

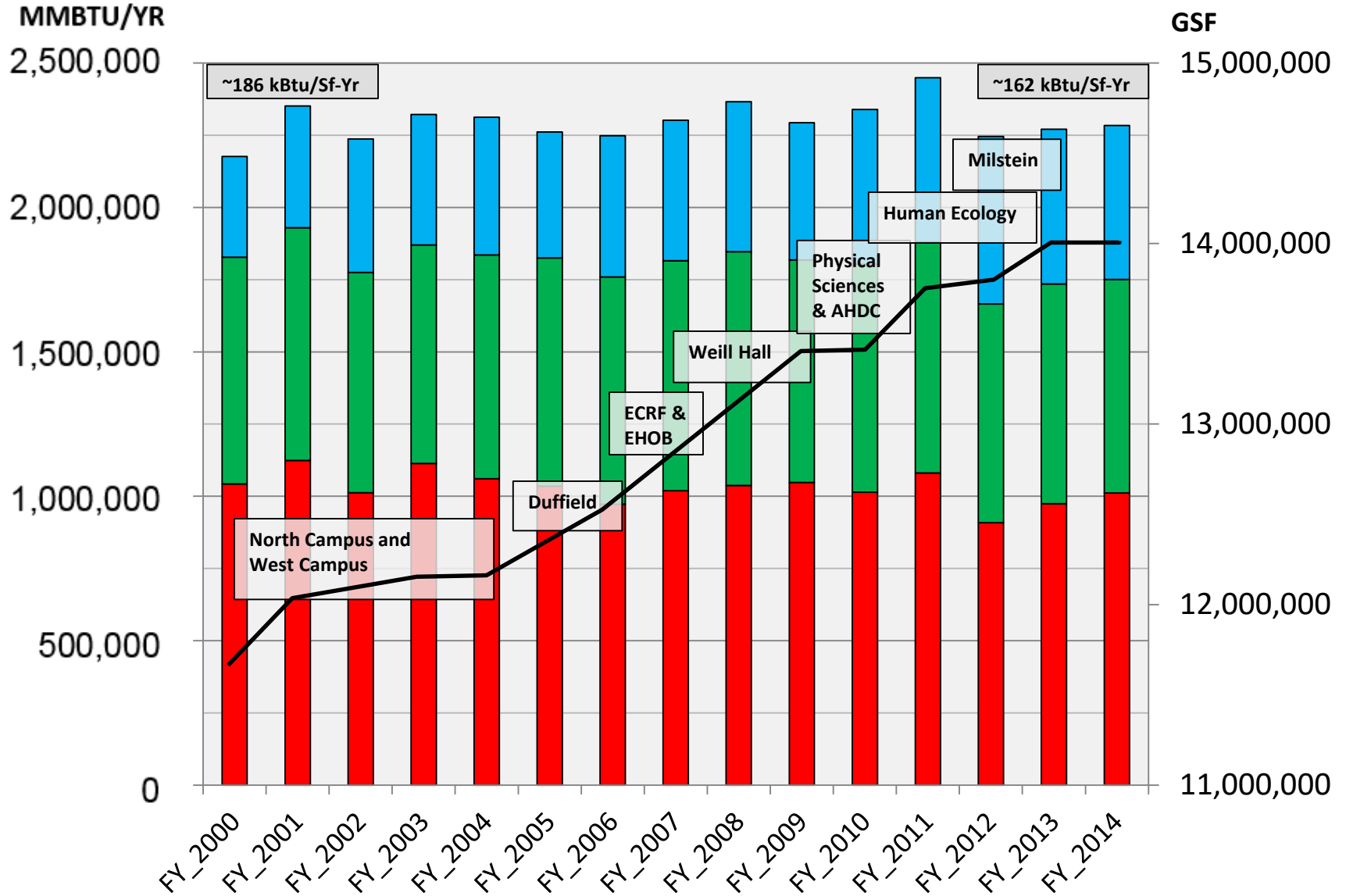
# Cornell's Energy Transformation - Leadership in Sustainability and Climate Neutrality

**Earth Source Heat from Deep Geothermal**  
**Jeff Tester**





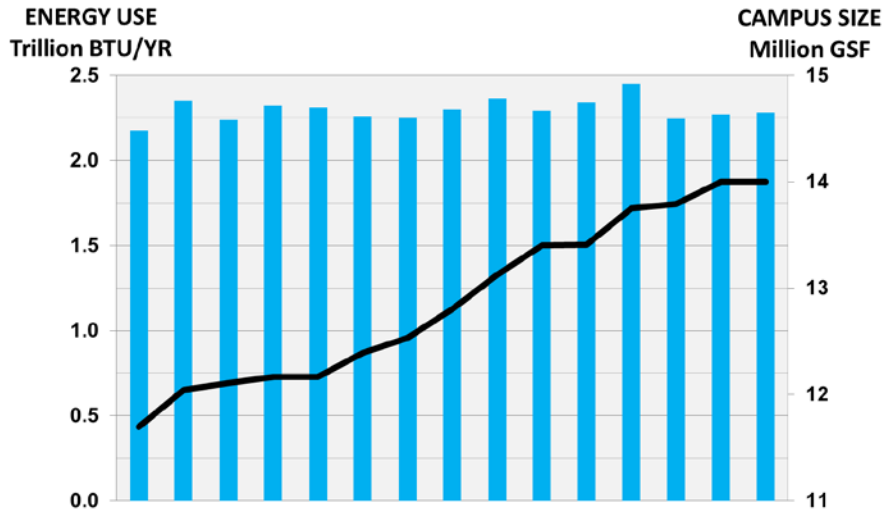
— CAMPUS GSF   
 ■ STEAM SALES\_MMBTU   
 ■ ELECTRIC SALES\_MMBTU   
 ■ CHW SALES\_MMBTU





**Cornell's heating demand is substantial (40% ) and there are not many renewable options to supply it...**

## Heat Options



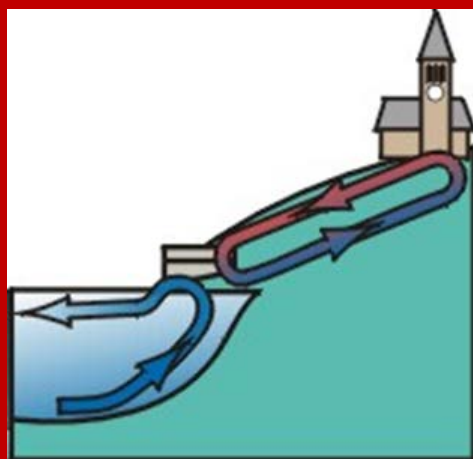
## Electricity Options

# Transforming Cornell's Combined Heat & Power plant – first from coal to gas and then to renewable energy sources



**Renewable energy options for Cornell's campus with 30,000 students, faculty and staff**

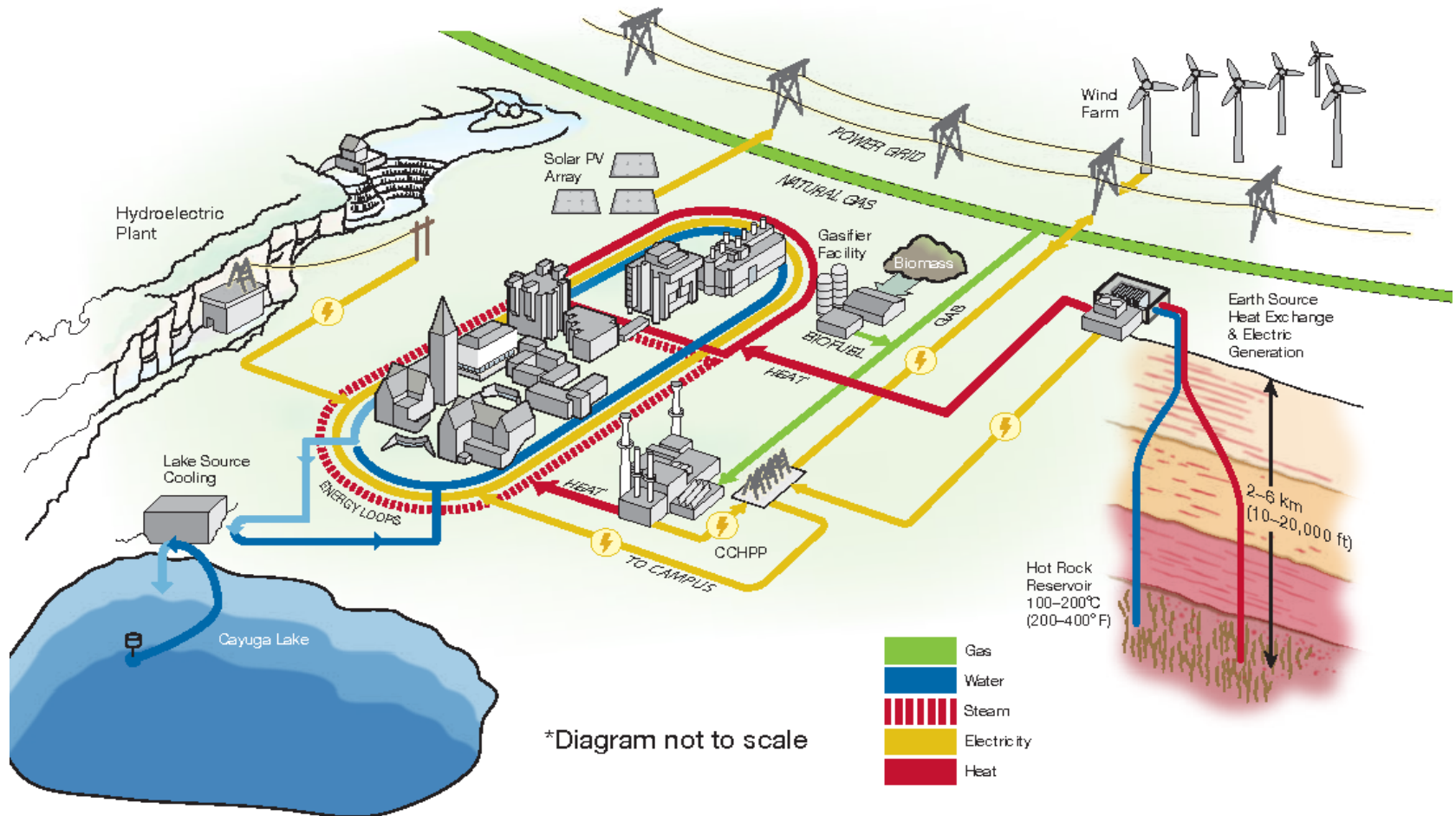
1. Lake source cooling implemented 15 yrs ago
2. Transition from coal to natural gas
3. Cornell's hydro plant upgraded and operational at 1 MW<sub>e</sub>
4. Solar PV at 10 MW<sub>e</sub> on line expanding to 28 MWe with partners
5. Wind power potentially deployed with regional partners
6. Biomass using Cornell's 14,000 acres of ag and forest land
7. Geothermal of lower grade in the East – useful for district heating and co-gen



**Extensive district energy infrastructure**



## Campus Energy Systems

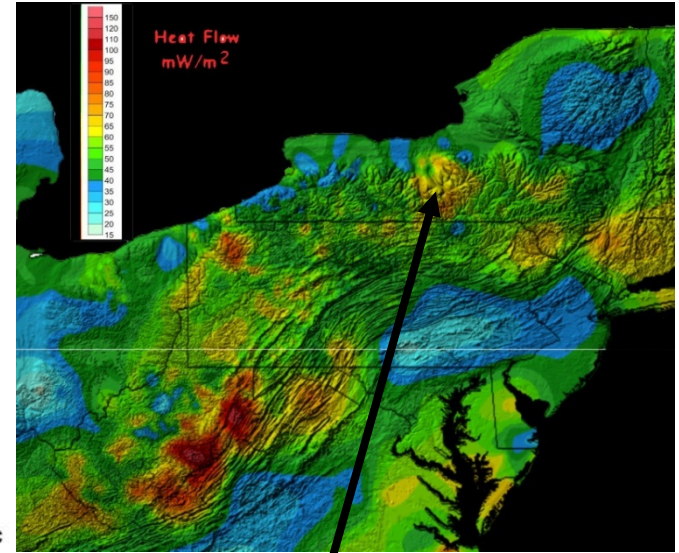
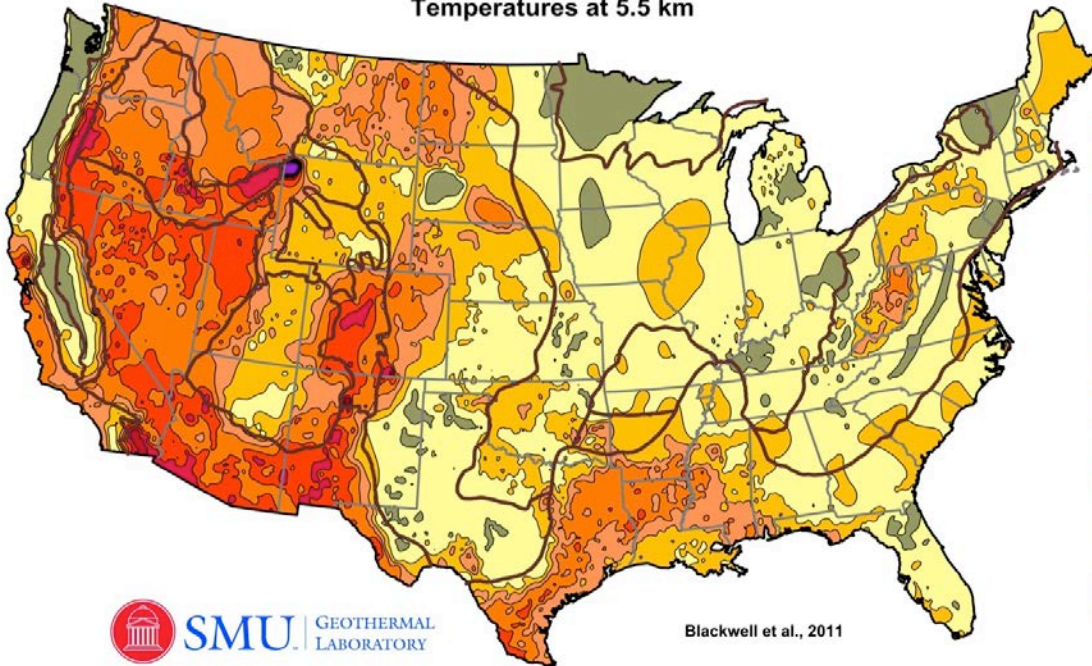


To meet its heating demand deep geothermal and biomass are feasible options and land exists for siting a demonstration



## New York contains a large region of higher geothermal heat flow

Temperatures at 5.5 km

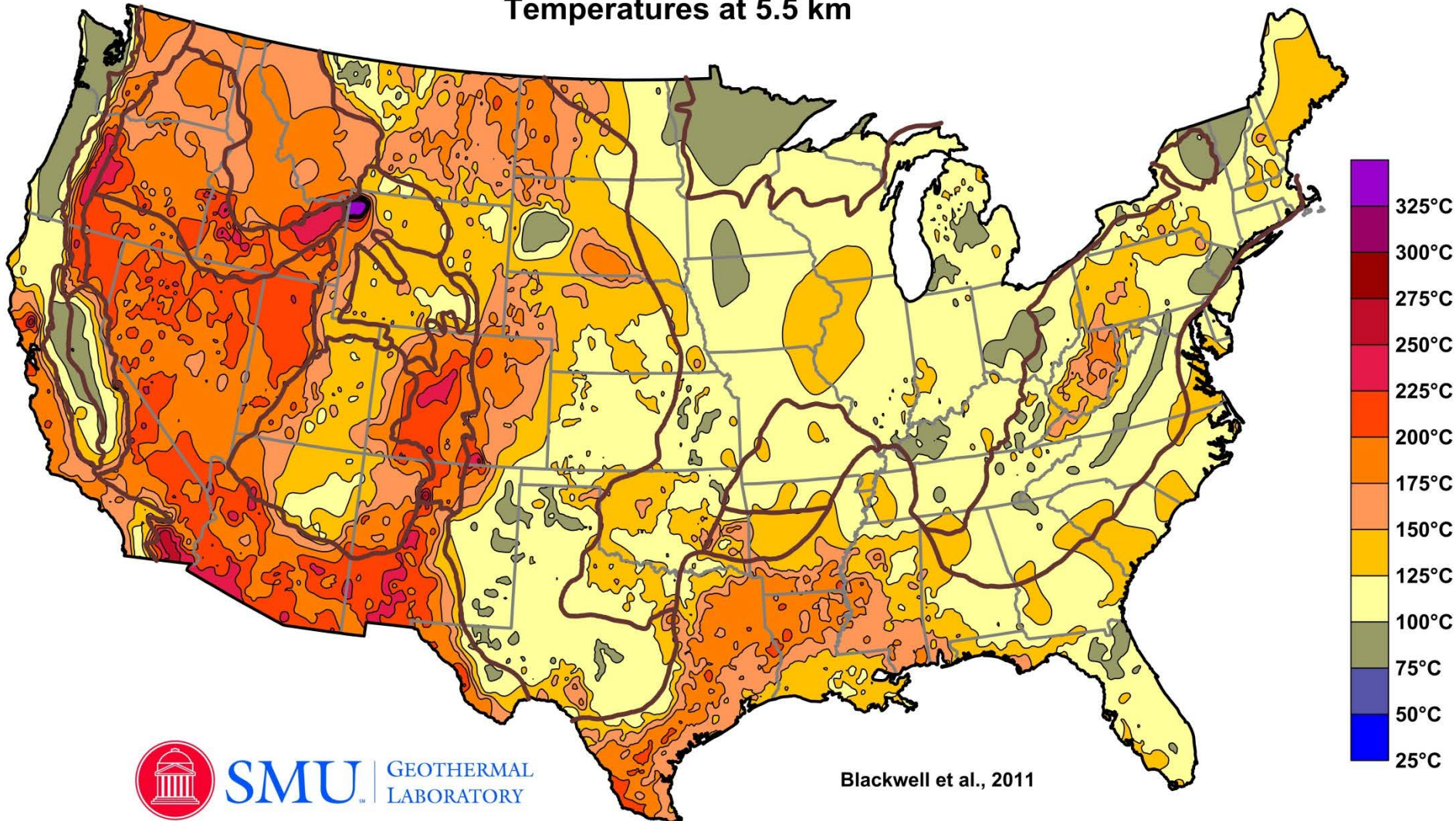


**Cornell**

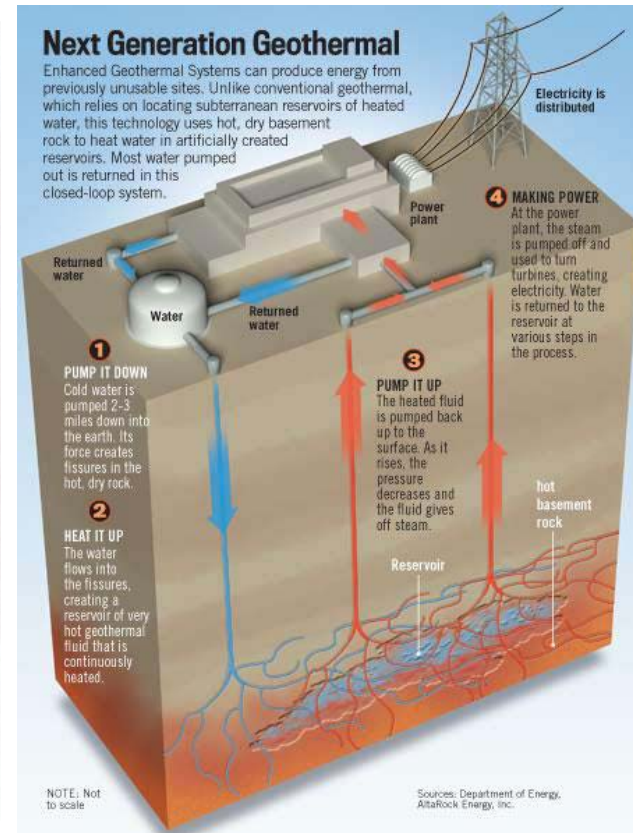
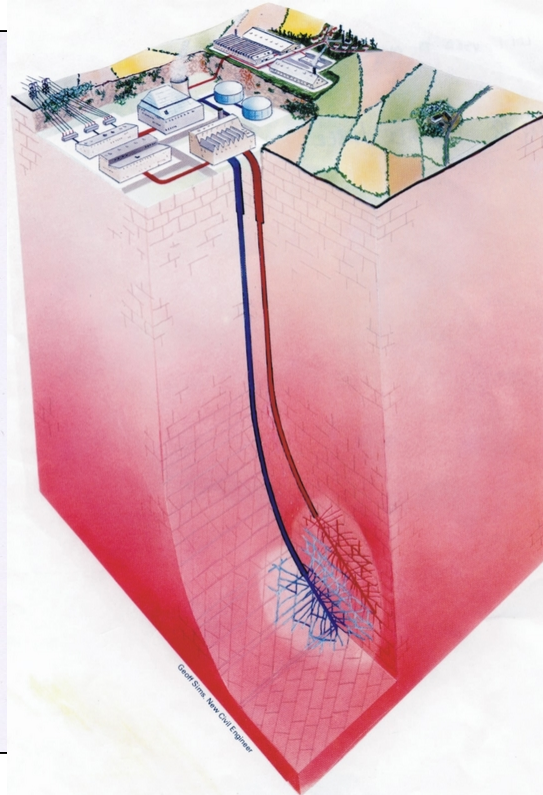
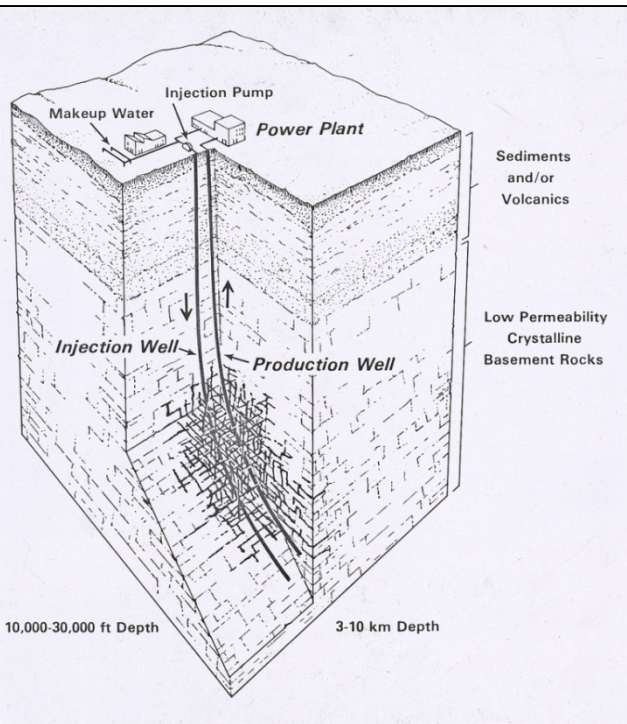
To reach rock at 100-140°C well depths of 10,000 to 15,000 ft. are needed

Many regions of the US have accessible geothermal resources and high heating demand similar to NY

Temperatures at 5.5 km



# Enhanced/Engineered Geothermal Systems (EGS) could provide a pathway to universal heat mining



**EGS defined broadly as engineered reservoirs that have been stimulated to emulate the production properties of high grade commercial hydrothermal resources.**



# Multidisciplinary Earth Energy Research

## Three areas of interest

1. Geothermal – Earth Source Heat
2. Unconventional fossil – shale gas and oil
3. Carbon capture and sequestration

- Geophysical and geologic characterization of reservoirs**
  - Seismic imaging and deformation imaging using INSAR
  - Heat flow / temperature gradient and in situ stresses
- Tracers** for reservoir sizing and lifetime predictions
- Seismic risk** in earth energy applications
- Mineral recovery** from geothermal brines  
(Li and rare earth elements (REE))
- Systems design and simulation** for ESH applications

# Energy Institute Partnerships

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- ❑ **Memorandum of Agreement with Iceland** -- Renewable Energy Education and Research and the creation of Renewable Energy Parks
- ❑ **Verizon** -- geothermally cooled cell tower and data center energy management
- ❑ **US DOE** -- direct use geothermal in NY, PA and West Virginia,
- ❑ **NY State** -- Systems approach to sustainable communities development in Utica NY - design a multi-block section the city that includes
  - Renewable district energy system
  - Retrofitted energy efficiency improvements
  - Utilizing geothermal heat pumps, solar PV and thermal, and anaerobic digestion of food wastes

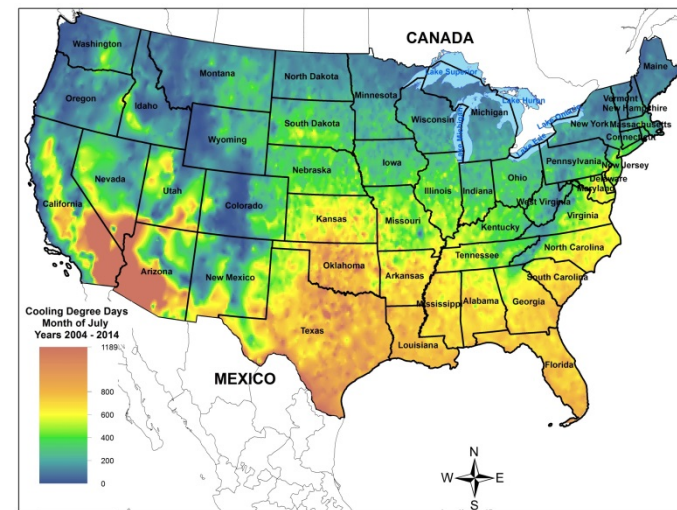
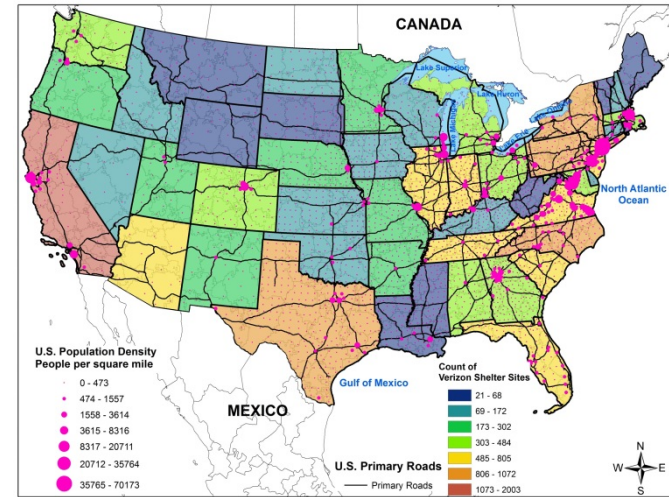
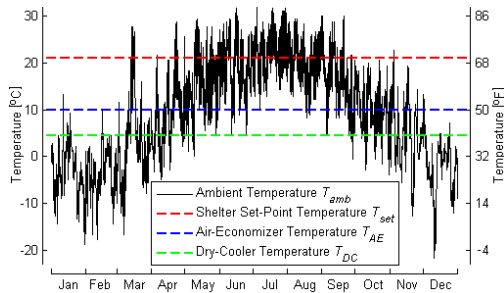
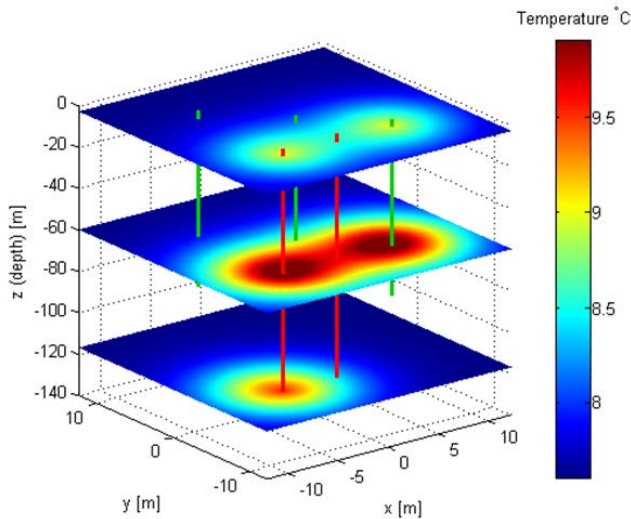
# An opportunity to work with Iceland



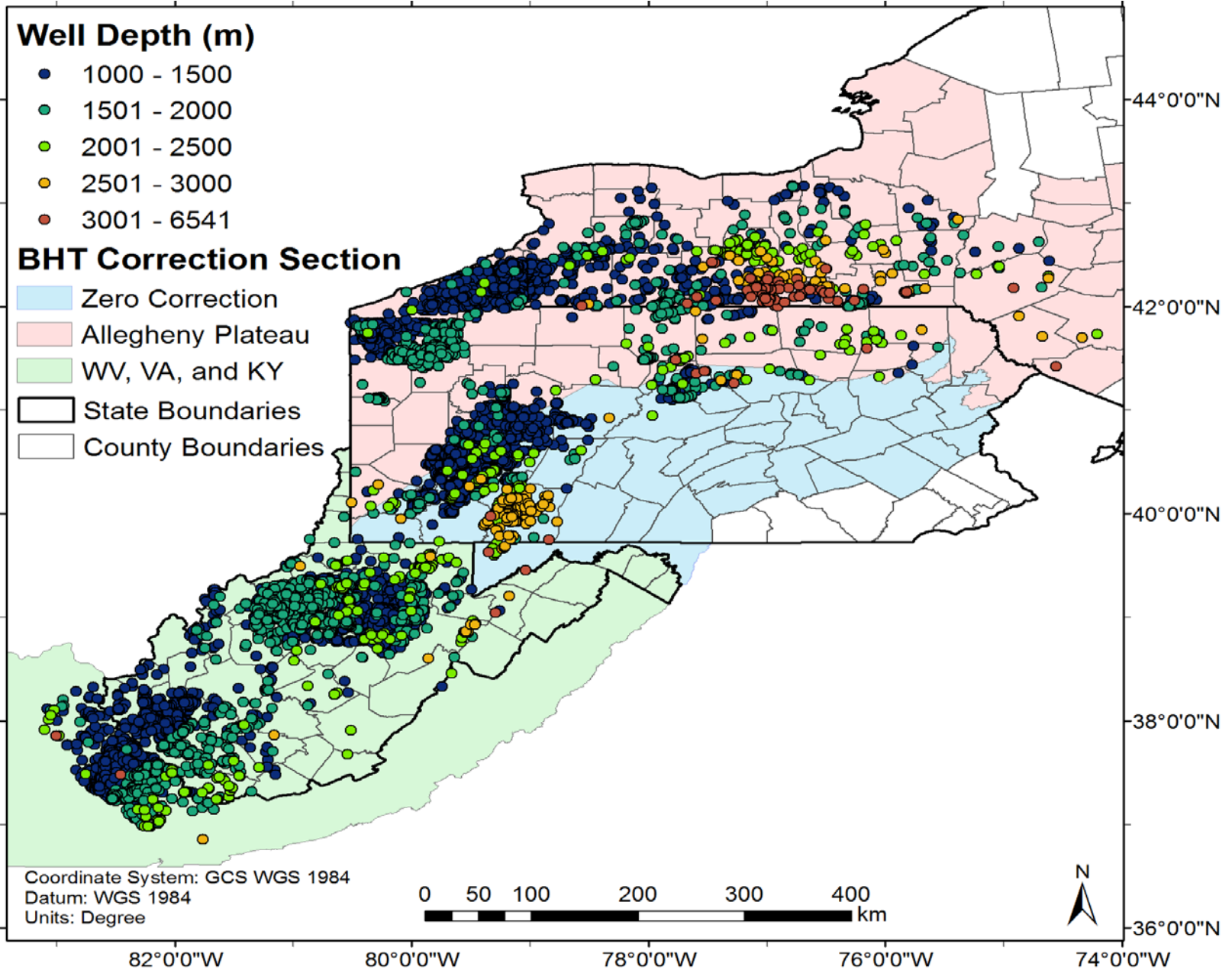
# Geothermal Cell Tower and Data Center Cooling and – sponsored by Verizon

## Project Goals

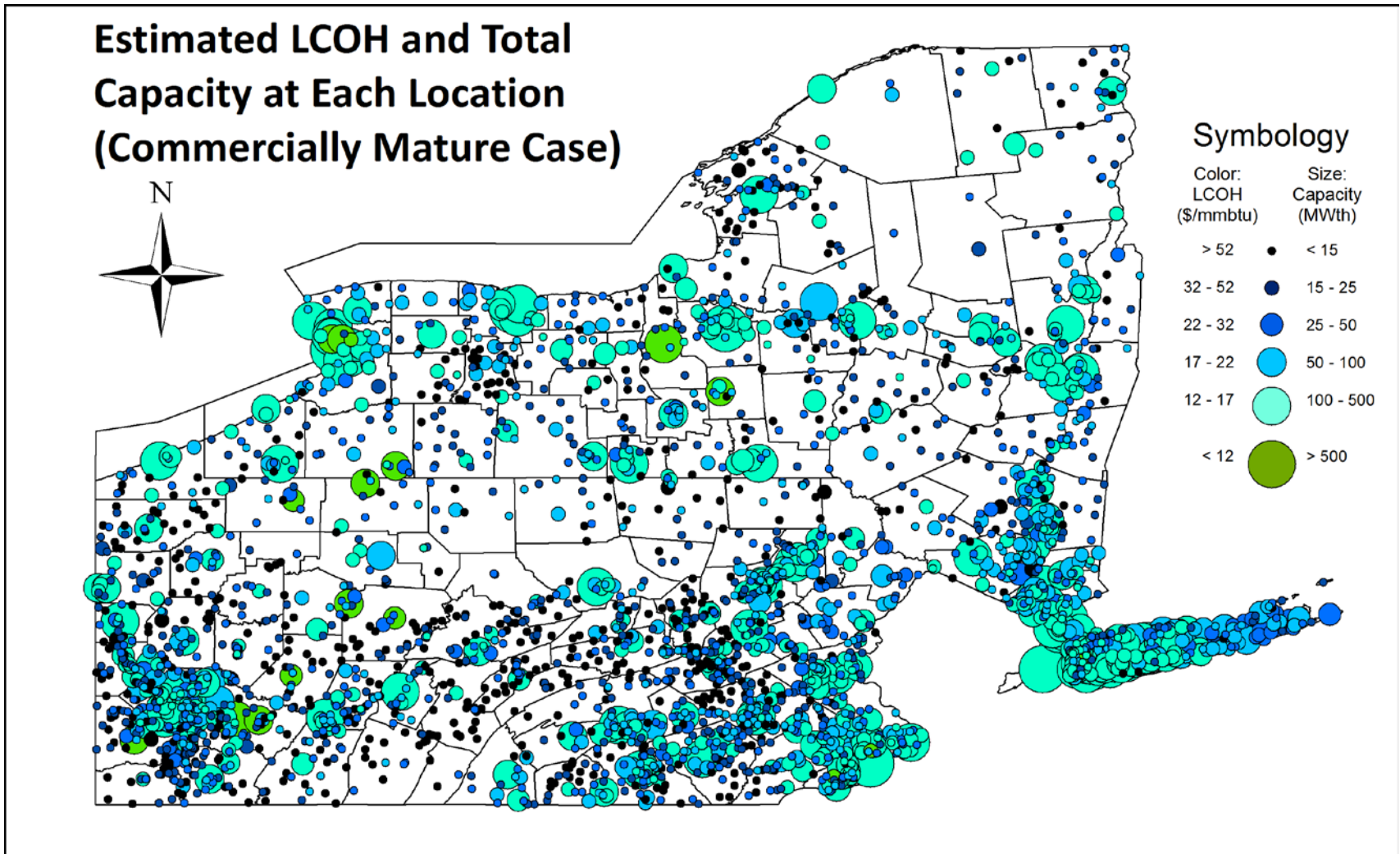
- Feasibility of Using Geothermal Heat Pumps for Cellular Tower Shelter Cooling with 0 kWe continuous load
- CO<sub>2</sub>, Cost, Energy savings replacing conventional AC
- Nationwide impact (40,000 towers @ 10kW<sub>th</sub>/tower)



# Geothermal Potential of the Appalachian Basin



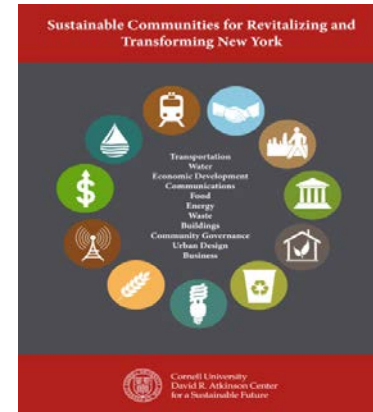
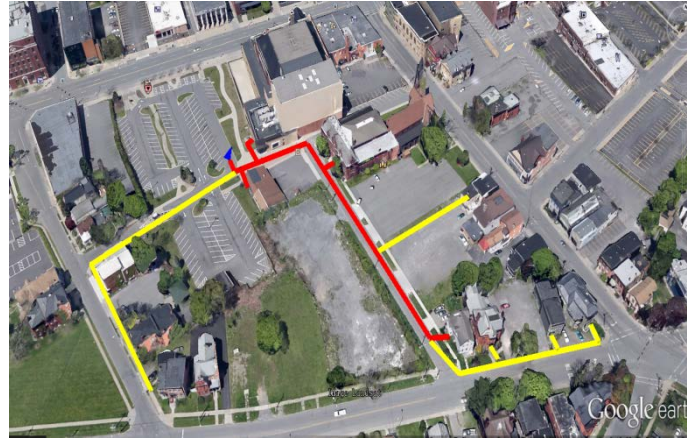
# Potential of geothermal district heating in NY and PA



Reber et al., "The Transformative Potential of Geothermal Heating in the U.S. Energy Market: A Regional Study of New York and Pennsylvania", *Energy Policy*, 70, 30-44, (2014)

# Sustainable Communities in Upstate New York – A living laboratory approach

Large group of faculty, students, and staff applying a systems approach to evaluating and deploying sustainable energy options in rebuilding aging infrastructure



# Summary

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- ❑ Cornell as a living laboratory to demonstrate the application of low temperature geothermal resources
- ❑ Relevance of geothermal - ESH for district carbon-free heating applications at scale for the US
- ❑ Strong connections to Cornell's multidisciplinary research and education in subsurface science and engineering
- ❑ Developing partnerships to increase the impact of geothermal in NY State and US as a sustainable energy option