DISTRICT ENERGY DIGEST

No. 9, October 2024

DISTRICT ENERGY DIGESTS are produced every four months by the **Boltzmann Institute**, **described here on Page 8.** This issue begins with four pages of notice and analysis before the actual digest of recent items relevant to the deployment of district energy. Pages 1-2 provide advance notice of the Boltzmann Institute's first public event, on heating planning. Page 3 includes a critique of current planning. Page 4 provides comparison of the climate impacts of natural-gas furnaces and air-source heat pumps. An annex (Pages 9-11) is dedicated to our main ongoing project. Back issues of the *Digest* are at link. To subscribe, please write to link.

Early notice for a one-day event on March 20, 2025, to answer the question, "Should Ontario municipalities be required to engage in heating planning?"

This event will be held at the University of Toronto's Faculty Club (link), with a space limit of 130 participants. We'll be finalizing the program, sending out personal invitations, and opening registration in early December 2024. If you'd like a personal invitation to this event, please let us know well before December at march20@bi-ib.ca.

Heating planning is a desirable, perhaps essential, step towards decarbonization of energy use in buildings. This was a strong conclusion from the Boltzmann Institute's study tour of northern European district energy facilities earlier this year (link).

Heating in Ontario buildings results in more than ten times the greenhouse-gas (GHG) emissions of cooling (link). (The difference may be declining slightly with increases in Ontario's fossil-fuel generation of electricity – which tripled from 2017 to 2023 [link] – and with changes in climate.) The event's focus is heating planning, with cooling considered where appropriate.

Heating planning for a neighbourhood, municipality or larger region has three elements:

1. Assessing current demand for heating and future demand until 2050 (or another year)
2. Noting current sources of heat and potentially available carbon-free sources
3. Putting #1 and #2 together in a feasible decarbonization plan with 5-year sub-targets.

Why is heating in buildings important? Because buildings are *the* main source of GHG emissions in the Greater Toronto and Hamilton area (link), and they are the or a main source in Ontario's other major population centres including Ottawa (link), Kitchener-Waterloo (link), London (link), and Windsor (link) — and because fossil-fueled space and water heating are the major sources of GHG emissions from buildings (link). All this seems also true of many smaller centres, e.g., Sudbury (link).

What does heating planning have to do with district energy? Progress towards establishing collective systems such as heating networks can be helped by heating planning, but so for many areas can progress towards individual systems such as in-building heat pumps. It depends on the results of the heating planning exercise for a particular neighbourhood, municipality or region. Whatever the outcome, heating planning can be a necessary tool for ensuring that decarbonization of heating is done in the most efficient manner that is also socially and environmentally responsible.

See Page 8 for information about the Boltzmann Institute as well as our website at www.bi-ib.ca.

Why consider making heating planning a municipal responsibility? One reason is that municipalities have good understanding of what is in their areas including, for example, building types and usable sources of waste heat. Another reason is that they are skilled at *planning*, mostly for development but also in other ways.

A third reason is that municipalities may be the most effective agents for ensuring decarbonization of buildings. In 2023, the European Union directed member states to mandate that municipalities with over 45,000 inhabitants prepare local heating and cooling plans (link) – as has been required in Scandinavian countries and The Netherlands for some years. (The most interesting plan we've seen is Amsterdam's at link, produced in 2019 and now due for an update.)

How would heating planning differ from the work a municipality may have done in developing a Community Energy Plan (CEP)? It would build on the CEP, doing a deeper dive into how spaces in buildings are being and can be heated (and cooled), taking into account sources of energy that are available and can be made available. The resulting heating plan would be an implementable guide for decarbonizing what is often a community's main source of GHG emissions.

Germany is of particular interest. Its federal government has decreed that municipalities with over 100,000 inhabitants must develop heating plans by 2026; others by 2028, with municipalities under 10,000 allowed a simplified procedure (link). The federal government is funding preparation of heating plans with grants averaging the equivalent of about C$10 per inhabitant. (I.e., city with 250,000 inhabitants could receive the equivalent of about C$2.5 million.)

The program for the one-day conference on March 20 will have two parts. After quick welcomes and overview at the 9 am start, the first part will focus on what is happening in Germany as municipalities there reach or move towards their deadlines for preparing heating plans. It will also touch on *implementation* of heating plans. We'll hear and discuss presentations by two of Germany's leading experts on heating planning, Dorian Holtz and Raphael Wittenburg, who'll be with us throughout the day.

The second, longer part of the event will focus on Ontario, specifically on the opportunities and challenges presented by municipal heating planning. We'll be seeking overviews of how heating planning is done now (by Ontario's Independent Electricity System Operator [IESO] and by Enbridge Gas Co.). We'll be looking for perspectives on the topic from federal and provincial governments and agencies, local electricity distributors (e.g., Hydro Ottawa), developers, heating providers, engineers, NGOs, and, above all, municipalities themselves. We'll ask what might happen in Ontario if municipalities *don't* get involved in heating planning.

The proceedings will conclude at about 5 pm with a social/networking event until 7 pm, also at the Faculty Club.

We're expecting this could be a landmark event in the evolution of energy policy for Ontario and even for the rest of Canada. Again, registration is not going to open until early December, when we expect to have a near-final program in place. If you'd like a personal invitation to the event, please let us know soon at march20@bi-ib.ca. There'll be a registration fee – to cover what will be a nice lunch, etc. – but not more than $100. Let us know if you want to attend but can't afford the fee.

A problem in the way home electricity use is now being planned for in Ontario?

A press release issued by Ontario's Ministry of Energy and Electrification on May 9, 2024, reads: "The Ontario government and Ontario's Independent Electricity System Operator (IESO) announced today that their latest round of procurement secured a total of 2,195 megawatts (MW) of [battery storage] capacity, enough to power the peak demand of 2.2 million homes." (link) This is one kilowatt (kW) per home. But a typical home's future peak demand is likely to be much higher, perhaps 20 times higher.

Let's consider a 179-m^2 (1,925-square-foot), single detached home – the average floor area of the housing type that in 2021 constituted 56% of Ontario's housing stock and 66% of the total residential floor area (link). Soon, this typical dwelling is expected to be heated and cooled by a heat pump and to provide for electric vehicle charging (link), as well as all the other domestic uses of electricity.

Imagine a mid-week early evening in the middle of a cold spell (yes, we could still have some of those in Ontario for decades to come). Conservatively, the heat pump could be using about 12 kW (link, link), the EV charging could be drawing about 5 kW (link, link), and other uses could total 3 kW (a kettle or coffeemaker draws about 1 kW, a stove-top element uses about 2 kW, a TV or a desktop computer can each draw about 0.1 kW). The total comes to a peak demand of about 20 kW – i.e., 20 times what the IESO and the Ontario government seem to be planning for.

You could say that all these things won't happen at the same time in every home, even on the year's coldest weekday evening. But if somehow the overall peak demand from these homes is only half the total illustrated above, that's still hugely more than what Ontario appears to be planning for.

You may think planning for only 1 kW per home is a one-off typo or other unintentional error. Note too that the 683-MW Halton Hills natural-gas-fired power plant has been said "to generate enough power to meet the needs of approximately 700,00 homes" (link) – again with the apparent expectation that 1 kW per home is enough to meet demand on a cold weekday evening.

Our conclusion is that unless Ontario gets smarter about its energy planning – for space heating in particular – our electricity system will soon not be able to cope with the demands on it.

Points about battery costs arising from the Ontario government's press release

Highlighted in the release was the "390 MW Skyview 2 Battery Energy Storage System … [to] be the largest single storage facility procured in Canada," located about 120 km north-east of Kingston. It's to cost C$750 million (link) – US$540 million or about US$345/kWh for a total capacity of 1,560 MWh (i.e., 390 MW for four hours). This is well below a U.S. government projection of US$440/kWh for the cost of grid-scale, four-hour batteries in 2024 (link), but much higher than the cost of storing the same amount of energy as hot water (link).

Many cold spells last much longer than four hours (link). For the same capital cost, hot-water storage could be developed to meet heating needs for a couple of weeks (link). This is another reason why it makes less sense to heat buildings with electricity than with hot water – if a thermal network can be available. (In spite of the release's wording, we're not implying that IESO seriously thinks batteries will meet peak heating loads, although we'd much like to know exactly they'll be met with electricity.)

Air-source heat pumps (ASHPs) can increase emissions of greenhouse gases

Imagine that a 15-year-old natural gas furnace warms your house – floor area 186 m^2 (2,000 sq ft.) – and you're wondering whether to replace it with a new furnace or a heat pump, in part to reduce GHG emissions, if affordable. Even though it's likely much better for the environment, you've ruled out a ground-source heat pump (GSHP) because you don't have enough space for it or it's too expensive. A typical Ontario price including installation for an ASHP (14 kilowatt/48,000 BTU/4 ton) seems to be about C$22,000 (link). It's harder to give a comparable price for a GSHP, but it could easily be double that (link). A provincial rebate of up to $7,800 may be available (link, link).

Ontario's electricity is about 90% fossil-free, but you've heard that natural-gas generation has tripled recently – from 5.9 terawatt-hours (TWh) in 2017 to 19.1 TWh in 2023 (link, link). For the foreseeable future *new* demand is likely to be met by natural-gas-fuelled power plants (link, link). But you still assume an ASHP might confer an environmental advantage, so you're crunching the numbers.

Ontario's natural-gas generation is becoming more efficient through use of combined-cycle technologies, e.g., at the Halton Hills plant noted above. Plants now average about 42% efficiency (projected from link). Allowing 10% loss during transmission, etc., this means they emit 470 grams of the GHG carbon dioxide (CO_2) for every usable kilowatt-hour (kWh) of their electricity (link). A new 95%-efficient, 60,000-BTU natural-gas furnace – costing about $6,000 installed (link) – produces 187 grams of CO_2 for each kWh of heat produced. For a heat pump to do better, it would have to produce at least 2.5 kWh of heat for each kWh of electricity used (470/187=2.5). Put another way, it would have a Coefficient of Performance (COP) of 2.5 or higher. Field-testing the performance of over 500 ASHPs in individual home in six countries including Canada indicated that, as expected, COP declined with outside air temperature (link). *On average*, an ASHP's COP fell below 2.5 when the outside air temperature fell below -3°C.

Thus, a new residential ASHP powered by natural-gas generation of electricity could on average be better for the climate when the outside air temperature is above -3°C and increasingly worse as the temperature falls below -3°C. (This conclusion applies to ASHPs' heating mode. ASHPs also provide cooling in summer, not considered here because cooling results in only a small fraction of heating's environmental impact.) Here are average hourly temperatures in °C in seven Ontario locations during December to February over the last 20 years: Thunder Bay -12, Sudbury -10, Ottawa -9, Kingston -5, Toronto -4, London -4, and Sarnia -3. In Sarnia, ASHPs could on average be worse for the climate half the time during those months – and more than half the time in the other locations.

Most of the heat from burning natural gas to generate electricity is unused. About 58% is merely ejected into the environment. If thermal networks were available, most of this heat could be used or stored for later use (link). This would both raise the average efficiency of the natural-gas plants and, where thermal networks were established, eliminate much of the need for natural-gas furnaces or heat pumps. Ontario's electricity system could then focus less on providing for space heating – a low-grade use of electricity – and more on meeting irreplaceable demands for electricity in industry, transportation, informatics, and health care.

News from the Greater Toronto and Hamilton Area, Ontario and Canada

The district energy plans of Markham – just north of Toronto, population 370,000 – are *the* most ambitious towards achieving climate goals. This was the opening thrust of an article by Glenn Miller in the latest issue of *Renew Canada* (link). It noted the July 16 groundbreaking for Markham's Low Energy Carbon Centre (see photo), which will include what has been described as "the largest wastewater energy transfer [WET] project in the world." It will use heat pumps to extract up to 18 megawatts (MW) of thermal energy from municipal wastewater (link).

In our June 2023 *Digest*. we noted another WET project by Noventa Energy: the 19-MW system under construction at the Toronto Western Hospital (link). Canada is an evident leader in this use of wastewater. Of the four firms mentioned in the Massachusetts government's December 2023 comparison of WET systems (link), two are Canadian: Noventa and SHARC Energy of Port Coquitlam, B.C. (link). Noted too was the U.S. firm HUBER Technology, whose ThermWin system is used by Noventa, and Germany's Uhrig Group, said to have implemented more than 120 WET projects across Europe of up to 20-MW capacity. Also see the German 18-MW WET system that makes use of ammonia heat pumps (link). (The thermal capacities in MW given here may not be strictly comparable. It's hard to say which is the largest WET system.)

On November 5, 2024, an all-day event "Unlocking Ontario's low-carbon future with district energy" is being held by the Centre for Community Energy Transformation (CCET), the Consulate General of Denmark in Toronto, and the Region of Peel, at 10 Peel Centre Drive, Brampton. Go to link for the scope of the workshop and the day's agenda, as well as for registration details and a location map.

A slideshow previewing the 2025 Annual Planning Outlook (APO) was presented by the Independent Electricity System Operator (IESO), Ontario's main electricity planner, on October 16 (link). Consumption of electrical energy is now to grow by 75% between 2025 and 2050, instead of the 60% projected in the 2024 APO. Growth in peak demand is to remain at about 50%. (We believe these growth expectations are far too low, chiefly but not only *if* there is to be widespread use of heat pumps.)

The IESO's most astonishing projection is that by 2050 only 373,000 more dwellings will be heated with heat pumps than in 2025. This would be in addition to 2025's total of about 450,000 dwellings with heat pumps (projected from link). The 2050 total of about 823,00 such dwellings will be less than 10% of the total number of Ontario households, which IESO says will be 8.3 million (up from 6.3 million in 2025). Anticipating only a 10% market penetration of heat pumps by 2050 is astonishing because IESO had given the impression that its long-term planning assumed all new buildings would have net-zero space heating from 2030 and in most other buildings fossil-fuel heating sources would be replaced by electrified heating, mostly heat pumps (link, link).

The unexpectedly low uptake of heat pumps begs some key questions: How does IESO (and in effect the Ontario government) think most Ontario homes will be heated in 2050? Still by natural gas furnaces? Or, is IESO quietly assuming that most Ontario buildings will be served by district heating?

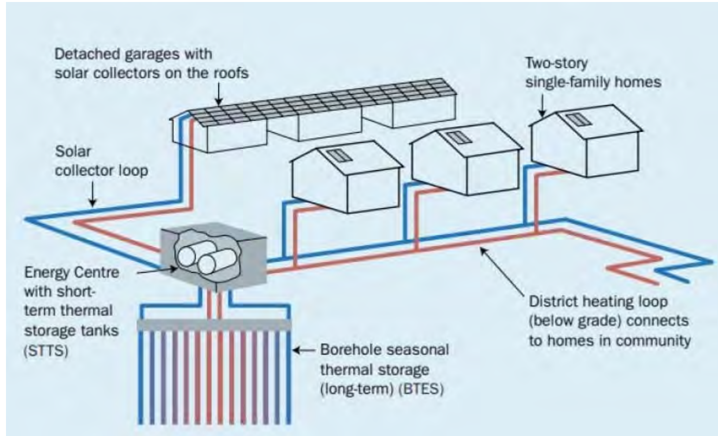
A serious approach to our emissions challenges requires effective heating planning. Whether this should be done by municipalities is the topic of our March 20 event (see the first item above).

Part of the district heating and cooling system in London, Ontario, is to be shut down. *Digest No. 7* noted the closure of the district heating system in Guelph. We suggested that poor heating planning could have been a cause. In May, district heating in another Ontario city suffered a setback. Enwave Energy announced that its low-pressure steam system providing heat to 17 customers in London has become unreliable and potentially unsafe, and is to be decommissioned in May 2025 (link). The remaining 43 customers are served by a medium-pressure network that will remain in operation.

London's system is among the oldest continuously operating systems in the world, dating from 1880 or even earlier (link). Enwave acquired the system in 2017 and undertook a $50-million upgrade in 2019 that included funding from the provincial government (link). The financial impact of the decommissioning on affected customers promises to be substantial. London's Mayor Josh Morgan has proposed seeking stronger regulation of Ontario's district energy systems.

Feasibility study for a major biomass-fuelled district heating plant in Chapleau. Forestry, a CPR rail yard, and tourism are the main businesses of this township of some 2,000 residents, about 170 km north-east of Sault Ste. Marie. To be investigated is the construction of a plant fuelled by locally-sourced wood chips that will heat up to seven public buildings, with the possibility of expansion to other buildings (link). Installation of the plant by Commercial BioEnergy Inc. (CBE) is being funded in part by the federal government's Green Municipal Fund, administered by the Federation of Canadian Municipalities (link). CBE also installs combined-heat-and-power plants (link), but it's not clear whether electricity is to be generated as part of this project. Chapleau Hydro was bought by Hydro One in November 2023 (link).

A Smart Heating Solution For Canada's Fiscally-Strained Municipalities. A new report with this title was issued in September by the Royal Bank of Canada as one of its Climate Briefings (link). We noted a previous RBC Climate Briefing, *The Price of Power: How to cut Canada's Net Zero electricity bill*, in the October 2022 issue of this *Digest* (link). That Briefing said Ontario faces electricity shortages as early as 2026 (link). The new Briefing provides five policy recommendations as to how municipalities can facilitate connection of new development to district energy systems. The most potent is the first: "Introduce mandatory connection by-laws." Municipalities are allowed to do this in British Columbia, not so clearly in other provinces, including Ontario. Another recommendation is to identify where district energy systems can best be deployed. Any municipality may do this, but with no guarantee they'll be built or, if they are built, that they'll be used.



Sun goes down on Drake Landing Solar Community. This was a June 28 headline in OKOTOKSonline (link) about a 52-home subdivision some 40 km south of Calgary. Drake Landing achieved a far-reaching reputation as "the leading solar heating community of its kind in North America" (link) , not long after it became operational in 2007. It was conceived by Natural Resources Canada as a four-year project to examine the feasibility in Canada of a community-scale solar storage system capable of supplying over 90% of annual space-heating needs. Solar collectors on garage roofs fed summer heat into borehole storage, from which the heat was extracted for winter use (see the diagram from link). The four-year test exceeded expectations. The system was retained beyond 2011. As late as 2015-2016, it supplied all the heat required by the 52 homes (link).

Problems emerged, chiefly from aging equipment for which there were no replacements or insufficient funds for replacements. By 2023, the homes were 100% reliant on natural-gas boilers installed at the Energy Centre. The fundamental problem seems to have been that revenue from homeowners was tied to the cost of natural gas heating, which remained unexpectedly low. The low revenue could not fund adequate maintenance – which in any case was challenging because of the experimental nature of the project. Such a system installed today could well thrive as a result of the Drake Landing experience.

Items from outside Canada

Hot|Cool: a no-cost, informative, on-line magazine on district energy technology. You'll likely have at least a little interest in district energy if you've read so far into this issue. If so, you'll find Hot|Cool worth subscribing to (link). Issues in English of about 25 pages are produced monthly by the Danish Board of District Heating, which naturally gives the publication a Danish flavour. The September 2024 issue focuses on energy storage, the relatively low-cost feature that, where feasible, provides district energy with its strongest advantage.

Finland has been much in the district energy news, not the least because it is becoming a leader in use of heat from nuclear reactors (link, link, link, link). As well, what has been described as "the first of its size" air-to-water heat pump is planned for Helsinki (link). It's to be capable of operating at outdoor temperatures as low as -20°C and to supply 20-33 MW of heat to the district heating system depending on air temperature. A Google data centre in Hamina – population about 15,000 – is to meet some of its massive cooling needs by donating heat to the community's district heating system, enough to provide for 80% of the community's annual needs (link). This is all in addition to the huge cavern storage facility for hot water for district heating that is under construction in Vantaa, a Helsinki suburb (link), mentioned in the last edition of this *Digest* (link).

Larger *water-to-water* heat pumps are available. The same German company (MAN Energy Solutions) that is supplying the above-noted heat pump is to supply the district heating system of Aalborg, Denmark, with four heat pumps each to provide up to 44 MW of heat extracted from seawater (link).

Equinix is seeking partners for district heating ambitions. Styling itself "the world's digital infrastructure company" (link), Equinix is calling on district heating companies to take the waste heat from its 260 data centres located in 72 metropolitan areas worldwide. One of them that already does is Markham District Energy (also see the first item on Page 5), which uses heat from the TR5 data centre at 8100 Warden Avenue. An Equinix vice-president said, "Our Heat Export program is one important way data centers can give back to their local communities" (link)

Eavor to supply deep geothermal heat to Hanover. The German subsidiary of Eavor Technologies Inc. (link), headquartered in Calgary, has a contract to provide 30 MW of heat from about 3 km depth to meet about 15% of the thermal energy needs of Hanover's district heating company – which meets about half of the total heating needs of this city of about 540,00 inhabitants (link, link).

Production of Austrian cucumbers and concrete helped by district heating. District energy is usually thought of as a means of providing comfortable temperatures for people in buildings. Two recent items from Austria point to other uses. In Vienna, the district heating system – one of the largest in Europe – provides ideal growing conditions within urban greenhouses (link). The system in Klagenfurt, 250 km south-west of Vienna, provides heat for a concrete mixing facility, contributing to the production of low-CO_2 concrete (link). We encountered yet another use for district heating during our recent study tour (see next item). On the Swedish island of Gotland, we learned that a district heating system there provides heat for grain drying.

Report on the Boltzmann Institute's May-June study tour is now available

In the June 2024 issue of this *Digest*, we gave a brief account of our study tour of district energy facilities in northern Europe. The full 33-page report is now available at link.

About the Boltzmann Institute

We're a federally incorporated, not-for-profit think tank founded in 2022, seeking to help eliminate harmful emissions from human energy use, named for Ludwig Boltzmann, a 19th-century Austrian founder of the science of thermodynamics.

We aim to contribute research and education towards securing carbon neutrality by 2050, initially focusing on thermal energy use in buildings (heating and cooling).

Our website at www.bi-ib.ca is a growing resource – now partially bilingual – on district energy and related matters including electricity generation.

Our early funding came from generous private contributions. The Government of Canada is now contributing $750,000 to the work of the Boltzmann Institute described in the annex to this *Digest* on the next three pages.

WHAT WE'LL SEE DOWN TWO PATHWAYS

This is a regular annex on the Boltzmann Institute's Two Pathways project, which is considering the pros and cons of two pathways to zero direct emissions from buildings: one where heat pumps predominate and the other where most buildings are served by district energy systems (thermal networks). It contains reflections by the project manager, John Stephenson.

The Two Pathways research project, partly funded under a Contribution Agreement with Environment and Climate Change Canada aims to advise the Net Zero Advisory Body about the societal cost, the costs to consumers and likely success of pursuing emission reductions from residential and non-residential buildings down each of two paths.

The two paths are 1) major heating demand reduction through deep retrofits, and air-source heat pumps (ASHPs) in individual buildings to meet the remaining demand, and 2) thermal networks, using, among other clean technologies, more efficient heat recovery heat pumps (HRHPs) and large-scale thermal energy storage (both of which are well proven in Europe).

The Boltzmann Institute proposed this study to address the fact that there has been no progress reducing emissions from buildings in Canada. There seems to be a huge gap in knowledge about the relationship between peak heating demand, real-world performance of ASHP coincident with peak heating demand, and coincident availability of clean electricity. There's lack of information too about the potential of heat networks to enable **intelligent electrification**, with dispatchable load when HRHPs are coupled with thermal energy storage.

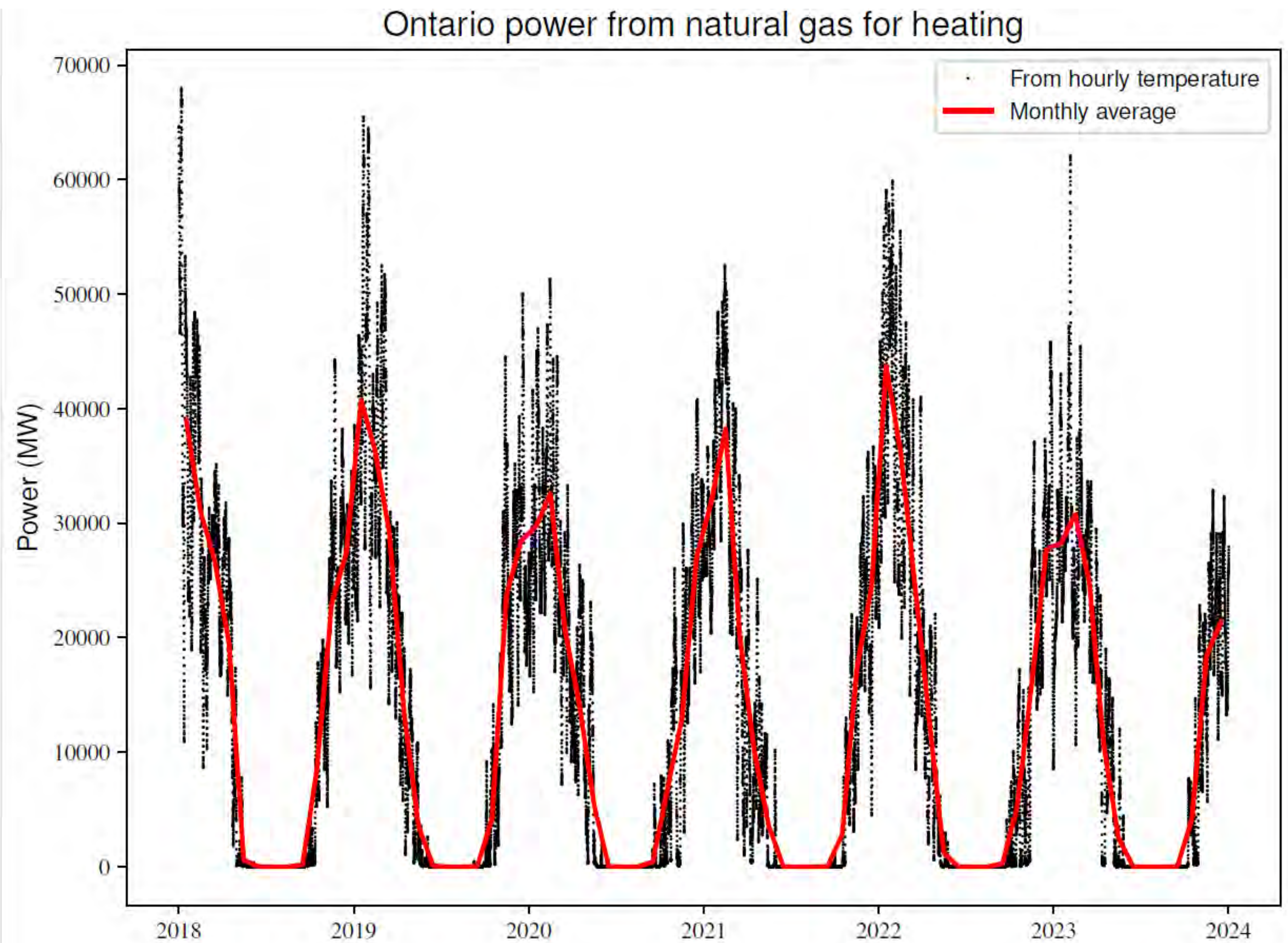
The potential of heat networks for reducing emissions in typical communities and neighbourhoods in southern Ontario will be well illustrated in work subcontracted to district energy specialists FVB Energy Inc (FVB). FVB's role in the Two Pathways project is to design and cost out thermal networks serving an illustrative community composed from an amalgam of typical urban areas found in Ontario. It consists of about 70,000 homes with an associated downtown and eight distinct neighbourhoods with a range of densities. Heat load profiles have been developed with associated customer connection and piping costs. Exclusively clean heat source technologies have been proposed and selected. Next steps involve costing of Energy Centres, business case and environmental impact. The report will inform municipalities and others of the costs and benefits of developing heat networks in different circumstances. The main message expected to come across from this study is "yes, we can!" (even for existing buildings).

Regarding the availability of clean electricity: although there have been announcements about the IESO procuring more wind, storage and nuclear (and so-called hydrogen-ready, a transparent euphemism for more gas), demand growth seems likely to outpace the addition of the clean generation sources for at least the next decade. Shuttering Pickering for refurbishment that will last until the mid 2030s won't help. Incremental loads, such as created by ASHPs and new buildings, will be served almost entirely by burning more gas. Some electrification advocates don't seem to recognize this. They continue to be mis-guided by the average grid emissions factor and manufacturer's steady state seasonal average COP of ASHPs. But using average grid emissions factor for this purpose is just plain wrong because non-emitting power sources will be fully used even without the new load (link). And our Two Pathways report will rigorously debunk the common claim that ASHPs can efficiently heat buildings even on the coldest days.

Peak heating demand itself is rarely measured, either for an individual building or the diversified heat demand of a community (except by a few operating heat networks, who have shared this data with us). It is a truism that something not measured cannot be managed very well.

This problem is being addressed by a team composed of seasoned energy professionals at the Boltzmann Institute and faculty-supervised graduate students and post-doctoral fellows at the McMaster Institute for Energy Studies (MIES). At this stage, all I want to say about this work is that it is looking at the problem from several angles, some quite original.

The following chart illustrates just one way we have looked at this problem. It depicts, red line, monthly average gas heating power in Ontario (derived from total monthly gas consumption from two



sources, checked against each other, the Ontario Energy Board and Statistics Canada, after subtracting non-heating gas demand) against hourly demand; black dots, where each dot is for an hour, derived from the gas data heating degree hours in each hour (for Ontario as a whole from weather data in various places, weighted by population). The peaks are several times the existing electricity system capacity. The significance of that is brought in focus when coupled with our conclusion that the real-world effective COP of ASHP, backed by electric resistance, coincident with peak heating demand is about 1. Each MW of peak heating demand served by ASHP, backed by electric resistance, would add 1 MW to the electrical demand, and this will often be coincident with the morning winter peak.

* * * * *

This project is supported by a contribution from federal government agencies (see the logos below) awarded to the Boltzmann Institute after a competition among universities and think tanks. The project is to be completed by March 31, 2025. We'll be disseminating results as we get them through future editions of this *Digest* and other means. Please e-mail the project manager John Stephenson (link) with questions, comments or in-kind contributions to the project.

This project was undertaken with the financial support of the Government of Canada
Ce projet a été realisé avec l'appui financier du gouvernement du Canada