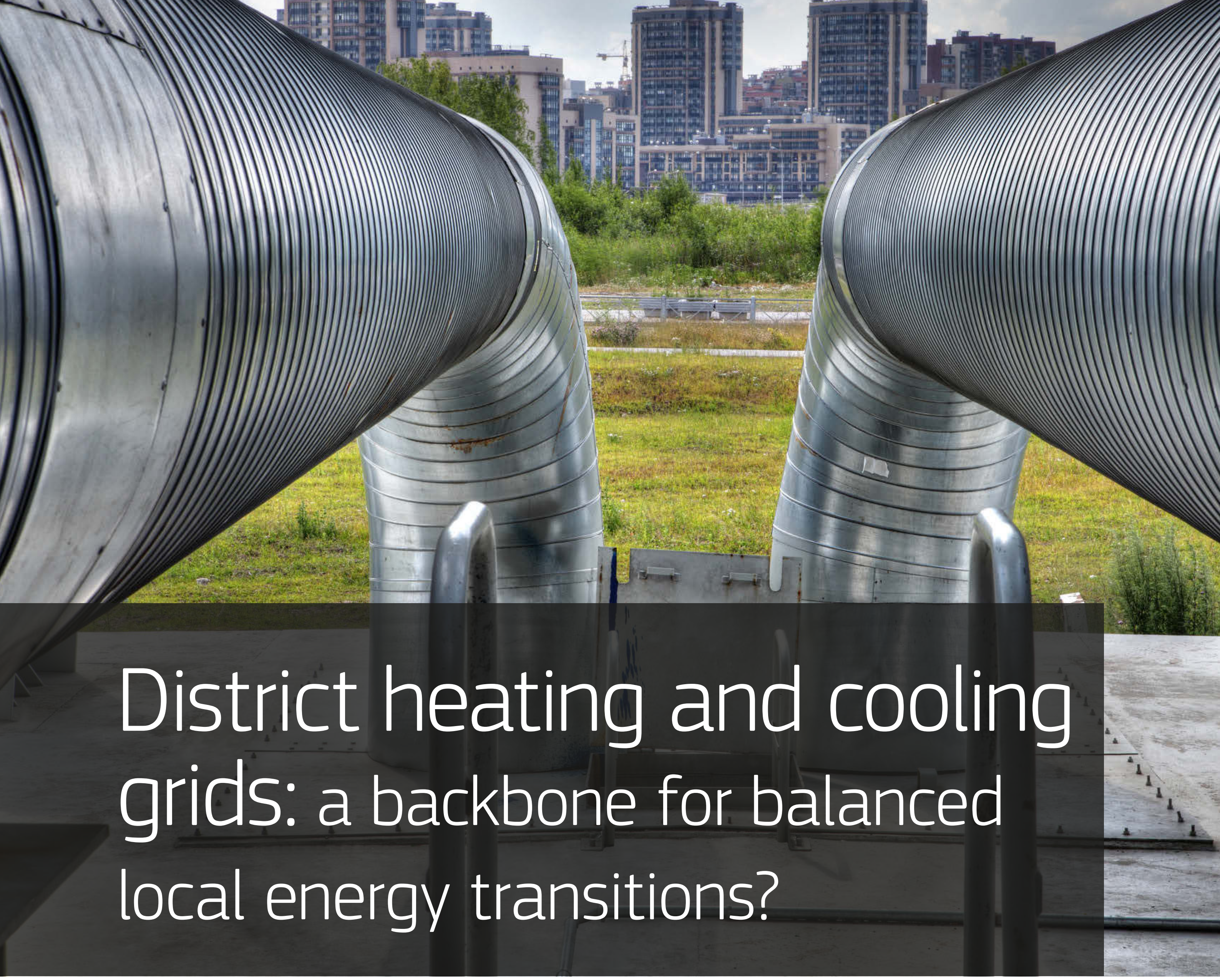

District heating and cooling grids: a backbone for balanced local energy transitions?

As the energy transition focuses on holistic energy efficiency policies at the local level, more attention is paid to efficient district and heating and cooling (DHC) networks. Because of their various advantages, they appear in many respects as a potential backbone for coherent local strategies, mainly due to the fact that they enable local authorities to combine a variety of energy efficiency and decarbonisation leverages.

At one end, they can be supplied by several local renewable energies, ranging from various biomass fuels to geothermal energy, but also including biogas from waste or sludge, often through cogeneration, and other potential sources. At the other end, they are closely linked to efficiency policies in buildings, both as regards new construction and refurbishments. Although it is sometimes emphasised that progress in buildings' energy consumption might reduce the economic scope for urban heating grids, both can actually be part of a renewed strategy: many field cases evidence that those new building performances do not undermine the relevance of densifying or developing urban heating networks, though they certainly influence the technical models and pricing structures that underpin their development.

As an example, the new DHC grid of the Saclay research and universities cluster, south of Paris, which combines tertiary buildings and collective housing, mainly based on low-temperature geothermal energy, is being developed after it has been evidenced that it will provide a more efficient heating and cooling supply than autonomous, building-level solutions.

In many cases, this combination of fuel decarbonisation and optimised consumption is a powerful cost-efficient leverage for deep local decarbonisation. It also stimulates local economic activity and paves the way to more balanced, resilient energy systems.

But the scope for developing new, efficient heating and cooling networks goes beyond this, especially if one considers it from a mid- to long-term perspective. Two other sets of factors are to be considered, that will allow deeper energy optimisation to occur, and will provide increasing scope for developing efficient district heating and cooling in the near future.

The first one, particularly relevant in low- and mid-temperature grids (<40°C), providing both heating and cooling, is related to the numerous possibilities for energy recycling and exchanges which those grids make possible. In those cases, the grid not only conveys energy from primary sources to end users, but can be used as a complex optimisation system, connecting various energy profiles at different points of their cycles, in order to optimise their combination, and multiply secondary energy sources within the grid itself. New remote control and smart metering devices create a range of new possibilities in those grids.

The second set of factors builds on possibilities to connect those "smart" heating and cooling grids with electricity and gas grids. This will gradually enable real time arbitration between multiple energy sources to supply specific local needs. But it will also help in managing the costs and addressing the technical challenges of the instability linked to the increased share of renewables in electricity grids. The reason for this is that heating and cooling grids comprise key devices such as heat pumps, small cogeneration facilities or cheap centralised or decentralised thermal storage, which, when properly combined with local electrical systems, can help to efficiently manage intermittency from wind and solar sources, at a far lower cost than current electricity storage or power-to-gas devices. In a country like Denmark, the installed renewable capacity now roughly equals peak power demand: a large part of the resulting instability is managed through small, decentralised, power driven combined heat and power (CHP) facilities. Those small CHP facilities provide, on average, 50% of Denmark's electricity, and they are connected to various DHC grids, and to thermal storage devices, usually through water. They were consciously designed and gradually developed from the 1980s onwards as a key component of optimised systems enabling the country to develop its renewable power capacity well beyond the points that were long regarded as thresholds beyond which local electricity grids would become unmanageable, or unaffordable.

Energy systems will only be "smart" if they enable this flexible multi-energy supply to build up, and to a large extent, the backbone of those future multi-energy grids will be in DHC grids, because most of the devices and equipments allowing cost efficient, real time supply-need adjustment will be both rooted in local heating and cooling systems, and articulated with other energy supply grids and systems.

In order to facilitate these new transition steps, several policy challenges will have to be addressed at local, national and European level. Though heat represents more than 50% of our total energy consumption, the average share of district heating and cooling networks in its supply is currently only 12% in EU Member States.

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At the local level, a range of concrete challenges have to be faced by public city planners, grid managers and energy providers in order to allow for new grid architectures to emerge, allowing complex energy optimisation to occur. Some of these challenges are different in new urban areas and in old ones.

As regards new areas, planning authorities have to face a high degree of complexity, and the corresponding modelling work, in order to choose or promote energy solutions and grid architectures that will minimise total life cycle costs for new grids, including connection/metering and production/storage devices which are best suited to the needs and resources of the area.

This choice is not simple, for several reasons. Competing energy providers and various off-takers usually promote different solutions. The value of future price stability, which can be achieved by replacing market exposed fossil fuels by renewables such as geothermal energy or biomass, is hard to estimate on long period/life cycle budgeting approaches, which are relevant in these cases, and so are positive environmental externalities, most of which are under-priced in the current economic environment. Last but not least, defining a "collective local optimum" requires due consideration and ponderation of various parameters that affect various stakeholders in different ways.

Moreover, as efficient, downsized, sub-systems develop, though the benefits of a collective grid usually depend on the width, diversity and density of its customer base, choices have to be made in order to promote collective optima without deterring decentralised innovation, freedom of choice and initiative. This balance is not always easy to strike.

In older urban areas, where development of DHC networks is linked to various parameters, such as pre-existing boilers at building level vs individual ones, margins for developing new grids or extending existing ones may seem narrower. But densification can occur on a large scale, heating needs will remain much higher than in new, energy efficient, buildings, and yet unaddressed cooling needs may also provide scope to reengineer overall energy supply concepts, providing new scope for DHC grids. Several European cities, such as Stockholm or Vienna, have successfully conducted such developments in densely built urban areas.

At national level, adequate support schemes and relevant legislation can also play a key role in supporting highly efficient, environmentally friendly DHC grids. As the collective benefits of these projects increase over time, and as both the predictability of variable energy costs and environmental externalities are usually under-priced in the current EU environment, investment subsidies and tax incentives based on those criteria can alleviate the cost of service for the first users of innovative, capital-intensive solutions such as geothermal-fuelled DHC grids, who might bear a proportionally larger part of capital costs through tariffs than later users. In some cases, mandatory connection rules, which support densification and reduce overall investment payback, can also be relevant, provided that they maintain incentives for new competitive supply to be integrated over time.

As most of the decision-making power lies at municipal level, and part of those systems can be developed in-house by those public local bodies, EU policies can't shape the DHC markets as directly as they've done for gas and electricity supply. But numerous instruments remain available to support municipalities and local bodies to develop cost-efficient, environmentally friendly DHC grid systems.

On the supply side, cogeneration and tri-generation often appear as the cornerstone of smart local systems, especially when they combine industrial and household customer bases. A stronger support to those facilities, potentially articulated with emerging capacity market rules, could be a valuable way to indirectly support modern DHC grid systems.

On the conception and engineering side, the various means by which European policies support and finance efficient local energy systems, based on a combined assessment of needs and resources, also provide indirect support to DHC grids - which often emerge as the relevant off-taker of newly tapped local energy resources - and integrate them into a balanced, real-life assessment of energy needs.

Last but not least, research on smart grid systems must focus on multi-energy systems, and should integrate a stronger DHC grid component. The first demonstrators were mostly electricity focused, and lacked a multi-energy dimension. New European research programmes will also have to be up-scaled in order to enable public authorities to use system operation feedback as an input to new system architecture, and reduce investment in production and grids due to better peak shaving, the anticipation of which will spare both new capacity and grid reinforcement investments in local systems. They will also integrate a broader variety of energy uses, such as electric mobility, into the scope of their experiment.

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