European Commission

Science for Environment Policy

Energy-efficient data centres? How recovered waste heat could be sold to district heating networks, Finland

30 May 2019
Issue 526
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Source: Wahlroos, M., Parssinen, M., Rinne, S., Syri, S., and Manner, J. (2018). Future views on waste heat utilization – Case of data centers in Northern Europe. *Renewable and Sustainable Energy Reviews*, Volume 82, Part 2, February 2018, pp.1749–1764. https://www.sciencedirect.com/science/article/pii/S1364032117314314.

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Concern is growing around the issue of energy efficiency in data centres (DC) as more and more data are saved, processed, and transferred to facilitate myriad digital services worldwide. Utilising waste heat from DCs as heating for nearby districts may be a potential solution if technical and knowledge barriers are overcome, suggests this Finnish study, which identified key obstacles to this concept and possible methods of implementation.

It is estimated that DCs accounted for up to 1.5% of global electricity consumption in 2010. Such centres are growing increasingly large and require specialised locations: they must have access to cheap, reliable energy; be located in politically stable environments; ideally be close to where the data itself will be used, in order to minimise delays in data transfer; and, a greater hurdle in remote areas, have sufficient telecommunications links to transfer data. They also require significant cooling, making sites in colder areas — such as the Nordic countries — especially suitable.

This study used a combination of life-cycle assessment and literature review to explore the current solutions, technologies, and future potential of using DC waste heat as a source of district heating (DH) to improve energy efficiency — a system already seen on a large scale in Finland and Sweden. In Finland, while many DCs are built close to existing DH networks, these are owned by separate entities, presenting challenges to integration.

The researchers reviewed 37 metrics used to measure and quantify energy efficiency and heat flow for a large modern DC (these included energy consumption by infrastructure, use of renewables, DC servers and power supply), and selected the 13 most impactful and relevant within the scope of the study. They then analysed the economics of waste heat utilisation in DH and the cooling technologies used in DCs, and suggested a systematic approach to overcome the various barriers identified in waste-heat recovery and use.

The study estimates that most of the power consumed by DCs in Finland — by servers, for cooling — could later be used as a heat source for DH, potentially providing up to 20% of total DH heat production over a year (8 terawatt hours (TWh) of ~35 TWh) and reducing oil use from 10% of the DH's total heat supply to just 4%.

The two most significant barriers identified were heat demand and profitability, but several barriers reduce the efficient reuse of DC waste heat in the Nordic countries even when heat demand is adequate. In most cases, the main reason for not utilising waste heat was the low quality of the heat (at low temperatures or from unstable sources), followed by high investment costs (despite repayment periods only being a few years).

However, these can potentially be overcome, for example by using heat pumps to upgrade heat quality and building more convenient infrastructure. Complex hurdles are generally less technical and more to do with a lack of economic and technical knowledge — for example, DC operators planning to sell their waste heat, but unsure of how to make a profit. This is caused, in large part, by a lack of transparency around how to sell waste heat to DH companies, missing business models, and scarce data on energy consumption and waste heat production from DCs themselves.

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The researchers suggest a way to overcome such obstacles systematically via an **'effective eight-step change process'**:

1. **Create a sense of urgency.** Communicate and discuss the importance of change with local groups, strengthening this message with stakeholder support and real results.
2. **Form a powerful coalition.** Convince people that change is necessary via strong leadership, support, and commitment from regulatory authorities, academia, and relevant organisations.
3. **Create a vision for change.** Distil critical values and strategy to a core message.
4. **Communicate the vision.** Ensure the message is present in daily decision-making and problem-solving, with open discussion about the sustainability of IT, energy efficiency and waste-heat recovery.
5. **Remove obstacles.** Build a structure for change — hire change leaders, revamp organisational structures, and act to rapidly remove barriers.
6. **Create short-term wins.** While long-term success is the core aim, short-term 'wins', such as steps to implement smart cooling and heat minimisation systems, will help further motivate stakeholders. Identify projects, set targets, and analyse results.
7. **Build on the change.** Target continuous improvement to launch a system that truly works.
8. **Anchor the changes into culture.** For lasting change, the entire process must be culturally integrated.

The study also highlights the need to establish a standard for measuring energy efficiency and waste-heat potential, and to communicate energy-related costs to ICT decisionmakers. The sector must adapt to new ways of thinking, say the researchers, and should raise awareness of new energy sources and of how waste heat can be successfully utilised to the benefit of all parties.