

ENGINEERING
TOMORROW



End-to-end solution to achieve the green transition





DIGITALIZATION



ELECTRIFICATION



URBANIZATION



CLIMATE CHANGE

GLOBAL MEGA-TRENDS

transforming our world



FOOD SUPPLY

ACCELERATE THE GREEN TRANSITION

Danfoss Climate Solutions provides integrated, energy-efficient heating and cooling solutions to enable sustainable development in buildings, cold chains, industrial applications, and infrastructure.

With end-to-end application expertise and a broad product portfolio, we're leading the way to a greener future and helping you do more with less.

The CO₂-neutral city starts with district energy

A study from Aalborg University shows that European decarbonization goals can be reached by 2050 by combining energy efficiency with the smart integration of renewable energy through sector coupling.

https://vbn.aau.dk/ws/portalfiles/portal/316535596/Towards_a_decarbonised_H_C_sector_in_EU_Final_Report.pdf

FIVE KEY TAKEAWAYS

70 bn EUR

REDUCTION IN TOTAL ENERGY
SYSTEM COSTS PER YEAR

Smart integrated
systems are more
cost-efficient



30%

REDUCTION OF SPACE-
HEATING DEMANDS

A system approach
ensures optimal use
of investment and
resources



**Decarbonizing
the European
heating and
cooling sector
by 2050**

120 TWh

ADDITIONAL ANNUAL
PRIMARY ENERGY SAVINGS

Modern low-
temperature
district heating
will substantially
increase
efficiency



Up to 40%

ENERGY SAVINGS

Significant potential
in moving from a
supply to a
demand-driven
system with
automatic controls



16,500

NEW DISTRICT HEATING SYSTEMS
TO BE BUILT BEFORE 2035

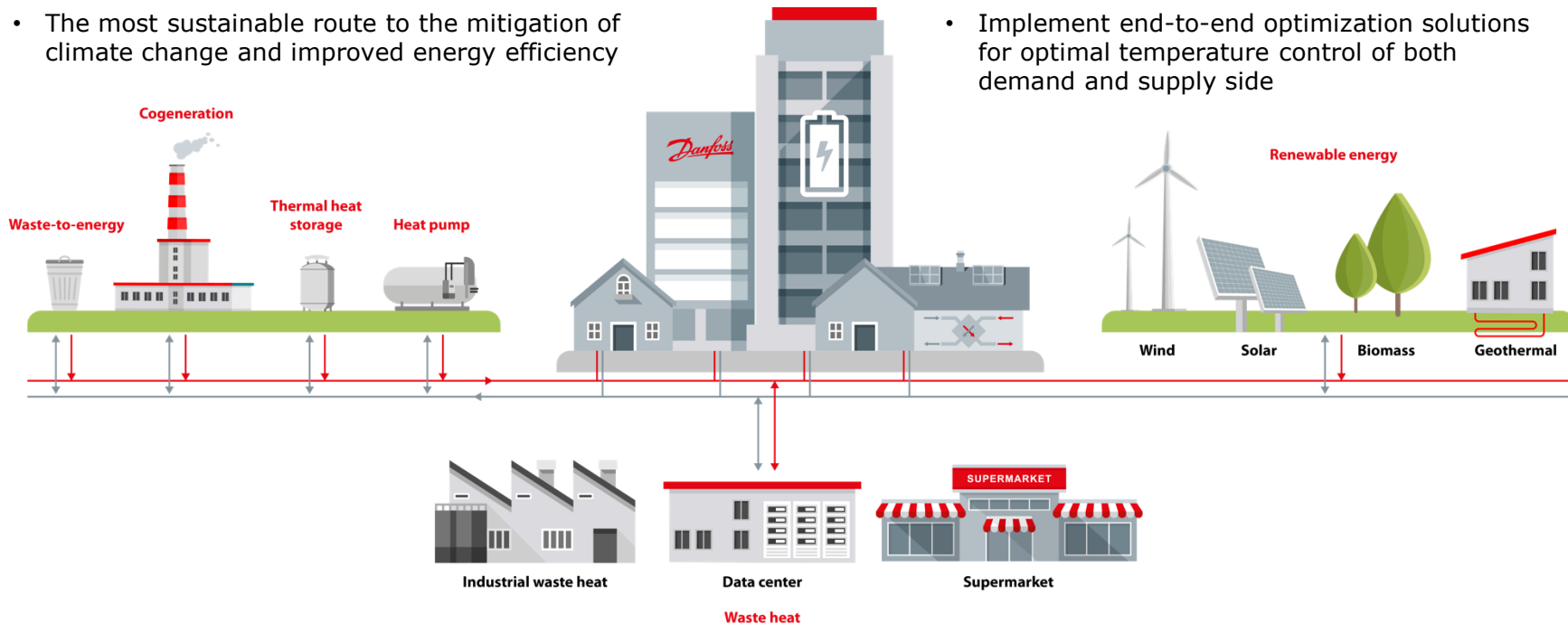
The enabling framework
must be established now



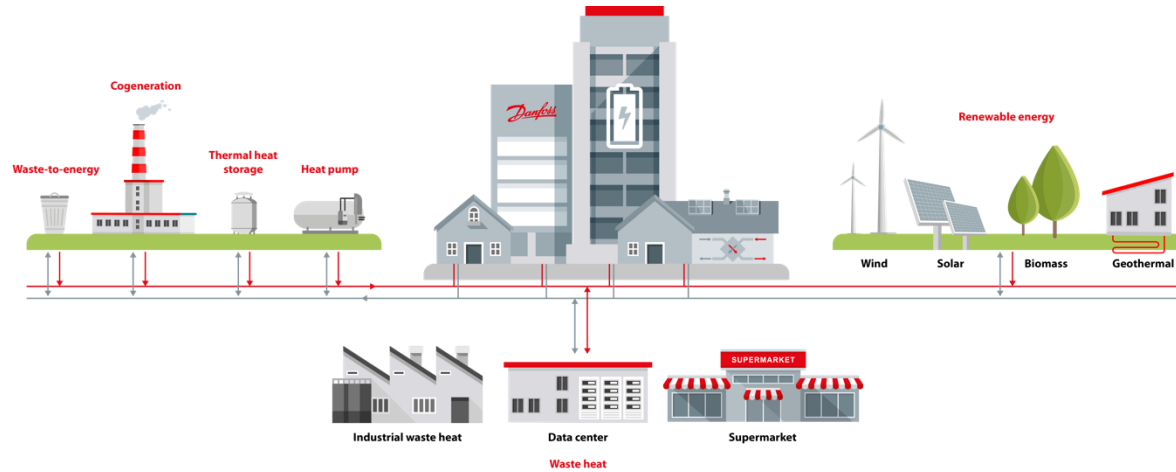
Tap into the **potential of district energy**

- The most sustainable route to the mitigation of climate change and improved energy efficiency

- Implement end-to-end optimization solutions for optimal temperature control of both demand and supply side



Trends driving the **district energy evolution**



From single source to...

MULTI-SOURCE

From fossil to...

**RENEWABLES &
SURPLUS ENERGY**

From high temperature to...

**LOW TEMPERATURE
DISTRICT HEATING**

Key challenges in district energy



Discover holistic heating optimization. **From production to people.**

Heat production accounts for a staggering 25% of the world's CO₂ emissions.

With countless solutions on the market focused on siloed changes, heating utilities, building owners, and public stakeholders are left without a holistic solution.

Danfoss Leanheat® offers innovative end-to-end software systems and services for the control and optimization of district energy systems - from production to distribution.

By unlocking the potential of connectivity, our optimization tools make it possible for utilities and service providers to effectively meet demands for energy efficiency while improving business operations and costs.

**Lean
on
us™**



Discover holistic heating optimization. **From production to people.**



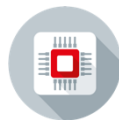
Modular

Tailored to the need and scale of your application.



Comprehensive

A one-stop-shop for hardware and software optimization solutions.



Open

Third-party hardware is supported.



Secure

Data is backed by secure APIs.



Trusted

Verified results with a wide and growing customer base.



Expertise

Decades of frontline expertise in the district heating chain.



Partnership

We connect people and ease work processes.



Leading change

We empower you to accelerate the green transition in district energy.



Danfoss

ENGINEERING
TOMORROW

Danfoss Leanheat® Software Suite & Services enables an end-to-end optimization of district heating systems



Leanheat® Production (LHP)

Leanheat® Network (LHN)

Leanheat® Monitor (LHM)

Leanheat® Building (LHB)

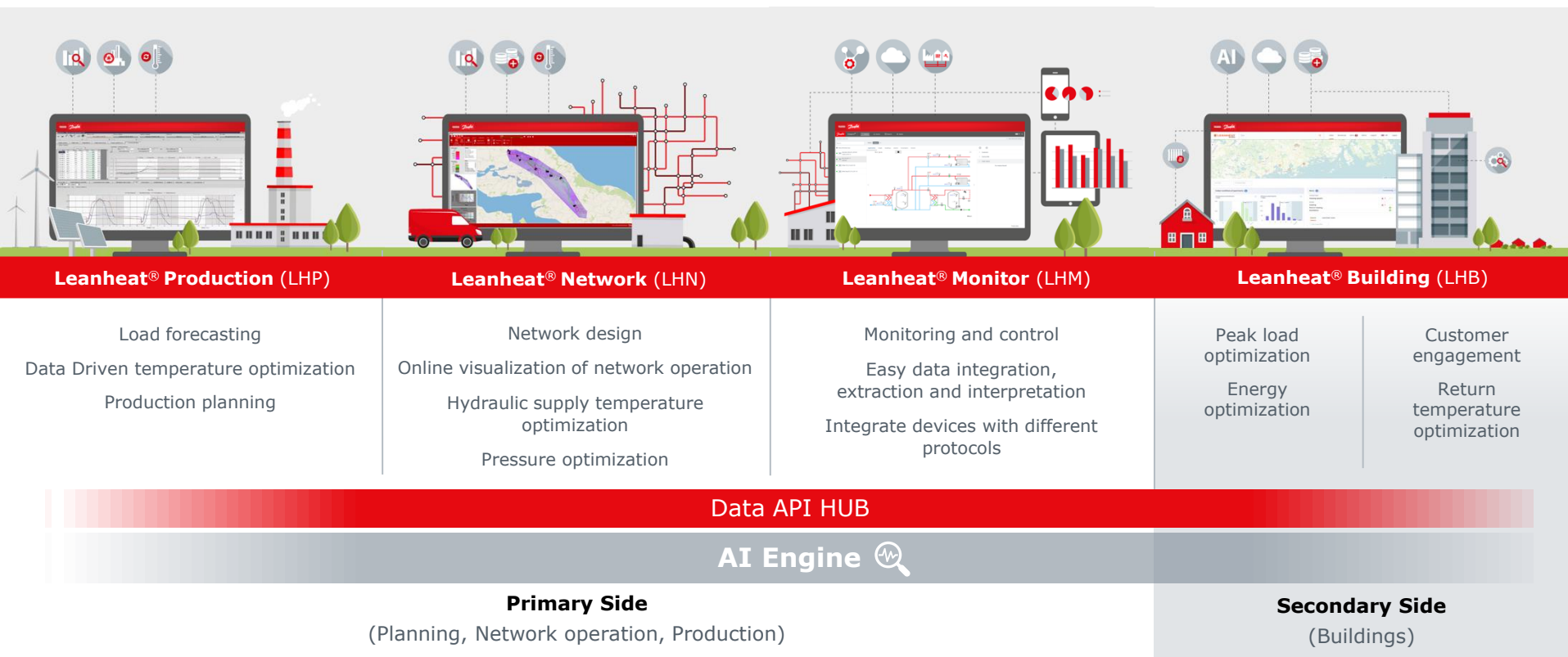


**PRODUCTION & DISTRIBUTION
PRIMARY SIDE**



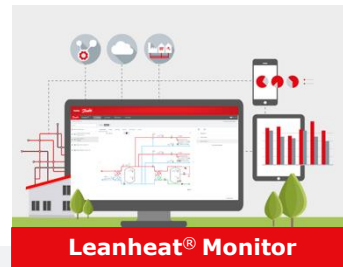
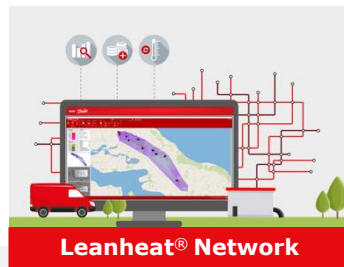
**DEMAND
SECONDARY SIDE**

End-to-end energy optimization solutions



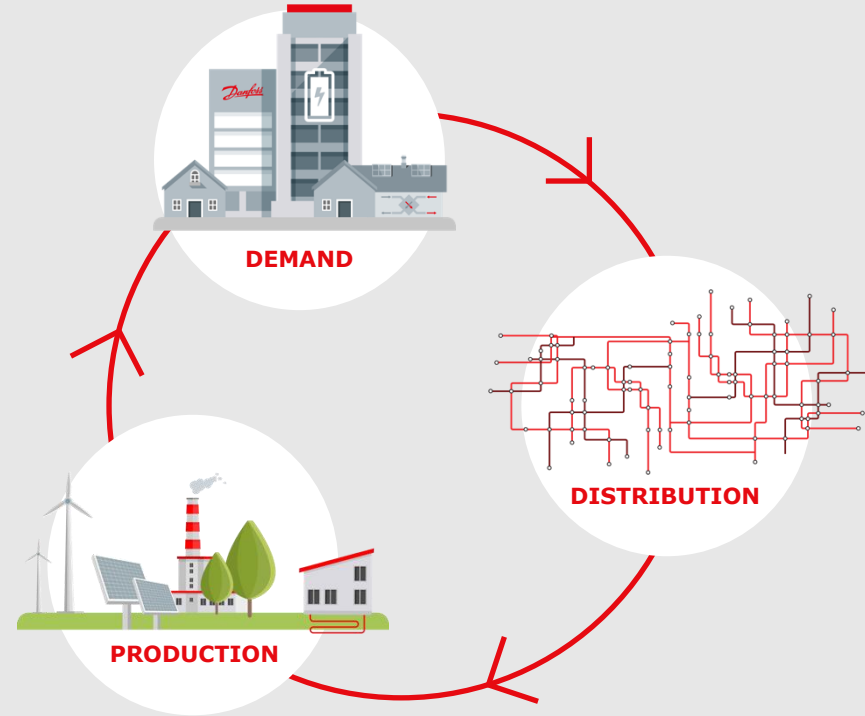
Danfoss Leanheat® is **leading** the **green energy transformation**

A complete portfolio of products, components, and software for end-to-end optimization.



Increase operational efficiencies and reduce costs with smart, **end-to-end optimization**

Danfoss Leanheat® is an innovative suite of end-to-end optimization solutions that harness the power of digitalization to help users in the entire district energy network increase operational efficiencies, decrease costs, and accelerate the green transition.



Leanheat Production





Leanheat® Production

Leverage data to maximize energy efficiency.

Leanheat® Production is an advanced software tool for forecasting, planning, and optimizing district energy production and distribution. The future-proof software helps adjust, reduce, and optimize energy consumption.

- **Load forecasting** predicts exact in-network heat consumption
- **Production optimization** saves between 1 – 3% on fuel costs annually
- **Temperature optimization** reduces heat loss by 5 – 10%
- **Low ROI** between 0-5 – 2 years



Predictive maintenance



**Improved reliability,
uptime, service life**



Leanheat® Production

Forecasts

Weather Forecast

Locally optimized weather forecast

Load Forecast

Heat demand forecasting

Optimization

Production Optimization

Optimal electricity production

Peak boiler optimization

Heat storage optimization

Temperature Optimization

Data Driven Temperature Optimization

Reducing the temperature in the supply pipe to minimize the cost of producing and transporting energy

Leanheat® Production

Achieve more with optimization and planning

➤ Leanheat® Production **supports the operation staff in the daily operation to:**

Reduce loss in
the district
energy network

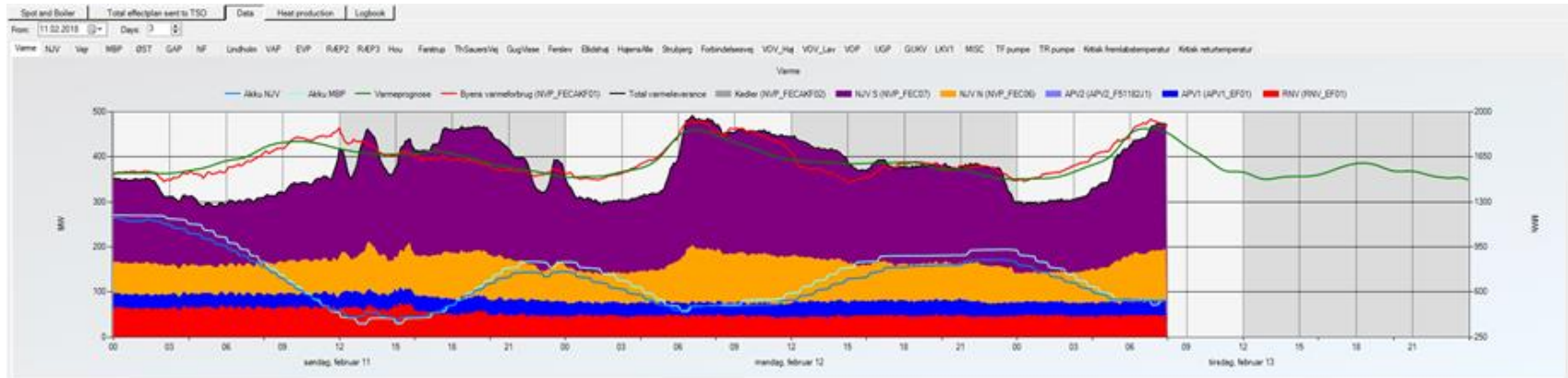
Suggest the
most
**economical
operating
schedule**

Collect all the
relevant data

Achieve **time
savings** in
daily operations

Ensure the best
possible **price on
energy** during
security of supply

Develop and
maintain **the
skills** of
operating staff



Leanheat® Production optimization

CONCEPT

PRODUCTION OPTIMIZATION

means

Heat production scheduling

(Calculate the most economical heat schedule while securing heat supply)

+

Electricity production scheduling

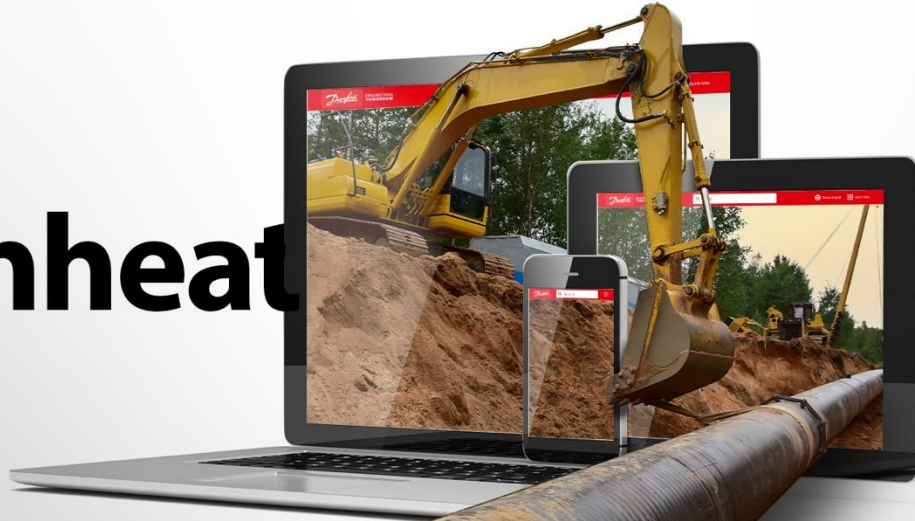
(Electricity market planning and reporting)

=

Combined optimization of heat and electricity production



Leanheat Network



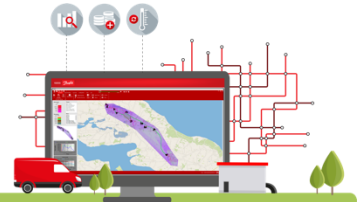


Leanheat® Network

Plan, visualize, and optimize a sustainable network operation.

Leanheat® Network is a thermo-hydraulic modeling tool developed specifically for use in district energy systems to support the planning, design, and operational processes.

- Network design to **build and maintain models**
- **Simulate** hydraulic and thermal conditions in district heating network
- **Optimize** network supply temperatures and pressure conditions
- **Predict** and interpret future consumptions on your network using AI



Leanheat® Network

Off-line

LHN Designer

Network Design
+
Hydraulic Analysis

Optimization

LHN Online

Visualization of the temperature, flow and
pressure at any point in the network

Real time measurements from SCADA
+
Load forecast
(Weather Forecast)

LHN Optimizers

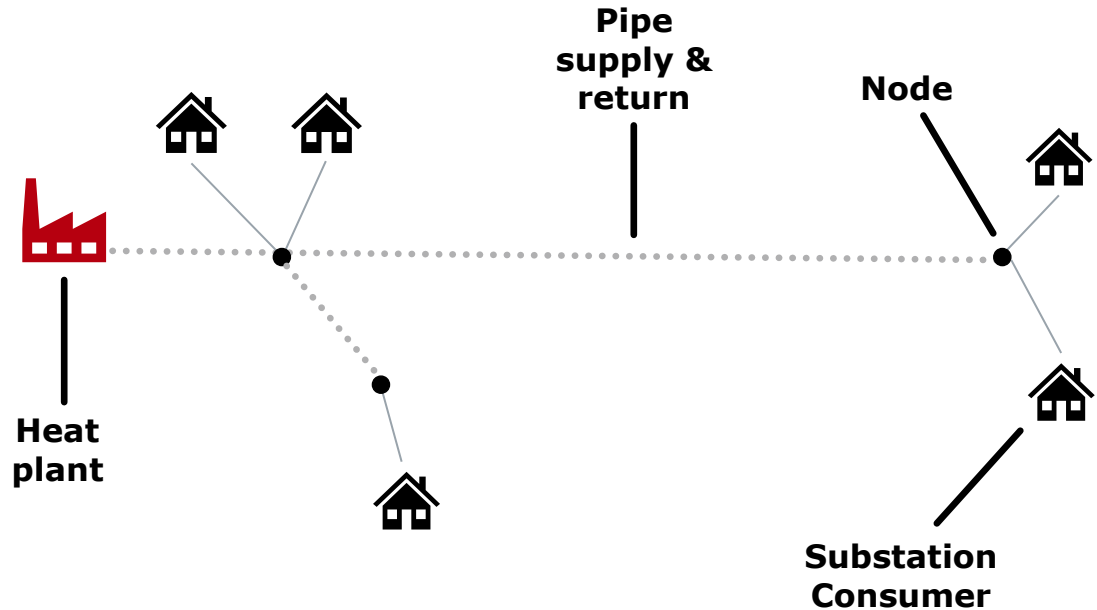
Temperature Optimization
+
Pressure Optimization



Basic elements for building a hydraulic network model?



Transfer GIS/database data
to a model



Leanheat® Network Designer offline tool

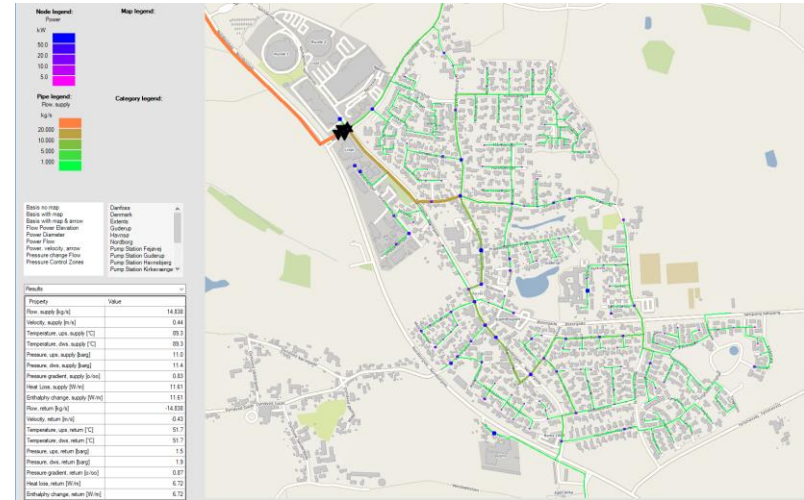
LEANHEAT® NETWORK

DESIGN OF DH NETWORKS

HYDRAULIC ANALYSIS

Leanheat® Network as a development support tool

- Optimization of expansions, refurbishments and new connections
- Analysis of impact of expansion, refurbishments and new connections on the rest of the network
- Development of contingency plans
- Database of knowledge about network



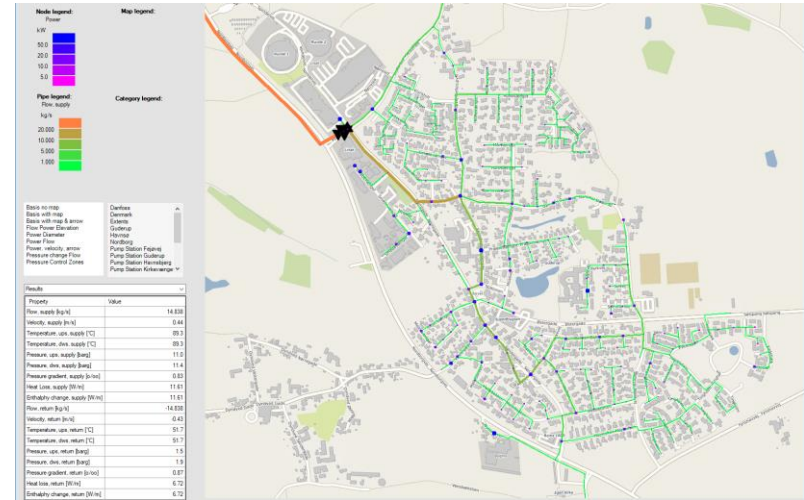
Leanheat® Network Designer offline tool

LEANHEAT® NETWORK

DESIGN OF DH NETWORKS

HYDRAULIC ANALYSIS

- Creation of new networks and make extensions of existing networks
- Easy to create hydraulic models from imported GIS data
- Simple and flexible built-in calibration module
- Automazed generation of network layouts – easy for feasibility studies



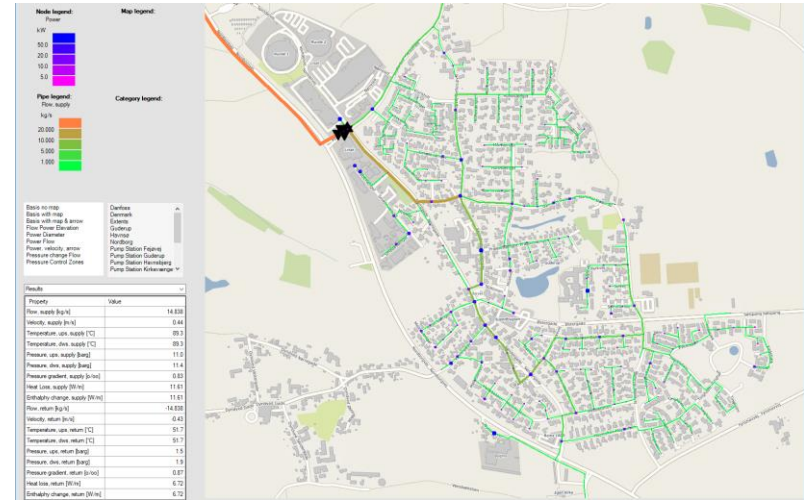
Leanheat® Network Designer offline tool

LEANHEAT® NETWORK

DESIGN OF DH NETWORKS

HYDRAULIC ANALYSIS

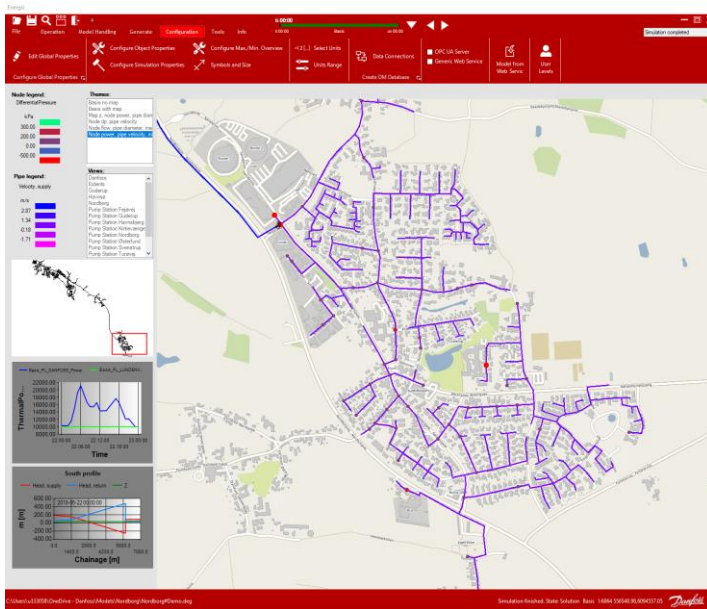
- What-if analysis
 - What happens if we add a new area?
 - Do we have any violation of design conditions?
 - Do we have bottlenecks in system?
 - Will a pump solve the problem?
- Hydraulic and thermal simulations of state (pressure, flow and temperature) in district heating/cooling networks



Leanheat® Network

Achieve improved and sustainable network operation

Leanheat® Network as an online support tool



Calculate **optimal hydraulic parameters** and apply them

Overview of the **temperature, flow and pressure** at any point in the network

Overview of **the composition of production sources** at any point in the network

Simulation of future conditions based on weather prognosis

What-if analysis for daily operating challenges and critical events

Planning of interventions with **effective execution** and **quality of services**

Leanheat® Network Temperature Optimization

TEMPERATURE OPTIMIZATION

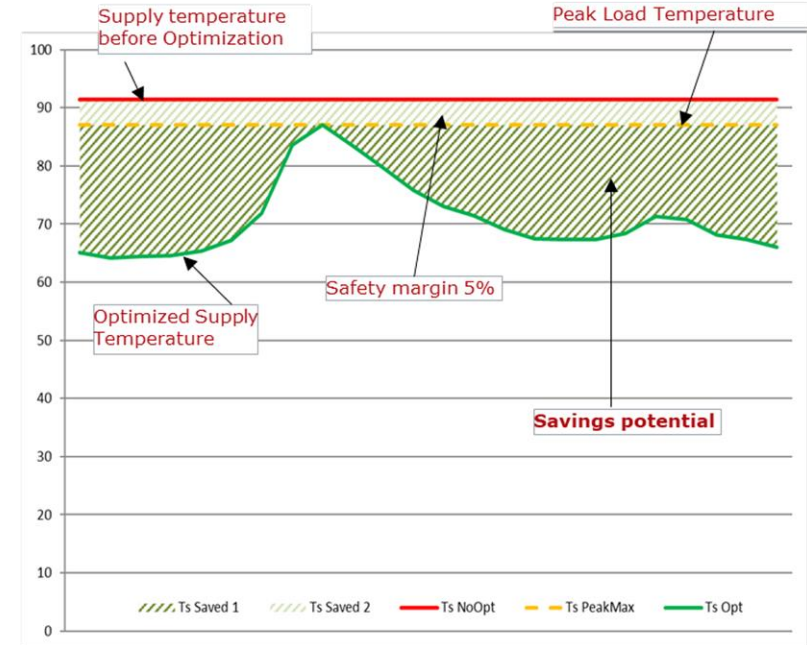
HEAT LOSS REDUCTION

What is Temperature Optimization?

- Optimization of the supply temperature
- Reduction of the network heat loss

What does TO offer?

- Ability to predict the heat demand up to 5 days head
- Possibility to optimize the thermo-hydraulic balance of the distribution network
- Minimizing pressure fluctuations hence extending the lifetime of the network
- Considerable savings and reduction of carbon emissions

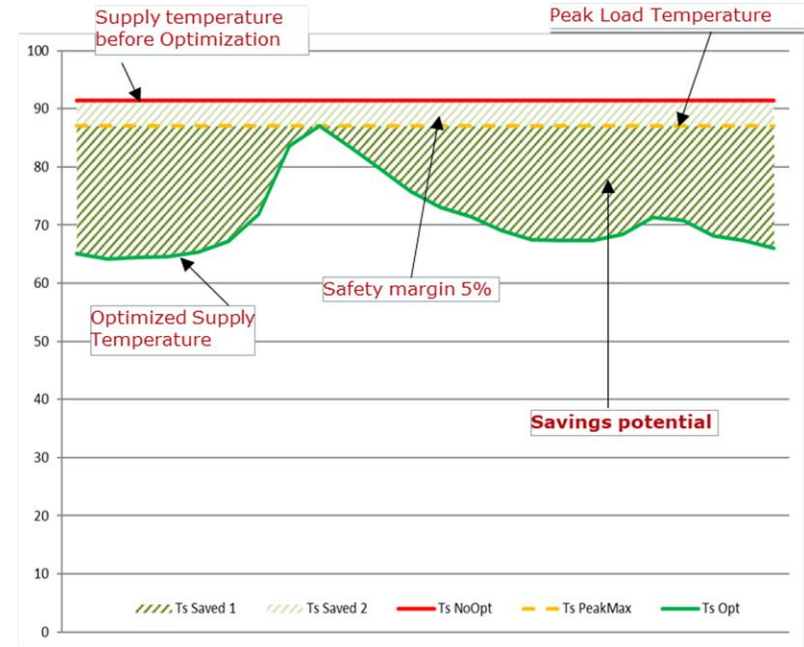


Leanheat® Network Temperature Optimization

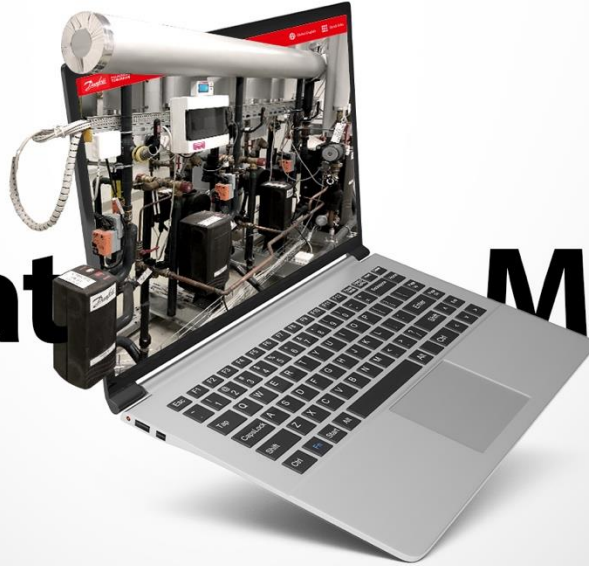
TEMPERATURE OPTIMIZATION

- Reduce the annual supply temperature by app. 6 to 8°C
- Reduce existing pipeline network loss by app. 8 to 10%
- Reduce the production cost up to 2%
- Minimize pressure and temperature fluctuations in the network
- Considerable energy savings. Minimize carbon emission and protect environment
- Reduce maintenance and support of pipeline network

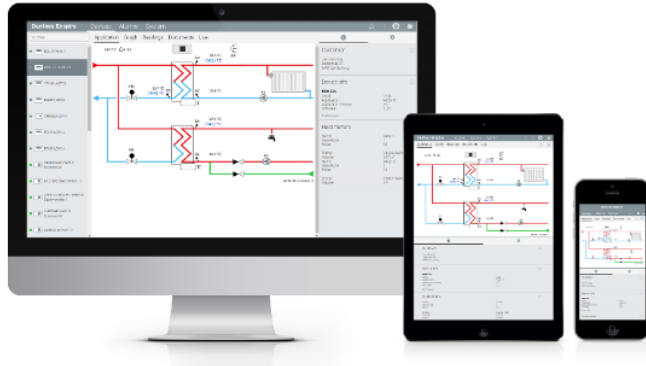
HEAT LOSS REDUCTION



Leanheat Monitor



What is Leanheat® Monitor?



- ✓ Danfoss software solution for monitoring and control of District energy systems
- ✓ Cloud based software application hosted in Microsoft AZURE
- ✓ Comparing with traditional Visualisation (SCADA) systems, LHM is designed and optimized for District energy systems
- ✓ Interaction with Danfoss controllers is very easy and automated as much as possible

Why Leanheat® Monitor?



Open, connected
and transparent



Modern web-based
solution



Customized for
district energy



Lower investment
and predictable
operation costs

Why Leanheat® Monitor?



Open, connected
and transparent

- **Easy integration** with business intelligence and optimization solutions

API

- Connect with any device using **standard communication**

Modbus
RTU

Modbus
TCP

OPC

- **Part of Danfoss district energy optimization suit**

LH Network

LH Production

LH Building

Why Leanheat® Monitor?

- Always **up-to-date** – the latest version automatically available for your use



Modern web-based solution

- **Access from anywhere** and from any device (mobile, desktop compatible)
- Trusted security mechanisms for **safe and secured** data storage

Why Leanheat® Monitor?

- **Improve** your **work efficiency** with functions like auto-commissioning, group setting, ...
- **Improve** your network **control and management** with actionable information insights, predefined report templates and alarms, ...
- **Easy integration** of new devices



Customized for
district energy

Why Leanheat® Monitor?

- **Lower** your total cost of ownership and **improve** return on investment
- **Reduced IT investments and maintenance costs** using Software as a Service
- Unlocking your resources to **focus on your primary business**



Lower investment
and predictable
operation costs

Danfoss Leanheat® Monitor around Europe

95 projects

6000+ devices

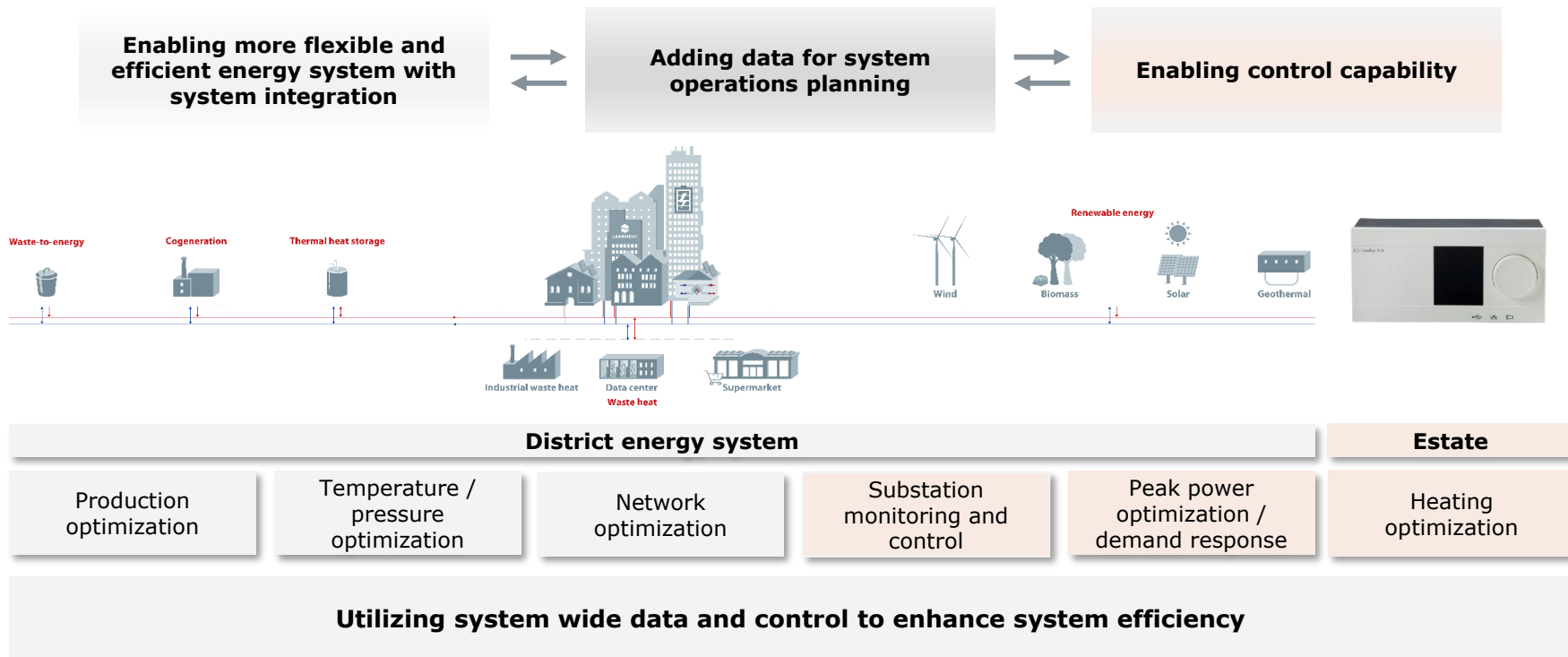
14 countries



Leanheat Building



Customer as a part of district heating network control



Leanheat® Building

Leanheat control differences compared to traditional heating control

TRADITIONAL HEATING CONTROL

Manual control based on:

- Outside temperature
- Experience
- ...

- Inaccurate
- Manual maintenance
- Uneven indoor temperatures
- Wasted energy



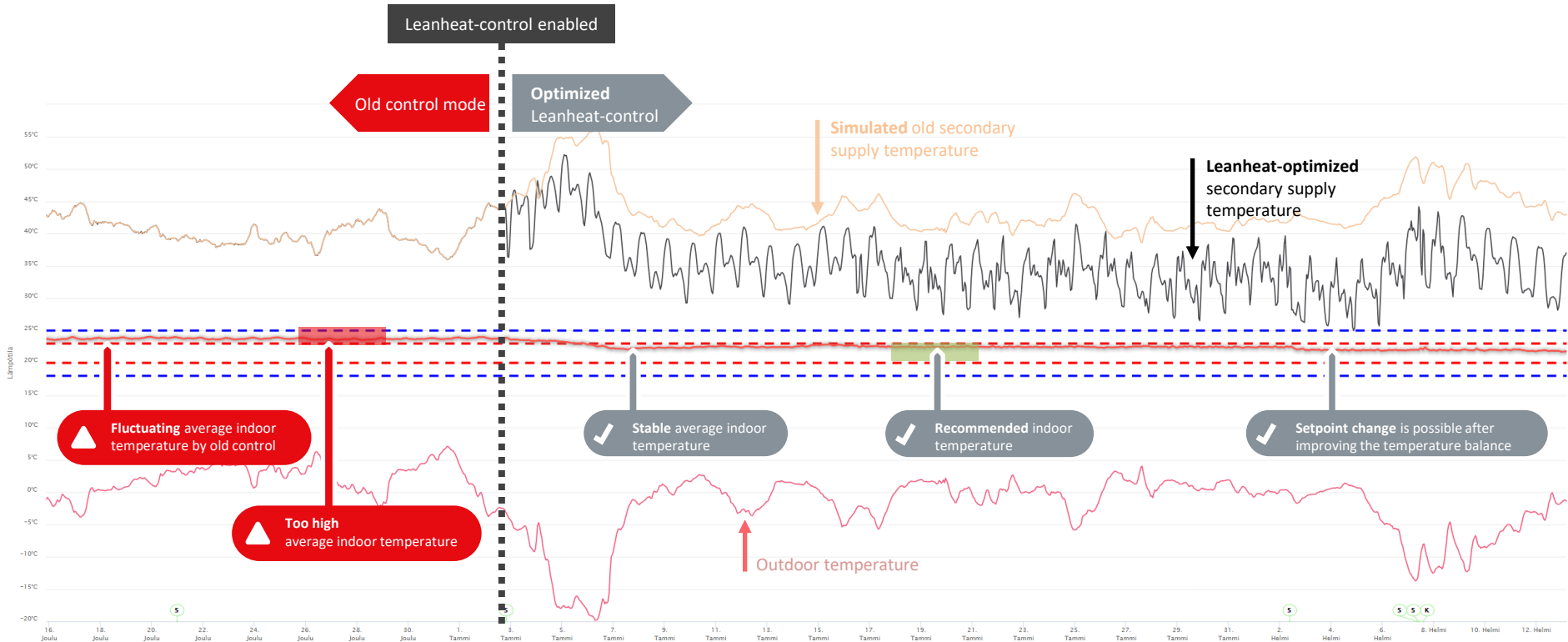
LEANHEAT-CONTROL

Automatic control based on:

- Indoor temperature
 - Weather forecasts
 - Building thermodynamics
 - Residents behavior
-
- + Forecasting
 - + Self learning and updating
 - + Fully automated
 - + Even indoor conditions
 - + Optimized energy efficiency
 - + Possibility to peak shaving and demand response

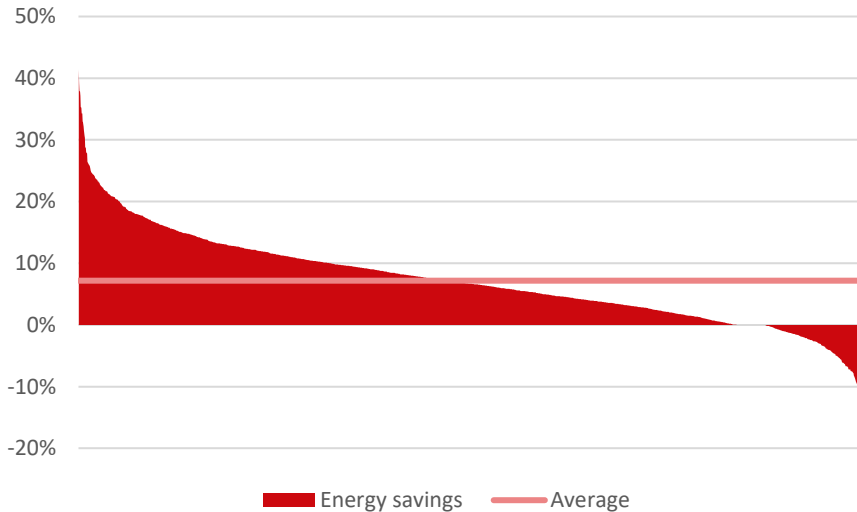


Example of Leanheat AI control in action

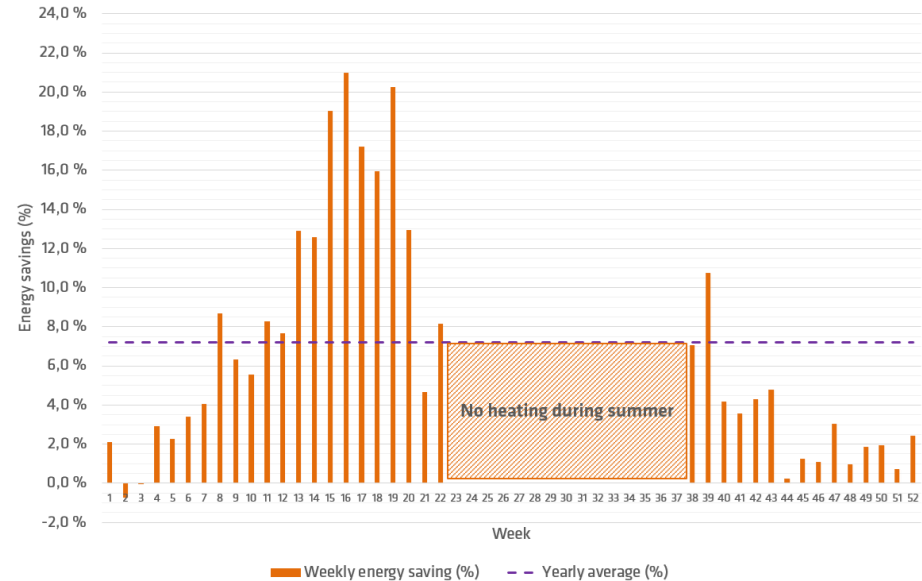


Leanheat saves 5-10 % of energy in apartment buildings **while maintaining indoor comfort**

Yearly weather compensated energy savings in 100 000 apartments

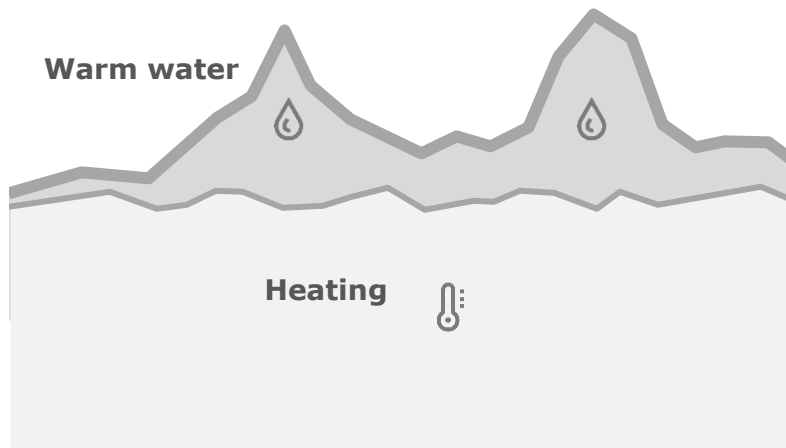


Leanheat weekly energy savings
Yearly average 7,2%

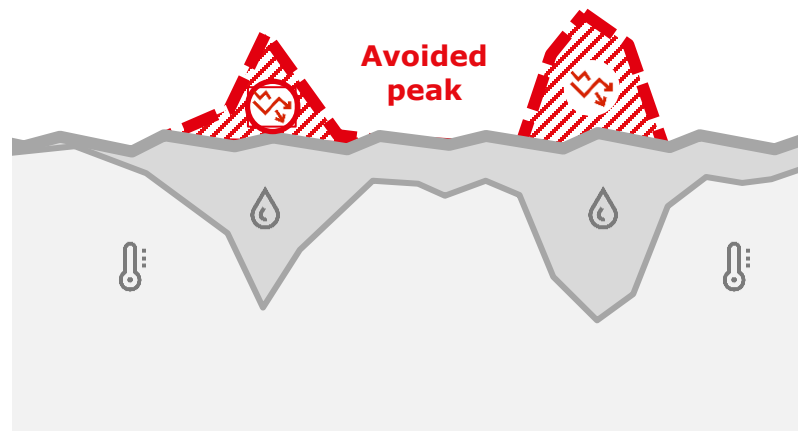


Peak shaving → 20% lower peak power

24H TOTAL POWER NEED
TRADITIONAL HEATING CONTROL



24H TOTAL POWER NEED
LEANHEAT CONTROL



Demand Side Management starts by **engaging end customers**

1. Demand side **energy optimization**

- Reduce average consumption **immediately by 5-10 %**

2. Start utilizing the **built-in thermal flexibility of buildings**

- Reduce peak loads **by 20 %** on average

3. Connect demand side to **production & network optimization**

- Expose all connected buildings as **virtual heat storage**

Example of models to **engage end customer**



Seasonal energy price



Peak power component
in pricing



Reduction to heating prices
CO2 neutral district heating



Good indoor comfort

End-to-end optimization:

real-life case of district heating utility Vatajankoski, Finland



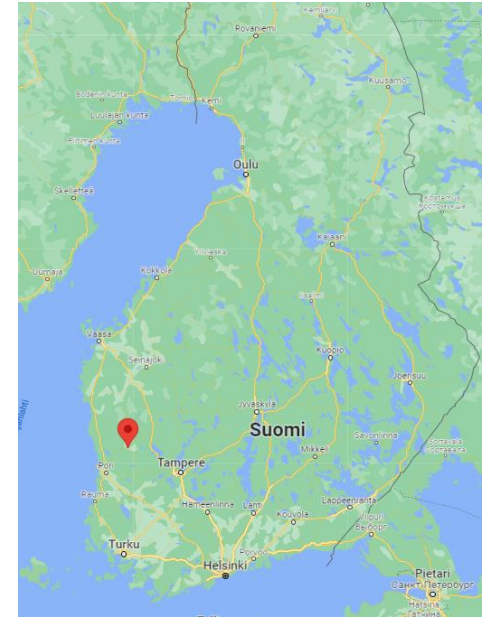
Vatajankoski has combined heating demand response to production optimization with Danfoss Leanheat®

- An innovative local energy company at Kankaanpää (Finland) originally built around local hydro power.

Main businesses:

- Energy services
- Construction and maintenance services for networks and industry
- Electricity transmission, district heating and cooling

2019 turnover was 30,3 million euros and profit 2,6 million euros



Business challenges

- Danfoss' partner for building heating optimization service since 2018 with significant share of Kankaanpää multi-family houses on their service
- 2021: **new waste heat plant** and **large conventional heat** storage → Need for optimizing the production
 - In addition to new investments Vatajankoski has a **bio-CHP** plant and **gas** and **oil boilers**.
- Extend partnership to production optimization

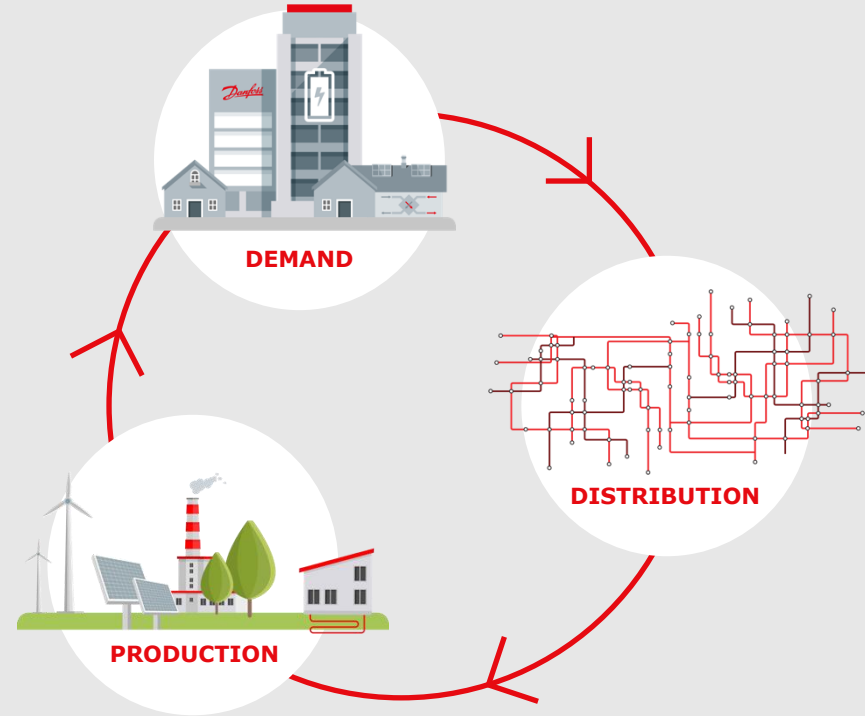


Solution

- Preliminary modelling and analysis for the production optimization benefits compared to baseline situation
- Demand side management

Goals:

- Precise load forecast
- Robust optimization
- Demand flexibility is integrated to production optimization



Building and **implementing** the solution

- Working group to specify and deploy commercial process, automation and integrations
- Key topics: value outcome, daily process and modelling quality
- Based on experience integration to automation systems is most critical technical part, but it was tackled with close collaboration with automation vendor
- In addition to automation, integrations to weather service, prices and Leanheat® Building were established

Building and **implementing** the solution #2

- As a lesson learned even more focus could have been put on daily process especially when earlier there was no experience on production optimization.
- In the beginning we put effort to think about testing, when in this case we had possibility to run solution aside current operations to get familiar with it and tune it.
- When replacing existing solution focus would be more on optimization results and fit to existing environment

Business **benefits** and outcomes

- Solution is now used by Vatajankoski operations and schedules through automation views by their control room
- Provided schedules have been robust and consistent
- Clear value can be shown compared to baseline operation without optimization
- Set project goals were achieved except direct dispatching through automation has not yet been implemented





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