AUTHOR: WILLIAM RALSTON SECTION: WORLD PAGE: 32 PRINTED SIZE: 1138.00cm² REGION: KL
MARKET: Malaysia PHOTO: Full Color ASR: MYR 15,749.00 ITEM ID: MY0058835343

13 MAY, 2024

How sewage is helping along the energy transition

The Malaysian Reserve, Malaysia

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A growing number of municipalities are incorporating district heating into their plans to cut fossil fuel consumption

by WILLIAM RALSTON

IN FALSE Creek, a waterfront community in Vancouver, Canada, the energy being used to heat homes comes from an unlikely source.

Instead of a boiler, each building's hot water arrives in underground pipes from a city-owned plant — a system called district heating. A growing number of municipalities are incorporating this strategy into their plans to cut fossil fuel consumption, using renewable energy (RE) sources such as geothermal or solar instead of oil or natural gas.

But in the case of False Creek, they're using sewage.

It turns out that the water flowing out of your kitchen sink, washing machine, shower, dishwasher — and yes, toilet — is warmer than when it first shows up at your house. Wastewater flowing through municipal sewer pipes can maintain a temperature of between 50°F (10°C) and 68°F even in the coldest months.

So rather than waste that heat, False Creek uses it. In 2022, the local utility said it generated 23,441 megawatt hours of thermal energy from sewage water — enough to heat 3,000 residential apartments for a year. "What we're doing is converting wastewater into a resource," says Derek Pope, manager of neighbourhood energy for Vancouver. "In doing so, we're able to heat up an entire neighbourhood."

With the energy transition falling behind as global warming continues to accelerate, cities are scrambling to find ways to help bridge the gap. Wastewater is one of a number of alternative energy options being exploited.

Across the globe, 380 billion cu m of municipal sewage is generated annually, according to a 2022 report by the European Investment Bank. As cities grow, that's expected to increase 51% by 2050. According to the US Department of Energy, a year's worth of American wastewater contains an estimated 350 terawatt-hours of energy, which could heat 30 million homes. In other words, that's a lot of unused heat.

The energy used to heat homes and workplaces is among the highest contributors to individual carbon footprints. Gas boilers and wood stoves release vast amounts of carbon dioxide, while electric heaters are only as green as their power source — often gas or coal. Globally, heating accounts for 40% of all energy-related emissions.

It may then come as no surprise that, according to a 2023 report by global engineering firm Danfoss, excess heat is the world's largest untapped energy source. Around 2,860 terawatt-hours of waste heat is generated annually in the European Union (EU) alone, almost the same as the area's total energy demand for heat and hot water in residential and service sector buildings.

A global push to capture this heat could help avoid the burning of almost 30 million barrels of oil per day, or 650 billion cu m of natural gas per year, the report says. That's around four times what the EU imported from Russia in 2021.

"This is not only about reducing greenhouse gas (GHG) emissions; it's also about rethinking how we view waste heat resources like sewage," says Pope. "Around any given city, there are various waste heat resources that systems like ours could make use of, and we need to begin thinking about them seriously."

Aaron Gillich, a professor of building decarbonisation at London South Bank University, said initiatives like False Creek's make it easier to implement stricter building limits on GHG as well as more sustainable urban planning. In Vancouver, a big part of that is reducing dependence on natural gas. "We use so much that no single thing can replace it on its own," Gillich says. Wastewater "is potentially a really significant ingredient in squaring that circle."

Wastewater is an appealing source of energy because its supply is stable — as is its temperature. That means the pumps that transfer its heat to clean water can operate in winter, when demand for heating is highest. But how exactly does this all work?

To start, a liquid refrigerant is passed through an evaporator, turning it into a gas that's funnelled into pipes surrounded by wastewater. The gas absorbs the water's heat and is then run through a compressor to make it even hotter — as high as 80°C. The hot gas is then circulated around pipes containing clean water. While that water flows through insulated distribution pipes to individual buildings, the gas reverts to its liquid form. Though heat pumps like these use some electricity, they are four times more efficient than boilers or electric heaters. And in False Creek, the pumps get their power from hydroelectric dams.

In Oslo, Hafslund Oslo Celsio is tapping into a main sewage pipe to provide heat and hot water for 13,000 apartments

The practice of wastewater heat extraction has been adopted in many European countries. Switzerland began taking heat from sewage back in the 1980s, and German company Uhrig says it has constructed more than 100 wastewater heat projects, both in Germany and abroad. In the UK, the method has become an "emerging sector," said Antoine Reguis, a renewable energy (RE) expert at Edinburgh Napier University. Gillich estimates the energy contained within the UK's 4.2 billion gallons of daily wastewater could provide space heating and hot water to 1.6 million homes.

In Vancouver, a city of 680,000 on Canada's west coast, buildings account for 57% of GHG emissions. False Creek's system, which Pope says was the first North American application of raw sewage heat recovery, began operation before the 2010 Winter Olympic Games to supply heat to the athletes' residential complex.

Back then, the system heated nine buildings; today it serves 46, including 6,000 residential apartments. In 2022, 71% of the neighbourhood's heating energy came from renewables, with sewer heat being the primary source.

But the False Creek project was purpose built. Installing the necessary infrastructure in existing developments can be cost prohibitive. Moreover, maximum energy recovery from wastewater is at or near water treatment plants, where the flow is greatest. Such facilities tend to be on the outskirts of cities, which means heated water has farther to travel.

"Even well-insulated pipes will have some amount of heat loss per metre, so you want the pipes carrying the heated water to run as short as possible," says Gillich. But according to Nick Meeten, director of New Zealand-based consultancy Applied Energy, beneath every city there are places where flow rates are high enough to supply heat to large buildings, or even whole city blocks.

In Oslo, RE company Hafslund Oslo Celsio is tapping into a main sewage pipe where it says more than a million gallons of wastewater passes per hour. The project provides heat and hot water for 13,000 apartments a year, the company said.

Specific points with large demand can be chosen for a localised transfer of wastewater heat — a hospital, a train station, a swimming pool or a university campus. In Rockhammar, Sweden, residual heat from a paper mill's wastewater is used to heat an industrial-scale greenhouse, for example.

"You map the flows of wastewater heat, and you look for where the big heat energy users are, and you look for some matches," Meeten says. "Almost invariably, with every city you'll find a half a dozen without looking too hard."

Wastewater is just one of many strategies being used to limit fossil fuel use in this way. In the Islington neighbourhood of London, the local government says it provides heating for hundreds of homes, a school and two recreation centres using energy generated by the electric motors and brakes of subway trains. Sanepar, a company in Curitiba, Brazil, combines wastewater and organic residues from a food distribution centre to generate biogas for electricity which is then fed into the grid.

But more commonly, waste-heat recovery involves buildings themselves. Typically, warm air from large structures is released into the atmosphere through ventilation shafts. But it can also have its heat removed. Swedish utility Stockholm Exergi taps into waste heat from supermarkets, ice rinks and data centres. "Everywhere where we have mechanical work or cooling, we also have excess heat," says Erik Dahlén, the company's head of research and development. Collaboration with retailers and industries, called "open district heating," also allows those businesses to charge for the energy they provide.

Perhaps the most obvious sources of waste heat are the massive data centres proliferating in and around cities everywhere. Servers emit vast amounts of excess heat that can be captured to heat water.

In Greater Helsinki, excess heat from two Microsoft Corp data centres is set to be diverted to more than 250,000 customers, according to Fortum, the Finnish energy company. It will ultimately provide around 40% of the district heating needs of Espoo, Kauniainen and Kirkkonummi, saving around 400,000 metric tonnes of annual CO2 emissions.

As part of Vancouver's climate emergency action plan, the False Creek Neighbourhood Energy Utility said it plans to be fully renewable by 2030, with 70% of its energy coming from sewer heat, saving an estimated 7,000 metric tonnes of GHG emissions annually.

To be sure, whole cities are unlikely to be heated by waste heat anytime soon, if ever. But the race to slow global warming requires every option be explored, said Semida Silveira, professor in systems engineering at Cornell University. Despite the challenges in harnessing and scaling such heat sources, it makes sense to invest in the technology, since every little bit helps.

And in the case of sewage, at the very least it could be used to save energy treating water. "It is actually surprising that more cities have not used this more before," Silveira said. — *Bloomberg*

The False Creek development in Vancouver

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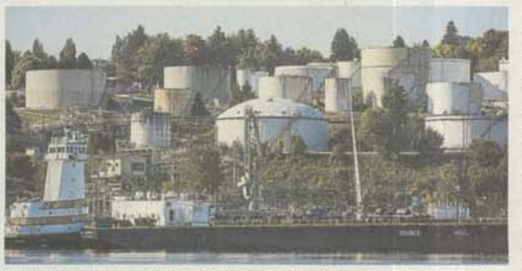

A double-hulled tanker sits docked in front of the Burnaby Refinery, near Vancouver. Natural gas is a key component of the city's energy use