

[SQUEAKING]

[RUSTLING]

[CLICKING]

PROFESSOR: And so next we have Susan. You need the clicker?

SUSAN I do need the clicker. I don't need this.

MURCOTT:

PROFESSOR: It's about the MIT project.

SUSAN Wow, that was fantastic. I also want to add my voice to this chorus, my voice and my colleagues' voice, and to
MURCOTT: start by thanking Zeyneb and this incredible group that's joined here today. And to say that you all are pioneers.

I've been so moved by so much creative work by so many leaders in the field that have been brought together. It's truly remarkable. And so thank you.

I'm going to introduce to you the MIT Thermal Energy Network, or MITTEN, plan for rapid, cost-effective decarbonization at MIT campus. It is the work of MACA MIT campus group. MACA stands for MIT Alumni for Climate Action, in collaboration with Geo at MIT, which is the student group that we've worked with. MACA was founded in 2018.

The idea for a thermal energy network for MIT campus goes to Rick Clemenzi a colleague of Garen Ewbank, who we heard from earlier. Rick and Judy won a Climate CoLab competition that MIT sponsored in 2016. But it didn't go anywhere. MIT wasn't interested at the time in listening to that. We picked that up at MIT-- the MACA group picked up that idea and have built on it for the past three years, and we just introduced it formally in a class that I taught this past week, and in an hour-long presentation, which has been reduced to 10 minutes for today.

So moving along, MIT's decarbonization challenge is that 97% of MIT's greenhouse gas emissions are from the operation of its buildings. And 26% of all of Cambridge's greenhouse gases are from MIT.

MIT has had two climate action plans in 2016 and 2021, which postponed significant investment in direct campus decarbonization until later. Its emphasis in the early years, 2020 up to 2040 and going on, is a power purchase agreements in the Midwest, and mainly the power purchase agreements. But it hopes for some major breakthroughs in the future. And is going to-- there are voices among this chorus at MIT who would like to see small nuclear reactors or deep geothermal at some future point when it becomes a reality.

The MIT thermal energy decarbonization plan is an all-electric campus fueled by carbon-free power. It implements energy conservation measures, including waste heat recovery from ventilation systems to reduce heating and cooling. We're installing high-efficiency water source heat pumps in each building distributed for heating and cooling. It repurposes the existing chiller loop to an ambient loop, circulating 45 to 85-degree water year round to water source heat pumps in each building.

It repurposes the oil tanks at the CUP, Central Utilities Plant, for thermal storage. And there are energy transfer stations operated by the Cambridge Water Department, exchanging heat with the ambient loop where possible. And if not, then looking to the MWRA and the wastewater sewage or drilling geothermal boreholes.

The plan is the most cost-effective and energy-efficient way to decarbonize the campus. It demonstrates MIT leadership. It leverages MIT's investment in existing infrastructure. It eliminates the cost impact of maintaining separate systems because the water source heat pumps provide both heating and cooling. It eliminates energy transmission losses, enables the capture of free energy where there is concurrent heating and cooling on campus, and perhaps will tap into future subsidies. The Met building already demonstrates this, and that demonstration is underway.

How is the campus heated and cooled now? It has a central utilities plant with cogeneration. It produces steam and hot water. It operates on a steam-driven chiller. It generates over 22 megawatts of electric power connected to steam distribution, connected to chilled water distribution to most buildings. And the cooling load is high and most affected by global warming.

Decarbonization issues with the existing plant, the grid decarbonization is rapidly reducing carbon, once touted for a combined heat and power. Fossil fuel backup is necessary. Efficiency of 50% to 55% source to output. Low turndown rate of about 30%. High thermal losses in the steam distribution system of 10% to 20%.

Nonzero losses in the chilled water system of 5% to 15%. And also the hot water district system have losses also. And hot water is what MIT's administration is currently seeming to embrace for its favored geothermal pathway option.

How would the MITTEN plan heat and cool the campus? Distributed heat pumps connected to a network of sources and sinks. No one solution, since the buildings range over a history of 100 years. Use of building-to-building and building-in-building sources and sinks. Use of thermal energy storage and ground coupling with, as I've said, Cambridge Water, sewer, or ground thermal exchanges.

We consider this a fifth or sixth generation district HVAC decarbonization transition with an ambient loop, two-pipe system, exhaust recovery, distributed water source heat pumps, thermal storage, air source heat pumps, and ground heat exchange, municipal water thermal, and other. And the chiller loop to the ambient loop conversion, we would use the same two pipes that exist already. First of all, the blue buildings have currently chiller loop.

Oh, and I didn't say we have-- MIT administration provided us with a memorandum of understanding to test fit our idea to six buildings. And those six buildings are here. W20 is the Student Center, and the rest are the athletic complex, W31 to W35. And three of those buildings have-- the blue buildings-- have the chiller loop, but the other three do not. So our plan would-- for the test fit, would require the chiller loop to be added to these three-- excuse me. The ambient loop to be added to these three buildings, as represented by the green dots.

Were our proposal for these buildings expanded to the whole campus, we would also need an ambient loop here. Those were the only two places that we would need to do work. And I meant to say that here are the six buildings on a graph of the EUIs of a number of the buildings-- not all the buildings, but most of the buildings. And MIT has very high EUIs with the lab buildings being-- ah, backwards-- the worst performing buildings. And what's interesting is that these six buildings represent quite a huge span of the campus current EUIs.

So this is where in W33 the ambient loop would run. And this is the cluster from above on which the ambient loop that you just saw would be running from the chilled water loop connection through what you just saw, and through this building and into this building and also into W20. We would also put solar collectors on these wonderful flat roofs that are hidden from view.

And we would put on the roof of W20, the Student Center, multistack heat pump units where there's already space for that. We would put, as one option, multistacks in W34 as well. Perhaps another option would be the AAON SA-23 in W34. And then to compare, a central plant four-pipe distribution system, as is being proposed, you can see that MIT currently has installed hot water pipes in the Sloan complex. It represents about 15% of the campus.

And the consultant's plan would require hot water pipes with, I believe, 180 to-- they call it low-temperature pipes, but not so low-- 180 to 240, I believe, degrees Fahrenheit hot water in these pipes. And all of this would need to be installed. And of course, that would need steel pipes and insulated pipes as opposed to the ambient loop small areas here. The central thermal plant has heat losses in transmission. It starts off with a lower COP and MITTEN's has limited heat losses because of each heat pump being in the building itself. So

To sum up a kind of top line comparison of approaches. Both approaches meet building HVAC specs. Both approaches achieve zero emissions. Our approach achieves those emissions by 2035 were we to start this year with a pilot on the existing six-building complex. Ours is minimally disruptive, as you saw, with the ambient loop only needing to be extended in a few places.

We need a pilot to confirm our projections and to learn, as the heat Eversource demonstration has learned, a tremendous amount. We need to do that learning on the MIT campus by a real project. It's easy to upgrade over time. It's fiscally responsible. And it's unclear whether MIT will seriously consider our proposal. Our proposal we call a thermal transition leapfrog. And would go from the existing chiller plant to a distributed energy network.

So finally, at the end of the day, the project is not just about public relations, but it should result in real progress. The central utility plant will play an important role in the MITTEN solution. Our plan is available now. We're using off-the-shelf equipment. It's cost effective. It will eliminate carbon emissions and be minimally disruptive.

We feel that we can show the world and demonstrate to other campuses, not only in Boston area or across North America, but around the world, that this is an approach that is cost effective, rapid, and doable. MIT's the world's leading research institute and should do something that's not just a cookie cutter that other campuses have already done, like Princeton or like Stanford, and it is a centralized approach. And we need to do a pilot and advocate for that for 2025 so that we can get to net zero by 2035.

And I'll close with words of Sally Kornbluth at her inauguration. Climate change and its mounting consequence is the greatest scientific and societal challenge of this or any age. We need energy and expertise from every MIT school and college, and from every lab and every center, from every member of the faculty, and from every one of you.

So thank you. And I think I want to end really with this slide. We want to get there by 2035. And we're asking MIT, when can we start?

[APPLAUSE]