

# HEAT 4.0

## takes the district heating sector into the next digital level

Useful results for further digital developments

In the later years, dynamic changes in society and the demand for energy-efficient solutions pushes the energy sector towards digitalization. The HEAT 4.0 provides access to new digital inventions on a cooperative basis and has taken a huge leap to secure data exchange in a common system-independent infrastructure.



By Alfred Heller, Managing Director, DTU Compute, Technical University of Denmark and Eva Lange Rasmussen, Communication expert, NIRAS, Denmark

The overall objective within the project HEAT 4.0 is to integrate intelligent IT solutions in a new digital framework to reach a holistic district heating (DH) approach, previously presented in Hot Cool. The HEAT 4.0 addresses the digital needs of the whole sector, from the production site over distribution to the end-users, and creates synergy between design, operation, maintenance, and delivery of DH. Such solutions we call Cross System Services (CSS) and are based on co-operation between components suppliers, scientists at universities, DH companies, consultants, and essential for this article, a common platform provider.

### Data-based optimization and common sharing platform for concrete services

The work of this project is mainly based on combining already existing IT tools from the DH sector. The purpose is to build a new bridge between today's different software operating systems to connect systems, exchange and use data securely and more intelligently to obtain innovative and holistic solutions. The methods developed in HEAT 4.0 have typically been based on digital models derived from DH systems in operation today. Therefore, the used methods are relatively simple but still reproduce reality as well as possible and create a satisfactory concept for further evolution. The solution can be divided into two steps of methods:

1. The first and most straightforward method lets the individual IT models/software share their data insights, called peer-to-peer (p2p). For example, consumers (buildings) share their heating demand forecast with the network component (distribution). The network software can include this information to improve the correctness of its own model. It can hereafter share its predicted operation (flow and temperature) with the production component that optimizes the heat production accordingly.

In a more advanced solution, the involved software tools give feedback information to each other. For example, the production component could ask to shift demand in time to avoid bottlenecks in production or critical load in the network. The network and building optimization tools would analyze whether this is possible and return updated predictions. Other scenarios could be envisaged.

2. A system-independent data-sharing platform is established for communication between tools and the DH infrastructure. This common platform enables any digital system to share data (inclusive prediction and setpoints for controlling district heating). In future versions, the platform will also be able to host common algorithms and software components.

### Data management is the central starting point

DH companies are used to handling all their data within their individual IT infrastructure and SCADA systems. Communication with the surroundings was not applied. Aiming at a much more complex control of the next generation DH demand change in minds, data must be communicated in secure manners to enable a more efficient operation of the entire district system and other services.

The HEAT 4.0 solution has succeeded in developing a 'common data platform' which will guarantee the quality of data by, e.g., validating data, entering missing data, and resampling data

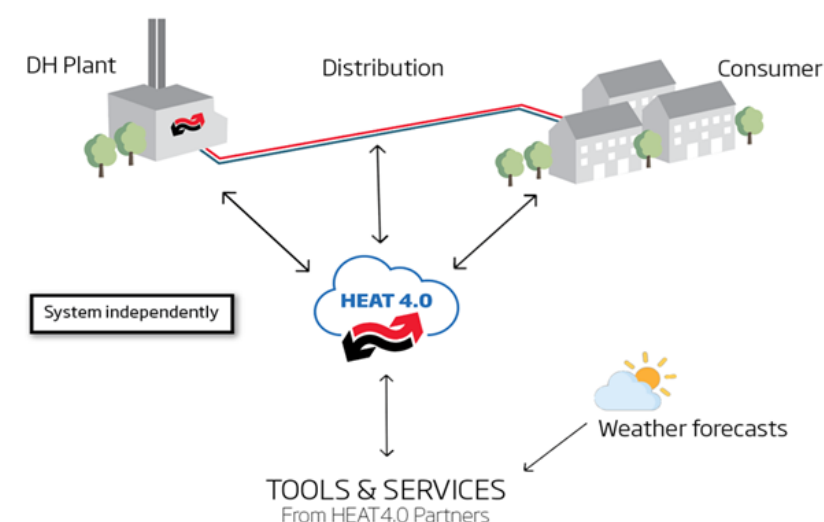


Figure 1: The ICT infrastructure of HEAT 4.0 (very simplified drawing). In the center, you have the consortium-common infrastructure part (cloud). The partner companies' digital tools and services can be provided through the 'common cloud,' enabling the DH operators to choose any combination of services.

to the necessary sampling rates. It also enables DH operators to choose and replace digital services and connect them with plug-and-play technologies through standard data interfaces.

The project partner Center Denmark, a non-profit organization, is in charge of developing this new, commercial cloud platform within the HEAT 4.0 project, enabling business-based value chains. The versions of CSS p2p mentioned above are implemented on this platform for the involved three DH companies. Standardized data exchanging interfaces are tested and ready. Generalized versions are under development, enabling other software firms to involve. The objective is a secure, efficient, and adaptable platform that will save integration hours for the DH companies, making data much more intelligent and giving freedom of choice to the operators. At the same time, the platform supports the operators to meet the privacy regulations, known as GDPR.

### Demand for an agile system architecture

Within the HEAT 4.0 project, three DH plants are involved in testing the innovations' ideas, but no DH system in Denmark looks the same. Two of the three DH companies, Brønderslev DH Ltd. and Hillerød Forsyning, have their own and various production sites. In contrast, the energy company TREFOR

Varme buys heat from a heat distributor. Since 2014, Brønderslev Forsyning had already e-meters installed whereas Hillerød Forsyning has not. It means that the components involved are all different at the three sites. From a HEAT 4.0 perspective, this variation is a technological advantage as it ensures robustness for the project results and solutions developed.

The DH companies are using first-generation tools that are working independently. The IT tools usually are directly communicating with the SCADA systems - a cumbersome task that often leads to high costs and high time expenditure. In the HEAT 4.0 project, the data integration solutions were developed and standardized, inspired by Industry 4.0, general ICT- and security guidelines. This relatively simple adoption enables the companies to integrate easily and operationally with any IT service provided from outside.





DH from TREFOR Varme, 60,000 DH customers, is environmentally friendly and economically advantageous. TREFOR Varme uses surplus heat from the local Shell Refinery, waste incineration, and wood chips as green energy sources.



Brønderslev Forsyning, Varme, with 5000 DH customers, has one of the most energy-efficient CHP plants globally. It combines concentrated solar heating (CSP) with wood chips and converts the energy into electricity and DH via a so-called ORC system (Organic Ranking Cycle).

#### Case studies - lessons learned – and valuable results

TREFOR Varme was the first DH company within the project to raise the demand for a 'common infrastructure component.' Thanks to their steadfastness and their enormous organizational effort to 'digitize' their internal system, the HEAT 4.0 partners can refer to precious insights and experiences from this case study. TREFOR Varme introduced a cross-utility ICT strategy that highlights security and robustness. Based on these strict regulations, the current HEAT 4.0 Cross System Optimization (CSO - an optimization service demonstrating the concept of CSS) solution is set in place because it empowers the company to control external services similar to internal hardware and control systems. This was impossible a few years ago, where all controls had to be placed physically within the company property. The head of the DH department, Helge S. Hansen, put it this way.

“Our motivation for joining the HEATman project was partly to contribute experiences and knowledge about the digitization of the heating sector and not least to do so in a cyber-secure way. Next, to try to pull the industry in the direction of an integration function, as our own vision was to integrate up to a single “common integrator” [technology]. The new IT solution was integrated by 'HEAT 4.0 Ready' software suppliers and the benefits of this co-operation we are to achieve these days.

**Helge S. Hansen, CEO,  
TREFOR VARME Heating, Kolding, Denmark**

From own experiences, TREFOR Varme concludes that it is a good idea for DH plants, in general, to let other competent specialists handle IT integration in a time where systems and threats from cybercrime have become significantly more complex. In a few bullets, they sum up the specific results they have achieved through their project involvement so far:

- As the cyber-secure connection, high data security is to be predetermined by one integrator, which continuously optimizes and improves the concept. In other words, secure data exchange, which can be used for the entire district heating sector.
- There are economic and timewise savings, fewer problems with incorrect data through standardized technical integration and “one integrator contact.”
- The secured data exchange between several software systems enables especially smaller DH companies to digitize.

Another DH plant involved in the project, Brønderslev Forsyning, has announced their satisfaction being a test partner of the project and put it in this way:

“At Brønderslev DH Ltd., we have for some years successfully been working with data from Smart Meters to create added value for the company and the customers. The HEAT 4.0 project has given us new unique possibilities to step up in digitization and explore the

use of more advanced technologies. Especially, the idea about the cloud-based Cross System Optimization has given us new valuable insights and provided us with more advanced tools to operate the entire utility more efficiently - from production to distribution and end-consumers.

**Thorkil B. Neergaard , CEO,  
Brønderslev DH Ltd., Denmark**

#### The industrial approach – a new beginning?

In the HEAT 4.0 project, 17 innovative partners have worked closely with universities and DH companies to deliver state-of-the-art digital solutions to the DH market. The project has pushed the development of existing digital products and new innovative cross-system products.

The pioneers are a) EMD International provides investment and production optimization software, added bidding software to the electricity markets in an integrated portfolio, b) Enfor provides localized weather and heat load forecasts, plus temperature optimization software for the network operation, and c) Neogrid. Leanheat and NorthQ that provides optimization and control software for all size building operation. Danfoss that has acquired the partner Leanheat within the project's lifetime, has designed a software solution suite – “Danfoss Leanheat Software Suite” - that is an end-to-end solution. This solution is similar to the system described above but since it's an open architecture it can easily integrate with EMD, ENFOR and others. Combinations are possible. As a result, HEAT 4.0 has shown the

flexibility of the approach with open interfaces, standards, and shared infrastructure components. (IoT-based) data-services support the shared infrastructure by the pipe producer LOGSTOR (part of Kingspan Group), pump producer DESMI and metering provider Kamstrup, which all together aim at monitoring and predicting maintenance and other services that both support the DH-company and their customers, as well as balancing energy-, economic efficiency with the secured high indoor environment. Examples of value generation from sector integration enabled by the given agile infrastructure proposed by HEAT 4.0 also consist of utilizing large thermal capacities of buildings and the DH network for storage, called flexibility. This service aims at supporting the stabilization of the electrical systems by shifting demands in time and power. Other integrated services optimize temperature, flow control qualified by measurements across system components, models, and automated analytics.

The examples mentioned above show the limitless opportunities for new, more intelligent IT systems. We are proud of the small successful steps HEAT 4.0 has taken towards digitalizing the DH sector. As a result, various combinations of cross-system-optimization (CSO) tools implemented prove the agility of such an ICT architecture. HEAT 4.0 is reaching its final stage, and we are looking forward to presenting the exact values of the partners' efforts during the year 2022. The digital journey has just begun with the innovative project HEAT 4.0, supported by the Innovation Fund Denmark.

#### Partners in HEAT 4.0, 2021

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|-----------------------|----------|
| Niras                 | Danfoss  |
| AAU                   | Leanheat |
| DTU Compute,          | EMD      |
| DTU Management and    | Enfor    |
| DTU Civil Engineering | Neogrid  |

TREFOR Varme  
Kamstrup  
Grøn Energi/  
Dansk Fjernvarme  
Brønderslev Forsyning

LOGSTOR/Kingspan  
Hillerød Forsyning  
NorthQ  
DESMI  
Center Denmark