



Liquid cooling cuts data center emissions

Nokia's Tampere Data Center is at the heart of a sustainable ecosystem. It uses natural liquid cooling for its data center operations and sends waste heat to homes and businesses.

Data centers use a lot of electricity. They generate heat and need to be kept cool to operate. Typically, half of the energy consumed in a data center is used for cooling. For example, at Nokia's data center in Tampere, there are over 1,200 square meters of hardware, supporting 50 kilowatts (kW) per rack that amounts to a total output of up to 4 megawatts (MW).



On track to a sustainable data center

Changing to 100 percent renewable energy is an important step for a data center, but this does not make it 100 percent sustainable. However, the Finnish city of Tampere has installed a cooling system that makes Nokia's data center highly sustainable and improves the quality of life for its citizens.

“20 percent improvement in energy efficiency
and 90 percent reduction in CO₂ emissions.”

Tampere is 180 kilometers north of Helsinki and lies between several deep lakes— the largest of which are Näsijärvi and Pyhäjärvi. These glacial depths are a great natural resource and where the innovative liquid cooling solution begins. By pumping water from the deepest part of the lake through a network of underground pipes, the data center's air conditioning can keep it sufficiently cool without expending as much electricity to do so.

The lakes presented an opportunity for Tampere, which started to consider a district cooling grid line through liquid cooling in 2012. While Nokia's data center— located within our 5G R&D facility— in the city was among the first to implement it, owing to the considerable energy necessary to cool its infrastructure.

By Q3 2016, the system was online and the results were profound. The Tampere data center saw a 20 percent improvement in energy efficiency and 90 percent reduction in CO₂ emissions. And better still, the power usage efficiency (PUE) also dropped falling from 1.35 to under 1.1. Today liquid cooling drawn from 'lake energy' produces 95 percent of the site's annual cooling energy.

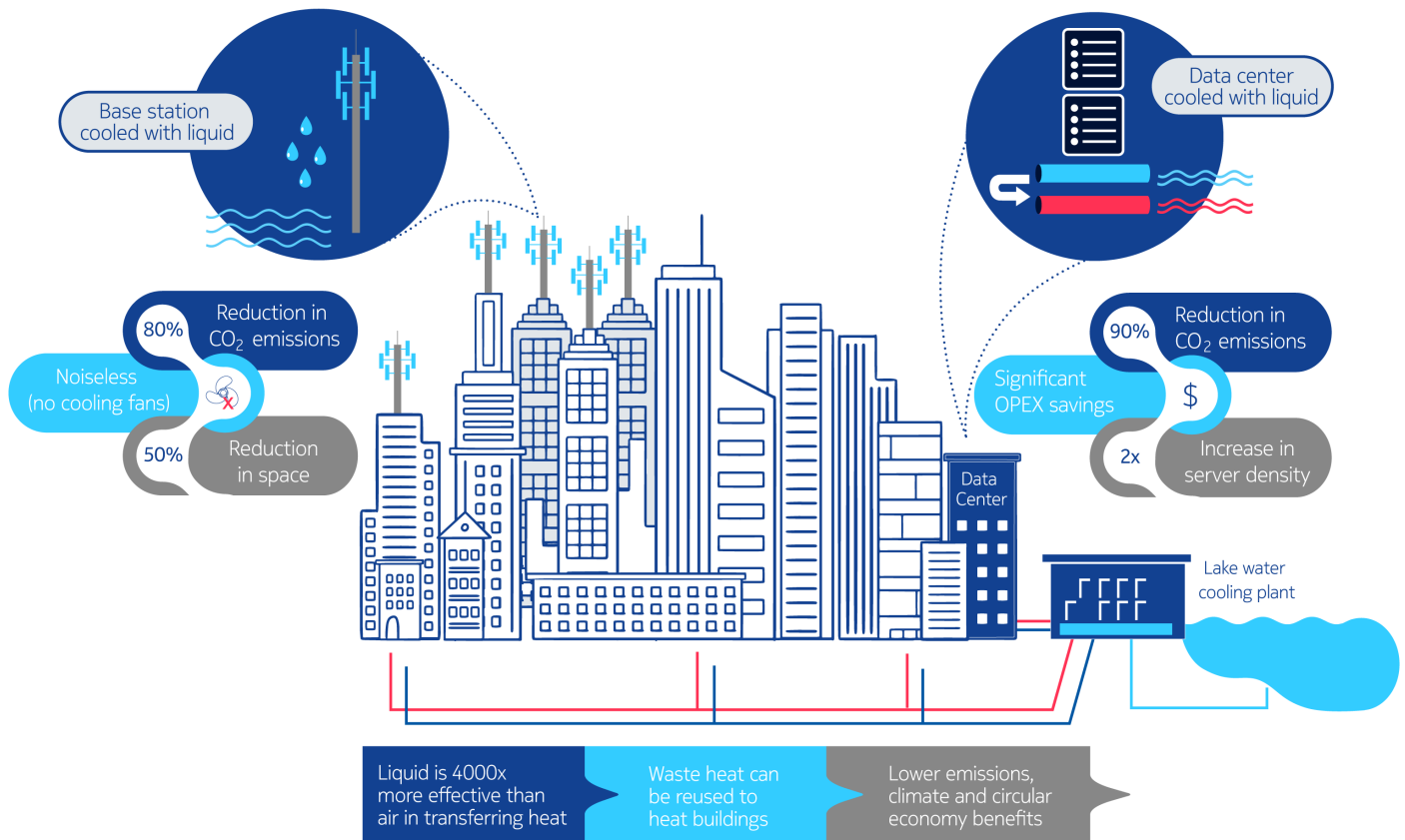
Water can store more energy than air

Cooling on a mass scale would clearly have a positive effect on carbon emissions and climate change. It would also go a long way to helping Finland achieve its goal of having a carbon-neutral footprint by 2035 and using energy-efficient alternatives.

“Water can store 4,000 times more energy
than air does at the same volume.”

The efficiency speaks volumes — literally. It's not sustainable to run a data center using air-cooled components as the primary source, particularly when a large portion of the center's power output comes from the cooling system itself. However, water can store four thousand times more energy than air does at the same volume (see Figure 1). Thermal conductivity is also up to 22 times lower.

Figure 1 Sustainable liquid cooling systems



Source: Nokia

Self-sustaining system allows reusing data center waste heat

While the data center draws in liquid cooled air, it still produces heat. In fact, a data center like this requires a lot more energy for cooling than other structures — like hotels, hospitals and office buildings — that are connected to the same system. This makes the facility an important customer for the City of Tampere.

In addition, the heat produced by the data center can be distributed back to the system. This is an extremely valuable asset as the heated water would upset the delicate ecological balance clearly if it were to go back into the lakes. So instead, the city of Tampere recycles its heat waste by using its grid line to deliver [district heating](#) to residential, commercial and industrial sites.

Rather than having an individual boiler in a building, a heat distribution or district heating system delivers heat from a centralized energy center— in this case, from the data center. Waste heat from the data center typically routes back to the city's grid line for district heating, usually at a modest



temperature of 23-24 degrees Celsius. While this is not warm enough to heat up entire buildings on its own, heating system pumps can help by distributing excess heat for use at public facilities.

There are other sustainable benefits. It's a closed loop system and has few moving parts. This means that malfunctions and maintenance are kept to a minimum. In any event, onsite chillers powered by renewable energy can also step in to cool the water down or help offset any reduction from the liquid cooling system. It also reduces noise pollution, as air-cooled fans are not needed, and as the pipes are part of the fabric of the building it doesn't require floorspace. The higher the efficiency, the lower actual electricity costs per megawatt hour, which helps the bottom line.

As part of a broader tax reform, the Finnish government proposed a new energy tax rate for data centers that would see it fall to among the lowest levels allowed in the European Union. This came into effect in 2021 and is set to make Nokia's Tampere data center among the most cost-effective in operation. With the country seeking a carbon-neutral footprint by 2035 and more energy-efficient alternatives, this sustainable system will cover the data centers and city's heating and cooling needs.

Liquid cooling and heat distribution make Nokia's Tampere data center a key part of the city's wider infrastructure by not only consuming electricity, but also contributing to its heating needs. It's a circular operational model which works fluidly with minimized environmental impact, and importantly, at a reasonable cost.

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Document code: CID210962 (November)