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[RUSTLING]

[CLICKING]

PROFESSOR: Yeah. Next up, we'll welcome to the stage Nicholas Fry, who is the Thermal Energy Networks Market Lead for Jacobs.

NICK FRY: All right. Good morning, everybody. As mentioned, I'm the Thermal Energy Networks Market Lead for Jacobs in North America. So I primarily deal with district energy systems, ambient temperature loops, things of that nature. Single building systems is something that I consult on every once in a while, but we have other design teams for that, generally speaking.

So I will go through some basic differences. I think it's hard to follow Connor for a better introduction to ground-source heat pump systems for standalone building systems, but this should give you an idea of when we transition to networks, the advantages that we can harness and use to optimize our building, heating, and cooling systems across large scales. So city-scale systems, regional-scale systems, neighborhood is easy in my opinion.

So back to the basics just a little bit. I'm sorry I wasn't here yesterday. Hopefully, you got a little bit of this. There are different completion types for vertical ground heat exchangers that are important in considerations when we're thinking about a utility-scale product. So this has to be something that is less capital intensive and can be paid for over the duration of the system operation.

Typically, A utility wants to look at a 30 to 50-year time scale. Gas networks, they go out to 70-year projections. So we want to make sure that we reduce the capital costs at the beginning.

The typical ground-source completion in the United States right now is conductive closed loop vertical systems. Those are actually capital cost intensive by comparison to open loop systems. Of course, you're leveraging a reduction in operations and maintenance costs by using the closed loop systems and going with conduction dominant. You're sacrificing the potential of taking the groundwater directly, and using that heat exchange and the heat capacity it's offering to the system to reduce the amount of drilling that you have to do.

But we can also consider geothermal networks as being multisource and multisink. So we don't just have to do drilling. We don't have to meet our entire load with the drilling. And the buildings around us have their own histories. So we have some relic structures that are designed around our steam systems. And to retrofit those, for example, Empire State Building, quite a task. You can imagine that that thing was built around a steam system. And you don't want to just gut the iconic structure itself.

So over time, we're going to have to think about expanding on the peripheries of our existing central systems. So you're going to encounter various requirements on building entering water temperatures that are going to dictate how you have to put this system together. The temperature regimes are going to vary.

So you're going to encounter perhaps combined heat and power systems when you're looking at building stock decarbonization. And this goes into something that is already a district energy unit. It's considered very high efficiency. But you're also exposing the owners to variable fuel cost.

So in this case, I've got biomass systems shown. But you can also have-- you can also have everything from coal to natural gas for these combined heat and power systems. And you can think about expanding with geothermal energy networks at the periphery where these district energy systems exist.

And so going into the sources and sinks that exist across our geographic area that we can leverage to decrease that capital cost at the beginning of your project consideration and your feasibility studies, one of the majors that's taking its place in geothermal and hybrid systems is wastewater energy transfer. There's a few different manufacturers out there. You can either do interceptor connects, which is those fluid conduits that are exiting each structure, or running down your neighborhood in a main collector.

Or you can do an effluent heat recovery. So in effluent heat recovery, you have to go directly to the sewage facility itself to recover the heat that they need to reject. So all of those effluent facilities are now exposed to regulations that say they can't discharge to surface water, as they have without meeting a minimum, or rather, a maximum temperature differential over the year.

So we're seeing time and time again, they have megawatts, like hundreds of megawatts, of thermal just from single sewage facilities that they need to discharge, and they don't have a place to go with it. So imagine the possibility of reducing your capital costs on drilling and making these geothermal energy networks more viable.

You can hybridize it directly with the surface water that you want to perhaps harvest heat from or reject heat to. But again, if you're going to reject heat to that surface water system, you have to operate within these future confines of the projected regulations that say you have a maximum temperature differential. It's actually quite simple for new construction to meet that minimum standard, because you can imagine that we built a city on top of the Earth. We're actually influencing the ground temperatures more than anything. And so our influence on surface water, nearby surface water resources is quite high already.

So you have to just prove or disprove that your system discharge is operating within those environmental regulations. And if you reduce the operating temperatures by implementing geothermal energy networks for your HVAC systems, it becomes much easier to meet that norm.

And geothermal energy networks, if we get into a lower temperature regime like Connor had mentioned, somewhere between 40 and 90 degrees of operating across a season between your highs and lows, you can also introduce load sharing. So as that heat pump is rejecting to a hydronic network, then another building along the route may be extracting heat from that network. And that, in fact, does reduce primary energy consumption across our cities. So that's a resource that you can tap into to decrease, again, capital costs, but also mitigate your emissions from the system even in scope 2.

And then we can consider all these sources and sinks in aggregate. I'm not sure if you saw this slide from yesterday, but very simply put, we know that we're electrifying building heating and cooling already. It's just a matter of doing it right, responsibly, or we're doing it irresponsibly. And this is based on a system-by-system basis.

Connor mentioned that Seattle might be a good place for some cold climate air source heat pumps to operate efficiently, but you also have district energy operators that have to switch over to electrification strategies of their own. Oftentimes, you'll see them putting in electric boilers with a coefficient of performance of 1 or less right. So that has impacts on our electrical infrastructure, the grid-scale impacts or consequence that we all have to deal with.

If we can implement geothermal energy networks and achieve more passive heating and cooling opportunities, load sharing across our cities, then our coefficient of performance can increase from the COP of 1 for the electric boiler, up to about 6 to 14 for most systems that have been measured so far. And of course, passive cooling opportunities exist where you have surface water bodies because the temperatures that they require are sufficient to leverage the water source itself.

So you might think of between 42 degrees Fahrenheit and 50 degrees Fahrenheit, you can use the surface water directly as a cooling source, and your coefficient of performance can then exceed 20, perhaps reaching as high as 60. So that's energy in versus the thermal energy that you get out. And really quickly, these are network topologies that you have to consider. A ringed network is the ones that we've been talking about more commonly for this workshop. But there are other variants that you see as you get to larger and larger scale systems.

Meshed networks can be an evolution of that, but they have more hydraulic disadvantages, in some cases. You can have stagnant loops. And radial grid systems are the most commonly seen in conventional district heating and cooling.

So in this case, you can also have what is a near-ambient distribution system in a radial configuration with distributed heat pumps. But you're going to also have to have a central plant. So you can either have distributed equipment, you can have central equipment, or you can have a hybridization of these. And you can also, in this example, connect existing high-temperature district heating and cooling systems with their own near-ambient energy exchange loop. So there are ways to decarbonize and leverage ground source systems without always having to go to ambient temperatures.

And these are, again, the many process heat recovery sources that you can encounter, such as data centers, the wastewater energy transfer, and existing CHP systems that you already have existing across the cities. So the heat sources and sinks themselves are numerous. And these have design consequences that Brian is going to get into next and describe with a case study and then give you some decision-making points to think about next.

Final thought here. If we skimp on design, we sacrifice everything else. Our operating and maintenance is going to be abysmal. And we're going to be stuck with these systems for the next 50 years. So that's why having this conversation now, as we're transitioning to electrification and building heating and cooling, is important. We're going to live with this. All right. Thank you.

[APPLAUSE]