The Heat Beneath Our Feet

Colorado’s Geothermal Energy Opportunities

Introduction

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COLORADO ENERGY OFFICE

Who is the Colorado Energy Office?

Mission

Reduce greenhouse gas emissions and consumer energy costs by advancing clean energy, energy efficiency, and zero-emission vehicles to benefit all Coloradans.

Vision

A prosperous clean energy future for Colorado.

Impact

Economic Benefits: Creating jobs, supporting businesses, and fostering economic growth through energy initiatives.

Environmental Benefits: Reducing GHG emissions, improving air quality, and promoting sustainable practices.

Community Benefits: Enhancing energy affordability, equity, reliability, and access for all Coloradans.

Presentation Agenda

1. **Overview: what is geothermal energy?**
    a. Heat pumps
    b. Single-structure geothermal
    c. Thermal energy networks
    d. Deep geothermal (enhanced, advanced)
    e. Colorado context

2. **Colorado Case Studies**

3. **Federal and state geothermal incentives**
    a. Inflation Reduction Act
    b. State grant and tax credits
    c. Colorado Geothermal Market Assessment

Overview: What is geothermal energy?

Ormat Steamboat Hills Geothermal Power Plant in Reno, Nevada. Photo by Bryce Carter. October 2023.

The Magic of Heat Pumps

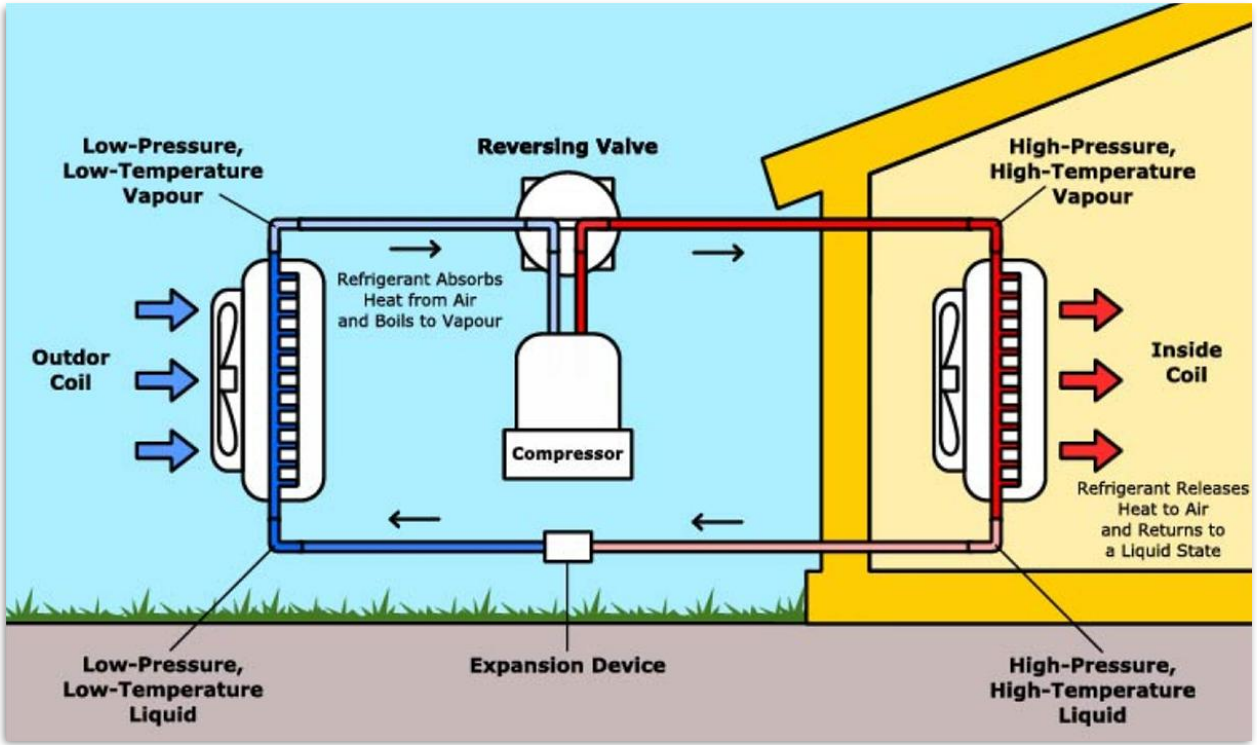


Image Source: Department of Energy

Ground Source Heat Pump

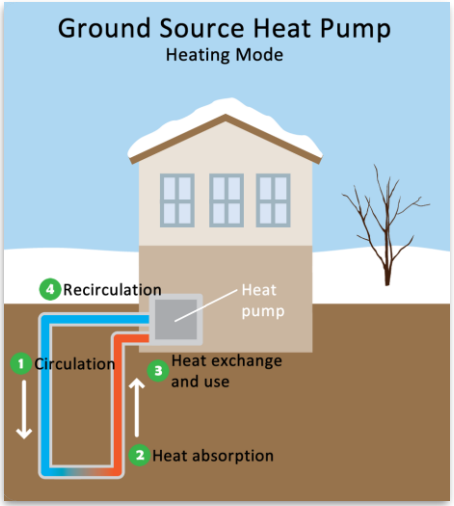
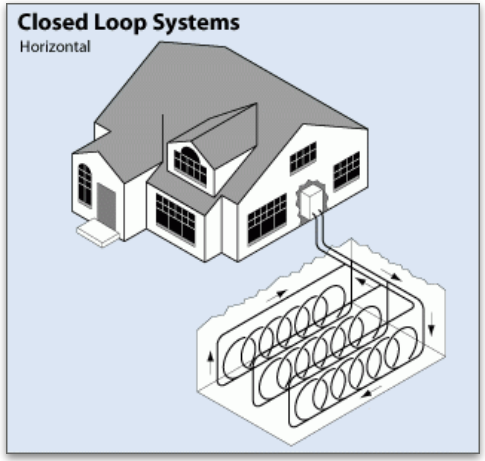


Image Source: EPA



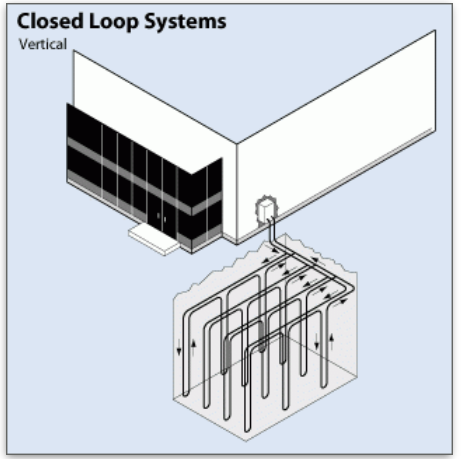


Image Source: Department of Energy

Ground source heat pumps use the constant ambient temperature of the ground (55˚F / 13˚C) resulting in 3 to 5 times greater efficiency than using air as a variable heat source

Thermal Energy Networks

Heat Producers

- Data centers
- Industry
- Power Generation
- Sewage
- Oil & gas
- Hot spring runoff
- Grocery stores
- Ice rinks
- Building cooling

Image source: https://buildingdecarb.org/resource-library/tens

Image Source: Pagosa Springs, Bryce Carter

Geothermal Exchange System

System is sized, monitored and actively managed to balance heating and cooling needs throughout the year, ensuring efficient ground temperatures and system balance

Heat Consumers

- Building heating
- Agriculture
- Industry
- Snowmelt

Traditional Geothermal Electricity Production
(above 250-300˚F or 121-150˚C)

From steam to Organic Rankine Cycle (ORC) process

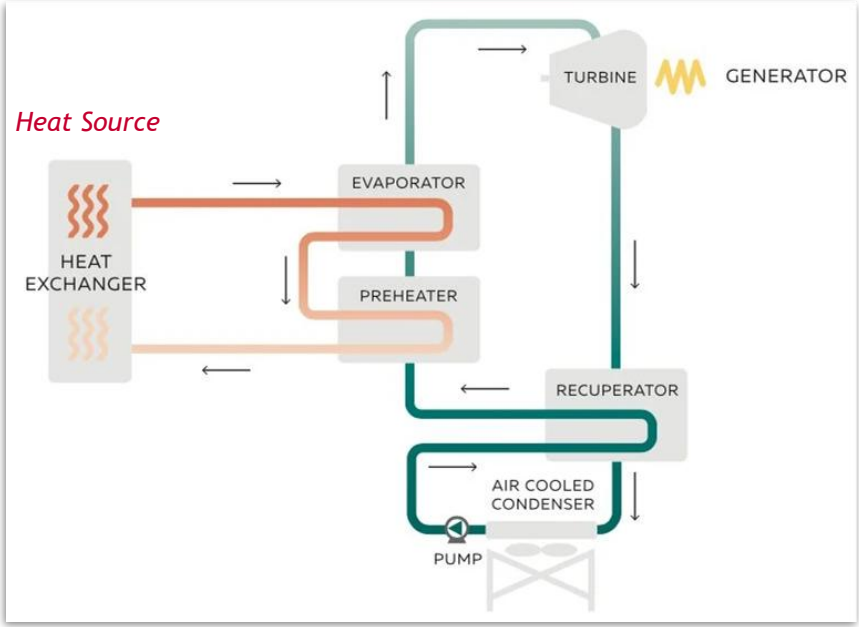


Image Credit: Exergy. The Organic Rankine Cycle.

Ormat Steamboat Hills Geothermal Power Plant in Reno, Nevada. Photo by Bryce Carter. October 2023.

Enhanced Geothermal Systems

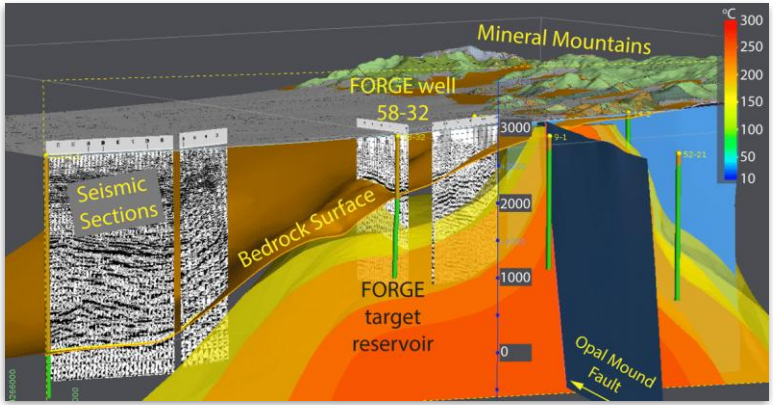


Image credit: Utah FORGE

Image Credit: Gosia Skowron, EGI, TheDriller

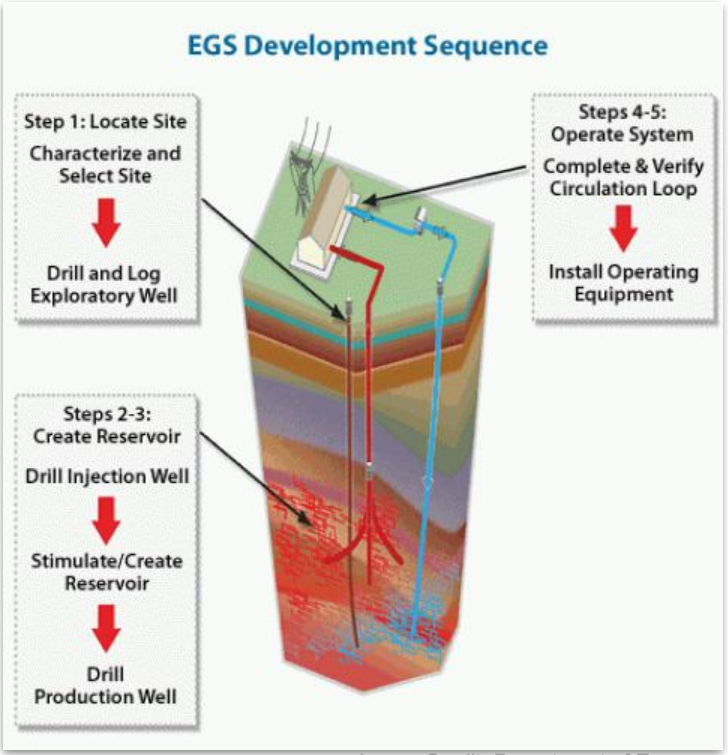
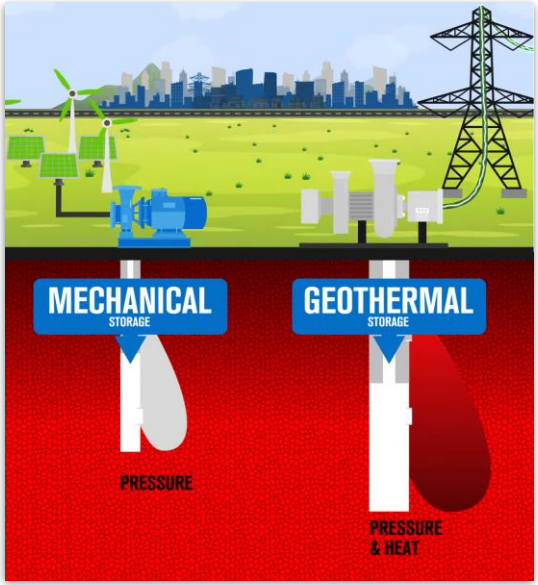


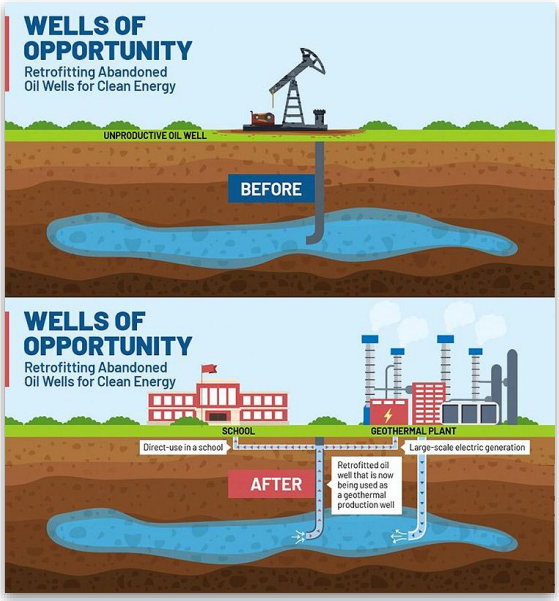
Image Credit: Department of Energy

As you drill deeper the hotter it gets!

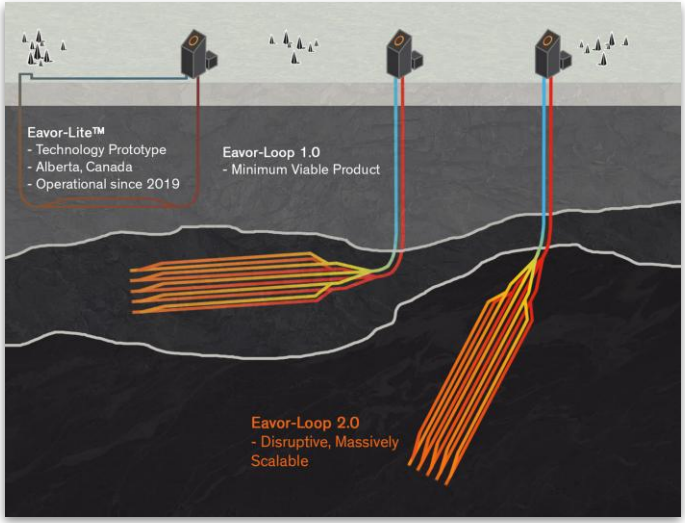
Advanced Geothermal Systems



https://www.sagegeosystems.com/geothermal-energy-storage-solutions/



Source: National Renewable Energy Laboratory



https://www.eavor.com/faqs/

Why geothermal in Colorado?

Colorado has a goal of **net-zero emissions by 2050**, including achieving 80% renewable electricity by 2030 and 100% by 2040

- Geothermal energy is the most efficient means of heating and cooling, which **reduces peak demand** and **supports rapid grid electrification**
- A lower life cycle cost and predictable return on investment **reduces energy burden** for families and businesses alike
- Geothermal energy is a key tool for **community resilience** in the face of extreme weather events, which can keep both the lights and heat on
- Geothermal electricity is a **carbon-free, renewable and consistent electricity resource** which will help decarbonize our electric grid

Why geothermal in Colorado?

Colorado has over **33,400 miles** of gas distribution pipelines (NCEL, 2011) and over **54,000 workers** in the natural gas and oil industry (API, 2023)

- Geothermal energy networks for heating and cooling use the **same type of pipes** as gas networks, requiring the **similar workforce skills** to build and facilitate these systems.
- Deep geothermal projects require the **same drilling technology** as the oil and gas industry to access high temperature heat many thousands of feet below.
- High and low temperature geothermal energy can be produced LOCALLY, which supports **long-term careers** and **keeping energy dollars within the community**
- Thermal energy networks provide an opportunity to **minimize investments in gas infrastructure** and **avoid stranded gas assets** in the future.

Colorado Case Studies

Case Study: Lennar Homes and Dandelion Energy

CANARY MEDIA

Clean energy journalism for a cooler tomorrow

Lennar will build 1,500 new Colorado homes with geothermal heat pumps

- One of the country's largest deployments of ground-source systems being built in Ken Caryl, a southwest Denver suburb
- Expected to save residents approximately $30 million in energy costs over 20 years
- Will reduce anticipated peak electric demand by 6 MW, helping reduce costs for all utility ratepayers

Colorado Mesa University

- **1.2 million sq feet networked with diversity of heating/cooling needs**
  - 3,113 ton cooling load
  - 2,728 ton heating load
  - No use of boilers in 22'-23' heating season
- **Compared to a conventional system:**
  - ~650 kW demand reduction (13%)
  - ~1.3 GWh energy savings (10%)
  - ~58,000 Dth natural gas savings (55%)
  - ~10 million gallons water savings
- **$1.5 million savings per year have resulted in a 2% reduction of student tuition**

CMU networked geothermal efficiency vs. a standard system

	Networked Geo COP	Conventional COP
Spring	7.0	1.9
Summer	3.6	3.4
Fall	5.8	2.0
Winter	8.9	1.2
Overall	**5.7**	**1.9**

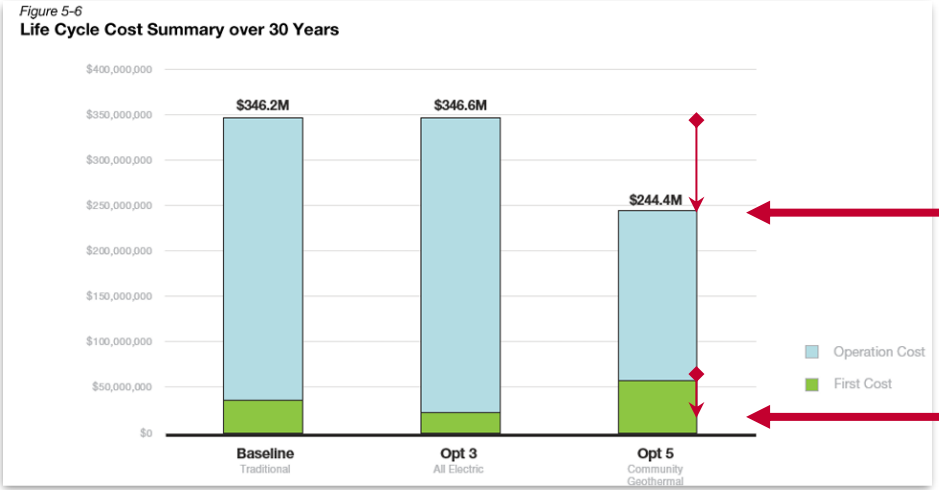
Source: Evaluating a Community Ground Source Heat Pump System at Colorado Mesa University, 2023

Brown Ranch Geothermal Study

STEAMBOAT PILOT & TODAY

February 11, 2023

Brown Ranch to utilize geothermal heating system



- Proposed 1,100+ home community
- Study showed networked geothermal system has nearly double upfront cost, but-
- Community would realize **$100 million of savings** over 30 years compared to a traditional or all electric approach with ROI of ~10 years
- Upfront cost **may be reduced by half** through IRA federal incentives, not yet including available state incentives

Image sources: Brown Ranch Energy Master Plan

CU Boulder - Advanced Geothermal

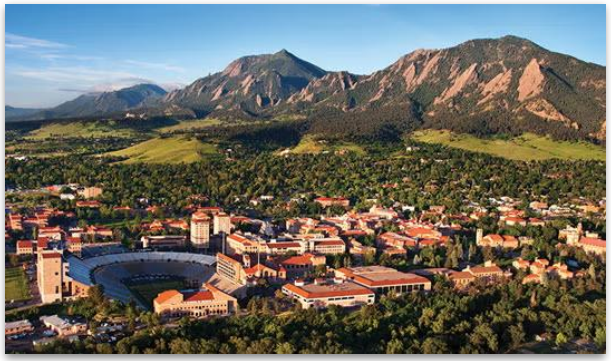
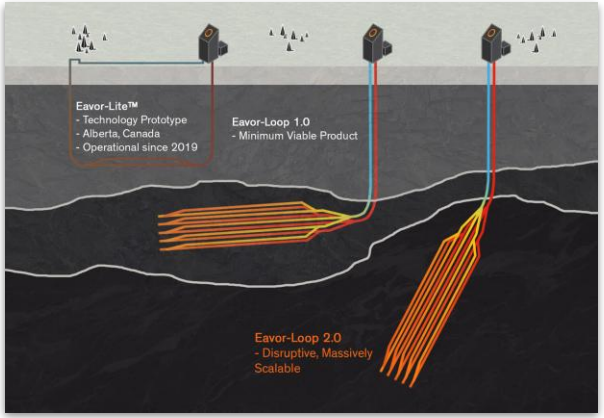


Image Credit: CU Boulder



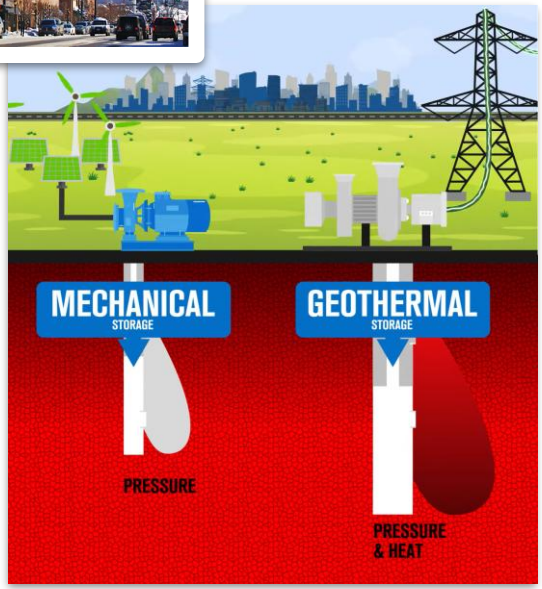
https://www.eavor.com/faqs/

CU Boulder is working with Eavor to explore pathways toward their carbon neutrality goals

- Pre-feasibility study for utilizing at least several megawatts of geothermal electricity at its campus
- Developing schematic designs for 12 million square feet of conditioned space for thermal energy networks across Williams Village, East Campus, and Main Campus

Pure-Green Colorado, Inc.

Image Credit:
Steamboat Ski & Resort Corp

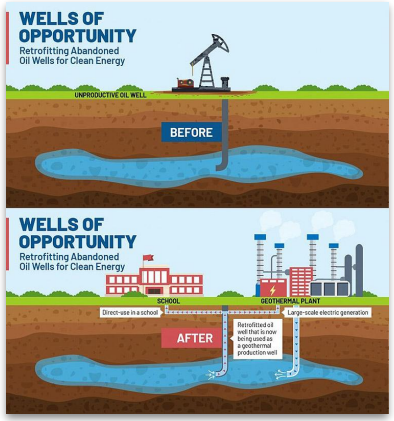


https://www.sagegeosystems.com/geothermal-energy-storage-solutions/

Had to withdraw from grant award, but still exploring other opportunities for geothermal resources for mountain towns

- 3 MW geomechanical energy storage using pressure and heat
- Up to 500 kW of hydrogen production
- Cogeneration of heat for snowmelt (offsetting up to 5 MW of demand) and thermal energy network

Town of Pierce - Gradient Geothermal



Source: National Renewable Energy Laboratory

Image Credit: Gradient Geothermal

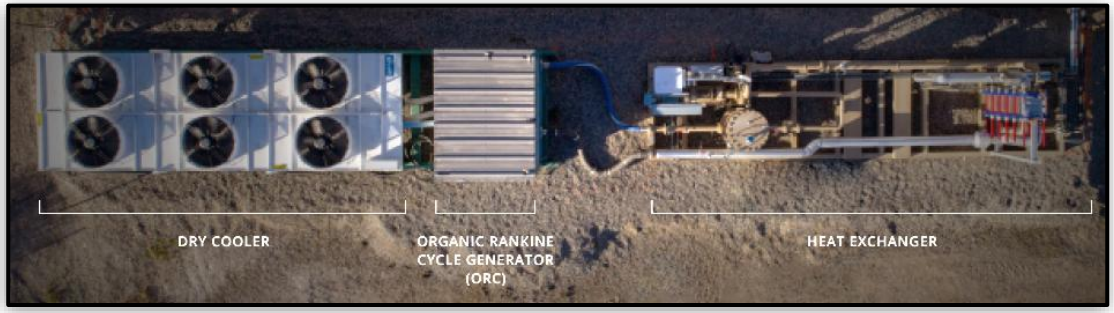


Image Credit: Gradient Geothermal

Awarded $100,000 to study feasibility of utilizing inactive oil and gas wells in Pierce, CO

- Direct use opportunities of 120°- 150°F (49°C to 66°C) for community
- Exploring power production opportunities using existing well field

Federal and State Geothermal Policies

Inflation Reduction Act - Geo Investment Tax Credit

Residential

- **30%** | 2022-2025

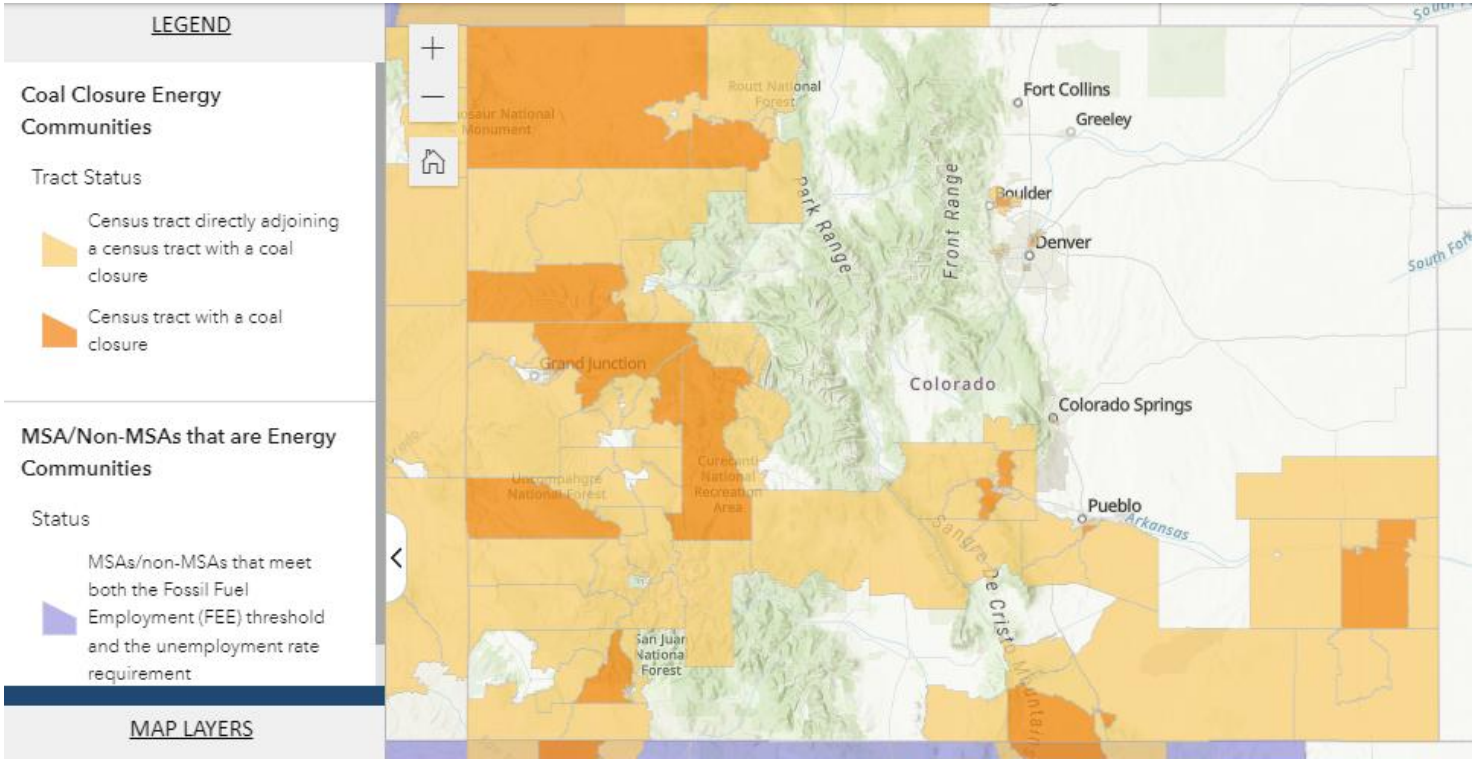
Image Credit: Montclair State University

CEO cannot provide tax advice.
Please consult your tax advisor.

Investment Tax Credit (Commercial):

- **6%** | Base Rate
- **30% | 5x Bonus Rate** (6% base x 5)
  - Projects under 1 MW (approx. 284 tons) qualify
  - Projects over 1 MW (approx. 284 tons) must meet prevailing wage and apprenticeship requirements
- **10% | Domestic content bonus**
  - US production of steel/iron; % requirements of components
- **10% | Energy Community**
  - Brownfield redevelopment, fossil-fuel focused economy, census tract tied to retiring coal communities

US DOE - Energy Community Tax Credit Bonus



https://arcgis.netl.doe.gov/portal/apps/experiencebuilder/experience/?id=a2ce47d4721a477a8701bd0e08495e1d

Colorado State Incentives & Policies

In recent years, Colorado has passed several critical policies to help kick-start the geothermal energy market including:

- **HB19-1261 and SB23-016:** Statewide Greenhouse Gas (GHG) pollution reduction goals including net zero emissions economy-wide by 2050
- **SB21-264:** Clean Heat Framework to support gas to electric transition for utilities and consumers; reducing natural gas emissions by 22% by 2030
- **HB22-1381:** CEO Geothermal Energy Grant Program established with $12 million
- **HB23-285:** Energy and Carbon Management Commission oversees deep geothermal regulations
- **HB23-1252:** Gas utilities may create Thermal Energy Networks; Xcel pilot project

HB23-1272: State Geothermal Tax Credits

Geothermal Energy	2024 - 2033
Geothermal Electricity (Investment Tax Credit)	30% - 50% ITC, merit-based $5 million cap per project
Thermal Energy Network (Investment Tax Credit)	30% - 50% ITC, merit-based $5 million cap per project / study
Production Tax Credit	$0.02/kWh

Heat Pump Technology (per residential unit)	2024 - 2025	2026 - 2029	2029 - 2033
Air-Source	$1,500	$1,000	$500
Ground-Source, Water-Source, or combination system including either	$3,000	$2,000	$1,000
Heat Pump Water Heater	$500	-	-

The nonresidential building rate is the tax credit multiplied by the number of increments of 4 tons.

Thermal energy networks may combine the credit per connected residential unit and nonresidential building.

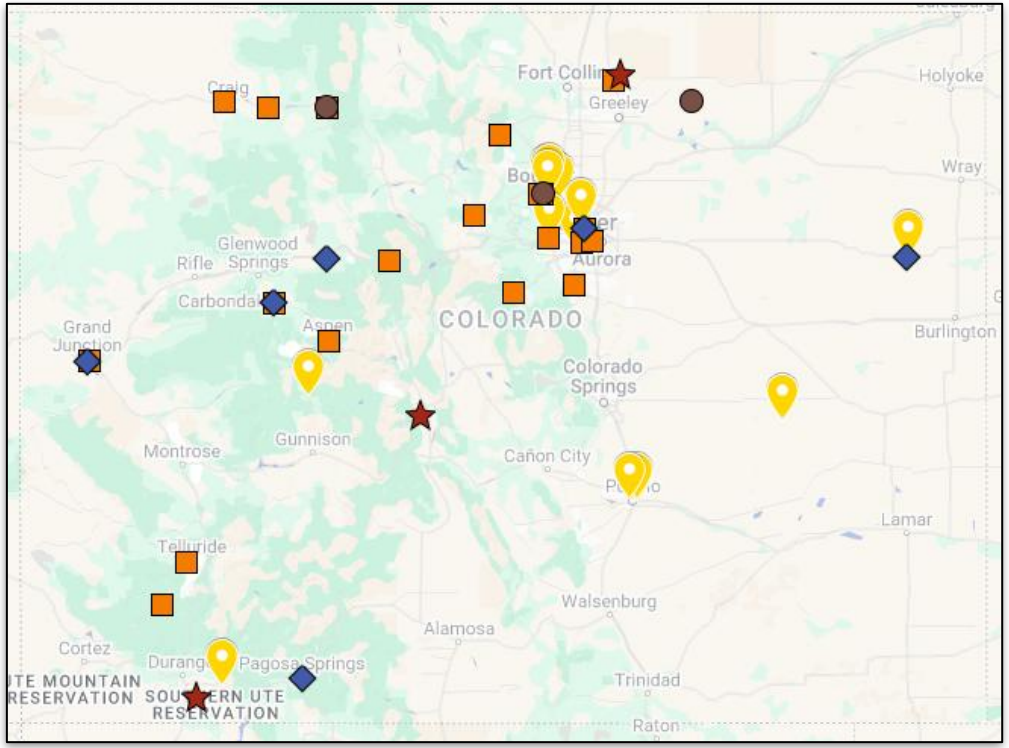
HB23-1272: Heat Pump Contractor Certification

- Contractors administering state tax credits must be certified by the CEO
  - Streamlines credit for consumers
  - Provides needed market data to better inform future policy to support the sector; workforce development

- Contractors may retain a percentage of the tax credit to support overhead (e.g. 66% or $2,000 per GSHP)

Image Credit: Bryce Carter

Projects Utilizing Colorado's Geothermal Incentives



$12 million in grants and **$35 million in tax credits** to support the use of zero-emission, geothermal energy for electricity generation and space/water heating and cooling in homes, businesses, and communities.

- **Single-Structure Geothermal Installation**
- **Thermal Energy Network Study**
- **Thermal Energy Network Installation**
- **Geothermal Electricity Award**

As of June 2025, $23.8 million has been awarded across 60 Colorado geothermal projects!

Fostering a Learning Community

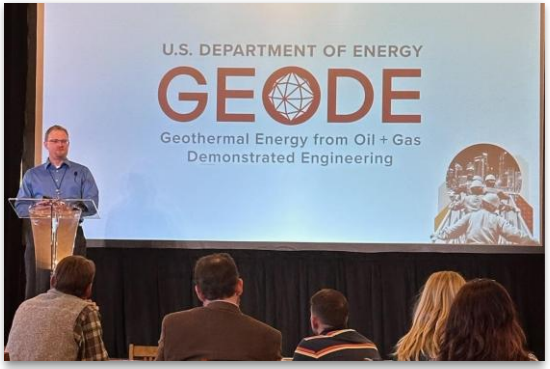


Image Credits: Bryce Carter; TR: Johanna Ostrum

Colorado Geothermal Market Assessment

CEO Geothermal Program effort to support our incentive awardees to:

- Establish publicly accessible baseline data to track ongoing market progress
- Build community trust and buy-in across geographic networks
- Establish and facilitate technical engagement framework
- Highlight opportunities for private sector leadership
- Facilitate working groups to explore technical learnings, workforce development, utility dialogues, financing opportunities, and communications / engagement strategies

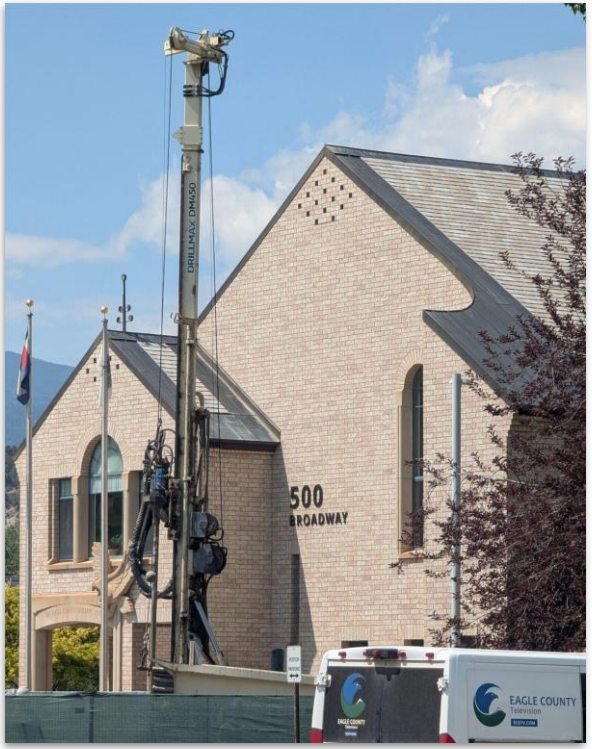


Image Credit: Bryce Carter

Thank you!

More information is available at:
geothermal.colorado.gov

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SCAN ME

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