Low Temperature Geothermal Resources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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AAPG's Low Temperature Webinar
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Presentation Overview

Key topics included in the presentation:

- What are Low Temperature Geothermal Resources?
- Where do low temperature geothermal resources fit within petroleum exploration and production?
- What is coproduction? When and where are low temperature geothermal resources coproduced with oil and gas?
- What are the economics of low temp geothermal coproduction?
- Where are some of the best locations for coproduction?
- Case studies and examples of low temp geothermal and oil / natural gas co-production.

Geothermal Technologies Program Overview

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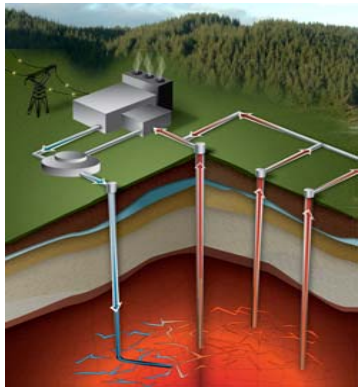
The mission of the Geothermal Technologies Program (GTP) is to establish geothermal energy as a significant contributor to America's future electricity generation by partnering with industry, academia and the national laboratories to discover new geothermal resources, develop innovative methods, and demonstrate high-impact technologies.

The Geothermal Vision – By 2020

- Geothermal capacity in the U.S. reaches *12 GWe* of clean, baseload domestic power – a *fourfold gain from 2010*
- Energy from Low Temperature and Coproduced resources costs *$0.08/kWh by 2016* and *add 3 GWe* of geothermal capacity
- *One GWe of undiscovered* hydrothermal resources are *confirmed* and brought *online*
- Geothermal energy expands to new regions across the U.S., *spurring the economy* and creating *high-quality green jobs* nationwide



Pathway: Key Improvements

Technology to Advance

- *Innovative exploration technologies* (e.g. 3D-seismic and remote sensing) to reduce exploration risks and costs
- *Reservoir stimulation technologies* to enable the creation of high-performance, sustainable enhanced geothermal reservoirs with high flow rates and low thermal drawdown
- *Advanced working fluids* and *cooling systems* to reduce costs, improve efficiency, and expand the range of resource temperatures that can be utilized economically

Addressing Market Barriers

- *Improving the permitting process* while ensuring robust environmental assessments
- *Educating* stakeholders to mitigate the upfront risk of exploration
- Attracting and *training the next generation* of the geothermal industry's workforce

Geothermal Technologies Sub-Programs

Enhanced Geothermal Systems

- EGS are engineered reservoirs created to produce energy from geothermal resources that are otherwise not economical due to a lack of fluid and/or permeability
- Water is injected into hot basement rock with limited fluid content and permeability at a sufficient pressure to propagate fractures and improve permeability

Permeable Sedimentary

- Naturally permeable sedimentary formations as a hydrothermal resource
- A reduced environmental risk: stimulation unnecessary
- A reduced financial and technical risk: sustained heat recovery (~20 years) without further development, reduced risk of thermal drawdown

Innovative Exploration Technologies

- Decrease upfront risk for geothermal developers and accelerate speed and scale up of geothermal deployment by improving the likelihood that geothermal prospects will become successful projects
- Improving methodology for optimizing data interpretation and site identification
- Demonstration of these new technologies

Low Temperature and Coproduced Resources

- Low temperature resources (<150 C)
- Geopressured
- Coproduced

Low Temperature and Coproduced Sub-program Overview

Issue:

- Numerous resources too cool for flash steam generation
- An estimated 10 barrels of water are produced per barrel of oil in North America
- Facilities have lower cost, shorter lead time, broader geographic distribution than conventional geothermal

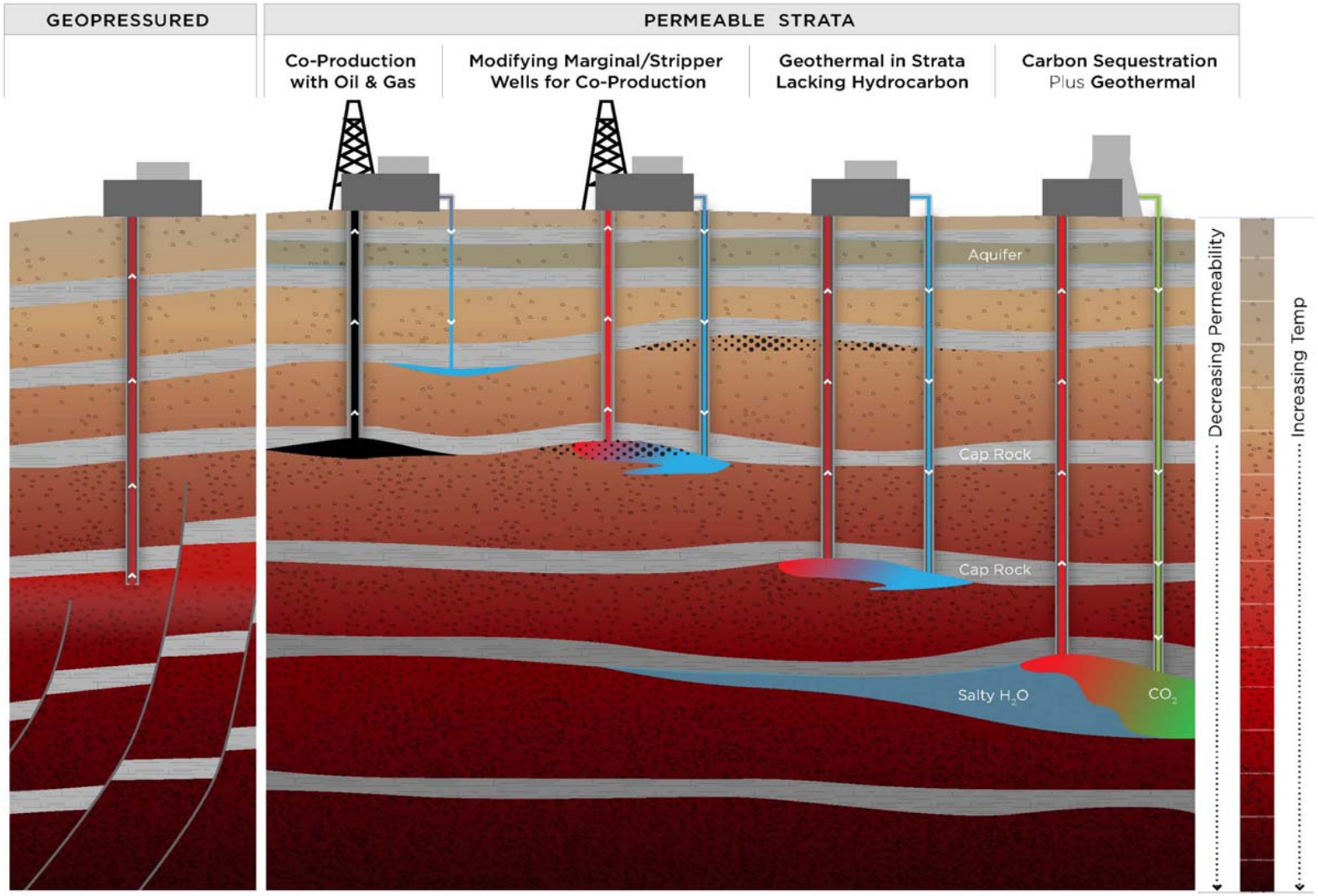
Objective:

- Demonstrate production from oil and gas fields, geopressured fields, and low temperature resources across the U.S.

Action:

- Up to $18.7M in American Recovery and Reinvestment (ARRA) funds for 10 near-term energy projects including new hybrid plants, and speedy modular plant designs and up to $20 M in available funding for seven energy projects with FY10&11 funds

Spectrum of Low Temperature and Coproduced Resources



Low Temperature Geothermal Resources

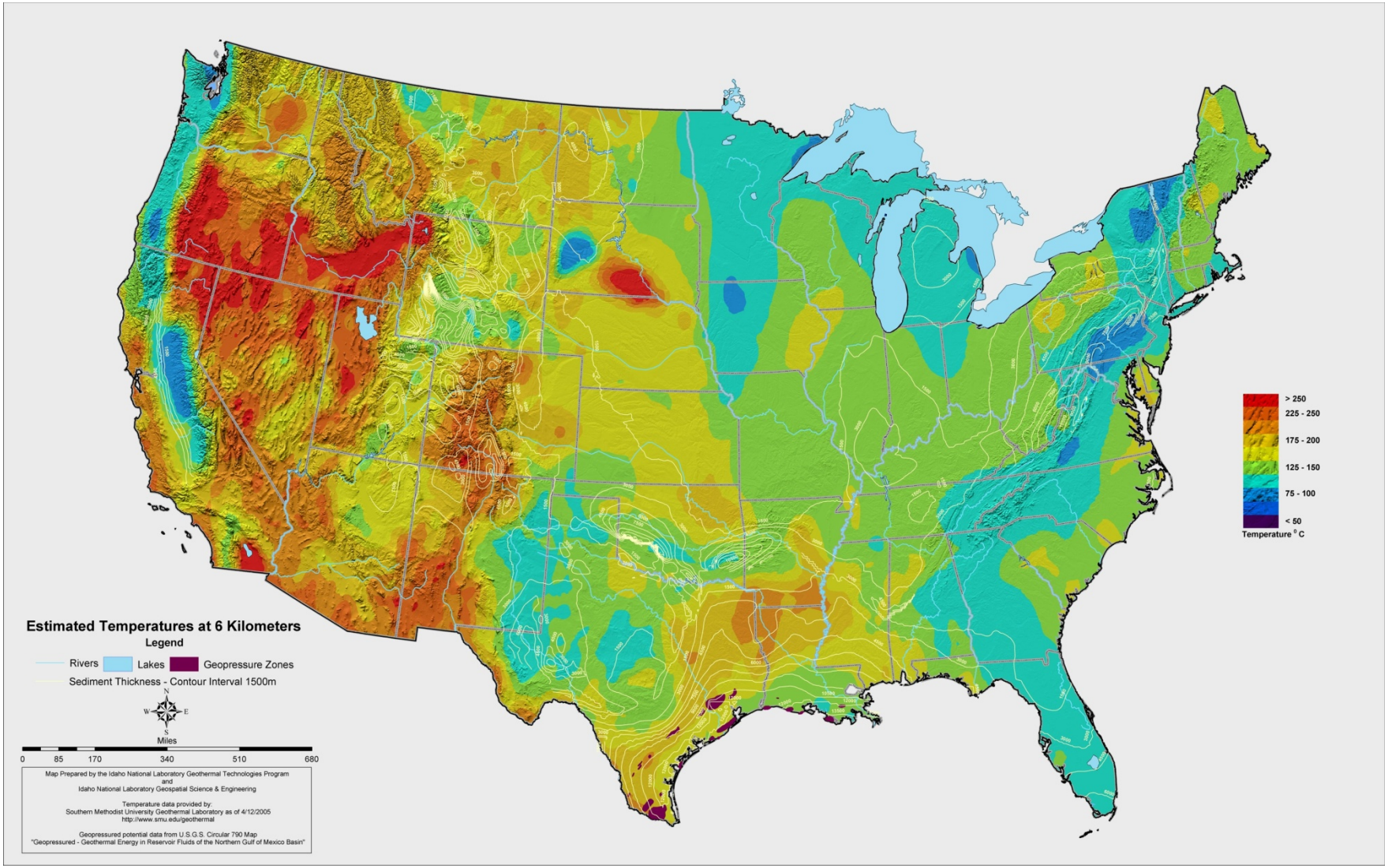
What are Low Temperature Geothermal Resources?

Low-temperature geothermal energy is defined as heat obtained from the geothermal fluid in the ground at temperatures of 300°F (150°C) or less

These resources are typically used in **direct-use** applications or can be harnessed to **generate electricity using binary cycle**

Low-temperature geothermal resources are more difficult to extract power from since the highest temperature in the power generation cycle has a very strong effect on the overall efficiency

Where are Low Temperature Geothermal Resources?

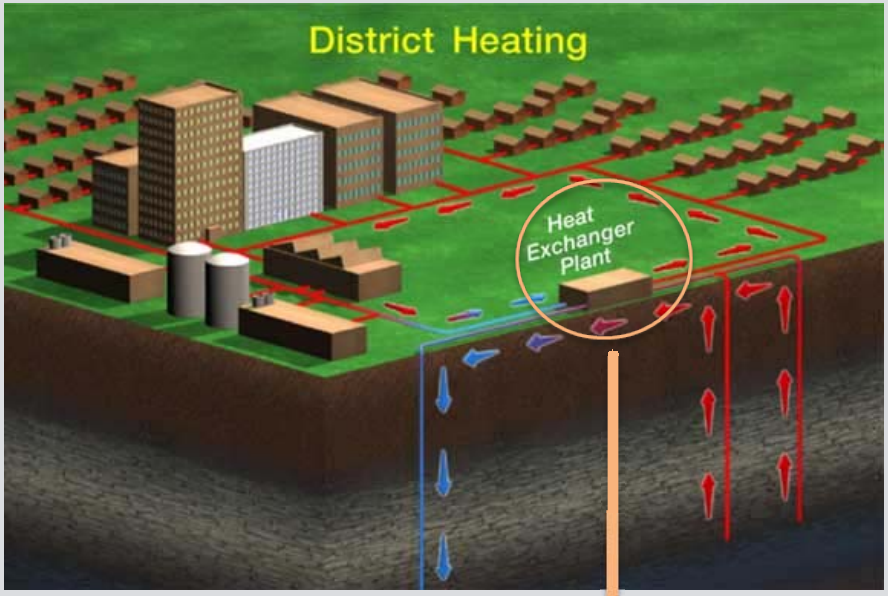


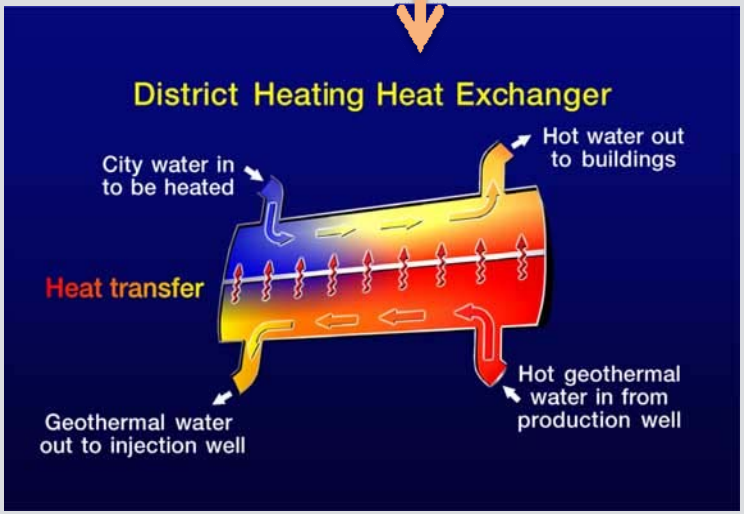
Map prepared by Idaho National Laboratory
Temperature Data provided by Southern Methodist University

Low Temperature – Direct Use

Direct Use

- Spas
- Direct space heating
- Aquaculture
- Agricultural drying
- Snow melting

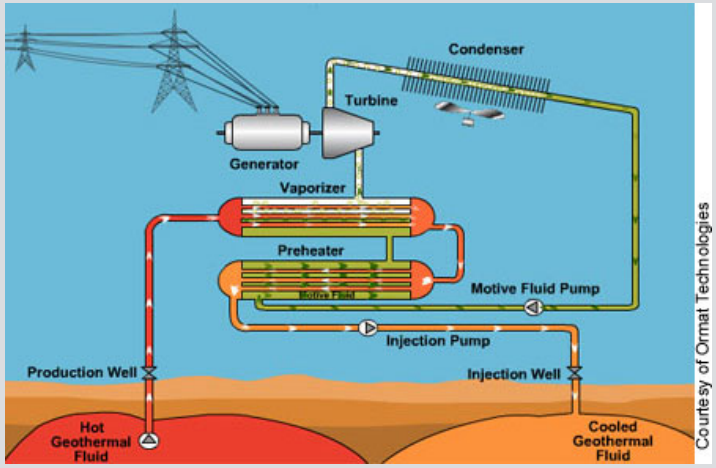


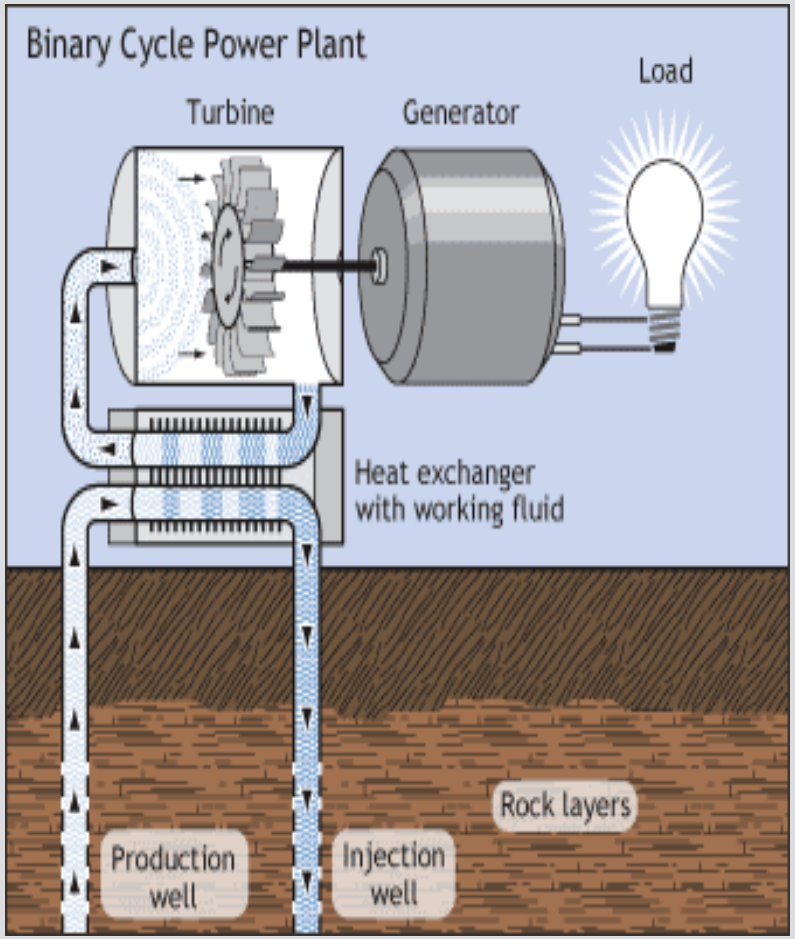


Low Temperature – Electricity Production

Binary Systems

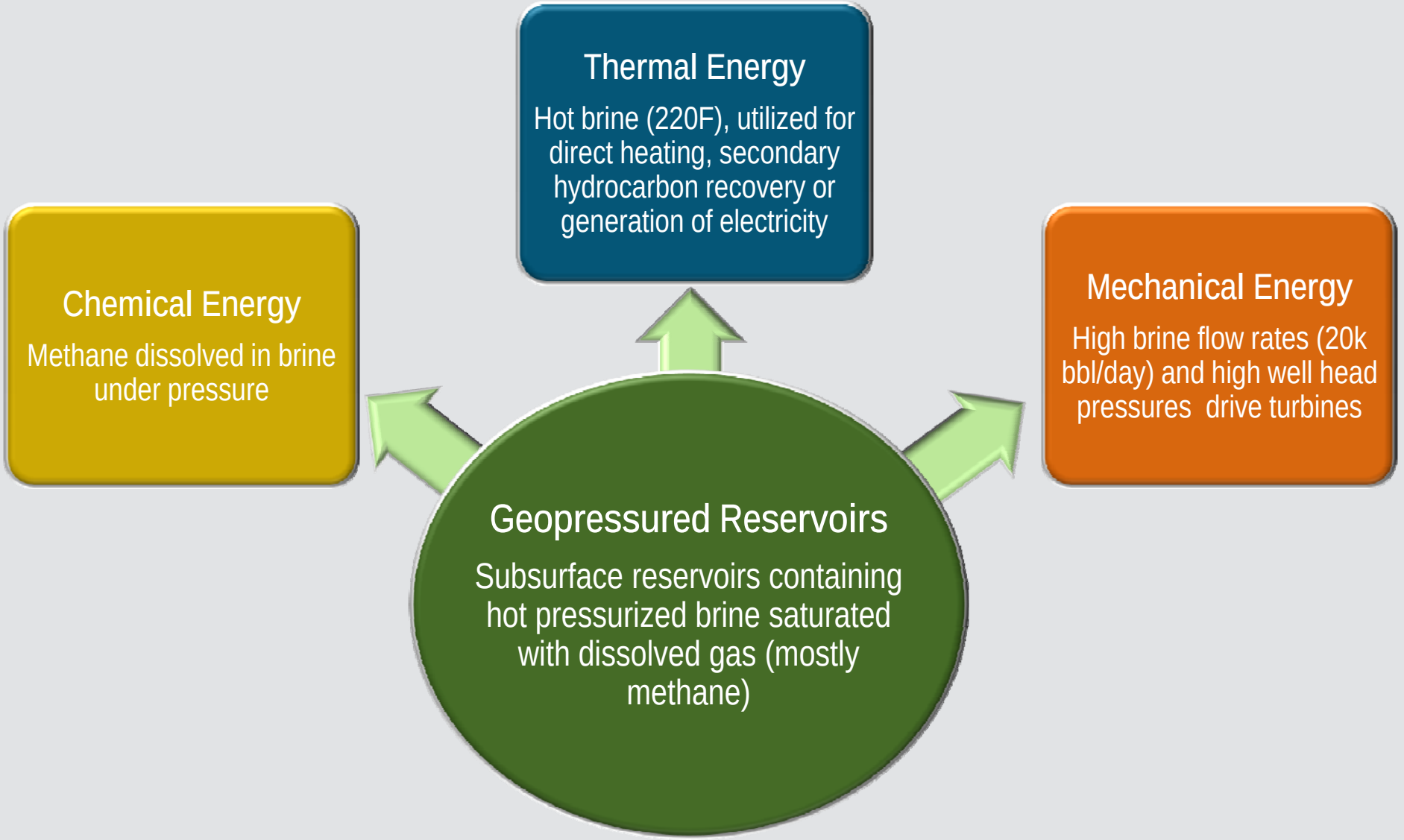
- Difficult to extract power from resources <150 C
- Utilize Organic Rankine Cycle (ORC) units
  - Transfers the heat from geothermal fluid to a second fluid that vaporizes at a lower temperature and higher temperature than the primary
  - Vapor drives a turbine, producing electricity
  - System is closed loop with minimal emissions



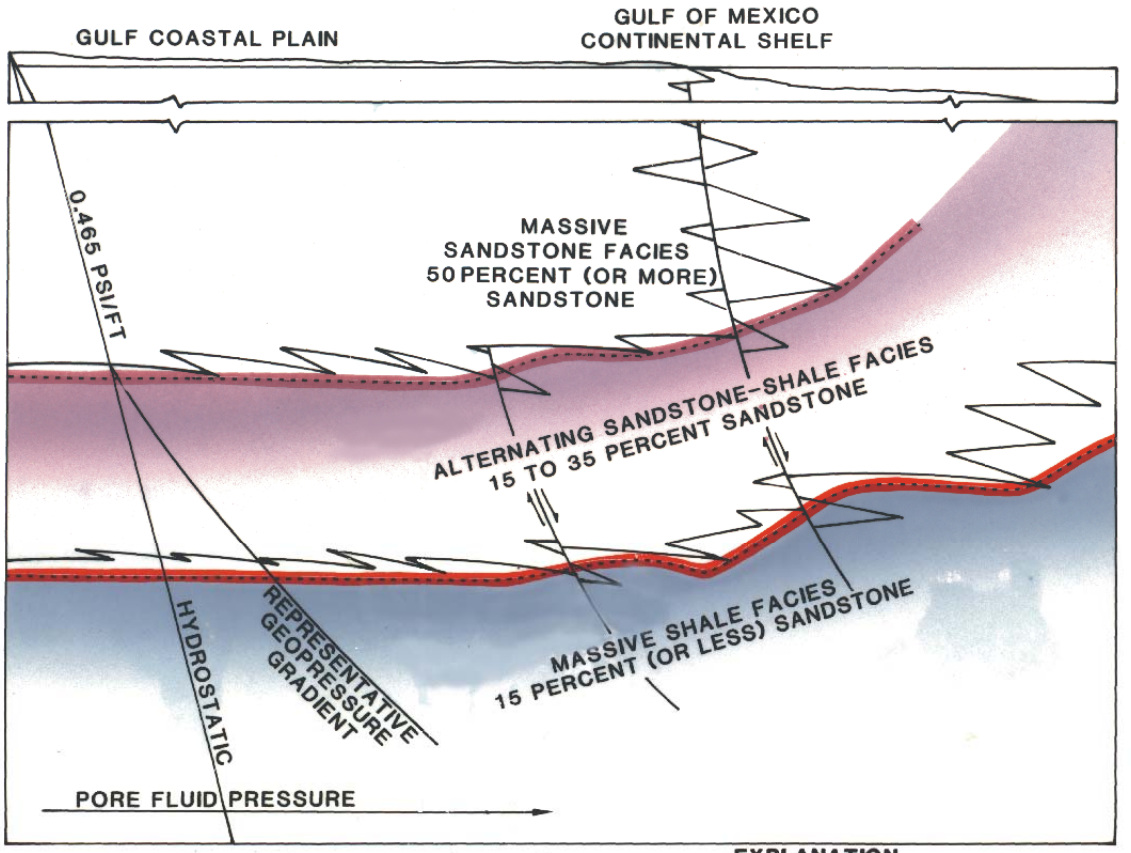


Geopressured Geothermal Resources

What are Geopressured Geothermal Resources?

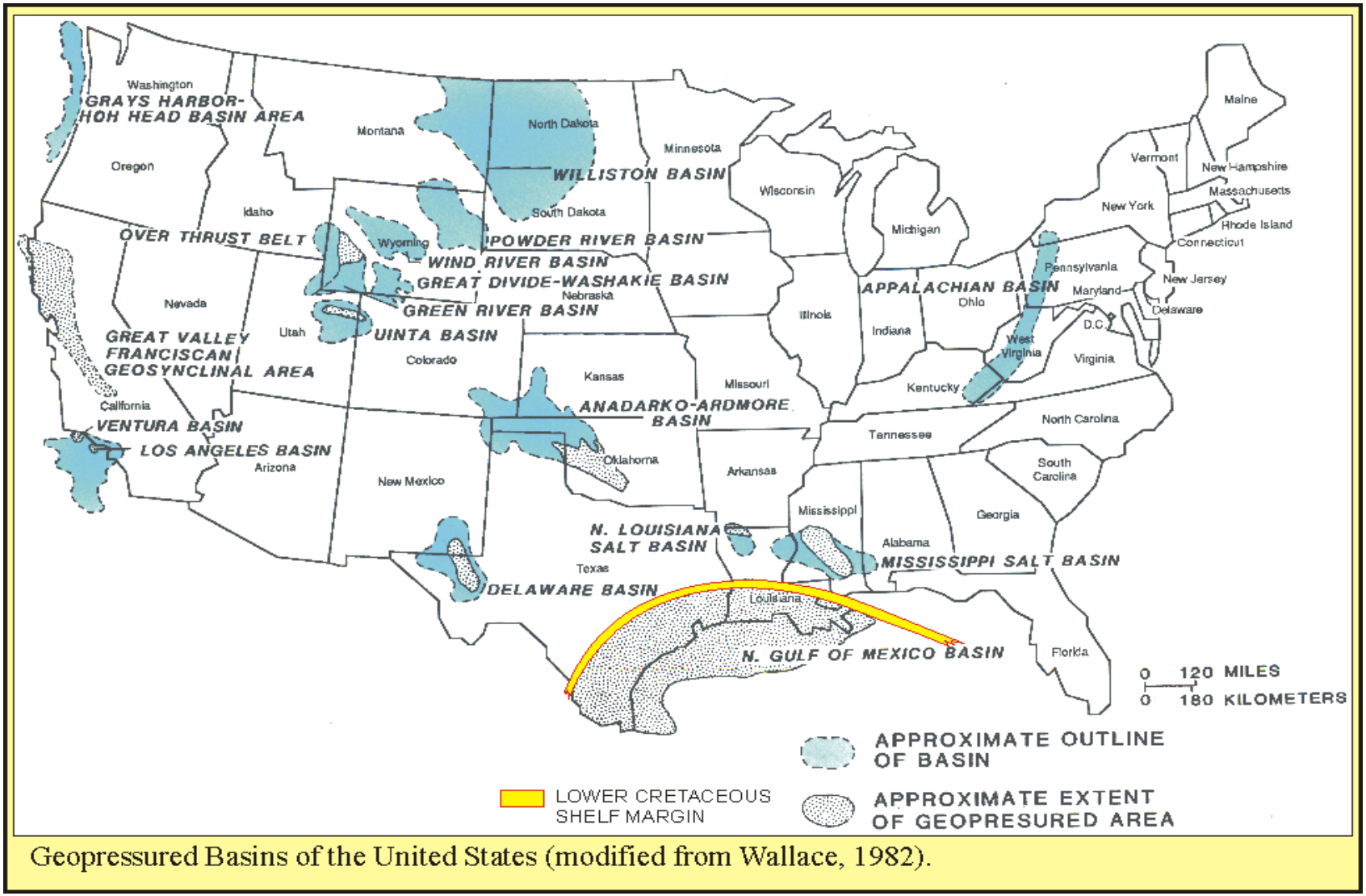


Geological Environment for Geopressured Geothermal Resources



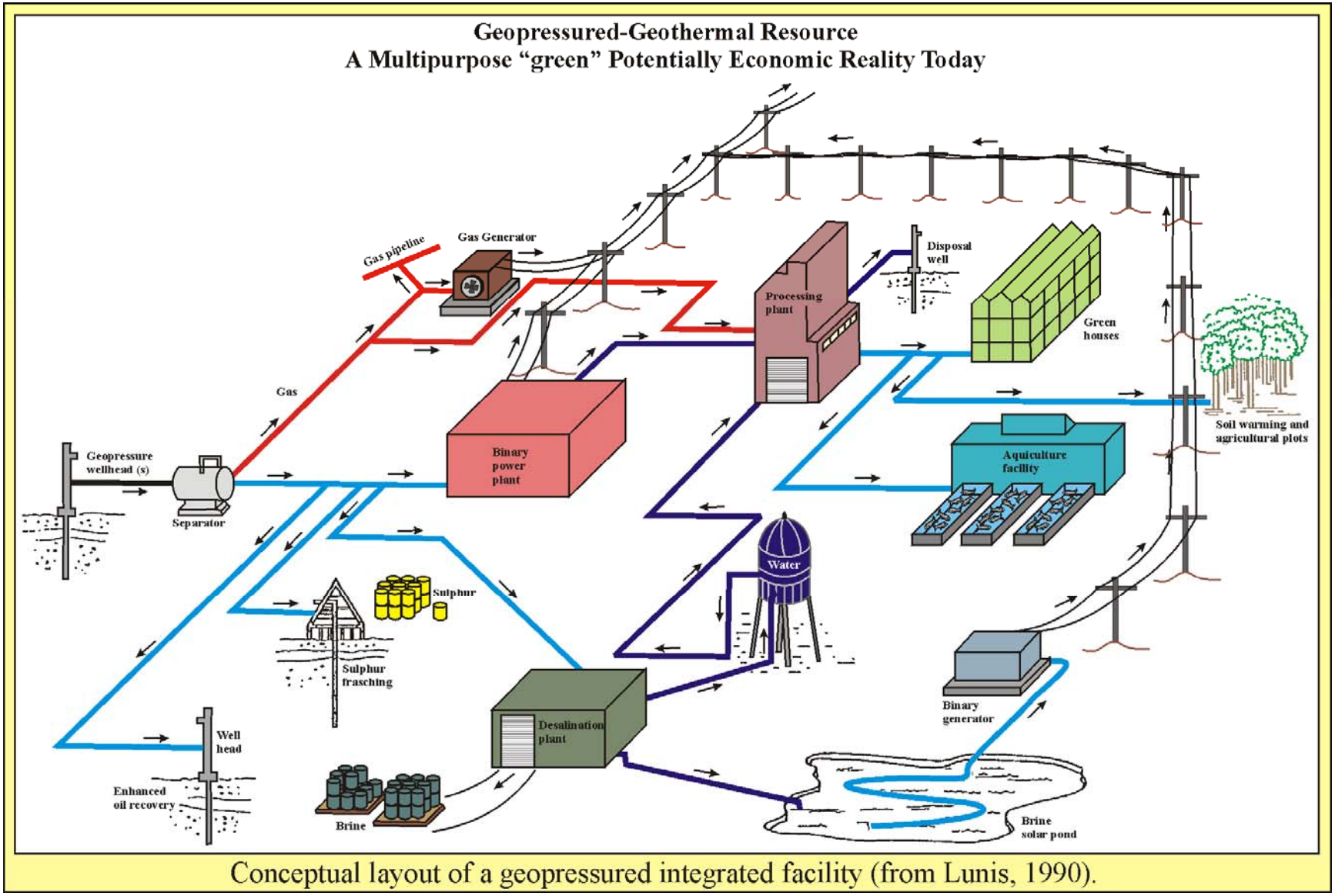
Generalized sedimentary model of the northern Gulf of Mexico basin based on sandstone percentage and showing the relation of gross lithology to fluid pressure gradient and growth faulting.

Where are Recoverable Geopressured Geothermal Resources?



Geopressured Basins of the United States (modified from Wallace, 1982).

Fully Integrated Geopressured Geothermal System (hypothetical)



Conceptual layout of a geopressured integrated facility (from Lunis, 1990).

Coproduced Geothermal Resources

What are Coproduced Geothermal Resources?

Coproduced geothermal resources are derived from the use of hot water recovered by oil and gas wells to generate electricity

Coproduced hot water is a by-product of oil and gas wells within the United States

A resource to produce electricity for field use or to be sold to the grid

What are Coproduced Geothermal Resources Barriers and Benefits?

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25 billion barrels of hot water are produced annually from oil and gas wells

- Largely seen as an inconvenience
- Requires costly disposal

Could be used to produce electricity for on-site field operations or sold to the grid

- Near term energy savings
- Diminish greenhouse gas emissions
- Extend the economic life of oil and gas fields
- Profitably utilize abandoned oil and gas infrastructure

Innovative technologies are expanding the geothermal resource base by utilizing lower-temperature fluids

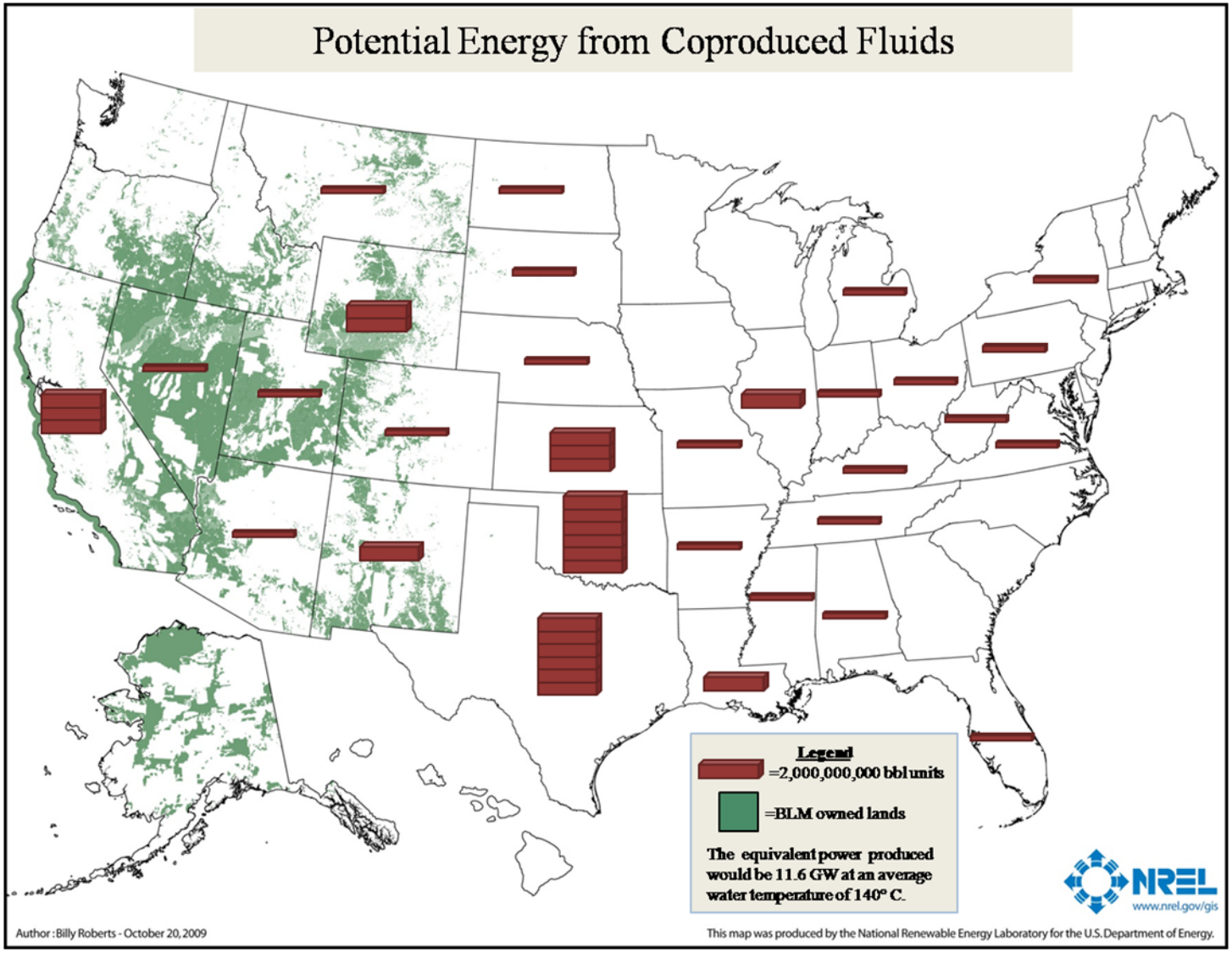
- Coproduction validations are currently using a binary Organic Rankine Cycle (ORC)
- Results in mechanical, turbine driving energy

Energy Potential from Coproduced oil/gas fluids is Substantial

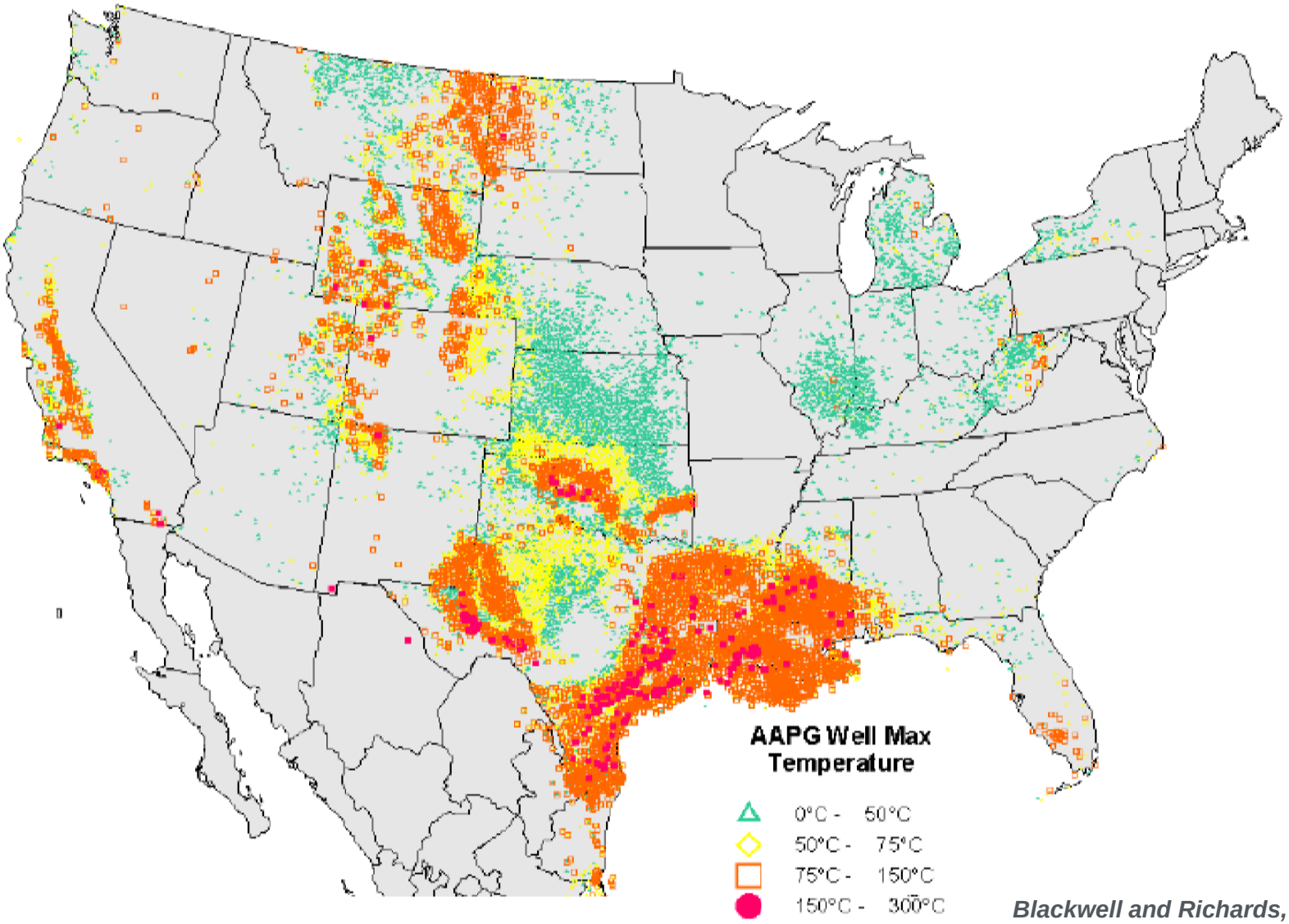
- In certain water-flood fields in the U.S. Gulf Coast region, the produced water/oil cut is 95%
  - Fields produce up to 50,000 barrels/day of fluid (20-40 wells)
  - Paid for (in terms of pumping costs), by existing operations
  - Water is shipped off site as a waste product

- Collecting and passing this fluid through a binary electrical plant is readily performed
  - Most produced fluid is already passed to a central collection facility for hydrocarbon separation and water disposal
  - Piggy-backing on existing infrastructure eliminates the need for expensive drilling and hydro-fracturing operations that are often required for EGS
  - Reducing the majority of the upfront cost of geothermal electrical power production is critical to its widespread use

Where are Recoverable Coproduced Geothermal Reserves?



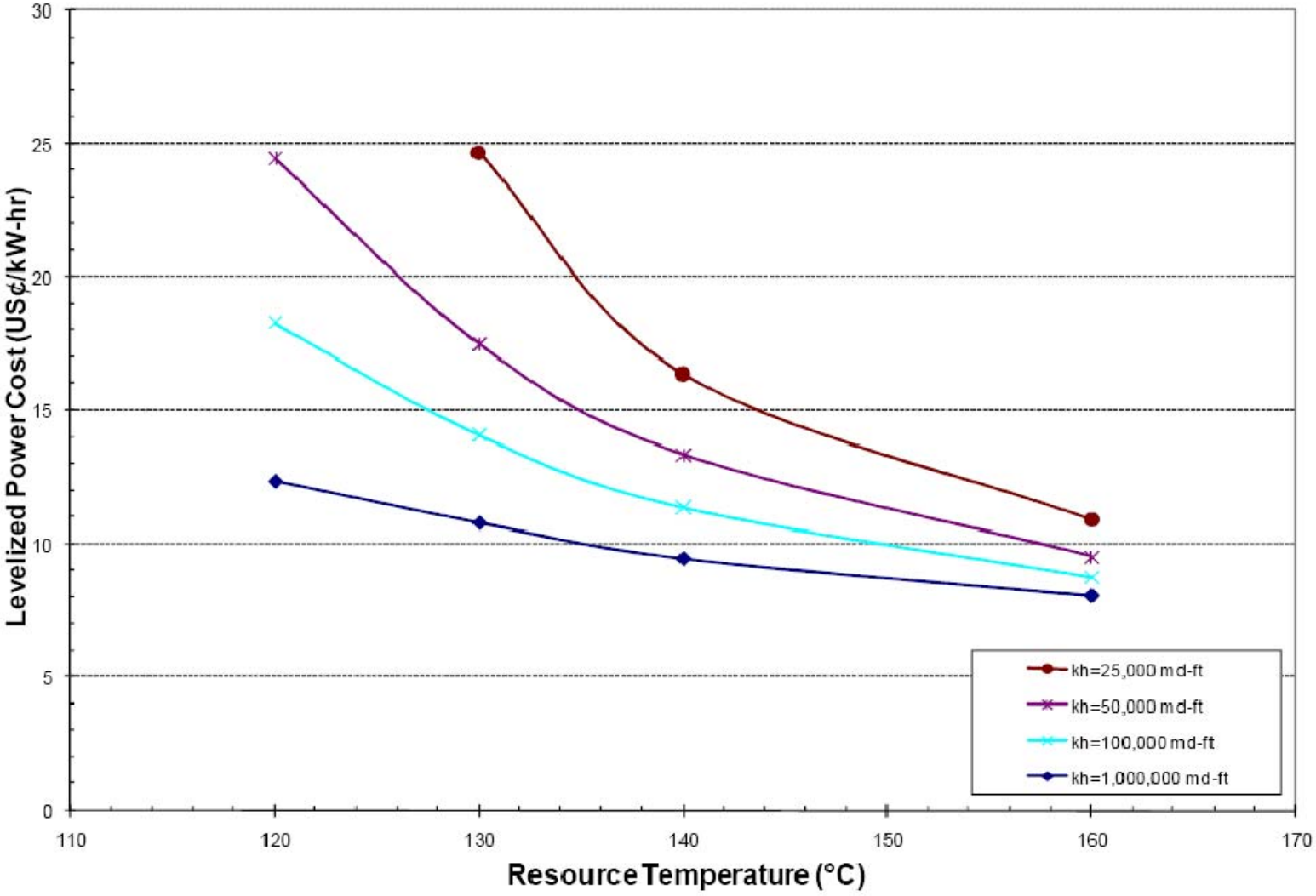
Coproduced Geothermal Resource Map



Blackwell and Richards, 2005

Resource Economics

Low Temperature, Coproduced and Geopressured Economics



DOE-Funded Case Studies

Case Study: Rocky Mountain Oilfield Testing Center (RMOTC)

Naval Petroleum Reserve No. 3 / Rocky Mountain Oilfield Testing Center

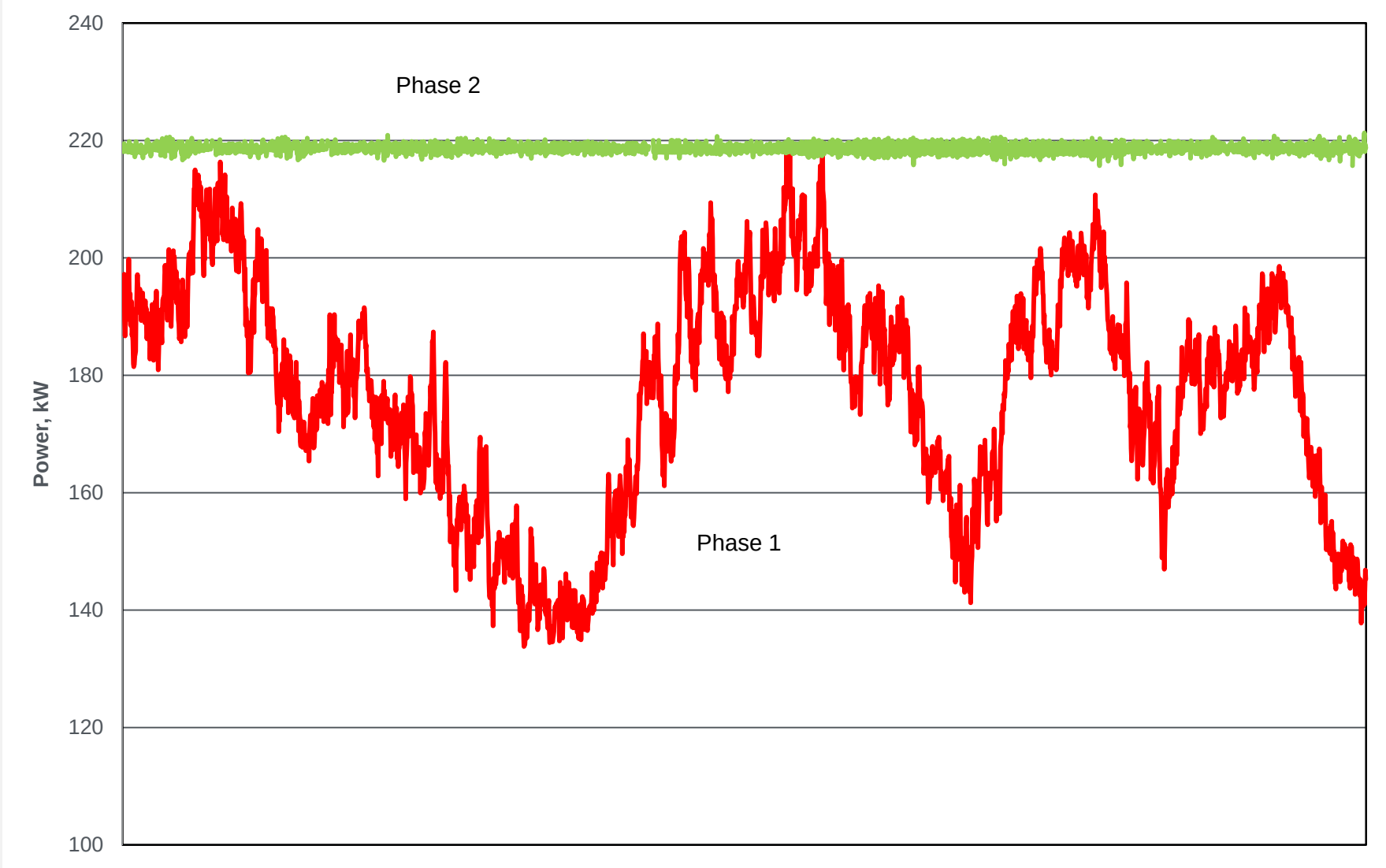
Purpose:

- DOE with partner, ORMAT Technologies (Reno, NV), validate the oilfield application of an air-cooled, binary geothermal power generation system using low-temperature (<220 °F) produced water to generate electricity in the field
- 2-year test (minimum)
- Technical and economic analysis

Results:

- Achieved first successful generation of electricity from oil/gas coproduction in September 2008
- Producing 150-250 gross kilowatts of power

Case Study: RMOTC



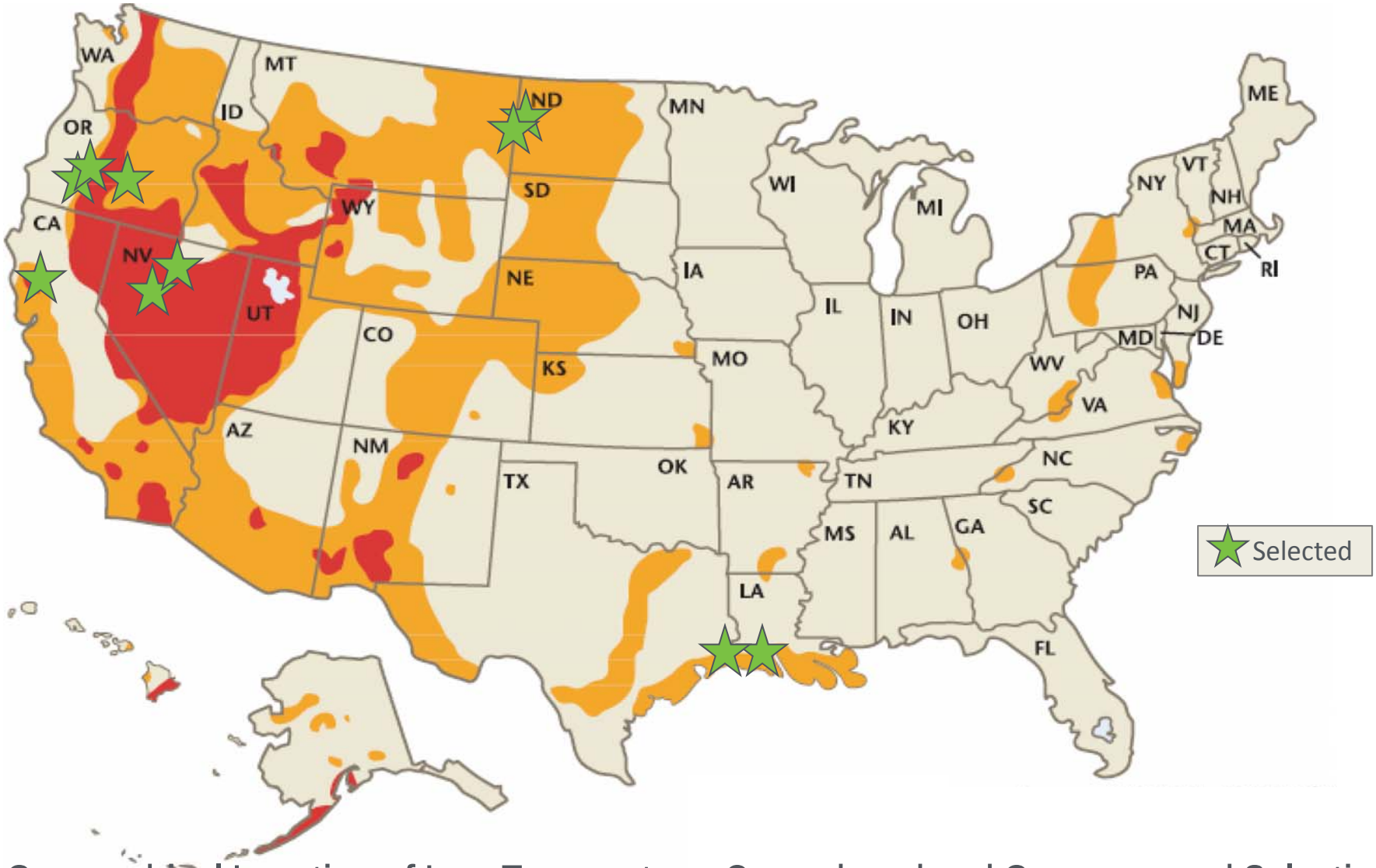
Case Study: American Recovery and Reinvestment Act (ARRA)

ARRA Topic	Grantee	Project Title	"Short" Description
Geothermal Demo	Beowawe Power, LLC	Beowawe Bottoming Binary Project	Beowawe Power, LLC will install a new low temperature binary unit that will be attached to an existing plant to provide 10% additional power
Geothermal Demo	City of Klamath Falls	Klamath Falls Geothermal Low Temperature Power Plant	This funding will facilitate construction of a low temperature power plant combined with a district heating system to help power the city of Klamath Falls, OR
Geothermal Demo	Johnson Controls, Inc.	Novel Energy Conversion Equipment for Low Temperature Geothermal Resources	Johnson Controls, Inc. will install a low temperature unit on the Oregon Institute of Technology Campus
Geothermal Demo	University of North Dakota	Electric Power Generation from Low-Temperature Geothermal Resources	The University of North Dakota will construct a power plant in Bowman County, ND, that will run off of low temperature (not coproduced) fluids
Geothermal Demo	Oasys Water	Osmotic Heat Engine for Energy Production from Low Temperature Geothermal Resources	Oasys Water plans to develop a new method for utilizing low temperature geothermal fluids to produce power

Case Study: American Recovery And Reinvestment Act (ARRA)

ARRA Topic	Grantee	Project Title	"Short" Description
Geothermal Demo	Surprise Valley Electrification Corporation	Rural Cooperative Geothermal Development Electric and Agriculture	Surprise Valley Electrification Corporation will build a binary power plant utilizing low temperature fluids and enable the construction of a local aquaculture facility
Geothermal Demo	Terra-Gen Sierra Holdings, LLC	Dixie Valley Bottoming Binary Project	Funding for Terra-Gen Sierra Holdings will facilitate the installation of a low temperature binary unit that will add to power generation from the existing 60 MW Dixie Valley power plant
Geothermal Demo	Universal GeoPower LLC	Technical Demonstration and Economic Validation of Geothermally-Produced Electricity From Coproduced Water at Existing Oil/Gas Wells in Texas	Universal GeoPower LLC will utilize a modular low temperature binary unit to produce power from oil and gas wells in Liberty County, Texas
Geothermal Demo	University of North Dakota	Electric Power Generation from Coproduced Fluids from Oil and Gas Wells	The University of North Dakota will utilize a low temperature binary unit to produce power from oil and gas wells in Bowman County, North Dakota.
Geothermal Demo	Louisiana Tank, Inc.	Demonstrating the Commercial Feasibility of Geopressured – Geothermal Power Development at Sweet Lake Field Cameron Parish, Louisiana	Louisiana Tank, Inc. will demonstrate the feasibility of a geopressured power plant in Cameron Parish, Louisiana

Case Study: American Recovery and Reinvestment Act (ARRA)



Geographical Location of Low Temperature, Coproduced and Geopressured Selections

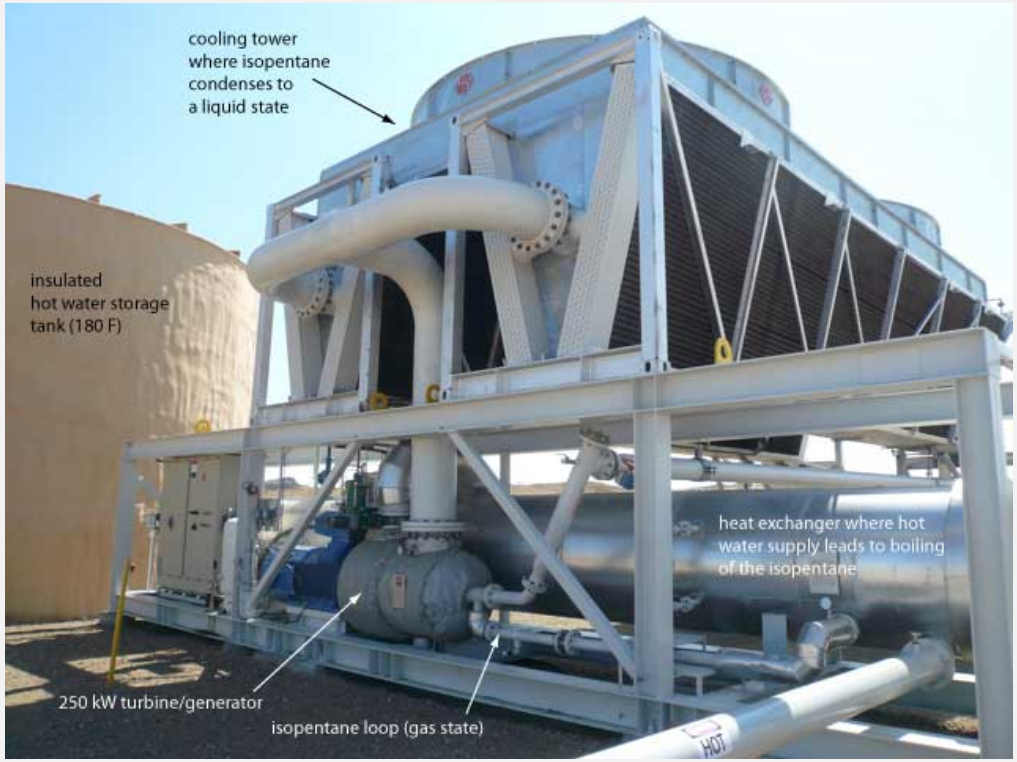
Current Sub-Program Activities

RMOTC-GTP Agreement

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE DEPARTMENT OF ENERGY'S GEOTHERMAL TECHNOLOGIES PROGRAM
AND OFFICE OF FOSSIL ENERGY'S ROCKY MOUNTAIN OILFIED TESTING CENTER (RMOTC)
REGARDING THE DEVELOPMENT OF GEOTHERMAL PROJECTS AT THE ROCKY MOUNTAIN OILFIELD TESTING CENTER

Products and Deliverables;

RMOTC Site Visit: July 27-28, 2010
Draft MOU Agreement: August 6, 2010
Final MOU Agreement: October 19, 2010



Low Temperature Sub-Program Roadmap

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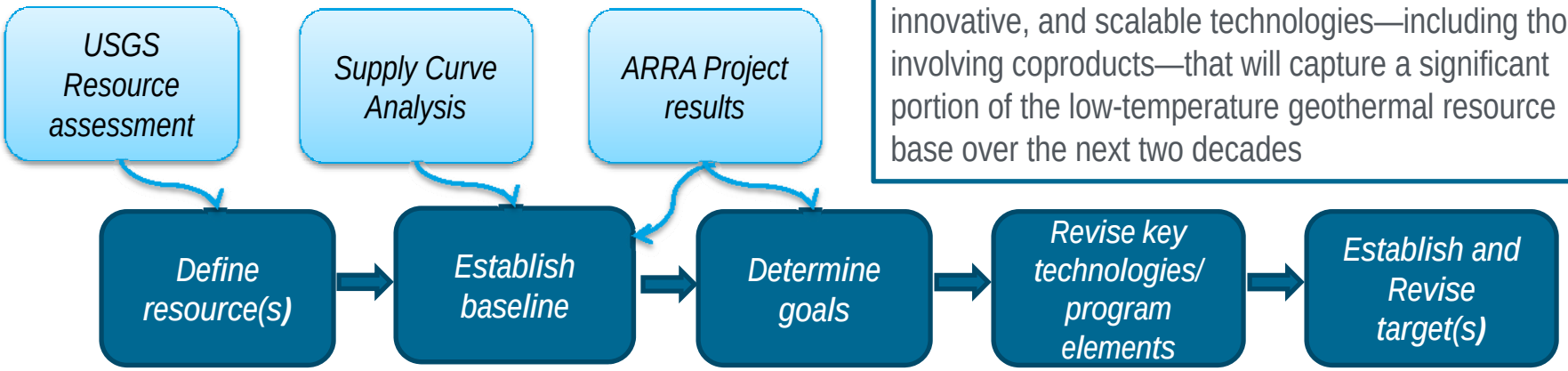
Reach 3 GW of Low Temp geothermal energy capacity by 2020

Sub-Program/Technology Area Mission :

Support DOE's goals of energy security and diversity by providing reliable, clean, baseload power to a variety of sectors

Roadmap Draft Vision

Our vision is to provide the geothermal community with the means to achieve development and widespread deployment of economically viable, innovative, and scalable technologies—including those involving coproducts—that will capture a significant portion of the low-temperature geothermal resource base over the next two decades



Low Temperature, Coproduced & Geopressured FY10 FOA

FINANCIAL ASSISTANCE FUNDING OPPORTUNITY ANNOUNCEMENT

U.S. Department of Energy
Golden Field Office

The complete Funding Opportunity Announcement can be viewed on FedConnect:
www.fedconnect.net/FedConnect/PublicPages/PublicSearch/ Public_Opportunities.aspx

DOE's Geothermal Technologies Program works in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the domestic energy supply.

For more information on these awards, please visit:
http://www1.eere.energy.gov/geothermal/low_temperature_resources.html

Funding was made available in the following topic areas:

A. Low temperature geothermal fluids at temperatures up to 300°Fahrenheit (F) or approximately 150°Celsius (C)

B. Geothermal fluids produced from productive, unproductive, or marginal oil and gas wells, mining operations or other hydrocarbon or mineral extraction processes

C. Highly pressurized or "geopressured" fluid resources that show potential for cost-effective recovery of heat, kinetic energy, and gas

Thank you.

Questions?

Contact Information:

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