DISTRICT ENERGY

First steps towards Power-to-X

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Power-to-X, the concept of combining a number of electricity conversion, energy storage and reconversion pathways, makes effective use of surplus electricity production. It is creating great excitement among governments, non-governmental organizations (NGOs), and industry. This is especially because it offers a seamless approach to converting surplus energy for use in heating, cooling or even in electric vehicles (EVs). Therefore, it could reduce the use of fossil fuels and help address the global sustainability challenge.

However, while there is considerable discussion about the role that the hydrogen economy might play in these plans, there is another important aspect of Power-to-X that has a more immediate role to play. That is the capability for the coupling of various heating and cooling sectors, which is effectively the basis for district energy schemes.

According to the UN Environment Program, the Asia-Pacific is one of the most vulnerable regions to climate change and impacts are projected to become more intense in the future. It also accounts for nearly half of global greenhouse gas emissions. However, it is anticipated that the region will have an abundance of solar, as well as land and offshore wind power capacity by the end of the decade. Therefore Power-to-X, in the form of sector coupling, is very interesting to help meet climate change challenges.

THE RENEWABLE ENERGY CONUNDRUM

All currently scalable renewable energy sources have the challenge that they are not controllable relative to the need for power. They produce power literally as the wind blows or the sun shines. This is often not when the energy is needed, and while energy storage is growing there is not yet sufficient capacity to allow effective "time-shifting".

In fact, it is quite common for the output of wind farms to be curtailed simply because there is too much electricity available relative to the demand at a given time. This results in less renewable power being used than is possible theoretically and is a waste of resources.

By making the right connections between different sectors, such as heating, cooling, fossil-fueled generation and renewables, there are several options for buffering the energy. District energy solutions could then be used in place of fossil fuels, or to offload the electrical grid from the load during peak consumption hours when less wind power is available.

As an example, it is feasible for a district heating utility using large heat pumps to run them at higher load than the heating network requirement and then store the heat in large ground pits - known as pit thermal energy storage (PTES) or in insulated tank thermal energy storage (TTES). This heat could then be used to reduce the power usage from the heat pumps when there is less available renewable energy. There is also new technology emerging, such as thermoelectric generators (TEGs) that can convert heat back into electricity, with an efficiency of around 60 percent.

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HEAT REUSE

District heating networks comprise a distribution system of insulated pipes that takes heat from a central source and delivers it to several domestic or non-domestic buildings. The heat source might be a facility that provides a dedicated supply to the heat network, such as a combined heat and power (CHP) plant. Or it could be waste heat that is recovered from industry, such as large data centers, or energy from metal processing or chemical plants. Heat networks provide an opportunity to exploit larger scale – and often lower cost – renewable and recovered heat sources that otherwise cannot be used.

District heating systems can vary in size, distributing heat just a few hundred meters or up to 50 kilometers and, at their largest, can encompass an entire city. The smaller communal heating systems will service a single campus or a village.

One of the benefits of district heating is that it is agnostic to the source. It can utilize whatever is available locally and can even be flexible over days or weeks. This is where digitalization comes in to optimize the process and also to allow operators to participate in the open power market. For example, if the system includes waste-to-energy plant that produces both electrical power and heat, it is possible to use the waste to generate more power in the period when the market price for electricity is high. On the other hand, when demand is low, the hot water for heating can be stored and used later, because storing energy as water is almost 100 times cheaper than storing it as electricity.

EXPERIENCE THAT COVERS THE ENTIRE DISTRICT ENERGY VALUE CHAIN

Over the past 40 years, ABB has been involved in many district energy projects worldwide, including Europe, China and Mongolia. Our experience covers the whole value chain from production, operation, transmission and distribution to the end customer. The scope of supply is comprehensive, from the high-technology variable speed drives (VSDs) and motors that are essential for the energy-efficient operation of the multiple pumps at the heart of district energy schemes, right through to the SCADA systems that provide the over-arching control to balance production and demand.

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PRACTICAL EXPERIENCE IN CHINA

ABB has supplied a complete district heating system to Dêqên Tibetan Autonomous Prefecture Heat Development in Shangri-La in the Himalayas, China. Shangri-La suffered badly from air pollution caused by wood-burning stoves that were the primary source of heat for its 50,000 residents. ABB supplied all equipment from the steam to water heat exchanger in the boiler room to the end-user installation. This included electrical and mechanical equipment needed to provide heat to the citizens.

ABB automation and electrical solutions interconnect and monitor the new heating plants for maximum efficiency, while air-source heat pumps have enabled the move from individual heat-only boilers and stoves to boilers based on electricity. The pumps boost the system's energy efficiency and help improve the quality of life substantially by reducing coal-fired emissions.

To meet the changing needs of the population, five local SCADA systems communicate with the central control and monitor the system to deliver heat most efficiently. The shift from stoves to the district heating systems has provided substantial environmental benefits. About 17,000 tonnes of coal is no longer burnt in Shangri-La every year, which is the equivalent of 105,000 tonnes in annual carbon dioxide emissions, and dust emissions is reduced by 460 tonnes.

In another project in China, the heating needs of Shuozhou, a city of 1.7 million people, are served by large numbers of coal-fired boilers, which also have efficiency limitations and contribute to carbon emissions. A new district heating project, supported by an ABB digital platform, will use surplus steam from an existing 2,000 megawatt (MW) power plant to generate heat. The heat will be piped to two heat transfer stations and distributed via an underground pipeline grid to all the houses and buildings in the city.

Substituting the existing heat generation source with the new district heating grid will help eliminate substantial amounts of greenhouse gas emissions – estimated at 2.88 million tonnes of carbon dioxide, 35,500 tonnes of sulfur dioxide, and 0.37 million tonnes of ash. It will also contribute to the conservation of natural resources, including 1.5 million tonnes of coal and two million cubic meters of water.

DEVELOP FOR THE FUTURE OR IMPLEMENT TODAY?

The Asia Pacific region has a great deal to gain by investing in the deployment and development of district energy. In particular, using smart digital solutions to connect multiple heat sources and facilitate control and planning according to forecast availability will make it possible to start leveraging the available energy faster. To further the development of other technologies for the increased use of renewables and improved energy efficiency, it is sensible to run a number of pilot projects in parallel. These could include the generation of fuel from power. However, they are technologies for the future. There are still challenges with scalability and they will not have a significant immediate impact. Yet the pressing need to address climate change needs fully-commercialized and industrial-scale solutions right now. That is why the time for district energy has arrived.

FOR FURTHER INFORMATION, ON DISTRICT ENERGY:

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