Welcome to the

Community Heat Pump Systems Webinar

A Series of 17 Webinars regarding Community Heat Pump Systems

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Learning Institute

Community Heat Pump Systems: What They Are and Why It Matters to You

Presented by:

Lisa Meline, P.E., Member ASHRAE

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Learning Objectives

1. Describe the three main components of all District Energy Systems (District Heating, District Cooling, and Community Heat Pump).
2. Understand major US policies regarding CFCs and GHGs.
3. List at least four different types of energy sources that may be incorporated into a Community Heat Pump System.
4. List the top two planning and design considerations for Community Heat Pump Systems.

Instructors

Speaker: Lisa Meline, P.E., Member ASHRAE
Meline Engineering Corporation
Sacramento, CA

Moderator: Gary Phetteplace, Ph.D, P.E., Fellow ASHRAE
GWA LLC
Lyme, NH

Agenda

- Community Heat Pump Systems Defined
- Why This Matters to You
- Energy Sources for Community Heat Pump Systems
- Community Heat Pump System Configurations
- Planning and Design Considerations

Community Heat Pump Systems

NYSERDA's vision is a strategic network of distribution pipes serving multiple buildings:

- Meet the thermal needs within a building (HVAC and DHW) using renewable electricity
- Expand clean energy options for customers who have insufficient footprint space to serve their own needs
- Leverage economy of scale
- Use this approach to address New York State's nation-leading climate goals

District Energy Systems

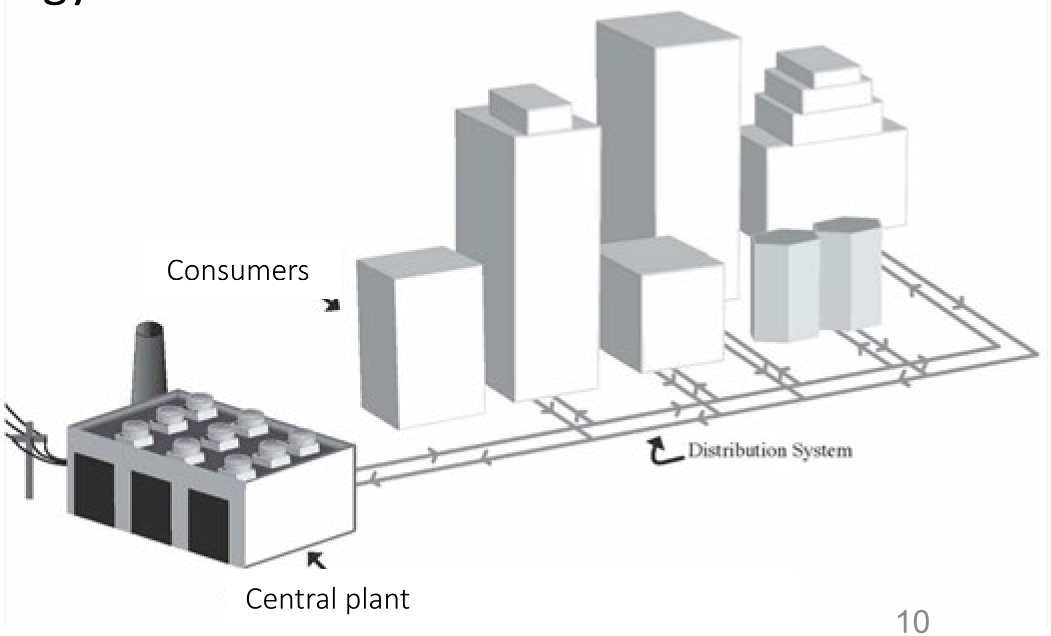
District Energy is the production of thermal energy from one or more plants distributed to more than one building.

- This includes District Heating and Cooling Systems, and
- Includes Community Heat Pump Systems (with a variation)

District Heating and Cooling Systems

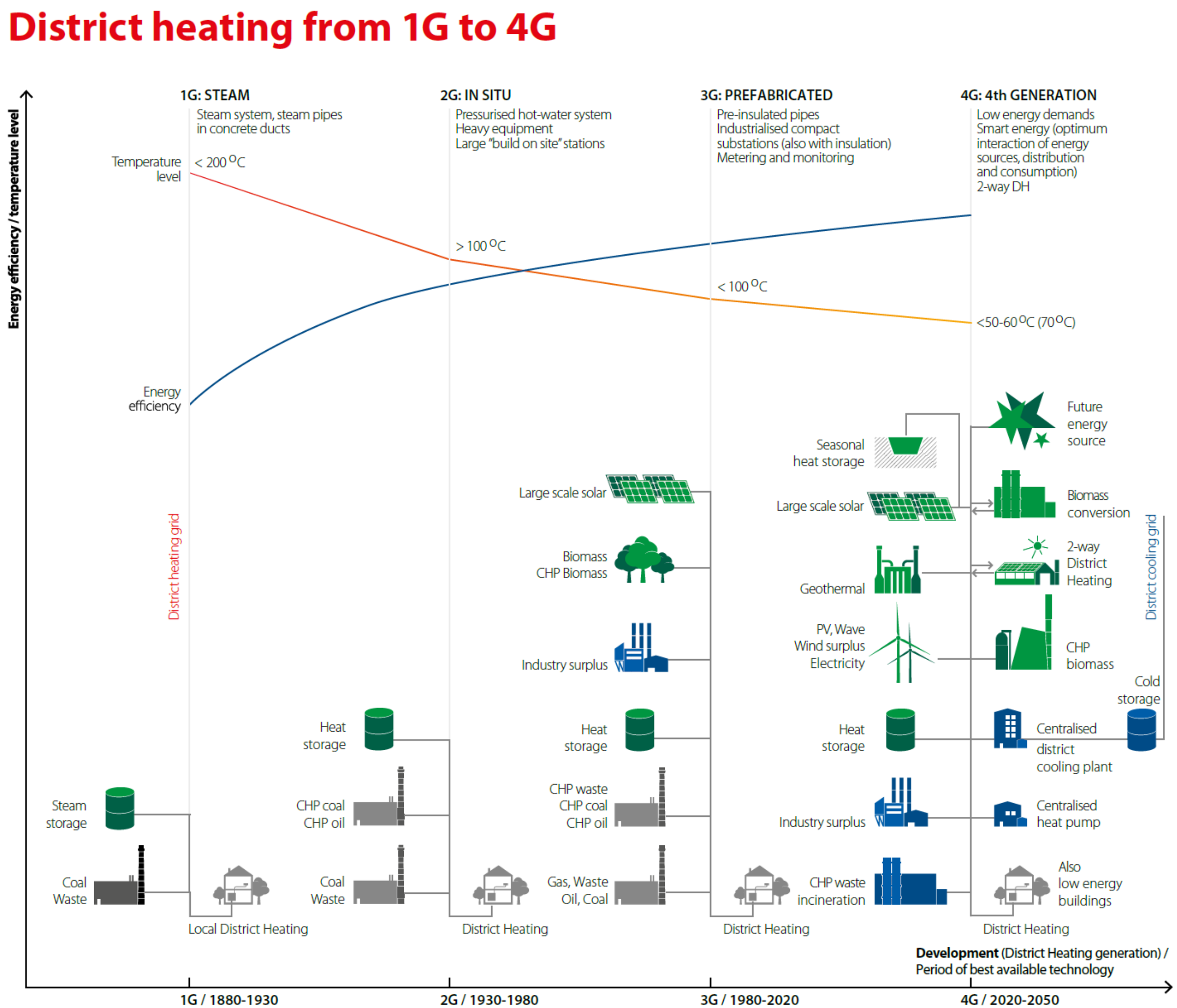
Main Components:

- Central plant or production source
- Distribution network piping
- Consumer interconnection (Energy Transfer Station)



Courtesy of ASHRAE District Heating and Cooling Guides

Generational Development of District Heating

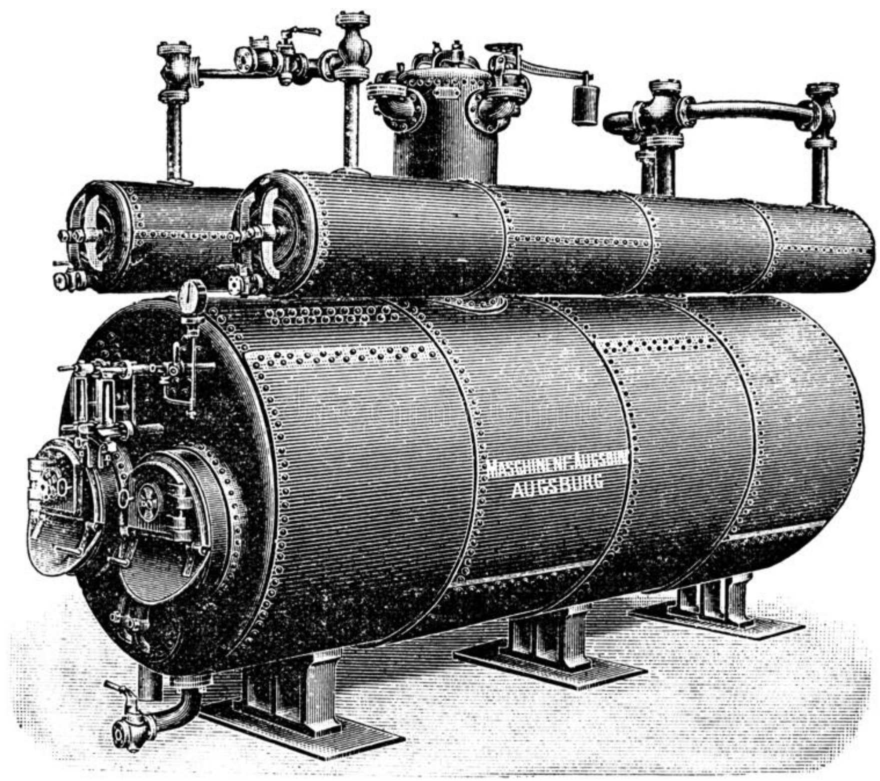


Courtesy of Danfoss 'District heating application handbook'

1st Generation District Heating

1880s

- Heat is transported with steam.
- First steam-based systems built in the US (Annapolis).
- High heat content resulting in low mass flows.
- Heats buildings and provides a heat source for other industry applications: absorption cooling, food preparation, laundry, sterilization.



2nd Generation District Heating

1930s

- Heat is transported by pressurized hot water
- Fueled by coal and oil.
- Combined heat and power plants provide energy savings.

3rd Generation District Heating

- Current designs impacted by the energy crisis of the 1970s; energy efficiency improvements.
- Hot water delivered at a lower temperature (than Gen 2).
- Extensive R&D as well as field studies resulted in the standardized EN253 for pre-fabricated, pre-insulated distribution system.
- Expands to include biomass and waste energy as an alternate to fuel oil as well as geothermal and solar energy.
- Centralized thermal storage.

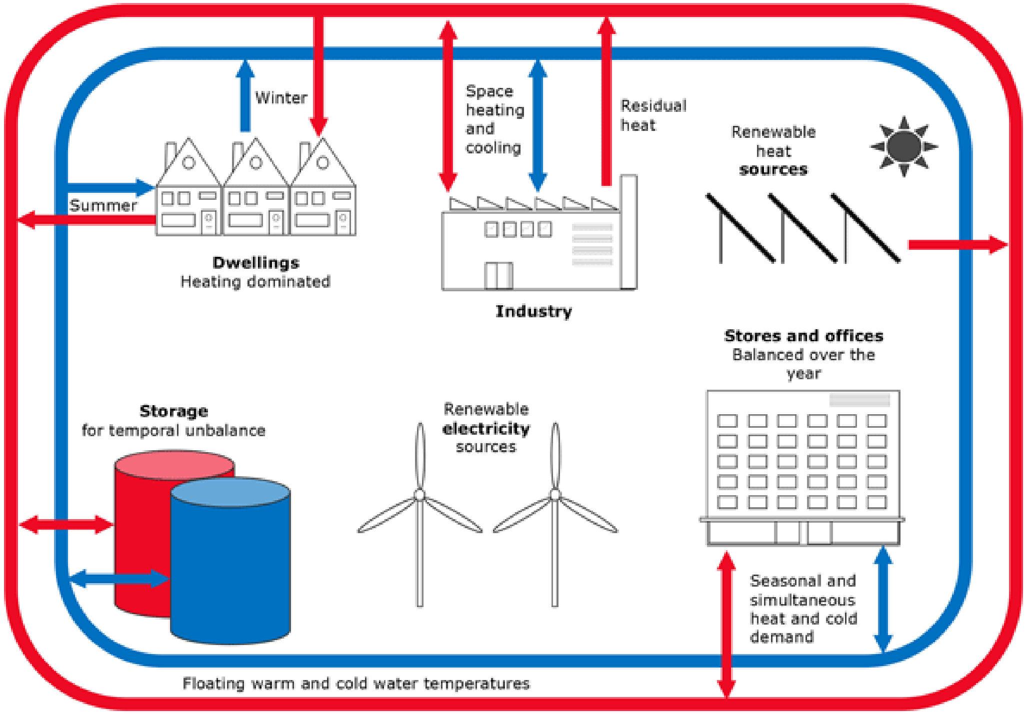
Prefabricated curved pipes. Source: Logstor A/S
Linked-In article by Oddgeir Gudmundsson, December 9, 2016

4th Generation District Energy Systems

- Focused on designs to combat climate change local waste heat and other sustainable energy sources.
- Use of low temperature heat of space heating and domestic hot water which allowed for the introduction of large-scale heat pumps.
- Introduction of district cooling.
- Desire to increase efficiency by cogeneration of heat and power.

Image from Interreg North-West Europe 4DHC technology guide

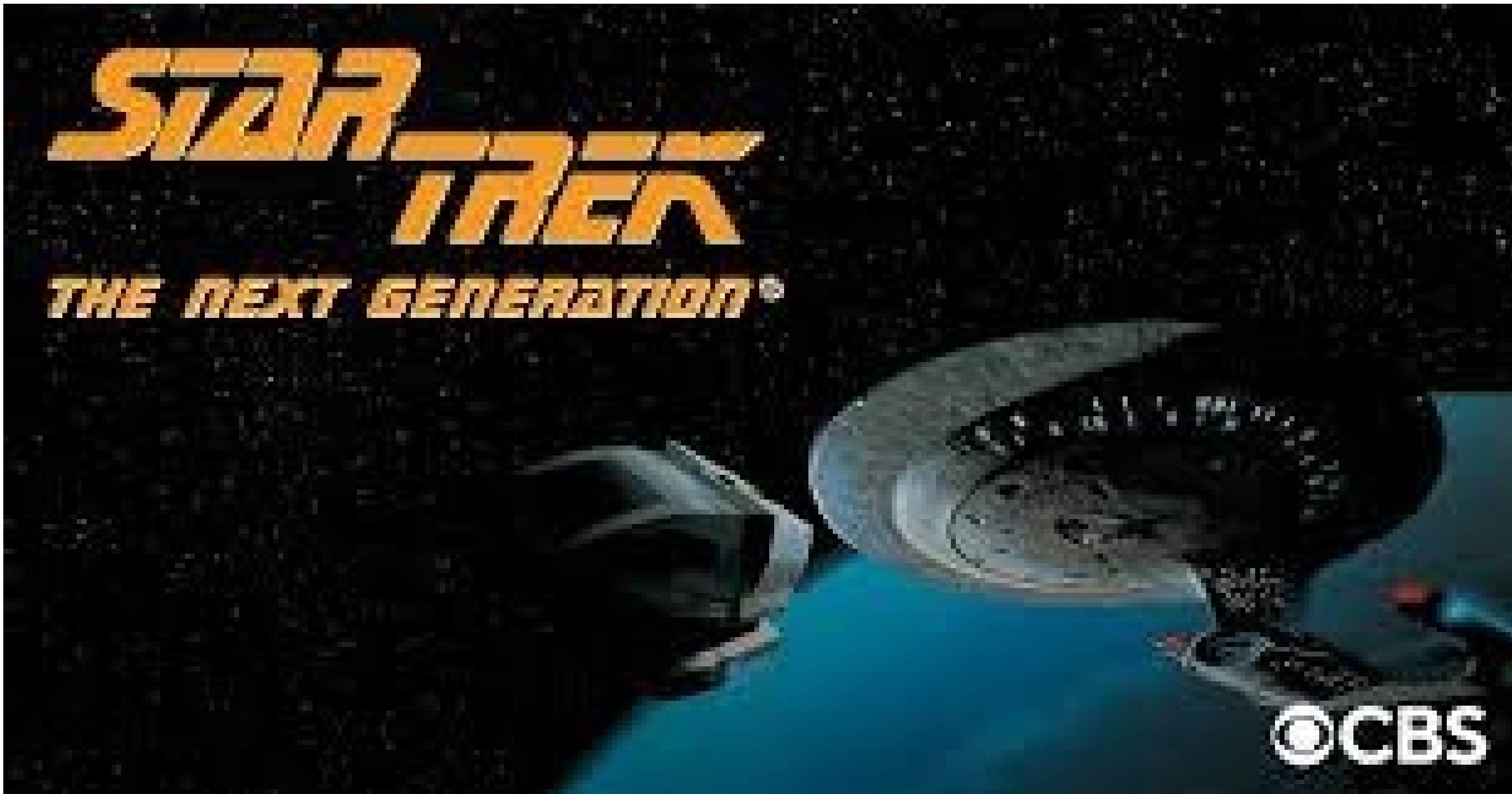
5th Generation District Energy Systems



Boesten, S., Ivens, W., Dekker, S. C., and Eijdems, H.: 5th generation district heating and cooling systems as a solution for renewable urban thermal energy supply, Adv. Geosci., 49, 129–136, https://doi.org/10.5194/adgeo-49-129-2019, 2019.

- District heating and cooling approach using renewable resources
- District heating and cooling components may be decentralized.
- Systems may be bi-directional, close to ground temperature
- Seasonal storage
- All electric. Ideally, no CO2 produced on sites.
- Includes Community Heat Pump Systems.

Next Generation



Why Does This Matter to YOU?

1988 Montreal Protocol: a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances.

1997 Kyoto Protocol: first document with legally binding limitations for limiting greenhouse gas emissions.

2015 Paris Agreement: an international treaty on climate change. The goal is to limit global warming to well below 2 deg C compared to pre-industrial levels based upon the best available science.

Why Does This Matter to New York?

2004 Renewable Portfolio Standard (RPS) established with a goal of increasing the proportion of renewable energy use by its citizen. The current goal is 70% renewable energy by 2030.

2008 Energy Efficiency Portfolio Standard was created with the purpose of reducing electricity usage in New York.

2008 Regional Greenhouse Gas Initiative: the first mandatory, market-based effort to limit greenhouse gas emissions in the United States.

2009 NY State Executive Order No. 24: established a goal to reduce greenhouse gas emissions 80% by the year 2050 and required the preparation of a climate action plan.

2015 State Energy Plan states that 50% of all electricity consumed in New York State by 2030 should be generated from renewable sources.

2019 Governor signed the **Climate Leadership and Community Protection Act** that requires "jurisdictional load serving entities to secure adequate amounts of renewable energy resources to serve at least 70% of the load in 2030. AND there are zero emissions in 2040 associated with electrical demand.

NYS Clean Heat Market Development Plan Goals

- ❑ Help achieve the state’s energy savings targets from the installation of heat pumps.
- ❑ Make electrification solutions available to LMI customers and disadvantaged communities
- ❑ Reduce the cost of heat pump installations by at least 25%.
- ❑ Provide consumer education & community engagement to build demand & reduce soft costs
- ❑ Advance clean heat supply chain development to ensure that products are affordable and available when & where consumers need them
- ❑ Provide technical assistance to help consumers navigate/assess options & build market confidence
- ❑ Invest in technology innovation/demonstrations to drive performance improvements
- ❑ Train and develop a clean heating & cooling workforce that ensures a talent pipeline to support the market growth necessary to meet NYS goals

Courtesy of Donovan Gordon, NYSERDA

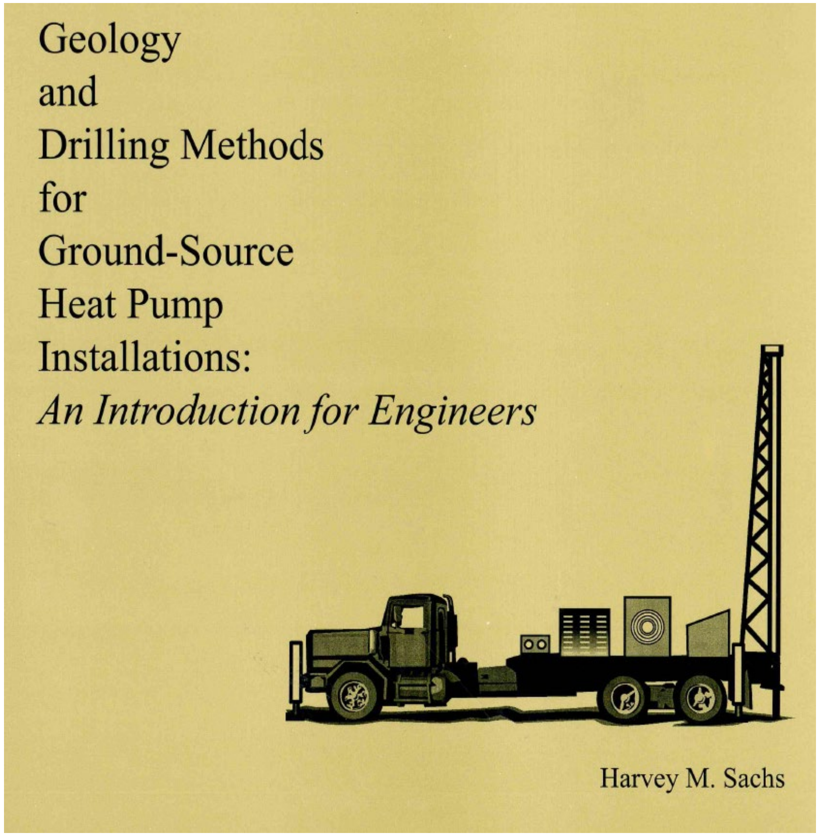
… just in from the EPA

EPA is challenging architects and building owners to achieve ENERGY STAR for all commercial new construction projects by adopting energy-efficient decarbonization strategies that move the next generation of buildings to zero carbon.

Community Heat Pump Energy Resources

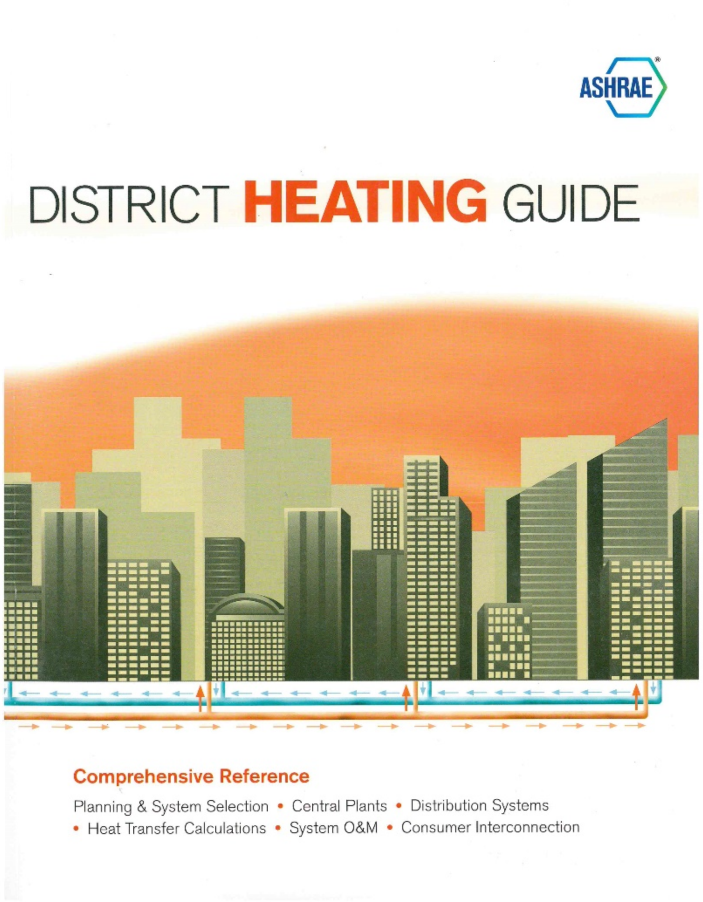
Start with a site survey

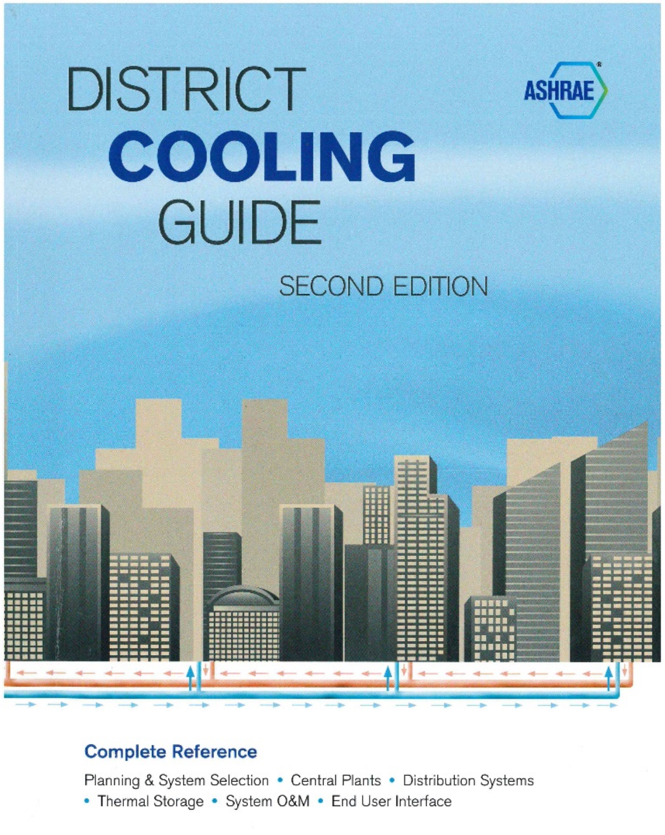
- 2019 ASHRAE Applications Handbook, page 35.4 for Site Characterization
- ANSI/CSA/IGSHPA C448.1-16 provides guidance in **Section 6** Site Survey Requirements.
- Also, survey existing building and distribution resources.



2002, ASHRAE Product Code: 90423

Community Heat Pump Energy Resources





Heat Recovery Opportunities

‘Sewer Heat’ Could Be Hidden Ally Against Climate Change. Here’s How Denver Is Pulling It To The Surface

By Sam Brasch | May 11, 2021

Hart Van Denburg/CPR News

The National Western Center plans to use excess energy from Denver's existing wastewater system to heat and cool buildings, now under construction at the 250-acre site, including Colorado State University's new "Spur" campus.

CPR News – May 11, 2021

Heat Recovery Opportunities

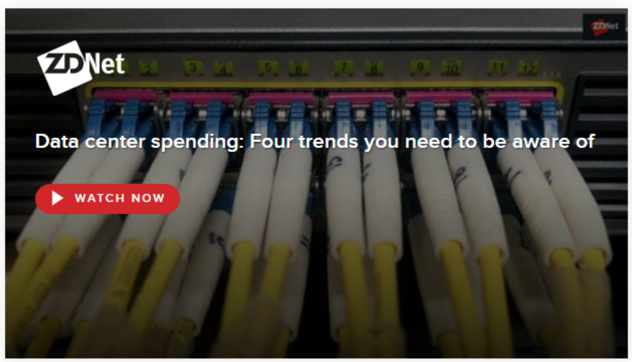
ZDNet 5G BEST VPNS CLOUD SECURITY AI MORE NEWSLETTERS ALL WRITERS

MUST READ: These 'technology scouts' are hunting for the next big thing in tech. Here's how they do it

Facebook is recycling heat from its data centers to warm up these homes

As it publishes its first sustainability report, Facebook showcased a new heat-recovery system in one of its data centers in Denmark.

By Daphne Leprince-Ringuet | July 8, 2020 -- 10:04 GMT (03:04 PDT) | Topic: Data Centers



In the Danish city of Odense, the depths of the winter months see average temperatures verge on -1°C. And for the last few months, many of us have been unknowingly warming up their households by the click of a "Like" button on Facebook, or the sharing of a post on Instagram.

ZD Net – July 8, 2020

Surface Water Opportunities

Lake Loop Installation On-going for Geothermal Heat Pump System

Posted on November 26, 2014

Installation is on-going for the lake loop portion of a closed-loop lake source heat pump system for the new Resource Center at Southern Union State Community College. The system consists of approximately 30,000 feet of pipe in bundles of 500 ft each will be installed in the lake as the heat source/sink for the geothermal heating and cooling system. Water-source heat pumps are designed throughout the building and are connected to the lake system with central pumps. Dedicated outside air units are provided for the entire building, with CO_2 control in densely occupied spaces.

Courtesy of HBB Engineers, P.C.

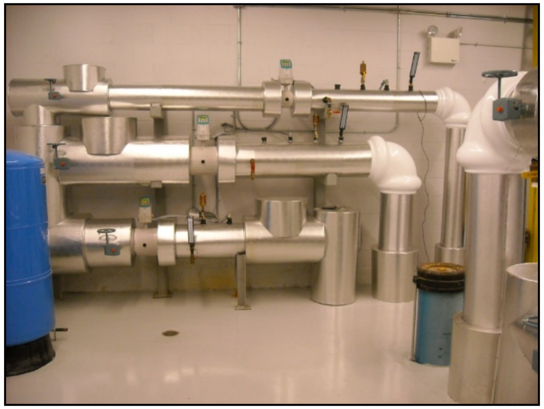
Surface Water Opportunities

Courtesy of Air Connection

Ground Heat Exchangers

Ground Heat Exchangers

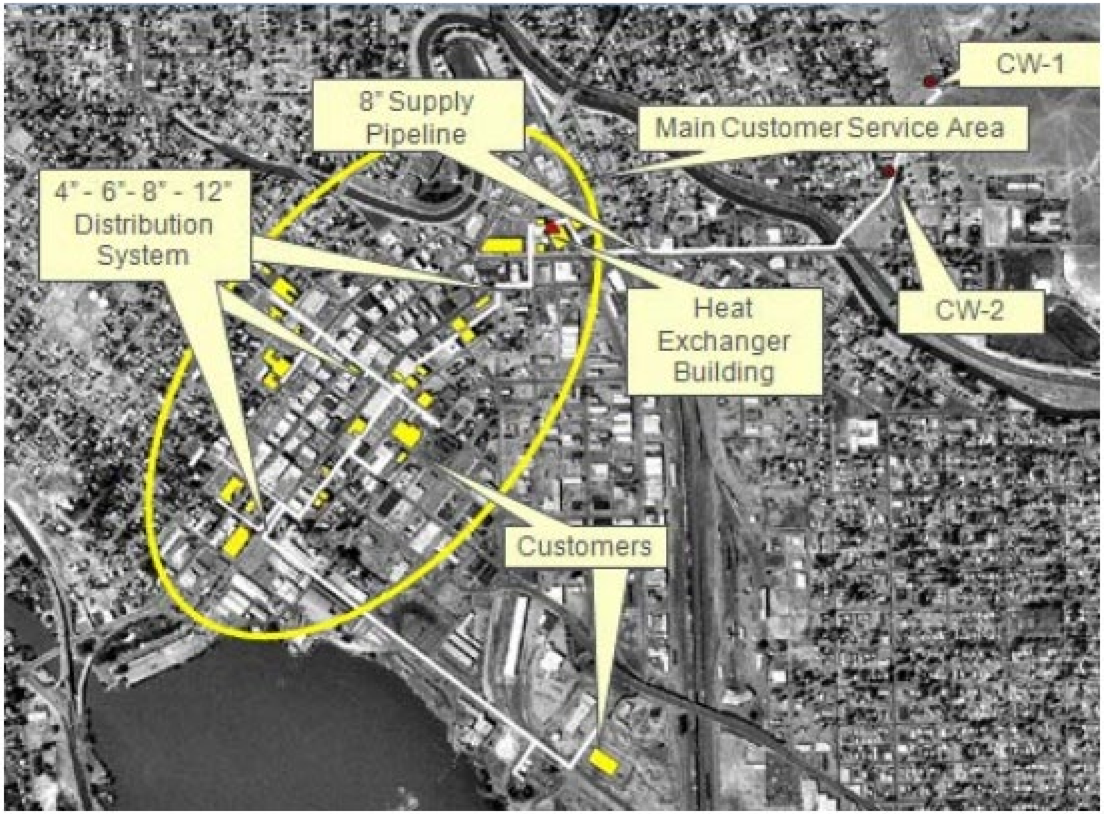
Ground Water Opportunities



© 2012 Kevin Rafferty, PE

Geothermal Opportunities

Figure taken from City of Klamath Falls, Oregon, Geothermal Power Plant Feasibility Study by Stephen F. Anderson, P.E., July 2011



Geothermal Heating System Aerial View

Solar Thermal Opportunities

Recycled Water Opportunities

Community Heat Pump System Configurations

- Single owner of multiple buildings on a single parcel of land
- Single property with a common developer which is later subdivided into multiple properties.
- Multiple owners of buildings on numerous parcels of land and no regulation.
- Multiple properties with different owners creating a utility.
- Multiple owners of buildings on numerous parcels of land with fully integrated geothermal system.
- Just 5 of 11 scenarios evaluated by Pace University.

Reference: Overcoming Legal and Regulatory Barriers to District Geothermal in New York State – Final Report prepared by NSYERDA by Pace University, Pace Energy and Climate Center, June 2021.

Clarification!

District Geothermal is also known as Community Heat Pump Systems

Geothermal heat pumps are ground-source heat pumps. Specifically, they are extended-range water-source heat pumps that exchange energy with ground water, surface water, or the earth.

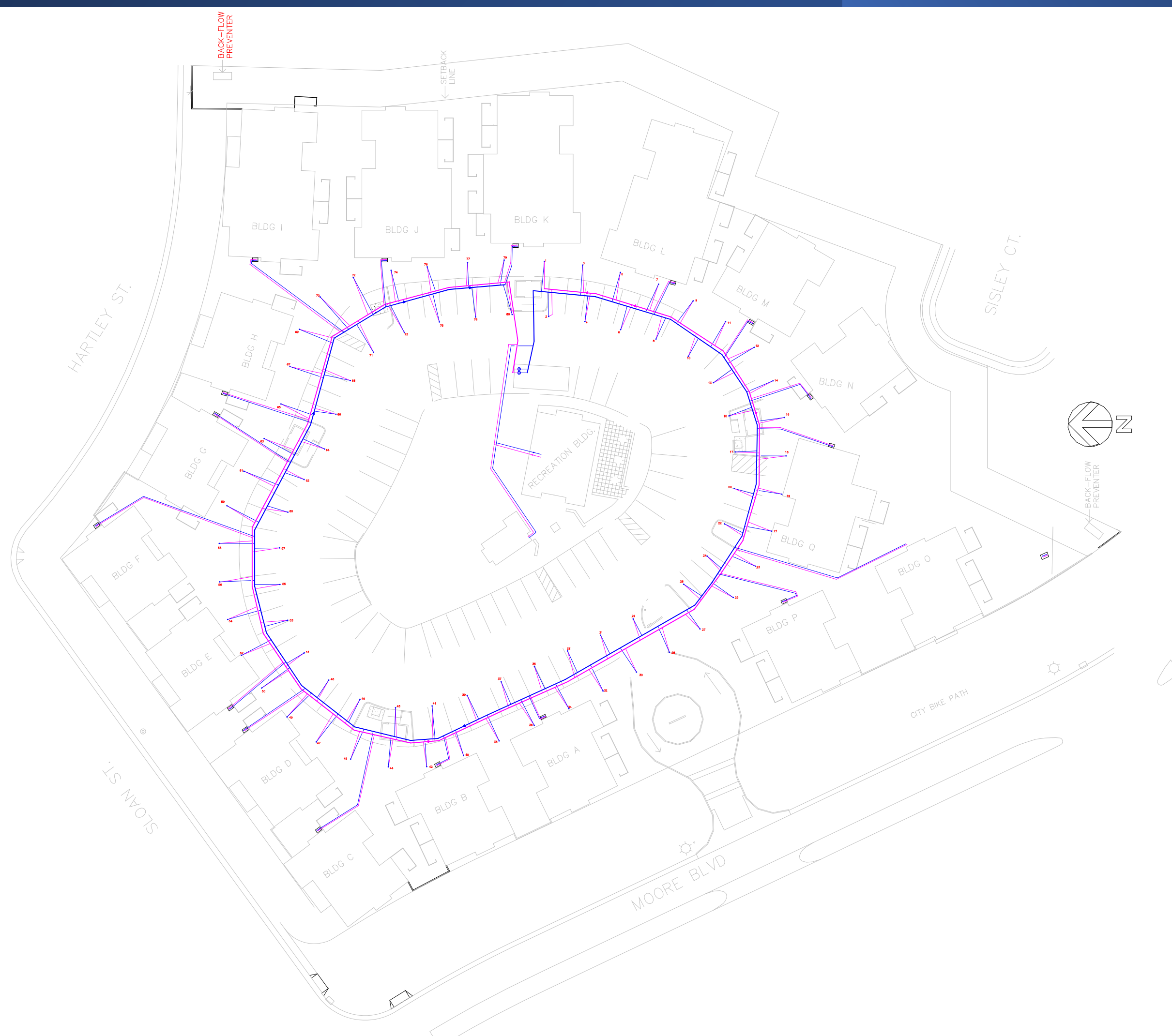
Single Property & Owner – Multiple Users

- Owner hosts a geothermal system on a single property that serves multiple users or tenants.
  - College campus
  - Multi-family housing
  - Hospitals
- Simplest of property rights and permitting arrangements.
- May include metering of individual building for internal accounting/cost centers.

Single Property – Common Developer – Subdivided into Multiple Properties

- Simplest property and permitting possible at the time of construction.
- Complexity of subdivided properties addressed through strong documentation established by the developer and accepted by future owners as a condition of sale.
- Metering will probably be required.
- Advantages: marketing a differentiated product and leveraging economies of scale to reduce borrowing and procurement costs.

Single Property – Common Developer – Subdivided into Multiple Properties



Multiple Properties & Owners – No Regulation

- Without any pre-existing relationship increases the complexity of legal arrangements significantly.
- Costs and delays increase as the number of stakeholders and properties increase.
- In absence of dedicate geothermal regulation, this model relies entirely on contract law.
- Metering will be required and isolation heat exchanger if older building are to be connected.
- Presents the greatest opportunity because it represents the vast majority of existing building situation to which this approach might be applied.

Multiple Properties & Owners – No Regulation

Unsplash

Multiple Properties & Owners – Regulated Utility

- This model would be advantaged by a regulatory arrangement that provides certainty and transparency to consumers.
- Geothermal development following this model involves more complex property rights arrangements because geothermal system components will need to cross property lines, requiring easements across properties and public rights of way.
- Public Service Commission empowered to adjudicate stakeholders' interests.
- Private, unregulated services providers would still maintain a role in the market of service providers and contractor to utilities.

Multiple Properties & Owners – Fully Integrated Enhanced Geothermal

- Regulation mandates multiple utilities and service providers coordinate their activities on a shared geothermal system.
- Utility-Grade metering will be required.
- Regulated utility with a geographic monopoly would serve as the system operator regulated by the Public Service Commission for standards of service and pricing.
- Presents the greatest potential to further optimize resources to reduce GHG emissions and introduce competitive pricing for consumers.

Time for the TOP TEN!

Planning and Design Considerations

1. Load Accuracy: Understand Coincident and Peak Block Loads
2. Preliminary Site Planning
3. Ownership model
4. Load Synergy; Heat Recovery over Ground Loop
5. Supplemental Heating or Cooling Sources/Shave off Peaks

Planning and Design Considerations

6. Flexibility, Scalability
7. Ground water protection; building loop protection
8. System design temperature appropriate for heat pump delivery.
9. System design temperatures for building systems.
10. Owner/operator buy-in, Training

Conclusion

Much of the content referenced for this webinar series is available due to the cadres of volunteers who work through ASHRAE Research and Technical Committees such as

TC6.2

District Energy

TC6.8 Geothermal Heat Pump and Energy Recovery Applications

QUESTIONS?

Join us for the next webinar in the series:

- Date: Wednesday, October 13, 2021
- Topic: Overview of Community Heat Pump Systems Currently in Operation Globally

Register at https://www.ashrae.org/CHPSWebinars

NYSERDA Resources

- Funding Opportunity PON 4614
- Fact Sheets of Prior Winners at PON 4614
- List of Solution Providers focused on this Marketplace
- Report regarding Regulatory Issues affecting this Marketplace
- Please see www.nyserda.ny.gov/district-thermal-systems

ASHRAE Task Force for Building Decarbonization

Learn about the ASHRAE Decarbonization Initiative and the ASHRAE Task Force for Building Decarbonization (TFBD) at

https://www.ashrae.org/decarb

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If you have any questions about the webinar certificate, please contact Kelly Arnold, Coordinator Professional Development, karnold@ashrae.org.

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