BUILDING DECARBONIZATION COALITION

BDC Presents: Unlocking The Power of Thermal Energy Networks (TENs)

December 14, 2023

Summary:
Join us to learn about the exciting potential of thermal energy networks (TENs) and where they are being installed nationwide. TENs provide an opportunity to reimagine how we heat and cool our homes free from fossil fuelsTENs are an elegant solution to a complex problem: how to eliminate the use of fossil fuels in our buildings at scale while providing a just transition for workers and delivering clean affordable heating and cooling to customers. We've known about this technology for nearly half a century.

Now, states and cities are newly considering thermal energy networks as they pursue options to rapidly reduce emissions from buildings, which can sometimes equal more than a third of a state's total emissions. Dive into the core principles of TENs, explore the multifaceted benefits they offer, and gain a comprehensive overview of the nationwide movement. From enhanced environmental sustainability to economic resilience, TENs hold the promise of a brighter, cleaner future for all.

Resources:

- Slides
- Recording
- BDC newsletter sign up

Key Takeaways

- Geothermal energy and thermal networks, especially utilizing ground source heat pumps, offer a promising solution for decarbonizing buildings.
- The deployment of thermal energy networks has the potential to achieve substantial cost savings, increase energy efficiency, and contribute to environmental goals, with successful pilot projects in various states.

Building Decarbonization Coalition's Approach

- The Building Decarbonization Coalition is employing a collaborative and scalable approach to decarbonize buildings, as highlighted in its webinar series introduction.
- Upcoming webinars in January will delve into topics such as neighborhood-scale decarbonization and thermal networks, featuring insights from experts within and beyond the coalition.

Rising Dominance of Heat Pumps and Impact on Gas Utilities

- The discussion underscores the growing popularity of heat pumps in the US, posing a substantial threat to gas utilities due to their efficiency, versatility, and installation incentives.
- Emphasis is placed on the ongoing transition of gas systems to electric heat pumps, projecting decreased fixed costs for gas companies and advocating for a more equitable transition.

<u>Exploring Geothermal Energy and Thermal Networks</u>

- Exploration of geothermal energy's potential includes successful pilot projects and instances like Eversource's conversion in Framingham, MA.
- Geothermal systems are highlighted for their energy efficiency, cost savings, and resilience, supported by studies showcasing their impressive performance during extreme weather conditions.

<u>Legislative Support for Thermal Magnet Technology</u>

- The need for legislative support is emphasized to facilitate the pilot of thermal magnet technology by gas companies, citing examples from several states.
- Evaluating Cost Dynamics and Efficiency of Geothermal Systems
- Detailed discussion on the costs and resilience of geothermal systems, shedding light on potential savings, payback periods, and the system's robustness during adverse weather conditions.

<u>Engineering Considerations for Optimal Geothermal Systems</u>

- Various factors, including energy needs, storage capacity, and meticulous site selection, play a critical role in determining the number of boreholes in geothermal systems serving multiple homes.
- Ongoing research is focused on developing shared network sizing tools to optimize the performance of geothermal systems.

<u>Thermal Networks and Strategic Site Selection</u>

- The conversation underscores the strategic importance of site selection and planning for heat networks, taking into account geology, government investment, and community involvement.
- The significance of weatherization is highlighted for energy conservation, irrespective of the choice between air source or ground source heat pumps.

<u>Efficient Waste Heat Utilization and Reliable Backup Systems</u>

- Insights are shared regarding the efficiency of utilizing waste heat for both heating and cooling applications, with a particular emphasis on the missed opportunities in this domain.
- Considerations for reliable backup systems for air source heat pumps are discussed, encompassing options such as gas backups and generators to ensure optimal functioning even during power outages.

<u>Resources Mentioned In the Presentation</u>

- Neighborhood Scale White Paper - https://buildingdecarb.org/resource/neighborhoodscale?
- Falcon Curve Study: https://www.nature.com/articles/s41598-022-15628-2
- DOE Report - https://www.osti.gov/biblio/2224191
- Upgrade NY site with MAP: https://www.upgradeny.org/about-thermal-energy-networks
- TENS page: https://buildingdecarb.org/resource-library/tens
- Upgrade NY labor video https://www.youtube.com/watch?v=RI_e1G-MyjA

Q & A

1. **Can you touch a little bit on the cost of doing it? What are the considerations for cost of building?**
- Understanding the cost dynamics associated with implementing geothermal systems for decarbonization remains intricate due to a scarcity of publicly available data. Instances like Colorado Mesa University illustrate a payback period of 10 to 12 years, driven by substantial energy and water savings. Nevertheless, the precise costs for utility companies installing these systems are yet unknown, as initial installations are underway in Massachusetts. The "Leg Up Study," conducted in collaboration with national labs, utilities, engineers, and the Massachusetts Clean Energy Center, aims to deliver a comprehensive analysis of technology performance, customer satisfaction, and costs, with findings expected next spring.
2. If you do geothermal for one home only, you need one borehole. **If you do multiple homes, can you use only one borehole per several homes, perhaps a deeper/wider borehole?**
- The number and depth of boreholes in geothermal systems depend on factors like the neighborhood's energy requirements, storage needs, and available space. Unlike individual houses, thermal networks don't need to be designed for peak demand, allowing for more efficient construction based on average usage, around 80%. The key challenge in network geothermal lies in identifying thermal sources and sinks, requiring the development of more sophisticated shared network sizing tools. An anecdote from Colorado Mesa highlights the untapped potential of shared energy transfer between buildings, showcasing the resourcefulness of networked geothermal systems.
3. **I would like to know more about companies working in the thermal energy space.**
   Please contact us: ACamargo@buildingdecarb.org
4. **How do you see the difference between pipe dimensions for gas and water?**
- So water pipes and gas pipes really are the same. While visiting the Framingham, MA site, it was confirmed that the pipe is the same size pipe but they could be bigger; One could size the pipe for the capacity you're trying to meet.
5. **What type of density is needed for TENs to be viable? Is this restricted to urban settings or are more suburban locations feasible?**
- Efficient deployment of geothermal systems depends on factors like local weather patterns, emphasizing the economic benefits of areas with significant temperature variations. Density and mixed-use developments enhance the effectiveness of these systems. However, in regions with consistently mild temperatures, air source heat pumps might suffice, and the economic viability of geothermal systems diminishes. Additionally, optimal results are achieved when buildings are closer together, minimizing the distance between them for increased efficiency.
6. **Can the networks serve as closed systems? If there's some disruption to the larger network, can smaller neighborhood networks/loops continue to operate?**
- Gas utilities are contemplating a strategic approach to transitioning from gas systems, envisioning the process like a hand where the main pipe is the central arm. Conversations with gas utilities suggest a methodical dismantling, akin to removing little fingers before the primary arm. This approach involves identifying sections at the ends of lines or on the periphery that can be decommissioned without affecting the overall system, demonstrating a thoughtful consideration for minimizing disruption during the transition.

7. **In the context of retrofits rather than new construction, what types of geographies, climates or building typologies are poorly suited for TENs?**
- Considerations for implementing geothermal systems include mixed-use developments and density, as evidenced by the site selection process in Massachusetts, where factors like geology, local government support, and community interest played a pivotal role. The emphasis was on fostering community investment and optimizing efficiency through shared energy loads and staggered heating and cooling needs across buildings. The challenging task involved evaluating numerous potential sites to identify locations that aligned with these criteria.

8. **Is there currently any standard on sizing of Networked Geothermal? What is approximately the temperature swing for Networked Geothermal?**
- A single-pipe ambient temperature loop is favored for geothermal systems due to its efficiency, maintaining water temperatures between 40 and 90 degrees. This design minimizes thermal drift flux, reducing heat loss and enhancing overall efficiency compared to traditional hot water systems. Additionally, the ambient temperature loop allows for both heating and cooling, providing versatility in the system's functionality.

9. **Apart from the piping, what other infrastructure is needed to have functioning thermal networks?**
- You need the borehole, central loop, and central pumping station that moves the water in the system. There are variations that may involve other system components like in cold weather climates.

10. Ground temperature and neighborhood density appear to be some good parameters to consider. **How do you determine a good site for implementing such a network?**
- The team in Massachusetts looked at the geology, customer and local government interest, density and EJ interest. These were more so focused on the way to identify pilot locations but the gas utility will want to look at the “fingers” and not the mains so they are trying to identify the locations where they can transition without impacting the main system.

11. **Heat pump is used to condition the ambient loop or the ambient loop uses only the geo loop to balance out the load?**
- ASHRAE's technical guide on geothermal systems is here.
- NREL and others are working on new tools to size the shared networks.

12. **Are you seeing 1,2,3 or 4 pipe systems?**
- A single-pipe ambient temperature loop is favored for geothermal systems due to its efficiency, maintaining water temperatures between 40 and 90 degrees.

13. **In the NorthEast are you seeing heating only or heating and cooling for residents? If cooling, are you cooling the sites that are providing waste heat?**
- The dual functionality of providing both heating and cooling is a notable advantage of the discussed system. The cooling process involves rejecting heat, which can then be redirected into the pipe for use elsewhere or stored for future applications. This versatile approach allows for efficient temperature control and strategic utilization of rejected heat, contributing to the system's overall efficacy.

14. Depending on the jurisdiction, heat pumps may need backup heating. **Are backup systems a necessity when implementing TENs?**

- These systems typically incorporate two types of backup mechanisms. The first type ensures the temperature in the loop remains between 40 and 90 degrees, optimizing heat pump efficiency. Colorado Mesa, for instance, employs a gas backup for supplementary heating and cooling, although it has rarely been needed due to stable temperatures. The second type serves as a contingency in case of electricity outages, with some systems equipped with generators to maintain the electric side, and examples like Verily utilizing solar and power walls for added resilience during power disruptions.