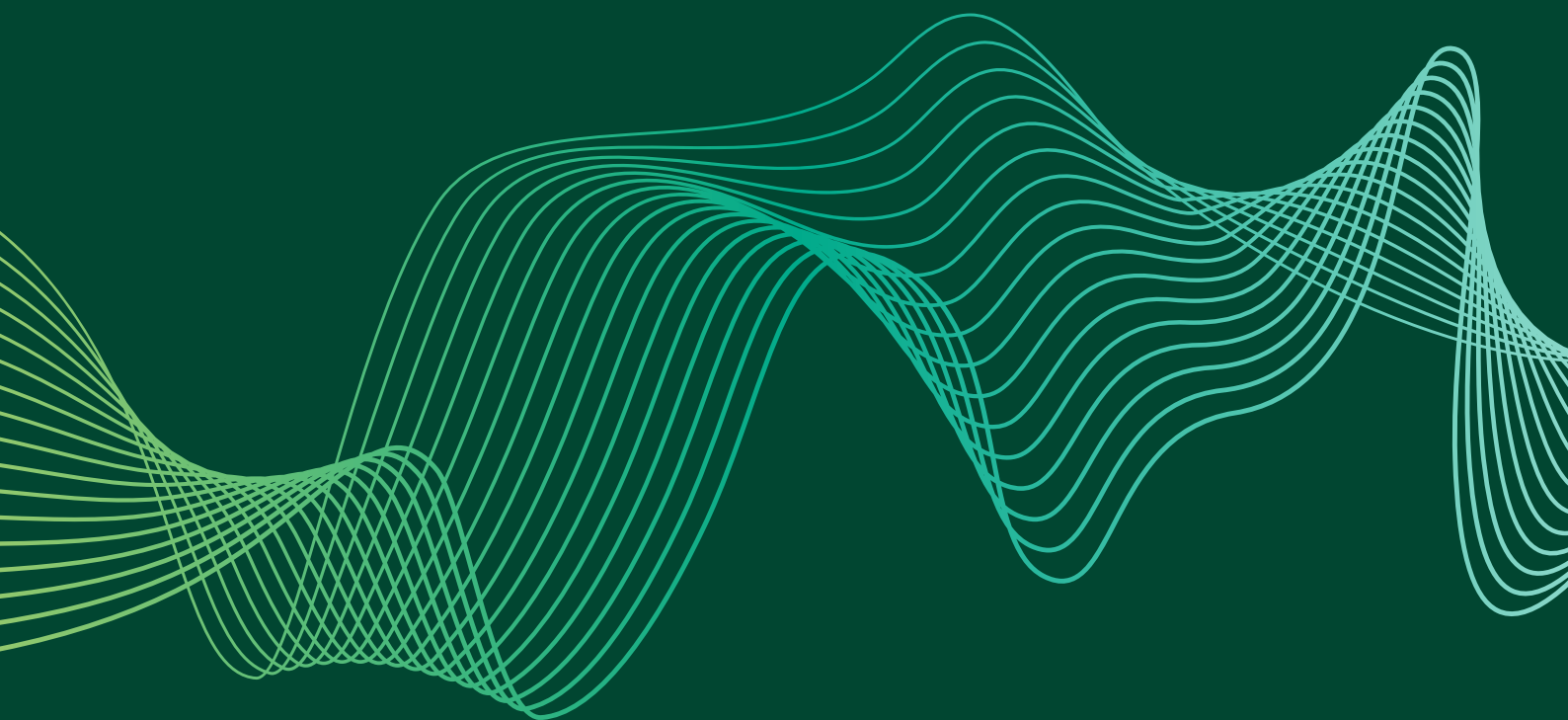


Digitalisation of the Danish District Heating Sector

Get inspired by 18 cases of digitalisation and data-driven operations from Denmark's district heating sector



DIGITALISATION OF THE DANISH DISTRICT HEATING SECTOR

Get inspired by 18 cases of digitalization and data-driven operations from Denmark's district heating sector

June 2023

ORIGINAL VERSION

Inspirationskatalog: Digitalisering og datadreven drift i danske fjernvarmeselskaber (2023)

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DESIGN

B14

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Introduction

FOREWORDS

Denmark is heading towards a transformation of the energy system. Away from fossil fuels and towards the use of renewable energy and excess heat as an integrated part of the energy mix.

In general, Denmark is focusing on a far more effective use of resources – among other things through optimising our energy efficiency in buildings, industry and transport. Therefore, it is also the ambition that different energy sectors are linked together, so that electricity, heat, cooling, transport and production of renewable fuels will be much more connected in the future.

District energy plays a major role in the energy transition, as it can tie the future energy system together in an effective way by utilising both fluctuating renewable energy sources such as wind and solar; surplus heat from industry; data centres and production of fuels (Power-to- X).

One of the means to achieve this transition is an extensive use of data that is increasingly provided by the district energy companies across the value chain and in the processes that constitute the basis of efficient district energy operation.

We hope this catalogue will serve as an inspiration.



Jesper Koch
Chief of Analytics, Grøn Energi



Finn Mortensen
Director, State of Green



About the catalogue

BY DANISH DISTRICT HEATING ASSOCIATION (DDHA)

In recent years, the Danish District Heating Association (DDHA) has been focusing particularly on the digitalisation increasingly used by district heating companies. Through workshops and surveys of its members' digitalisation and use of data, DDHA can conclude that more than two-thirds of the industry are well on the way with the transition.

The aim of the projects is typically to utilise remotely read heat meters – not just for invoicing, but also to optimise operations and administration for better customer service.

There are plenty of examples of how this is done in practice, and this catalogue of inspiration presents some of them.

At DDHA, we believe that, within just a few years, more than 70 percent of our members will procure and utilise high resolution data. This means that district heating companies can contribute significantly to the green transition, not least by converting natural gas customers to district heating.

Potential savings just from temperature optimisation in all Danish district heating networks are estimated at € 90 - 110 million annually. The Future District Heating in the Greater Copenhagen Area in year 2050 (FFH50) report assesses the value of low-temperature district heating to be € 33,5 million annually.

There are also benefits from optimising buildings' energy consumption and interaction with the district heating system as well as more efficient administration.

Big potential for savings

A conservative estimate is that increased use of data for the district heating sector has a saving potential of approximately € 134 million annually.

Why digitalisation?

Digitalisation makes financial sense

District heating companies can utilise data from remotely read heat metres for temperature optimisation, thereby reducing both network losses and consumer prices by 5-10 percent. Companies can also minimise the investment required to convert gas customers to district heating, because the use of remotely read data can provide a 5-10 percent better utilisation of the existing distribution system and installations.

Today, more than 60 percent of district heating companies in Denmark use hourly or daily data from settlement metres in their operations, even though they are only required to read metres once a month. Most district heating companies can share this high resolution data with their customers without additional costs.

Data-driven operations can:

- Accelerate the green transition and sector coupling through effective integration of renewable energy and PtX
- Utilise existing production and distribution capacity in connection with conversions from gas
- Reduce heat loss and required pump performance in distribution networks
- Integrate the heat capacity of buildings to reduce the need for peak load during morning hours
- Perform condition-based maintenance
- Free up administrative resources for increased customer service
- Contribute to innovation and development of new digital services

Sharing consumption data across utilities sectors

In recent years, the desire for access to consumption data has increased significantly, both for customers with large buildings with high energy consumption – e.g. the central government, municipalities, housing associations and the business sector – and for companies offering energy optimisation for this type of building.

DDHA is ready to make data available for innovation and development of new effective solutions, and this is confirmed in some of the cases in this catalogue. Many district heating companies have already entered into agreements on sharing data and participating in development projects. However, there is a requirement for solutions that protect citizen data and business data as well as digital systems against cyber attacks.

In 2022, the Danish government presented a new digital strategy to help increase digitalisation in Denmark. Among other things, the new strategy focuses on the green transition and cyber security.

The new digital strategy will establish a utilities data program to drive developments towards a cohesive green utilities sector that better utilises resources and infrastructure across value chains and different utilities. The strategy has been allocated approximately € 2 million from 2023 to 2026, a total of approximately € 8 million.

With this catalogue of inspiration, the aim is to present the current status of the industry in Denmark. The catalogue also aims to contribute to the development of a joint utilities data programme across electricity, water, heating, wastewater, etc. Not only in Denmark, but also inspire globally and drive digitalisation and use of data and digital solutions from Denmark across the borders.

This will bring data from district heating into play in the best possible way in terms of the green transition and sector coupling in the Danish energy sector in general.

The approach

DDHA includes members' experience and opinions regarding digitalisation, data-driven operations and sharing of data across sectors when dealing with authorities and other industry associations.



Overview

Digitalisation throughout the value chain

The catalogue is structured so that it includes projects from the entire value chain from procurement and production over distribution to consumption and customers.

The projects are spread over several processes, where data-driven operations help optimise administration, planning, operations, maintenance and investment.

EXAMPLES OF DIGITALISATION AND DATA-DRIVEN OPERATIONS

Value chain	Procurement	Production	Distribution	Consumption
Process				
Administration	Supplier management	Project management and follow-up	Project management and follow-up	Handling customers converting to district heating and new customers
Operations	Electricity market registration	Electricity market optimisation	Temperature optimisation by-pass and sectioning	Peak shaving energy optimisation cooling
Maintenance	Sourcing spare parts	Condition-based maintenance	Condition-based maintenance	District heating units
Planning	Utilisation of surplus heat fuel procurement and sourcing	Audit planning long-term-forecasts reports to the authorities	Renovation of service pipes	Budgeting heating price forecasts
Investment		Establishment of heat pumps and other installations	Network extensions	Gas conversions subscription schemes

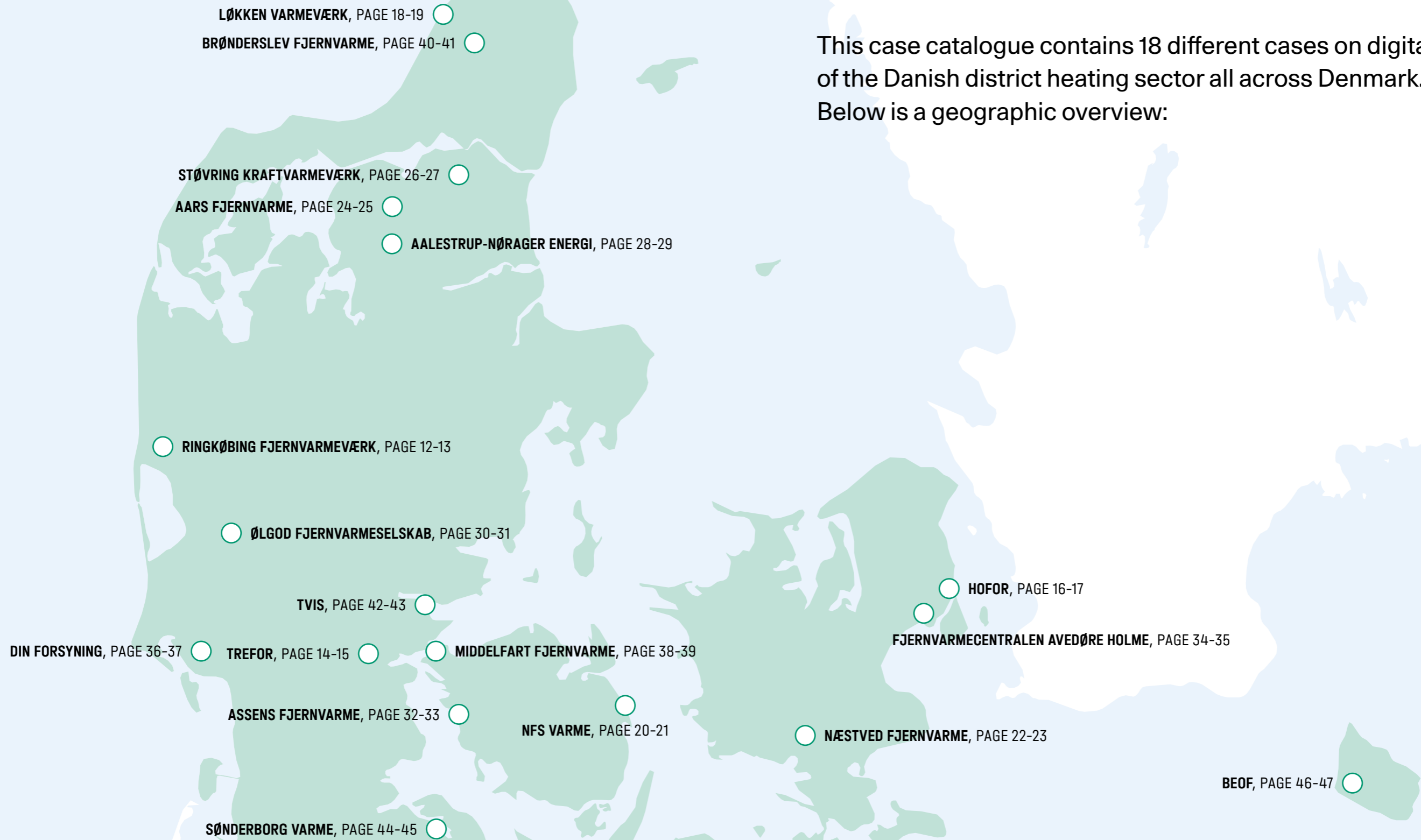
Categories of cases

FIND EXAMPLES OF CASES IN THE DIFFERENT CATEGORIES HERE

Company	Page	Procurement	Production	Distribution	Consumption
Ringkøbing Fjernvarmeværk					
TREFOR					
HOFOR					
Løkken Varmeværk					
NFS Varme					
Næstved Fjernvarme					
Aars Fjernvarme					
Støvring Kraftvarmeværk					
Aalestrup-Nørager Energi					
Ølgod Fjernvarmeselskab					
Assens Fjernvarme					
Fjernvarmecentralen Avedøre Holme					
DIN Forsyning					
Middelfart Fjernvarme					
Brønderslev Fjernvarme					
TVIS					
Sønderborg Varme					
BEOF					

Cases of inspiration

This case catalogue contains 18 different cases on digitalisation of the Danish district heating sector all across Denmark. Below is a geographic overview:





“WITH ENERGYTRADE, WE CAN PLAN PRODUCTION, WHILE ENERGYPRO HELPS US WITH ANALYSES. BUT THE COMPUTER DOESN'T HAVE A SIXTH SENSE. IT MAY BE NECESSARY TO CHANGE THE PROGRAM'S PROPOSAL IF YOU SENSE THAT REGULATION IS ON THE WAY.”

MARTIN HALKJÆR KRISTENSEN, CEO, RINGKØBING FJERNVARMEVÆRK

CASE 1

Ringkøbing Fjernvarmeværk a.m.b.a

Use of Decision Support Tool to Optimise Electricity and Heat Production

Challenge

Shifts at Ringkøbing Fjernvarmeværk are divided between five people, each with a one-week shift, i.e. there are four weeks break between each shift.

In order to establish a clear framework to plan operations, it was decided to procure the decision support tool: energyTRADE. The energyPRO system was procured for budgeting and analyses for the future.

Solution

Using weather, energy price and consumption forecasts, the energyTRADE system proposes a production plan, whereby the production equipment produces the cheapest heat at a given point in time. Ringkøbing Fjernvarmeværk also uses the energyPRO system to budget and to analyse whether it would be a good investment to build new equipment in the future.

Results

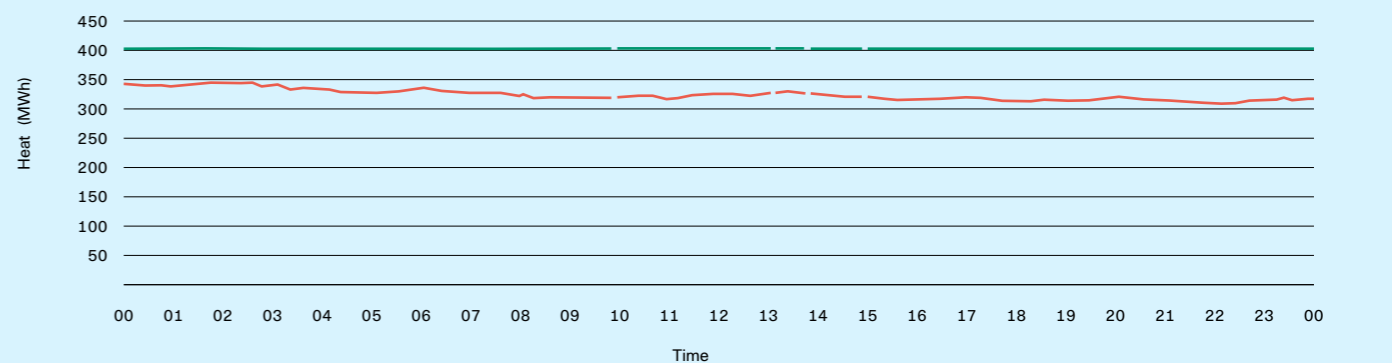
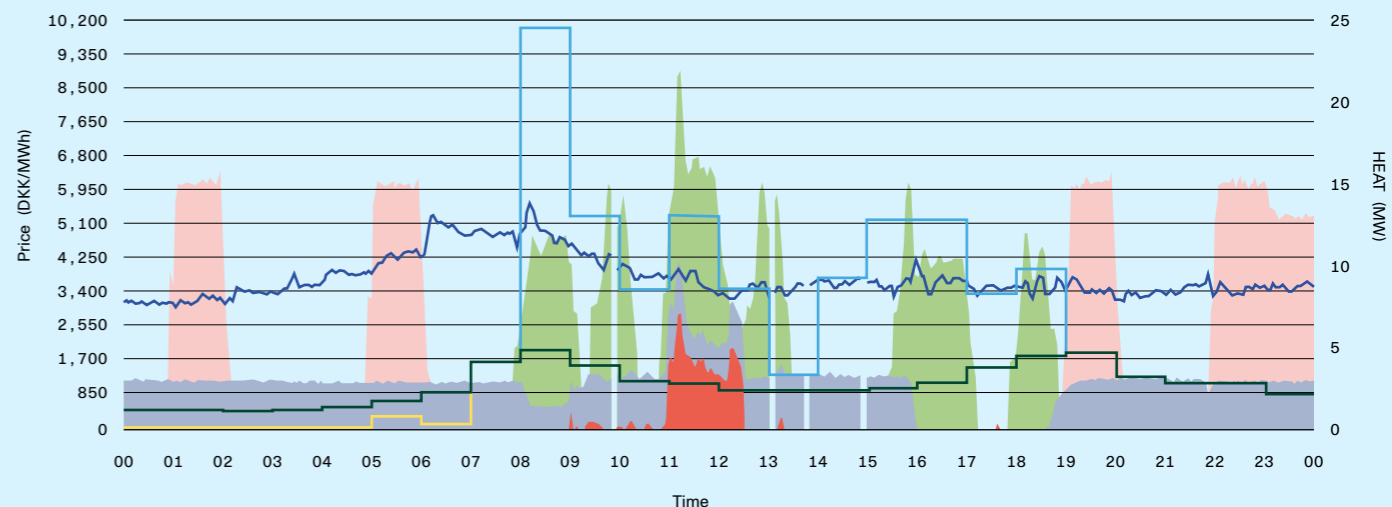
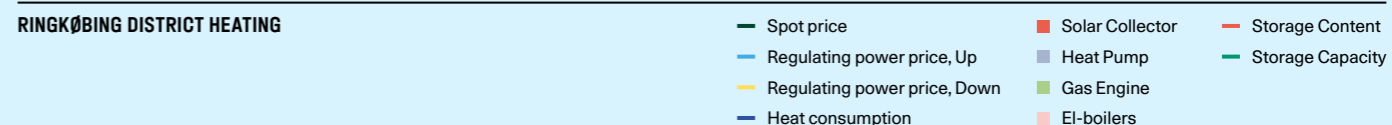
A digital twin of the production equipment is made in EnergyTRADE. Automatic actions are set up to retrieve

weather, energy price and heat consumption forecasts. The model optimises operation of the production equipment, so that district heating is produced at the cheapest possible price based on the forecasts. The system can automatically register the production plan for the production balance responsible (PBA) - the company responsible for the delivered electricity production - if you trust the program enough.

EnergyPRO works with statistical data. This could be average data for the entire industry, or own historical data, used directly or in corrected form to reflect the future you believe in. Perhaps you expect the fuel price or heat consumption to change, and in this way the system can provide its best bid on how best to use the plant's production equipment to get the most out of it, and the effect on finances.

For Ringkøbing Fjernvarme, this has resulted in easier and more uniform planning of day-to-day operations. The plant personnel can relatively quickly analyse the financial effect of large fluctuations in the market.

RINGKØBING DISTRICT HEATING



INFORMATION

Company	Ringkøbing Fjernvarmeværk a.m.b.a	Meters	4.781
Solution Providers	EMD International A/S	Address	Kongevejen 19, 6950 Ringkøbing
Employees	8	Email	rfv@rfv.dk
Heat	100 GWh	Phone	+45 97 32 32 44



CASE 2

TREFOR

Temperature optimisation through cloud solution

Challenge

TREFOR Varme is obligated to operate the district heating system in the best possible way. This requires automated tools that can contribute to operations optimisation, including temperature optimisation, in which integration between production environment and external suppliers is a necessity.

Through the R&D project HEAT 4.0, TREFOR wanted to integrate the production environment with a cloud solution to create a platform that can use tools from different suppliers *without* having to invest in more integration solutions.

Solution

The Heat 4.0 R&D project aims to develop intelligent software solutions that can make district heating more efficient, and throughout the project, TREFOR Varme has focused on the following data-driven tracks:

- *Efficiency improvements* focusing on reducing transmission losses.
- *Heat production and production planning* focusing on utilising the possibilities in reduced supply and return temperatures.
- *Plug and play-software* focusing on developing a cloud-based algorithm to enable simple and secure massive data exchange between various IT systems.

The case was established with outset in TREFOR Varme's need for temperature optimisation and the three focus areas above.

The aim of the case was to integrate a SCADA system with a cloud solution to be able to receive data for temperature optimisation via data exchange with an external supplier through the cloud solution.

Results

After establishing the functional needs, a meeting was held with every conceivable supplier of the applications/systems expected to be part of the solution. The suppliers, including TREFOR Varme's own IT department, focused on securing the following needs:

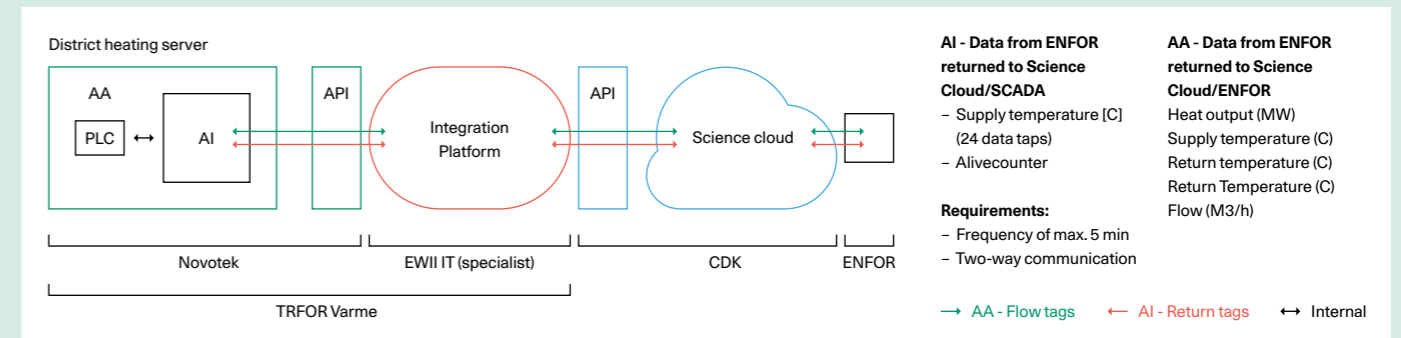
1. IT security – IT security must be in place when opening communication between the production environment and a cloud solution.
2. Uptime – The system as a whole should have high uptime. The system should not require much support/maintenance for the district heating company.

In collaboration with suppliers, TREFOR outlined a communication diagram for the case. The diagram shows the needs (data flow) and the applications/suppliers involved with each area of responsibility.

“THE SYSTEM AS A WHOLE PERFORMS FAR BETTER IN TERMS OF OPERATING HOURS THAN THE OLD SYSTEM, WHERE THE DISTRICT HEATING COMPANY WAS RESPONSIBLE FOR SERVER OPERATION. DUE TO THE HIGH UPTIME, THE SYSTEM CONTRIBUTES TO MORE STABLE OPERATION OF THE HEATING STATION.”

FREDERIK STJERNHOLM BUSK, ENGINEER, TREFOR

DIAGRAM OF THE SCADA INSTALLATION



The above communication diagram shows the type of data to be exchanged between the SCADA installation (district heating server) and the company ENFOR that supplies temperature optimisation software.

The system works in a way, where TREFOR Varme's district heating server sends data to Science Cloud (hosted by Center Denmark) that forwards the data to ENFOR. ENFOR then uses the data to calculate an optimal supply temperature from the station and returns the results to Science Cloud. Science Cloud then forwards the results to TREFOR Varme's district heating server.

These results are used to control setpoints in the SCADA installation.

The IT department in TREFOR requires an integration platform between the district heating server and Science Cloud that can validate data sent from outside and ensure that no unauthorised people have access to our production environment.

The largest barrier in the project was to ensure IT security across many suppliers and systems. At TREFOR, which is part of a multi-utilities company, IT security is the no. 1 priority in developing technical solutions. Therefore, it is important to include your IT security officers from the very beginning; otherwise, the project may have to be postponed for several months.

The system offers several benefits. Heat loss is expected to be reduced by 2 percent if the trend for temperature optimisation (TSO) operations in spring 2022 continues compared with TSO operations from the old system.

A positive spill-over effect of this project is a reduction of internal resources to manage TSO operations. This is primarily because the old TSO solution was placed on internal servers, and we were therefore responsible for maintaining and operating the server ourselves.

Furthermore, it was more difficult for the supplier of the system to access the server, because it was connected to the production environment.

INFORMATION

Company	TREFOR
Solution Providers	NIRAS & ENFOR
Employees	14
Heat	714 GWh

Meters	30.357
Address	Kokbjerg 30, 6000 Kolding, Denmark
Email	trefor@trefor.dk
Phone	+45 70 21 11 00



CASE 3

HOFOR District Heating Flexumers in Copenhagen

Challenge

Together with HOFOR and Københavns Ejendomme og Indkøb (KEID), Danfoss is exploring the potential for optimising the CO₂-neutral baseload production in Copenhagen by utilising AI-based heat control from its Leanheat AI system.

The first part of the demonstration took place in the 2021-2022 heating season and covered 29 municipal buildings (primarily day-care centres and schools). The primary objective of the demonstration is to reduce the peak heat consumption in the mornings (from 6 am to 10 am) by making consumption more flexible.

Therefore, the project has been called District Heating Flexumers.

Solution

The Danfoss Leanheat AI learns how the buildings behave and utilises the thermal flexibility of buildings (the ability to store heat in the building stock over a period) to reduce peak loads. During the morning peak period, the Leanheat AI diverts the heat stored in the buildings by reducing the heat input by up to 20 percent, whereupon it is recharged before the next morning.

Results

The initial results of the project show that the average morning peak load fell by 14 percent at building level, and at the end of the second part of the demonstration in the upcoming heating season, it is expected to be able to determine what this means at system level.

The connected buildings also slightly reduced their heat energy consumption because of compensation from solar energy forecast by the Leanheat AI.

Based on the overall results of the demonstration, it will be possible to quantify the overall financial and environmental benefits.

Looking at the total heating consumption on an hourly basis as an average per building, the peak output fell from 27.5 kW/building to 21.5 kW/building (-22 percent).

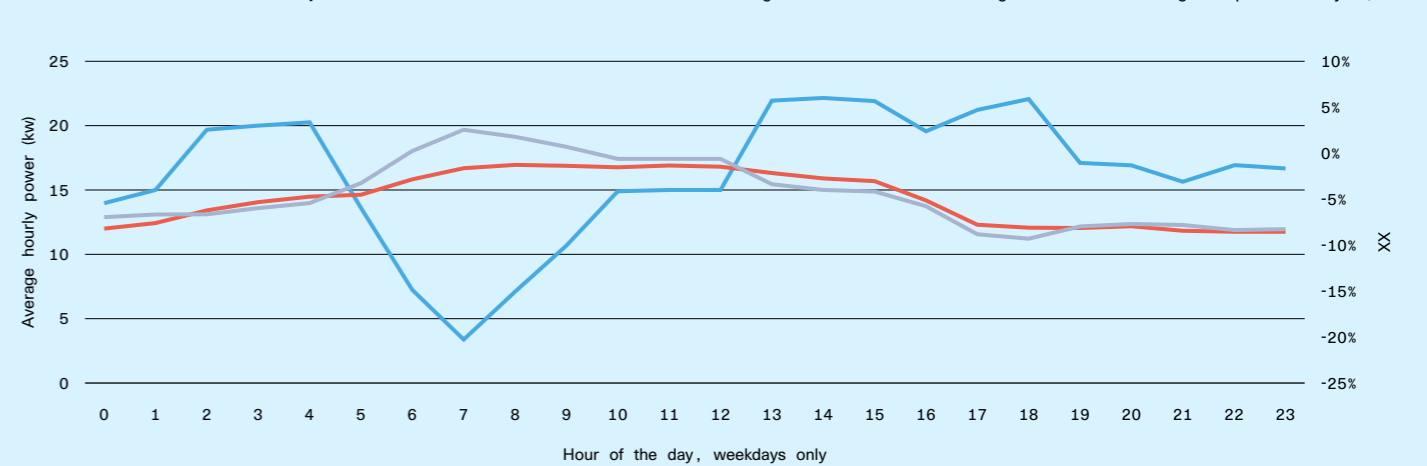
The calculation was made by comparing the highest peak during peak load displacement with the highest measured peak last year under the same outdoor conditions. Any obvious outliers were ignored in the analysis.

“AS A DISTRICT HEATING COMPANY, HOFOR CONSIDERS DISTRICT HEATING FLEXUMERS AS AN IMPORTANT STEP TOWARDS REDUCING PEAK-LOAD PRODUCTION AND CREATING ACCESS TO MORE RENEWABLES-BASED HEAT GENERATORS.”

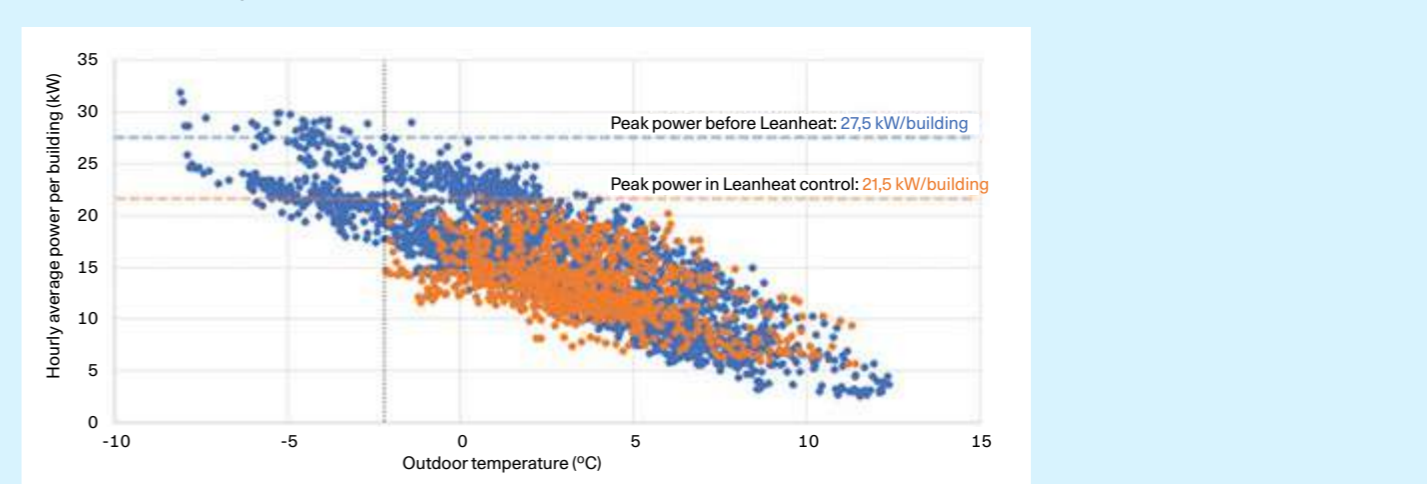
KRISTIAN HONORÉ, ENERGY PLANNER, HOFOR

The graphs show how the peak load period is moved by heating the building before the peak load occurs.

AVERAGE DAILY POWER PROFILES, LOAD SHIFTING ON AND OFF



HOURLY AVERAGE POWER, ALL



INFORMATION

Company	HOFOR	Meters	35.000
Solution Providers	Danfoss Leanheat	Address	Ørestads Boulevard 35, 2300 København S
Employees	1.500	Email	hofor@hofor.dk
Heat	4.400 GWh	Phone	+45 33 95 33 95



CASE 4

Løkken Varmeværk a.m.b.a. Use of Online Data for Condition-Based Renovation

Challenge

Approximately one in four homes in the supply area around Løkken, Denmark is a holiday home, and this share is increasing. This places high demands on keeping the pipelines warm as opposed to all-year houses with a constant baseload. Moreover, rental houses have greater demands for useful metre readings, because it can take a while to discover possible damaged metres.

In 2016, Løkken Fjernvarme began to dig up the oldest pipelines in the distribution system and found that many of them were in a good condition. The replacement, which was part of a long-term renovation plan, was therefore paused after a couple of years until the data basis for carrying out condition-based renovation was in place.

In connection with replacing settlement metres, it was decided to move from drive by to an aerial solution, so that data from the metres could be used for analyses, etc.

Solution

Løkken Fjernvarme has combined new metres from Kamstrup with the visualisation tool Heat Intelligence, which is

Kamstrup's analysis platform that combines facts about the pipelines in the network with data from the remotely read metres. This provides a good basis for optimising the district heating network.

The solution was implemented in less than one year to support the use of a motivation tariff and to ensure a quick return on the investment.

Results

Network reading, new readers and new analysis software have contributed to lower pressure in the network, efficient leak detection and optimised renovation of pipelines, because the district heating company now has the right decision basis.

The annual software licence is quickly paid for by the optimisations and savings made because the district heating company uses Heat Intelligence. Previously 5 percent of the operator's time was spent on meter reading.

This time can now be spent on more value-creating tasks. The district heating company's new decision-making basis

“I THINK THAT HEAT INTELLIGENCE IS A GOOD TOOL. PARTICULARLY THE COMBINATION OF THE REMOTE READING MODULE READY WITH HEAT INTELLIGENCE PROVIDES A LOT OF INSIGHT – REGARDLESS OF WHETHER I RETRIEVE DATA FOR TROUBLESHOOTING, LEAK DETECTION OR MAINTENANCE.”

CLAUS CHRISTENSEN, OPERATIONS MANAGER, LØKKEN VARMEVÆRK A.M.B.A.

is completely different from the annual snapshot generated by the modelling tool they used to have. Today, Heat Intelligence is fully available online 365 days a year, and he can go back, look into a specific development and learn from it. This is a huge gain.

After a short period with the new solution, Løkken Fjernvarme has achieved tangible results by optimising the distribution network. Among other things, the district heating company has succeeded in lowering the average pressure from 1.2 to 0.7 bar and to around 1 bar in peak periods.





This has resulted in annual savings of € 2.000-3000 for the district heating company. They also use Heat Intelligence to look at behaviour in terms of when the energy has to be accumulated in the network in the mornings. They used to work on the basis of assumptions, but now they have a tool for the task.

Moreover, Løkken Fjernvarme has used Heat Intelligence to achieve a more balanced flow in the two main pipes. Although the town has grown, the district heating company set the valves in the network as they always had, but new knowledge about the number of cubic metres flowing around the system revealed that some valves had been set incorrectly.

After implementing Heat Intelligence, it became clear that the load on the distribution system was extremely uneven. The load distribution used to be 80/20, but now it is 50/50.

This has resulted in less wear and stress on the pipelines, and in a significantly lower pressure. Consequently, the company now uses less energy and less money on pumping water in the system.

BENEFITS FOR LØKKEN

 <p>Lowering of average</p>	 <p>Annual savings of DKK 20,000 on lower pump</p>	 <p>More balanced distribution of the flow in the</p>	 <p>Possibility of condition-based renovation</p>
------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------

INFORMATION

Company	LØKKEN VARMEVÆRK A.M.B.A	Meters	1.225
Solution Providers	Kamstrup	Address	Industrivej 18, 9480 Løkken, Denmark
Employees	3.5	Email	info@loekenvarmevaerk.dk
Heat	24 GWh	Phone	+45 98 99 12 29



CASE 5

NFS VARME

From Manual to Digital Data Processing

Challenge

NFS Varme in Nyborg has replaced manual data processing and reporting with a digital solution in the form of a SCADA database. The database collects key figures for the utility company and the figures are then used to draw up accounting and operations reports.

The solution has not necessarily lightened the workload for the district heating company. Instead the company has an important management tool that brings financial and production data into play in completely new ways.

Solution

With a wish to release time in the administration, NFS Varme chose to digitalise the company's data processing. Previously, budget follow-up, monthly reports and annual readings were carried out in spreadsheets, which was very time-consuming.

The utility company therefore decided to install new remotely read metres and implement a SCADA database to gather all financial and production data in one place. The database was supplemented by the reporting system ReportPlus from Novotek, which gathers the key figures for the district heating company and draws up reports on the basis of the figures. The aim of all this was to streamline payments to suppliers, monthly and annual tax returns, as well as calculation of surplus heat tax.

Results

Jimmy Jørgensen, Head of Heating at NFS Varme, is uncertain whether this actually made reporting and data processing easier. However, the utility company has clearly benefited in other ways:

"When you start digitalising the reporting process, you might expect that the main advantage is that you can prepare a report quickly and easily. But for us, the real advantage has been that we've been forced to keep much better track of our data. We have streamlined our reporting and become much more disciplined in our data registration," he says and continues:

"This is a new way of doing things. But we can't get away from the fact that it takes time and resources. You can't suddenly do without three employees, but it optimises the company in other ways. This is particularly relevant today, with the enormous focus on reporting and increasing demands to submit figures to the authorities.

Specifically, NFS Varme has optimised calculation of tax refunds for stand by heat. NFS Varme has been able to run this calculation process monthly. Overall, Jimmy Jørgensen says that the link between production figures and accounting figures has become closer, and this has resulted in much better accounting follow-up.

"IT'S NOT EASY TO DIGITALISE A DISTRICT HEATING COMPANY'S DATA. IT TAKES TIME, AND REQUIRES A LOT OF EFFORT. ON THE OTHER HAND, YOU GATHER A CORPUS OF DATA THAT YOU CAN UTILISE IN THE FUTURE."

JIMMY JØRGENSEN, HEAD OF HEATING, NYBORG FORSYNING

Data future-proofs the district heating company

Even though digitalisation of NFS Varme's reporting has not saved time, Jimmy Jørgensen still considers the new way of processing data an important step for the district heating company. Not least because they have now started on their digitalisation journey, and they can begin to explore what opportunities the future holds.

"Digitalisation is also about finding out what computers are good at, and what people are good at. And then it's just a matter of laying the interfaces in the right places," he says. The digital interface in processing the company's key figures has turned out to be one of the 'right places' that Jimmy Jørgensen is talking about. Company figures are now much more visible, because updated figures are available once a month at the click of a button.

"It has become much easier to keep track of production figures and compare them with previous months. In short, we retrieve our reports once a month and are confronted with reality," says Jimmy Jørgensen and continues:

"This will protect us in the future in that we can keep track of our meter data and store everything in one database. It makes good sense to register your data so that it can be used in the future – for example to plan conversion projects. Eventually the various readings will merge, providing a smooth transition, in which the solution increasingly becomes a management tool."

MONTHLY REPORT, FEBRUARY 2022 - 1 MARCH 2022

VAT deduction	Standstill heat	Unit price	
Mineral oil	94.578	15.7836	1,492.78
Surplus heat	94.578	0.0000	0.00
Oil & liquefied petroleum gas tax			1,492.78
Waste heat	94.578	78.8085	7,075.24
Coal tax			7,075.24
Natural gas	94.578	0.0000	0.00
Natural & town gas tax			0.00
Excise duty	Heat produced from oil	Unit price	DKK
NO _x tax on bio oil	275.900	0.3000	297.97

INFORMATION

Company Nyborg Forsyning
Solution Providers Novotek
Employees 8
Heat 168 GWh

Meters 8.500
Address Gasværksvej 2, 5800 Nyborg, Denmark
Email nfs@nfs.dk
Phone +45 63 31 50 00



“WE'RE VERY PLEASED WITH THE RESULTS, AND WE HAVE A CLEAR AMBITION TO CONTINUE THIS WORK BY VISITING CUSTOMERS WITH POOR COOLING AND BY OPTIMISING SUPPLY TEMPERATURES IN THE DISTRIBUTION SYSTEM.”

JENS ANDERSEN, CEO, NÆSTVED FJERNVARME

CASE 6

Næstved Fjernvarme Reduction of Energy Consumption in Næstved

Challenge

In 2017, Næstved Fjernvarme entered into a partnership agreement with the project owner Næstved Municipality in the southern part of Denmark. The purpose of the partnership agreement was to improve energy efficiency in buildings with district heating, minimise energy loss in the district heating system and ensure greater efficiency from the heat pump at AffaldPlus, an inter-municipal waste management company located in the south of Zealand, Denmark.

Solution

District heating systems set the pressure and temperature based on the needs of the customer in the worst position to ensure that all buildings receive the necessary heat/energy. It is important for energy efficiency that the return temperature from a building is as low as possible, and thus the district heating water is cooled as much as possible. This means that the energy content of the water is supplied to the building and used in it.

Improving cooling provides several benefits, such as less energy loss in the distribution system and at the individual customer, increased capacity in district heating pipes/system and greater energy efficiency in the heat pump installation.

All district heating customers at Næstved Fjernvarme have heat metres from Kamstrup, submitting data every hour to the central database. The use of data has meant that customers with poor energy utilisation were selected via a metering system on a daily basis.

On the basis of this data, customers with the poorest energy

utilisation/highest return temperatures were contacted to arrange a visit.

After each visit, the customers were given a report with a description of defects and deficiencies in the customer's district heating system.

Results

A total of 1,221 visits were made during the project period, and some customers received more than one visit. The defects and deficiencies observed were:

- Defective valves/controls
- Limescaled/soiled hot-water tanks/domestic water exchangers
- Incorrectly set or defective installations
- Summer valve (operation error)
- Under-dimensioned radiators/underfloor heating

The visits showed that the usual cause of poor cooling is a defective district heating system.

Among other things, Næstved Fjernvarme has introduced an incentive tariff to give customers a financial incentive to repair defective systems. The new tariff increases the variable tariff by 1 percent per degree Celsius when the return temperature exceeds 50 degrees Celsius.

The results of the project are illustrated by the temperature settings for 2017 (reference year prior to project start) and 2020. The average supply temperature at the inlet to the distribution system has been lowered from 85.3 degrees Celsius in the reference year to 73.7 degrees Celsius in 2020,

which is a total reduction of 11.6 degrees Celsius corresponding to 13.6 percent. The average return temperature at the outlet from the distribution system in the same period fell from 48 degrees Celsius to 43.9 degrees Celsius, corresponding to 8.4 percent. The same trend is seen for temperatures at customers, as illustrated in the graph below.

More than 300 new district heating units were installed during the project period. This has led to energy savings, and lowering the return temperature has also improved the efficiency of the heat pump installed at Næstved Fjernvarme's waste incineration plant. This means that it is now possible to produce approx. 800 MWh (2.880 GJ) more a year.

Total energy savings are thus 4.936 MWh (17.769 GJ), and with a heating price of DKK 518/MWh including VAT, this means that total annual savings for customers are DKK 2.6

million. Furthermore, customers have saved DKK 1.4 million including VAT in incentive tariffs.

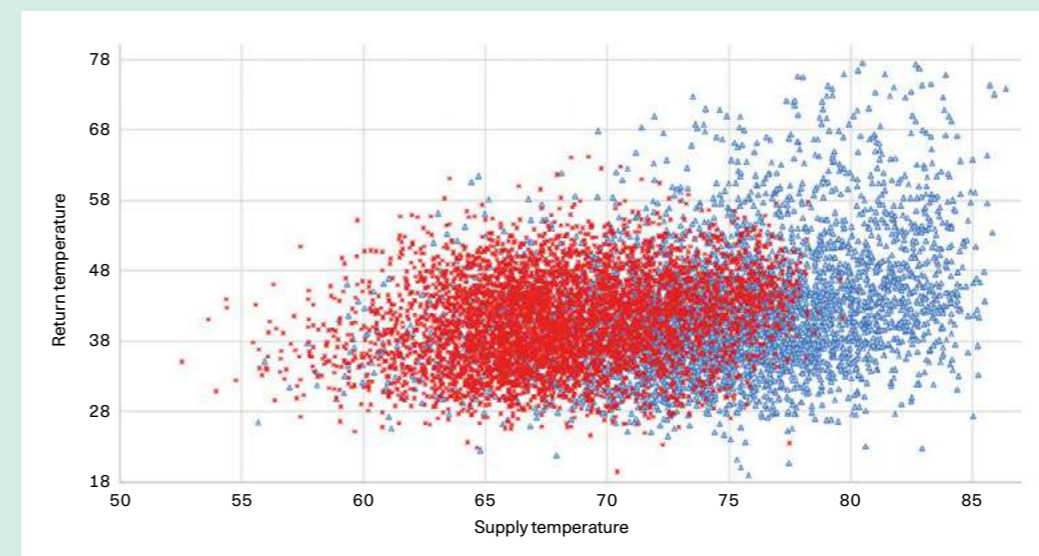
Overall, customers in Næstved have saved around DKK 4 million including VAT – every year. Næstved Fjernvarme emits 0.127 tonnes of CO₂ per MWh, and therefore total saved CO₂ emissions amount to 627 tonnes.

Laying out a district heating distribution system in a new area would cost approx. DKK 110,000 per building. Total energy savings in the project were calculated as standard consumption for 227 buildings.

This means that 227 buildings can be connected without upgrading the existing distribution system. With some caution, it can therefore be assumed that DKK 25 million were saved by not investing in a new distribution system.

COMPARISON OF THE AVERAGE TEMPERATURE SETTING PER BUILDING

▲ 2017 × 2020



INFORMATION

Company Næstved Fjernvarme a.m.b.a
Solution Providers Kamstrup
Employees 19
Heat 1.04 GWh

Meters 5.400
Address Maglemølle 62, 4700 Næstved, Denmark
Email info@naestvedfjernvarme.dk
Phone +45 55 72 56 65



“WHEN PRIORITISING WHICH AREAS TO RENOVATE, WE NOW PRIMARILY USE ANALYSES FROM HEAT INTELLIGENCE REGARDING HEAT LOSS AND/OR LACK OF HEAT SUPPLY.”

KASPER NEVE, ENGINEER, AARS FJERNVARME

CASE 7

Aars Fjernvarme a.m.b.a. Data-Driven Operations and Renovation

Challenge

Until recently, Aars Fjernvarme primarily used data for invoicing, but it seemed obvious to use the data collected on supply and return temperatures and flow to be able to look more closely at the condition of the distribution system – all the way to the end-users.

Combining two types of data sources makes it possible to generate new insight into the distribution system. The district heating company provides GIS data about the distribution system and meter data, e.g. from Kamstrup or Diehl, to Heat Intelligence, which then translates the data into a digital twin of the distribution system named Heat Intelligence.

The model can be accessed online and used directly to optimise operation of the distribution system.

Solution

The idea came from Kamstrup, based on conversations with customers. A need to use the meter data for other and more purposes than invoicing consumers was identified. The company needed an optimisation tool.

In Heat Intelligence, temperature and flow data are coupled with GIS data on the distribution system. GIS data includes pipe lengths, pipe diameters, degree of insulation and age of pipes.

This is a commercial product, and Aars Fjernvarme has served as a close sparring partner in ongoing development of the system.

Results

Aars Fjernvarme has gained completely new insight into their network. Temperatures can be monitored to and from each customer, and this data can be linked to the flow in each service pipe and compared with the length, dimensions, insulation and age of the pipes.

This is valuable knowledge when monitoring the condition of the network and planning renovations and replacements.

Aars Fjernvarme can now identify problems related to excessive heat loss much more quickly and better assess which branch pipes are expendable. The district heating

company can also find places where it may be necessary to establish a temporary branch pipe due to lack of demand.

As Aars Fjernvarme optimises the network, the supply temperature can be lowered even more, and this will reduce transmission losses. Aars Fjernvarme is continuously working to lower consumers' return temperature, as this will directly reduce heat loss from the return pipes and increase their energy production at the waste incineration plant, which includes flue gas condensation.

The return temperature is important for the efficiency of flue gas condensation. This directly affects the company's operating budget.

Besides lower supply and return temperatures, Aars Fjernvarme also achieved a better understanding of the hydraulics of the distribution system. It has become much easier to ensure supplies of the temperatures customers want.

Teaching Kamstrup's organisation how district heating companies think and work has been challenging. Aars Fjern-

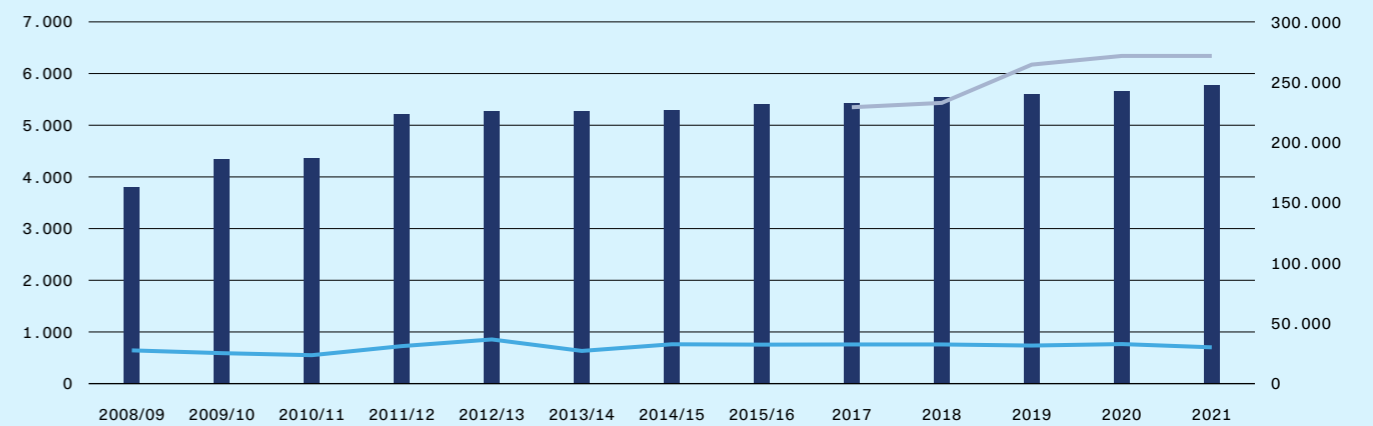
varme has spent a lot of time removing teething troubles from the system and gearing the system for larger supplies.

There are still challenges, but hopefully they will be resolved in the long term.

The orange line in the diagram shows the number of MWh lost in the distribution system per year, and the columns show the number of consumers connected to the distribution system. The grey line shows the increasing number of metres of pipes necessary to connect more consumers.

The result of Heat Intelligence is basically that Aars Fjernvarme can reduce transmission losses by approx. 1,500 MWh/year even though it continues to connect around 100 more consumers a year and is expanding the network by several kilometres every year.

The figures in the graph show 2,788 MWh, but the graph includes another project completed by Aars Fjernvarme that has reduced transmission losses by a further almost 1,300 MWh.



INFORMATION

Company	Aars Fjernvarme a.m.b.a	Meters	5.647
Solution Providers	Kamstrup	Address	Dybvad Møllevej 1, 9600 Aars, Denmark
Employees	12	Email	info@aaarsfjv.dk
Heat	110 GWh	Phone	+45 99 98 80 70



CASE 8

Støvring Kraftvarmeværk Temperature Optimisation and Localisation Of Faults In Customer Installations

Challenge

Støvring Kraftvarmeværk wanted to save time and reduce costs by optimising the meter-reading process.

Prior to the project, Støvring Kraftvarmeværk used the 'post-card' method to collect consumption data from heat meters.

Furthermore, the district heating plant was losing up to 15 m3 of water every day. The process being used at the time to collect consumption data was a resource-heavy manual process with many places where things could go wrong.

The most important requirements were to localise and stop water losses faster, and to optimise supply and return temperatures to achieve a more sustainable energy supply and corresponding reductions in CO₂ emissions.

Solution

Støvring Kraftvarmeværk a.m.b.a now automatically receives remotely read data from SHARKY 775 meters, provided by Diehl Metering. This means manual readings are

now a thing of the past. Consumption data is automatically transferred to the invoicing system, and the entire process is faster, easier and less prone to errors. High-resolution data and alarm notifications from the SHARKY 775 meters is analysed by IZAR PLUS Portal Meter Data Management software.

An alarm notification is sent directly to Støvring Kraftvarmeværk if a pipe bursts or a leak is detected. This makes it possible for the plant to intervene immediately and to prevent additional water losses from causing damage to consumers' homes.

Results

Once the project was launched, many leakages were discovered at consumer households. These leakages have now been fixed. Støvring Kraftvarmeværk now provides an additional service with leakage alarms for consumers.

Ongoing data analysis also helped reduce losses in the distribution system. The analysis tool in the IZAR PLUS Portal

“WE CAN NOW ANALYSE THE RETURN TEMPERATURE FOR EACH HOUSEHOLD AND HELP CONSUMERS IMPROVE THEIR HEATING HABITS. WE’VE INSTALLED LEAKAGE ALARMS IN CONSUMER METERS, WHICH MEANS WE CAN RESOLVE PROBLEMS BEFORE THEY BECOME SERIOUS.”

CLAUS HAPARANDA, OPERATIONS MANAGER, STØVRING KRAFTVARMEVÆRK

can now quickly discover any irregularities such as broken heat exchangers, adverse settings on a meter, or inappropriate consumer behaviour (e.g. using only a few radiators at maximum settings).

By helping consumers become aware of defective installations, for example, and/or inappropriate heating habits, Støvring Kraftvarmeværk has been able to reduce the return temperature.

Thanks to the analysis functions in the IZAR software, the return temperature of each household can be analysed and consumers can receive tailored guidance to help them improve their heating habits.

The solution not only provides significant financial savings, it also makes it possible to increase transparency by providing additional services such as access to a web portal or app that lets customers check their daily data, including consumption and temperatures.



INFORMATION

Company	Støvring Kraftvarmeværk	Meters	3.215
Solution Providers	Diehl Metering	Address	Hjedebakvej 2, 9530 Støvring, Denmark
Employees	5	Email	kvv@stoevring-varme.dk
Heat	55 GWh	Phone	+45 99 98 80 70



CASE 9

AN Energi a.m.b.a

Digitalisation of Water and Heating Consumption Data

Challenge

In 2014, Aalestrup Varme and Aalestrup Vand entered into a contract with Kamstrup on a three-year project to replace all energy meters. Subsequently, the Aalestrup and AN Energi heating plants merged, and a similar system was quickly established at AN Energi in the northern part of Jutland, Denmark.

The heating plant already had a 'drive-by' solution, and the waterworks used meters that remotely read data from consumers once a year.

We decided to ask local plumbing companies for estimates for meter replacement. The plumber was to change both the water and heat meter when he was at the house. The heating plant would also cover the cost of a quick service inspection by the plumber of the consumer's installation.

The plumbing company had three years to complete the project, which could be carried out when the company had free slots in its schedule.

The project could therefore be completed at a relatively low cost.

“THERE ARE HUGE FINANCIAL BENEFITS FROM MERGING A HEATING PLANT AND WATERWORKS. BOTH DURING THE CONSTRUCTION PHASE AND AFTER THE PLANT IS OPERATIONAL. REMEMBER TO DISCUSS EXPECTATIONS WITH THE SYSTEM SUPPLIER. AND MAKE SURE TO KEEP YOUR METER-READING SYSTEM SIMPLE.”

PALLE PEDERSEN, OPERATIONS MANAGER, AN ENERGI A.M.B.A

Solution

Much of the hassle and expense of reading meters manually is related to accessing the property. The board therefore decided the time had come for a change, as the majority of batteries in existing heat meters were worn out.

The board wanted processes to be technologically up to date after such an investment. They therefore settled on the manufacturer's best two-flow heat meter, which made it possible also to monitor for any leakages in individual households.

Results

Aalestrup has now been using the new system for a while and is very happy with it. There is a huge potential in exploiting the ability to read meters remotely, and there are constant new developments.

As purchasing licences is relatively expensive, and as it requires many working hours to get the most out of the systems, not all options are currently relevant.

However, some of the benefits, achievable by most, are:

- Annual meter readings completed in just a few hours. Only a few meters need to be read manually, and this is done from a handheld terminal in the service vehicle. All readings from the plant and consumers are therefore done simultaneously, minimising administrative costs.
- Readings when customers move house are also carried out on the precise date.
- Consumers can keep track of their consumption and temperature levels daily on the company's website.
- They can make graphs to assist in fault finding, particularly if they have purchased additional meters to log consumption at single-minute intervals.

- Guidance on cooling, consumption, etc. has been made considerably easier since actual values can now be read. It is very helpful to be able to provide documented data, especially when consumers think their supply temperature is too low.

Alarm notifications from both water and heat meters in the event of water losses or water penetration are available. The alarm notifications are particularly helpful for water meters. Damaged heating installations seem to be rarer. The two flows have not quite met expectations, especially because only alarm notifications are recorded and not the associated flow on both flow meters. This can cause difficulty identifying the cause of the alarms.

When Nørarger needs to repair main pipes, the company exploits their ability to identify the maximum consumption level, especially at large consumers/companies, where rules of thumb are less exact.

Nørarger corrects supply temperatures manually based on temperature measurements at consumer households.

Budgetary follow up and accrual calculations have become much easier and less time consuming.

There are also a large number of smaller fires that can be put out; fires that Nørarger had not predicted. This also means that, although cost reductions may not have been achieved, it has become possible to provide far better customer service using the same resources, and unnecessary call-outs have also been reduced.

INFORMATION

Company AN Energi a.m.b.a
Solution Providers Kamstrup
Employees 6
Heat 54 GWh

Meters 4.000 (both heat and water)
Address Elmegaardsvej 6, 9620 Aalestrup, Denmark
Email info@an-energi.dk
Phone +45 98 64 13 55



“80% OF OUR ASSETS ARE UNDERGROUND IN THE FORM OF PIPES. AND DATA ABOUT THEM MUST BE DOCUMENTED AND SHAREABLE. THIS IS THE ONLY WAY WE CAN SHARE KNOWLEDGE ABOUT OUR DISTRIBUTION SYSTEM WITH OUR EMPLOYEES.”

HENRIK JESSEN, OPERATOR, ØLGOD FJERNVARME

temperatures and cooling for individual households. This has made it easier to optimise the distribution system.

“Our employees use the themes in WebGIS to find out where we need to take action. The geographic overview helps some employees. Seeing the information displayed as it is on the devices helps us gain a better overview,” explains Henrik Jessen.

He also mentions the options of generating a ‘shut-down’ list. The list makes it easier to inform customers about any leakages in the distribution system, and he is pleased with the water-well inspection app that helps the company register, document and organise its inspections in one place.

Finally, he is excited about the automatic pipeline register responses, which meet the new requirements for pipeline ownership registers.

CASE 10

Ølgod Fjernvarmeselskab a.m.b.a. Generating Value with Pipeline Data

Challenge

Besides administration and running Ølgod Fjernvarmeselskab, located in the western part of Jutland, Denmark, employees at the company also administer and run the water plant Ølgod Vandværk, as well as a number of smaller, local waterworks.

The smaller waterworks also have their pipelines registered with Ølgod Fjernvarmeselskab. And, somewhat unusually, the smaller waterworks carry out their own pipeline work for both water distribution and district heating.

This is why it was important to implement a comprehensive system for pipeline registration. Automation was needed in the event of pipeline leakages and to cut the costs of the pipeline register. A future proof system that could easily be accessed from various platforms was also necessary.

Solution

ForsyningGIS - Softværket has made it possible for Ølgod Fjernvarmeselskab to register, share and exploit data on the company's most valuable asset:

its underground distribution system.

GIS software was hired to digitalise the distribution system, so data could easily be shared between employees and collaboration partners.

Ølgod Fjernvarmeselskab chose the desktop version, which had the most comprehensive selection of functions. Pipeline data from the company's previous system was transferred to the new system, and this made it possible for employees to enter information into the pipeline register themselves.

The company believes carrying out its own pipeline work increases the quality of documentation.

Results

There is nothing new in digitally mapping a distribution system within the utilities sector. One of the major advantages of ForsyningGIS is that the digitalised distribution system can be accessed from a mobile phone, tablet or computer via WebGIS.

Operator Henrik Jessen says that this changes the way they work. Everyone is much more up-to-date, because they are looking at real-time values. In the past, employees would walk around with a paper card that might already be two days out of date at the time of printing.

Having the distribution system in your pocket is not just useful when digging, says Henrik Jessen. Ølgod Fjernvarmeselskab also uses WebGIS to assess which customers need a service visit, as the tool provides information on return

SCREENSHOT OF GIS DATA ON THE DISTRIBUTION SYSTEM IN ØLGOD



INFORMATION

Company	Ølgod Fjernvarmeselskab	Meters	1.685
Solution Providers	Softværket	Address	Industrivej 9, 6870 Ølgod, Denmark
Employees	7	Email	otv@otv-olgod.dk
Heat	48 GWh	Phone	+45 75 24 4188



“THANKS TO FORSYNING|BI, WE HAVE BEEN ABLE TO COMPLETELY ELIMINATE SPREADSHEETS FROM OUR FINANCIAL REPORTING BECAUSE WE NOW RECORD EVERYTHING IN THE BACKEND SYSTEM FORSYNING|FOF. HAVING THE DATA WE NEED AT HAND HAS GIVEN US A REAL SENSE OF SECURITY.”

LISBET DAMSBO LUND, CHIEF ACCOUNTANT AND ADMINISTRATION MANAGER, ASSENS FJERNVARME

detected a significant improvement in the reliability of its reports. Managing director Marc Roar Hintze explains that reports have become more uniform. This means figures are more accurate and reliable. Previously, reporting was based on data input manually from large and complex spreadsheets. This led to uncertainty about the accuracy of the data in the reports.

helpful in other areas than administration. The ability to create a visual overview of temperature data and consumption at individual households makes the solution a good tool for temperature optimisation.

It is particularly helpful following the recent hikes in heating prices. Customers and the district heating company can easily pin-point installations that are not working optimally via the built-in temperature analysis in Forsyning|BI.

Marc Roar Hintze also explains that Forsyning|BI has been

CASE 11

Assens Fjernvarme

Efficient And Flexible Data Analysis Using Business Intelligence

Challenge

A heavy workload in connection with financial reporting and data processing spurred Assens Fjernvarme, located in the Western part of the Danish island of Fyn, to look for a tool to make administrative work processes more efficient and provide a better overview of the district heating company's data.

Solution

Assens Fjernvarme decided to use the software company Softværket's Business Intelligence software, 'Forsyning|BI'. The software enabled integration of the large amounts of data generated and collected in the different systems used by Assens Fjernvarme.

Forsyning|BI has replaced manual data processing in Excel spreadsheets with automatic reporting. Besides reducing the amount of time employees spend on administration, the solution has also increased flexibility and data security.

Results

The standard reports in Forsyning|BI in particular have helped Assens Fjernvarme save time.

The reports have been adapted to the utilities sector, and they provide real-time summaries of financial statements,

budgets, projects and abnormal meter readings. The reports also make it possible to visualise key figures from operations such as transmission losses, costs per produced unit, and additional waters.

In the past, Lisbet Damsbo Lund, Chief Accountant and Administration Manager, would have had to spend an entire day analysing and processing data in an Excel spreadsheet. This is no longer necessary thanks to the new reports.

She can now open a standard report to gain a quick overview or delve into individual items. This has made budget analysis both easier and faster.

Lisbet Damsbo Lund also mentions other benefits from being able to merge different data sources in the Business Intelligence solution. She has also found that Assens Fjernvarme has become much more flexible with regard to data processing.

It is no longer necessary to prepare a new report in Excel if someone urgently needs a specific report. Instead, the information can be extracted from Forsyning|BI immediately.

Since implementing Forsyning|BI, Assens Fjernvarme has

SCREENSHOT FROM SOFTVÆRKET'S BI SOFTWARE



INFORMATION

Company Assens Fjernvarme
Solution Providers Softværket
Employees 13
Heat 78 GWh

Meters 3.451
Address Stejlebjergvej 4, 5610 Assens, Denmark
Email post@assensfjernvarme.dk
Phone +45 64 71 10 24



CASE 12

Fjernvarmecentralen Avedøre Holme

Industrial Customers see the Value of Digitalising District Heating

Challenge

Avedøre Holme in the Southern part of Copenhagen is facing a substantial change in its district heating system.

The supply temperature will be lowered significantly from 165 degrees Celsius to 110 degrees Celsius. Over the next five years, the entire distribution system will be renovated. These are just a few of the major changes that are expected to reduce the heating bills of the company's industrial customers.

A great deal of work lies ahead for the district heating company. However, before work can begin, the manual data processing methods currently being used need to be re-

placed by digital solutions to monitor the process from start to finish. Once the changes to the heating system have been implemented, digital solutions will administer the company and continued optimisation of the distribution system.

The Avedøre Holme district heating plant has 145 industrial customers, and all of them receive hot water from Avedøreværket, a combined heat and power station. The water has a high supply temperature of 165 degrees Celsius. Combined with the plant's antiquated distribution system, heat losses are significant.

Solution

The plant has long wished to provide much more efficient

“WE WOULDN'T BE ABLE TO KEEP UP WITH THE IMPACT ON THE GRID WITH OUR CURRENT SYSTEM. WE RISK DAMAGING THE DISTRIBUTION SYSTEM IN THE PROCESS. AND THAT WOULD BE VERY COSTLY. IN THE FUTURE, WE'LL BE ABLE TO MONITOR TEMPERATURE FLUCTUATIONS IN THE PIPELINE AND IN INDIVIDUAL HOUSEHOLDS.”

THOMAS ALHMANN JENSEN, FJERNVARMECENTRALEN AVEDØRE HOLME

and economical district heating to its industrial customers. The supply temperature will need to be lowered and, in time, the pipe system will need to be replaced. The plant also needs to be able to monitor customers' consumption, temperatures and installations.

The plant has already installed remotely read meters. However, the meters are obsolete and can no longer communicate with the current administration system, which also has its own faults. Overall, this means that the plant currently has to process most of the data on the heating system manually.

The plan is to begin lowering the supply temperature from 1 January next year. The temperature needs to be lowered from 165 to 110 degrees Celsius. The temperature can only be lowered by one degree per day in order to monitor the effect on the system. The steel in the distribution system will contract as the temperature is lowered, and this can result in pipe bursts.

The current system cannot monitor the effect on the pipes, so the distribution system might be damaged during the process. Therefore, continuous and reliable hourly data on customer consumption is necessary to make it possible to lower the supply temperature as drastically as planned.

Avedøre Holme has therefore decided to replace its meters with remotely read meters from Kamstrup. The plant will also replace its current administration system with Softværket's ForsyningIFOF. Together, these two solutions guarantee that the plant can automatically receive and process data on invoicing, consumption, temperature, etc.

The district heating plant is also offering industrial customers the option to have a new district heating unit from Danfoss installed, with the plant taking over both the unit and

the service pipe. Taking over maintenance responsibilities means that the plant can be sure about cooling, temperatures and maintenance from the new hourly data.

At the moment, the plant has no way to compile data from its customers.

Results

Lowering the supply temperature in Avedøre Holme's distribution system is expected to reduce distribution system losses by a minimum of 10-20 percent. The reduced heat losses will naturally result in lower district heating costs for customers. The lower supply temperature will also make it possible to receive heating from the VEKS transmission network, which has a lower supply temperature.

Reducing grid losses by just 10 percent would mean annual savings of approximately € 1 million in heat losses and € 400.000 in operations and maintenance. Another important factor is the transition to solely providing comfort heating. The plant is also working on changing the way the capacity fee is calculated for customers.

The plan is to calculate the tariff based on maximum capacity, and this is another reason why a new system is required. Three years of historic data is needed to transition to the new and more up-to-date basis for calculation.

The plant's pipe system from the 1960s will need to be renovated within the next three to five years. Pre-insulated pipes will need to be installed and this will require lower temperatures. Temperature optimisation for the customer will be an important part of the digitalised heating system. The company will have a much better basis for lowering heating consumption if it takes over the unit and service pipe from its customers.

INFORMATION

Company	Fjernvarmecentralen Avedøre Holme
Solution Providers	Softværket & Kamstrup
Employees	7
Heat	72 GWh

Meters	145
Address	Industrivej 9, 6870 Ølgod, Denmark
Email	otv@otv-olgod.dk
Phone	+45 75 24 4188



CASE 13

Din Forsyning Monitoring, Troubleshooting and Maintaining Heating Plants

Challenge

The green transition of district heating is inextricably linked with lower temperatures in the district heating network. The efficiency of heat pumps depends to a high degree on return temperatures, and there are significant gains from lowering the temperature through effective flue gas condensation and less heat loss, for example. Today, 50-60 percent of heating installations covered by DIN Forsyning, located near the Danish city of Esbjerg in the western part of Denmark, are faulty or installed incorrectly. There is therefore significant room for improvement.

Solution

'Den Digitale Varmemester' (The Digital Heating Technician) was developed in a close cooperation between DIN Forsyning and Kamstrup. The goal of the collaboration was to develop a solution that would benefit the entire district heating sector. The solution is an entirely new proactive and structured approach to low-temperature district heating. The solution uses digitalisation and algorithms to streamline the process of monitoring, troubleshooting and optimising heating installations.

The solution also makes it possible to document and follow up on results, irrespective of whether the heating installation is the customer's own or the installation is owned and maintained by the district heating company. The first version of the solution will be released in November and will regularly

be updated with new modules and functions:

- Digitalisation and dimensioning troubleshooting. Continuous monitoring and automatic diagnostics make it possible to prioritise efforts, achieve better results through dialogue with the end customer and to document both.
- Easier access to plumber call-out and repairs. With the correct information at hand, a competent plumber, energy consultant, etc., will quickly be able to fix any problems.
- Ability to look ahead. Predict and intervene when, although heating systems are currently working, they will cause problems in the future. Find and resolve problems before they cause issues relating to lower temperatures.
- Customised solutions with greater effect. Combine analyses and application knowhow to customise communications and new services for specific groups of end customers.

The collaboration began in autumn 2021 and is expected to run for another one to two years. As part of the Fremtidens Fjernvarme project, DIN Forsyning needs to reduce temperatures in the distribution system by 6-10 degrees Celsius. The district heating company is on track, with its future production mixes and heating distribution. However, there is significant uncertainty regarding effects on the building stock and the adequacy of current optimisation efforts.

“DEN DIGITALE VARMEMESTER GENERATES SIGNIFICANT VALUE, AND WORKING WITH KAMSTRUP MEANS THAT WE CAN ACTUALISE THE GREEN TRANSITION BETTER AND FASTER THAN WE'D OTHERWISE BE ABLE TO. THE TRANSITION IS ONLY POSSIBLE IF WE BRING THE CUSTOMERS WITH US AND ARE ABLE TO HEAT BUILDINGS OPTIMALLY.”

CLAUS A. NIELSEN, BUSINESS DEVELOPMENT DIRECTOR, DIN FORSYNING

Issues discussed during start-up of the project included:

- What is the exact extent of the issue? How many heating installations can/must be optimised?
- How can existing faults be remedied quickly and efficiently?
- Can we predict which buildings will face issues due to lower temperatures, and can we be proactive with the customer in advance?
- Can we target communications with our end customers and improve our customer service?

The goal of *Den Digitale Varmemester* is to help structure and streamline implementation of low-temperature district heating by ensuring optimal heating installations in buildings.

Results

The strategic collaboration between DIN Forsyning and Kamstrup is primarily driven by a need to understand the issues facing district heating companies and to find solutions to them.

Working together over several days, both parties contributed with their knowledge and ingenuity - and they continue to do so. Den Digitale Varmemester is a comprehensive and practicable solution that would not have been possible in a normal customer/supplier relationship.

Short-term benefits: Processes at DIN Forsyning will be made twice as efficient by circumventing manual processes and integrating tools. The saved costs correspond to one full-time employee, as the current energy consultant will be able to do twice as much. A mapping of data before and during the project shows that current initiatives by energy consultants have resulted in a 0.5 degree drop in return temperature across the company's entire network. DIN Forsyning estimates that a 1 degree drop in temperature corresponds to approximately DKK 1 million in savings.

DIN Forsyning estimates an annual additional cost totalling of DKK 7.7 million (conservative estimate), when DIN Forsyning changes its energy mix during 2023, if the grid temperature is not lowered.

The situation today...

- Limited overview and scalability. Issues are mitigated reactively as they arise.
- Manual processes. Diagnostics require experts to interpret graphs and trends.
- Limited knowledge of effects and results.



Den Digitale Varmemester

- Ongoing monitoring and automated, data-driven diagnostics make it possible to triage which heating installations need to be dealt with first.
- Ability to easily notify end customers and provide them with the necessary means to solve the problem.
- Full transparency of results at individual customer level and at system level.

INFORMATION

Company	Din Forsyning
Solution Providers	Kamstrup
Employees	265
Heat	935 GWh

Meters	27.432
Address	Ulvsundvej 1, 6715 Esbjerg, Denmark
Email	post@dinforsyning.dk
Phone	+45 74 74 74 74



“THERE’S NO WAY WE’D HAVE BEEN ABLE TO HANDLE ALL THE QUERIES AND REGISTRATIONS IN MARCH AND APRIL IF WE’D HAD TO DO IT ALL MANUALLY. NOW, REGISTRATIONS ARE STREAMING IN AND PEOPLE DO EVERYTHING THEMSELVES.”

ANNE-METTE FIG, ADMINISTRATION MANAGER, MIDDELFART FJERNVARME

After entering their Danish Building and Dwelling Register address into a module on the Middelbart Fjernvarme website, consumers can now see if and when they can begin receiving district heating. Dividing the process into phases also means consumers receive tailored answers based on their address.

However, the biggest time saver is that consumers can register immediately using the same module. Middelbart Fjernvarme received 20 registrations per day in June. Under the old system, each registration would have taken three to five minutes to input manually.

Using ForsyningIBI (also from Softværket), Middelbart Fjernvarme is able to stay up-to-date on registrations to their district heating project. They can always see the number of registrations in each area and can easily check the connec-

tion rate for the different phases in the conversion project.

It is possible to zoom in on specific areas and quickly see where there are more customers. For example, a cluster of unregistered addresses may mean that it might be a good idea to check whether the addresses belong to a housing association, and then have a chat with the association.

Another important part of the digital registration process is the e-Boks integration. It is very important for Middelbart Fjernvarme to be able to send contracts to new customers.

The e-Boks integration is also important because Middelbart Fjernvarme can use it to communicate with customers going forward. This will ensure that the company can communicate digitally with customers from the beginning.

CASE 14

Middelbart Fjernvarme Fully Digitalised Registration

Challenge

Up to 6,000 conversions to district heating in the coming years pose an enormous administrative task for Middelbart Fjernvarme. The district heating company located on the edge of the island of Fyn, has therefore decided to digitalise the registration process to avoid the high amount of manual processing that would be required for the conversions.

Solution

The green transition is well underway at Middelbart Fjernvarme and the company is set to convert up to 6,000 consumers to district heating over the next few years. As part of this spike in demand for district heating, there will be many new registrations to process.

In the past, processing a high number of registrations was a huge administrative task for Middelbart Fjernvarme because customers had to register via the website or via forms distributed to households. All information received had to be processed manually.

When 2,000 consumers became eligible to register in May 2021, it quickly became clear that the current system was

no longer feasible. There was a lot of interest from locals in Strib, Røjle and Vejlbj, and by September, Middelbart Fjernvarme had received 1,000 registrations in just under four months.

This meant that the company was overrun for three months because it had to manually enter the consumer information into ForsyningIFOF.

The solution to this problem was to make the entire process digital with help from Softværket. Softværket provided Middelbart Fjernvarme with a number of functions from across its various solutions. The functions were specifically developed to digitalise the district heating registration process from start to finish.

Results

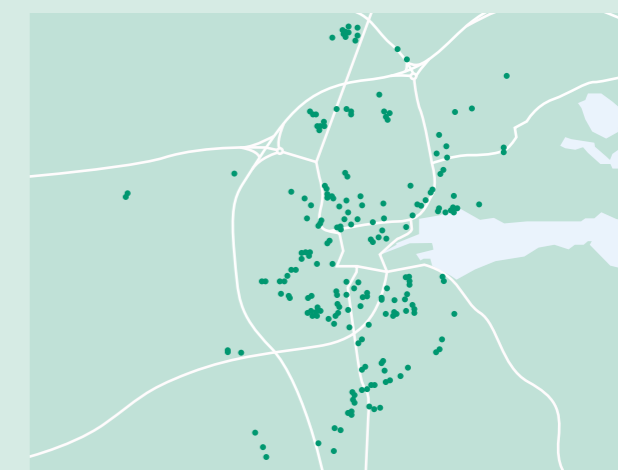
The first thing Middelbart Fjernvarme did was to use the Building and Dwelling Register to identify all potential district heating customers and then register them in ForsyningIFOF as passive consumers. These consumers were then divided into groups based on the conversion phase they belonged to.

EXAMPLES OF DASHBOARD FROM SOFTVÆRKET’S CE SOFTWARE

Registrations



Map of registrations



INFORMATION

Company	Middelbart Fjernvarme
Solution Providers	Softværket
Employees	15
Heat	153 GWh

Meters	8.170
Address	Skærgårdsvej 2, 5500 Middelbart, Denmark
Email	post@middelbartfjernvarme.dk
Phone	+45 64 41 03 42



“THE SUPPLY TEMPERATURE HAS BEEN LOWERED. WE CAN USE ANALYSES TO DETECT WHETHER A SERVICE PIPELINE IS IN POOR CONDITION, OR WHETHER THE FAILURE IS DUE TO A FAULT ON THE CUSTOMER'S INSTALLATION. WE'VE ALSO FOUND BRANCH PIPES THAT WEREN'T INCLUDED IN OUR REGISTRATIONS.”

THORKIL B. NEERGAARD, CEO, BRØNDERSLEV FJERNVARME

CASE 15

Brønderslev Fjernvarme Temperature Optimisation And Localisation Of Faults In Customer Installations

Challenge

With a top-of-the-line production facility, Brønderslev Fjernvarme wanted to optimise how it utilises the facility by collecting and using data from customers, the distribution system and weather forecasts.

The district heating company located at the northern top of Jutland, was part of the research and innovation project HEAT 4.0, with the aim to optimise existing systems and establish data-sharing across suppliers. The project ran from 2018-2021 and received funding from Innovation Fund Denmark.

Solution

The project focused on optimising existing systems, implementing new systems and establishing seamless data-sharing between suppliers using HEAT 4.0's cloud solution from Center Denmark.

Operational data can be shared via the cloud solution in an agreed format to benefit suppliers and universities.

Heat demand forecasting to manage the supply temperature in the district heating network has been further developed and implemented in collaboration with the energy forecasting company ENFOR. Pump performance and the supply

temperature have been lowered. Furthermore, a program is being developed to use meter data from a few selected meters to generate heat demand forecasts for a certain section. Currently, the data stems from measurement points in the district heating network.

Results

So far, great success has been achieved using just 15 meters.

Together with EMD, Brønderslev has developed an application to provide hourly rolling forecasts for all its 12 production units. The forecast is compared with the existing planning tools to document the optimisation of costs in connection with heat production. The application will be implemented soon.

In collaboration with Kamstrup and based on remotely read data from the settlement meters produced by Diehl Metering, Brønderslev Fjernvarme has been able to analyse whether there is a fault in a service pipes or in the customer's installation. This helps identify where a line needs to be fixed, and helps detect unknown branch pipes at the consumer's household.

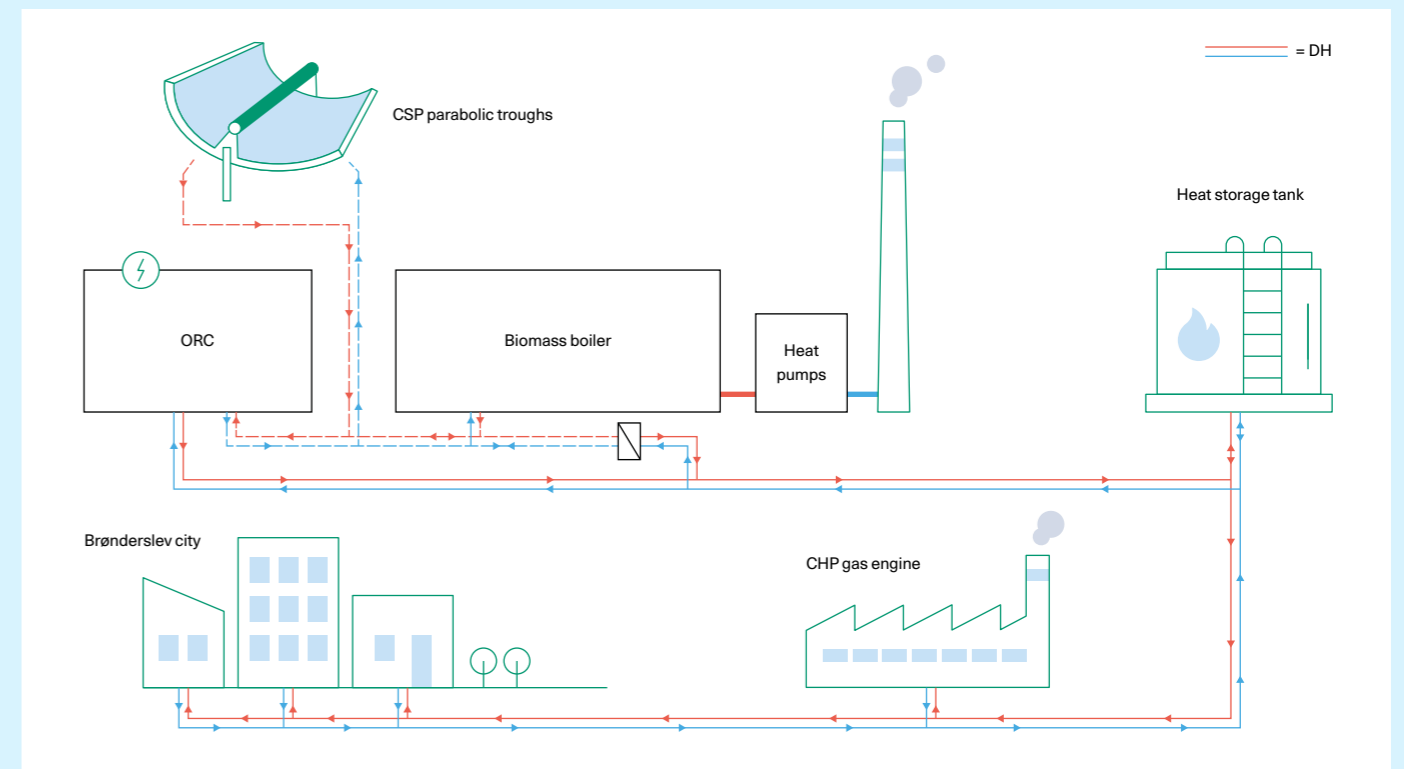
Together with DESMI, Brønderslev has begun monitoring a

pump installation. The monitoring will help the company assess the improvement potential at the company's pumping stations by measuring whether the pumps are functioning optimally and thereby most energy-efficiently. In collaboration with LOGSTOR, Brønderslev can now digitally monitor a local supply area using copper wires embedded in the insulation material around the pipes. The aim is to demon-

strate how the tool can be used to detect leaks early and thus prevent serious damage.

Brønderslev Fjernvarme has also greatly benefitted from collaborating with the universities that participated in HEAT 4.0. The operating data from the system was used in several research projects and publications.

BRØNDERSLEV FJERNVARME PLANT CONFIGURATION



INFORMATION

Company	Brønderslev Fjernvarme	Heat	100 GWh
Solution Providers	ENFOR, EMD International, Kamstrup, Diehl Metering, Center Denmark, LOGSTOR/Kingspan, DTU Compute, NIRAS	Meters	5.000
Employees	34	Address	Virksomhedsvej 20, 9700 Brønderslev, Denmark
		Email	forsyning@bronderslevforsyning.dk
		Phone	+45 98 80 15 89



“THE WELDMASTER PORTAL MEETS OUR HIGH EXPECTATIONS FOR EACH JOINT INSTALLATION. AS AN ISO 55001 CERTIFIED COMPANY, IT’S IMPORTANT TO US TO MAINTAIN AND EXTEND THE LONG OPERATIONAL LIFE OF OUR DISTRIBUTION SYSTEM, AS THIS REDUCES OUR MAINTENANCE COSTS AND LOWERS HEATING COSTS FOR THE CONSUMER.”

TOMMY H. HERMANN, MAINTENANCE MANAGER, TVIS

Solution

The welding process has become as automated as possible at TVIS thanks to the LOGSTOR WeldMaster portal and its traceable documentation on all fitted joints.

A 2D barcode on the weld joint is scanned using a PDA or a mobile phone. The correct welding machine settings for the specific joint are then automatically transferred to WeldMaster.

The PDA or the mobile phone notifies the operator via LOGSTOR Connect whether the joint installation is approved or not approved.

The joint is re-welded if it is not approved, and the difference between the approved and not approved weld is registered.

Operators then use Logstor Connect to certify via the PDA

or their mobile phone that the following have been completed during the joint installation: checks and inspection of the alarm system, leakage tests, test of foam moulding, and visual check of the final joint installation.

LOGSTOR Connect files image documentation of each joint installation and each weld is automatically numbered.

Results

Weld data is automatically uploaded, and TVIS, the contractor and the advisor, can access the documentation once it has been registered with a licence. This means that documentation for each joint installation can always be retrieved, and that TVIS can ensure each joint in their new district heating distribution network has been installed and documented correctly. TVIS also avoids the additional expense of repairing poorly installed joints during the lifetime of the distribution network.

CASE 16

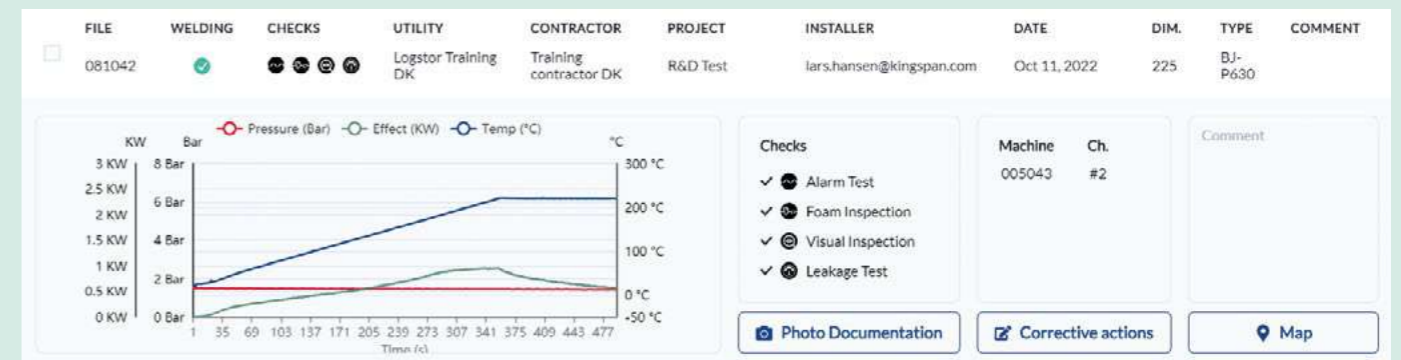
TVIS Strong Focus on The Welding Process for Joints and Documentation

Challenge

TVIS, the district heating company located on the east coast of Jutland, wanted to check, manage and digitalise its monitoring of weldings in its pipe system before the pipes are covered to ensure that the weld joint has been installed

correctly. The company also wanted to file documentation of correct installation of weld joints in the transmission system. The objective was to achieve a longer life span for pipes without unnecessary repairs on bad welds.

SCREENSHOTS FROM WELDMASTER SHOWING VALUES MEASURED DURING THE WELDING PROCESS



INFORMATION

Company	TVIS	Address	Tonne Kjærsvvej 11, 7000 Fredericia, Denmark
Solution Providers	KINGSPAN A/S	Email	tv@tv.net
Employees	26	Phone	+45 75 94 07 11
Heat	2000 GWh		



CASE 17

Sønderborg Varme

Digitalised Biomass Procurement

Challenge

It can be hard to determine prices when establishing a contract on the supply of biomass for district heating. It is also hard to be sure all potential suppliers can bid for the contract.

These issues have been under careful consideration for Sønderborg Varme, a district heating company from the southern part of Jutland, which primarily uses biomass and waste to produce district heating. The district heating company has therefore decided to test the market by pro-

curing some of its biomass via the online trading platform: BiomassAuctions. Erik Wolff, CEO of Sønderborg Varme, explains that the fundamental idea behind the auction platform is really good:

“We chose to use the platform because we thought it'd be a good way of making the market more transparent. Imagine if everyone used a platform like BiomassAuctions, we'd actually achieve a free market. And that's what we're looking for in reality.”

“THANKS TO BIOMASSAUCTIONS, WE CAN EXPOSE OUR PROCUREMENT TO MARKET MECHANISMS WHILE ALSO ENSURING EQUAL TREATMENT AND TRANSPARENCY FOR ALL OUR STAKEHOLDERS. THIS HELPS US ENSURE THAT ALL QUALIFIED SUPPLIERS CAN SUBMIT A BID ON EQUAL TERMS. THIS ALSO HELPS US ATTAIN THE CORRECT MARKET PRICE IN TERMS OF SUPPLY AND DEMAND.”

ERIK WOLFF, CEO, SØNDERBORG VARME

Solution

Changing procurement practices for biomass takes some getting used to. Sønderborg Varme had to make some strategic decisions on how best to utilise the platform, including the amount of biomass they would put up for tender, auction deadlines, and delivery times of the contracts. The company is still finalising some of these decisions. On the other hand, actual implementation of the platform was quite simple according to Erik Wolff. Another important element for him is that the company can define the basis for the contract that suppliers bid on:

“It means that suppliers are familiar with our quality requirements and the conditions of entering into a contract with us. This is a huge advantage, not least for the suppliers,” he says and adds:

“Using BiomassAuctions for procurement is effective, simple and transparent for us as the buyer and for interested suppliers. There are also significant time savings for all parties compared with conventional contract negotiations. And we reach a broader group of potential suppliers.”

Results

There are several advantages of digitalisation in negotiations. First of all, it is no longer necessary to attend long negotiation sessions where the parties argue about price.

These sessions can be a negative experience for both buyers and sellers, especially if there are different perceptions of price. All that can be avoided by trading digitally.

“It helps standardise the process of entering into a contract. What's more, digitalisation of trading generates value for Sønderborg Varme and the consumer, as it ensures the correct market price and the district heating company avoids paying too much or too little for biomass,” says Erik Wolff.

“Furthermore, we have the documentation to prove it. We're open and transparent about hitting the mark pricewise at the time of purchase. Consumers can see that everything is being done openly and professionally. That's how it should be.” The communication strategy stays the same after a contract has been entered, he explains:

“We send a letter welcoming suppliers to the heating season. Afterwards, we give them a call to agree on the time and manner of delivery, and check how it fits with their schedule.”

Sønderborg Varme has used BiomassAuctions to procure sustainable wood chips for several seasons. The company has gone from purchasing 5,000 tonnes in the first year to an expected 20,000-30,000 tonnes per year going forward.

INFORMATION

Company	Sønderborg Varme	Meters	1.500
Solution Providers	BiomassAuctions	Address	Nørrekobbel 54, 6400 Sønderborg, Denmark
Employees	52	Email	post@sfjv.dk
Heat	306 GWh	Phone	+45 73 43 50 00



CASE 18

BEOF

Intelligent Monitoring and Control Provide a Flexible and Optimised District Heating Network

Challenge

The future of district heating is digital and data-driven. This is the basis of the Flexibility Heat Grid Bornholm project, which involves 42 households in the small village of Listed, on the Danish island of Bornholm in the Baltic Sea.

The island's utility company, Bornholm Energi & Forsyning (BEOF) wanted to improve energy efficiency, reduce heat losses in its distribution system and increase the efficiency of heat production. The company therefore decided to place an intelligent control system in the district heating installations in households that voluntarily participated in the project.

Listed was selected because it is the area farthest away from the district heating plant in Nexø, and the fact that the area also suffers from capacity issues under certain weather conditions.

This made Listed the perfect place to test the impact of the new control system on the capacity of the district heating network and thus determine the added value of intelligent control to the utility and its consumers.

Solution

The Flexibility Heat Grid Bornholm project is a collaboration between the local district heating company, DTU - The Technical University of Denmark, Neogrid Technologies and Utiligize.

At the start of 2022, the new gateway from Neogrid Technologies was installed at the participating households, after which it then began to monitor and control their heating systems.

Utiligize designed a model of the distribution system that enables monitoring temperatures and pressure in the system.

“USING AN UNDERLYING ALGORITHM AND FORECAST MODEL BASED ON HISTORICAL DATA AND WEATHER FORECASTS, WE CAN CONTROL INSTALLATIONS AT CONSUMER HOUSEHOLDS DIRECTLY FROM THE PLANT. THIS CAN HELP US DETERMINE THE FUTURE HEATING DEMAND OF THE INDIVIDUAL CONSUMER.”

CHRISTIAN NYGAARD SØRENSEN, PROJECT DEVELOPER, BORNHOLMS ENERGI & FORSYNING

The same model can be used for data-driven investment planning.

However, heating consumption and energy utilisation at consumer level will make up the largest benefits in this project Christian Sørensen, Project Developer at Bornholms Energi & Forsyning explains:

“An underlying algorithm and a forecast model based on historical data and wather predictions enable heating system controls at consumer households directly at the heating plant and thus ensure optimal flow temperatures. This helps determine the future heating demands of the individual consumer.

Furthermore, the distribution system will contribute to monitoring temperatures and flows in household valves, which enables the utility company to alert the costumer and fix a possible malfunction in their installation if there is a sudden consumption increase or a lower temperature than expected. Thus, not only will the consumer have the certainty that any faults in their installation will be discovered, they will also be able to easily monitor and manage their consumption by using an webapp.”

Results

From the very beginning the project set three clear goals: to increase energy efficiency in households, to reduce heat losses in the distribution system and to optimise heat production. The three goals contribute to the overall target which is reducing energy consumption and energy production, which in turn will lead to reduced heat loss and lower CO₂ emissions. “Project results already indicate potentially significant cost savings”, Christian Nygaard Sørensen says.

However, cost savings depend on whether consumers are willing to adapt and let the systems take control of their heat units.

“The latest updated control configurations shows energy savings of 9 % on average in households with permanent residents. Although this control configuration has only been active since November 2022, we have been able to achieve up to 18 % energy savings in one singular case,” he adds.

LONG-TERM GAINS

The biggest benefit by far of the Flexibility Heat Grid Bornholm project for both the district heating company and the consumers has been the reduction in energy consumption and in the required amount of biomass. Thus, this joint effort contributes to the green transition.

In the long term and presupposing a completely intelligently controlled district heating network, Bornholms Energi & Forsyning will have a foundation of high resolution data which will contribute to optimising all aspects of district heating on the island of Bornholm.

“The Flexibility Heat Grid Bornholm project is a mere pilot project in which the main beneficiaries were clearly individual consumers as they were able to reduce their heating consumption on hosehold level,” Christian Nygaard Sørensen explains and adds:

“With the positive project outcomes of 2022 our ambitions are raised, and we are looking into upscaling the project which will be expanded with an additional 300 participating households in 2023 - 2024.”

The project has already provided Bornholms Energi & Forsyning with a lot of new knowledge about investing in intelligent control systems, and the imminent expansion of the project will provide an even more detailed data foundation for the company to benefit from in the future.

INFORMATION

Company	Bornholms Energi og Forsyning
Solution Providers	Neogrid Technologies, Utiligize
Employees	130
Heat	1.266 GWh

Address	Skansevej 2, 3700 Rønne, Denmark
Email	kundeservice@beof.dk
Phone	+45 56 90 00 00



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