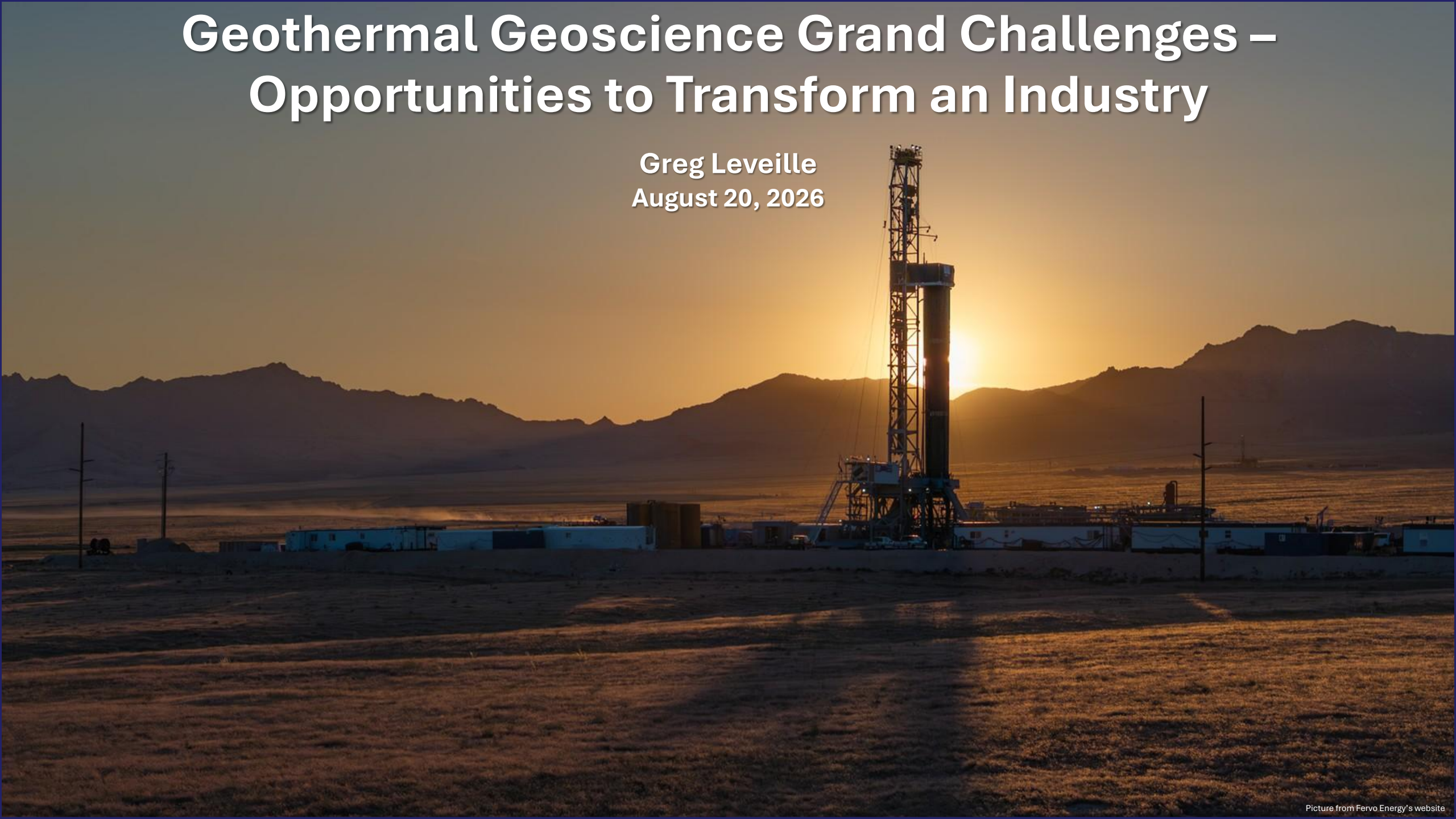
Geothermal Geoscience Grand Challenges – Opportunities to Transform an Industry

Greg Leveille

August 20, 2026



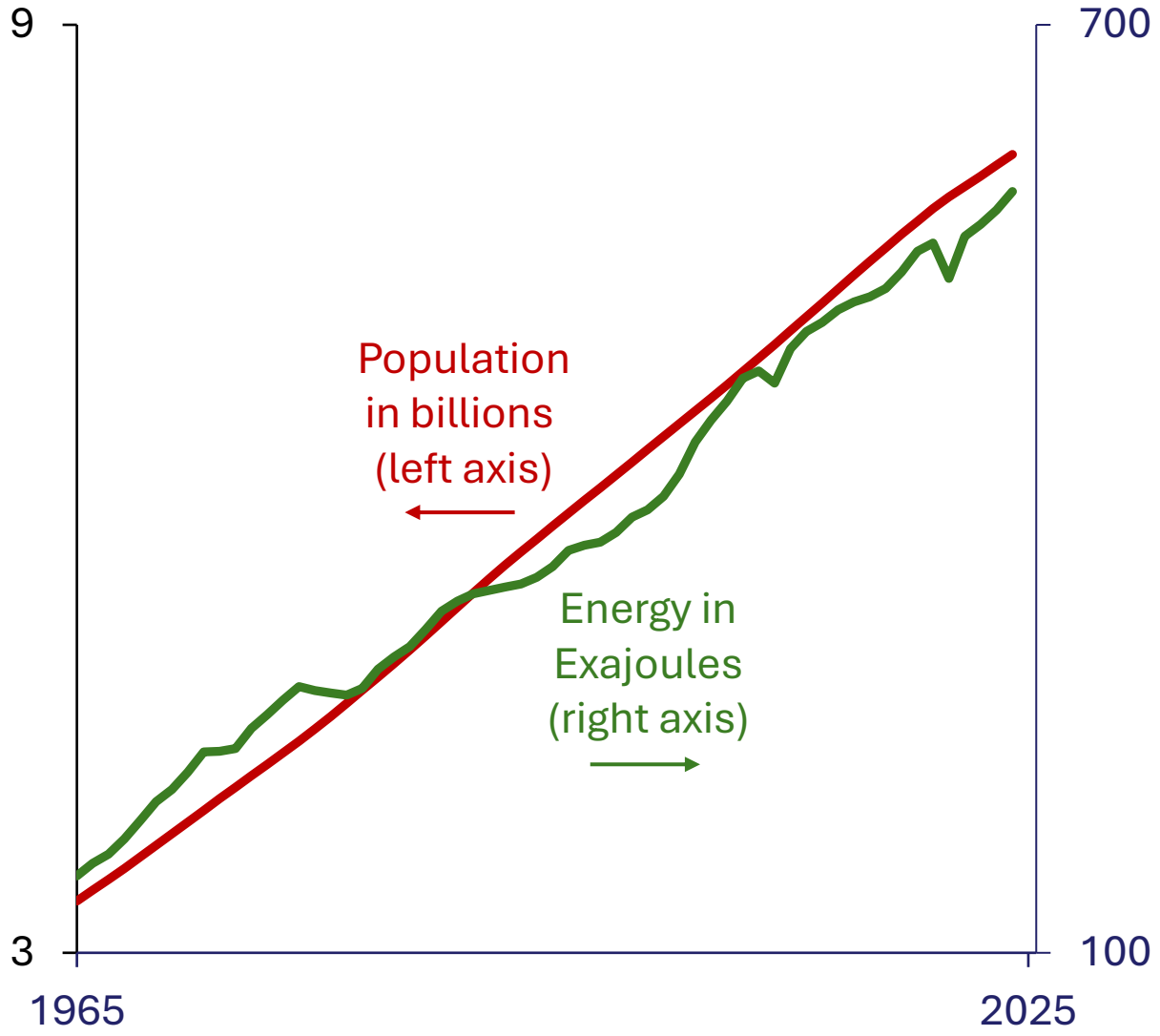
Picture from Fervo Energy's website

Geothermal Geoscience Grand Challenges – Opportunities to Transform an Industry

Presentation abstract: There are moments when exceptional careers are made and the fate of companies, industries, and nations forever altered. That such a moment occurred shortly after the turn of the century in the American oil and gas industry is clear with hindsight. At that time, a modest number of petroleum geoscientists and engineers developed a suite of technologies and know-how that toppled long standing paradigms about the prospectivity of unconventional reservoirs, and in doing so, transformed a slowly dying industry into a world-beating growth engine. Today, the global geothermal industry is poised to follow much the same path, with paradigms about its lack of profitability being upended by geoscientists and engineers who are pursuing innovative ways to reduce the cost of extracting heat from the Earth's crust and transforming it into electricity. For those attending IMAGE 2026, stopping by the Geothermal Hub to learn more about the rapid progress being made could very well be a career enhancing experience. So, whether you're simply curious about what is new in geothermal or considering making a career move, stop by the Geothermal Hub. Listen to talks by those driving innovation forward. Ask questions. Expand your network. For now is a moment when disruptive change is underway, much as was the case nearly a quarter century ago in the American oil and gas industry.

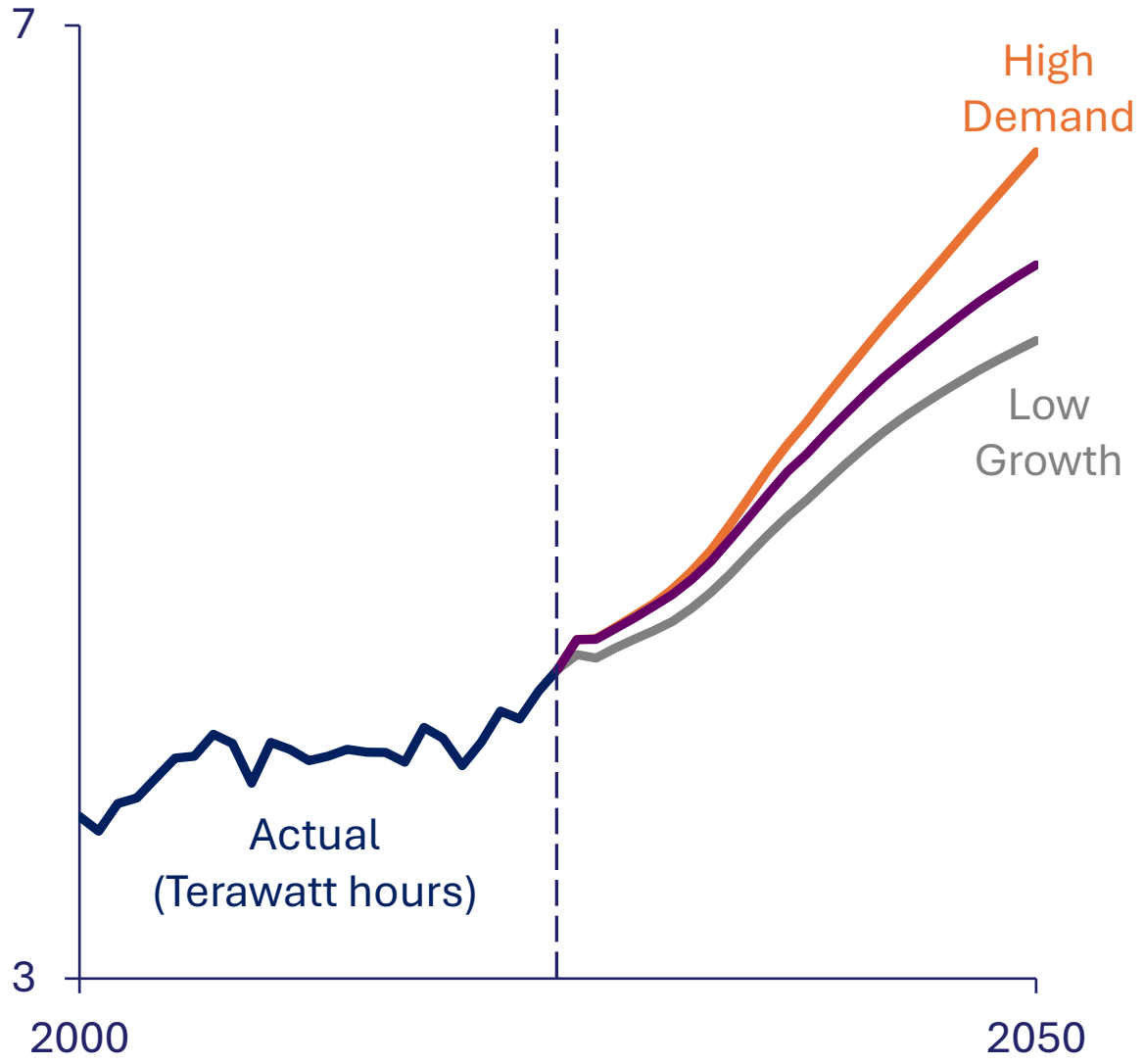
The modern world has a nearly insatiable need for energy

Growth in global population & energy consumption



Sources: Population = World Bank; Energy consumption = Energy Institute

Projected growth in U.S. electricity consumption



Sources U.S. Energy Information Administration

The rapid buildup of GHGs in the atmosphere argue for increased use of low-carbon energy

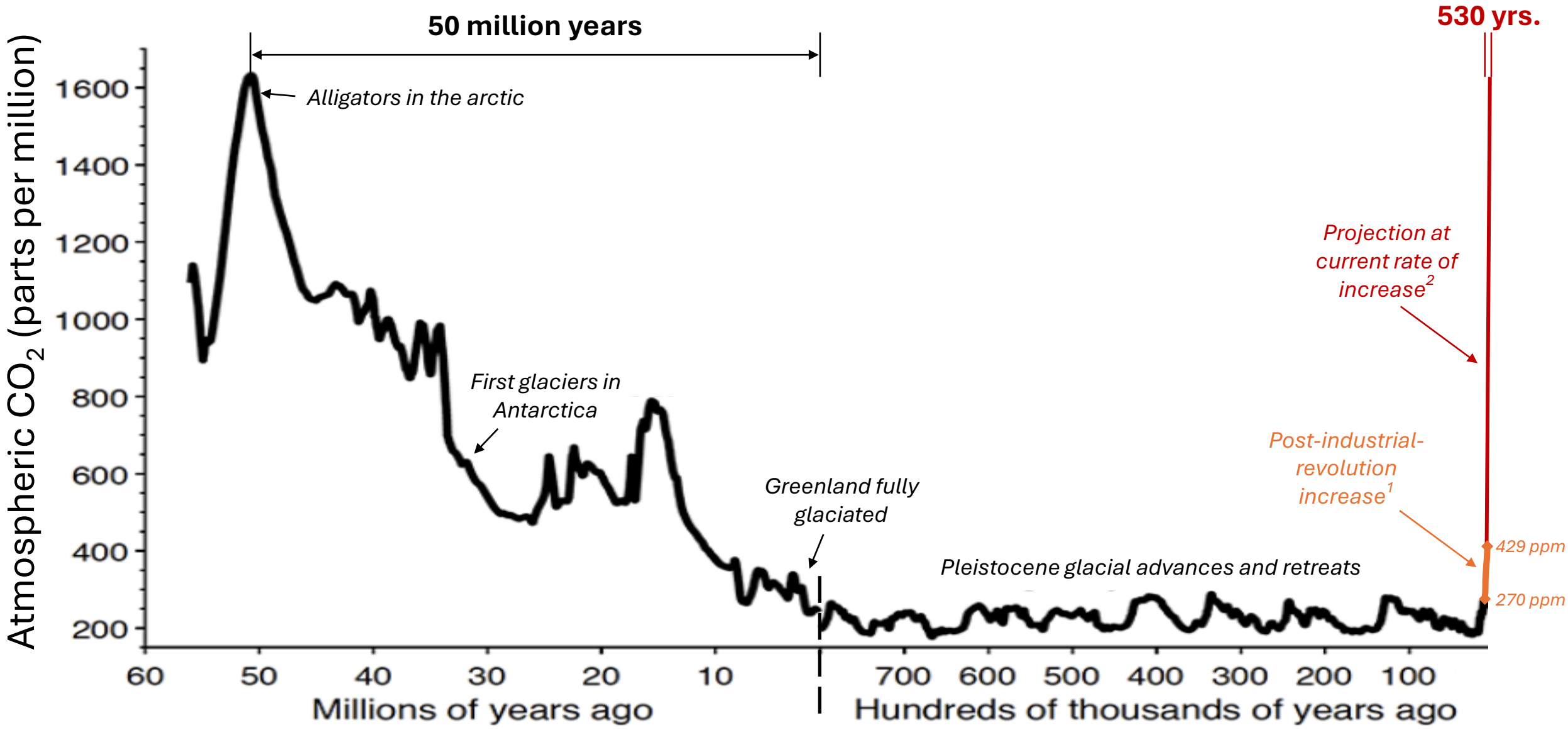


Diagram modified after Zhang, Y. and Liu, X., 2021. [1] From 270 ppm pre-industrial revolution to 429 ppm as of February 2026. [2] Rate of increase over the past 25 years has been 2.2 ppm per annum. PPM = Parts per million.

Heat within the Earth is sufficient to provide an almost inexhaustible supply of low-carbon energy

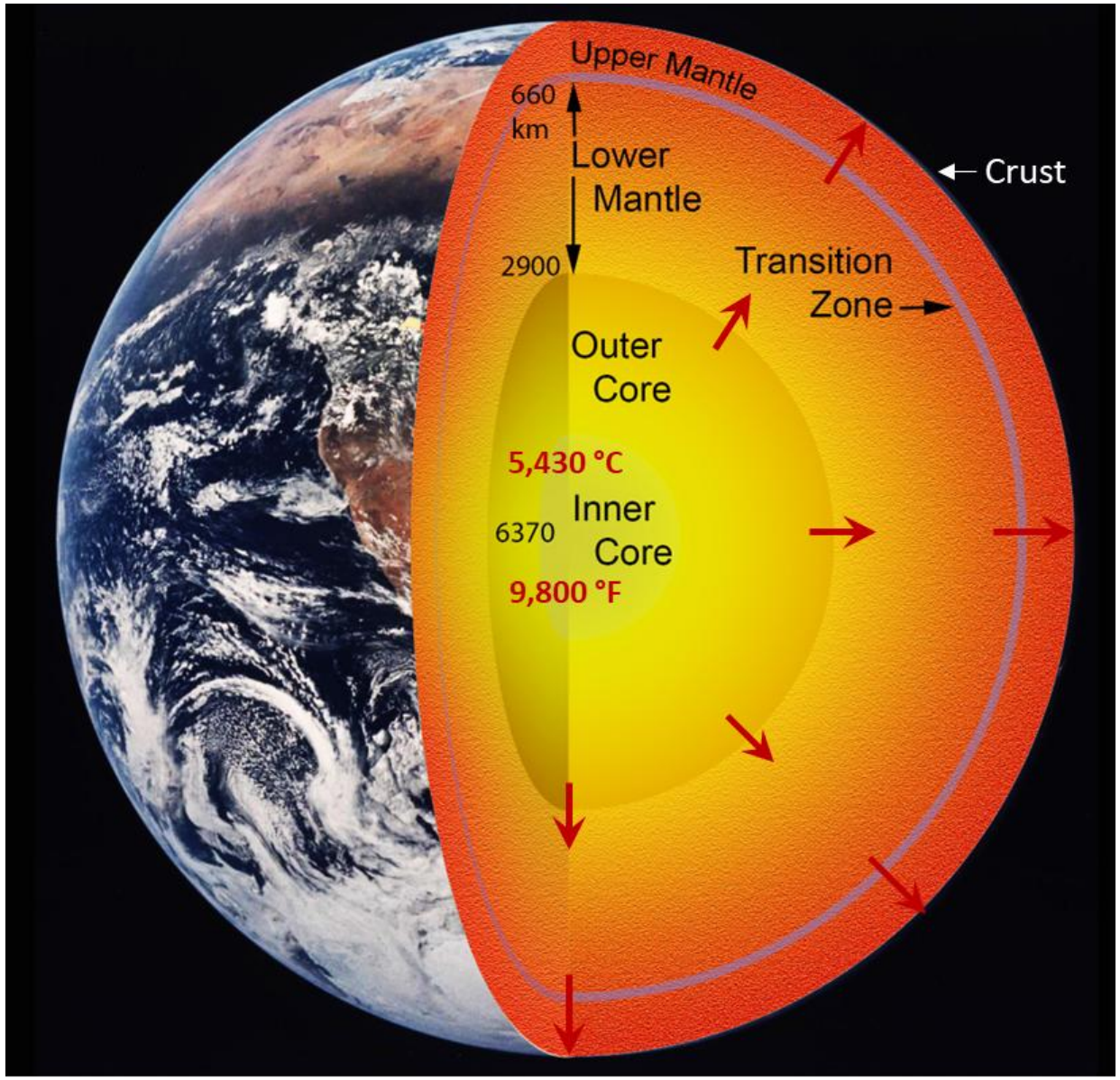
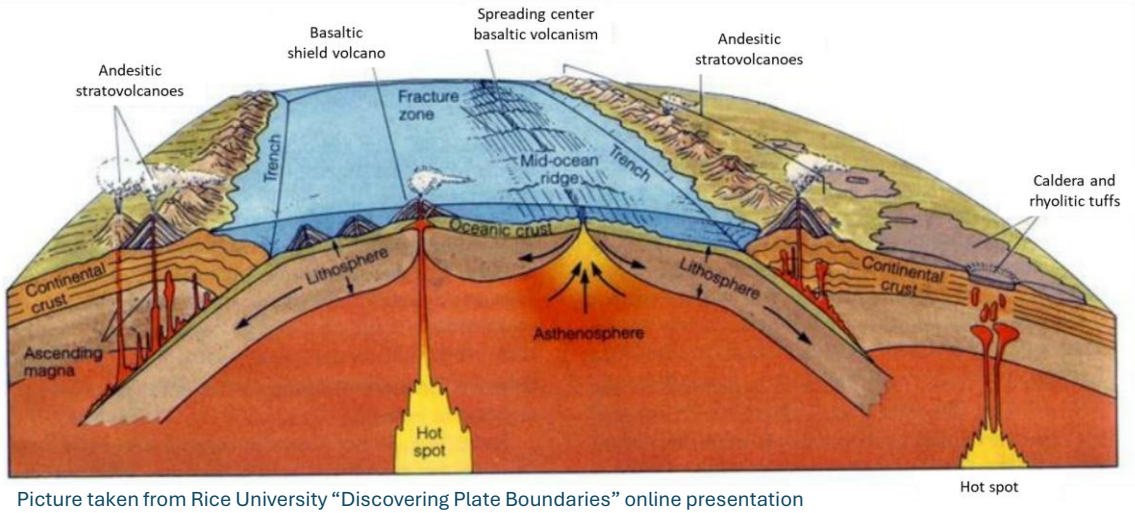


Diagram modified after Steve Jacobsen, Department of Earth, Environmental, and Planetary Sciences, Northwestern University



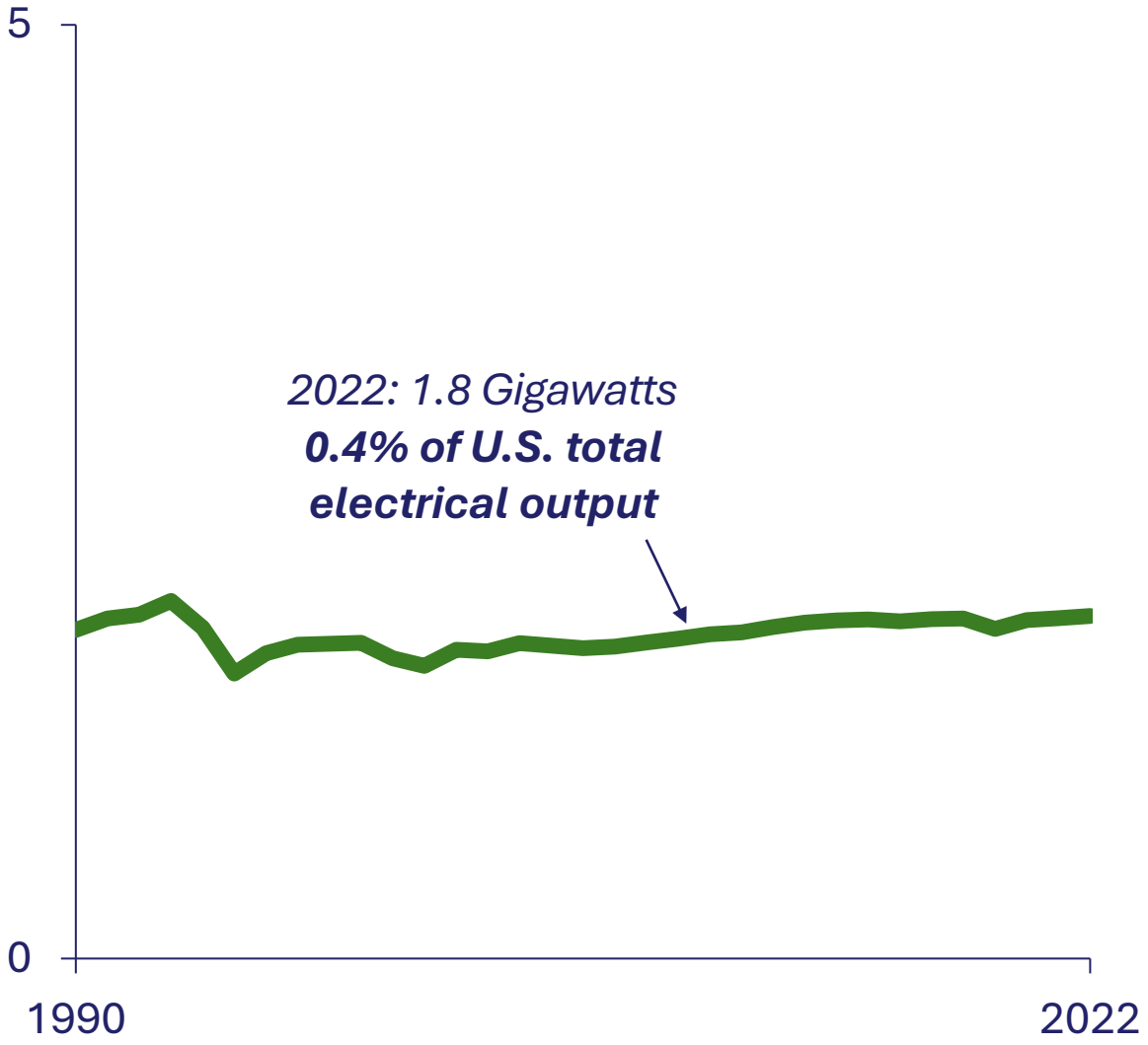
Picture taken from Rice University "Discovering Plate Boundaries" online presentation

Pictures taken from Smithsonian Institute Global Volcanism program website

Yet, the amount of geothermal energy utilized today is surprisingly small

U.S. average instantaneous power generation

(Gigawatts of geothermal power)

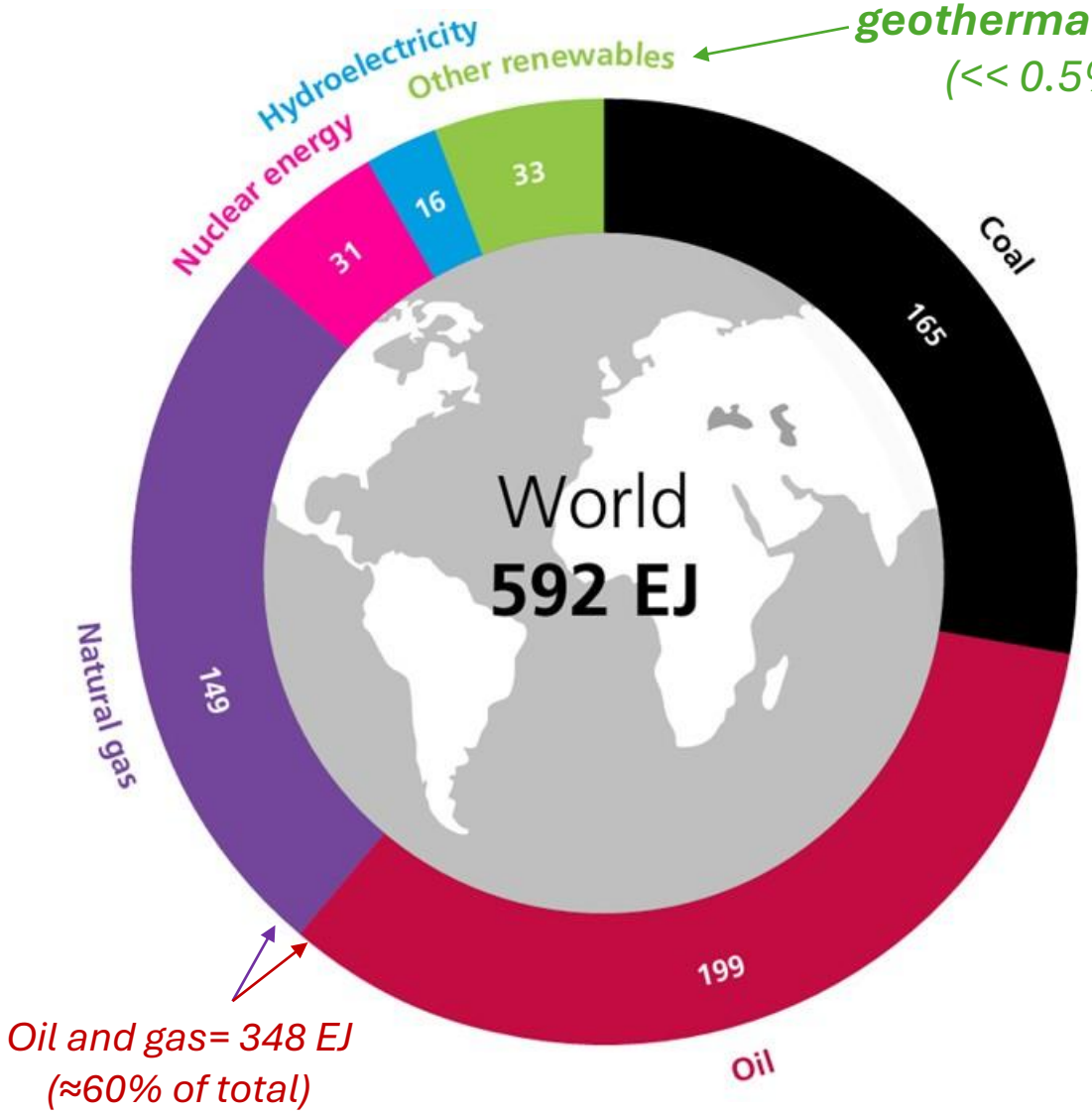


Source: U.S. EIA; curve shown is the average instantaneous output from geothermal power plants on an annual basis

Sources of energy

(2024 Exajoules)

Biomass and geothermal ≈ 3 EJ (<< 0.5%)



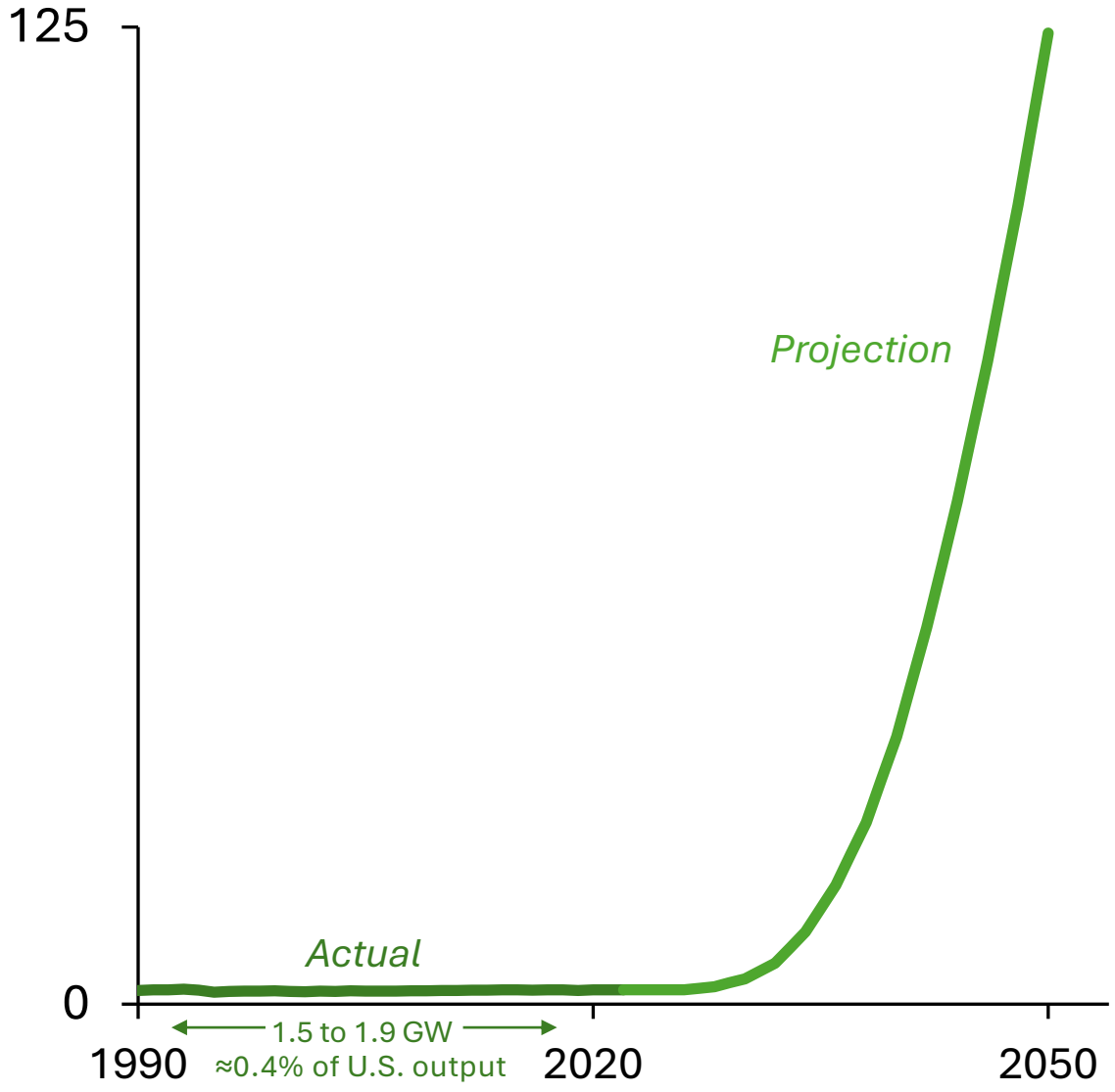
Oil and gas= 348 EJ (≈60% of total)

Source: Energy Institute; EJ = Exajoule

Geothermal energy production is poised for rapid growth, much like U.S. O&G in 2005

U.S. electricity output from geothermal

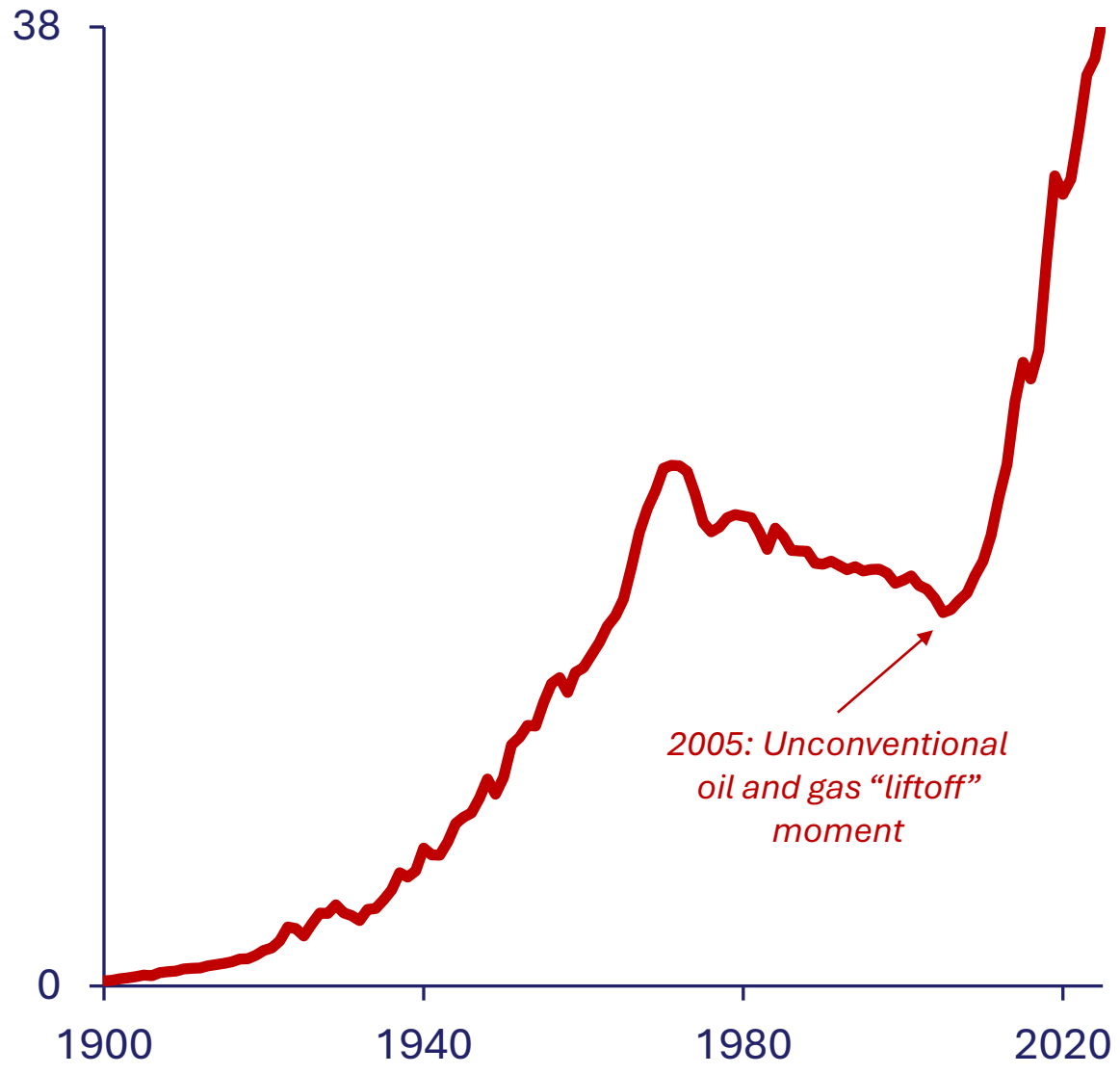
(Gigawatts)



Sources: U.S. EIA for 1990 to 2022; 2022 average output = 1.8 GW (0.4% of U.S. total); Projection mimics U.S. DOE 2024 liftoff report.

U.S. oil and natural gas production

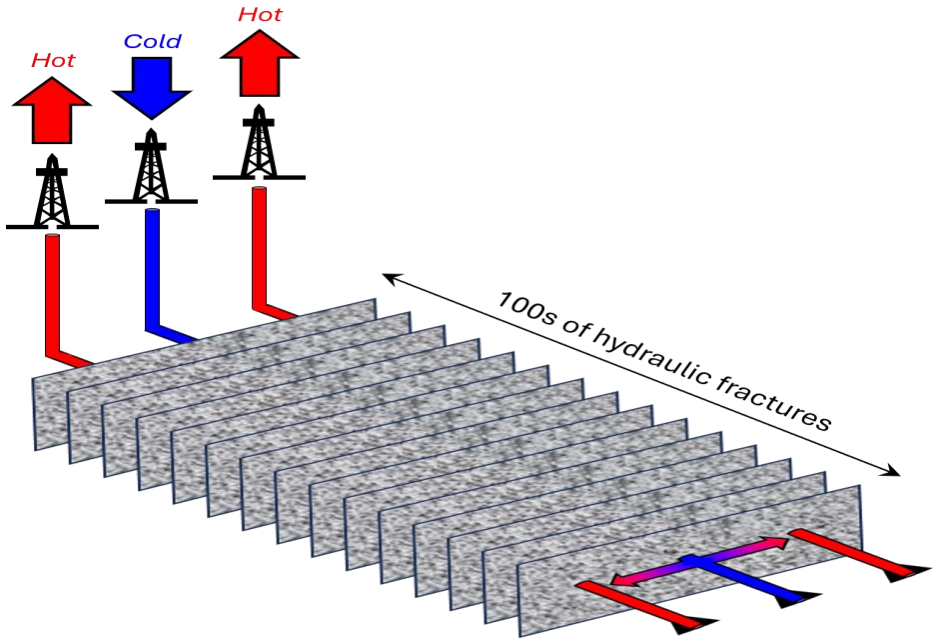
(Million barrels of oil equivalent per day)



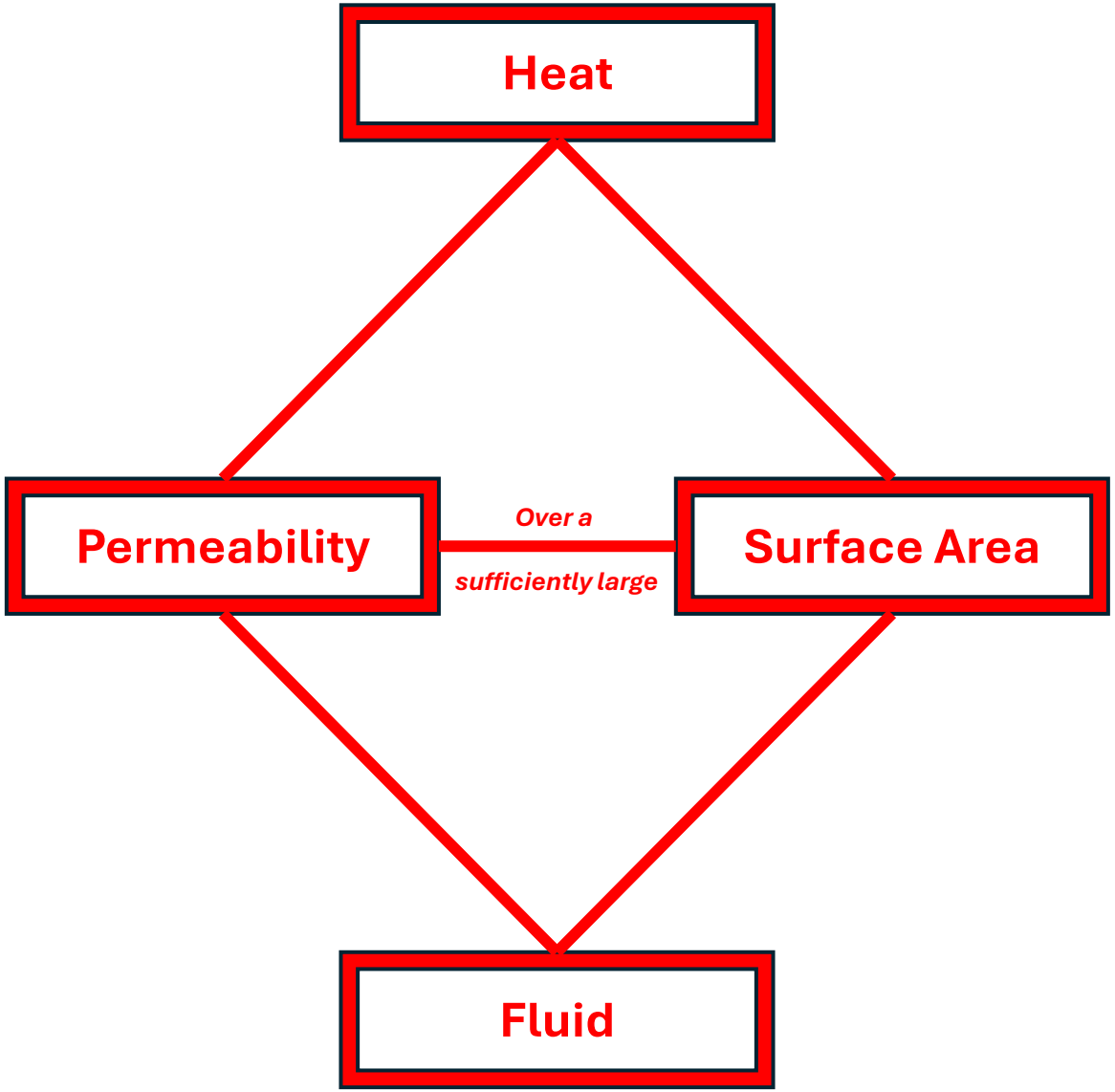
Sources: U.S. EIA and Energy Institute websites

Necessary steps for the geothermal energy industry to achieve liftoff

Use of state-of-the-art technologies & workflows



Make progress on geoscience grand challenges



Geologic grand challenges to be addressed in this session

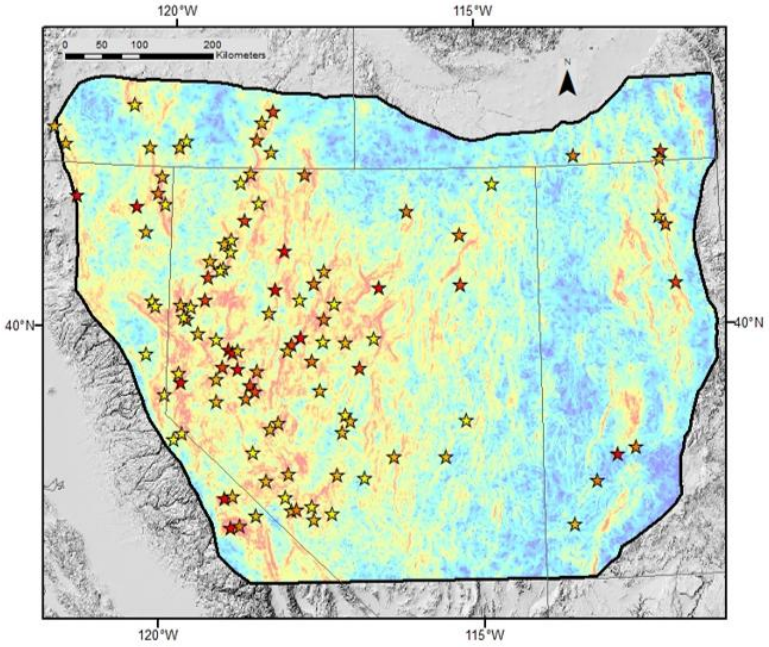
Producing from super hot rocks

Newberry Volcano SHR EGS project

Matt Houde
Quaise Energy
1:40 - 2:00 PM

Hydrothermal exploration

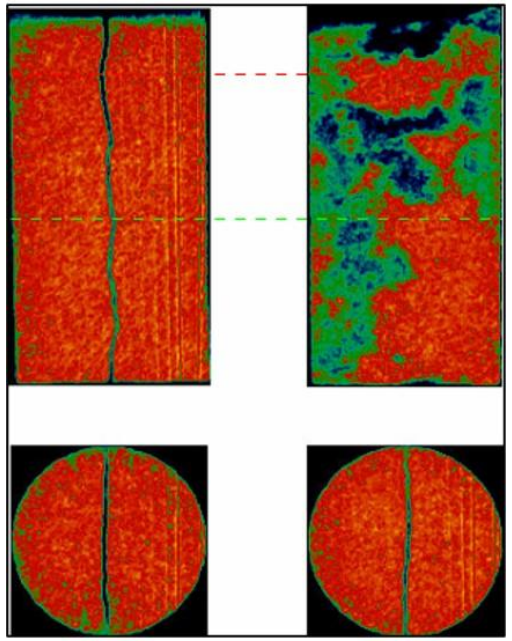
Great Basin structural favorability



Nicole Hart-Wagoner
Univ. Nevada Reno
2:00 – 2:20 PM

Experimental geomechanics

Tensile Fracture Conductivity Loss at 350° C



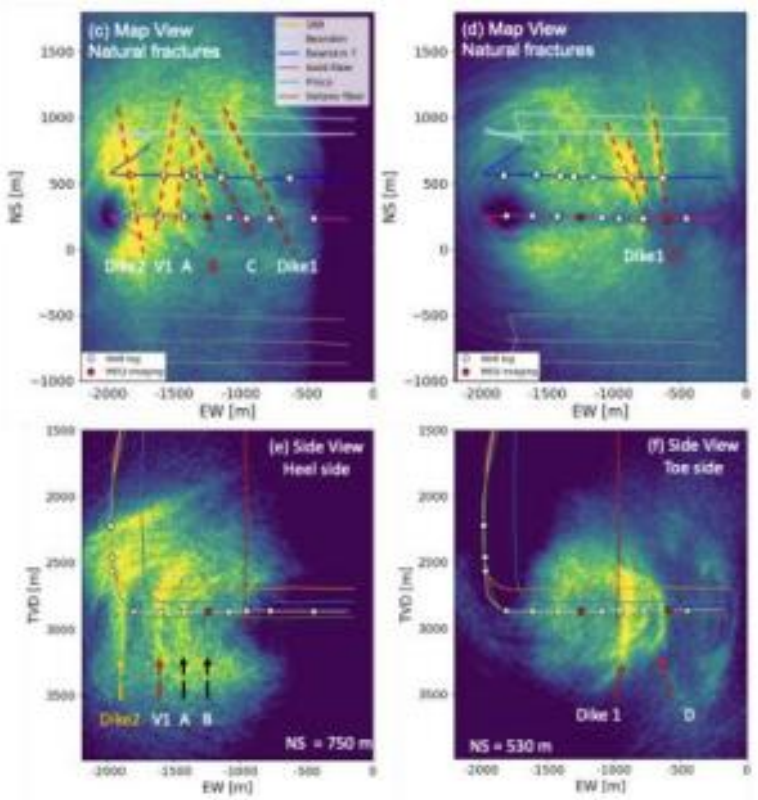
Deepak Gokaraju
Metarock Labs
2:20 – 2:40 PM

Geophysical grand challenges to be addressed in this session

Geophysics' high-temp. frontier

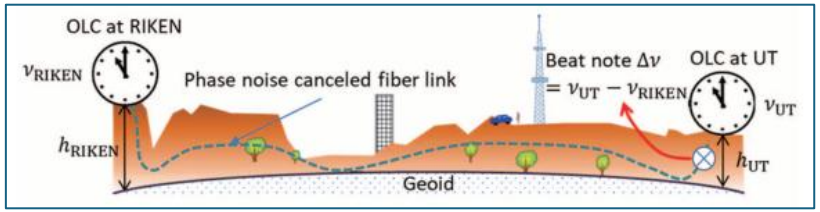
Sireesh Dadi
Fervo Energy
2:50 – 3:10 PM

Imaging "basement rocks"

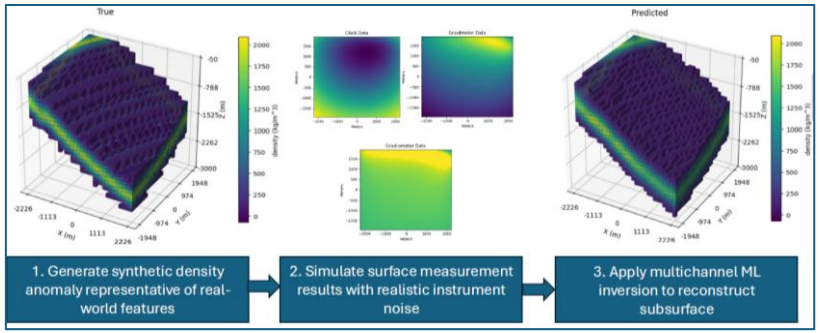


Jonathan Ajo-Franklin
Rice University
3:10 – 3:30 PM

High resolution grav./mag.



***Relativistic geodesy concept**: two clocks are compared via fiber link; their frequency difference corresponds to the height difference*

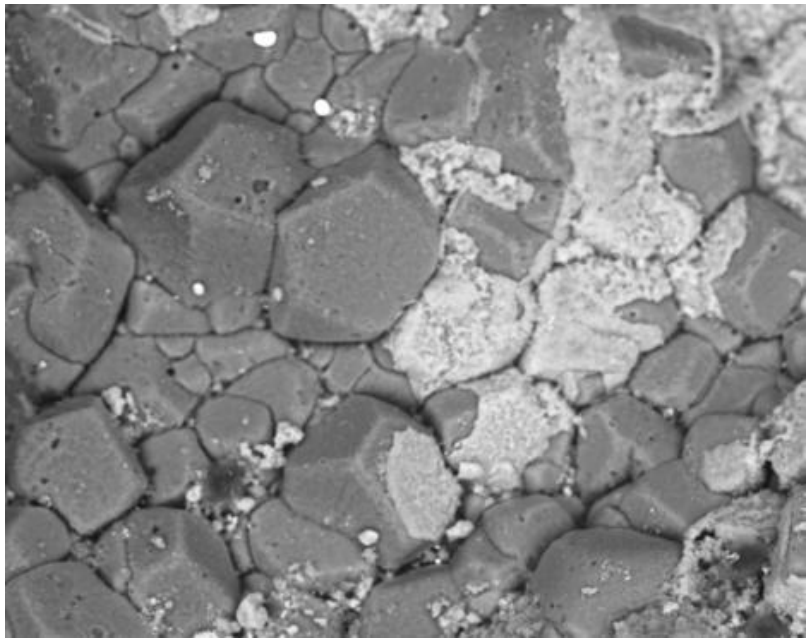


***Multichannel inversion algorithms** used to reconstruct subsurface*

Michal Ellen Ruder
Wintermoon
3:30 – 3:50 PM

Geochemical grand challenges to be addressed in this session

Fluid rock interactions

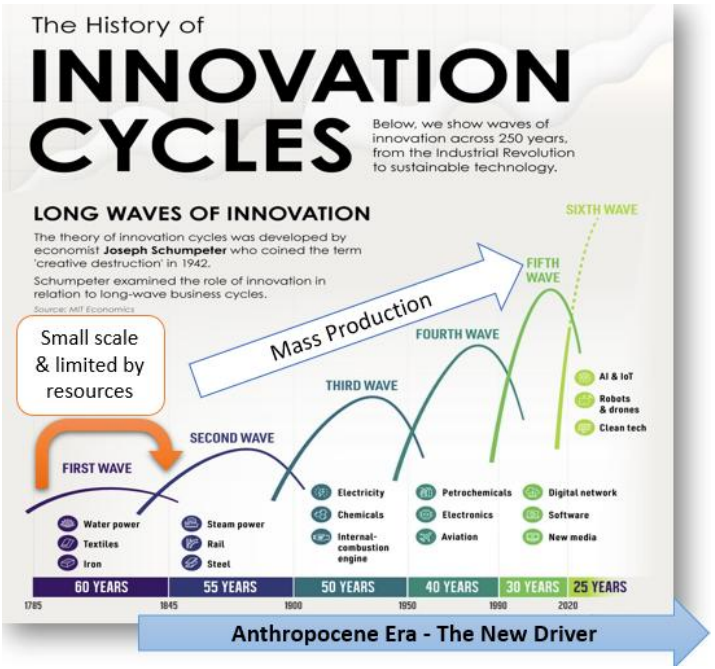


Kristie McLin
Utah FORGE / EGI
4:00 – 4:20 PM

Super hot rock geochemistry

Angela Seligman
Clean Air Task Force
4:20 – 4:40 PM

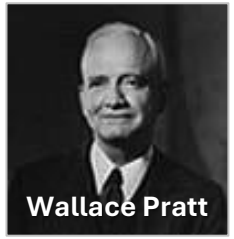
The materials opportunity

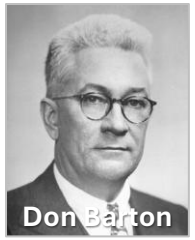


Katerina Yared
3M
4:40 – 5:00 PM

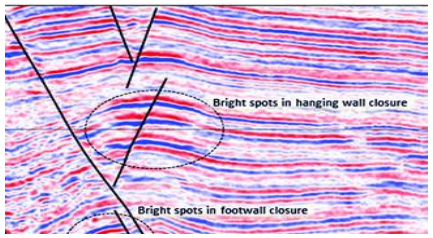
Why might you want to get involved in solving one of these grand challenges?

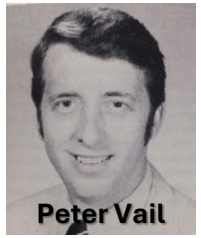
Onshore conventional fields
(early part of the 20th century)

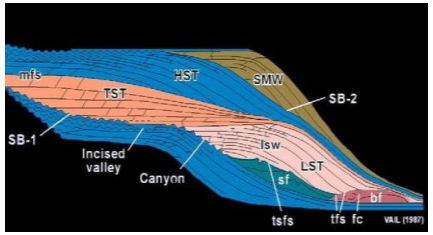


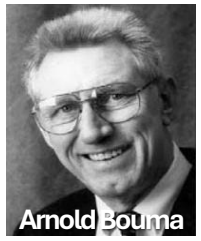


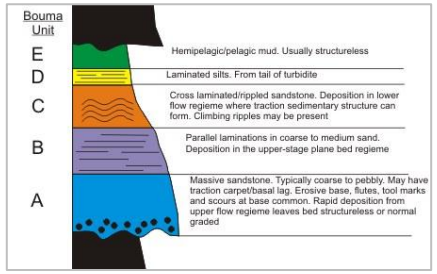
Offshore E&P
(Middle part of the 20th century)



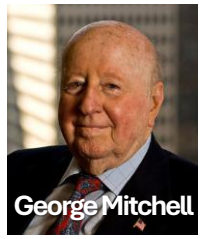


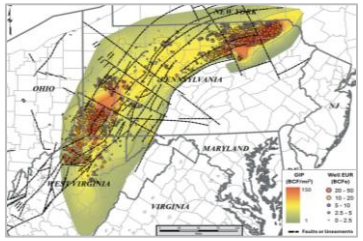


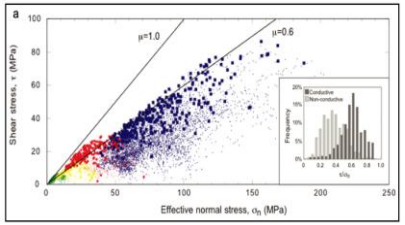




Unconventional reservoirs
(Dawn of the 21st century)





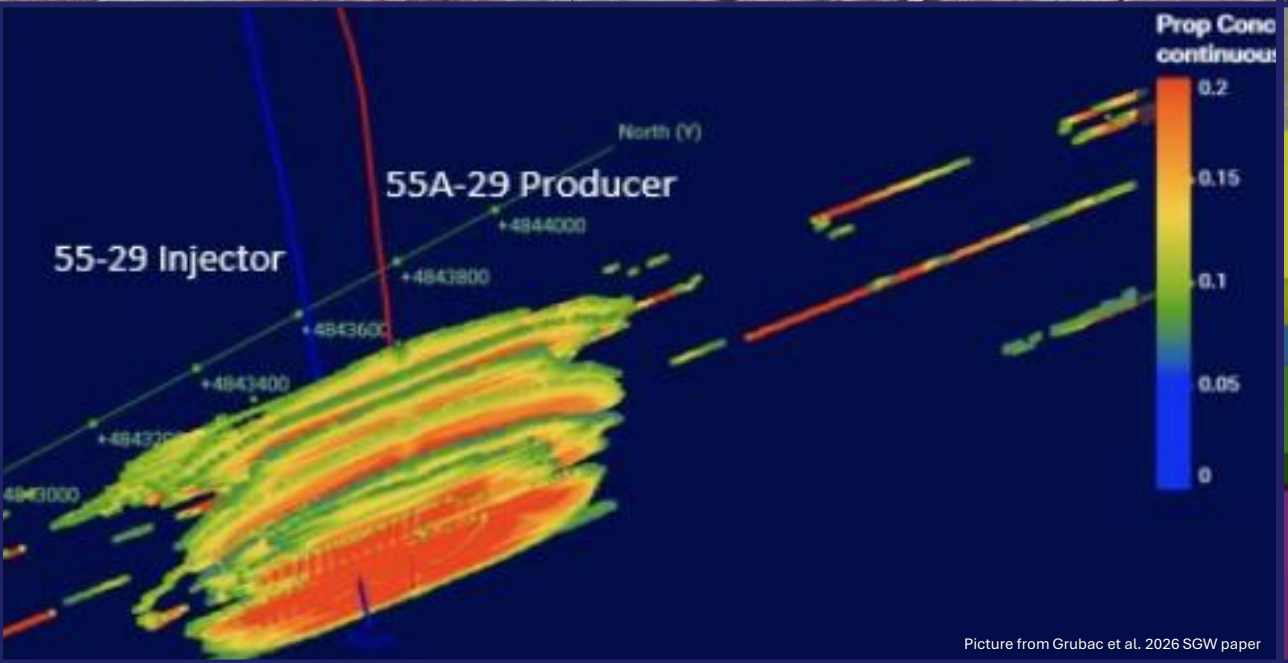


Moments that matter – moments when exceptional careers are made and the fate of companies, nations, and global industries decided

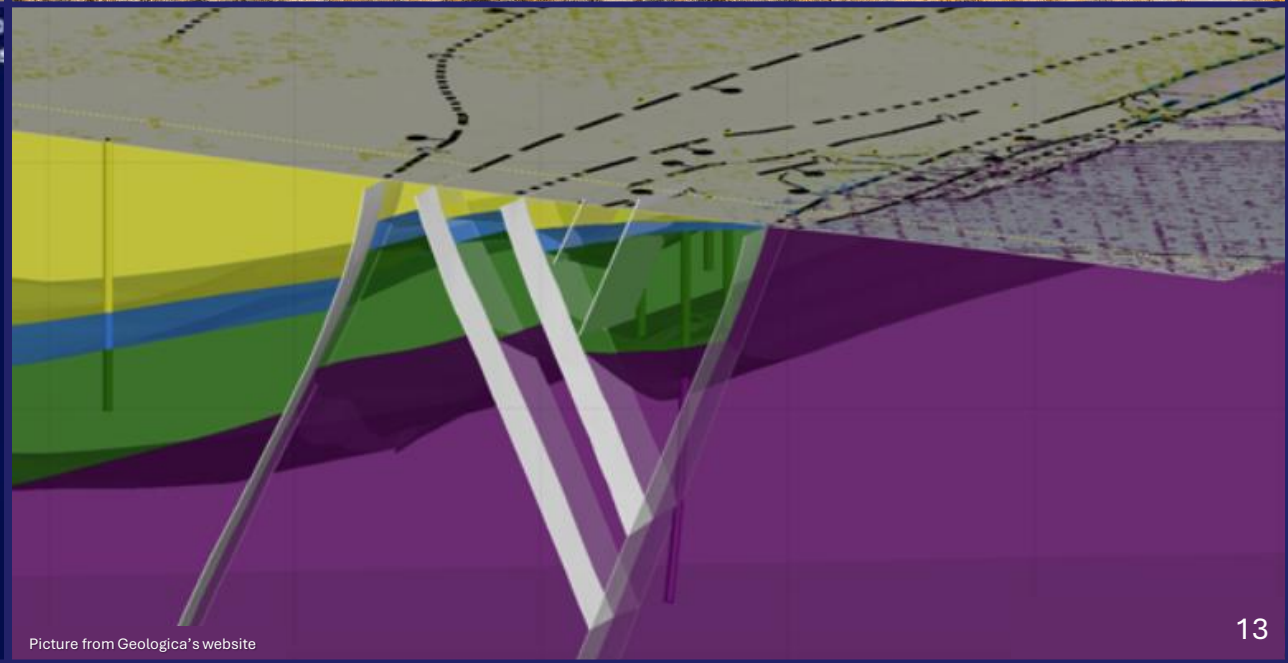
Now is a moment that matters for geothermal energy production

Picture from Fervo Energy's website

Picture from Zanskar's website



Picture from Grubac et al. 2026 SGW paper


Picture from Geologica's website

Key takeaway messages

- Geothermal energy production is poised for rapid growth
- Much progress has been made across numerous geoscience disciplines
- Several geoscience grand challenges still await innovative solutions
- Now is therefore an excellent time to join the geothermal industry
- Get involved, engage with industry experts, expand your network
- At moments like these when disruptive change is underway, exceptional careers are made and the fate of companies, nations, and global industries decided

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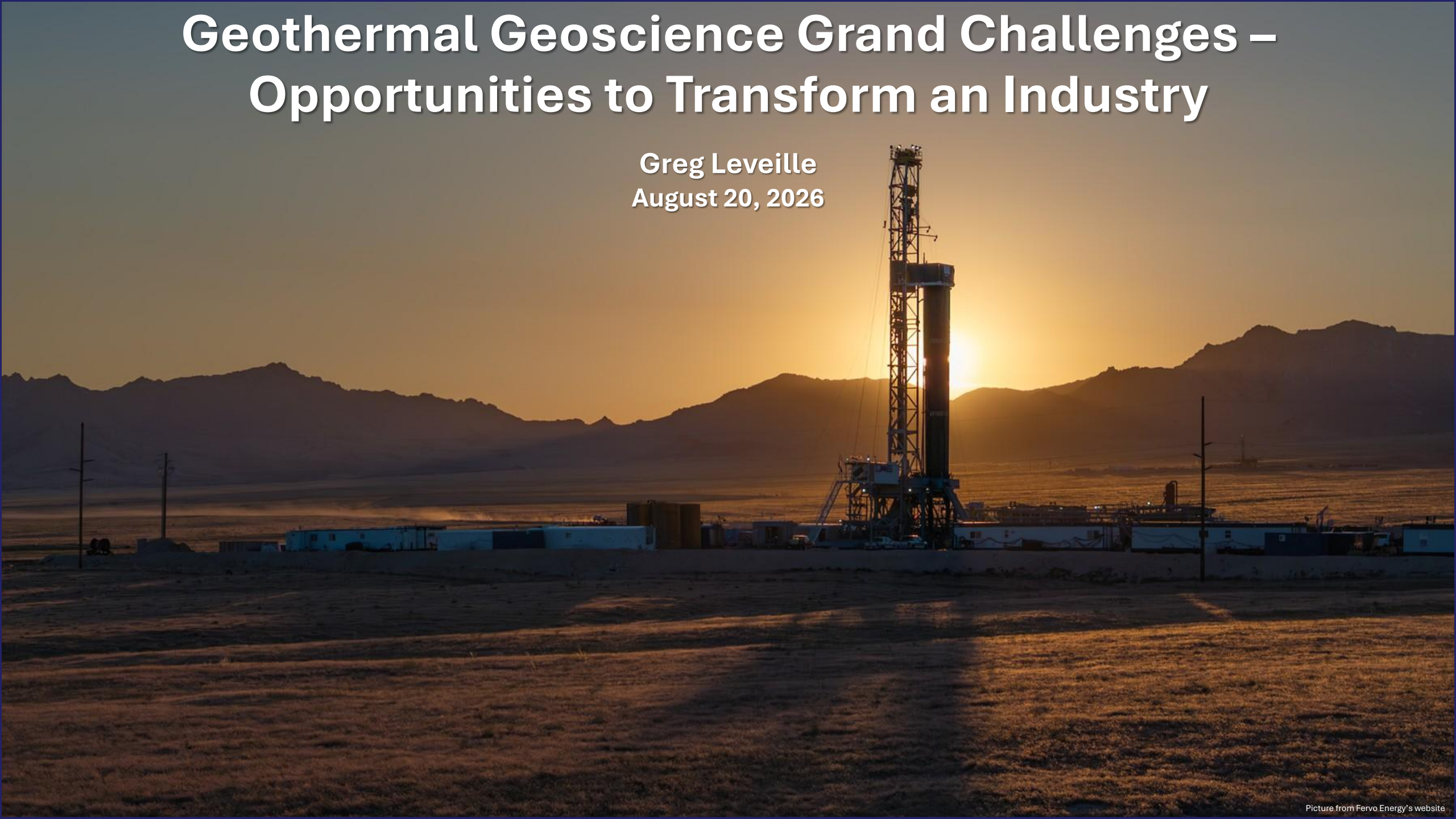
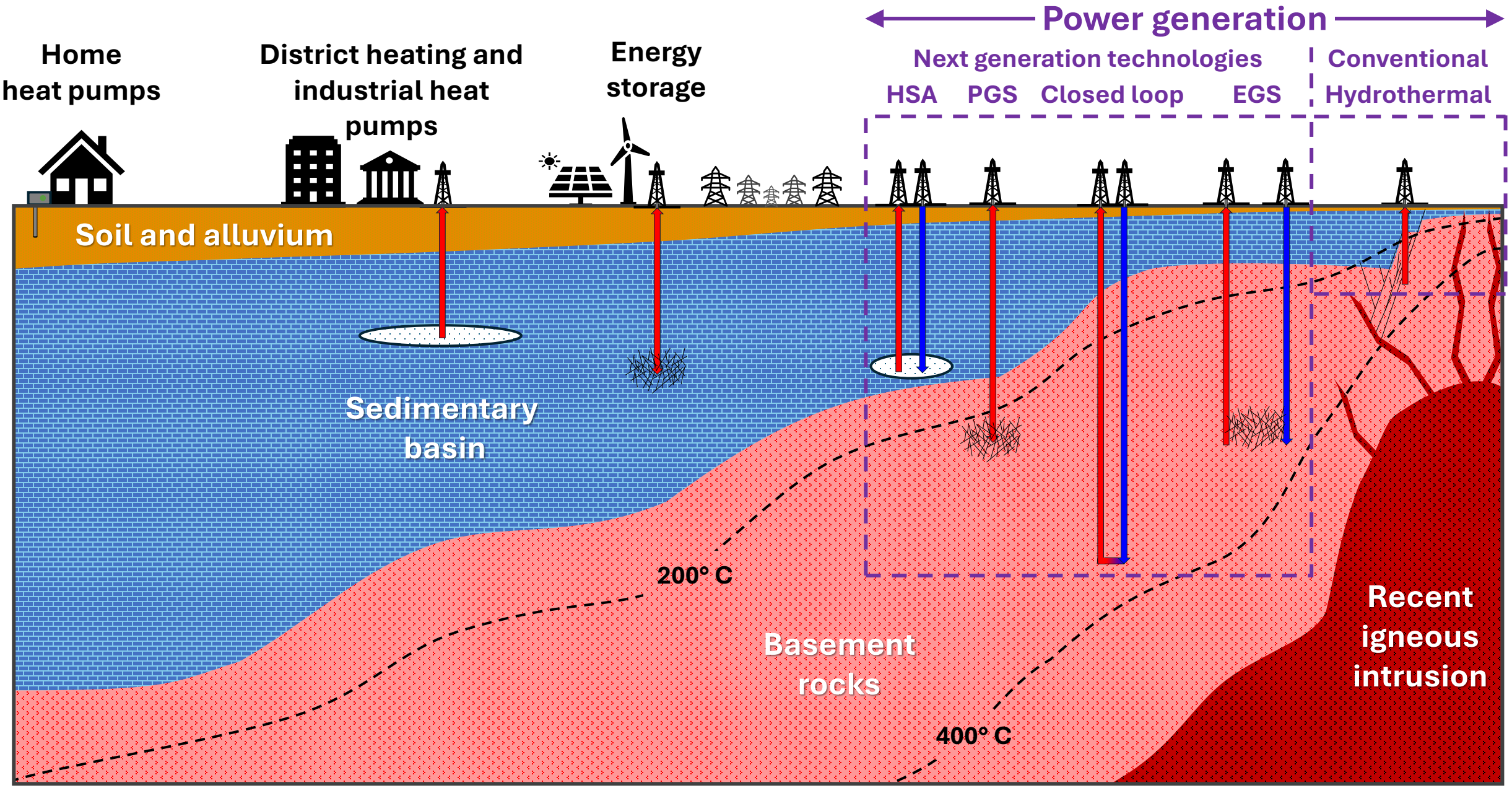


Picture from Fervo Energy's website

There are many ways to utilize the heat beneath our feet. Power is the biggest economic prize



Cross section view; not to scale; depictions of geothermal systems are greatly simplified; HSA = Hot Sedimentary Aquifers; PGS = Pressure Geothermal Systems; EGS = Enhanced Geothermal Systems