Online simulation of Frederiksberg Utility's district heating system

Gert Andresen, Engineer, Frederiksberg Forsyning A/S

Frederiksberg Utility (Frederiksberg Forsyning) is a multi-utility company supplying district heating, electricity, gas, water and sewerage. In 2003, the company celebrated its 100 years anniversary of supplying district heating. Today, district heating is supplied to more than 3000 customers and the annual production is approximately 2700 TJ. The heat is supplied by "Centralkommunernes Transmissionsselskab I/S" (CTR) through six heat exchanger stations and two peak load stations. The network consists of 75 km distribution pipes and 55 km branches.

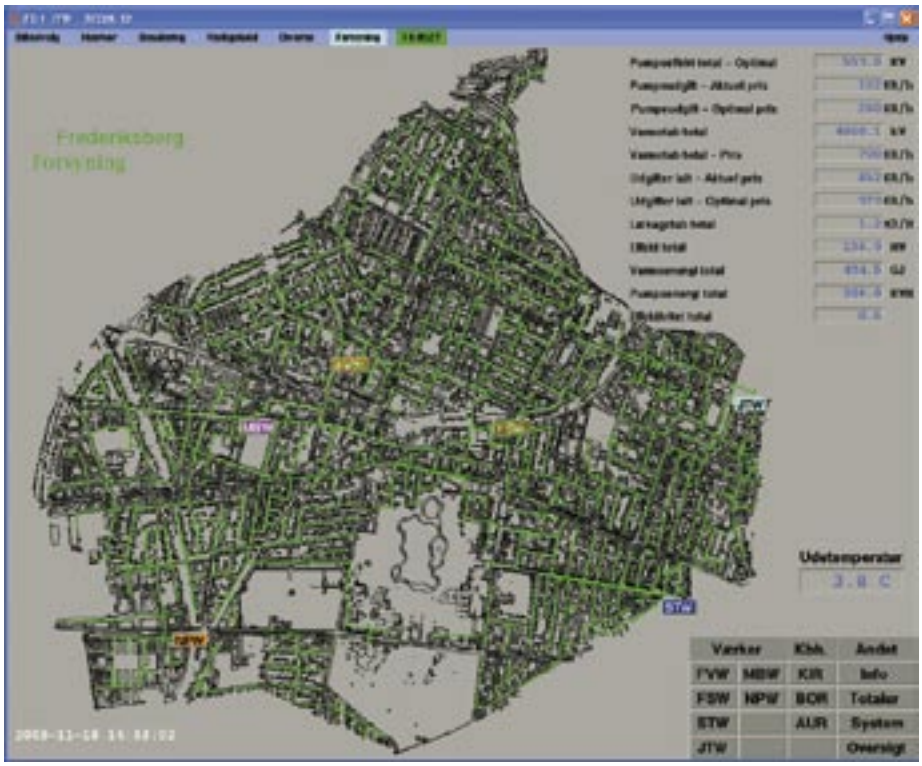
In 2000, Frederiksberg Utility installed an online system that is used for simulating the operational situation in the district heating system. The system was developed supported by the Ministry of Environment and Energy's Energy Research Programme, "EFP 1998".

The simulation model has been in use for four years now. Frederiksberg Utility states that the application is primarily used:

- To offer a general view of the operating situation of the network, as the programme can be followed from the control room and from eight PCs placed at selected staff.
- To present a dynamic illustration of the supply areas connected to the six heat exchanger stations. The supply areas and the number of heat exchanger stations operating vary according to the time of year.
- To calculate remaining quantities of water in connection with draining and refilling.
- To print valve lists in connection with repairs. The lists state the addresses of the consumers in question and are sent to the reception, to be used in the case of enquiries that need to be answered.
- To prepare lists of closings of valves in Word text files and use these in work descriptions.
- As a dynamic map containing information on calculated pressures and pressure difference etc. in the entire network.

The system has contributed in making the distribution system "visible" in the control room. Here, the system was shown by a wall map where the closing of valves was updated using coloured pins. Besides functions such as a dynamic key map the application has a series of built-in key figures used for optimisation of the operation.

Figure 1. Homepage, showing the distribution system.



Gross list

At the beginning of the project, a list of possible functions for an operations-related IT tool was made. The list ended up containing nine primary items:

- Geographic map information from pipe registration systems and GIS
- Classification of the supply areas with colouring of the respective district heating network
- Information from customers databases
- Calculation and presentation of key figures and deviations from optimal operational condition
- Measuring values and status information from SCADA systems
- Simulations and optimisations of the operating conditions of the network via a calculation application
- Work plans for operational readjustments
- Prognosis regulations and temperature regulations
- Optimisation of the operation of heat accumulators and preparation of long-term prognoses

The function of the IT tool as an integrating link to other applications is illustrated in the figure.

The project

Based on the gross list, a prioritising was carried out so that the list was limited to functions that were realistic in the project. The list ended up consisting of the following items:

- A dynamic map of streets and buildings
- A picture of the pipe network added to the map
- Viewing of all relevant valves in open or closed position
- Viewing of following values:

1. Present distribution of production
2. Temperatures and pressures from production units
3. Values from network measuring points
4. Simulated flow picture
5. Simulated pressure difference
6. Simulated pressure in the flow system
7. Simulated flow in the return system
8. Simulated pressure loss per meter
9. Simulated water velocity
10. Simulated temperature distribution in the flow system
11. Simulated temperature in the return system
12. Calculated heat loss

13. Set points for flow temperatures
14. Set point for difference pressure
15. Power consumption for pump operation
16. Data from weather station
17. Optimal pump choice

The installed application contains all of these functions. The application was installed in year 2000 and has been online ever since.

Experience
Experience has shown that the application functions reliably. The application continuously receives SCADA data from the SCADA system online. These data are used for network calculations which are presented on the dynamic map. In addition to the online situation, the application can be set in a simulation mode where data can be given as manual input. In this mode, different operational situations can be tested before they are actually implemented.

At Frederiksberg Utility primarily functions linked to the dynamic map (including the various lists and calculations in connection with disconnections in the network) have been used. The various key figures, on the other hand, have not really been used. This is partly due to the design of the network at Frederiksberg Utility. The system is very concentrated, with a large heat density which results in small temperature losses from plant to consumer and a relatively small heat loss. At the operational optimisation, it is therefore decided to operate the flow temperature as a function of the outdoor temperature and then pump, corresponding to the required differential pressures in the respective network measuring points.

Future plans
The installed application operates on a "Digital server" which means that it reacts very quickly. In order to be able to extend the system to a standard PC platform, it is considered how the system might be converted into a PC platform. Recently, specifications have been made with the aim of developing the application, opening for the possibility of logging thermography. In this way, the functioning of an online pooling of Frederiksberg Utility's pipe registration system and its maintenance system will be made possible.

Figure 2. Zoom showing streets, houses, valves and pipes.

Overall evaluation
All in all, Frederiksberg Utility estimates that the system has fulfilled the expectations that had been put to the system. The system offers a fine view of the network's immediate operating situation, both normal operation and with necessary closings in the system. The system will also be a good platform for connecting any further online functions as these are gradually developed.

For further information please contact:
Frederiksberg Forsyning A/S
Att.: Mr. Gert Andresen
Stæhr Johansens Vej 38
DK-2000 Frederiksberg
Phone +45 3818 5100
Fax +45 3818 5199
ff@frb-forsyning.dk