



New Pathways for Geothermal Microgrids

Presented to National Microgrid Conference

Who We Are

- **DESCRIPTION:** Pangea is a **climate tech project developer**
- **FOCUS:** Unique emissions control and next-gen 24/7 sustainable energy production
 - **Carbon Capture:** ammonia-based technology to convert SO₂ and CO₂ into fertilizer (**Pollution-2-Profit™**)
 - **Hydrogen:** Exclusive contract to deploy EV/H₂ charging stations to meet Europe's mandate
 - **Geothermal:** Heat, power, hydrogen
- **CAPABILITY:** Founding members,
 - Have \$60 billion track record deploying energy projects
 - Advise utilities in three continents on Power Purchase Agreements (PPAs)
 - Assisted with four, 300+MW solar projects, but prefer **geothermal uniqueness**



→ **Geothermal Developer, and Channel Partner with** →



Why Geothermal

IEA: 700% More Geothermal Needed Annually

→ → European Customers Drive Demand ← ←
U.S. DoD also Interested

Energy Global, 25 March 2021:

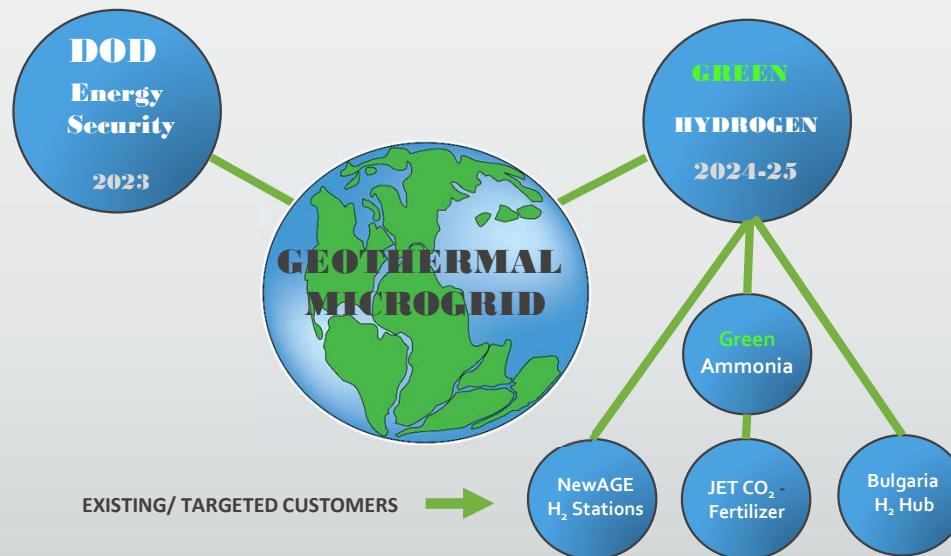
- “It is estimated that **only 2% of the world’s geothermal resource can be profitably harvested with conventional technology**”.

IEA Annual Report, November 2021:

- “Geothermal capacity additions averaged **500 MW per year** in the last five years, with Turkey, Indonesia and Kenya responsible for most of this growth”.
- “To reach the required Net Zero generation **~need 3.6 GW of annual capacity additions**”.
- “**Policies to decrease costs** and tackle challenges associated with predevelopment risks are needed to enlarge the deployment of geothermal resources for power generation”.
→ **Baker Hughes is taking these steps**

Our Geothermal Focus

- Geothermal to **green hydrogen** for H₂ charging stations in Europe. Bulgaria H₂ Hub
 - U.S. company gave Pangea exclusive contract (funding pending)
 - Europe mandates H₂ charging stations every 100KM
- Geothermal to **green hydrogen** and **green ammonia** to convert CO₂ to fertilizer
 - Client has technology proven SO₂ and CO₂ into fertilizer
- Geothermal **microgrids** at overseas military establishments





Why U.S. DoD: → World's Biggest Institution to Commit to Net Zero

While 22+ military establishments in the U.S. have identified 380MW of geothermal potential, our focus is overseas

Army Climate Strategy

“U.S. Army commits to 100% carbon free electricity by 2030”.

“By 2035 the Army aims to install a microgrid on every installation, with investments in onsite, backup renewable generation and large-scale battery storage”

Air Force Energy Installation Vision Geothermal #1

INNOVATION: PRIORITY PROJECTS

- Geothermal (#1 Priority)
- Small Modular Reactors
- Long-Duration Energy Storage
- Green Hydrogen
- Electric Vehicle Support Equipment



Next-Gen Microgrids: EV/H₂ Charging Stations

- Pangea has exclusive contract to deploy hydrogen charging stations in Europe
- While the developer awaits financial close, it has started earth work at site in U.S.
- The model: create H₂ on site
- To meet EU mandates, Pangea proposes geothermal to **green hydrogen**
 - U.S. company gave Pangea exclusive contract (funding pending)

U.S. Prototype Microgrid for EV/H₂ Charging Station., model for EU geothermal



H₂ Production Facility to be Open to Public



Geothermal Role in Converting Carbon to Fertilizer

- Pangea has a contract to deploy JET's ammonia-based technology proven to convert SO_2 and CO_2 into fertilizer
- JET seeks to provide a unique green ammonia utilization solution by converting CO_2 to food add production of **green hydrogen** and **green ammonia** to process
- In 2025-26, Pangea sees opportunity for geothermal to produce **green hydrogen**

JET Green Industrial Value Chain

Green Energy → Green H₂ → Green NH₃ → CO₂ Conversion → Green Products

Baker Hughes

Geothermal

IRMICROGRID™

Powering the Cyber-Physical Revolution

Solar, Storage, Inter-connect

Solar, Storage, Inter-connect

NEWAGE®
Powered by VODIK™

KBR

JET

MCDERMOTT

P.E.D.S.

TRETEQ

NEIL BUSH
GLOBAL ADVISERS



Meeting Tomorrow: World Bank/IFC



Why we like Baker Hughes: Unprecedented Range to Broaden Geothermal

Capability

- **40+ years geothermal experience across six continents**
- **Self-perform complete range of geothermal**
 - Assess, feasibility, design, build, operate → reducing risk and cost
- **Only firm in world capable self-perform above and below ground**

Expanding Innovation and Applications to Lower Cost

- 1) **Wells2Watts** the world's first closed loop geothermal laboratory
- 2) **Green hydrogen, green ammonia geothermal projects** → exploring scale up and adoption of novel technology solutions
- 3) **Advanced Geothermal Solution (AGS)** invested in a next-gen tech that opens new geothermal resources more economically



#1. Baker Hughes Delivers Across all Solutions

After 40+ years of district, conventional and enhanced geothermal, Baker is now leading the a new generation of options including **disruptive AGS**



DISTRICT HEATING

Portfolio of Baker Hughes subsurface tools and capabilities



CONVENTIONAL GEOTHERMAL

Portfolio of Baker Hughes subsurface tools and capabilities combined with surface turbines and pressure control



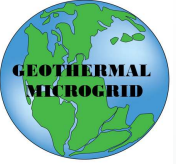
ENHANCED GEOTHERMAL SYSTEMS

Blend of conventional geothermal systems with new technology and reservoir stimulation methods

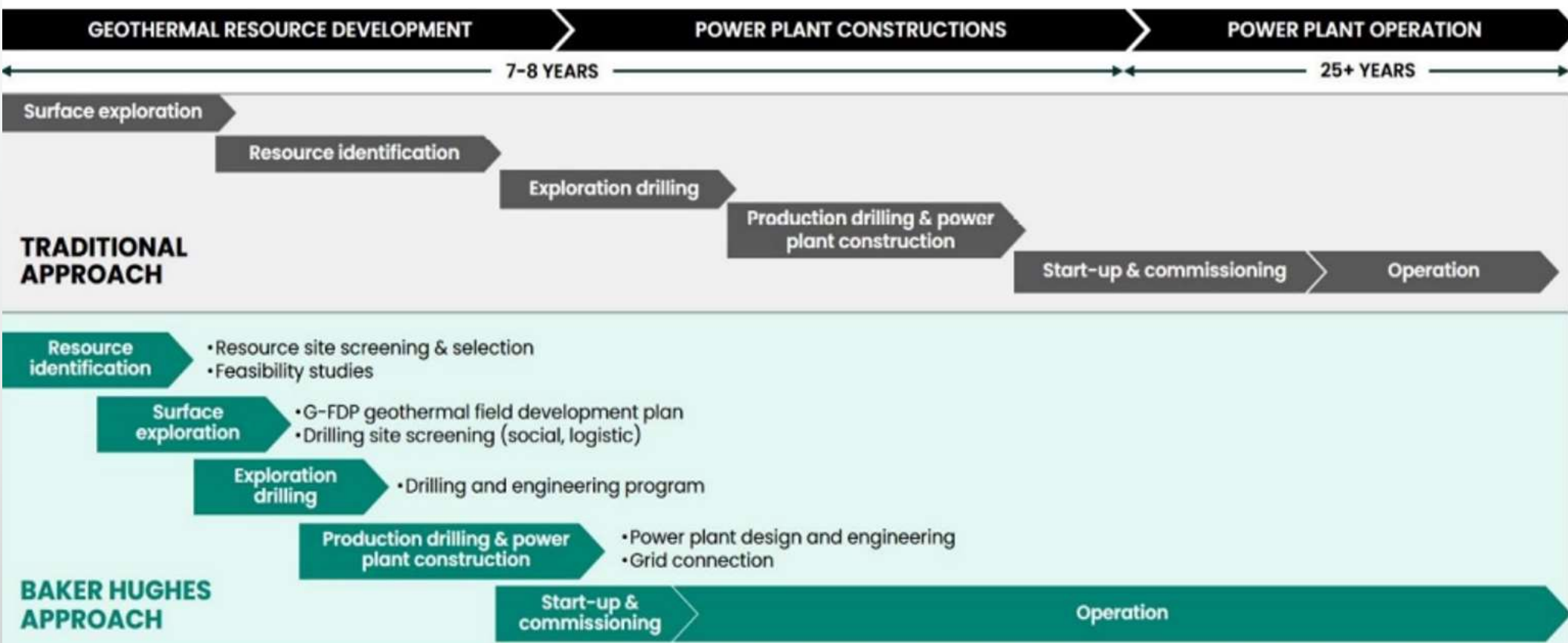


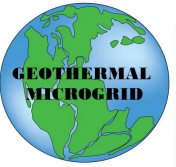
ADVANCED GEOTHERMAL SYSTEMS

Closed-loop underground designs - including well-retrofit technology - for heat extraction with less risk



#2. Integrated Approach Mitigates Risk. Gets Projects online up to 2x faster





#3. Taking geothermal energy forward will require *integrating the subsurface with the surface*



<p>Feasibility analysis Concept engineering Field economics</p>	<p>Value assurance Advisory services Reservoir expertise</p>	<p>Subsurface and surface products and services Technology and commercial innovation Strong partnerships in services community</p>	<p>Integrated communication Early engagement Procurement</p>
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Baker's technology portfolio delivers across the well lifecycle

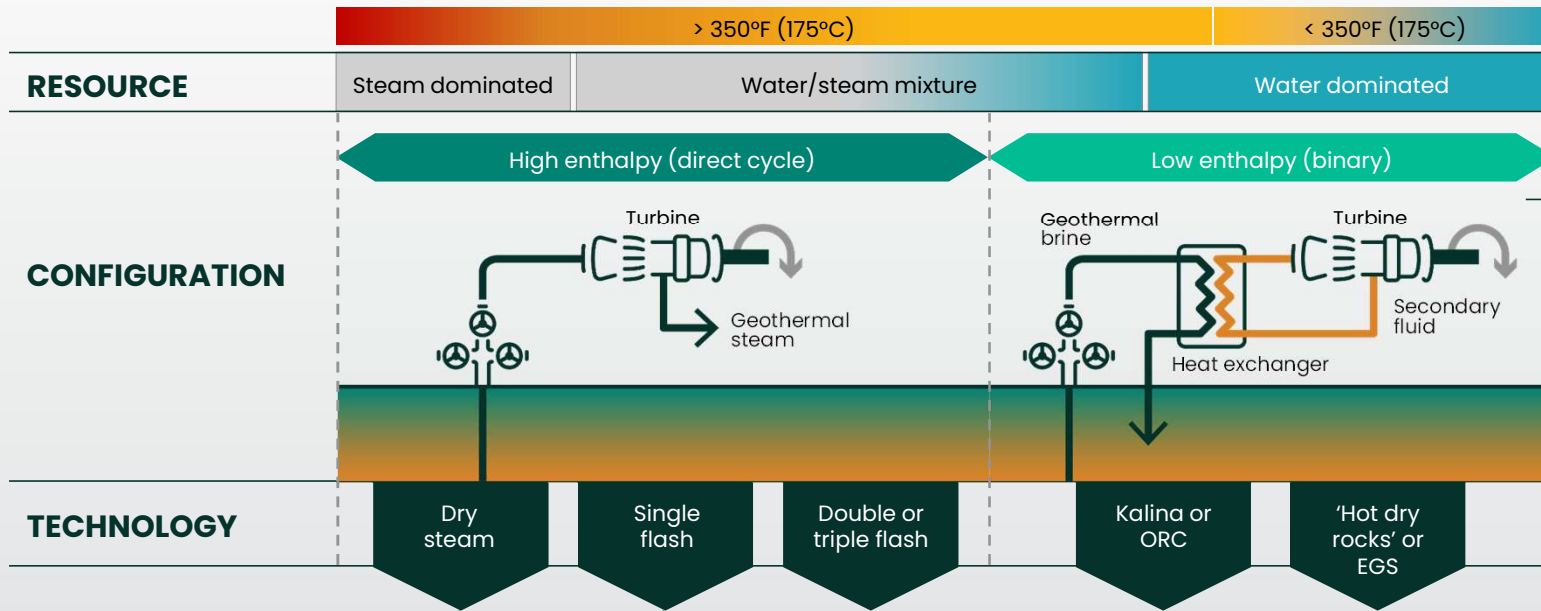


Baker: world's only company that can provide subsurface and surface products and services from planning to power generation



#4. Baker tailors power generation

Thermodynamic cycle adaptation depending on resource conditions



Binary/Organic Rankine Cycle

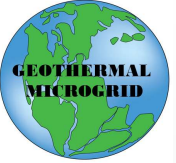
- Operate at **lower water temperatures: 110-175 °C.**
- The **organic working fluid with a low boiling point** uses the heat from the hot water to boil.

Direct-dry steam power plants

- **High enthalpy vapor-dominated resources**
- **Highest efficiency** among geothermal power plants
- **Simple** to operate
- Relatively **low capital costs**

Single / dual flash power plants

- Most common type of geothermal power plants
- **Medium- to high-enthalpy liquid-dominated resources**



#5. New Generation of Geothermal Innovation

Jan 31, 2023: “Baker Hughes and Fortescue Future Industries to jointly explore scale up and adoption of novel technology solutions for **green hydrogen, green ammonia geothermal projects.**” – **Sets groundwork for collaboration to decarbonize hard-to-abate industries including mining, steel, and cement.**

Dec 2022: Baker launched **Wells2Watts** the **world’s first closed loop geothermal laboratory.** Consortium of U.S., French and Japanese geothermal firms and Oklahoma State University exploring **Advanced Geothermal Systems (AGS)** technologies to:

- convert and retrofit oil and gas wells for geothermal energy
- revitalize dry non-productive geothermal wells
- develop greenfield opportunities for geothermal renewable electricity production.



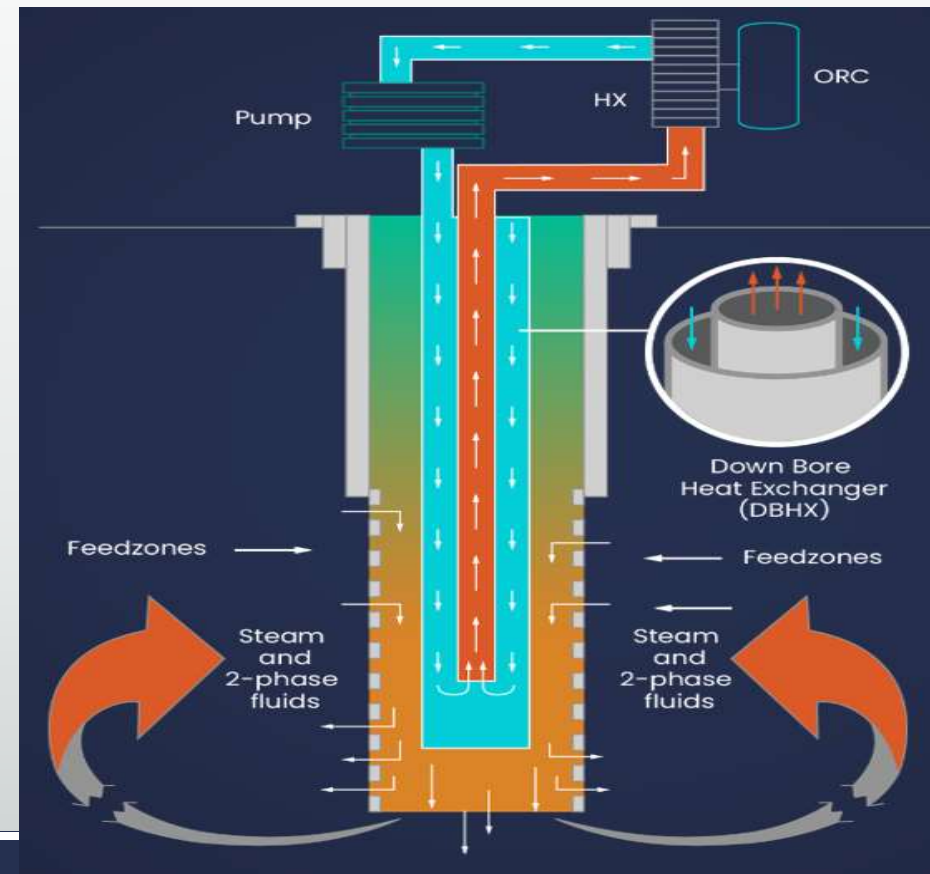
#6. Baker Invests in GreenLoop™ AGS

First closed-loop geothermal system to convert non-producing geothermal, oil or gas wells into power generation saving time and money.

- Bring hot dry geothermal wells into an energy produce state
- Convert existing oil & gas systems to generate power
- Reduce operating cost to extend economic service life of wells
- Avoid/defer plug and abandon cost
- Creates better scalability: single-well systems vs doubles
- Unlocks geothermal where conventional systems cannot effectively operate, typically, due to lack of permeability, water, or pressure.



California Demo 2019



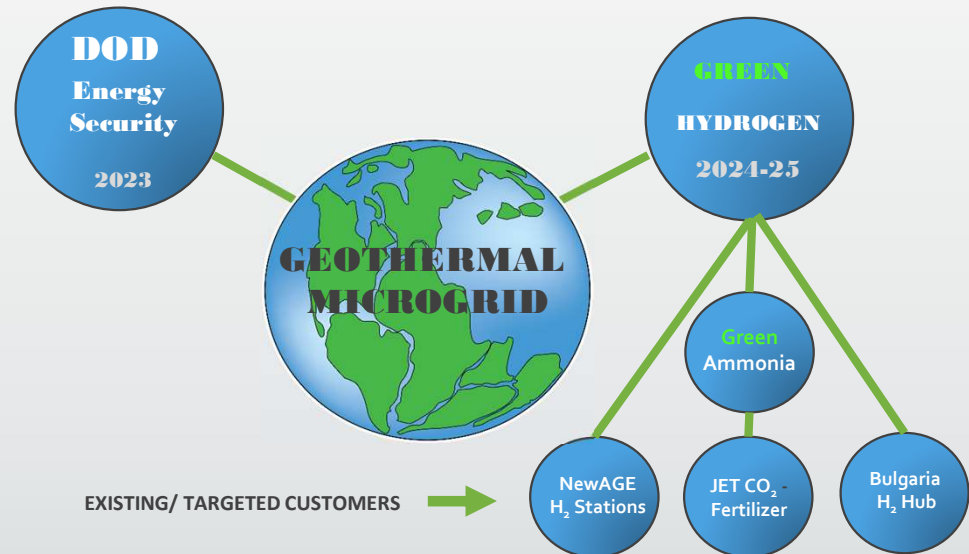
Recap: Geothermal as Next-Gen Microgrid

Appreciate the opportunity to present geothermal capability at National Microgrid Conference

We welcome:

1. Partners to broaden capability
2. Those interested in PPA services
3. Requests for copies of PPT

www.4IRMicrogrid.com



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