



**GEOHERMICA Initiative & CETPartnership TRI4
Workshop in Dublin 10/10/2023**

Low Temperature Geothermal for District Heat in the Eastern U.S.



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Agenda

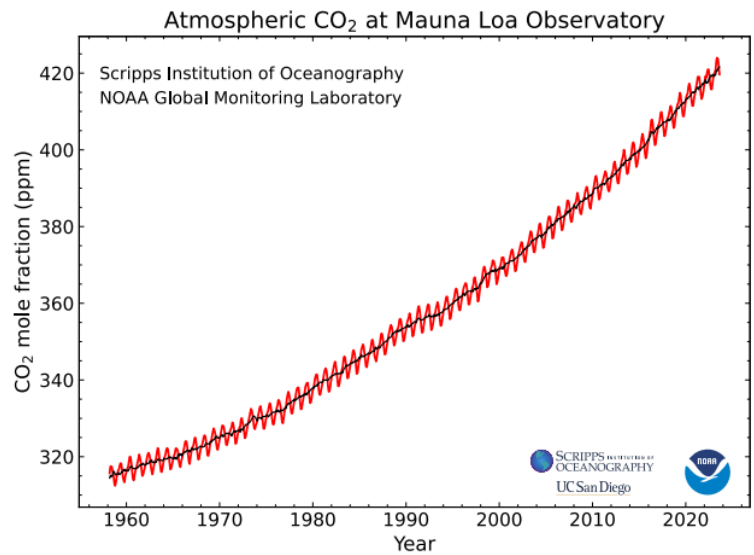
- Goal: reducing GHGs
- Electrification of **heat** using less electricity
- US Geothermal resources
- Cornell's approach and CUBO
- Other Eastern US efforts
- Q&A



Cornell seeks to demonstrate how low-temperature geothermal can provide baseline heat for the eastern U.S. at lower overall cost and risk than conventional resources.

The Goal: *Reduce Greenhouse Gas (GHG) Emissions*

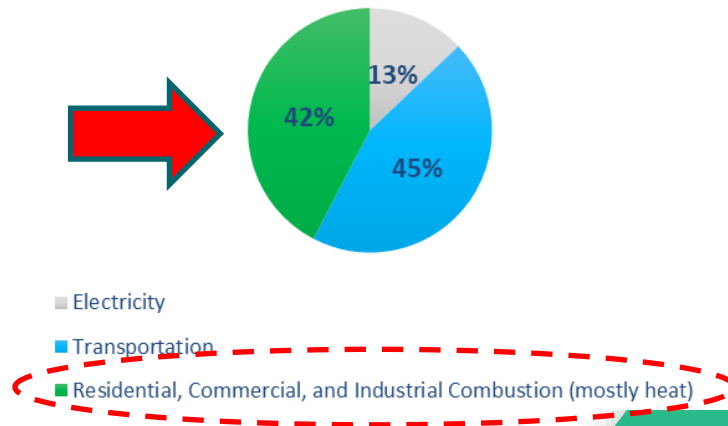
- We are not achieving emissions reduction targets – **GHG emissions are still growing**
- Current approaches are not making a significant difference (based on data)
- Vast amounts of **geothermal energy** are available everywhere in the world
- Challenge: finds ways use geothermal energy safely, effectively, and globally

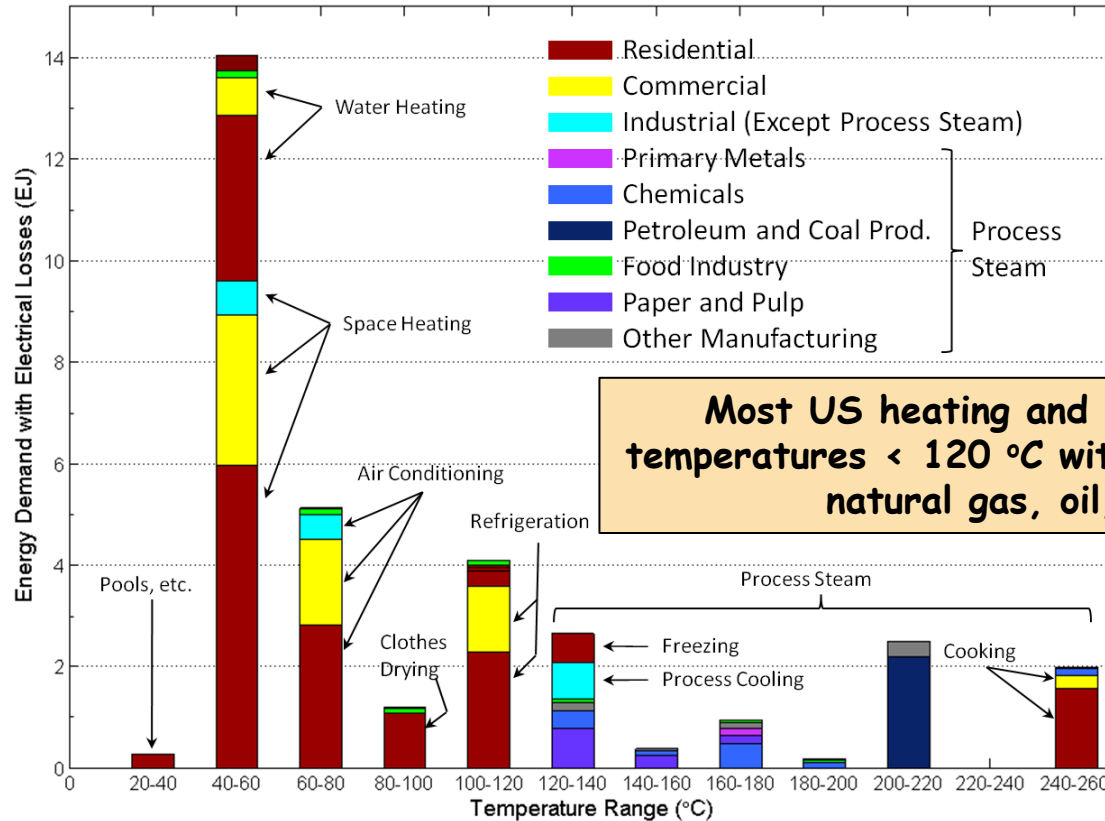


Heat is responsible for significant carbon emissions

- Elimination of fossil fuel combustion (by **electrification**) is essential to meet decarbonization goals
- **Geothermal “Direct Use”:**
“**Electrification that uses less electricity**”

2021 GHG Emissions
(mmt CO_{2e} GWP20)

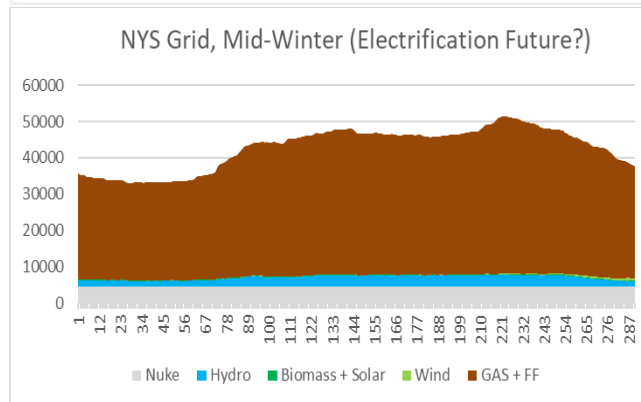
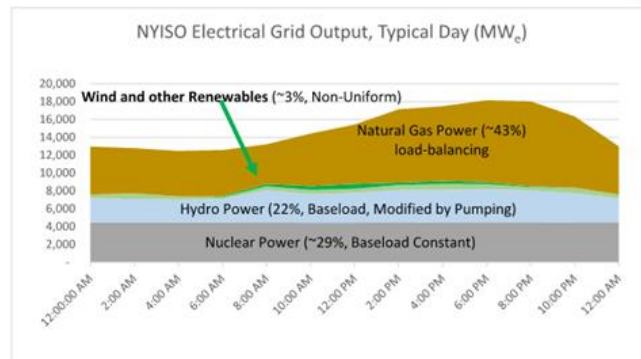




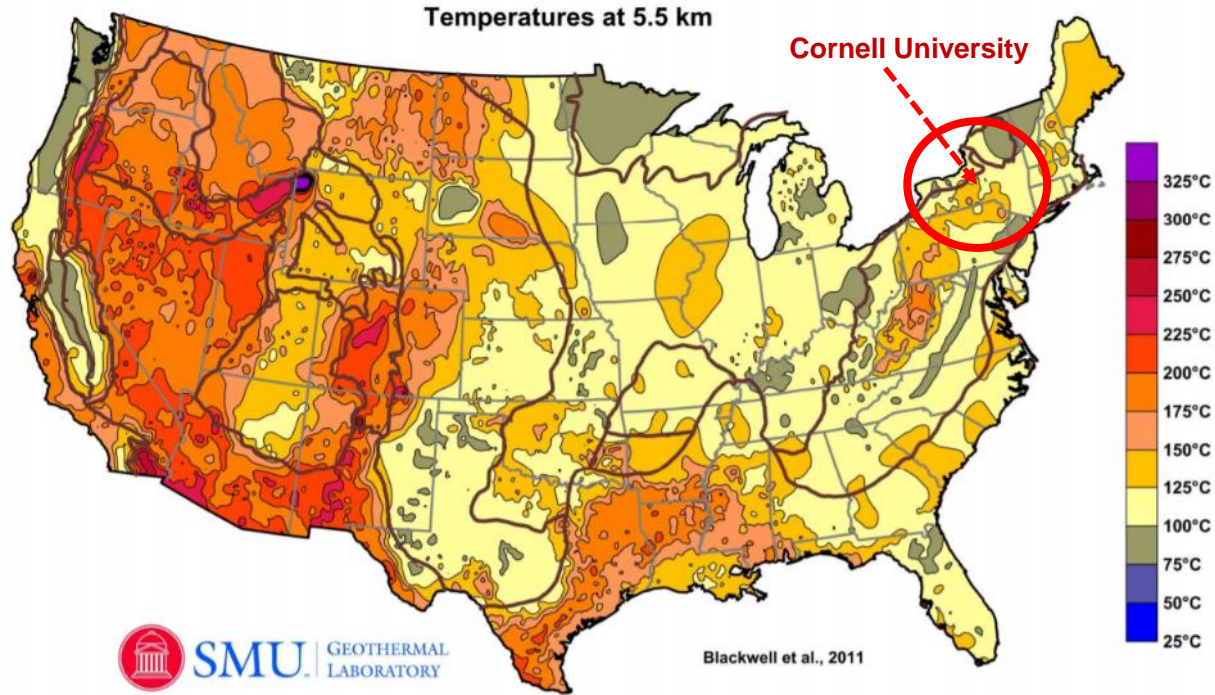
Most US heating and cooling needs are at temperatures < 120 °C with most of it supplied by natural gas, oil, and propane

NY's 2040 Goal: 100% Carbon-Free Grid

- To meet carbon reduction goals, we must electrify transportation and **heat**
- In the US, **fossil fuel generation** balances the regional electric grid(s)
- Conventional** solutions (ASHPs) require very large amounts of electricity in winter
- Highly efficient** thermal systems (like direct geothermal) significantly reduce this challenge



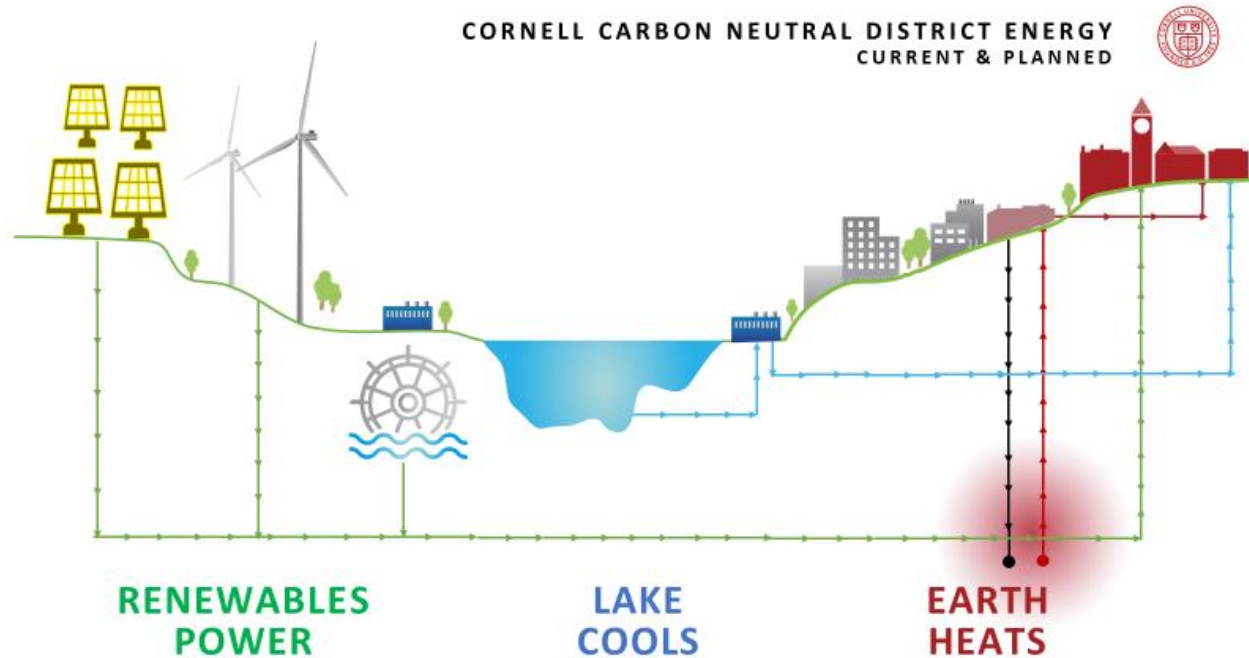
USA: Geothermal Resources



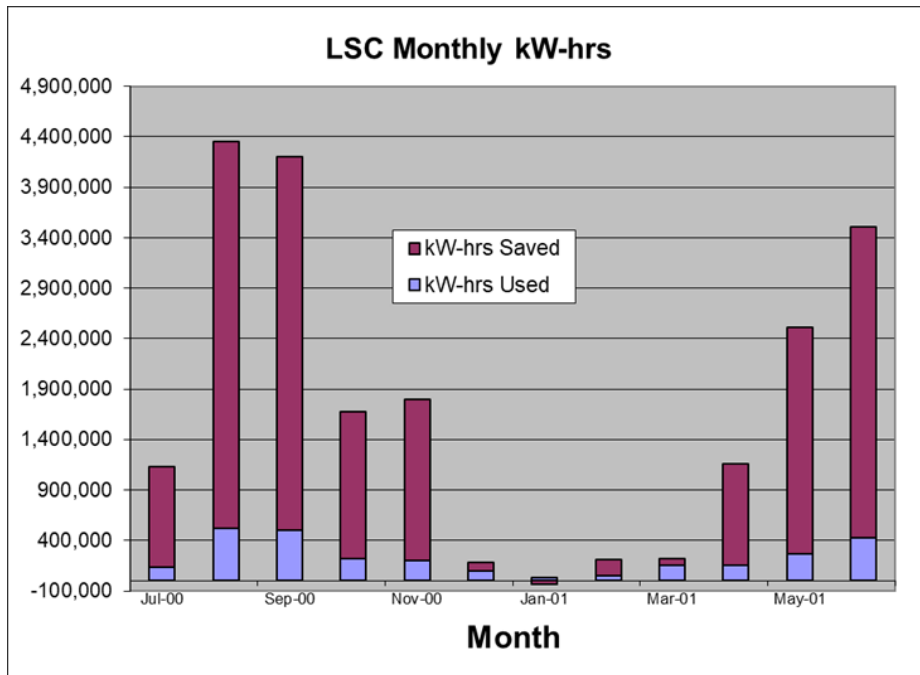
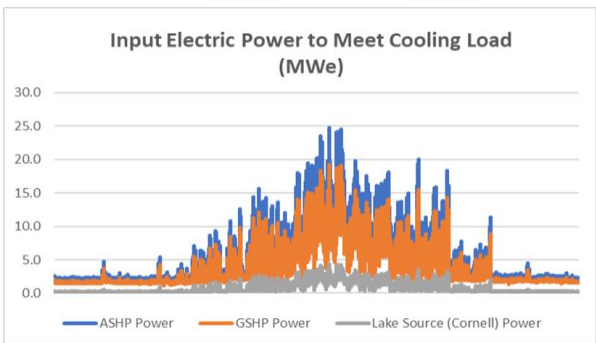
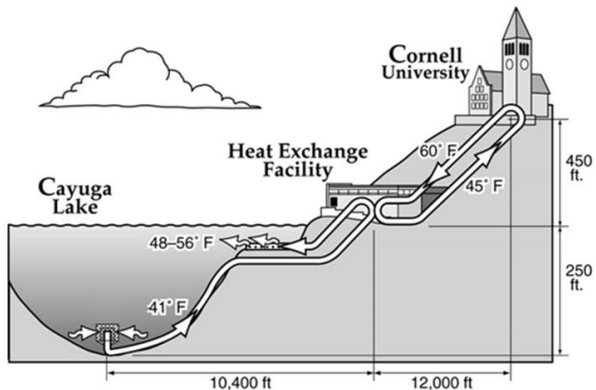
Direct Heat or Electricity?

- For temperatures at 3 km at Cornell (~80-90°C)
 - Direct use of heat is MUCH more efficient than conversion to electricity (about **16x as much heat as electricity!**)
 - Our proposed system includes very high efficiency (Coefficient of Performance ~8) heat pumps. This system produces heat using a fraction of the electricity of air source heat pumps (ASHPs)
 - Doing the math: **the total cost for renewable geothermal heat is much lower than using ASHPs** when factoring the cost of the required grid resources

Cornell's Goal" Carbon Neutral by 2035

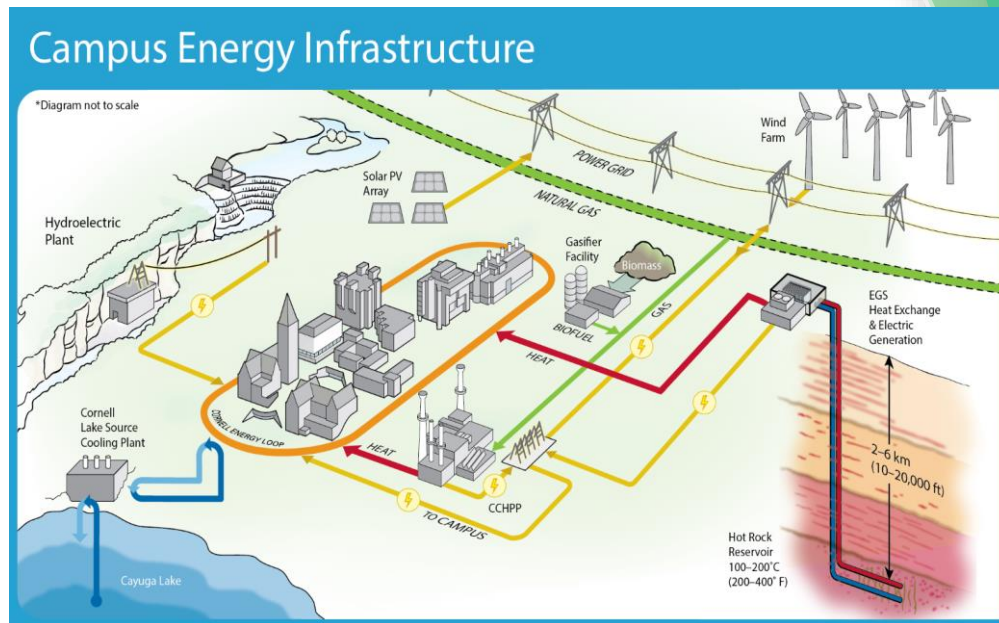


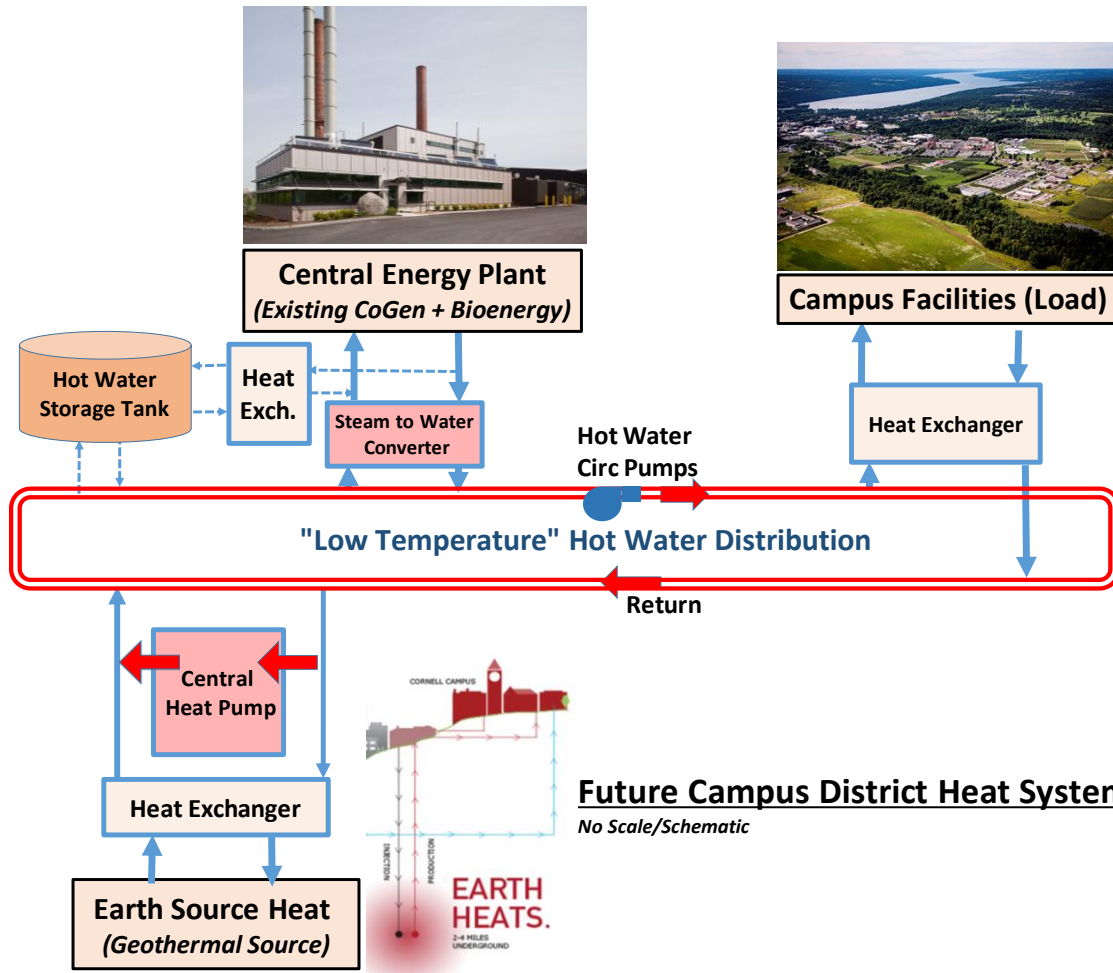
Thermal Innovation: Lake Source Cooling



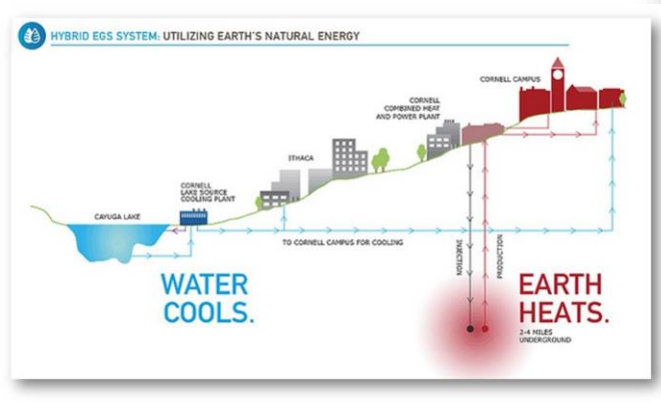
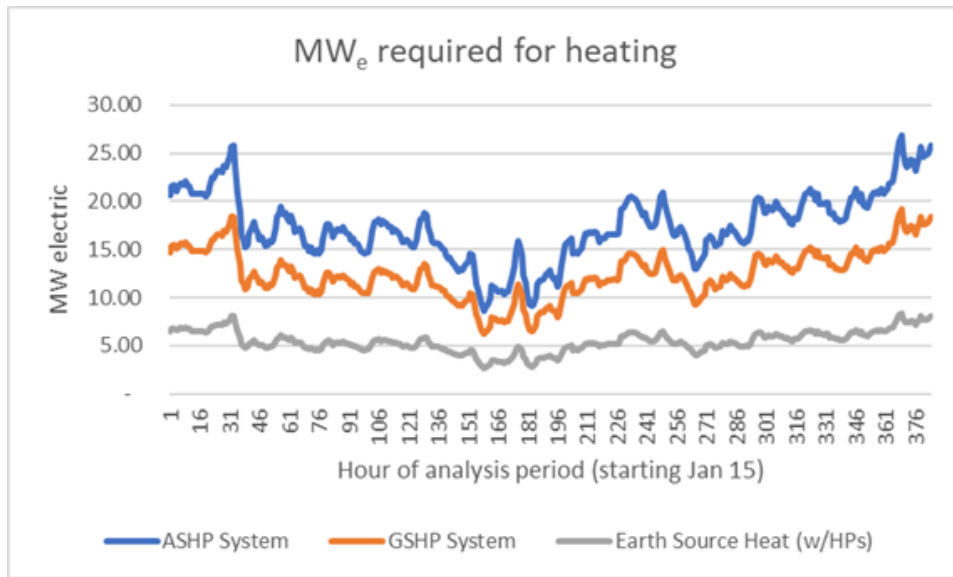
District Energy to integrate Renewables

- The electric grid allows integration of hydro, wind, or solar from remote (or on-site) locations
- “District” *thermal* energy infrastructure (buried water pipes) allows integration direct heat



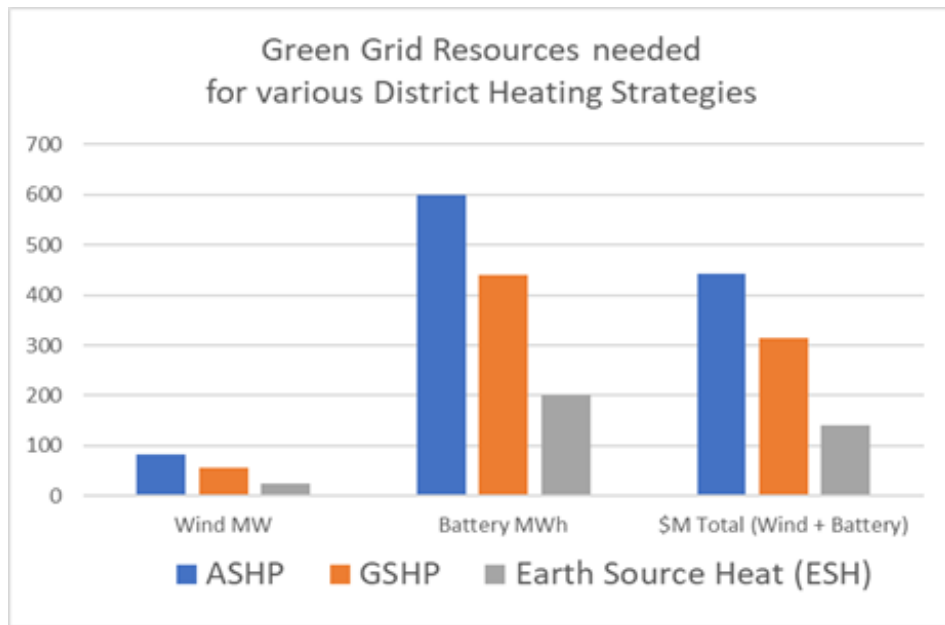


Electrification using less electricity



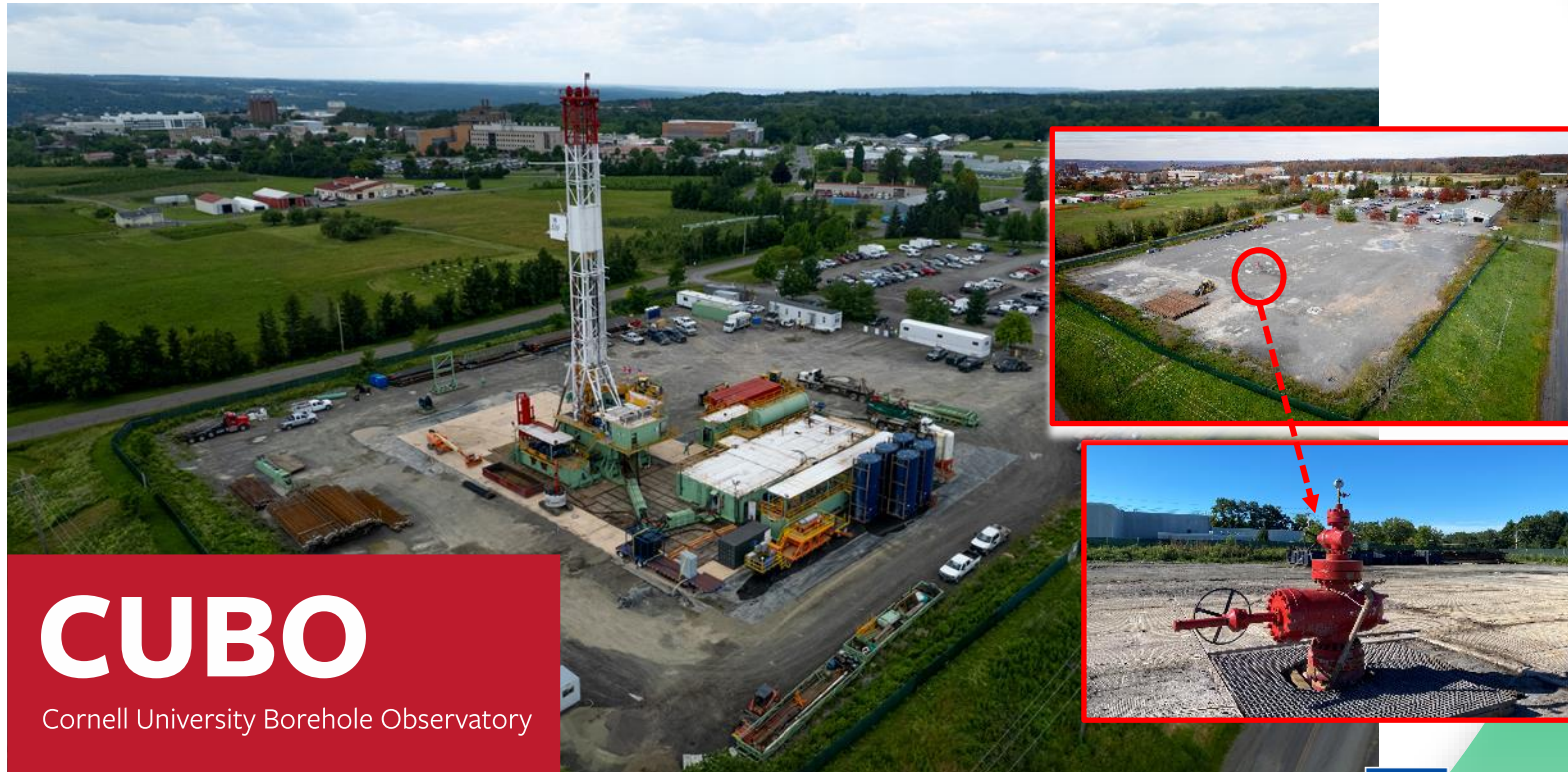
Cornell's Earth Source Heat aims to provide the same benefit as Lake Source: *Sustainable heat that requires minimal electricity.*

Financial Savings (for broader society)



Low Temperature Geothermal *just for Cornell* would reduce the need for (NYS) renewable GRID resources by ~\$300M!

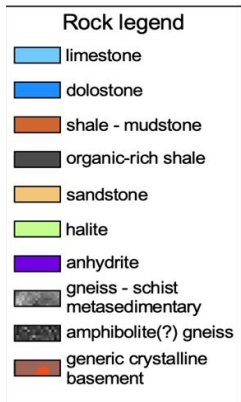
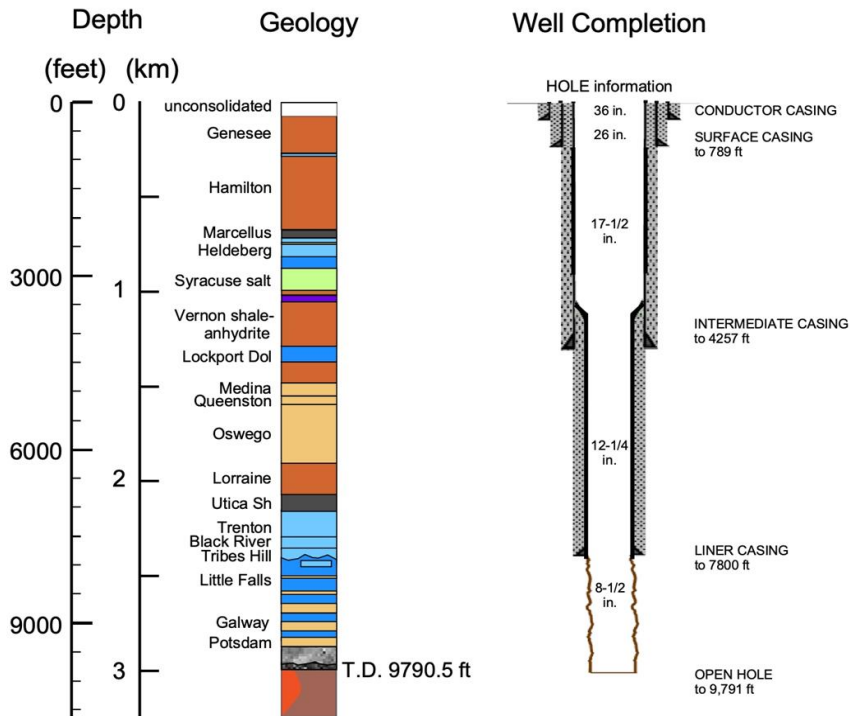
Cornell University Borehole Observatory (CUBO)



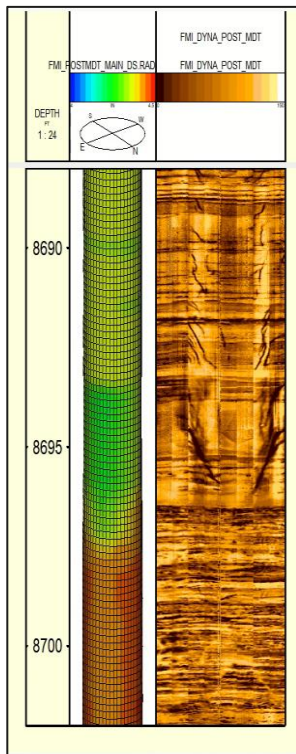
CUBO

Cornell University Borehole Observatory

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CUBO status and results

- Temperatures are sufficient (>80°C at 3 km)
- Subsurface conditions are relatively impervious
- Substantially vertical (principal) fractures (CUBO is vertical)
- Fluids are continually produced by the shut-in well (“artesian”)
- Cornell now assessing the potential for a two-well system
 - Stimulation testing proposed
 - The current project with the US Department of Energy (DOE) will continue through 2024

Other Eastern US Campuses working with DOE

- **University of Illinois** (based on existing well data)
 - High flow rate non-potable aquifer under campus at moderate temperature ($\sim 42^{\circ}\text{C}$) (use shallower aquifer for cooling?)
 - Compared to conventional (shallow) GSHPs, using this aquifer for HP heat transfer could save thousands of (shallow) boreholes and significantly reduce electrical energy use
- **University of West Virginia** (another current test well site)
 - Similar conditions to Ithaca, slightly hotter temps
 - Like in Ithaca (Cornell), key will be to establish hydraulic connections to feed campus district heating. Study continues!

Other Interested Eastern Locations

- City of Boston, MA
 - Sustainability leaders have approached Cornell to help assess potential
 - Deeper geothermal (+ ocean resources) in lieu of GSHP shallow boreholes may provide higher efficiency heating (+ cooling)
- Other Eastern colleges and universities
 - Many campuses using or switching to low temperature district heat
 - Seeking options to ASHPs and GSHPs (looking to Cornell as “test case”)
- New York(s) (City and State)
 - Utility experts have approached Cornell to help assess potential

Thanks for listening. Questions?



CUBO

Cornell University Borehole Observatory

