Affordable Heat and Electricity through Thermal Networks

Progress to Date

A Presentation to CACOR

May 6, 2026

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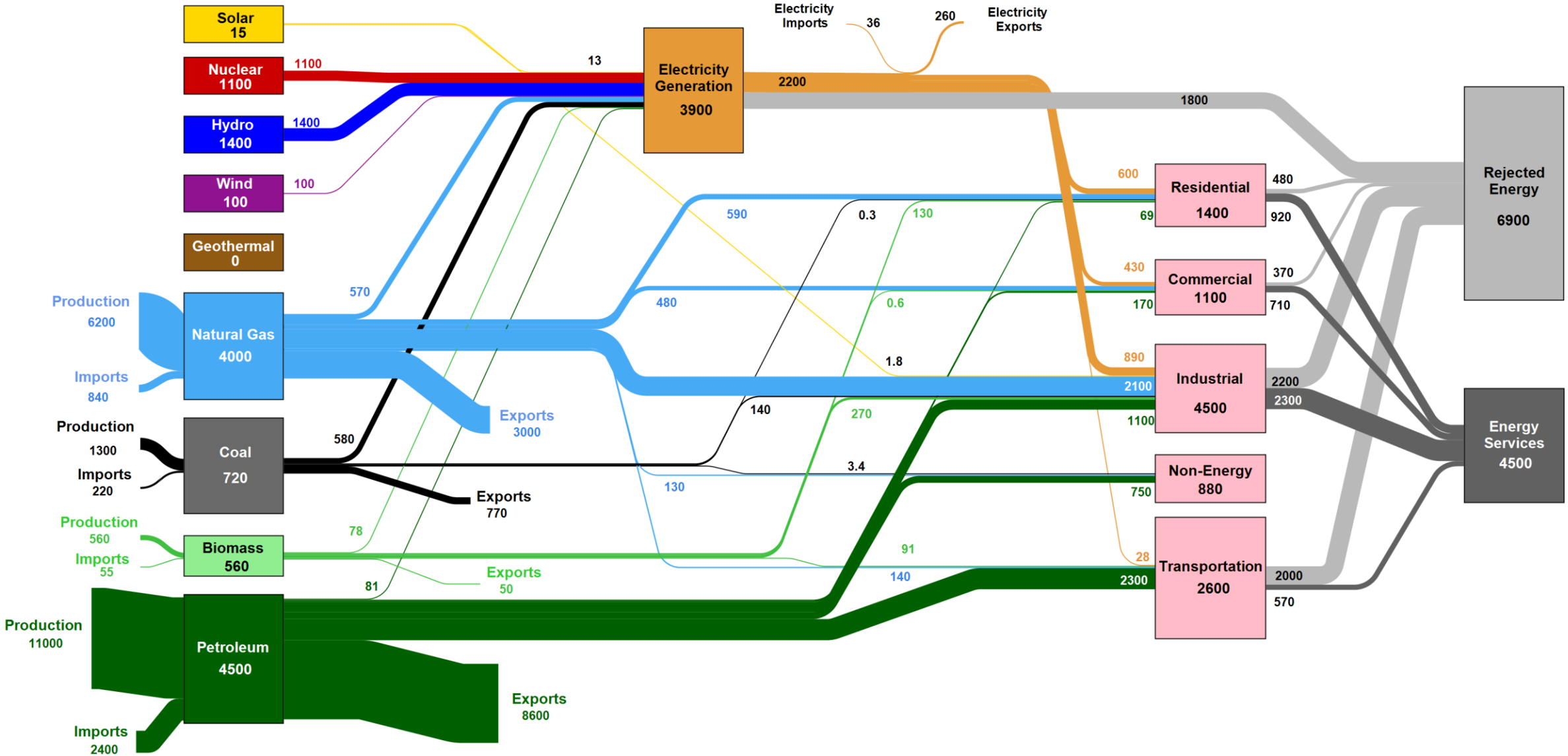
Canada Energy Flow in 2017: 13,000 PJ

Lawrence Livermore National Laboratory



Source: LLNL 2021. Data is based on IEAs Detailed World Energy Balances (2019 Edition). If this information, or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the U.S. Department of Energy, under whose auspices this work was performed. All quantities are rounded to 2 significant digits and annual flows of less than 0.10 PJ are not included. Total energy supply (top of chart) and energy resource statistics (left-side boxes) represent national energy use which is the sum of production and imports minus exports. Totals may not equal sum of flows due to independent rounding, stock changes, statistical difference and reporting inconsistencies. Further information can be accessed at https://flowcharts.llnl.gov. LLNL-MI-410527

Boltzmann Institute Commitment

- The organizations and individuals pursuing Sustainable Development or sustainable energy system are many.
- They often have differing pathways to a sustainable future and this may undercut progress – confuse policy makers.
- We need to unite, challenge each other's views and then come up with a shared pathway, or compatible pathways, to a sustainable future.
- Boltzmann Institute would like to do our part in collaboration.
- Sustainability Building Blocks might be a joint project.

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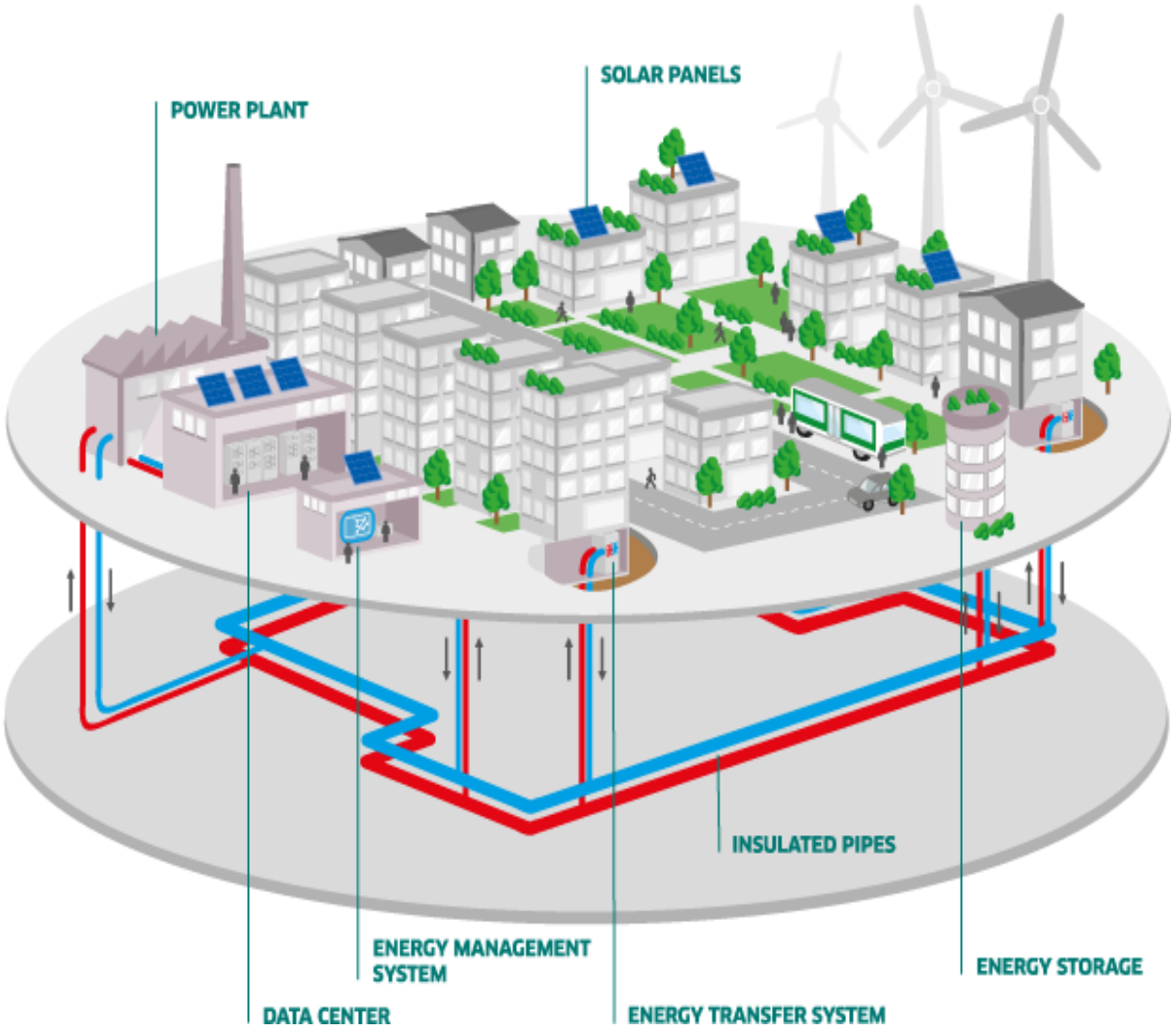
Thermal Networks (TNs) – a class of energy infrastructure with growing importance for Canada.

A network of pipes that can accept heat from a variety of sources and deliver it to buildings to displace fossil fuel and displace GHG

Planning studies in the EU find that such networks are a preferred decarbonization option for about 60% of buildings

A thermal network transfers responsibility for decarbonization from the building owner to the thermal network utility



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What is a Heat Network?

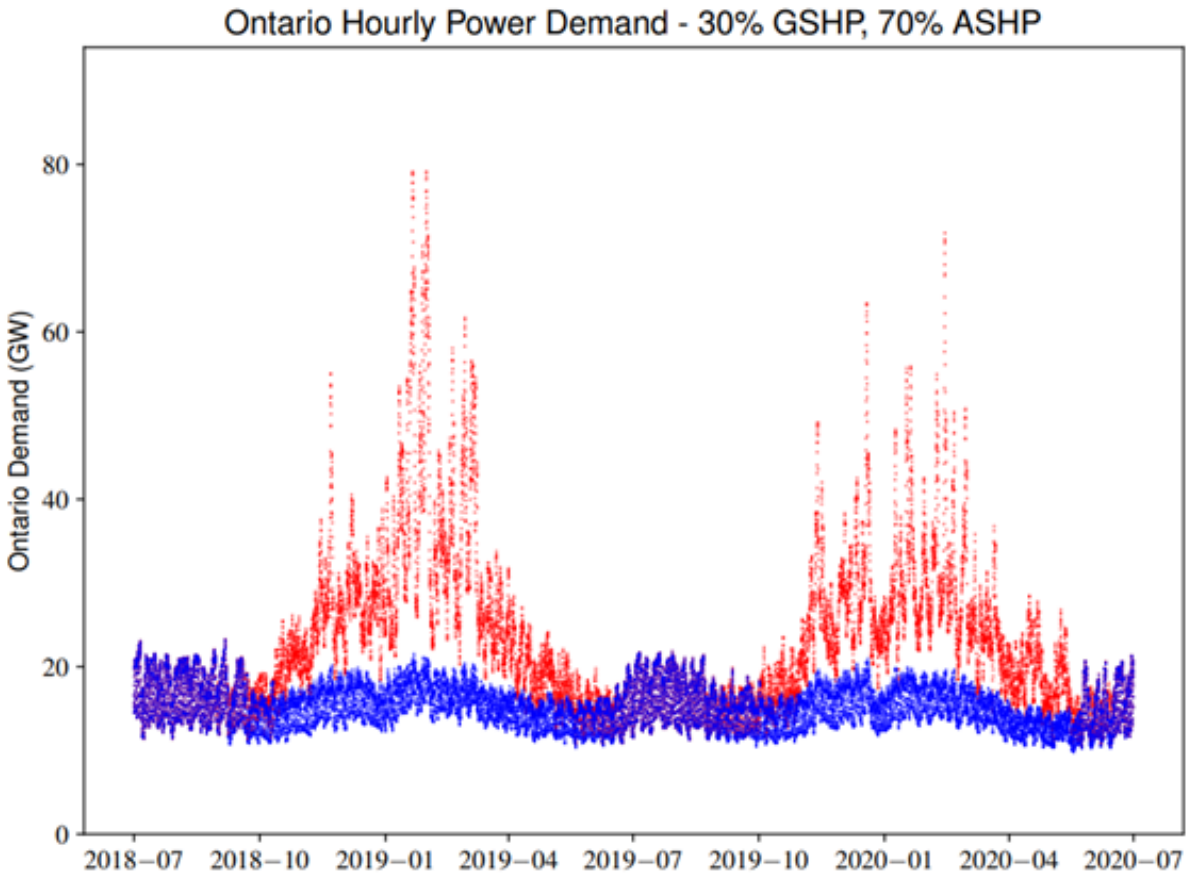
Municipal infrastructure like road, sewer or water supply renewal is not uncommon and short disruptions are accepted by the public as necessary and acceptable. Thermal networks are no different. Shallow buried technology allows heating pipes to be installed above existing infrastructure and disruption is similar or less than other infrastructure.

Pre-insulated district heating pipes have been widely used in Canada since about 1982. Frost or freezing is not a problem and pipes are only buried deep enough for structural protection; typically 600 mm to 1000 mm cover.

Underground infrastructure is advancing. Horizontal drilling and other techniques can construct service connections to buildings with minimal disruption.

Smaller pipes, below 400mm diameter, are available in high density polyethylene (PEX) rolls and can be routed around other utilities, trees etc.

HEATING IS SOMETHING COMPLETELY DIFFERENT!



- Ontario Electricity Peak Load – 23 GW
- Ontario Peak Load on Natural Gas – 70 GW

- Current Utilization – 67%
- Utilization with Heat Pumps – 26%
- Incremental utilization of ASHPs - <10%

- Impact on electricity rates?

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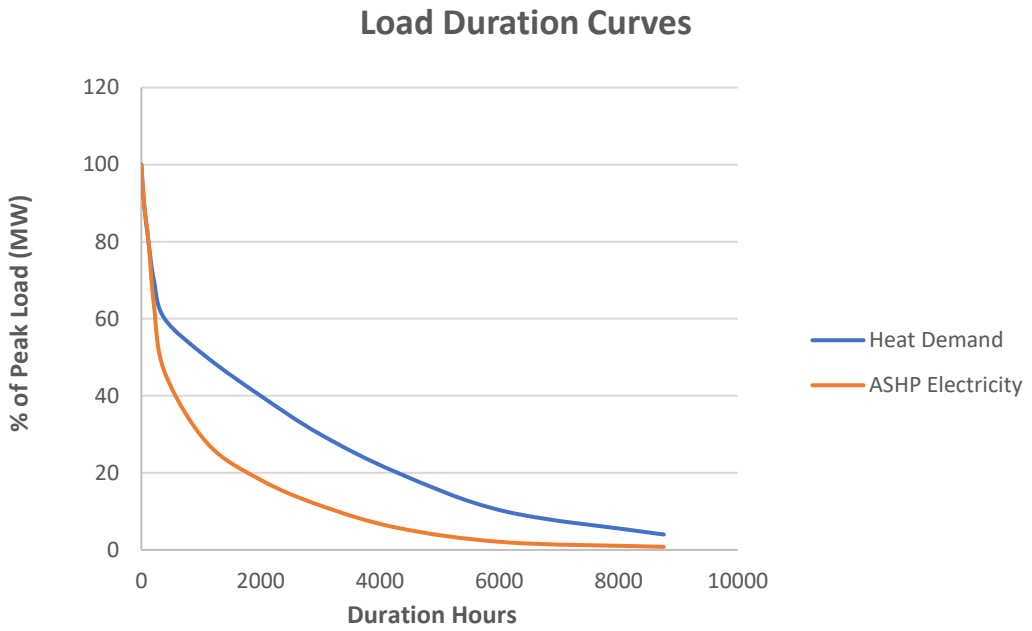
IMPACT OF ELECTRIFICATION OF BUILDING HEATING

- A load duration curve for heating reveals a utilization of capacity of only 25%
- Without fossil fuels, this is a challenge.
- With Air Source Heat Pumps, the utilization drops to less than 10%
- Good for customers but terrible for electricity utilities.



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Peak Load Management: Our Biggest Challenge

With Fossil Fuel – meeting peak loads is reasonably doable

- But to decarbonize – electricity or decarbonized energy sources - is a big problem.
- Electricity – expensive and good for hours or days
- Thermal energy storage – a few % of the cost and is good for months
- Where possible keep thermal loads on thermal networks where seasonal theral energy storage (STES) is possible.

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Constructed 100 metres underground, 1.1 million cubic meters, stores heat at up to 140 C and provides over 90 GWhs – enough to heat a medium sized city for a year.

Equivalent to about 1.3 million car batteries at about 1% of the cost.

Wesleyville?

WORLD'S LARGEST THERMAL ENERGY STORAGE TO BE BUILT IN VANTAA, FINLAND

Why a thermal energy system?

- Promoting a Circular Economy with the 3 Rs – Reduce, Reuse, Recycle.
- Moving from building based to societal efficiency and renewable or decarbonized energy use and adopting a 3 Cs approach (Conserve, Connect, Convert) as is standard for all utilities by:
  - Conserve - reducing building energy demand and temperature requirements for heating;
  - Connect – create or expand thermal networks and connect buildings, even if supplied by natural gas in the short-term, to increase the possibilities of decarbonized energy supply;
  - Convert – as heat loads are assembled, economies of scale will enable conversion to reject heat (industrial, CHP power plants and data centre reject heat) or renewable energy sources.
- We are unlikely to have affordable electricity and unlikely to meet Net-Zero emission goals without thermal energy utilities.

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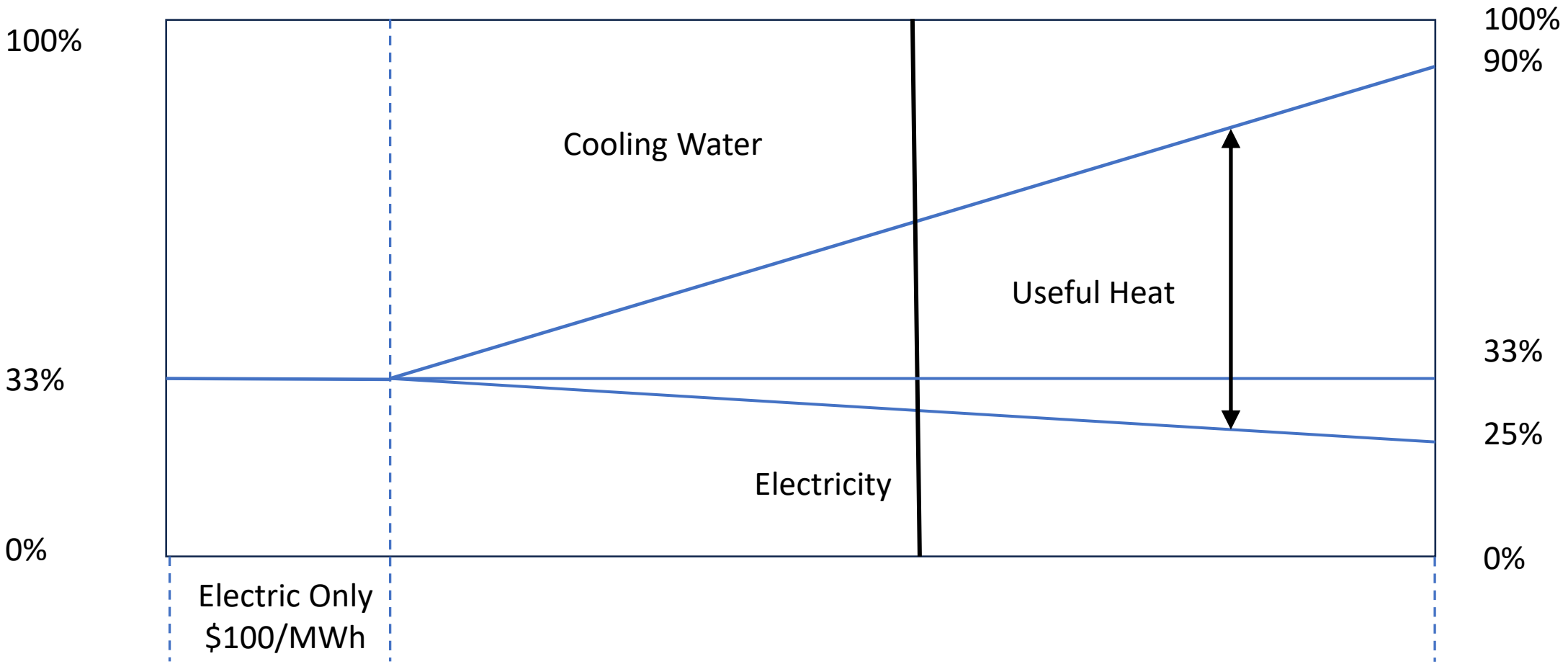
Pricing of electricity and heat from CHP generators



Impact of Heat Revenue on Electricity Price

Assumptions:

- Budget electricity price = $100/MWh
- Ratio of electricity loss to heat upgraded to 95 C = 1:7
- Break even heat price = $15/MWh
- Extra Heat revenues used to lower required electricity price.

Now – it's negotiation!

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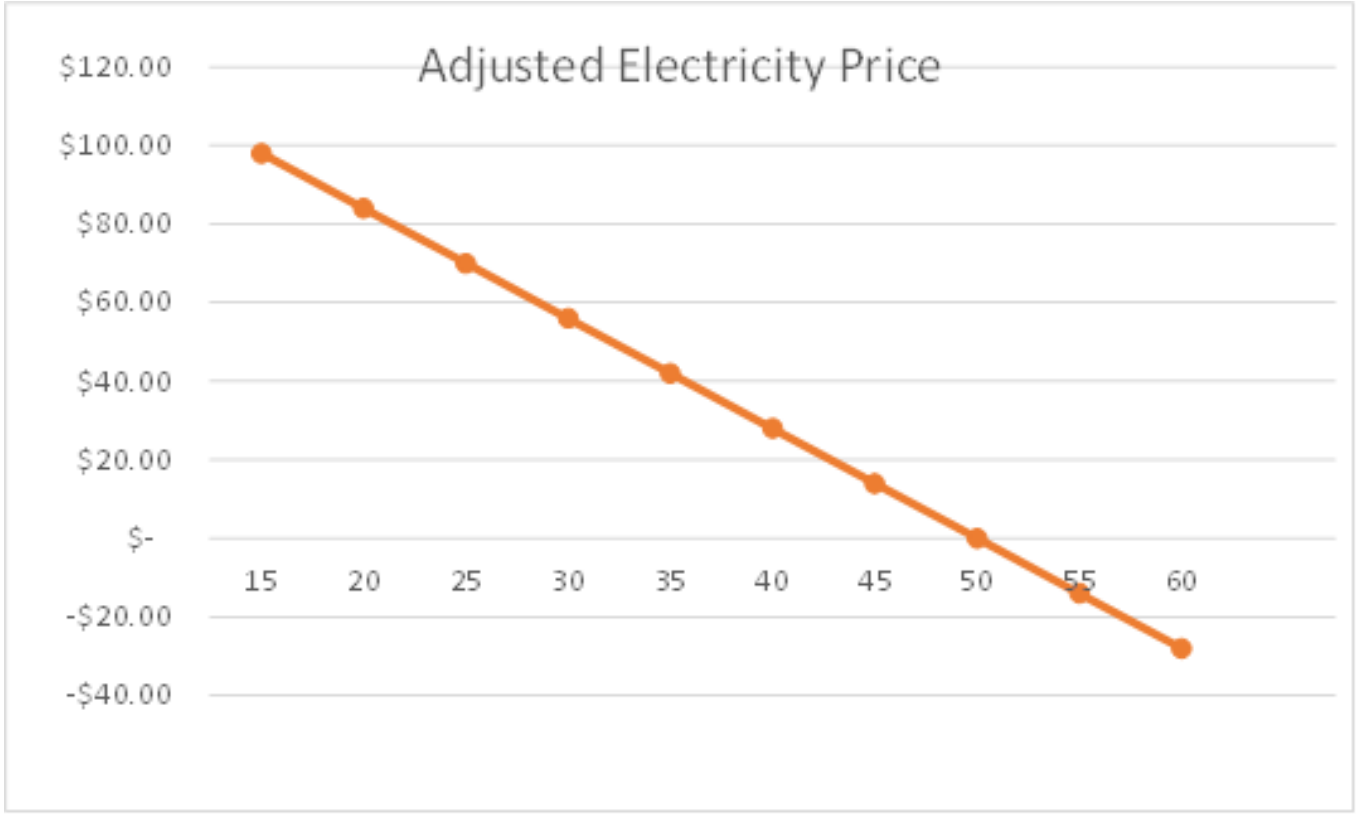

Sector Coupling Possibilities

- Use thermal energy systems instead of electricity – big peak load reduction with similar or improved capacity factors for the electricity system.
- Variable output CHP – Couple with Thermal Energy Systems including STES. Makes nuclear dispatchable.
- Surplus electricity can be stored and used as heat or cooling.
- Additional heat revenue, depending on negotiated price, could lower electricity prices.
- A thermal energy network with STES expands potential efficiency (reject heat) and renewable energy possibilities – multiple sources.

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Response to Our Initiatives

- OSPE Energy Task Force is fully on side and leading discussions with the Province.
- The 2 Pathways Study and suggestions for the implementation of thermal energy systems in Canada has been submitted to NRCan with assurance from the Minister that NRCan will review both.
- There have been ongoing meetings with both Federal and Provincial energy departments.
- We are collaborating with the OECD NEA on nuclear CHP.
- Both OECD NEA and CNL are collaborating on the pricing of energy from nuclear CHP plants.

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References

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Thank you for your attention. Michael Wiggin

Boltzmann Institute Website: https://bi-ib.ca/

2 Pathways Study Executive Summary:

https://bi-ib.ca/wp-content/uploads/2025/06/Two_Pathways_Executive_Summary.pdf

2 Pathways Report:

https://zenodo.org/communities/twopathways/records?q=&l=list&p=1&s=10&sort=newest

OSPE Position

https://ospe.on.ca/advocacy/ospe-launches-advocacy-for-thermal-energy-in-ontario/