



Adopting variable speed drives for district energy systems helps operators match output to demand Source: Adobe Stock

Taking District Energy Systems to the Next Level

District energy systems are regarded as inherently energy efficient as they displace buildings' needs for individual heating or cooling. But modern motor and drive technologies can take them to the next level.

New solutions and innovative technologies are stirring up much interest among governments, non-governmental organizations, and industry – most notably, the emerging concept of “Power-to-X.” This concept converts surplus electrical energy from wind turbines or solar panels into energy that can be stored and reused later. The “X” represents the type of energy into which the surplus is converted, such as hydrogen fuel. Consequently, Power-to-X could assist in the global battle against climate change by reducing the use of fossil fuels.

But what is the relationship between Power-to-X and district heat-

ing? Let's explain: The process of producing hydrogen requires a lot of electricity, but it also generates large amounts of heat. This heat can be used in a district heating network, provided the network exists in close proximity to the Power-to-X plant. Otherwise, this heat will be lost in a local cooling process, impacting the total energy efficiency of the plant.

This is a good example of sector coupling which facilitates the decarbonisation of a wider spectrum of economic activities by integrating the rising share of variable energy generation. The key to the success of Power-to-X schemes is

that they must make smarter use of energy – including using the heat from the hydrogen production process.

Driving ahead on energy efficiency

District heating systems use a network of insulated underground pipes that takes heat from a central source of energy and distributes it to multiple domestic or commercial buildings. These systems vary in size, spanning anything from a few hundred meters up to 50 km. The largest schemes can even cover an entire city.

District heating is essentially energy agnostic, and can switch between the different available heat sources, depending on actual cost and demand. It can operate flexibly over days or weeks but optimising energy efficiency is a constant critical success factor, regardless of the heat source.

The sources of thermal energy distributed by district energy systems vary. It might be a facility that provides a dedicated supply to the heat network, such as a combined heat and power (CHP) plant, also known as a cogeneration plant.

Another source could be waste heat from industrial processes, such as metal processing or chemical plants, or large data centers. With district energy systems, it's possible to exploit larger-scale and often lower-cost renewable and recovered heat sources that would otherwise go to waste.

Historically, motors used in district energy systems run continually at full speed. So if operators want to adjust the airflow of a fan or the flow from a pump they would use mechanical methods such as dampers and throttling. This is inefficient and wastes energy.

Adopting variable speed drives (VSDs) can play an instrumental role by applying precise controls to the motor speed and torque to achieve the desired output for optimal heat carrier flow rates and pressures. The outcome is that operators can match energy supply to the needs of the building while keeping the occupants comfortable. Simply replacing existing motors with modern high-efficiency equivalents and VSDs can have a significant impact.

Depending on the specific application, VSDs can typically deliver energy savings of 20 to 60%. By pairing VSDs with the latest IE4 or IE5 efficiency class motors network operators can significantly reduce energy consumption in heat generation,

transmission, and distribution (Figure 1). This can reduce a facility's environmental impact significantly in terms of carbon dioxide emissions. Furthermore, it can be stated that with energy costs continuing to climb, payback times from investments in energy efficiency are often reduced to a matter of months.

Digitalisation makes a difference

To improve operational resilience and identify areas of improvement within the entire system, operators should digitalise the process with sensors and connectivity devices, allowing them to collect data on device performance monitoring and improve decision-making. The VSD can also deliver information on energy consumption and load profiles.

Reliability and efficiency are critical requirements for district energy systems. Sensors placed throughout the system can proactively identify potential performance issues and inform operators. Ensuring easy, real-time access to this data in a cloud environment enables facility management teams to perform preventive maintenance and take early action before issues escalate.

Many modern drives can detect when variables leave the normal range. Advanced systems, including those that use artificial intelligence (AI), can automatically detect blockages in air systems, gears needing lubrication, heat pumps with impending bearing failures, or other issues that may compromise the system.

It is also important to consider programmable logic controllers (PLCs), which enable operators to create a dynamic, adaptable environment. Many operators choose a redundant or parallel PLC setup to ensure high availability of systems. This means that individual units and cables can be removed without

affecting the overall system, enabling downtime-free maintenance also via hot swaps. A scalable PLC system with open, state of the art protocols including cloud connectivity can work with the smallest applications as well as bigger plant controllers. The PLC monitors and controls the complete solution and enables the exact demand management of the entire plant.

Other digital technologies make it easier to keep the systems running. Some examples include easy-to-use smartphone apps for setup and tuning, and on-demand remote expert consultation.

A modern heat network in China

A practical example of a modern network is the complete district heating system that ABB supplied to the Dêgên Tibetan Autonomous Prefecture Heat Development in Shangri-La in the Himalayas, China. The city suffered from extensive air pollution caused by woodburning stoves, the primary heat source for its 50,000 residents. ABB supplied all equipment – from the steam to the water heat exchanger in the boiler room to the end-use installation.

The automation and electrical solutions interconnect and monitor the new heating plants for maximum efficiency. Air-source heat pumps replaced the individual heat-only boilers and stoves. The district heating system significantly improved quality of life by reducing the coal-fired emissions, simultaneously boosting the system's energy efficiency.

Five local Scada systems communicate with the central control and continuously monitor the system to optimise heat delivery. Moving from stoves to the district heating system yielded substantial environmental benefits. Shangri-La

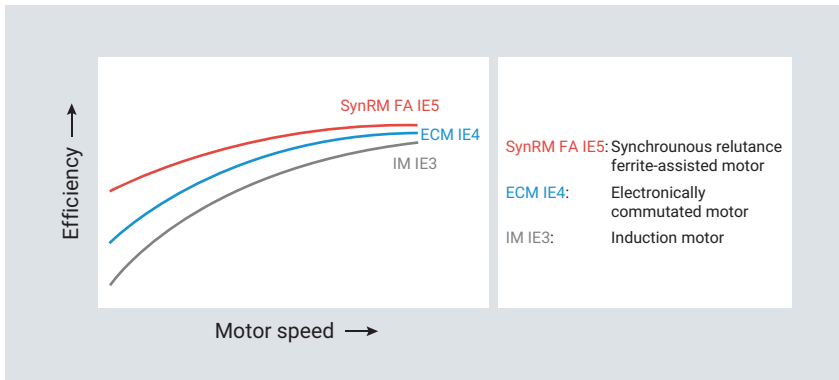


Figure 1. By pairing VSDs with the latest IE4 or IE5 efficiency class motors running at partial loads, energy consumption in heat generation can significantly be reduced

Source: ABB



Figure 2. The capital of Esbjerg and the heat production facilities is in close proximity from the wildlife in the Wadden Sea

Source: ABB

has eliminated the burning of nearly 17,000 t of coal annually – the equivalent of 105,000 t of carbon dioxide emissions. The reduction in dust emissions is 460 t.

Another project in China is in Shuozhou, where large numbers of coal-fired boilers serve the heating needs of the city's 1.7 million inhabitants. These boilers also have efficiency limitations and contribute significantly to carbon emissions. A new district heating project, supported by an ABB digital platform, will use surplus steam from an existing 2,000-MW power plant to generate heat. The heat will be channeled to two heat transfer stations and distributed via an underground pipeline grid to all the houses and buildings in the city.

The new district heating grid will help eliminate substantial green-

house gas emissions – estimated at 2.88 million t of carbon dioxide, 35,500 t of sulfur dioxide, and 0.37 million t of ash. It will also contribute to conserving natural resources, including 1.5 million t of coal and 2 million m³ of water.

Decarbonising district heat supply in Denmark

District heating is a critical part of the Danish port city of Esbjerg's ambition to become a CO₂-neutral municipality by 2030. Esbjerg faces the UNESCO World Heritage area of the Wadden Sea, which makes the city even more determined to achieve this goal (Figure 2). As part of this drive, the city is developing a new hybrid renewable district heat plant to replace heat supplied by Esbjerg's coal-fired CHP plant.

The city commissioned ABB to supply integrated electrical infrastructure for a seawater heat pump to deliver green heat to the city's 100,000-plus inhabitants. ABB will deploy its complete range of products, including motors and VSDs, for the plant pump's powerhouse.

The 50 MW seawater heat pump converts electrical energy into thermal energy and uses toxicologically safe CO₂ as refrigerant. Once operational in 2023, it will be the world's largest seawater heat pump using CO₂ as a refrigerant.

The need for speedy integration

District heating networks offer great potential for efficient, cost-effective, and flexible large-scale integration of low-carbon energy sources into the heating energy mix. Existing grids should be utilised as much as possible. Smart digital solutions that connect multiple heat sources to retrofit existing grids for higher energy efficiency levels is an effective solution. Operators can facilitate planning and control based on forecast availability to start leveraging the available energy faster.

There are fully commercialised and industrial-scale solutions available right now to address climate change. Therefore, cities around the world will benefit greatly by investing in the deployment and development of district heating due to the enhanced integration of green energy sources.

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