Energising smart cities

NODA Intelligent Systems discusses the contributions of district heating and cooling systems to smart cities

Around 66% of the Earth's population will live in cities in 2050, while in 1950 this figure was just 30%.[1] This trend in human settlement has the challenge of adhering to the COP21 agreement, adopted in December 2015 in Paris, France, by 195 members of the UN Framework Convention on Climate Change. This mainly consists of providing a framework for combatting global warming, with the key objective of limiting the rise in global temperature to below 2˚C. In that sense, cities will need to improve their efficiency in resource consumption and use of urban services.

One particular strategy, adopted by many cities around the world, in facing this challenge is to evolve into smart cities. A smart city is an urban development vision that integrates connectivity between infrastructures, facilities and citizens by means of data-driven solutions to manage the needs of urban areas. The main objective of smart cities is the use of ICT to improve the quality of life of citizens and to provide real-time responses to challenges.[2] We know it as 'digitalisation'.

Empowering citizens

The smart city is a broad concept that aims to empower citizens to interact with their environment, to create a community between cities and public government, to promote fun activities, to improve mobility and security, to foster tourism, to provide health services, and to contribute to developing low-income sectors, amongst others. However, there are some detractors regarding the benefits of the smart city concept, those who argue that smart technologies could be used in a way that infringes upon people's privacy, for example.[3]

Despite this wide concept of a smart city, one specific challenge that they face is in managing the increase of population, global warming, the rise of resource demand, and the need for security in energy supply. In that sense:

- Transport has to be decarbonised, improving urban flows using sensors and communication and reducing the emissions of vehicles;
- Energy refurbishment of existing buildings has maximum priority, including building structure and heating and cooling supply facilities. Buildings account for over one-third of total final energy consumption and are an equally important source of CO_2 emissions; and
- Infrastructures of energy supply, power grids and district heating and cooling (DHC) networks must be cost-effective, sustainable energy systems where fossils fuels can be massively replaced for solutions with a lower carbon impact.

To be more concrete, this article focuses on how district energy or DHC networks, as intrinsic to smart cities, are crucial infrastructures for the decarbonisation of cities by means of generating new business opportunities and economic growth.

Urban development

In comparison with individual systems on each building or apartment, DHC systems have several advantages that create cost-effective solutions to developing urban areas and minimising carbon emissions:

- High-capacity chillers or boilers placed in centralised facilities perform with better efficiency than individual small capacity systems;

- Waste heat recovery can be implemented in central plants. For instance, taking advantage of co-generation plants, waste heat from solid urban waste treatment plants or industrial parks, data centres, malls or public transport stations;
- Use of renewable energy sources (RES) by means of highly efficient technologies such as biomass, biofuel, solar thermal energy or geothermal energy, which can be used to reach 100% RES coverage; and
- Thermal storage systems can be implemented in DHC in a more efficient way and with a higher capacity than in individual systems. In the same way, heating and cooling networks are virtual storage systems themselves. Innovative district heating and cooling network controllers, such as NODA Smart Heat Grid, will increase the use of waste heat and RES, as well as boosting energy efficiency at the district level. Real application of these solutions is demonstrated in the Horizon 2020 projects STORM (http://storm-dhc.eu/) and FHP (http://fhp-h2020.eu/).

In a distributed energy system, where the penetration of renewables into the grid is very high (expected to grow by 30% from 2014 to 2020[4]), DHC infrastructures can be used as thermal storage to move the thermal energy production by heat pumps, electrically driven, shifting demand over time. In that sense, heating or cooling can be generated by efficient heat pumps driven by photovoltaic or wind farms when renewable resources are available.

Other suitable technology to reach 100% RES in DHC is the combination of biomass and solar thermal energy. Biomass boilers reduce their efficiency in summertime, when demand is only required for domestic hot water and not for heating. In this season, biomass boilers can stop most of the time and the energy can be obtained completely from the solar thermal field.

Nowadays networks are designed to minimise losses. They include high-performance insulation with optimised piping flow to reduce frictional losses. Besides that, they are designed to use lower temperatures to reduce heat loss. This feature is suitable for refurbished or new, nearly net-zero energy buildings with low heating/cooling loads.[5]

Breaking with tradition

Traditionally, some DHCs base their business models on selling as much energy as possible. However, as a result of the oil crisis in the 1970s, or energy efficiency policies, they are now a key component for reaching low carbon societies, and DHC businesses in several countries are evolving towards highly efficient technologies. In that sense, the added value of business is based on the optimisation of plant operation and the accurate maintenance and proper design to fit the energy demand while avoiding oversizing plants and pipes.

In that sense, online access to smart cities buildings will contribute to developing an optimal design of DHC infrastructures

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in order to maximise energy efficiency and reduce greenhouse gas emissions. Knowing social patterns and behaviours relating to energy use, together with the availability of renewable energy, will drive an energy management suitable to cover citizens' needs with the lowest impact to the environment.

To sum up, district heating and cooling systems are cost-effective solutions that contribute to developing sustainable energy cities with low carbon emissions. These infrastructures reuse waste heat and increase the penetration of RES in urban environments. Centralised energy management with customer interaction by means of intelligent digital solutions in a smart city is a great combination in optimising energy use and enhancing the creation of decarbonised urban places.

References:

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