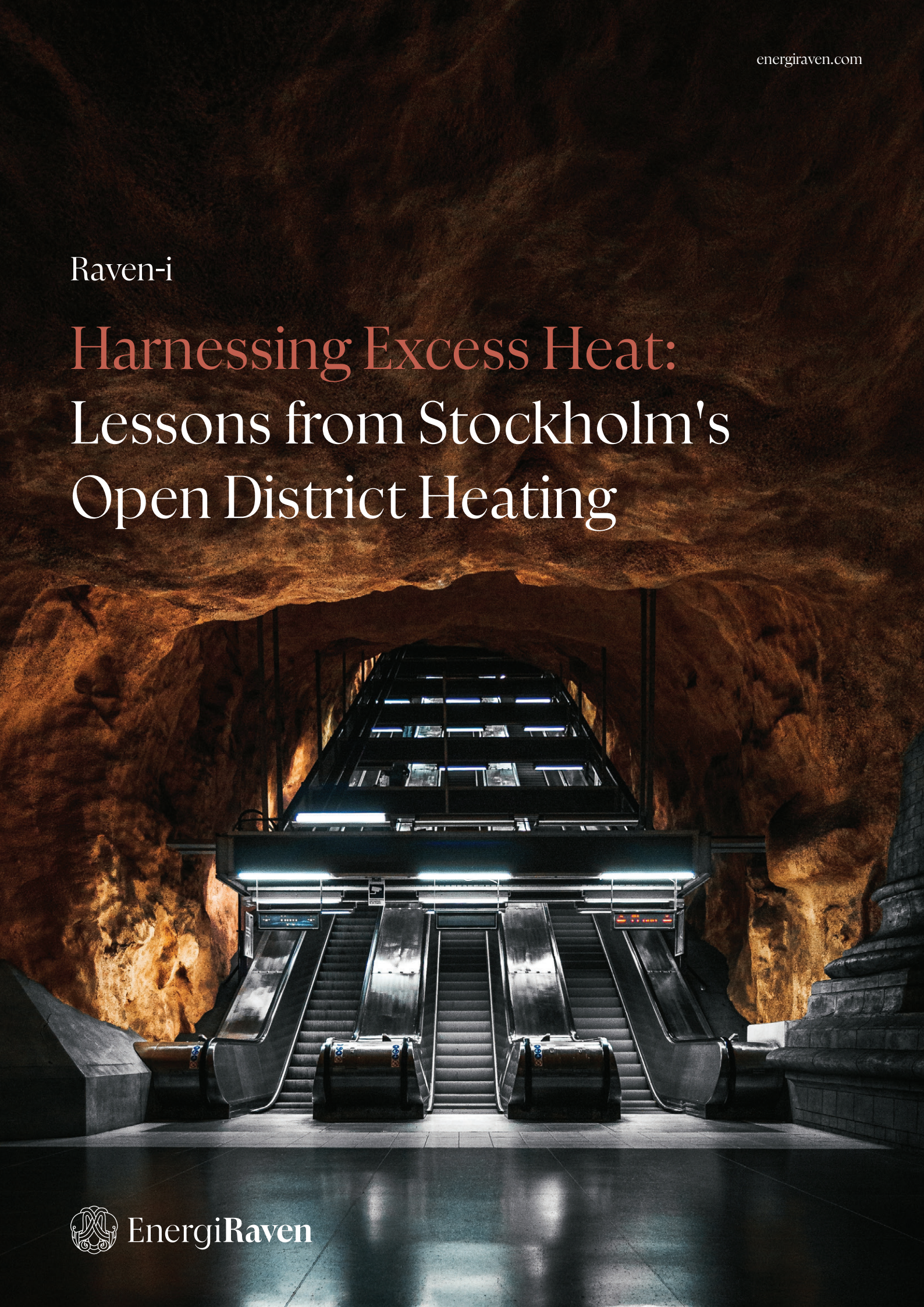
Raven-i

Harnessing Excess Heat: Lessons from Stockholm's Open District Heating



EnergiRaven

Harnessing Excess Heat

Open District Heating (ODH) is a one-of-a-kind offering for data centres, supermarkets, and other enterprises with surplus heat that want to sell it on the open market. Over 30 data centres in Stockholm are now connected to district heating and cooling networks.

As the United Kingdom strives to decarbonize its energy system, transitioning from a reliance on natural gas to a diversified, sustainable model is imperative. A promising avenue lies in the development of "green heat grids"—city-wide district heating systems that utilize excess heat from industries, notably data centres, to provide secure, low-cost, and zero-carbon heating solutions. Stockholm's Open District Heating system, operated by Stockholm Exergi, offers a compelling blueprint for this transformation.

Stockholm Exergi: A Model of Sustainability

Stockholm Exergi is the city's primary energy provider, a public-private venture owned equally by the Nordic energy company Fortum and Stockholm Municipality, together they have established a district heating network spanning approximately 3,000 kilometres, serving over 800,000 residents. This extensive infrastructure enables the efficient distribution of heat across the entire city, significantly reducing greenhouse gas emissions and enhancing energy circularity.

Companies and enterprises with excess heat near heating or cooling grids can sell energy to Stockholm Exergi at market pricing, allowing them to make use of energy that would otherwise go to waste.

Want to find out more about Stockholm Exergi? Scan the QR code:

Open District Heating

A cornerstone of Stockholm's symbiotic energy system is the Open District Heating initiative, launched in 2014. This program allows businesses generating excess heat—such as data centres, supermarkets, and industrial facilities—to sell surplus energy back to the district heating network. By converting waste heat into a valuable resource, Stockholm Exergi fosters a marketplace that benefits both suppliers and consumers, promoting a circular economy and increasing energy security.

Since its inception in 2014, Open District Heating has seen an increase in the number of excess heat producers linked to the system. A district cooling network is also integrated, allowing for the provision of both heating and cooling, particularly valuable for the many large hotels located in Stockholm.

Stockholm Exergi invests in pipe installation and connection to the district heating network, while suppliers invest in the requisite manufacturing and heat recovery facilities. Typically, establishing the appropriate technical infrastructure takes between six and nine months.

Practicalities of Supplying Heat to ODH

1. **Turn excess heat into a source of revenue.** Stockholm Exergi pays for supplied heat capacity depending on the cost of producing the comparable heat in their facilities. Payments are determined by the ambient temperature.
2. **ODH Call.** Suppliers and Stockholm Exergi agree on capacity levels to be delivered to the district heating network through ODH Call.
3. **ODH Spot.** Suppliers determine when to deliver heat depending on their own conditions using ODH Spot, and no particular capacity requests are made.

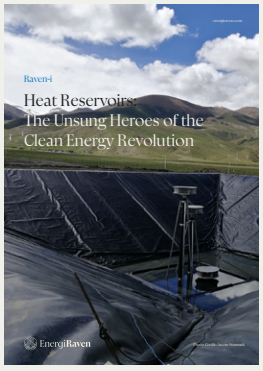
The Role of Data Centres

Data centres, essential for our digital infrastructure, consume substantial amounts of electricity, the majority of which is transformed into heat. In Stockholm, over 30 data centres are integrated into the district heating and cooling networks, contributing significantly to the city's energy efficiency. For instance, the Stockholm Data Parks initiative recovers over 100 GWh annually from 20 suppliers through Open District Heating, meeting the heating needs of approximately 31,000 modern apartments.

Exceptionally useful is integrating large-scale pit thermal energy storage (PTES) systems, known as heat reservoirs, with data centres. This enables the capture and long-term storage of excess heat generated during peak operation times, particularly during the warmer months. This stored thermal energy can be efficiently redistributed to provide consistent heating to residential and commercial buildings. Effectively decoupling heat supply from demand, eliminating the need for heat generation during times of low or no renewable energy generation.

According to the International Energy Association (IEA), data centres (including those for cryptocurrency and AI) consumed around 460 terawatt-hours of electricity in 2022, or almost 2% of the world's entire power supply. And with new AI data centres requiring up to ten times as much electricity as cloud computing facilities, the IEA projects these figures could more than double by 2026. This nearly 120% increase "is roughly equivalent to the electricity consumption of Japan," the report continues.

Want to find out more about data centres or heat reservoirs? Scan the QR code below.



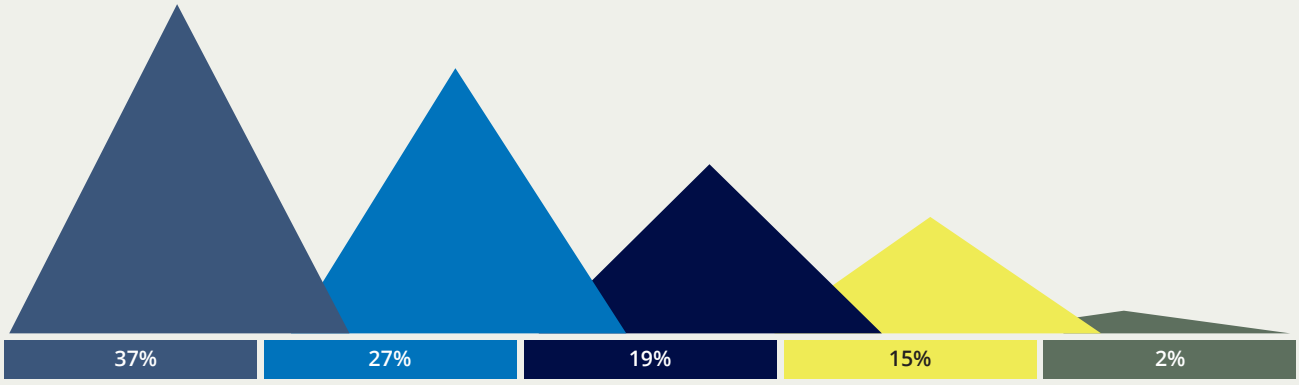
How District Heating Can Address Power Shortages

There is much debate about potential future electricity shortages in Stockholm. As growing numbers of electric vehicles need to be charged, the underground train network expands, new server halls open, and new homes are built, the need for electricity also increases – as does the need for smart and sustainable power solutions.

One of the grid balancing solutions, often overlooked in this context, is district heating which effectively decouples supply from demand: the sustainable, circular system that today provides heat for almost one million Stockholmers at the same time as it reduces pressure on the electricity network.

District heating can also create heat and electricity in the same process. Other forms of heating require electricity to create heat, so they increase electricity demand. District heating, on the other hand, counteracts potential shortages.

Solid biofuels and bio-oil account for 37 percent of the supplied energy:



Solid Biofuels and Oils	Residual Waste	Waste Heat from Municipal Wastewater, Other Activities and Energy from Lakes and the Sea	Electricity	Fossils Oils

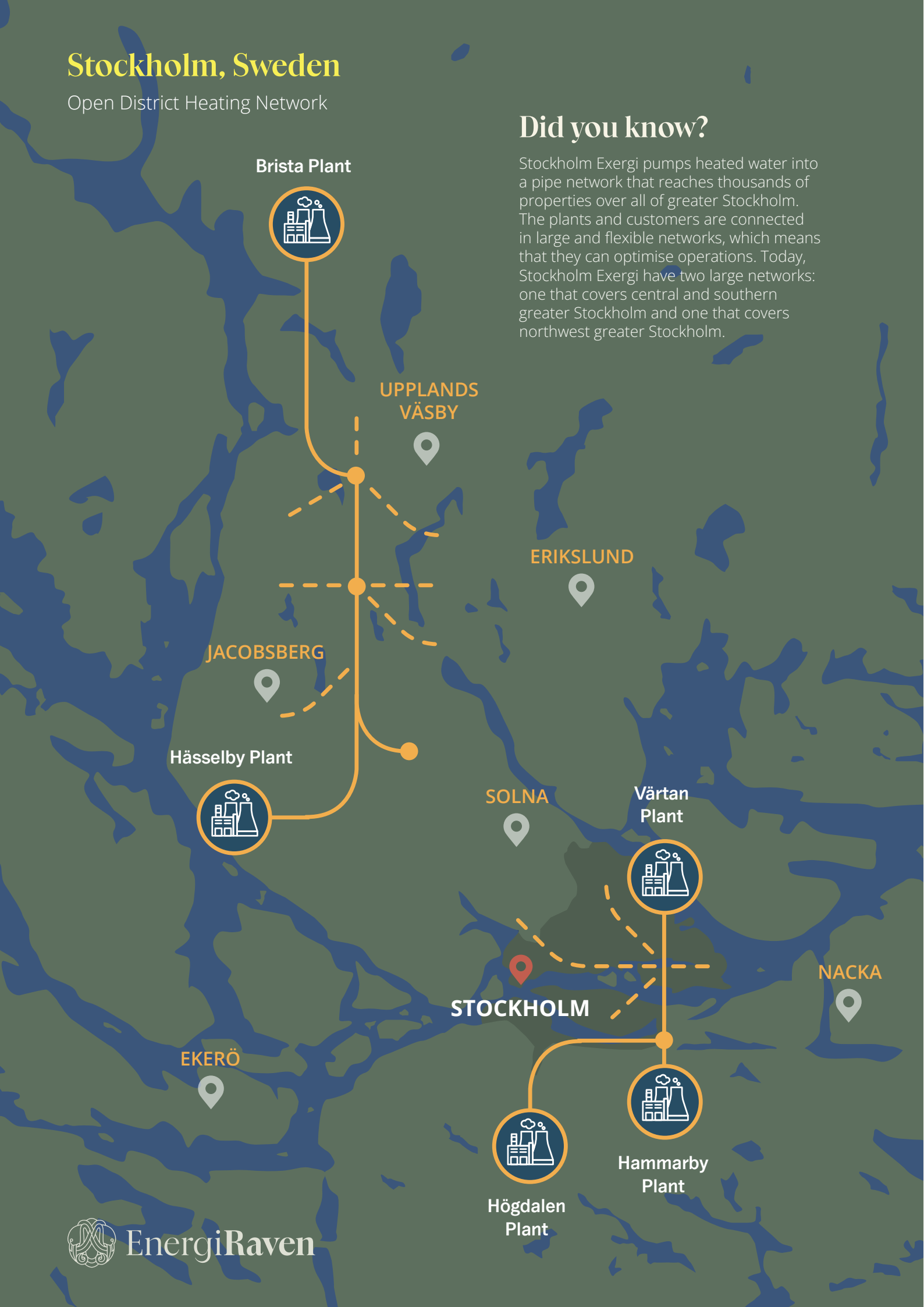
Source: Stockholm Exergi

Stockholm, Sweden

Open District Heating Network

Did you know?

Stockholm Exergi pumps heated water into a pipe network that reaches thousands of properties over all of greater Stockholm. The plants and customers are connected in large and flexible networks, which means that they can optimise operations. Today, Stockholm Exergi have two large networks: one that covers central and southern greater Stockholm and one that covers northwest greater Stockholm.



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Ekerö, Stockholm, Sweden

Sustainable Energy Demand Drives Us Forward

Stockholm Exergi meet Stockholm's electricity, heating and cooling needs through efficient and flexible energy production. They operate around 30 production plants that, in conjunction with each other and their partners' plants, ensure that greater Stockholm is supplied with cost-effective and sustainable energy regardless of weather and temperature. Their main energy sources are listed below.

Brista Plant

2023 production:

- 954 GWh heat
- 200 GWh electricity
- Steam boilers
- Waste and solid biofuel

Värtan Plant

2023 production:

- 2,783 GWh heat
- 372 GWh electricity
- Steam and hot water boilers
- Solid biofuel, bio-oil, and fuel oil

Hammarby Plant

2023 production:

- 1,452 GWh heat
- Heat pumps and hot water boilers
- Electricity and bio-oil
- No electricity production. Residual energy from wastewater from Henriksdal treatment plant used in heat pumps

Hässelby Plant

2023 production:

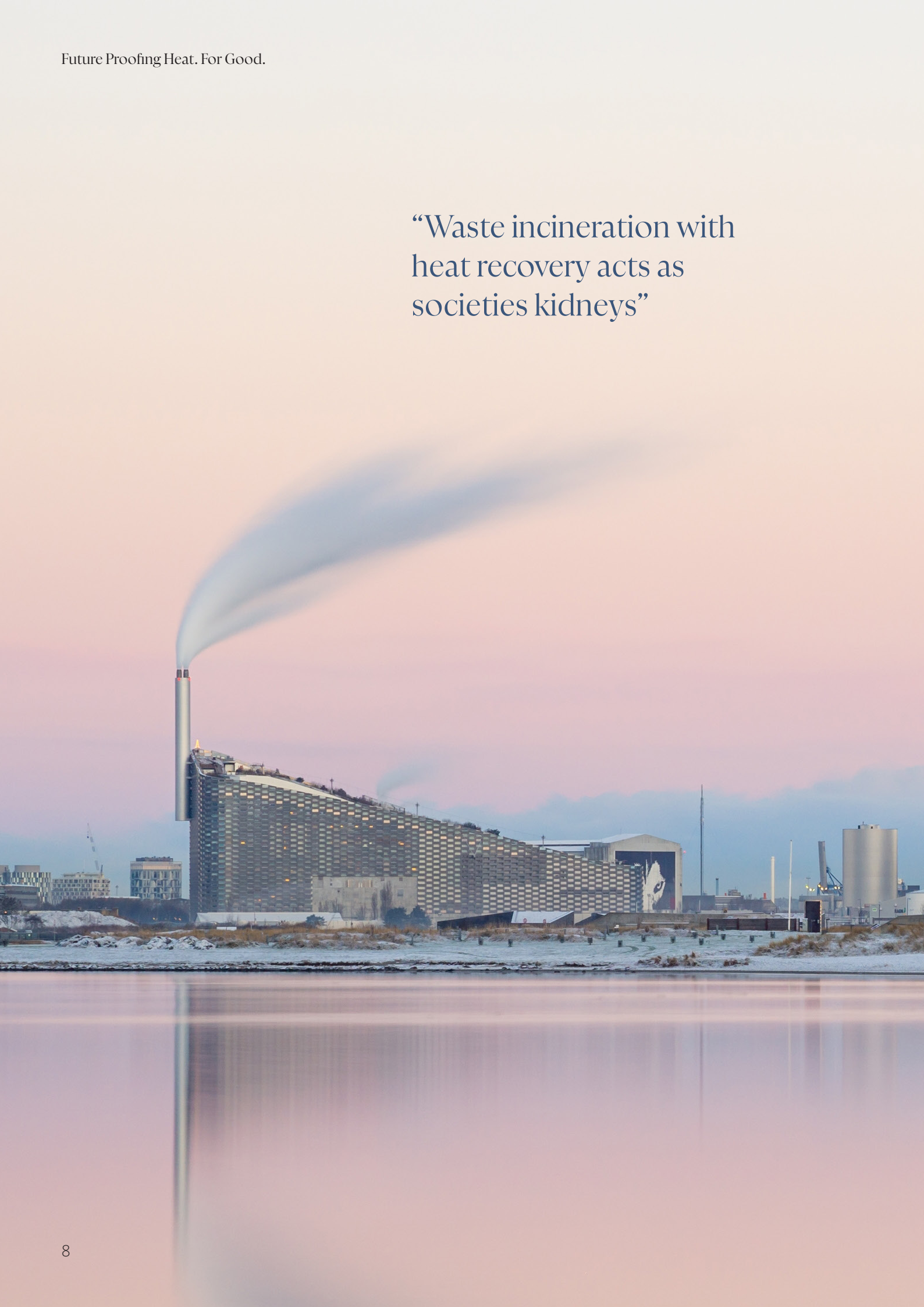
- 334 GWh heat
- 75 GWh electricity
- Steam boilers
- Wood pellets

Högdalen Plant

2023 production:

- 1,633 GWh heat
- 217 GWh electricity
- Steam boilers
- Waste, reclaimed wood and bio-oil

"Waste incineration with heat recovery acts as societies kidneys"



CopenHill, Denmark

South of Sweden in Denmark, CopenHill, also known as Amager Bakke, is a pioneering waste-to-energy plant located in the heart of Copenhagen that exemplifies innovative urban design and environmental sustainability. Designed by Bjarke Ingels Group (BIG), this facility processes up to 400,000 tonnes of waste annually, converting it into electricity and district heating for the city.

Notably, CopenHill imports waste from countries like the UK, Italy, and the Netherlands, operating with such high efficiency that its carbon footprint remains lower than if the waste were incinerated in less efficient plants in the countries of origin.

Beyond its industrial function, CopenHill integrates recreational spaces into its stunning architecture, featuring a year-round artificial ski slope, hiking trails, and the world's tallest climbing wall at 85 meters. The rooftop boasts a biodiverse landscape with over 200 plant and tree species, providing a unique urban green space.

This fusion of utility and leisure embodies "hedonistic sustainability," demonstrating that environmental infrastructure can also enhance urban life.

Lessons from Stockholm's Integrated Energy Approach

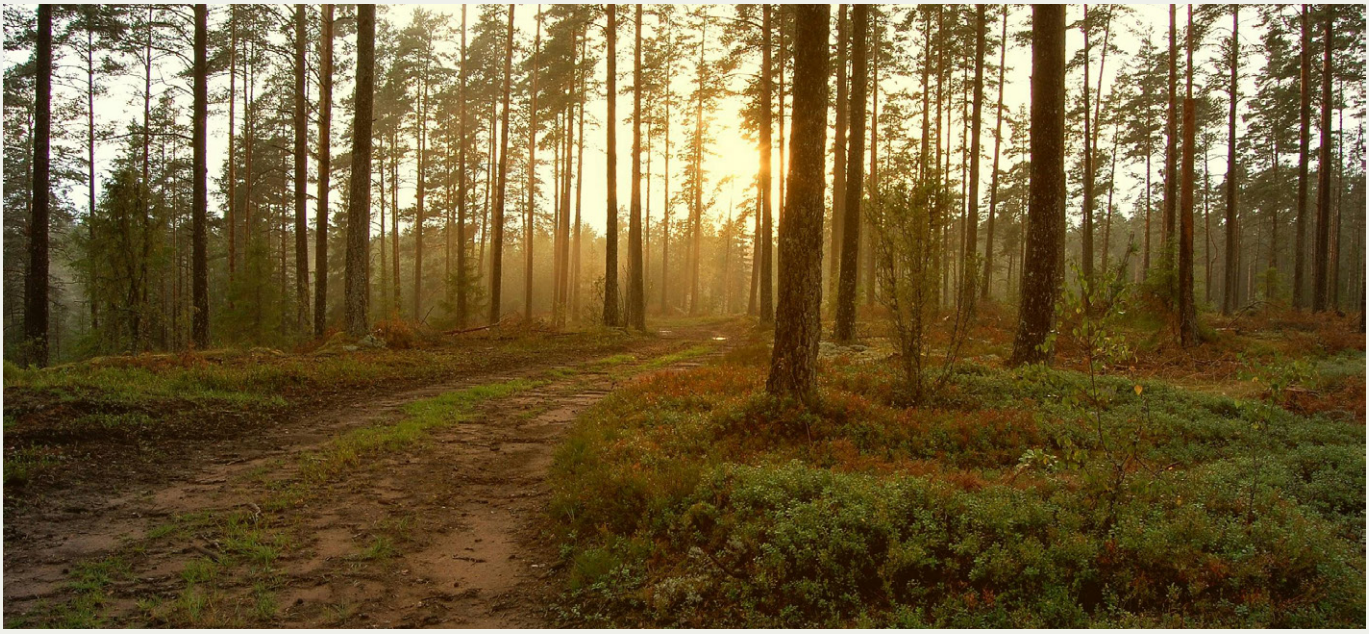
Stockholm's approach to waste management and energy production is redefining its urban sustainability. Stockholm Exergi operates facilities like the Högdalenverket plant, which annually processes approximately 700,000 tonnes of waste. Through advanced Energy from Waste with Combined Heat and Power (EfWCHP) technology, these plants convert non-recyclable waste into both electricity and heat.

Stockholm's Main Energy Sources

Powering district heating with 98 per cent renewable and recycled energy is not the only way to heat a city. There are large district heating networks in many cities around the world, but they tend to be heated using exclusively fossil fuels such as coal, oil and gas.

This integrated system exemplifies a circular economy, where waste becomes a valuable resource rather than an environmental burden. By diverting waste from landfills, Stockholm Exergi mitigates methane emissions — a potent greenhouse that is 28 times more harmful than carbon dioxide — as well as preventing potential groundwater contamination from hazardous substances and heavy metals. The EfW-CHP process achieves system efficiencies between 60 to 80 percent, significantly surpassing the approximately 50 percent efficiency of conventional electricity-only generation methods.

In contrast, many biomass or waste-to-energy facilities in the UK, such as the DRAX power station, primarily focus on electricity generation without incorporating heat recovery, resulting in lower overall energy efficiency. Adopting this Scandinavian model could enhance the UK's energy landscape by maximizing resource utilization and reducing environmental impact.



Woodland in Stockholm, Sweden

Sweden's Integrated National Energy and Climate Plan

Transitioning to a diversified, sustainable energy system in the UK requires the development of green heat grids that utilize excess heat from industries like data centres. Stockholm's Open District Heating system offers a proven model, demonstrating how urban areas can harness waste heat to provide secure, low-cost, and zero-carbon heating solutions.

This transition has been expedited by Sweden's Integrated National Energy and Climate Plan (NECP), a ten-year framework mandated by the European Union, addressing the five dimensions of the EU Energy Union: decarbonisation, energy efficiency, energy security, internal energy markets, and research, innovation, and competitiveness. The plan sets forth objectives to reduce greenhouse gas emissions, increase the share of renewable energy, enhance energy efficiency, diversify energy sources, and promote technological advancements.

The Open District Heating system exemplifies these objectives:

- **Decarbonisation:** To reduce GHG emissions thanks to medium and long-term targets and to increase the share of renewable energy in gross energy consumption.
- **Energy Efficiency:** To ensure energy efficiency with targets, roadmaps for the renovation of the national stock of residential and non-residential buildings, both public and private.
- **Energy Security:** To ensure energy security by increasing the diversification of energy sources and supply from third countries.
- **Internal Energy Markets:** To develop measures for the interconnectivity of the internal energy market.
- **Research, Innovation, and Competitiveness:** To develop the use of new technologies and services to facilitate the transition to a sustainable energy system.

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Did you know?

Stockholm Exergi delivers heating, cooling, electricity, and waste management services to over 800,000 residents and approximately 400 facilities, including hospitals and data centres. Their extensive 3,000-kilometre district heating network efficiently utilizes residual heat, biofuels, and non-recyclable waste to supply energy, thereby minimizing environmental impact. Committed to sustainability, Stockholm Exergi aims to make Stockholm the world's first climate-positive capital by phasing out fossil fuels and implementing innovative solutions like Bio-Energy Carbon Capture and Storage (BECCS) to achieve negative emissions.

Reduce. Reuse. Recover.

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