

# **Engineering Geothermal Systems in Oil and Gas Reservoirs**

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# Energy from the Earth's Heat

- Hydrothermal systems
  - › Naturally high permeability
  - › Can be developed without stimulation
  - › Usually at shallow depths <3 km
- Conductive heat energy

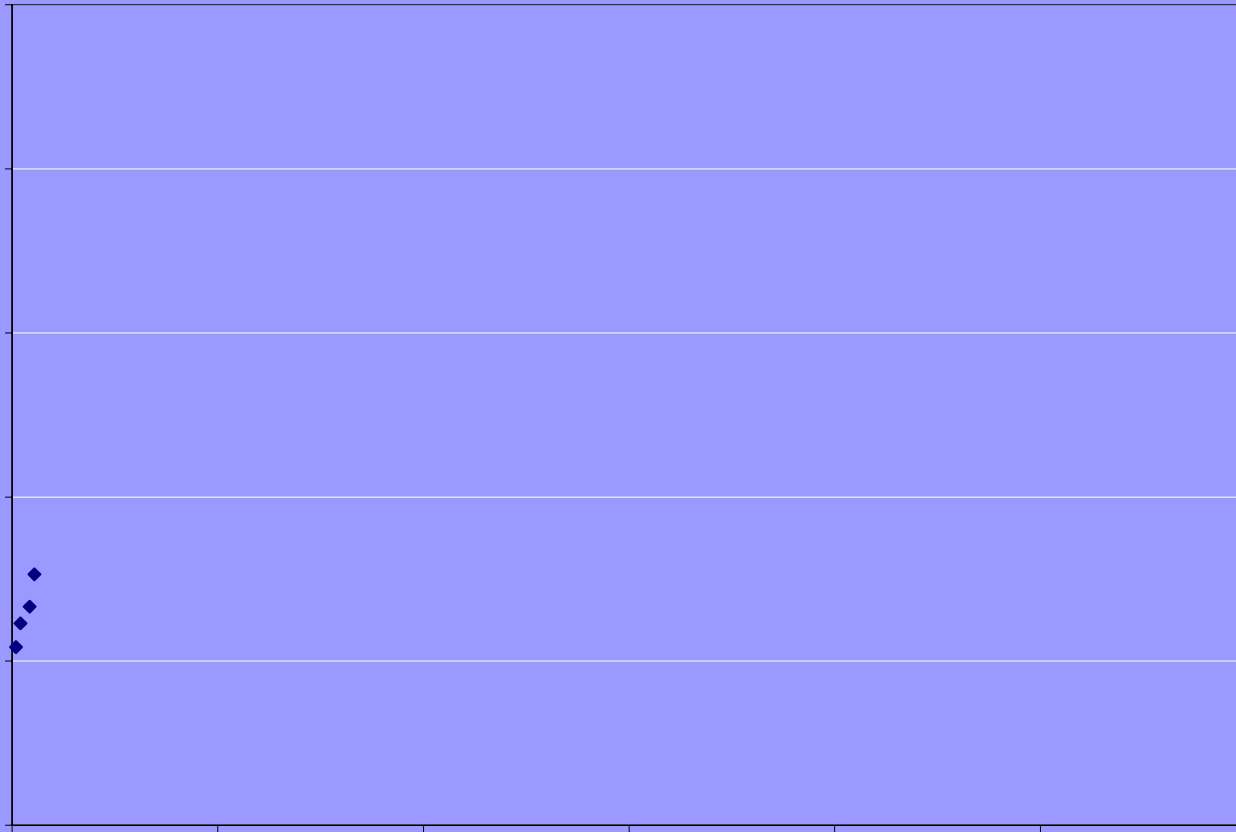
# The Geothermal Resource in Oil and Gas Settings



# Size of the Resource



# Supply of EGS Power at Cost



# EGS in Oil Fields

- Oil and gas wells provide data for geothermal development

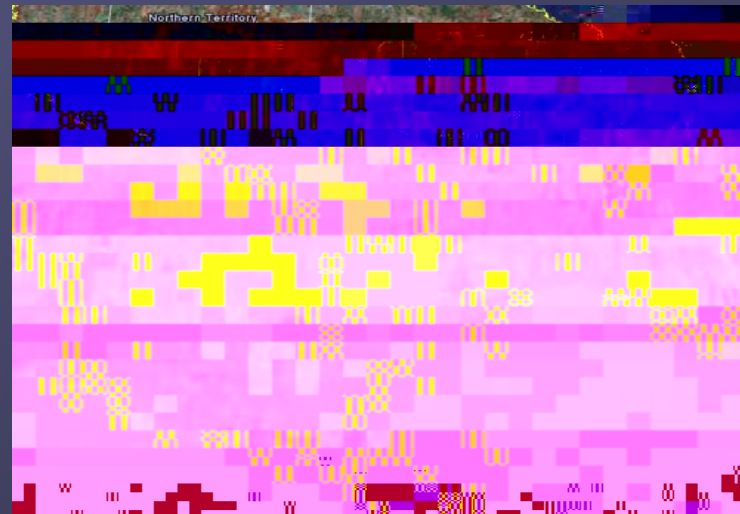
# EGS in Oil Fields

## ● Europe

- › Soultz
- › Landau
- › Grosse Schönebeck
- › Unterhaching

## ● Australia

- › Cooper Basin
- › Paralana GreenEarth Energy
- › Hot Rock Ltd
- › Geogen VictoriaT
- › Torrens Energy Ltd
- › Granite Power







# Resource Development

## ● Scenario 2 – Drill New Wells

### › Benefits

- Large size borehole can be drilled to maximize flow rates and accommodate a pump
- Well can be completed in hot water zones
- Temperature vs. Depth can be optimized
- Water already stored in sedimentary rocks
- Can be drilled to reach higher temperatures in underlying crystalline rocks

### › Drawbacks

- Deep wells can be very expensive
- Drilling risk must be considered
- May not have data in target zone

# Enhancing Permeability in Oil Fields







## Flow Profile & Significant Fracture Apertures

Openhole GPK-3 (4500 m - 5020 m)

Flowrate (l/s)

0 10 20 30 40 50 60

# Economics of EGS in Oil Fields

- Scenario 1 – Wells of opportunity assumptions
  - › Depleted oil field with 1000 psi overpressure
  - › Wells 12,000 ft deep with 5" completion
  - › Temperature 300°F
  - › Build 50 MW plant -\$110,000,000
  - › Need 117 wells!
  - › Competed above primary hot water reservoir

# Economics of EGS in Oil Fields

- Scenario 2 – Drill new wells assumptions
  - › Dry holes in area of soft geopressure ~1000 psi overpressure
  - › Wells 12,000 ft deep with 9 5/8" completion
  - › Temperature 300°F
  - › Build 200 MW capacity – 30 wells for \$190,000,000
  - › 200 MW binary plant for \$220,000,000
  - › Drill and complete with screen and gravel pre-pack
  - › Stimulate to achieve higher flow rates
  - › Pumped with 700 HP motor
  - › Maximum flow rate - 1500 gpm
  - › Cost of Power – 8.07 ¢/kWh

# Reality Check EGS

## What would need to happen to make EGS a reality?

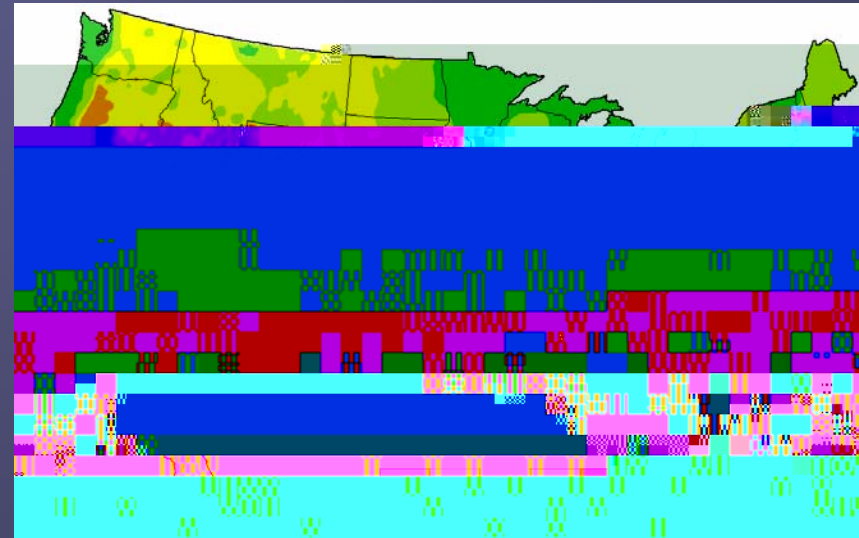
- › Reduce the cost of power through technology improvement and learning by doing
  - Increase flow rate per producer by improving stimulation methods
  - Reduce drilling cost by reducing number of casing intervals, improving rate of penetration and reducing risk
  - Improve conversion efficiency
- › Identify high temperature oil fields with potential for high volume water production
- › Develop a commercial project with DOE/industry in at least two areas with different geology



# Reaching the Goal

● To get 1000 MW of EGS power on line we need:

- › 1 well in 3 months, average 5 MW per well
- › 16 rigs drilling for three years
- › 4 sites with 250 MW potential
- › Identify fields with declining production and large numbers of wells that can be recompleted.
- › Identify large areas of uniform hot rock at reasonable depth from O&G drilling data
- › Use hot oil/gas fields to get data and starting points for projects



# Technology gaps and barriers

- Need reliable methods to increase the fractured heat exchange area without inducing felt seismic events or making short circuits
- Need to divert stimulation to zones that have been less affected
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# **Future Work to Overcome Gaps and Barriers**