CHESAPEAKE ENERGY

+

NEXT GEN GEOTHERMAL

Next Generation Geothermal

Reliable, Renewable Energy of the Future

2023 SPEE Annual Meeting

Key Takeaways

- Energy demand continues to grow, and we must consider the energy trilemma

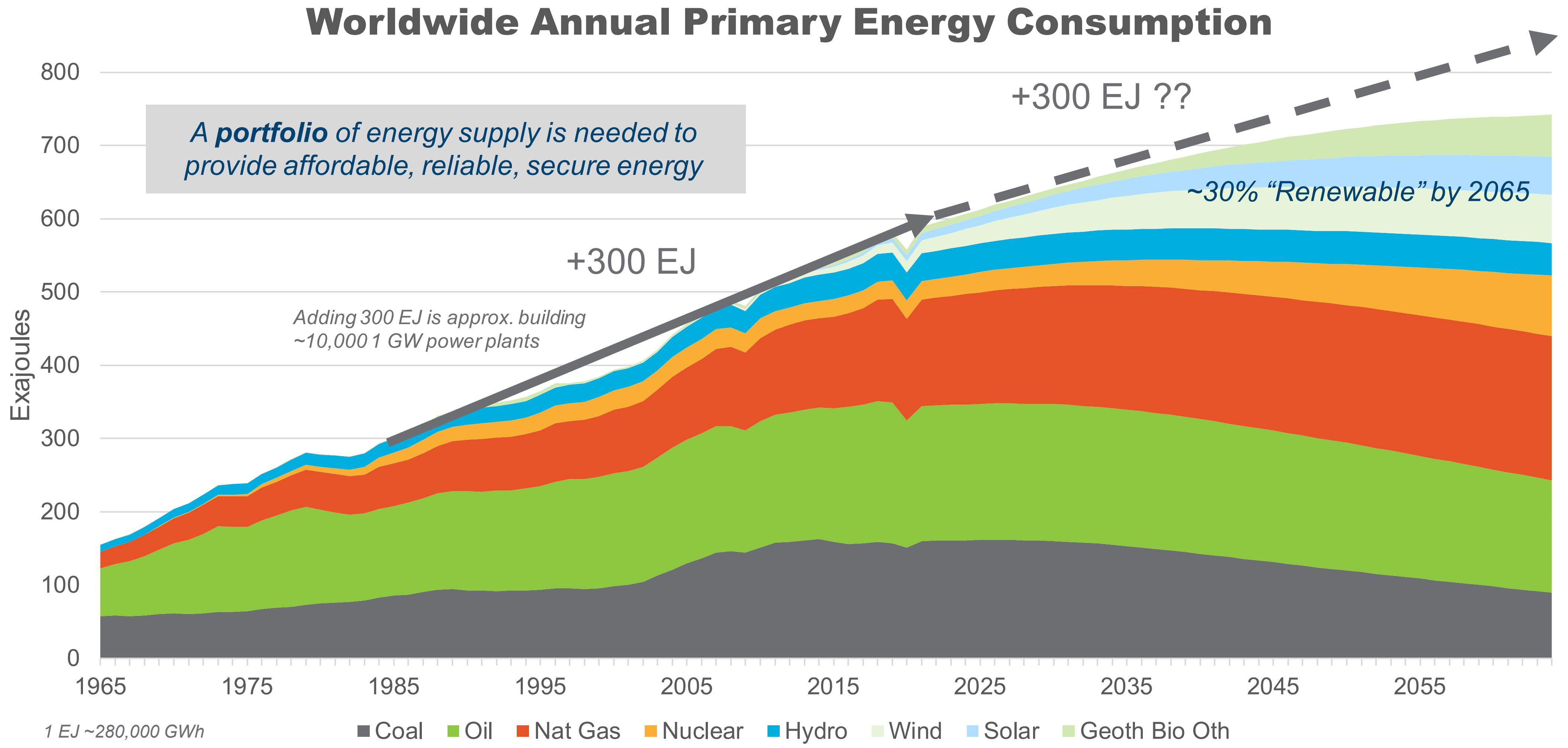
  Next Generation Geothermal could offer a viable decarbonization strategy
- O&G companies can leverage expertise to advance Next Gen Geothermal to meet decarbonization goals
- There are familiar concepts and overlapping skills in Next Gen Geothermal but also unique challenges
- The value proposition for Next Gen Geothermal is both a commercial, diverse revenue stream and environmental attributes

Momentum is building for Next Generation Geothermal

The Energy Trilemma

Honest conversation on energy demand and tradeoffs

Energy Needs Continue to Grow



Source: https://switchon.org/presentations/ ; Historical Data: BP Statistical Review of World Energy (2022) Future Scenario Scott Tinker, 2022

The Challenge: The Energy Trilemma

ENERGY SECURITY

Meet current and growing future demand with reliability

CHK delivers ~6 bcf/day of gross certified responsibly sourced gas

ENERGY EQUITY

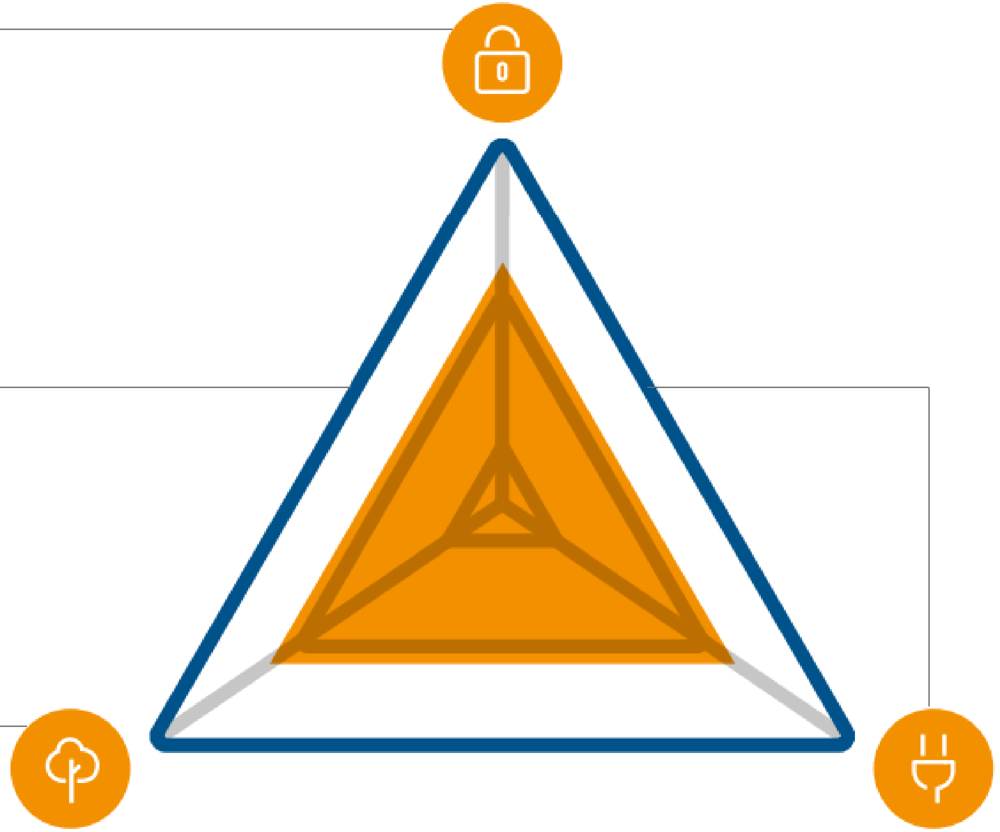
Provide access to affordable and abundant energy for domestic and international use

CHK believes in an all-of-the above approach to addressing global energy needs

ENVIRONMENTAL SUSTAINABILITY

Responsibly harness resources mitigating environmental impact for a sustainable, low carbon future

CHK supports the ambitions of the Paris Climate Accord, setting a net zero Scope 1 and 2 by 2035 goal



Our energy supply must balance all three; only focusing on one element could have detrimental impacts

Source: https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index

All Energy Sources have Tradeoffs

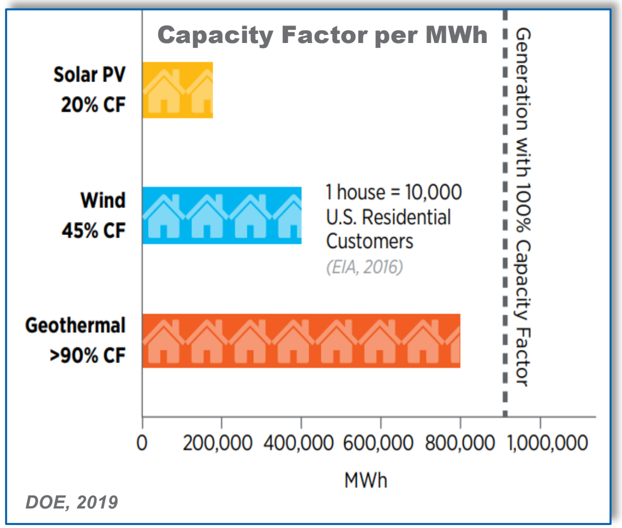
MW vs MWh	Megawatt (MW) is a measure of power plant output. Megawatt hour (MWh) is 1 MW of output for 1 hour
Capacity Factor	Operating uptime; a power plant with 1 MW capacity does not output 1 MW 24/7 due to a variety of reasons

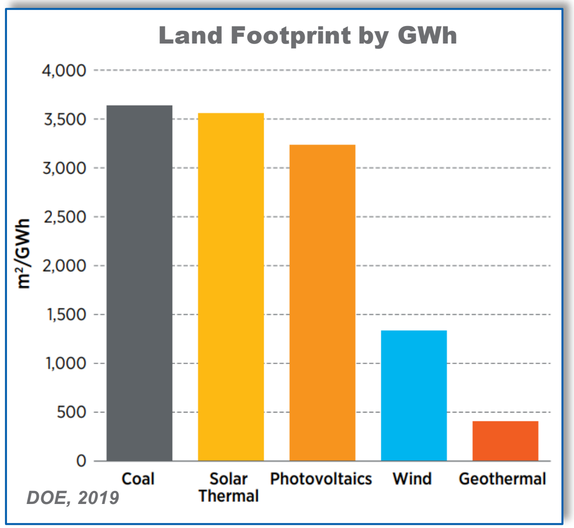
$$1\ MW\ for\ 1\ day = 24\ MWh$$

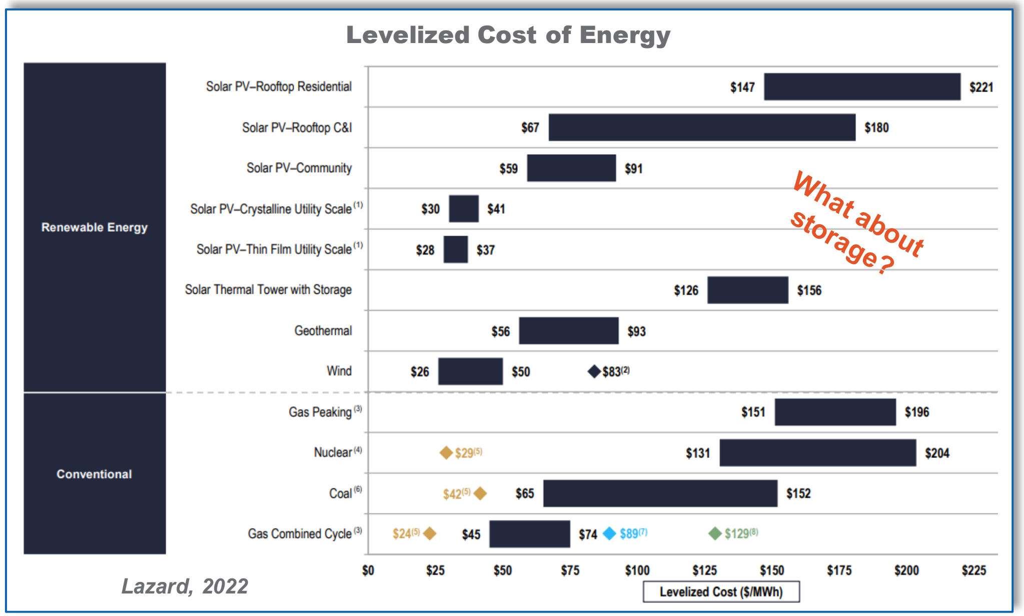
$$Max\ MWh\ in\ 1\ yr = 365\ days\ x\ 24\ hrs\ x\ 1MW$$

$$= 8{,}760\ MWh$$

$$Capacity\ Factor = \frac{Operating\ Uptime}{Max\ MWh\ in\ 1yr}$$







Energy sources vary on several key factors; to generate "clean" MWh, there are tradeoffs with intermittency, footprint, and cost

$$\text{LCOE} = \frac{\text{sum of costs over lifetime}}{\text{sum of electrical energy produced over lifetime}}$$

Why Next Generation Geothermal

NEXT GEN GEOTHERMAL

Oil & Gas Technologies + **Geothermal Innovations** = **Commercially scalable, baseload renewable energy**

Benefits

- The earth is a massive, inexhaustible heat resource
- Lower land use and better reliability than existing renewables; i.e. baseload
- Immediately apply proven technologies & advances of O&G Industry

Opportunities

- Various emerging technologies and approaches offer a suite of solutions
- Leverage expertise of O&G professionals to execute
- Potential for a commercially scalable approach that can help solve the Energy Trilemma

CHK's Sustainability Strategy

How an O&G operator can be a part of the solution

CHESAPEAKE ENERGY

New Energy Ventures in CHK's Sustainability Framework

Safety

Environmental

Reporting

People/Community

Responsibly Sourced Gas *Complete*	Partnerships to abate emissions from the natural gas value chain
GHG Abatement *Now*	Reducing the carbon footprint of our production operations
New Energy Ventures *5 – 10 years*	Exploring sustainable technologies for commercial and offset potential

Sustainability Leadership

Consistent and measurable progress on our path to net zero
https://sustainability.chk.com/

NEV is pursuing scalable, adjacent & commercial opportunities for CHK to meet & exceed net zero goal by 2035.

How to Deliver a Sustainable Venture and Achieve Net Zero

A Portfolio Approach to Mitigate Risk

- **Evaluate emerging technologies**
  Innovative applications in the energy transition market
- **Leverage internal experts and consultants**
  Avoids redundancy and manages resources
- **Embrace collaborations & partnerships**
  Share learnings and minimize financial exposure
- **Build a portfolio of compelling opportunities**
  Increases optionality and chance of success
- **Bias toward tangible projects**
  Demonstrate, learn, and iterate from practical experience
- **Scale & deliver results**
  Unleash CHK expertise and operational excellence

Opportunities Must Meet the Objectives

1. **Scalable** to offset significant GHG emissions
2. Competency **adjacent** to core O&G business
3. Potential for a **commercial**, diverse revenue

Focusing on Adjacent Technologies

Next Generation Geothermal

Carbon Capture & Sequestration

Nat. Gas to "Blue" Products

Geothermal Offers Multiple Decarbonization Pathways

Environmental Attribute (EAs)

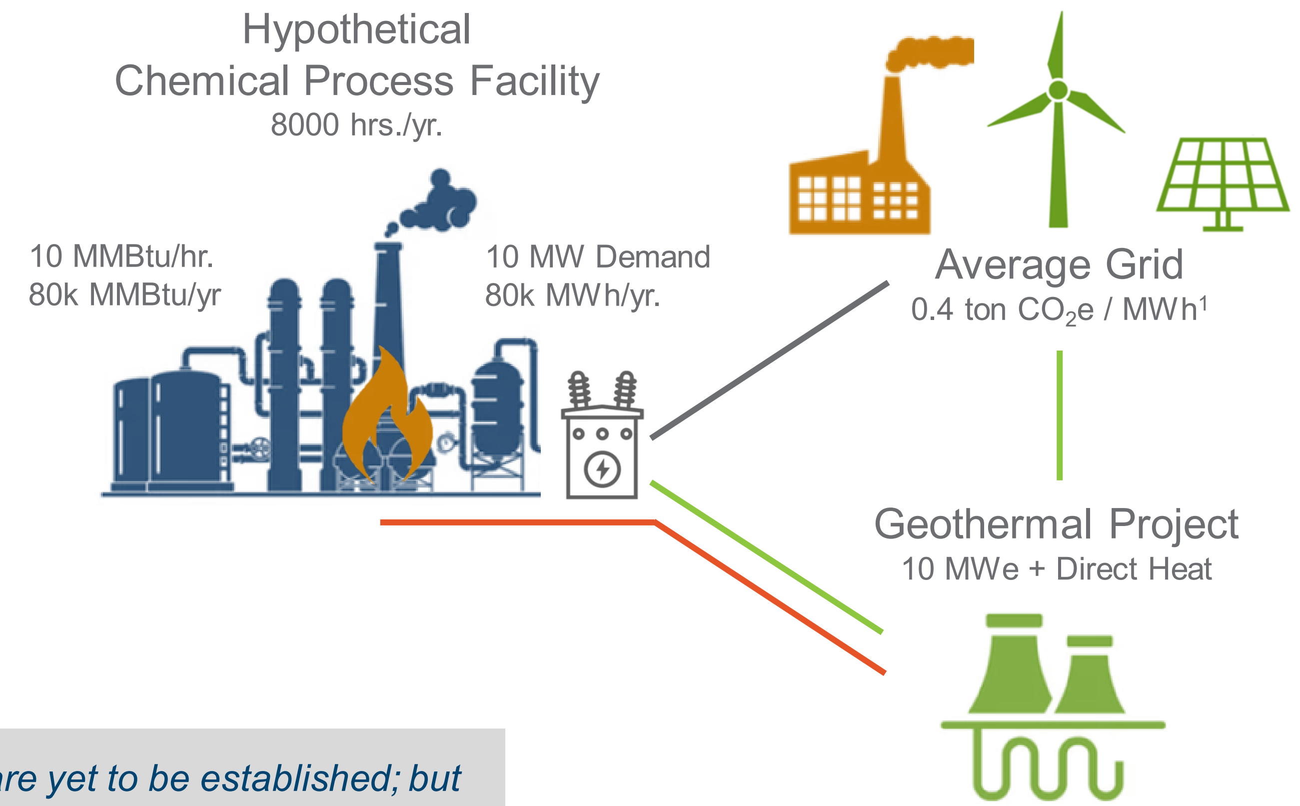
All credits, benefits, emissions reductions, offsets, and allowances, howsoever entitled, attributable to the [project] and / or its displacement of conventional energy generation

Current Emissions

Scope 1	Scope 2
4 ktpa	**32 ktpa**
0.05 ton CO_2e / MMBtu	0.4 ton CO_2e / MWh[1]

Potential Emissions

Scope 1	Scope 2
2 ktpa	**~3 ktpa**
Assume 50% reduction	90% geothermal runtime



Environmental Attribute methodologies for geothermal are yet to be established; but there is a logical path to decarbonization using geothermal electricity and direct heat

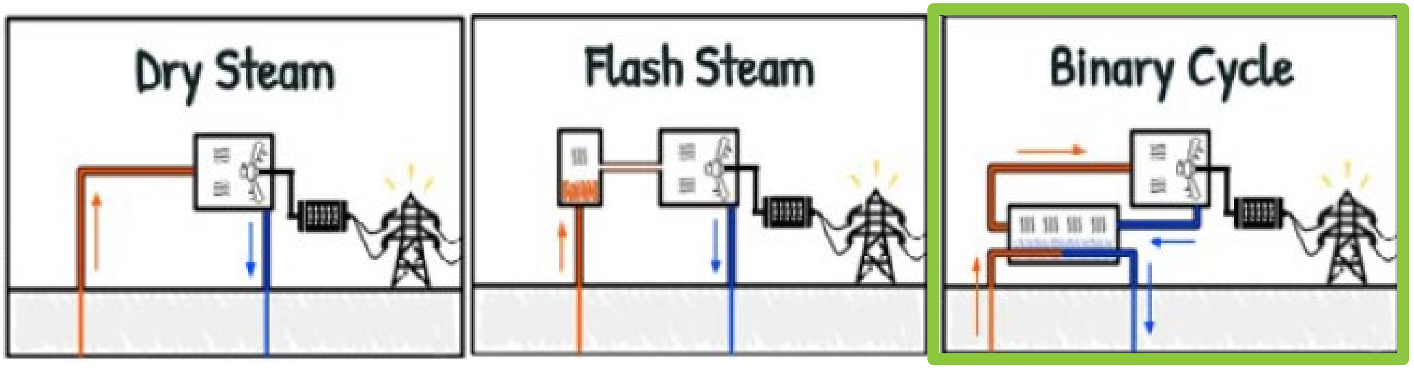
1. www.epa.gov/egrid/power-profiler

Geothermal Basics

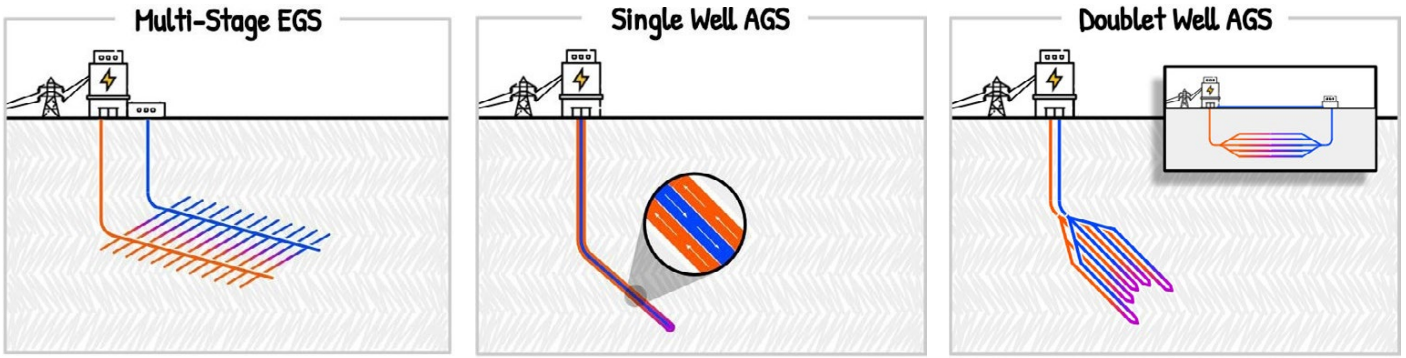
Familiar concepts with overlapping skills but also, unique challenges

Types of Geothermal & Applications

Conventional Geothermal Power Plants

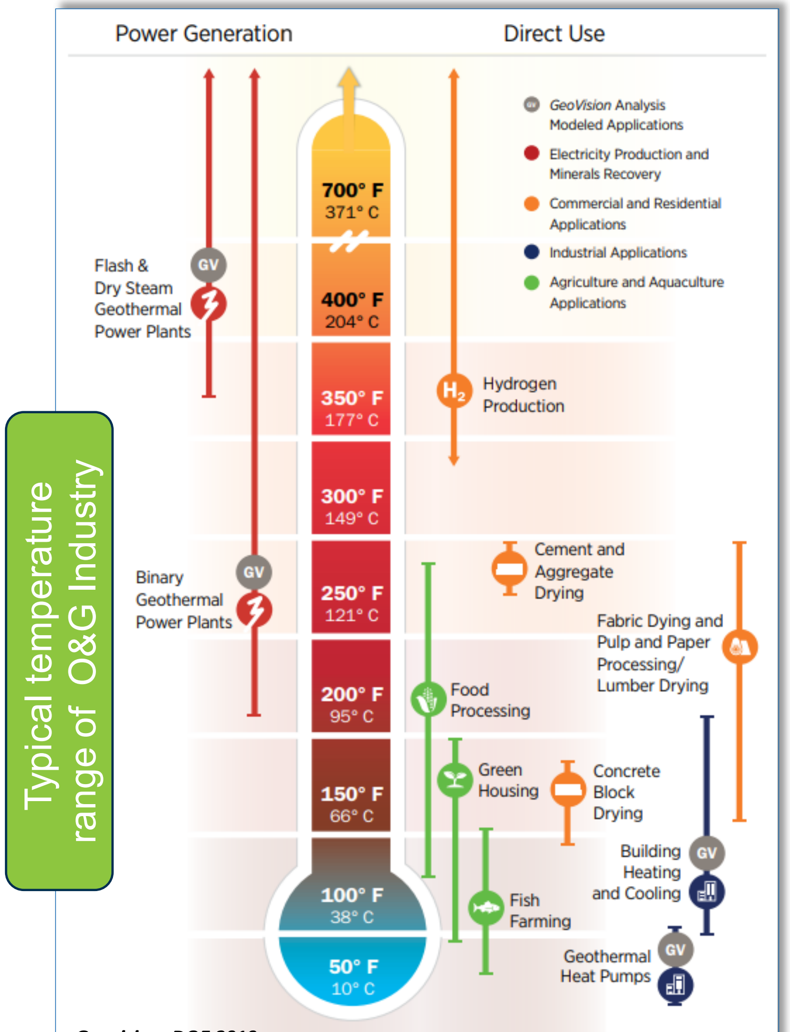


Next Generation Geothermal



Engineered Geothermal System   Advanced Geothermal System

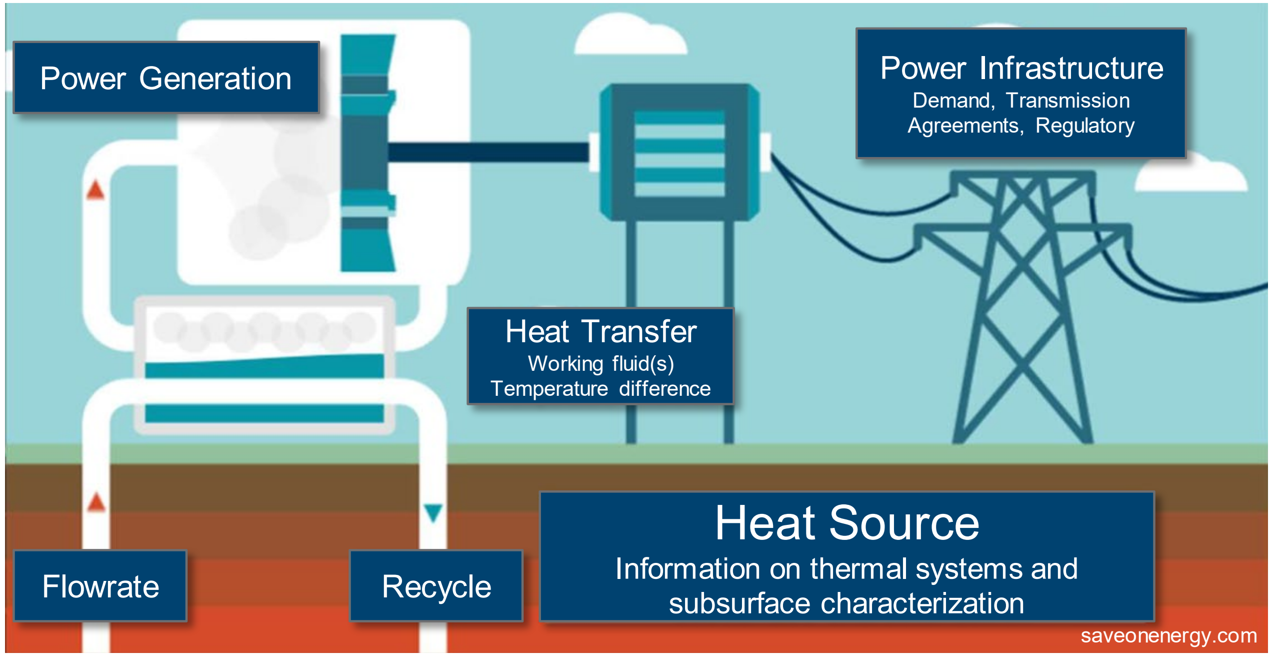
"The Future of Geothermal in Texas"; Project InnerSpace, 2023



Geovision, DOE 2019

Elements for a Successful Geothermal Development

Binary Cycle for Medium-Low Enthalpy



Heat Source

- Knowledge of geothermal resources and subsurface characterization; pressure, temperature, fluid composition, depth
- Safely and efficiently access heat source

Sufficient Flowrate and Disposal

- Requires high flow rates and drawdown management
- Strategies to reuse or dispose of fluids; potential for closed loop systems

Heat Transfer

- Clean fluids compatible with turbines and high heat capacity to transfer energy

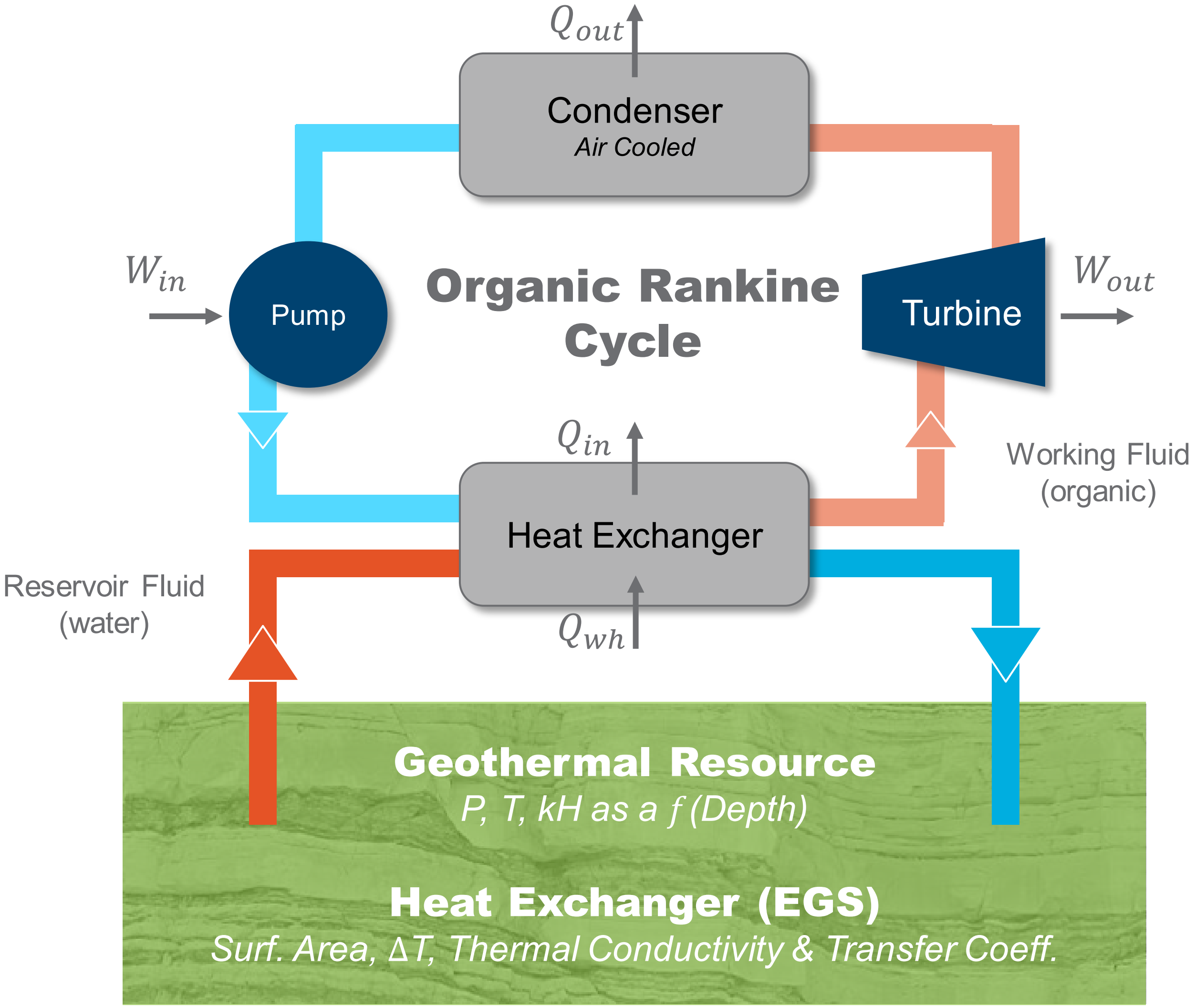
Power Generation

- Large scale for efficiency

Power Infrastructure & Agreements

- Transmission, substations to deliver to demand centers
- Agreements to sell power, surface use, etc.
- Favorable regulatory, owner and legal relationships

Transforming Heat and/or Kinetic Energy into Electrical Work



Heat Capacity Equation

$$Q = \dot{m} \times C \times \Delta T$$

Q = heat energy, kW
$\dot{m}$ = mass flow rate, kg/s
C= specific heat capacity, kJ/kg K
ΔT= temperature difference, °K

Approximate Power Estimates

Temp wh	275	F
	408	K
Temp inj	140	F
	333	K
Cw	4.186	KJ/kg K
System Eff.	0.15	frac
Mass Flow	21.25	kg/s
Density	950	kg/m3
Flow Rate	12,156	BWPD
Q	6,671	KJ/s
Qnet	1,001	kW

$$Q_{wh} = \dot{m}C_w(T_{wh} - T_{inj})$$

$$Q_{net} = \eta Q_{wh}$$

Heat in Place = Temperature + Volumetric Assessment

Heat Capacity Equation

$$Q = V \times \rho C \times \Delta T$$

$r = Rock$
$f = Fluid$

Bulk heat capacity

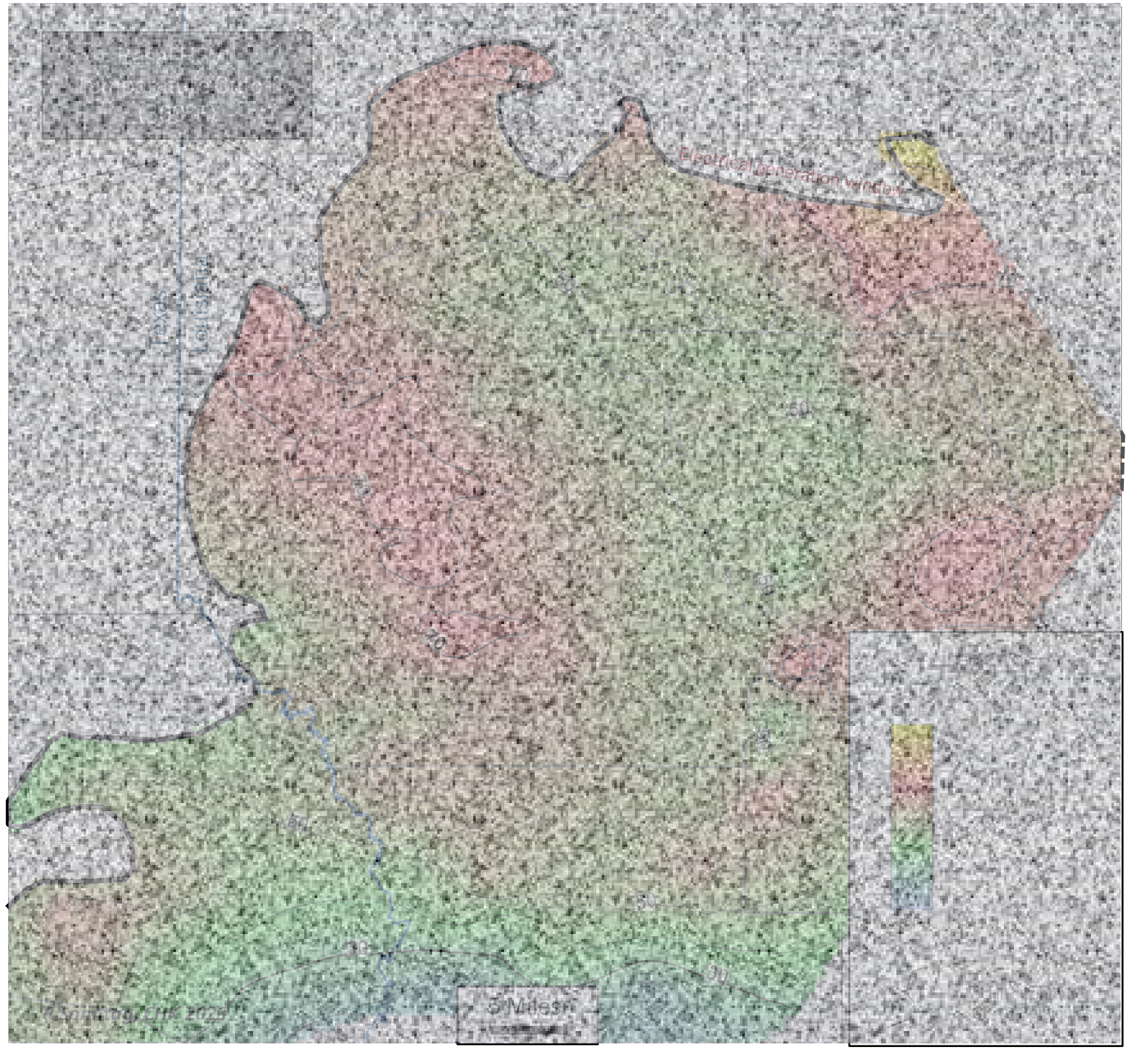
$$Q = hA \times [\rho_r C_r (1 - \emptyset) + \rho_f C_f \emptyset] \times \Delta T$$

$$\Delta T = T_{resv} - T_{inj}$$

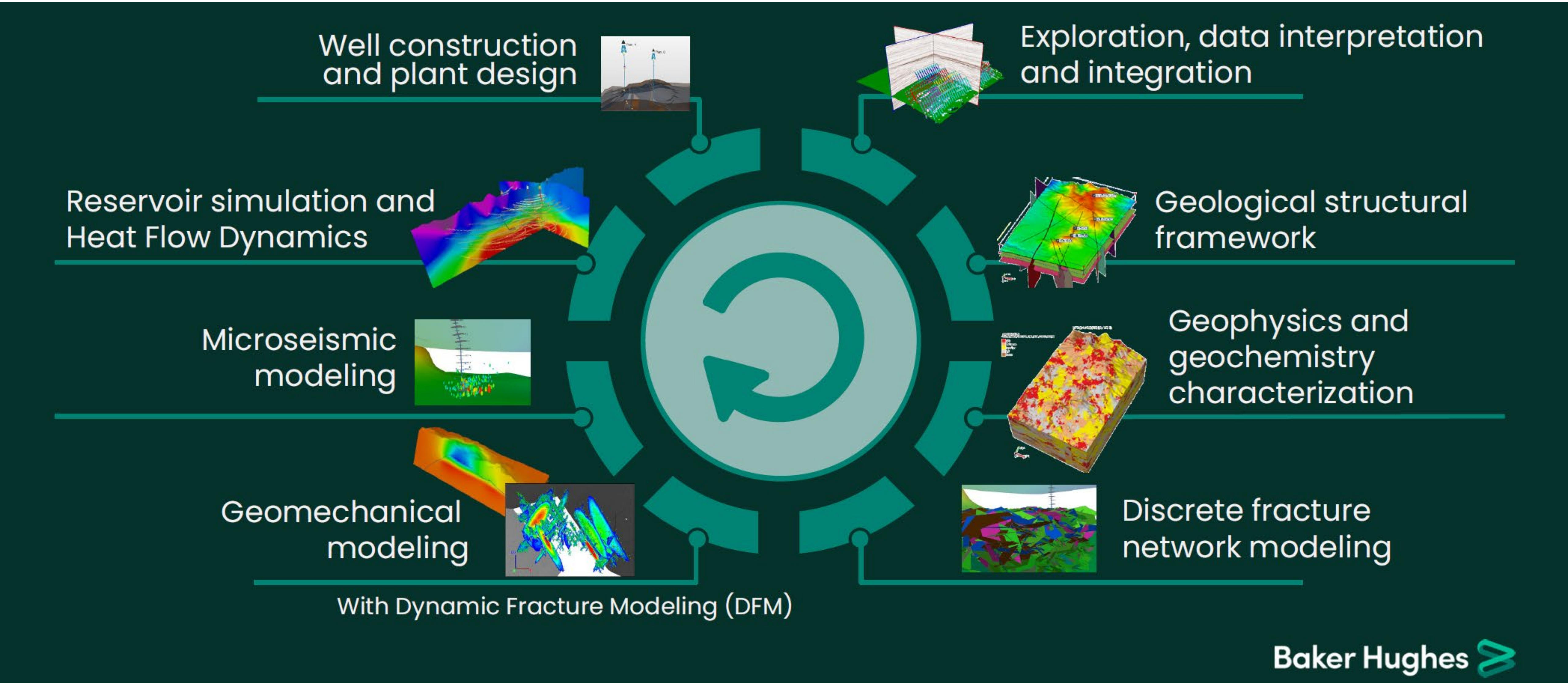
Mapping Inputs

- Temperature: DFITs, dips ins, log data
- Rock density: core data
- Porosity: PhiE mapping
- Heat capacity & fluid density: literature

North Louisiana Heat-In-Place (CI: 10 Petajoules/Section)



Complex & Dynamic Subsurface Geothermal Engineering



Similar Skillsets with Unique Challenges

Reservoir & Production Engineering concepts that translate:

- Static & Dynamic Reservoir Modelling, Volumetric Resource Estimation and Recovery, Pressure & Rate Transient Techniques, Injectivity, Sweep Efficiency, Project Economics, etc.

Next Gen. Geothermal

HTHP Hazards, Large Dia.
Connecting Fractures
High Volumes of Water
Subsurface Heat Transient
Demand Center Location
Power Pricing & Returns
Complex Heat Transfer
Heat Ownership

Commonalities

Drilling Long Laterals
Creating Fracture Area
Surface Facilities
Resource Characterization
Infrastructure & Planning
Price Taker
Reservoir Modelling
Land, Regulatory, Legal

Unconventional O&G

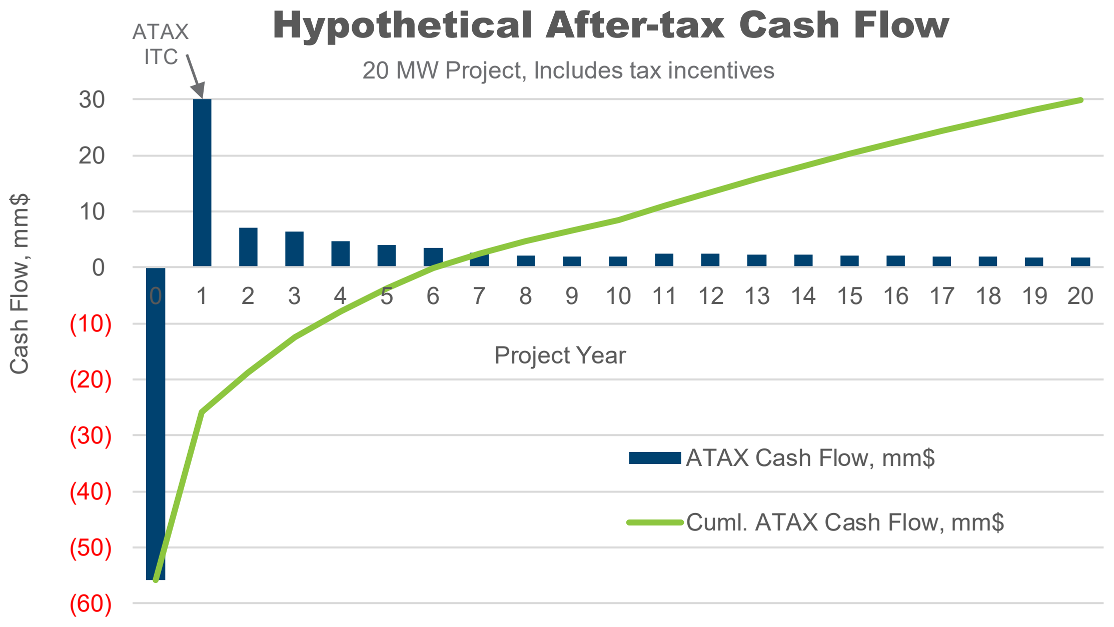
Targeting & Geosteering
Well to Well Communication
Multi-Component & Phases
Depleting Asset
Midstream Buildout
Volatile Commodities
Low Perm., SRV estimation
NIMBY

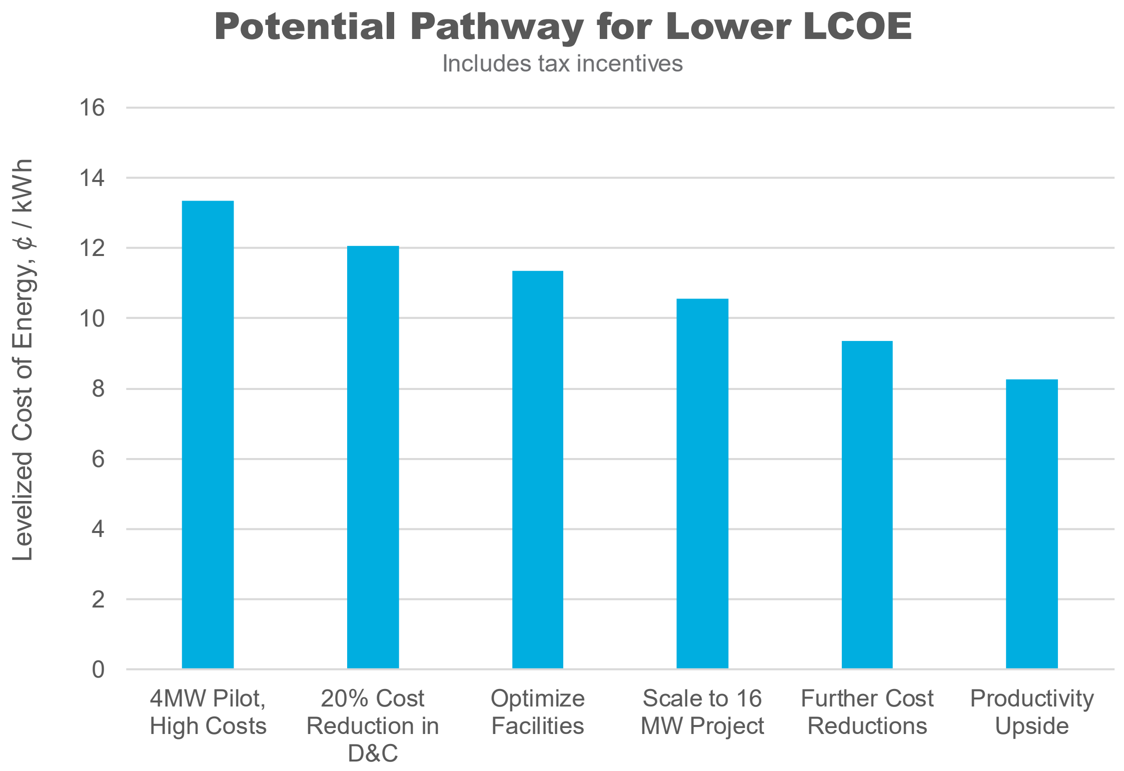
The Value Proposition

A commercial, diverse revenue stream and environmental attributes

Cash Flow and LCOE Pathway for a Conceptual Project

- Geothermal revenue is relatively flat due to power purchase agreements up front
- Multiple stakeholders, project finance and after-tax returns drive final investment decisions
- IRRs are like other utility projects: 5% - 20%





The path to competitive returns and LCOE is through collaborative innovation between O&G industry and technology partners

Model: National Renewable Energy Lab CREST

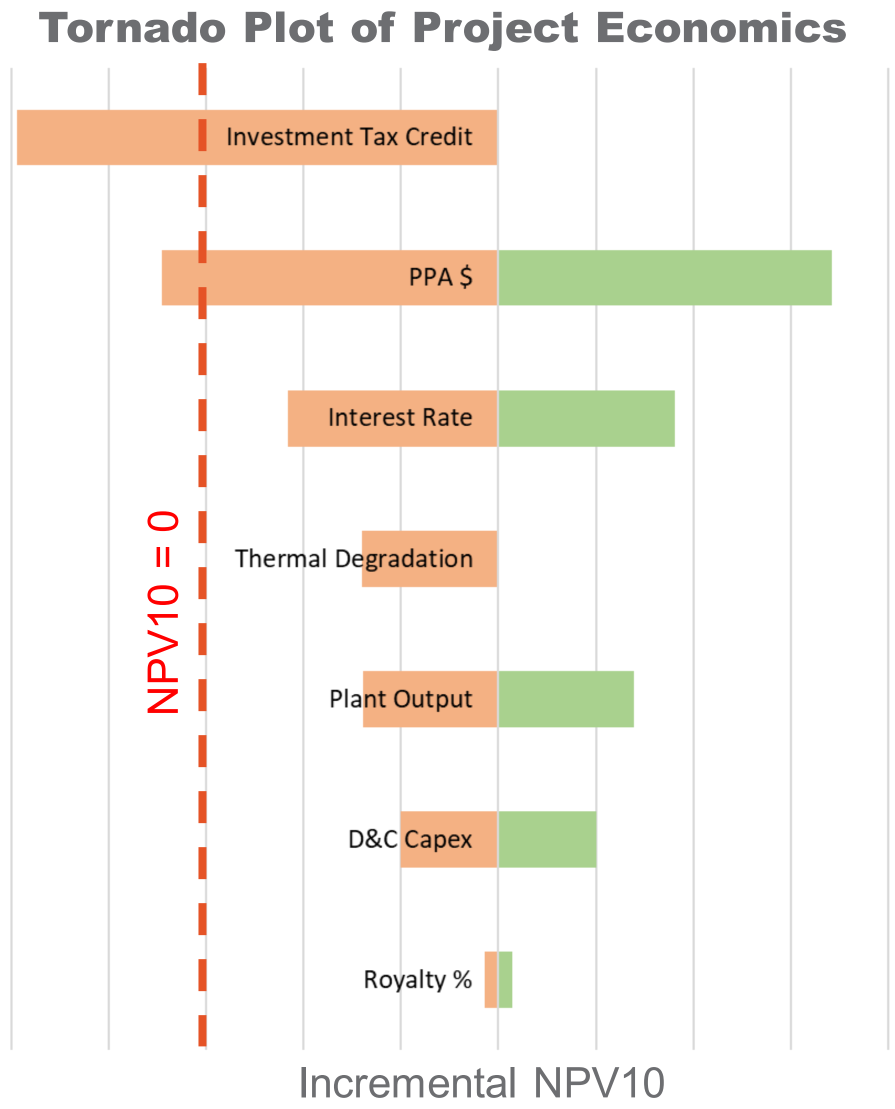
Key Value Drivers for a Conceptual Project

Significant Drivers

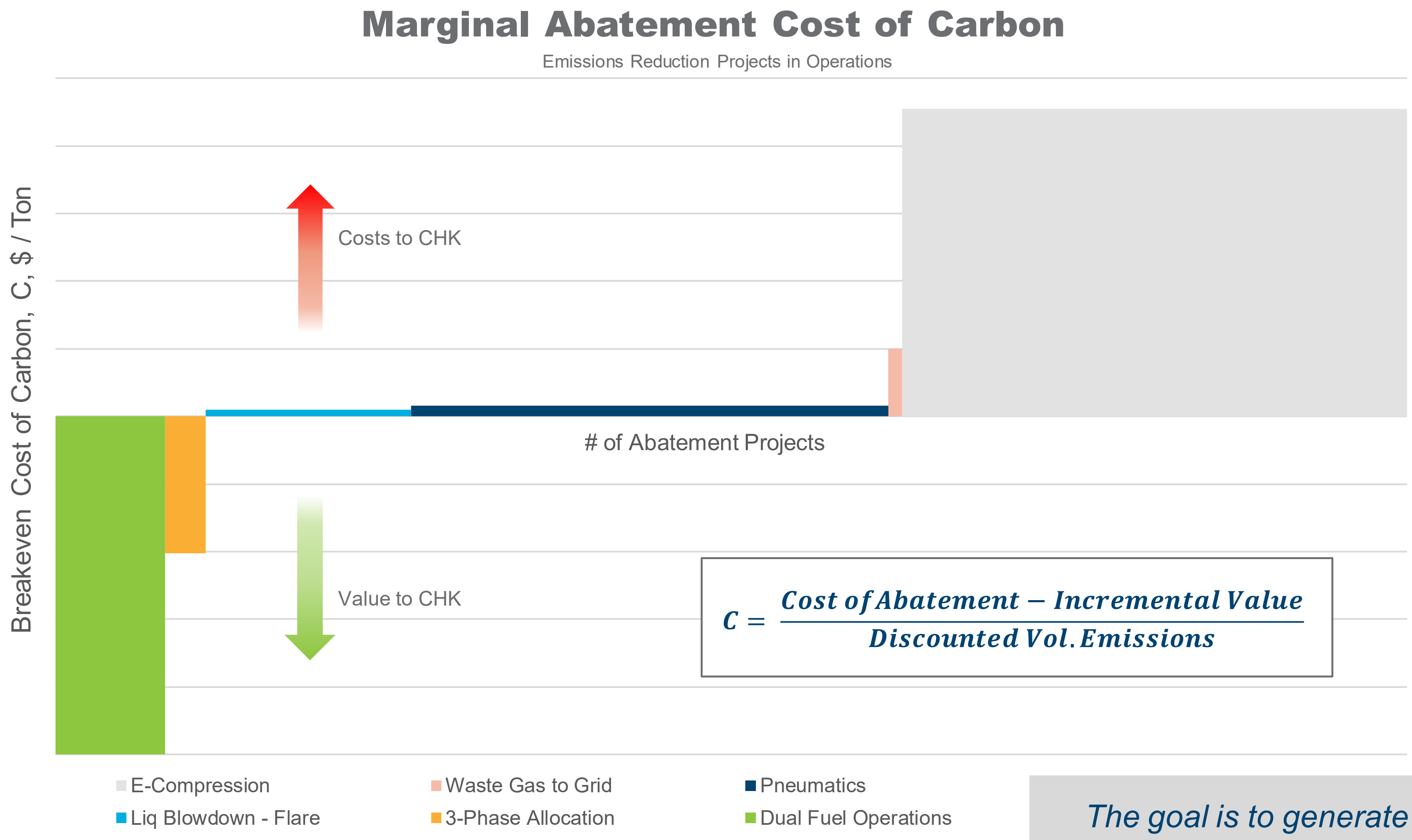
- Investment Tax Credit
  - Applied to depreciable costs in Yr. 1
- Power Purchase Agreement
  - Agreed upon early in project, flat or escalating throughout project life
- Financing Interest Rate & Fees
- Does not include the potential of monetizing EAs

Less Impactful

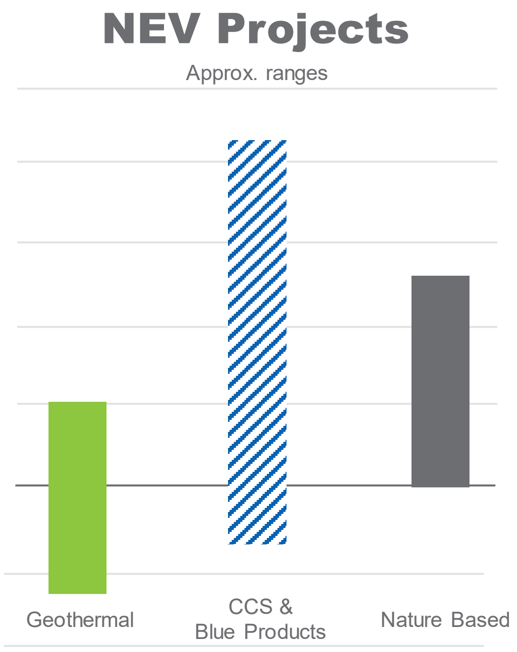
- D&C capex inflation
  - ±10% on materials, labor
- Developer fees and retained equity (not shown)
- Mineral or surface owner royalties



Creating Value through Abatement Projects



$$C = \frac{Cost\ of\ Abatement - Incremental\ Value}{Discounted\ Vol.\ Emissions}$$



CCS Carbon Cost directly offset by 45Q

The goal is to generate revenue; however, avoiding a potential carbon "tax" and/or lowering emissions creates shareholder value

What’s Next

The momentum is building

Examples of Government Funding & Research[1]

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Enhanced Geothermal™

Department-wide effort to dramatically reduce the cost of EGS—by 90%, to $45 per megawatt hour by 2035; funding of **$74mm** for up to seven pilot projects

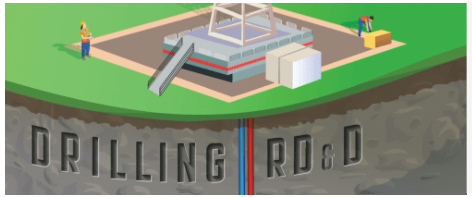
FORGE U.S. Department of Energy

Field site in Utah to develop, test, and accelerate breakthroughs in EGS technologies and techniques; ~**$90mm** to date[2]

Investing in research and development to support lithium extraction from geothermal brines in a variety of ways; **$4mm** prize

GEODE

Consortium of experts deploying **$165mm** to expand US geothermal energy by leveraging O&G technologies & workforce



$20mm in funding for demonstration projects that lower the cost and increase the speed of drilling geothermal wells

WOO WELLS OF OPPORTUNITY U.S. DEPARTMENT OF ENERGY

~**$10mm** to fund several pilot projects researching the reuse and retrofitting of abandoned O&G wells

$9mm funding for early-stage R&D in machine learning to improve exploration for and operation of geothermal resources

1. energy.gov/eere/geothermal/geothermal-technologies-office
2. Utahforge.com

A Growing Market and the Key Players

Operators / Technology Providers

- Start ups developing new technology to access more geothermal resources
- Early-stage investments and seed funding

Service Providers

- Next generation HTHP tools, innovative drilling

Advocacy Groups

- Industry / Academia / Regulator consortiums

Software Developers

- Predictive planning, dynamic reservoir models

CRITERION ENERGY PARTNERS

SAGE GEOSYSTEMS Geothermal Everywhere.

GreenFire Energy

FERVO ENERGY

CeraPhi energy

Eavor

ALTAROCK

Baker Hughes

NOV

slb

PATTERSON-UTI DRILLING COMPANY LLC

QUAISE

GA Drilling

project innerspace

HotRock

TEXAS GEOTHERMAL ENERGY ALLIANCE

Google

ResFrac

Microsoft

CHK's Active and Potential Projects

NEXT GEN GEOTHERMAL

NEXT GEN GEOTHERMAL PROJECT HOPPER

- **Wells 2 Watts**
- **Project Innerspace**
- **Criterion Energy Partners**
- **Defense Innovation Unit**
- **Haynesville Field Pilot**

Industry consortium studying closed-loop applications

- Baker Hughes led with E&P industry advisors; GreenFire technology provider
- Utilizing BKR test well and laboratory to calibrate & optimize before field trials

Geopressured prospects in south Texas

- Team of experienced, former O&G professionals with CHK advising, as necessary
- Equity investment and evaluating a project level investment to prove play idea

Repurpose wellbores and/or drill geothermal pilot in LA

- Decarbonize own asset or reuse wellbores near P&A
- Characterizing subsurface & evaluating candidates for power demonstration

Conclusion

NEXT GEN GEOTHERMAL

- Energy demand continues to grow, and we must consider the energy trilemma

  Next Gen Geothermal could offer a viable decarbonization strategy

- O&G companies can leverage expertise to advance Next Gen Geothermal to meet decarbonization goals

- There are familiar concepts and overlapping skills in Next Gen Geothermal but also unique challenges

- The value proposition for Next Gen Geothermal is both a commercial, diverse revenue stream and environmental attributes

Momentum is building for Next Generation Geothermal

Questions?

Special thanks to the CHK contributors, Baker Hughes & Project Innerspace

Appendix

Electricity Usage & Generation Cheat Sheet

1 kilowatt = kilojoule per second

How Much Power Does it Take?

Average American House

~1 kW

Small Town

~1 MW

Mid Size City

~1 GW

New York City

~12 GW

U.S.A

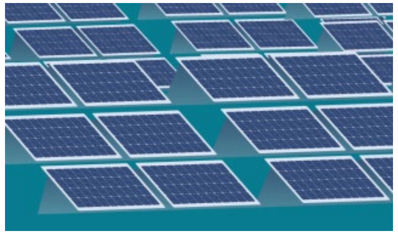
~1,000 GW

World

~5,000 GW

Typical Power Plant Capacity

Solar



Average Panel: ~320 W

Wind

Average Wind Turbine: ~2.3 MW

Natural Gas

Average: ~800 MW

Coal

Average: ~830 MW

Nuclear

Average: ~1 GW