Fifth Generation of District Heating

Energy Solutions for Future Smart Cities

District heating has a long history and its use has diversified and increased steadily over the years. The growth is a partial response to current environmental challenges and worldwide trends, such as urbanization, digitalization and rise of consumer awareness. New kinds of products and technologies are needed to meet the demands of digitalization, rise of consumer awareness and modern society. The journey towards Sustainable Smart Cities and the fifth generation of district energy has already begun.

Since the early days of district heating when the first commercially successful district heating system was launched in the US in the 19th century, much has changed. District heating has evolved through the years to meet the demands and needs of a developing society. Typically these changes have been driven by demand for reduced heating costs, better energy efficiency and longer network life among other things.

Development of the field has been primarily depicted through four generations, each characterized by major changes in technology. The majority of the currently existing district energy systems are part of the third generation. Starting from early 1980s, the third generation is often referred as »Scandinavian« district heating technology, since most of the development in this field was made by suppliers based in the Scandinavian and Nordic region. Also Finnish company Vexve has had a great influence on this generation.

The current generation's district heating systems operate at temperatures around 100 °C, and are also characterized by the use of pre-insulated pipes, traditional thermal plants as well as surplus industry heat. The third generation district energy system relies on metering and monitoring to optimize heat delivery [1].

Transition to the fourth generation and low temperature networks (operating temperatures lower than 60 °C) has already begun. The fourth generation is also considered as a solution to achieving a non-fossil and renewable based energy system. New generation energy systems integrate two-way district heating and cooling and use smart energy management to optimize supply, distribution and consumption. They also depend on renewable or secondary heat production. Fourth generation district energy systems are being implemented in several large cities around the world, but many sources estimate that the main era for the fourth generation will start in 2020 [1].

However, the fifth generation is closer than many might think. Urbanization, digitalization and the rise of consumer awareness has created new kinds of challenges for energy companies. These worldwide trends will accelerate and strongly shape the coming of the fifth generation of district energy.

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Towards more complex energy infrastructures

The Sustainable Smart City is synonymous with district energy's fifth generation (*figure 1*). In these cities, energy demand and energy peaks can be predicted and defined in more accurate manner. Also energy can be transmitted more efficiently to where it's needed. In addition customers can direct heating or cooling of their homes with smart apps. Current district energy networks are still far away from this goal.

With urbanization, the city's district energy network is becoming more and more complex, consisting of several production sources, both heating and cooling, two-way energy sales, different energy generations and energy storages. This means that a lot more intelligence is needed to maintain and operate the network. Building smart cities requires raising the digitalization level of the whole energy infrastructure.

Understanding digitalization

In addition to digitalization, IoT (Internet of Things), IoI (Internet of Industry), IoS (Internet of Service), and IoP (Internet of People) are buzzwords that are talked about a lot nowadays. But for those words to truly have a meaning and purpose, they have to be explained and integrated to the field in question. Vexve has organized digitalization workshops for energy companies in Europe, to determine how they see digitalization and which areas still need development. Based on these, our best perception of the digitalization of district energy is to visualize the process as a pyramid (*figure 2*). On the top of the pyramid you find the customers, on the next step services (e.g. outsourced maintenance and support of the district energy company), then processes (e.g. internal processes of power plant) and at the base, the hardware.

Most of the energy production in European power plants is already automated and metering data is available from the consumer end. The so called black hole lies in the network connecting the power plant and customer. In other words the IoT, the hardware forming the base of the pyramid is still undeveloped. Valves and other products shaping the network have remained practically unchanged for decades. In a district energy distribution network valves are the collection point for many kinds of information, which

is why their role is so significant. If the base of the pyramid is flawed in a digital sense, it is very hard for the energy companies to develop their operations to meet the requirements of future Smart Cities.

Added value to conscious customers

One of the most important must-win-battles for energy companies today and in the future is to provide sufficiently advanced services to customers, as they become more conscious and demanding in their choice of an energy distributor than ever before. This is why district energy companies need to invest in digitizing the base of the pyramid sooner rather than later. With intelligent networks district energy companies can, for example, locate leakage points faster, better plan anticipatory maintenance for components and operate networks remotely. In other words the data supplied by the network helps the companies better serve their customers and opens new revenue channels through intelligent operations and services.

Smart products of the future

Vexve has been strongly involved in developing district heating solutions since 1960 and nowadays exports its expertise and products to more than

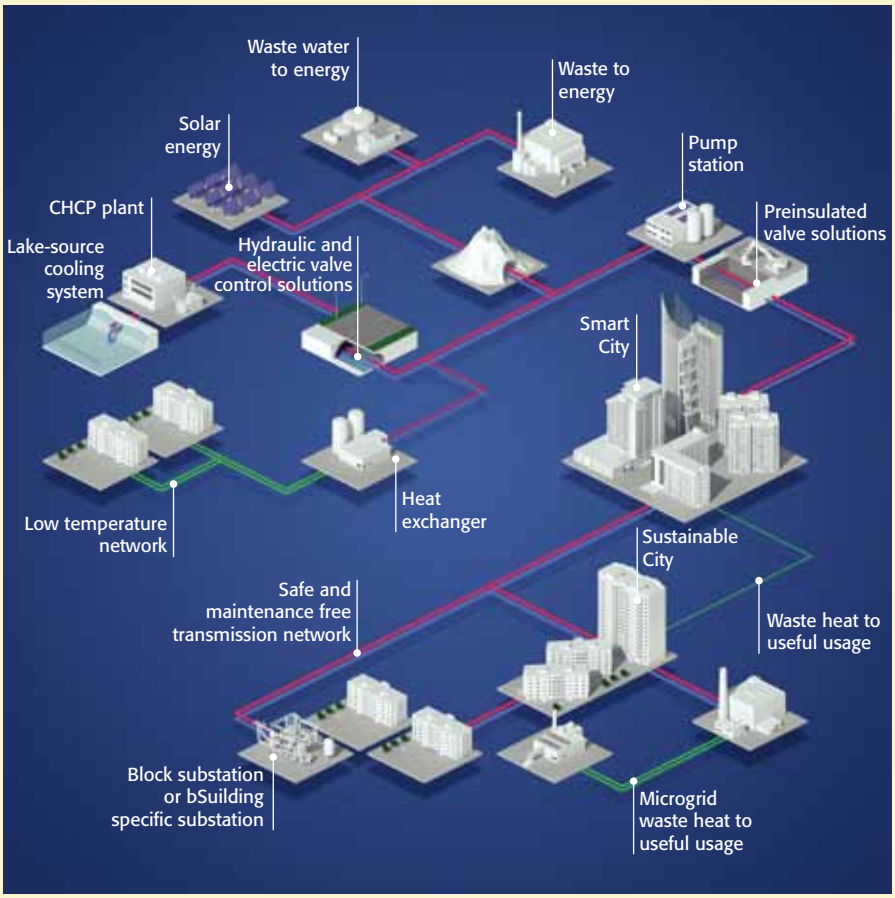

Figure 1. Future Smart Cities are complex network entities that need intelligent control methods and overall optimization from power plant to consumer

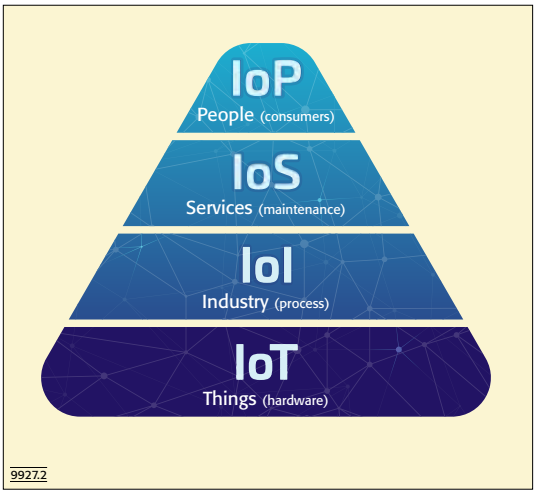

Figure 2. Successful digital transformation of district energy networks requires co-operation and digitalization at all levels. Intelligent hardware is the solid base of the transformation

30 countries all over the world. In the past few years Vexve has started actively to invest in bringing intelligence to its products. The role of near field identification technologies, metering and sending wireless data is going to increase in upcoming years. Smart products that take advantages of these features are central to the fifth generation of district energy and support the smart operation and optimization of complex networks all the way from the power plant to customer.

A good example of an intelligent and compact solution that serves the needs of a modern city are Vexve's underground solutions. The typical district heating line passes under heavily trafficked roads and to operate these valves (open/close) normally requires rerouting the traffic or shutting the road completely. Some traditional networks have a remote valve control possibility by electrical means. The electrical control method however always requires an underground concrete chamber. This is expensive, time consuming and often not an option due to lack of space.

Vexve has launched an overall underground solution (*figure 3*) that enables the remote operation of valves without concrete chambers or electricity underground. All the components of this overall solution are specifically designed for demanding district heating and district cooling applications.

The complete system consists of the following components:

- Vexve ball valve or butterfly valve,
- Hydrox hydraulic actuator,
- Vexve district energy plastic chamber and
- Hydrox HCU control cabinet for local or remote control.

The most enhanced version of the Hydrox product family, HCU Remote+ cabinet, also allows wireless operation of the actuators via computer or mobile device.

Vexve's hydraulic underground solutions have been delivered all over the Europe. The biggest benefits have been achieved in locations where a greater level of remote control has been desired or where the operating environment is especially demanding, e.g. ground water areas or places with limited space. Most of the cities in Europe face these problems when building or maintaining networks.

If 3D drawings to aid the planning phase, 3D manuals that accompany the valves wirelessly, near field identification technologies that enable anticipatory maintenance and maintenance logs, plus sensor technologies that enable metering of various kinds are added, Vexve can already talk about a fifth generation network, which is smartly operated and maintained.

All of this is achievable when the base of the digitalization pyramid is sound. Only then your city is ready to take the next step to become a Sustainable Smart City.

References

[1] C40 & UNEP: Good Practice Guide: District Energy. 2016. ■

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Figure 3. The hydraulic valve operation solution combined with a plastic access chamber is just one example of the kind of solutions that are going to be essential for future Smart Cities