STUDY TOUR
(Draft 2)

The Boltzmann Institute is arranging an intensive study tour – May 24 to June 8, 2024 – of eleven of Europe's district energy systems, including those in Amsterdam, Berlin, Copenhagen, Hamburg, Helsinki, Stockholm, and Tallinn, as well as the systems in four smaller communities.

The study tour itinerary is on the next two pages with notes on each location.

Travel among locations will be mainly by the cruise ship *Zuiderdam*, whose itinerary – Amsterdam to Amsterdam – is shown in the map to the right (also see link).

Arrangements for the eleven visits are being made by the Boltzmann Institute at no cost to participants. However, participants (including those from the Boltzmann Institute) will be responsible for their own travel expenses and arrangements: chiefly for the sea voyage and the flights to and from Amsterdam, perhaps totalling in the order of Can$5,000 per person.

Please contact Richard Gilbert at rgilbert@bi-ib.ca if you are interested in participating or would like further information.

Boltzmann Institute
Institut Boltzmann

PROPOSED STUDY TOUR SCHEDULE DRAFT 2

(Draft dated January 8, 2024)

DATE	PORT *(and time there)*	Notes
Friday May 24, 2024	Amsterdam is about 30 km from IJmuiden, the seaport where we'll board the *Zuiderdam*. The transit trip from central Amsterdam takes about 70 minutes (Metro and suburban rail). *The ship departs at 3:00 pm on May 25*.	Unlike most other countries to be visited, The Netherlands has low penetration of district heating (DH, 4% – see link for this and the other countries). Pumerend, a commuter town of about 90,000 inhabitants, 15 km north of Amsterdam, may have the highest penetration: about 75%, link. Of the places visited during this tour, Amsterdam (population 920,000, with 1.5 million or more in the metropolitan area) may have the space heating situation and prospects that are the closest to the Toronto region's. Most space heating is now by natural gas. In the excellent 50-page *Amsterdam Heat Guide* (2019, link), the city government explored how almost all of this could be replaced by non-fossil-fueled DH by 2040. DH now serves about 15% of the total. It identified potential heat sources and concluded they are likely sufficient even to accommodate substantial growth in floor space. Space served by DH would have to grow by >10%/y until 2040, much above the current rate. Expansion of DH service may be stalled by a 2022 threat by Vattenfall, the main DH provider in Amsterdam, to stop all investment if a national government plan – driven by municipalities – to have all heat networks publicly owned and managed (link). A feature of the *Heat Guide* is the proposed use of higher DH temperatures for areas with older buildings to save on renovation costs
Monday May 27	Kristiansand, Norway *07:00–16:00*	Norway's DH penetration is 4%.but Kristiansand's system thrives in spite of cheap electricity and high heat pump deployment. The system is run by Å Energi (link) using heat from waste incineration, industry, and biofuels.
Tuesday May 28	Aarhus, Denmark *08:00–17:00*	Denmark's DH penetration is 65%. Aarhus has the EU's largest ongoing deep geothermal project, to secure 60-80^{o}C water from 2-3 km depths using 17 wells, to provide (by 2030) 20% of the heat for the existing system, which serves almost all buildings (link) and is managed by Aarhus Affaldvarme, known for its "smart" metering of heat flows (link).
Wednesday May 29	Warnemünde (Rostock, Berlin), Germany *07:00–22:00*	Germany's DH penetration is 14%. To be studied could be the DH systems in Rostock (population 210,000; 10 km from Warnemünde) or Berlin (3.9 million, 4.5 million in the metropolitan area; 200 km). Fast trains enable being in Berlin from 11:00 to 17:00. The Rostock system (>60% DH penetration, link) – owned and operated by the City – has been used as an example of planning for decarbonization of DH (link). Berlin, like many other German cities, has seen recent interest in expanding its DH facilities, with demand for connections rising by about 70%. Berlin's government is seeking to buy back DH from Vattenfall – wholly owned by the Swedish government (link) – notwithstanding Vattenfall's having lowered GHG emissions from DH by 50% (link). (Also see Hamburg, below.) Of interest could be the "Berlin Thermos," Europe's largest above-ground hot-water storage tank, due to go into service this year.
Friday May 31	Tallinn, Estonia *08:00–23:00*	Estonia's DH penetration is 52%, with most communities in this former part of the Soviet Union having DH facilities. Tallinn has moved quickly from natural gas to biomass and to heat from sewage and seawater(link). Of interest may be how Tallinn's city centre of 14th-century and later buildings is to be served by DH (link). There are plans for Estonia to have one or more nuclear reactors serving DH, but not necessarily for Tallin (link).
Saturday Jun 1	Helsinki, Finland *06:00–17:00*	*This part of the tour is subject to a guide being available on the Saturday.* Finland's DH penetration is 38%. Helsinki is the most northerly of the tour stops – about the same latitude as the northern boundary of the Prairie provinces – and the coldest (average high/low in January and February -2^{o}/-7^{o}C compared with Toronto's 0^{o}/-7^{o}C. The city-owned Helen Ltd's DH operation may be the most fossil-fuel intensive of the systems to be examined, but that is to change rapidly (link). Of special interest could be plans to use a Finnish SMR for DH (link).

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Sunday Jun 2	Stockholm, Sweden *08:00–17:00*	This part of the tour will be hosted by Johan Pettersson, manager of the Stockholm office of FVB, consultants with deep knowledge of the Swedish (and Canadian) district energy scenes. Sweden's DH penetration is 50%. In Stockholm almost 90% of the buildings are served by DH – and increasingly by district cooling – through a 3,000-km heat network. Of interest could be the extensive use of heat from data centres and the world's largest heat pump plant for extracting "district heating and cooling from purified wastewater" (link). Stockholm Exergi – owned by the City and a private-sector consortium – claims its DH services are powered "97% with renewable and recycled energy" (link).
Monday Jun 3	Visby, Gotland, Sweden *08:00–15:00*	Visby (24,000 population) is the main town on Gotland (58,000), an island off the east coast of Sweden about half the size of the GTA. Its DH system provides 80% of the community's space heating and has been fossil-fuel-free since 2006. It uses forest residues, seawater augmented by a 11 MW heat pump, biogas from a closed landfill and a wastewater treatment plant, and "bio oils that replace fossil fuels" (link). The system is run by the electricity distribution company (GEAB), which imports all its power from the mainland.
Tuesday Jun 4	Ronne, Bornholm, Denmark *08:00–17:00*	Ronne (population 14,000) is the main town on Bornholm (40,000), another Baltic island off the coast of Sweden but part of Denmark – about the size of the City of Toronto. The island's communities opted in 2008 to be carbon-neutral by 2025, with DH as a key part of the strategy as well as waste reduction and solar and wind generation. Heat for DH comes from waste incineration, a CHP plant using wood chips and coal, and oil boilers (link). A German media source suggested Bornholm "might be the greenest island on the planet" (link).
Wednesday Jun 5	Kiel (Hamburg), Germany *07:00–17:00*	Kiel (population 250,000) is a seaport about 90 km north of Hamburg (2.5 million, 5.0 million in the metropolitan area; a 75-minute train ride from Kiel). The main heat source for Kiel's DH system is a natural-gas-fired CHP plant, installed in 2019 and said to have combined thermal and electric efficiency of 90% (link). The plan is to have carbon-neutral heat sources by 2035. Being explored the use of ≤76°C hot water pumped up from 2-3 km below ground, augmented with heat pumps to 90°C – "necessary for the DH network" (link). Hamburg is Germany's second city. Like Berlin it is one of the federation's 16 *Länder*, with powers and responsibilities similar to those of Canadian provinces and U.S. states. The city-state of Hamburg has already bought back its system from Vattenfall (see Berlin above) and is planning shutdowns of the main heat sources – coal-fired CHP plants – by 2030, creating a need to replace 700 MW of thermal output. Ongoing and potential sources include natural-gas- and biomass-fired CHP, waste incineration, industrial waste heat, sewage water, solar thermal, and deep geothermal – all supported by pit and aquifer storage of up to 2,000,000 m^3 of hot-water (link)
Thursday Jun 6	Copenhagen, Denmark *07:00–16:00* The *Zuiderdam* then sails to Ijmuiden (Amsterdam), to arrive at 7:00 am on June 8.	Copenhagen (population 660,000, 2.4 million in the metropolitan area) has been said to have the "world's largest DH system" (link), which the Toronto region could aspire to. The backbone of the Copenhagen system is a 160-km transmission system providing water at up to 110°C (at 2.5 MPa) connected by heat exchangers to 20 distribution systems serving customers in 22 municipalities in the metropolitan area. These distribution systems are owned by the municipalities or by consumer cooperatives. Each year the overall system supplies some 8.5 TWh of almost-CO_2-neutral heat to a floor area of 75 million m^2. The ongoing transition to 4th-generation DH includes using biofuels rather than fossil fuels for the CHP plant, extending the DH network and, even more, the parallel district cooling network, and getting consumers to renovate heating systems to allow use of lower temperatures (link). Of interest could be the Høje-Taastrup 70,000 m^3 pit storage facility (link), recently added to the system.