Geothermal Technologies Office

North Carolina Energy Policy Council
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Susan G. Hamm, Ph.D.
Director
Agenda

- Why Geothermal?
- About GTO
- GeoVision Analysis
- Geothermal in the Carolinas
Beneath our feet lies vast, untapped energy potential.

Geothermal energy...

- ...is always-on.
- ...is secure and flexible.
- ...provides baseload power.
- ...creates thousands of energy sector jobs.
- ...is an everywhere solution.
Continental US EGS Potential: 2.3 TW

Western US EGS potential: 500 GW

Undiscovered Hydrothermal: 30 GW

Current Installed Capacity: 3.8 GW
Geothermal offers a broad array of technology applications for both power generation and direct use. This diversity of applications is key to the geothermal industry’s continuous growth.

At higher temperatures, binary, flash, and dry steam power plants come into play.

At lower temperatures, direct use extends from agriculture and material production to home and commercial heating and cooling.
Geothermal Power Generation

- Fluid Production: Naturally porous rock combined with temperature at depth allow fluid to circulate and heat up.
- Fluid Reinjection: Fluid is recycled into the reservoir through the injection well.
- Power Generation: Hot fluid is extracted from the reservoir to produce power.
- Water vapor from cooling facility.

Electricity generation flowchart:
- Fluid is injected into the ground.
- Heat from the Earth heats the fluid.
- The heated fluid is brought to the surface.
- The fluid powers a turbine.
- Electricity is produced.
- The fluid is reinjected back into the ground.
Enhanced Geothermal Systems (EGS)

- High temperature heat is abundant at depth.
- Viable resource potential is estimated at 60+ GWe.
Geothermal Heat Pumps (GHPs)
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Current priorities across Renewable Energy (RE) offices present opportunities for collaboration and innovation.

- Energy affordability
- Energy integration
- Energy storage
What Does a Modern Grid Look Like?

20th century grid

- Centralized generation
- Limited visibility
- Susceptible to extreme events
- Limited consumer options

21st century grid - modernized

- Centralized and decentralized generation
- Visibility from generation to the grid edge
- Resilience through microgrids
- Customer choice and participation

GHP = Geothermal Heat Pump
The mission of the Geothermal Technologies Office (GTO) is to support early-stage research and development (R&D) to strengthen the body of knowledge upon which industry can accelerate the development of innovative geothermal energy technologies.

GTO supports research in key areas such as drilling, success probability, and new technologies that help reduce early-stage risk and cost.
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The GeoVision study addresses a fundamental question:

On the basis of detailed assessments of

• the geothermal industry,
• barriers to deployment,
• and both existing and improved technologies...

...what level of deployment would be achievable and what would be the corresponding economic benefits to industry and the environmental impacts of those deployment levels on the United States?
The GeoVision report is the product of years of rigorous research and analysis, with contributions from a broad range of participants representing industry, academia, national laboratories, and federal agencies.

Through increased geothermal deployment, America could...
...strengthen its energy base,
...achieve a more stable power grid,
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Optimized permitting could cut development timelines in half, leading to a doubling of geothermal development (13 GWe by 2050) versus business-as-usual.

District use could increase by orders-of-magnitude, from a current total of 21 geothermal district heating installations to as many as 17,500 nationwide. Geothermal heat pumps could increase from 2 million to 28 million.

Deployment could reach 60 GWe by 2050 with aggressive technology improvements.
GeoVision Analysis

Technology innovation is essential – it improves our understanding of subsurface conditions, helps to reduce risk, and accelerates growth of domestic geothermal power.

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The four Roadmap Action Areas target the three key objectives of the GeoVision analysis:

1. Increase access to geothermal resources
2. Reduce costs and improve economics for geothermal projects
3. Improve education and outreach about geothermal energy through stakeholder collaboration

Action Area 1: Improve exploration and achieve key technology advancements
Action Area 2: Optimize regulatory processes
Action Area 3: Optimize revenue and market structures
Action Area 4: Improve collaboration, education, and outreach
GTO Research

Action Area 1:
Improve exploration and achieve key
technology advancements

- Frontier Observatory for Research in Geothermal Energy (FORGE)
- EGS Collab
- Waterless stimulation
- Subsurface stress and lost circulation

Action Area 2:
Optimize regulatory processes

- Play Fairway Analysis
- Efficient Drilling for Geothermal Energy (EDGE)
- Zonal Isolation
- Machine Learning: Exploration

Action Area 3:
Optimize revenue and market structures

- Action Area 4:
Improve collaboration, education, and outreach
GTO Research

**Action Area 1:** Improve exploration and achieve key technology advancements

- Collaboration with Dept of Interior / Bureau of Land Mgmt
- Collaboration with U.S. Forest Service

**Action Area 2:** Optimize regulatory processes

- Potential collaboration with state and local governments

**Action Area 3:** Optimize revenue and market structures

**Action Area 4:** Improve collaboration, education, and outreach

- Collaboration with Dept of Defense
- Collaboration with state and local governments
GTO Research

Action Area 1: Improve exploration and achieve key technology advancements

Action Area 2: Optimize regulatory processes

Action Area 3: Optimize revenue and market structures

Advanced Energy Storage Initiative; improved valuation of geothermal

Coordination with Strategic Priorities and Impact Analysis team

Beyond LCOE

Critical Materials / Salton Sea

Action Area 4: Improve collaboration, education, and outreach
GTO Research

Identify plan for regular updates to the GeoVision Roadmap

New Zealand Memorandum of Understanding

Potential technical assistance to stakeholders interested in geothermal

Collaboration with GEOTHERMICA

Collaboration with military bases, universities, others

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Geothermal in North Carolina

According to a July 2015 report by the North Carolina Sustainable Energy Association:

“North Carolina’s soil is well suited for GHPs.”

The report indicates that the geothermal industry already has an impact in North Carolina:

- 12% of all clean energy firms in NC are geothermal.
- NC geothermal businesses generated at least $143 million in revenues in 2014.
- Geothermal accounts for 3% of North Carolina’s clean energy income.

Geothermal in North Carolina

• According to the Air-Conditioning, Heating, and Refrigeration Institute, since the NC Renewable Energy Investment Tax Credit was extended to include GHPs in 2009, more than 10,500 units have been shipped to North Carolina.

• At least 2,015 systems have obtained state-level permitting from North Carolina Department of Environmental Quality since 1978.

• Fort Bragg is the world’s largest military installation (by population) and recently installed multiple GHPs to supplement existing HVAC systems.

• Today, the top 5 counties in terms of permits are Buncombe, Orange, Durham, Wake, and Onslow.

Opportunities for Geothermal in the Carolinas

The GeoVision GHP Breakthrough scenario indicates significant economic potential for geothermal heat pumps in the Carolinas – more than 25,000 MW$_{th}$ by 2050. North Carolina accounts for 73% of this total with more than 18,000 MW$_{th}$ by 2050.

View more data on regional geothermal potential in the GeoVision scenario viewer: https://openei.org/apps/geovision/
Opportunities for Geothermal in the Carolinas

From 2030 to 2050 in the GeoVision GHP Breakthrough scenario, increases in GHP expenditure occur mainly in six states, including North Carolina.

Geothermal heat-pump expenditures (in millions of USD) for 2030 (left) and 2050 (right) by state under the GeoVision analysis Breakthrough scenario.
Opportunities for Geothermal in the Carolinas

The GeoVision Technology Improvement scenario indicates high economic potential for geothermal district heating installations – more than 14,000 MW$_{th}$ in the Carolinas by 2050, with almost 10,000 MW$_{th}$ of that in North Carolina alone.
State and Local Planning for Energy (SLOPE) Platform

- Delivers state- and locally-specific energy planning data in the areas of energy efficiency, renewable energy, and sustainable transportation.

- Enables “apples-to-apples” comparisons of adjustable energy futures with inputs from variety of data points, such as:
  - Electricity and natural gas consumption
  - Renewable energy generation potential
  - Levelized cost of energy (LCOE)
  - Projected population

Phase I: Mock up

Phase I: Projection data available (Jan. 2020)

Phase II: Integrated, granular platform enabling user saved settings and transportation and generation mix data (2020)

Questions? Contact: Aaron.Ng@ee.doe.gov
NC Sustainable Energy Association – Geothermal Heat Pumps
https://energync.org/geothermal-heat-pumps/

*Carolina Country* magazine: “It’s Geothermal”
https://www.carolinacountry.com/your-energy/it-s-geothermal

NC Department of Environmental Quality
http://portal-legacy.deq.nc.gov/web/wq/aps/gwpro/geothermal

Photo: History.com
“Making geothermal more affordable can increase our energy options for a more diverse electricity generation mix and for innovative heating and cooling solutions for all Americans.”

Rick Perry
U.S. Secretary of Energy

Visit us at: www.energy.gov/eere/geothermal