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District Energy & Thermal Energy Networks

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November 15 2023

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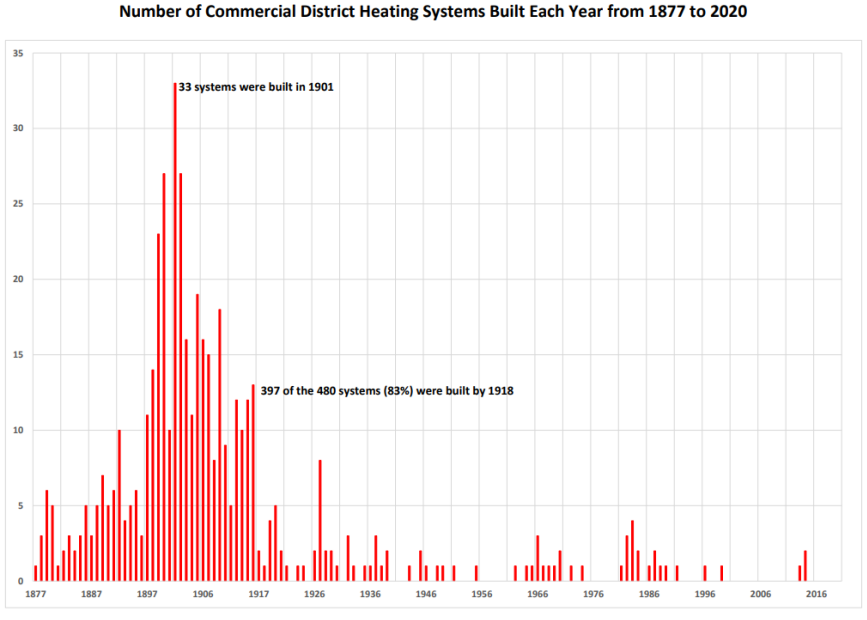
- District Energy Evolution
- Why Thermal Energy Networks?
- Why Illinois?
- Thermal Energy Context

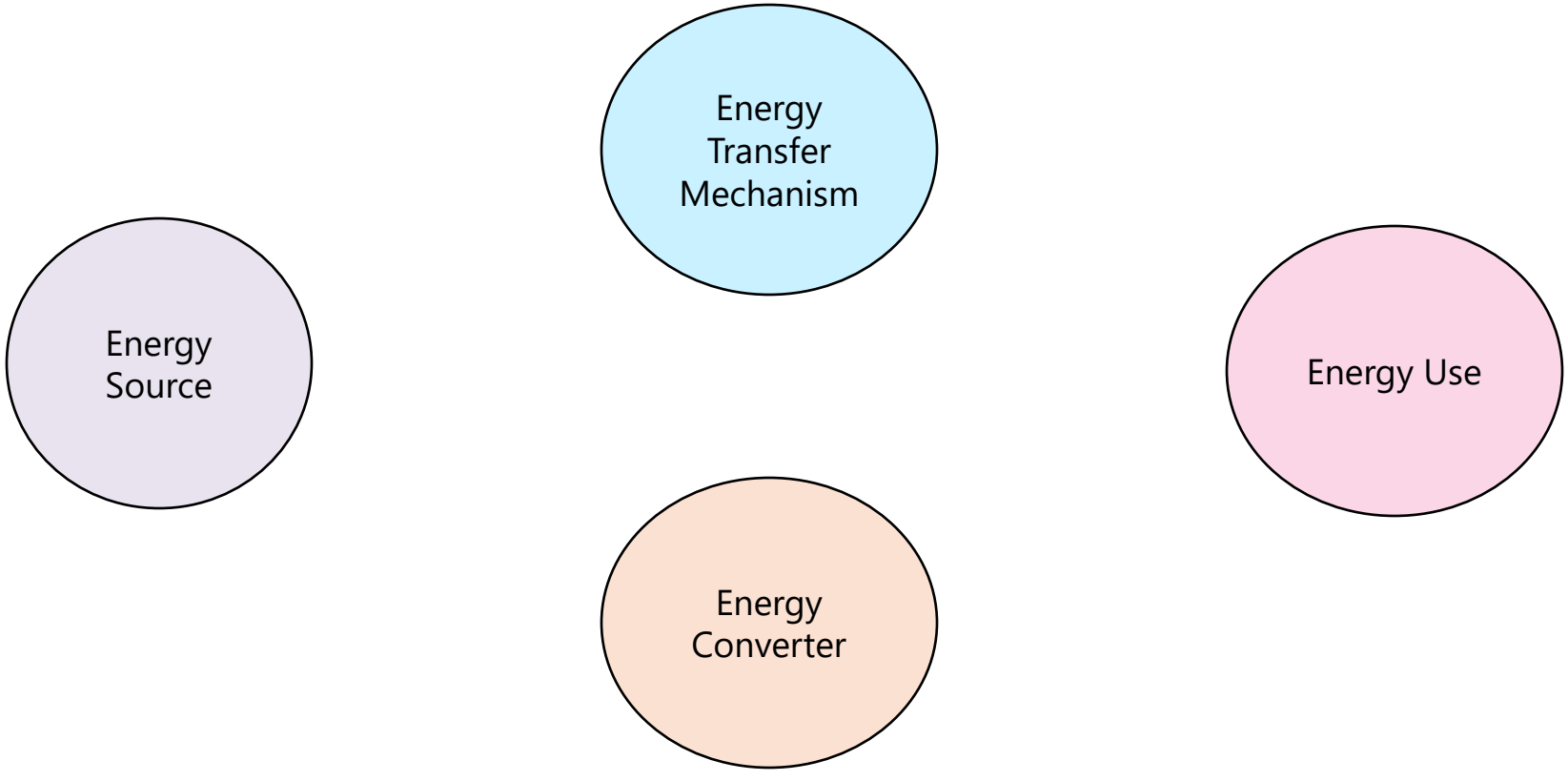
Types of District Energy

Steam

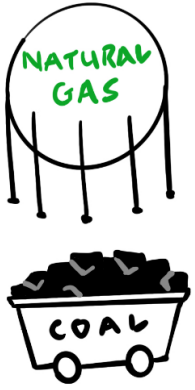


http://waterworkshistory.us/DH/

System Components



System Components - Steam



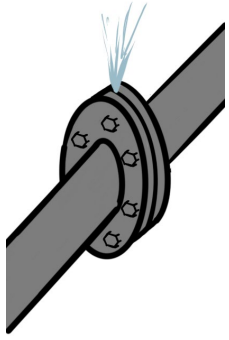
Energy Source

Coal
Natural Gas

Major Energy Input

Energy Convertor

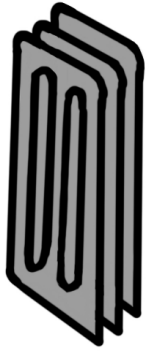
Steam Boiler



Energy Transfer Mechanism

High Pressure High Temperature Iron/Steel Pipe

250 oF+



Energy Use

Steam Heat Exchanger to Heat Emitter

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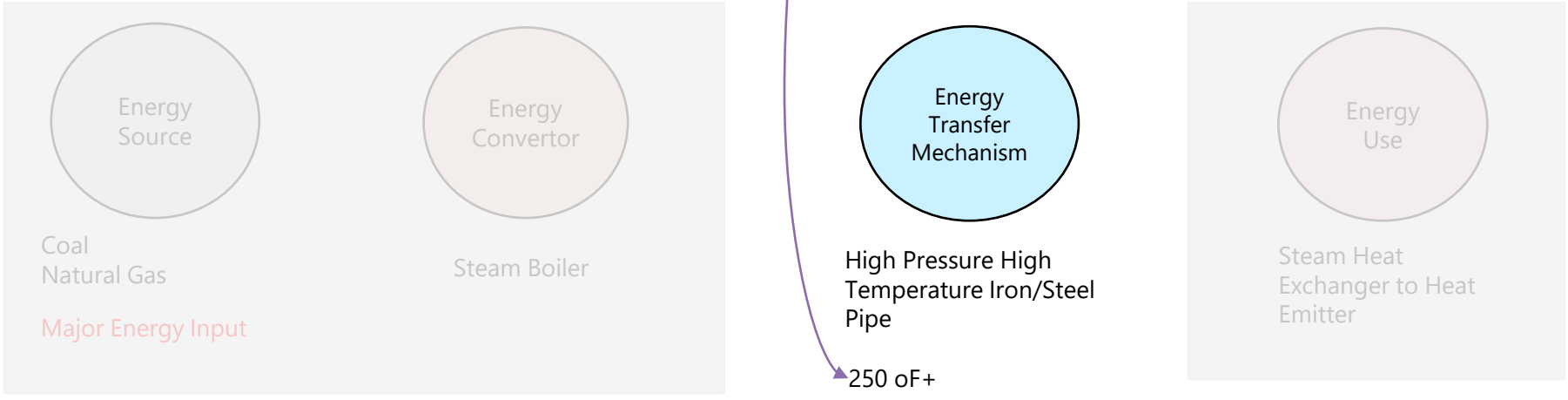
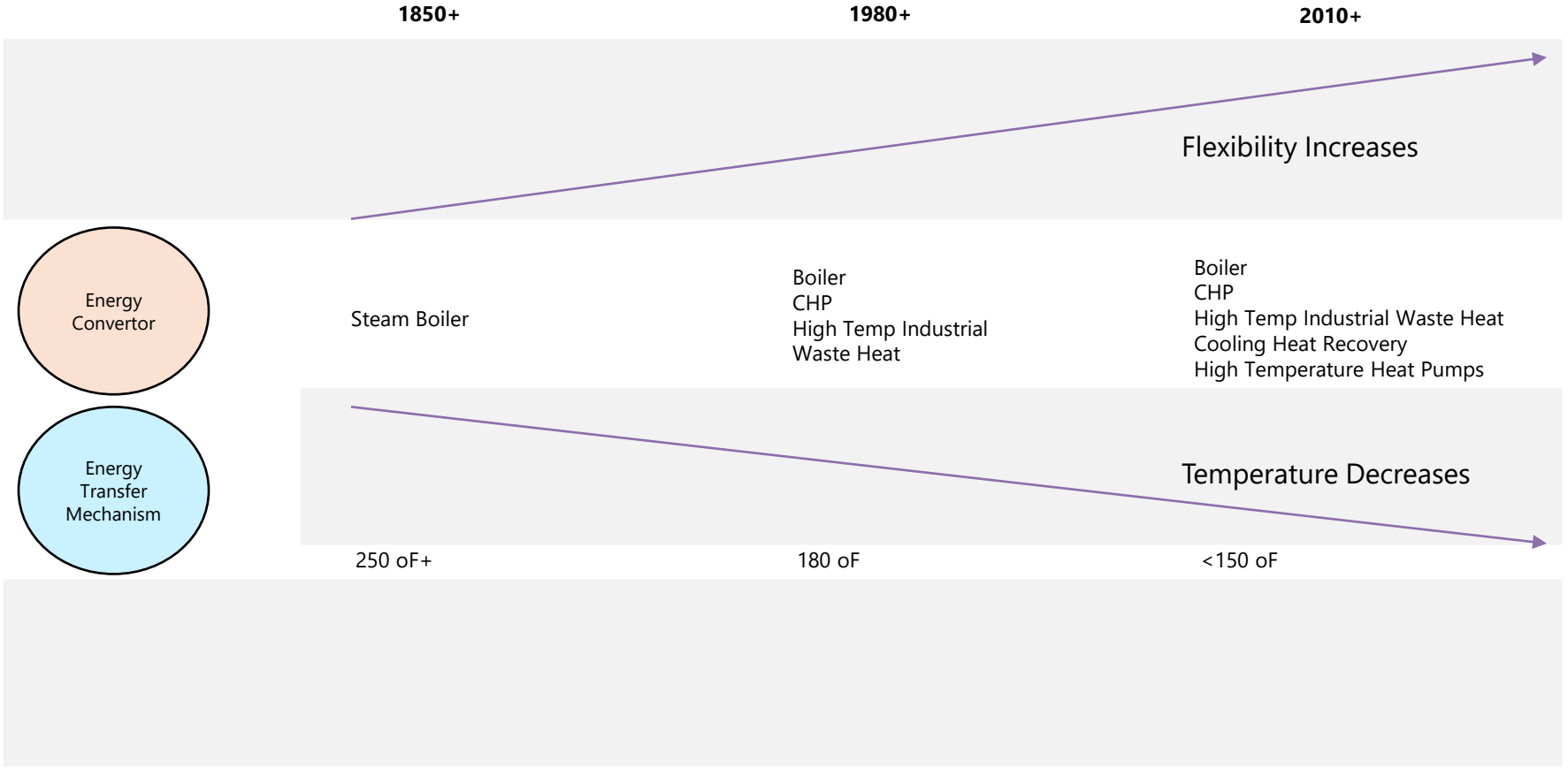
District Energy Evolution

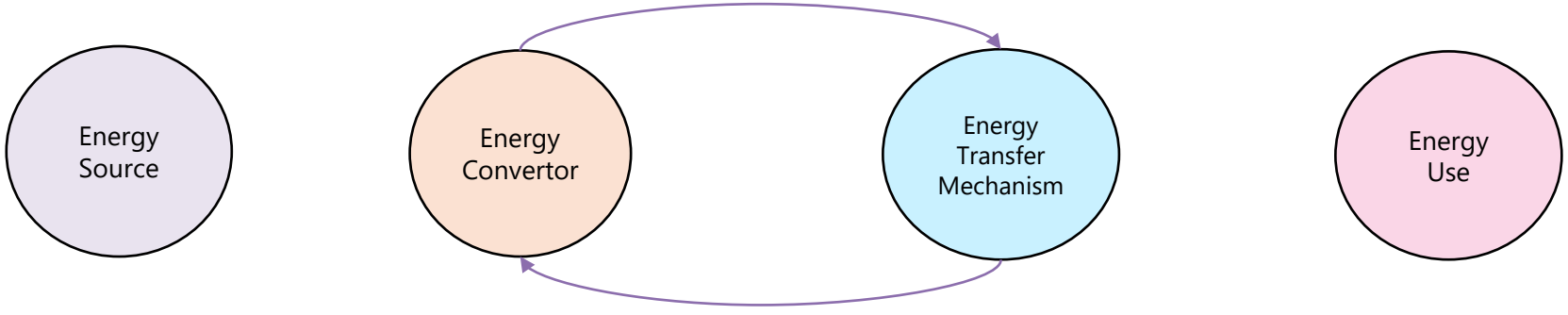
This temperature reduces, which enables all other change around it



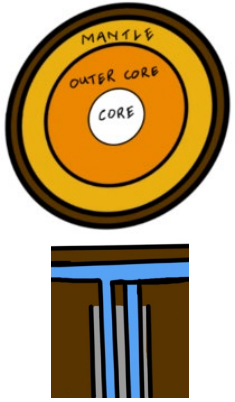
System Components – Traditional District Energy

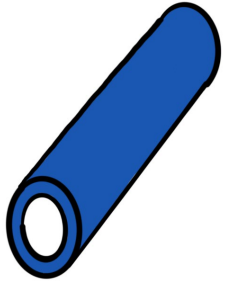


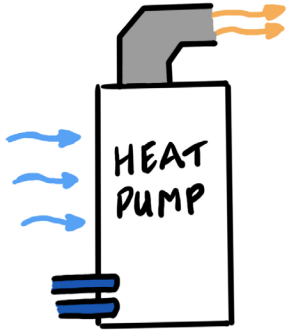
System Components – Thermal Energy Network

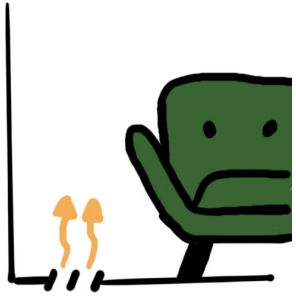


System Components – Thermal Energy Network









Energy Source

Energy Transfer Mechanism

Energy Convertor

Energy Use

Geothermal
Low Temp Waste Heat
Rivers/ Lakes

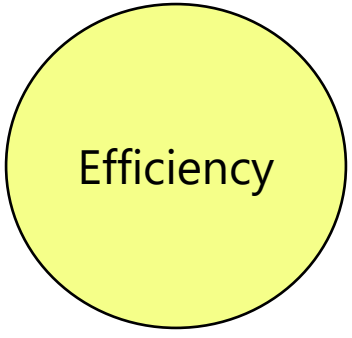
Major Energy Input

Plastic Pipe

Water Source Heat Pump
+
Electricity

Ducted Air
Low Temp Radiators
Fan Coil Units

Why Use a Thermal Energy Network



A heat pump connected to a thermal energy network is the most efficient repeatable way of providing electrified heat

The Heat Pump

Invented ~1850

Everyday Heat Pumps

- There are heat pumps everywhere
- Typically we experience **air source heat pumps**
  - Extracting heat from the air or rejecting heat to it
- Thermal Energy Networks use **water source heat pumps**
  - Extracting heat or rejecting heat from/to water filled pipes
- The efficiency is governed by the temperature of the source
  - **We can ensure a warmer water source year-round vs the air therefore it is more efficient**

The Heat Pump

Air Source vs Water Source

ASHP – Outdoor Only

WSHP – Outdoor or Indoor, Typically Indoor

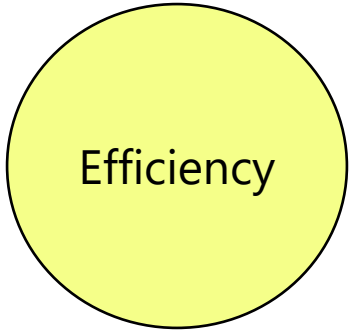
Reduce energy losses

Ambient temperature water in the ground has negligible energy losses

Steam is often 10%+ losses in the ground and 20%+ at generation

Enable Energy Sharing Across the Network

While something is cooling, it is rejecting heat – this is useful heat that can be used elsewhere, interconnecting the buildings enables this



Minimize Impact of Electrification to the Electrical Grid

Electricity grids are not currently equipped to handle full electrification in winter

Thermal energy networks can reduce the winter impact by over 50% compared to air source heat pumps

Lowest Whole Life Cost Route to Electrification In the Right Applications

Given the right building density and heating/cooling mix a thermal energy network is the most cost efficient way to electrify

Why Illinois

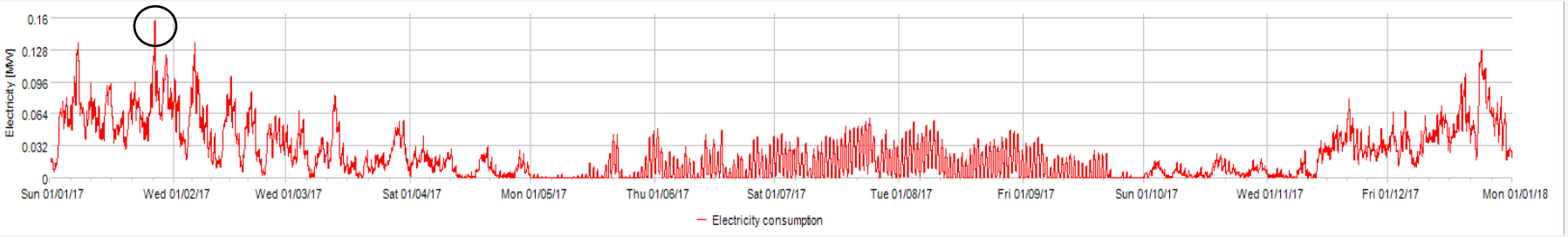
Reduce energy losses

This is thermodynamically true
across the country and the world

Enable Energy Sharing
Across the Network

Minimize Impact of
Electrification to the
Electrical Grid

Lowest Whole Life Cost
Route to Electrification
In the Right Applications



Efficiency

Minimize Impact of Electrification to the Electrical Grid

Electricity Profile of residential heating and cooling, with high efficiency cold climate ASHP, in Chicago

With a GSHP …

160% efficient in coldest hour

500% efficient, consistently

70% reduction in impact to electricity grid and energy cost to consumers

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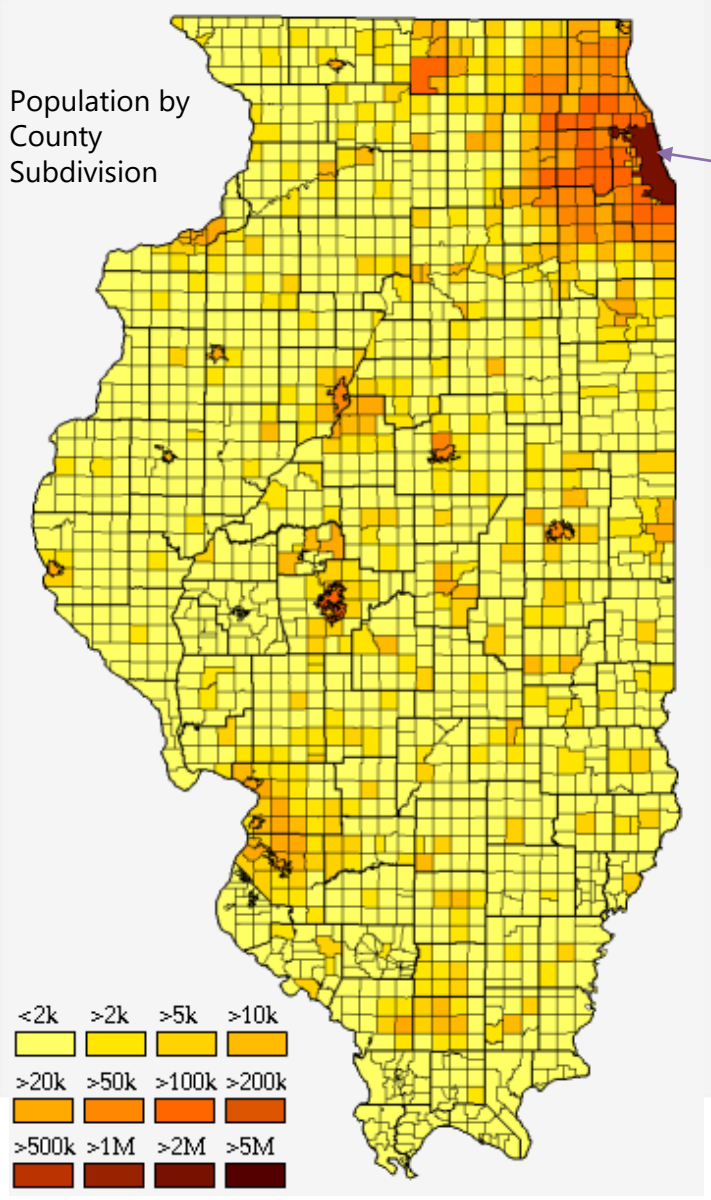


Efficiency

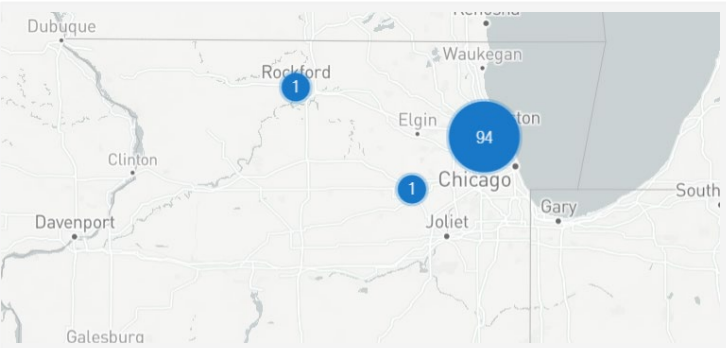
Lowest Whole Life Cost Route to Electrification In the Right Applications

Highlighted – situation where a geothermal thermal energy network needs to get creative to be feasible due to high building density

Everywhere else – technically could work 'right out of the box' and could be the most cost-effective solution in much of that area

Enable Energy Sharing Across the Network

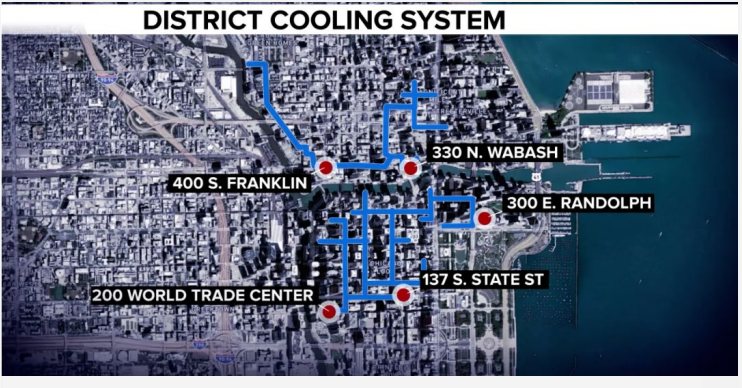
Exceptional opportunities for energy recovery – particularly in hard to tackle dense urban areas



More data centers than any other city in the USA

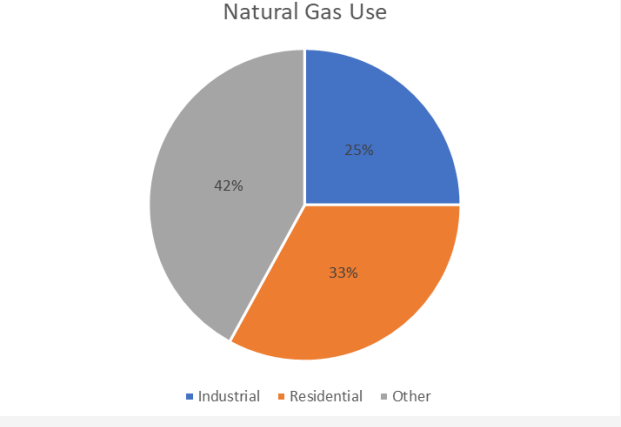
Excellent energy sharing opportunity

Efficiency



Largest District Cooling System in the World

Excellent energy sharing opportunity

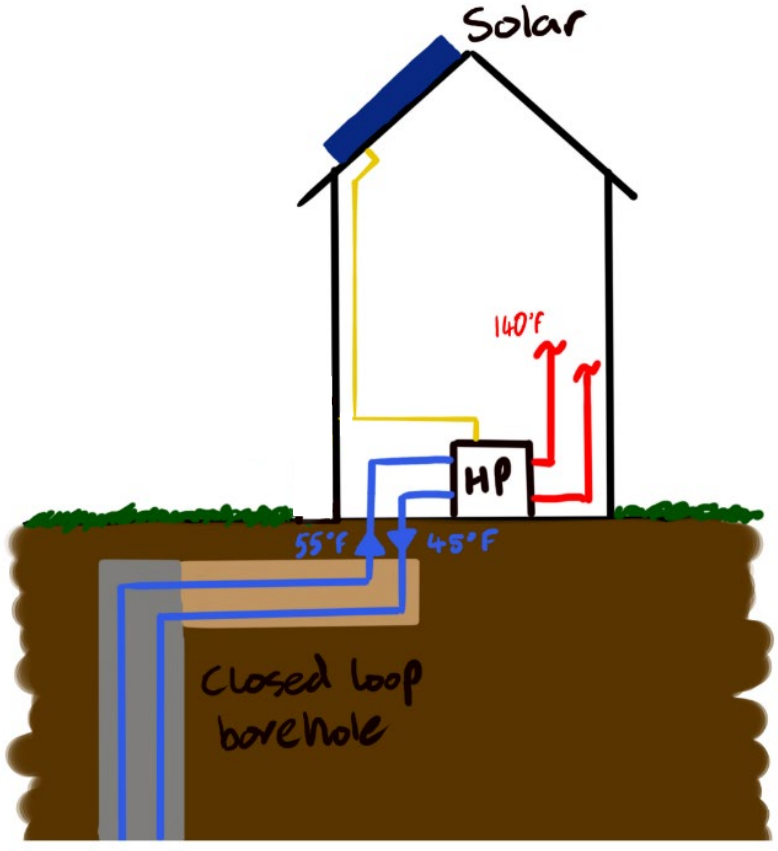


Significant industrial gas use – suggests waste heat availability

Thermal Energy Networks Context

Geothermal in the USA

- The simplest of thermal energy networks use geothermal energy as the main energy input, this is typically closed loop boreholes
- 1945 - the first closed loop geo installation in the USA
- 25% of the worlds total geothermal installation capacity is in the USA
- ~2 million units are installed per year
- **This is a mature technology with widespread uptake**



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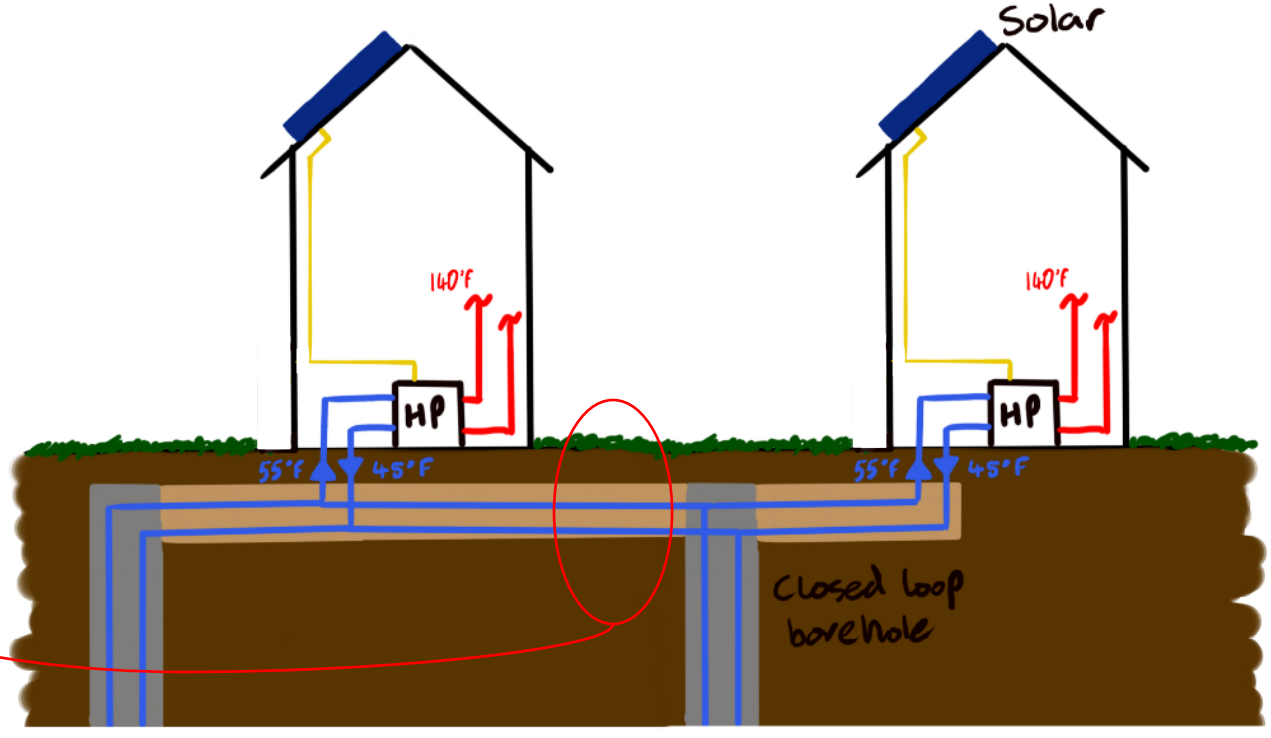
Geothermal Thermal Energy Network

- Connect buildings and it becomes a thermal energy network

- **All the benefits discussed are realized**
- **Diversity can be achieved reducing the overall system cost per consumer vs self installations**



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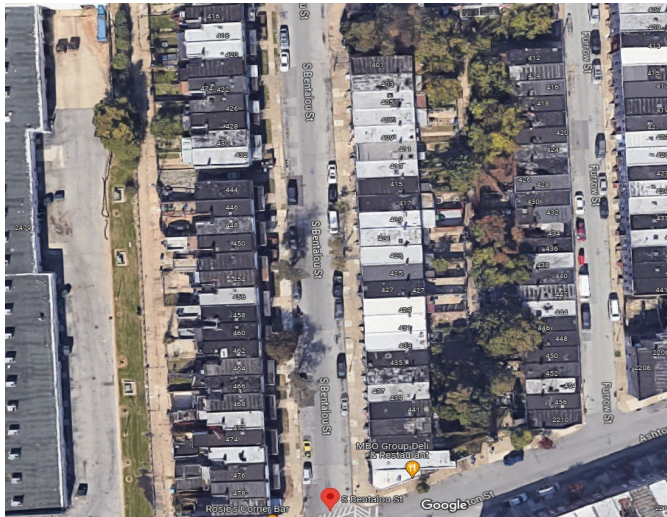
Baltimore Gas & Electric

- Current Buro Happold Project
- Utility exploring thermal energy networks to support thermal energy network legislation
- Concentrating on simple and repeatable closed loop geothermal clusters
- Also looking at capitalizing on waste heat opportunity

WWTP capable of providing energy to over 5000 homes

Relatively high density housing with potential to be thermally self sufficient



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bge AN EXELON COMPANY

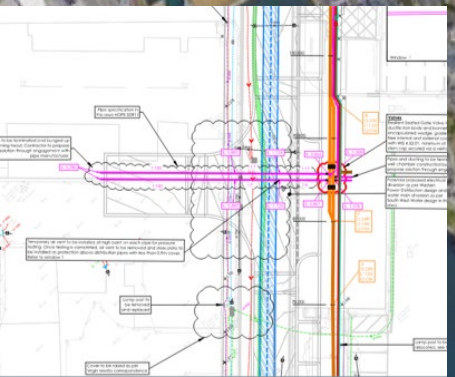
Plymouth – The UKs First Public Sector Thermal Energy Network

Target TEN / DH interface

Existing LTHW network with new high temp ASHP addition

Targeting WWTP interface with network.
Serve loads along whole spine

TEN w/ boreholes, targeting future sea water interface



Waste water treatment plant

To Summarize

- Thermal Energy Networks are a natural progression of district energy, efficiency increases over time.
- They are the most efficient and cost-effective electrification solution in situations with suit them.
- Illinois has multiple factors favouring the deployment of thermal energy networks.
- All components of the system are mature technologies, being used or explored in innovative across the US and Europe.

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Thank You

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