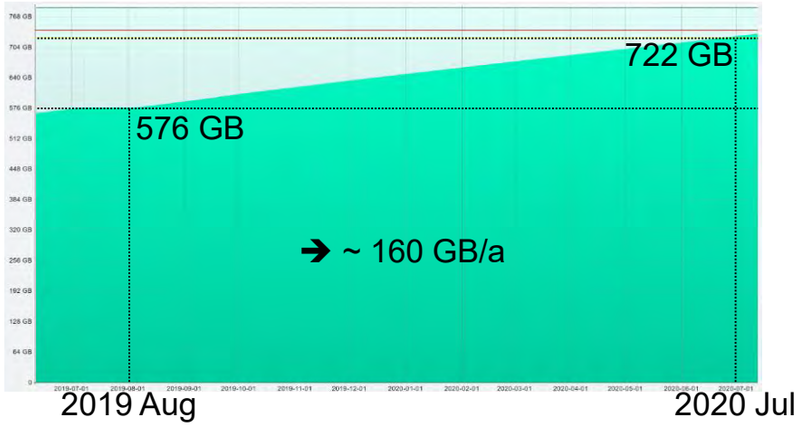
# Outline

- Applications
- Challenges
  - Process data → technical restrictions
  - Accurate network models → available data base and skills
  - Knowledge about customer behaviour → lack of information
  - Non-technical
- Wish list R&D-projects vs. operational needs

# Process data → technical restrictions

- **Available infrastructure meets current operational demands!**

- **New requirements coming up**
  - Collecting all data in a single data base with long time storage of highly resolved data (connectivity,…)
  - High data rate and high resolution of measurement values
  - Timestamping of measurements must be close to sensor
  - Performance of systems in transmission chain must be high enough (data losses, reliability,…)
  - … number of measurement devices might be too low
  - Unique measurement device IDs throughout all systems and documentation




- Solving this topics is technically possible.
- Costs originate from additional systems. Operation of improved systems is not much more expensive so far.
- Projects would not have been possible without funding.

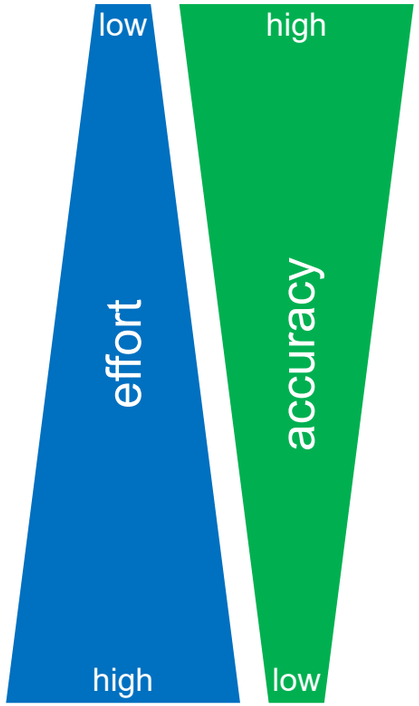
# Accurate network models → available data base and skills

- **Available data and skills meet current demand!**

- **New requirements coming up**
  - Not only GIS data but network models are needed
  - Measurement devices have to be placed at correct location in models and linked to measured data
  - Control of heat stations (and substations) has to be modelled sufficiently accurate

- Accurate network models can be established
- Effort depends strongly on the available skills and data base of the municipal utility

# Knowledge about customer behaviour → lack of information




- Best option is direct access to customer data (mass flow, pressures, temperatures,…) → smart meter data is promising, but…
- Next option is an online estimation of customer demand based on measurement data available
- Last **- and only option for prediction -** is to use customer profiles to estimate current and future demand

- Current challenge; different approaches are investigated

# Non-technical

- IT Security due to critical infrastructure
- General Data Protection Regulation (Datenschutzgrundverordnung DSGVO)
- Acceptance of new automatic solutions
  - Is it worth it (additional function vs. assumed higher costs)?
  - Is it safe? Who is responsible?...
  - What about my job? Who does all the new work?...
- These non-technical issues are mission critical (change management, transition,…)

# Wish list R&D-projects

- Software has to be integrated in existing systems
  (…maybe not all functions are wanted)
- Same data base for GIS and network models
  (bidirectional interfaces, versioning, planning, variants,…)
- Highly performant software even for medium to large grids
  (special applications leakage localisation and customer estimation)
- Open software and common data standards
- Software which allows including new/own applications

➔ this is somewhat different to out-of-the-box solutions

# Operational needs

- System requirements as low as possible
- Systems as simple as possible
  → fault clearance
- How many resources and
  what skills for operation?
- Adjustment to changes
  - network expansion/removal
  - new/lost customer
  - customer behaviour
  - DHC controls

➔ auto-adjustment possible?

# Conclusion and Outlook

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

- With leakage localisation and integration of geothermal heat two challenging applications have been presented
- There is research and development work needed for both applications – funding is gratefully acknowledged
- Challenges
  - Process data – Current system fulfil operational needs. Upgrading is technically possible.
  - Accurate network models → Effort depends strongly on the available skills and data base
  - Knowledge about customer behaviour → lack of information
  - Non-technical (IT Security, Data Protection, acceptance…)
- Wish list for R&D-projects ←→ operational needs

- We work on getting more information about our customers and are interested in customer load prediction
- Leakage localisation – One of three approaches is already used to evaluate measured data. Questions arise: Are approaches sufficient? How do they perform with measured data? What noise level do we have in practical? Do we need to improve algorithms or can we reduce noise?
- Integration of geothermal energy – First approach is defined; work in progress. Interested in other ideas.

Stadtwerke München

# Thank you very much for your kind attention

# Digitalisation solutions for heat infrastructures

*(Martin Brüssau, SAMSON)*

SAM® DISTRICT ENERGY


# Digitalisation solutions for heat infrastructures

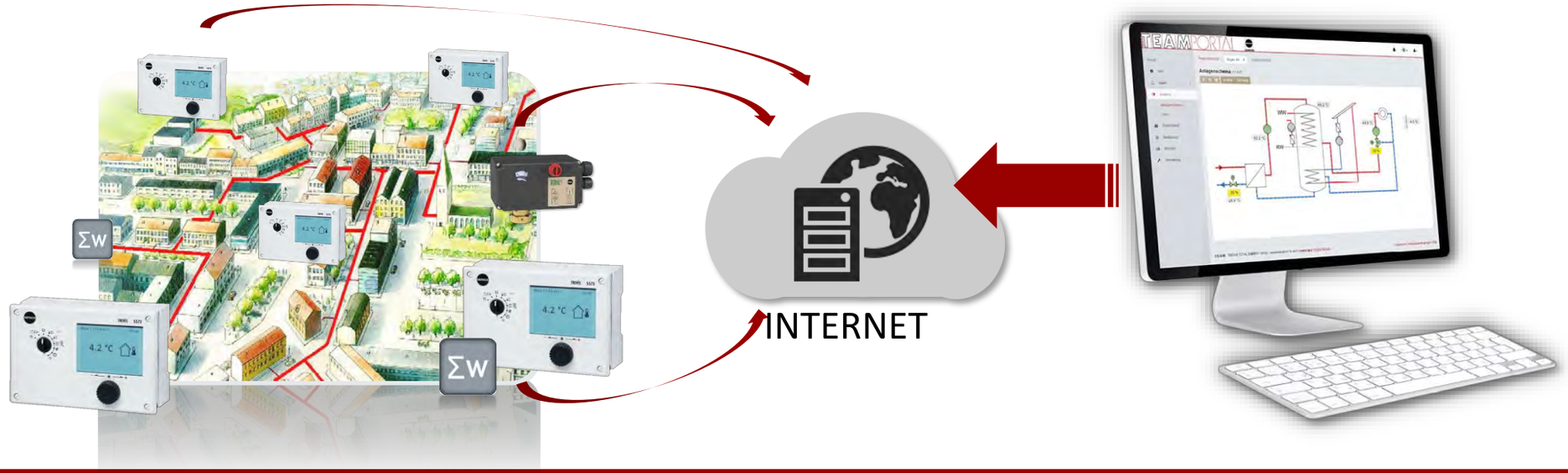
SAM® DIGITAL

# SAM DISTRICT ENERGY
## Introduction

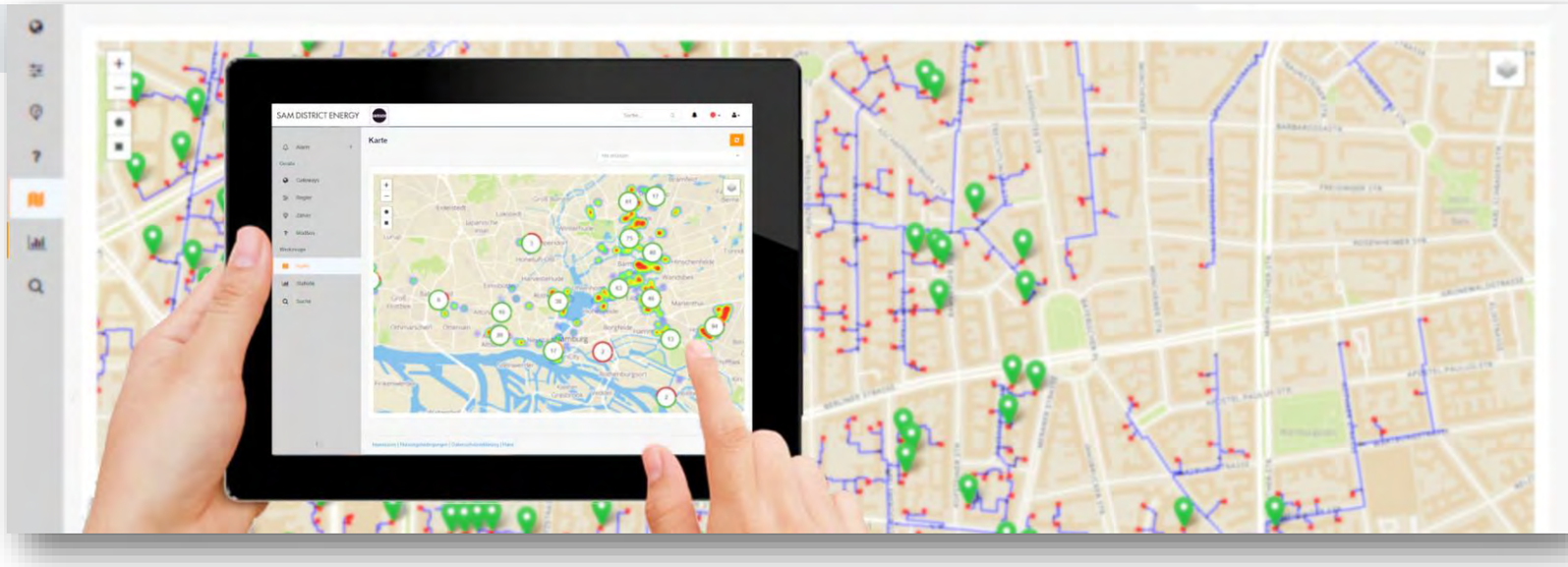
- **SAM DISTRICT ENERGY** is a **web-based solution** for **managing, controlling and optimizing** heating and cooling systems.

- The large amount of data recorded makes it possible to **increase efficiency** and **improve transparency** in local and district heating networks.

- The **connected** controllers, meters, sensors, actuators and other devices give you a **comprehensive overview** of your **stations** and consequently your **entire network**.



SAM® DISTRICT ENERGY



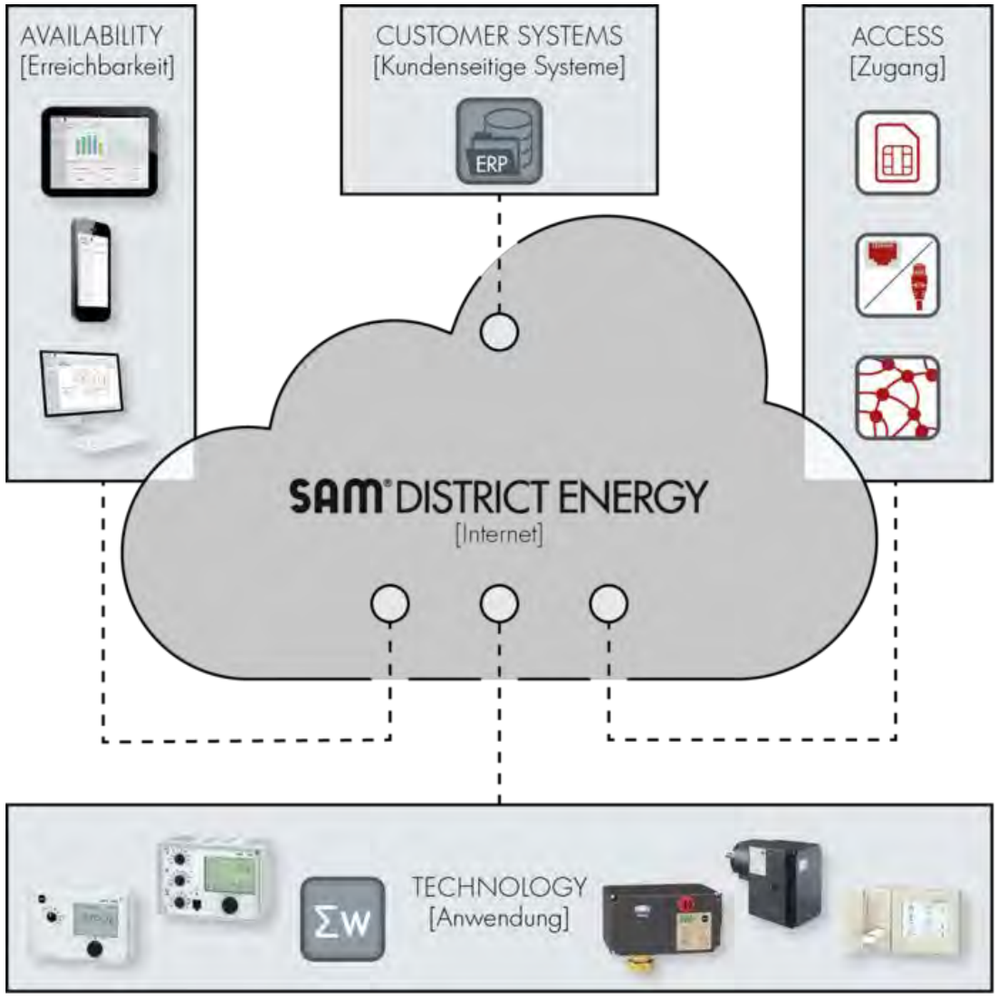

# Application

SAM® DIGITAL
SAM DISTRICT ENERGY

# Structure

- Flexible connection over SAM-LAN, SAM MOBILE or SAM HOME
- Overview of stations and networks by connecting controllers, meters, actuators, differential pressure data and pumps

- Interfaces to customers' servers
- Worldwide access over personal accounts
- Responsive website design



# Heat map

Visual analysis of the district heating network through relative **color coding of temperatures and pressures on a map** (heat map)

- **Dynamic detection of a network's point of worst efficiency**
- Show or hide stations according to dependencies
- Show values on a map
- Integration of **network route plans** on a map
- Overview of system status on a geographical map
- Interaction on a map

# Sensor sharing and cross communication

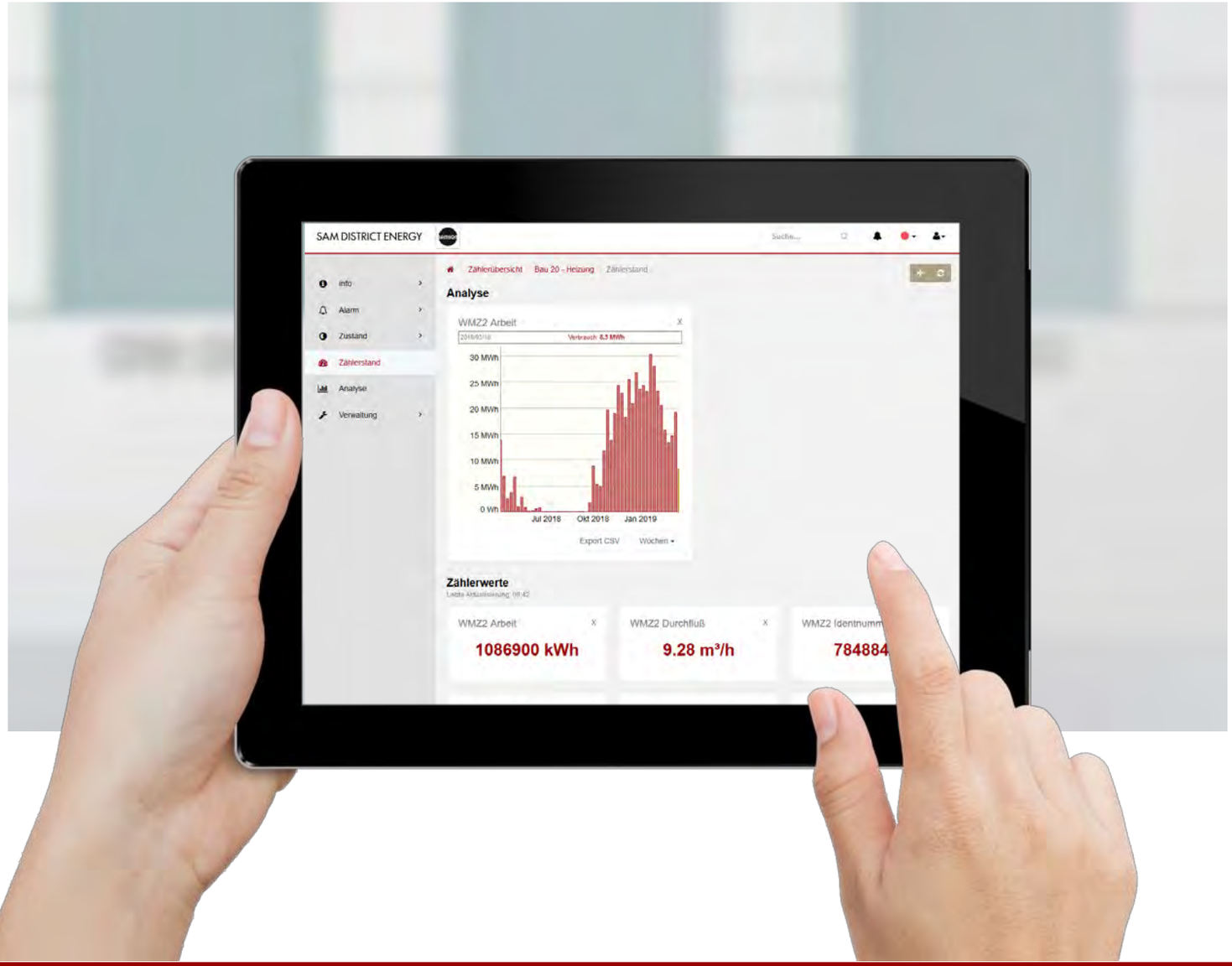
- Exchange data between sensors
- No need to install outdoor sensors
- Control based on differential pressures and valve positions
- Easy to switch feed pumps
- Exchange data on external demand
- **Network pump control**

# Reading data from meters

– Data export for billing

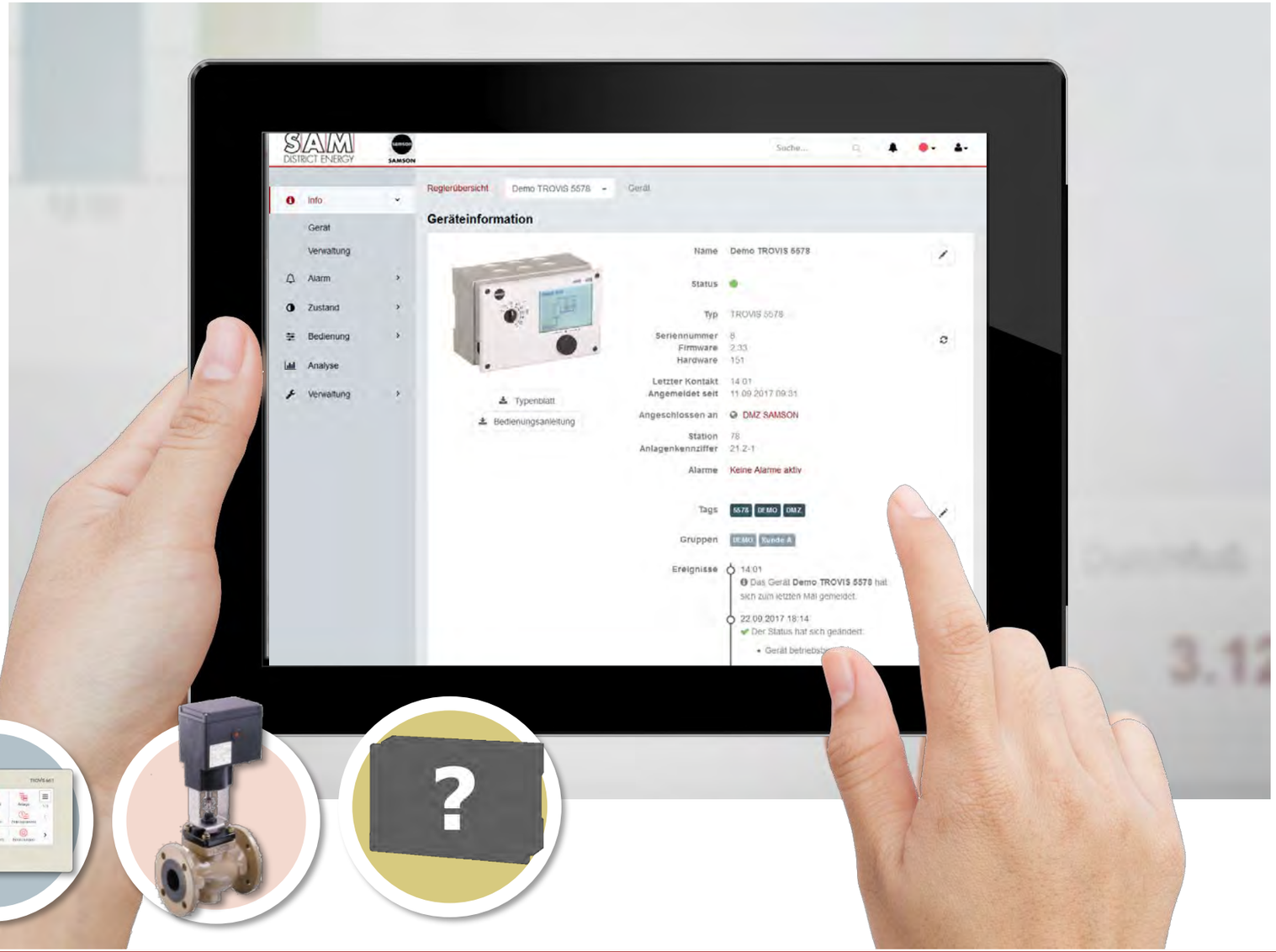
– **Network analysis** based on primary flow and return flow temperature

– Controller behavior with associated meter data for troubleshooting

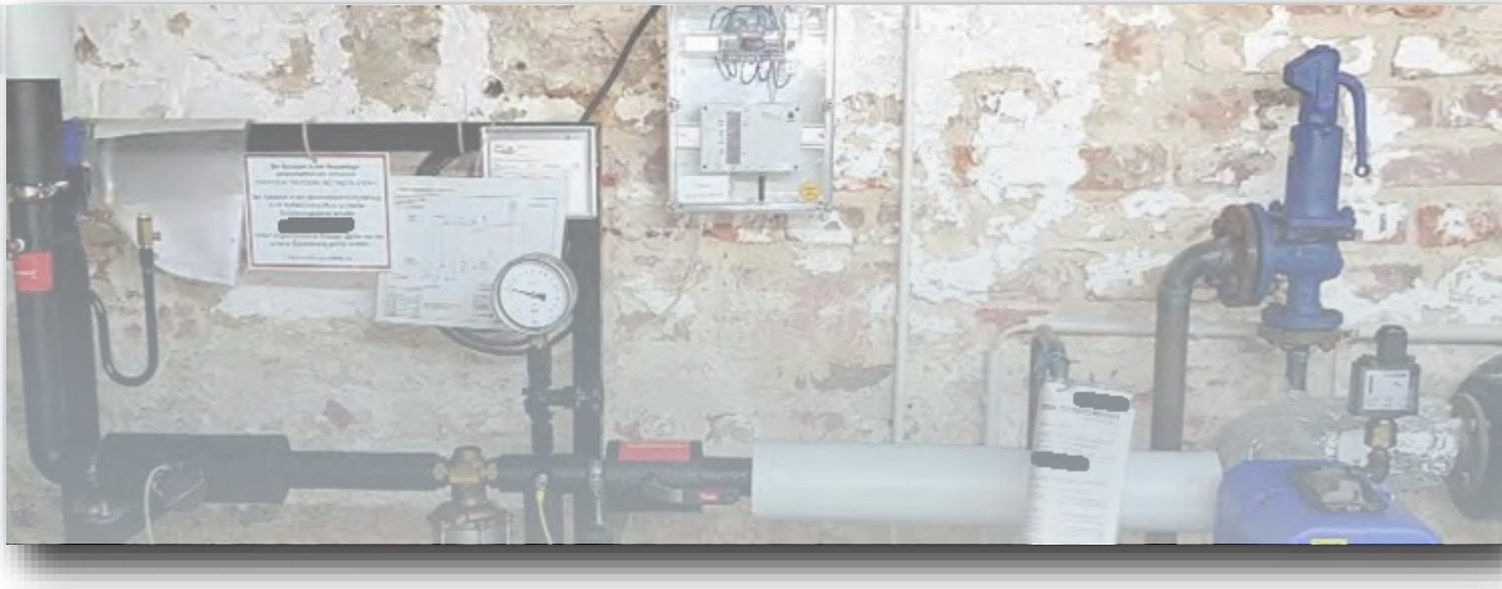


# Flexible connection

- Internet connection over mobile phone network or LAN (landline connection)
- Establish own networks using SAM-LAN in areas with poor mobile signal reception
- Connection of meters, controllers, PLC, actuators, pumps, sensors and universal Modbus devices to the web portal
- Interfaces to customers' servers and ERP systems over API




# SAM® MOBILE



## Wireless communication

SAM® DIGITAL
SAM DISTRICT ENERGY

# SAM MOBILE GATEWAY

## Basic functions

- Wireless connection using integrated modem
- Controller, actuator or Modbus universal device can be connected over Modbus

# Summary of the added value

# Added value

## Impact on network control

- Analysis of water flow times and routes by tracking large changes in temperature
  Objective: model-based hydronic balancing
  Impact on changes to the network structure (create or connect meshes)
  Avoid extending networks through analysis
- Analysis of flow rates and energy along a pipeline section or area
  Objective: to record heat load simultaneity and identify reserves in hydronic networks
- Analysis of individual systems in poorly balanced zones
- Better utilization of network pumps through the use of additional, more flexible pressure sensors
- Control valves in network sections by transmitting pressure data

# SAMSON AT A GLANCE

**STAFF**

- Worldwide 4,300
- Europe 3,300
- Asia 500
- Americas 200
- Frankfurt am Main, Germany 1,800

**SALES SITES**

- More than 50 subsidiaries in over 40 countries
- More than 200 representatives

**MARKETS**

- Chemicals and petrochemicals
- Power and energy
- District heating and cooling, building automation
- General industry
- Industrial gases
- Food and beverages
- Metallurgy and mining
- Oil and gas
- Pharmaceuticals and biotechnology
- Marine equipment
- Water and wastewater
- Pulp and paper

**PRODUCTION SITES**

- SAMSON Germany, Frankfurt
- SAMSON France, Lyon
- SAMSON Turkey, Istanbul
- SAMSON USA, Baytown, TX
- SAMSON China, Beijing
- SAMSON India, Pune district
- SAMSON Russia, Rostov-on-Don
- SAMSON AIR TORQUE, Bergamo, Italy
- SAMSON CERA SYSTEM, Hermsdorf, Germany
- SAMSON KT-ELEKTRONIK, Berlin, Germany
- SAMSON LEUSCH, Neuss, Germany
- SAMSON PFEIFFER, Kempen, Germany
- SAMSON RINGO, Zaragoza, Spain
- SAMSON SED, Bad Rappenau, Germany
- SAMSON STARLINE, Bergamo, Italy
- SAMSON VDH PRODUCTS, the Netherlands
- SAMSON VETEC, Speyer, Germany

SAMSON AKTIENGESELLSCHAFT
60314 Frankfurt am Main, Germany
Internet: www.samson.de

# Business opportunities from digitalisation *(Steen Schelle Jensen, KAMSTRUP)*

kamstrup

# Business Opportunities for Digitalisation

Wednesday September 9, 2020

Steen Schelle Jensen
Head of Business Development

# New demands New possibilities

## 2020

**October 25, 2020**
All meters installed after this date must be remotely readable.

Information to the end-users on a quarterly basis

Pay attention to the definition of *Final customers* and *Final users*

## 2022

**January 1, 2022**
Information to the end-users on a monthly basis

## 2027

**January 1, 2027**
All existing meters must be upgraded to remotely readable meters

...and New possibilities to optimise your business

Kamstrup's
Thermal Energy Meters

# MULTICAL®

Everything starts with the meter - the basis for getting new and critical knowledge about your network and end-users.

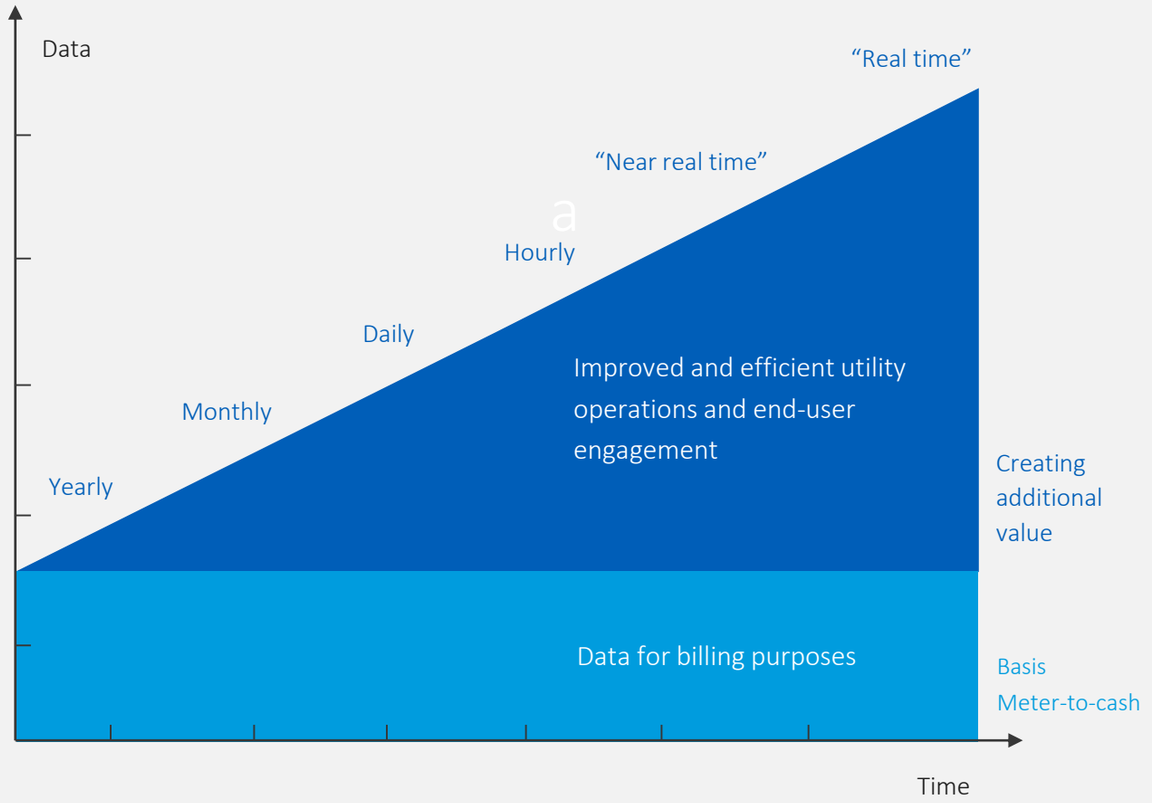
Secure investments

Basis for optimisation

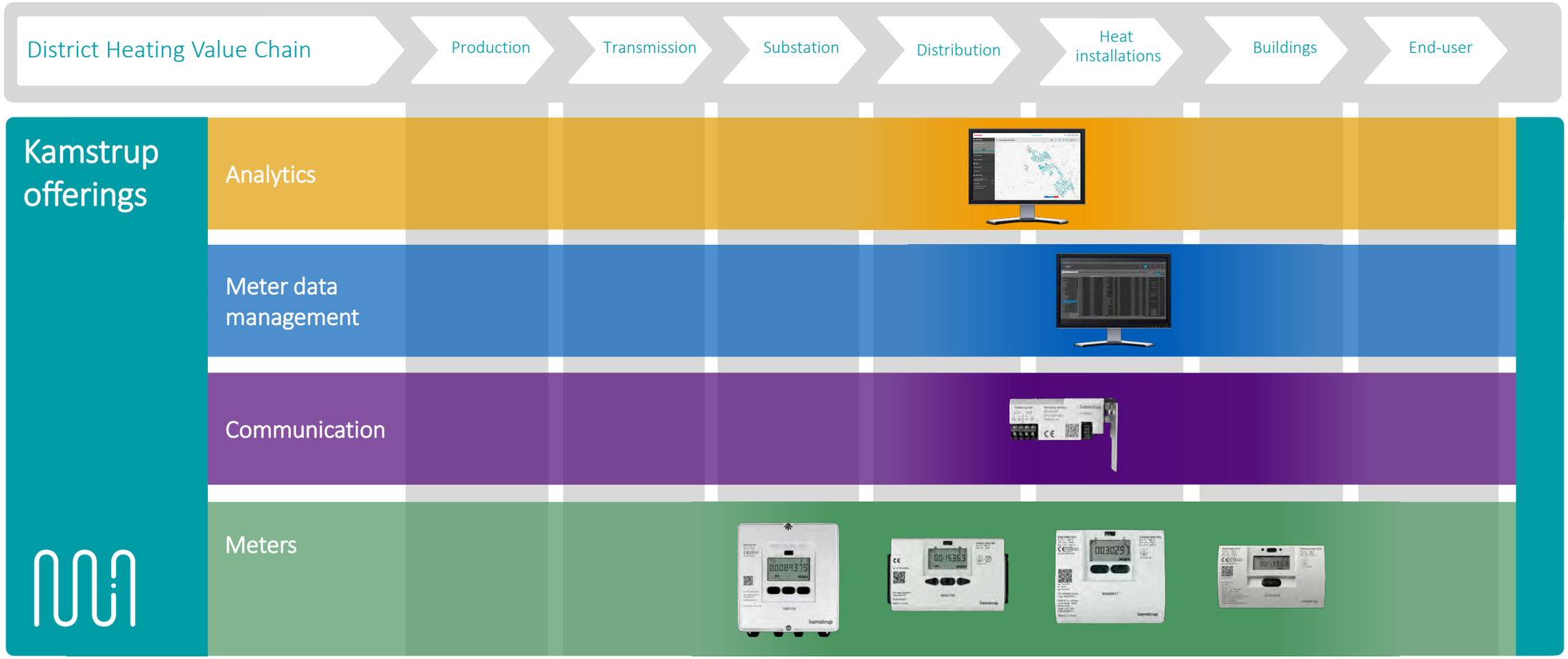
Reduce operational costs

# The Digital revolution

> You cannot optimise what you do not meassure



# Value chain overview – how are we positioned with our offerings?




Innovation at the core. We continuously look at expanding our offerings and innovation weighs heavy on our agenda.

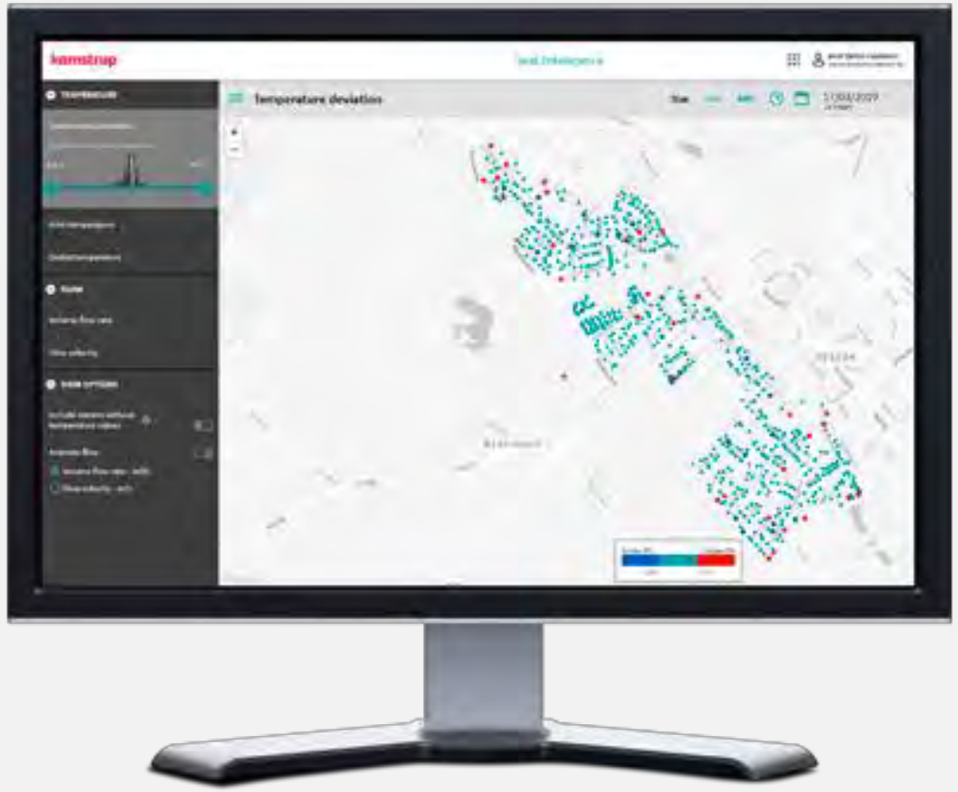
# Heat Intelligence Analytics

Heat Intelligence is a cloud-based analytics platform – enabling value creation via data analytics throughout your value chain.

Analytics based on facts instead of habit or “gut-feelings”

Reduce both operational costs and long-term investments

Innovative data-driven analytics




# Analytics you can act on!

Developed in close collaboration with district heating utilities

New level of transparency in your distribution network,
- all done without investing in additional expensive sensors in the field.

- Combining meter data with pipe characteristics
- Flow, temperature, pressure
- Determining the expected temperatures and visualizing deviations
- Multiple data sources deliver new insights
- Dynamically updated by real data

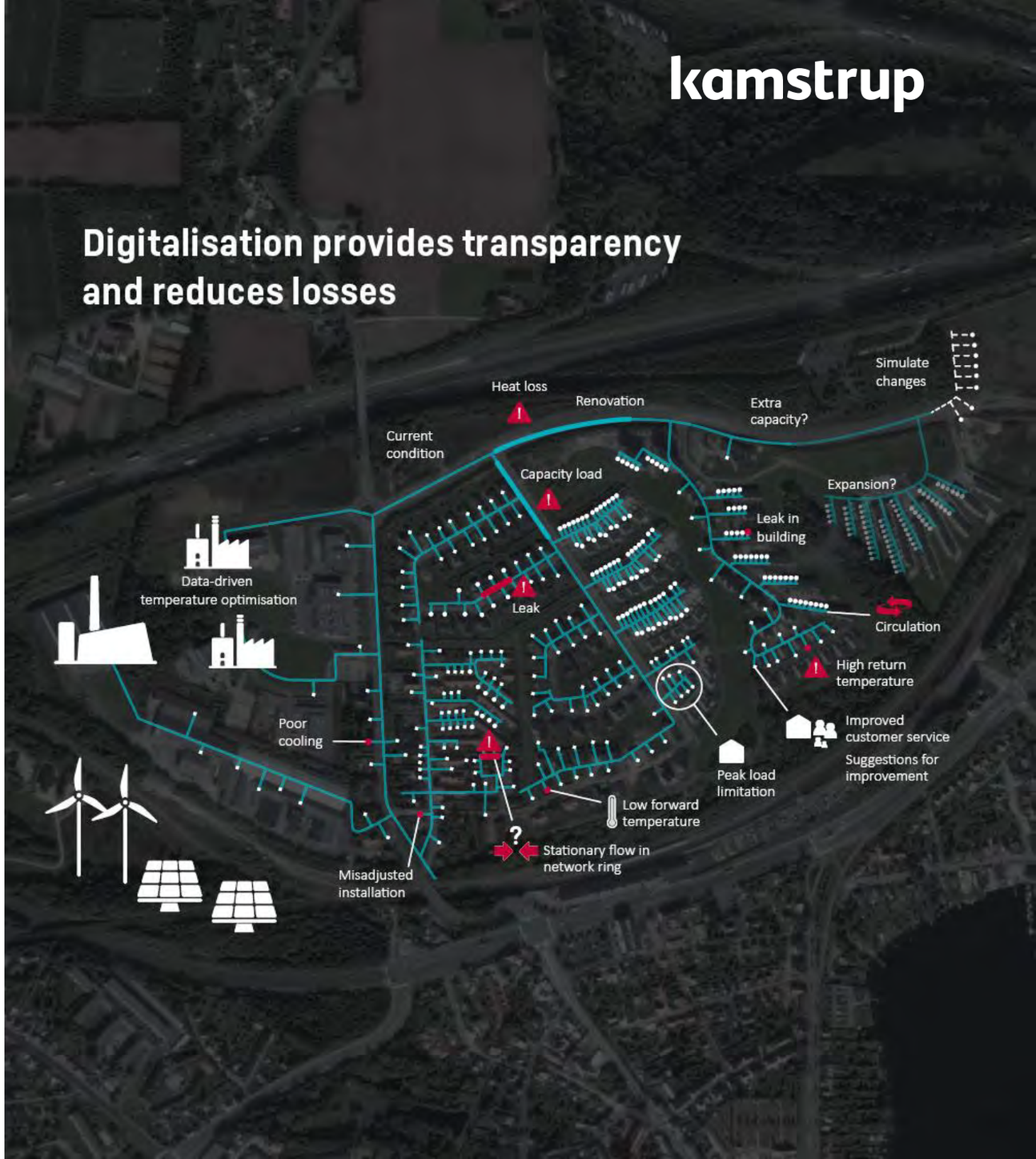
# Data-driven asset management for maximum impact

- Operate closer to the limits while documenting your quality of delivery
- Locate high heat losses and find small and large leakages
- Find bypasses and analyse the impact of these on the system performance
- Monitor load and capacity and identify what stresses your network

## Save energy

- Reduced heat loss
- Minimised pump operation
- More efficient production

**Improved cost-efficiency and happy customers!**
We ensure you get off to a hassle-free start for maximum value creation.



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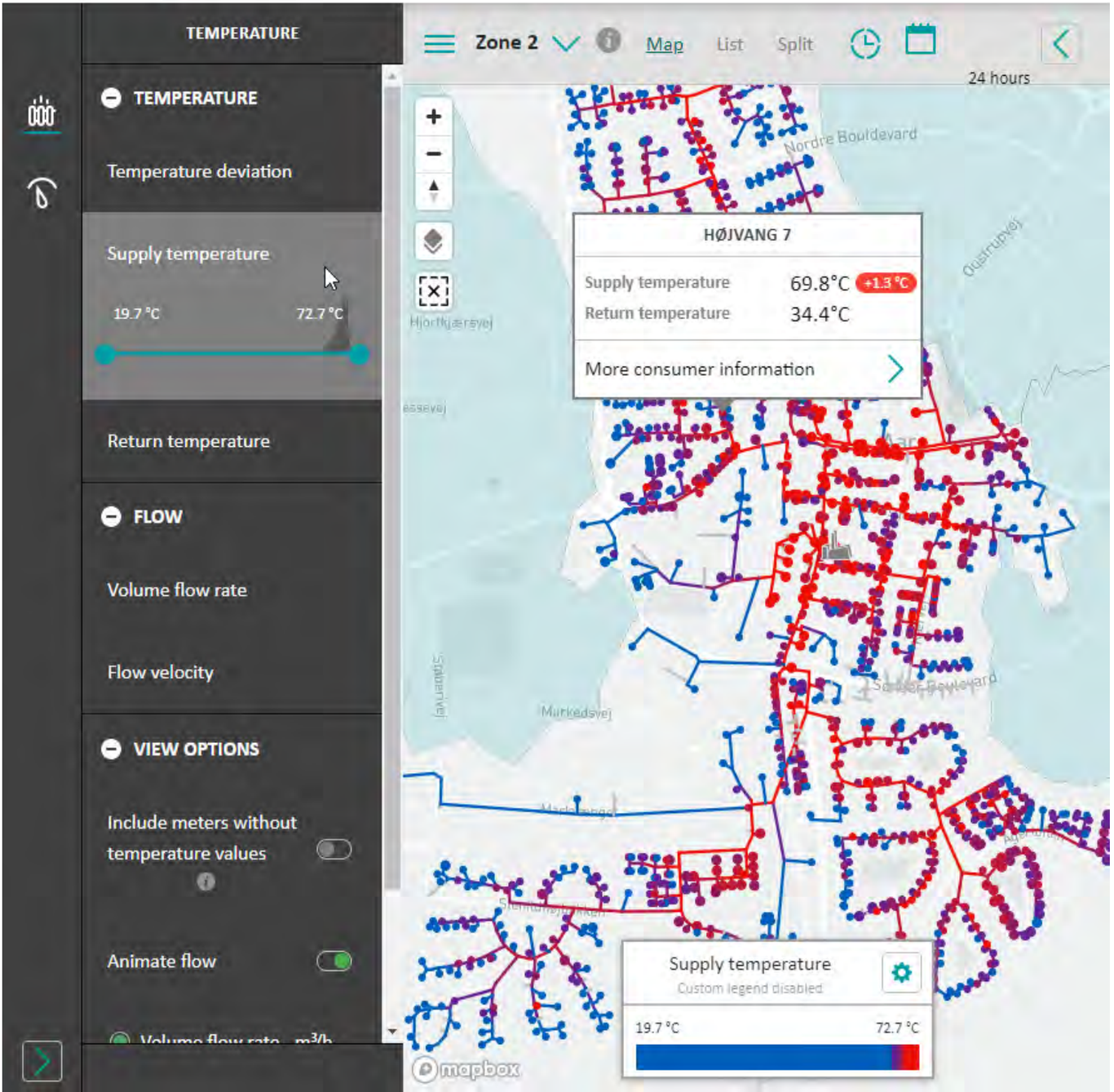


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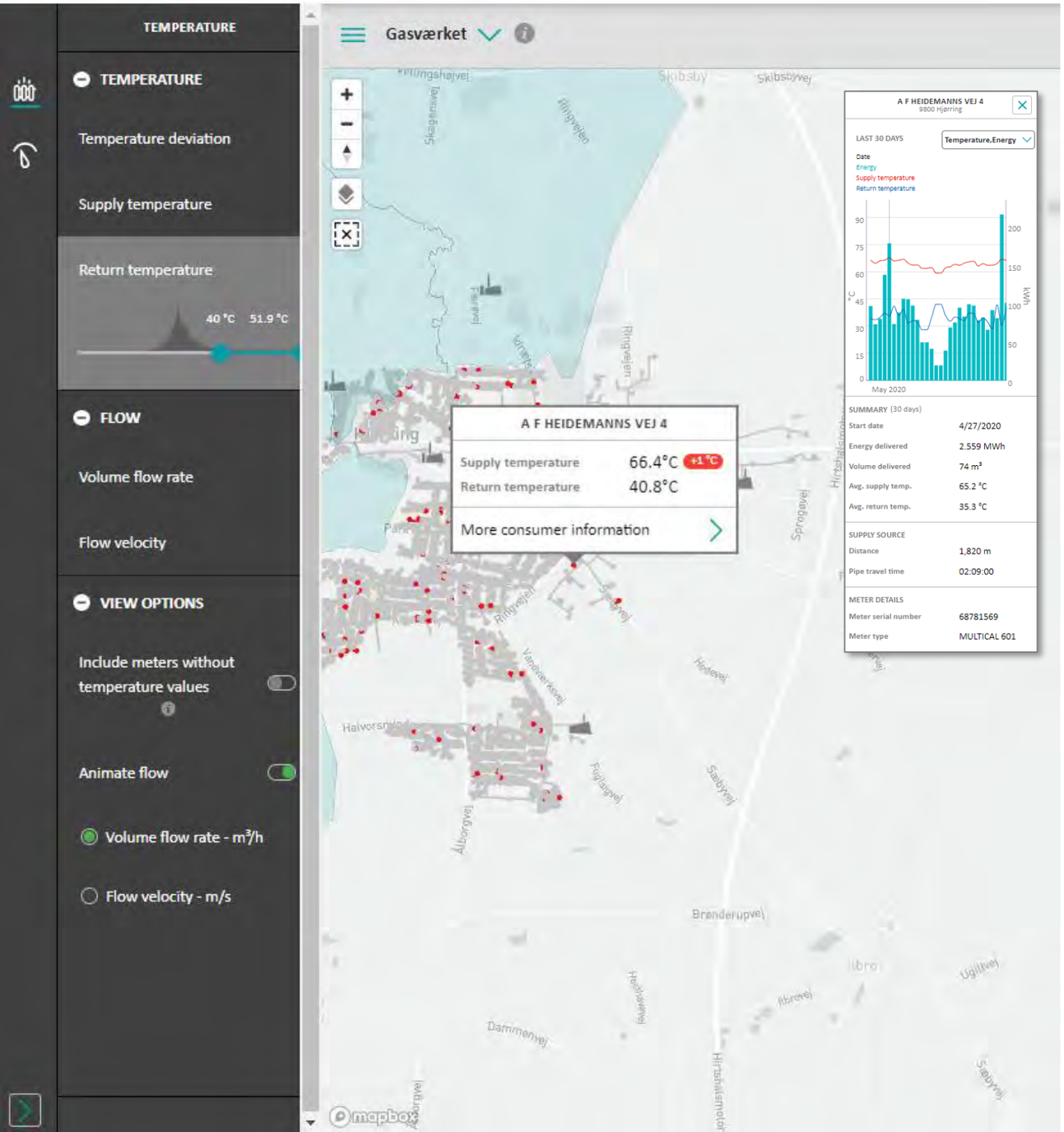
# Easy & intuitive user interface

Heat Intelligence dynamically visualizes your entire supply area and make it possible to see immediate effects on the map when toggling between dates, filters and functionalities

## Features

- Filter between different parameters, e.g. temperature, pressure, flow
- Select end points or pipe sections for more details
- Visualize results in graphs and over time
- Choose different views
- Choose date and time for analysis
- Export data



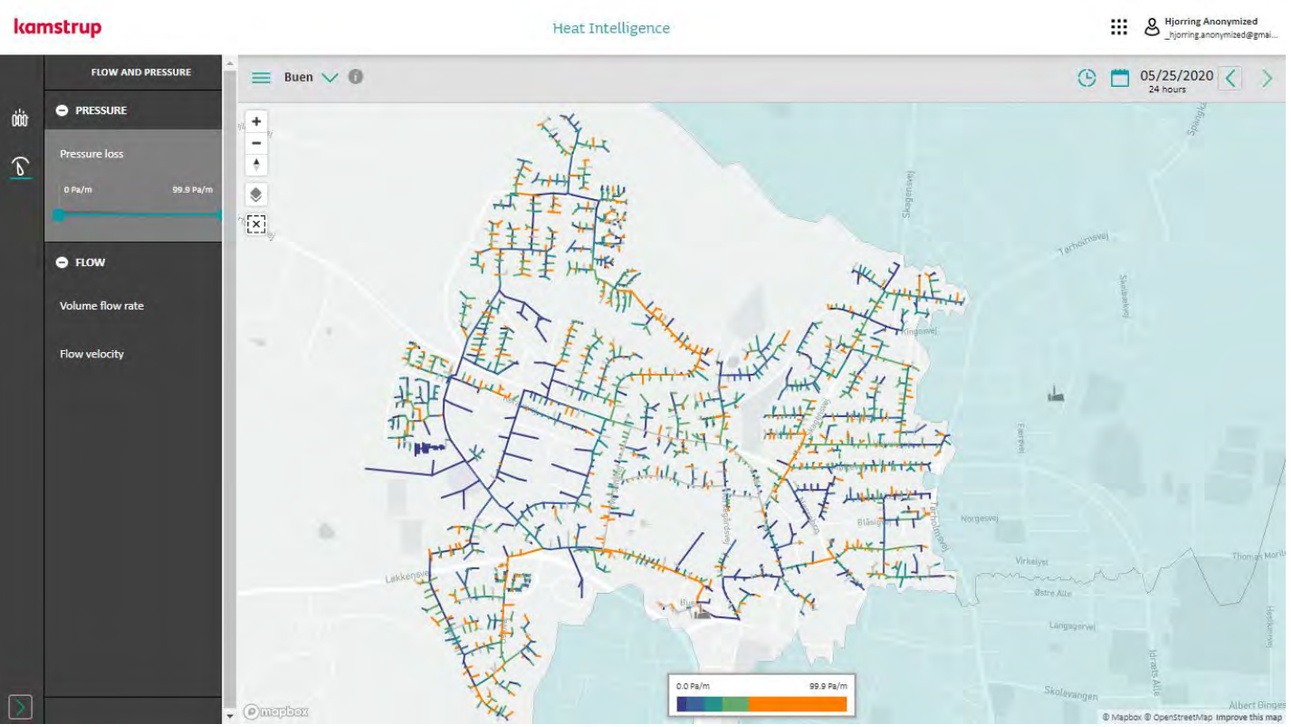

# Analyze return temperatures

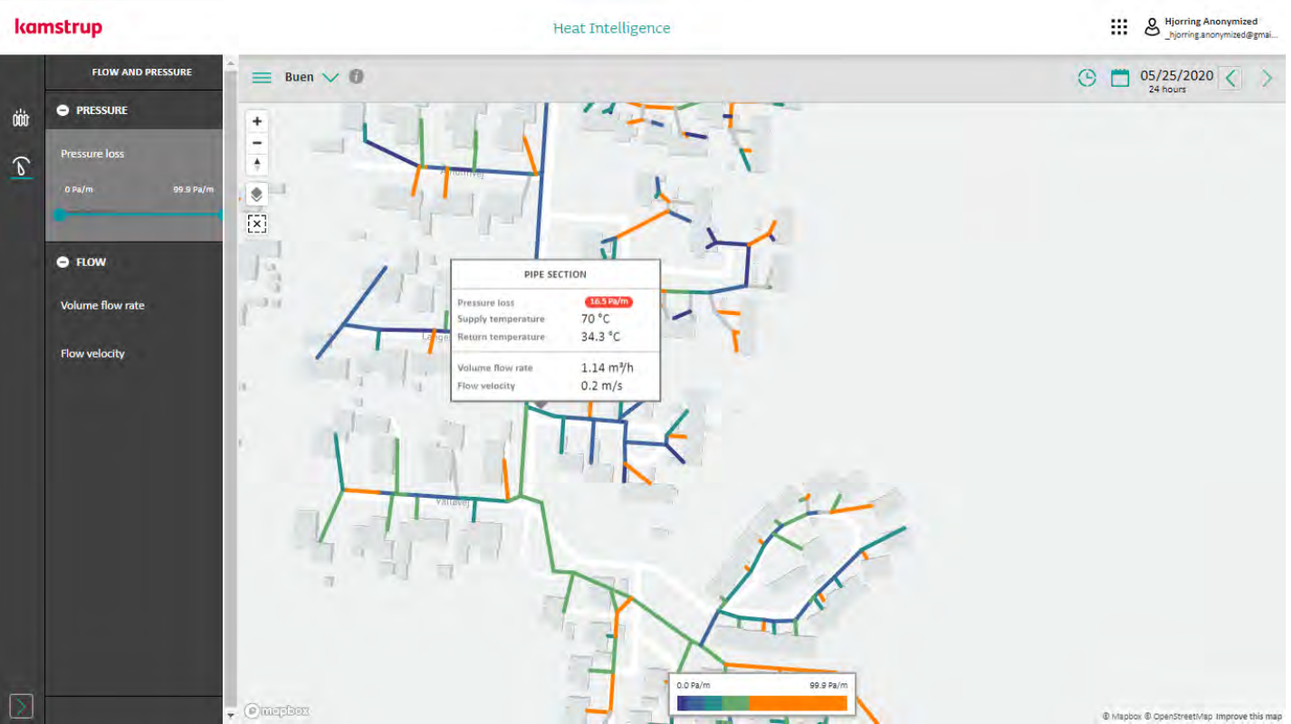
Low return temperatures reduce heat loss in the pipe network, minimize pump energy and ensure heat production can be done as efficiently as possible

## Features

Filter on return temperature and find out if some end-users are sending the water back with too high temperatures

- Who are the end-users with highest negative impact on return temperature?
- Should motivational schemes be considered (cooling tariff, incentives for installation improvement, communication to initiate behavioral changes, etc.)?
- View return temperature details over time and evaluate if problems have occurred with the end-user heat installation

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# Pressure loss (gradients)

Visualizing pressure gradients per pipe section makes it possible to understand the dynamic load and capacity of the distribution grid and helps you optimize ROI of your asset management

## Features

Filter on pressure loss to find out how your distribution grid is performing – in real conditions!

- How is your distribution grid performing during peak season / period?
- Do you have bottlenecks in the system which should be eliminated?
- Do you have enough capacity to extend your network?
- Where would you get most benefit (ROI) from your asset management/ renovation plan?

# Measurable results
# - optimisations based on frequent data

## Assens District Heating

ROI 4-5 years on investment in new meters, radio network, READy and Heat Intelligence.

> There is a paradigm shift underway throughout the whole value chain, which is supported both politically and regulatory. Digitalisation is charging ahead and will continue to do so."

- Network temeratures lowered by **6-8°c**
- A **2,5%** reduction of the annual heat production
- A **12%** reduction of pipeline losses

## Næstved District Heating

10% less pipeline losses alone represents significant annual savings without even touching the assets underground.

> We have lowered the return temperature by 5 degrees, and, for large periods of the year, we have lowered the forward temperature by up to 10 degrees."

- Reduced return temperature by **5°c**
- Reduced flow temperature by **10°c**
- Reduced pipeline loss by **8%**
- Reduced customer heating bills up to **10%**

# Measurable results
## - optimisations based on data analytics

### Small leakages and heat loss

Locate small leakages, poor performing transmission pipes and service pipes. Use this knowledge to optimize your asset management

> By changing 16 service pipes with wet insulation, we managed to reduce the energy need by 125 MWh”


### Wet insulation

Insulation soaking wet, causing abnormal heat loss.
Diffusion from widely used pex pipes caused at drop of 10 degrees in 10 meters.

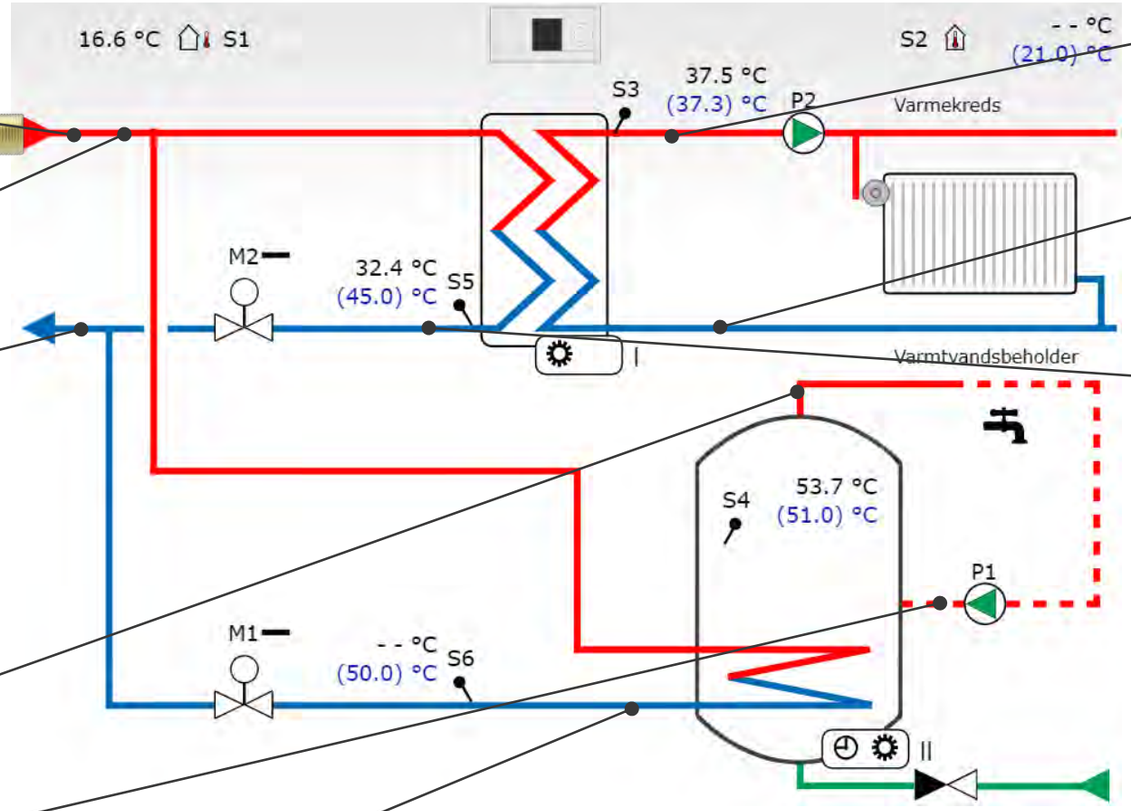
> As there was no burst or leak of water outside the pipe, other tools could not have revealed the poor performance"

# ”Heat Assistant” prototype – engaging with end-users and professionals

**Primary side:**
Flow (energy)

Supply temp.

Return temp.




**Space heating:**
Supply temperature

**Space heating:**
Return temperature

**Space heating:**
Return temperature to primary side

**Domestic hot water:**
Supply temperature

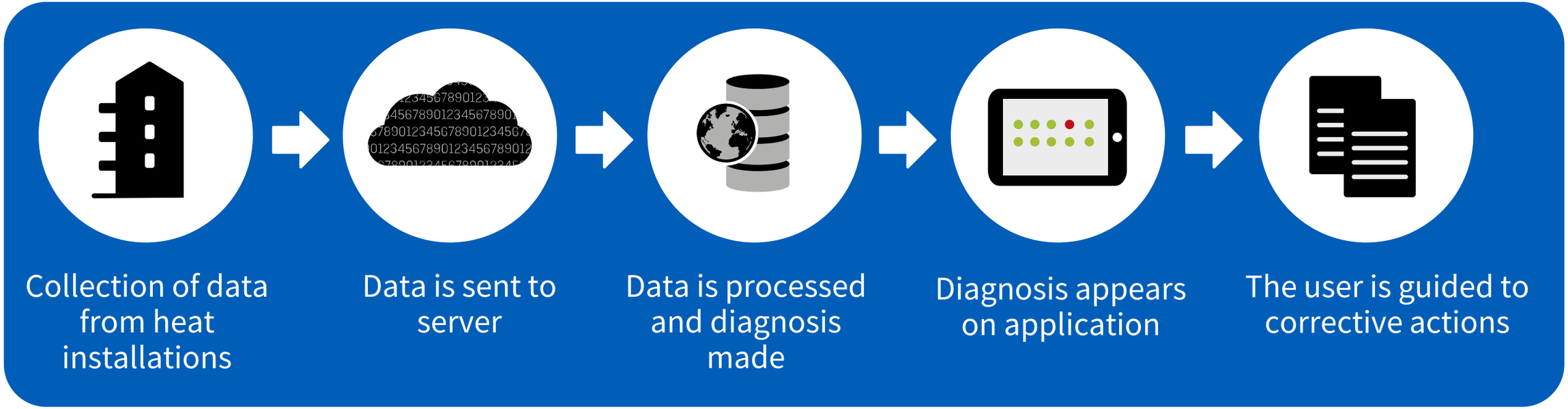
**Domestic hot water:**
Circulation temperature

**Domestic hot water:**
Return to primary side

# ”Heat Assistant” - prototype

The “Heat Assistant” prototype – a fully data-driven decision support tool removes the barriers and makes troubleshooting easy and understandable

Yes! – data-driven troubleshooting can be done. 77% of the analyzed heat installations can be optimized



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# Questions?

Think forward

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# Stay in touch
## - and get access to the latest news

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# Q&A to all presenters

# Summary and next steps

- We will make the **recording of the webinar** available on the IEA DHC YouTube channel https://www.youtube.com/channel/UCuYcqLjJi8thrUJCjzLBaow and send out the **presentation slides**

- If you want to **join the IEA DHC Annex TS3 or TS4**, please contact
  - Ralf-Roman Schmidt, ralf-roman.schmidt@ait.ac.at (leader TS3)
  - Dietrich Schmidt, dietrich.schmidt@iee.fraunhofer.de (leader TS4)
  - AND: contact your national IEA DHC representative for funding opportunities https://www.iea-dhc.org/home/

# Group photo - please smile

+ many others without webcam
(in total about 80 participants)

# Thank you for your attention!

**Webinar Digitalization for optimizing integrated district heating systems - Block II**

**9. September 2020**

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Dietrich Schmidt, Fraunhofer IEE, Germany, dietrich.schmidt@iee.fraunhofer.de (leader TS4)

*More information at*

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

*http://www.iea-dhc.org/the-research/annexes/2017-2020-annex-ts3-draft.html*

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