Characteristics of Geothermal Energy in Sedimentary Basins

- Conduction dominated thermal regimes with temperatures already known or easily obtained from various data sources
  - BHT and heat flow data provide understanding of the thermal regime
  - The temperatures are typically less than 150 °C and development requires binary systems
- The resource is widespread
  - Exploration and drilling costs are minimal
  - Risks are small
- The fluids for heat extraction exist throughout sedimentary aquifers
  - Geological data on aquifer properties is readily available
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Geothermal Perspective of the Williston Basin

- The temperatures, depths and hydrologic properties of the geothermal resource are well documented (Gosnold et al, 2012, 2015, 2016; Crowell and Gosnold, 2015)
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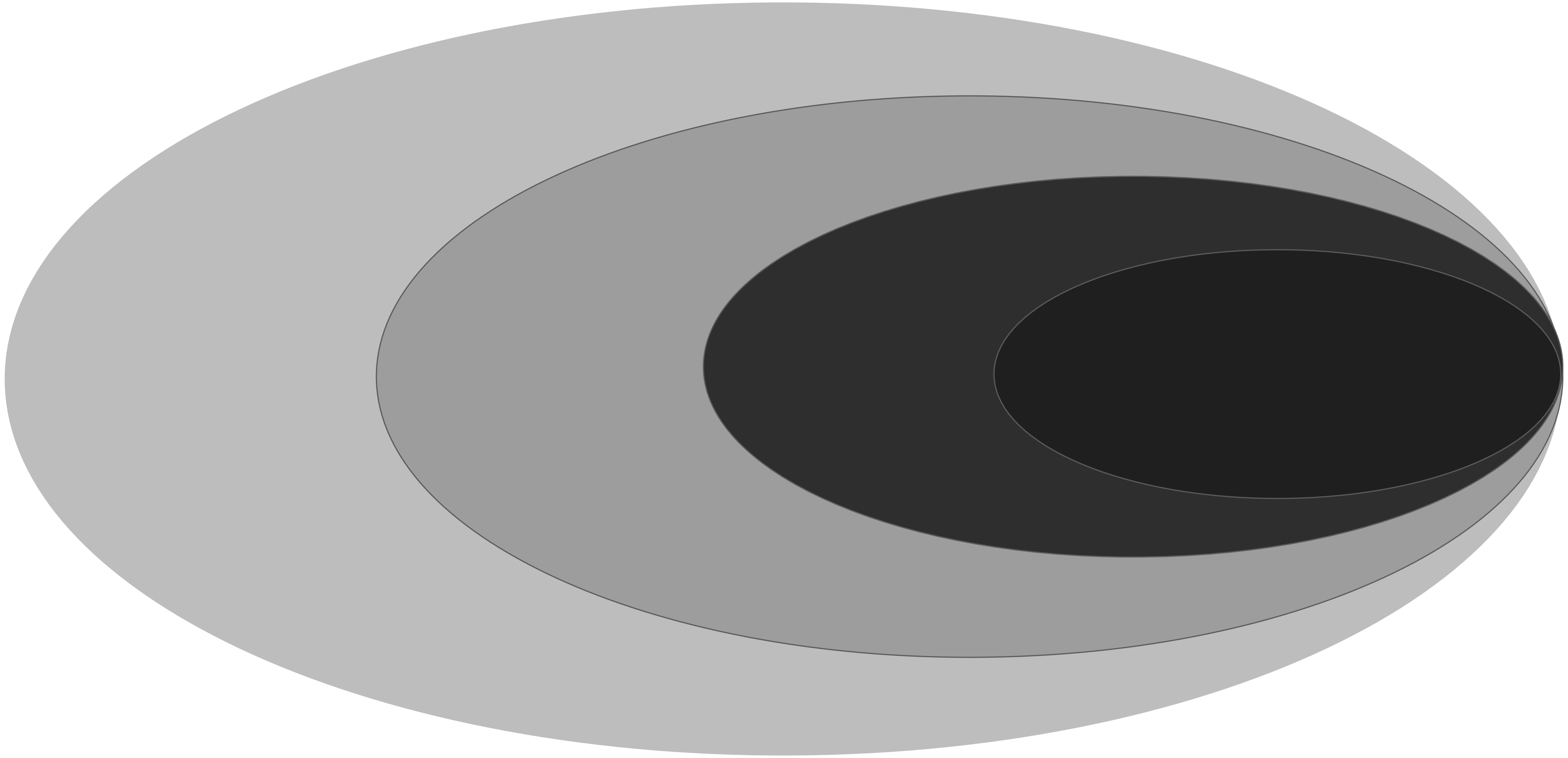
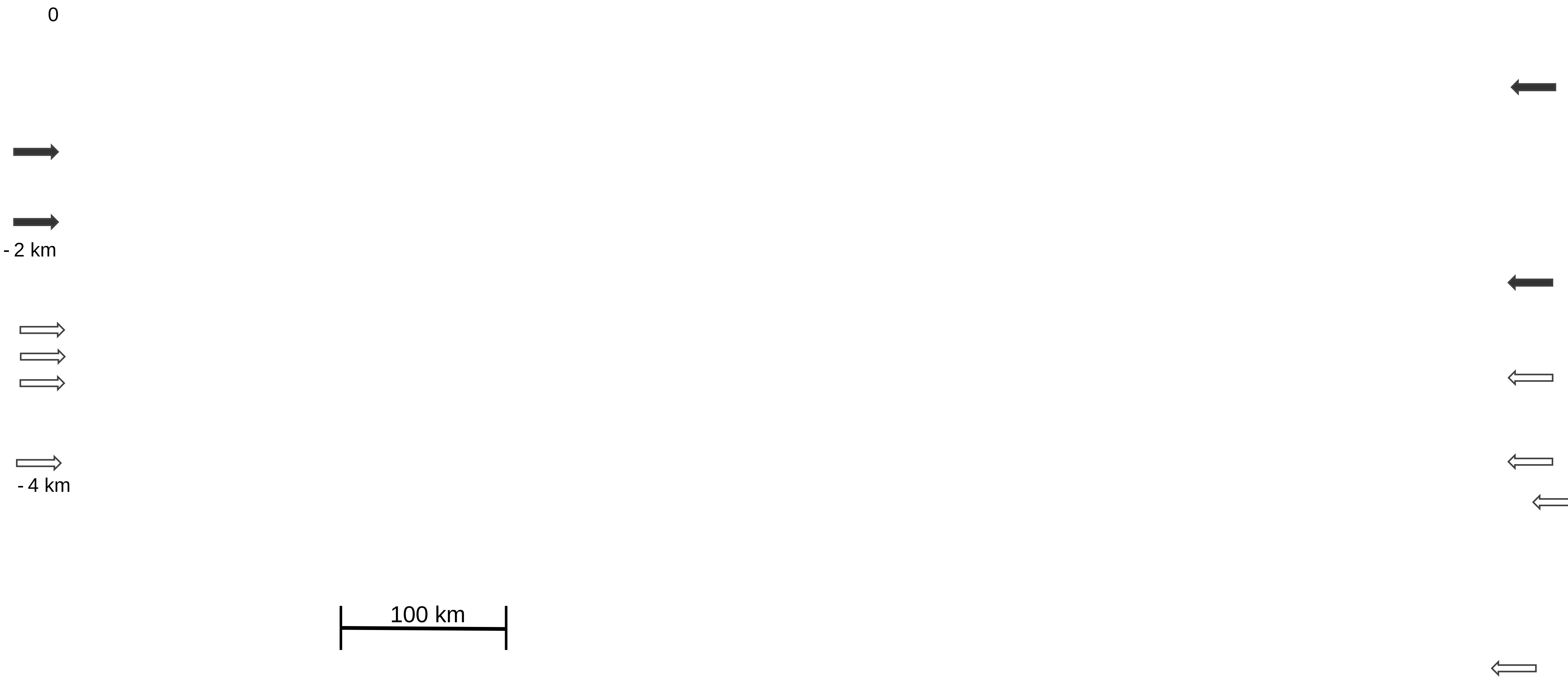


UND Geothermal Activities

- Resource assessment and the National Geothermal Database
  - North Dakota, Minnesota, and Nebraska
- Co-produced fluids and power generation with DOE
  - Wells in the Williston Basin produce low volumes of water
  - Multi-will pads do offer sufficient volumes
- Low-Temperature fluids and power generation
  - The UND-CLR binary geothermal power plant
- Now working on growing geothermal development

A great opportunity for distributed power

- 2,600 MW additional power needed to produce Bakken and Three Forks by 2032
- Existing power for ND-MT is from 6 coal or gas-fired power plants on Missouri River.
- Current supply for the boom is from diesel, propane & produced gas at 5 X grid power cost


0
- 2 km
- 4 km
100 km

Heat flow, thermal conductivity, and stratigraphy permit accurate temperature determination

0

- 2 km

- 4 km

Red dots are BHT
Green dots are "corrected" BHT

100 km

Thick blue line is equilibrium temperature log
Red-gold triangles are calculated temperatures

Temperature and depth contours
Deadwood Fm.

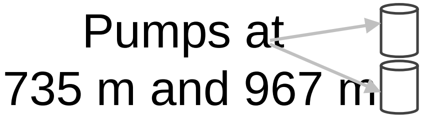
Temperature and depth contours
Madison Fm.

Temperature and depth contours
Red River Fm.

Temperature and depth contours
Dakota Group.

The UND-CLR binary power plant demonstrated that the low temperature resource can be produced economically

Production is from the Lodgepole formation: 3 km deep, 98°C-103°C


Pumps at
735 m and 967 m

Power Conversion Options

- Scalable ORC systems
- 50 to 250 kW modules
- Calnetix
- Ormat
- Recurrent (Kalina Cycle)
- Turboden
- Pratt & Whitney
- Electratherm
- Climeon

The Calnetix machines installed at the UND-CLR demonstration site produce 250 kW

The Climeon system could produce approximately one mW with the available water

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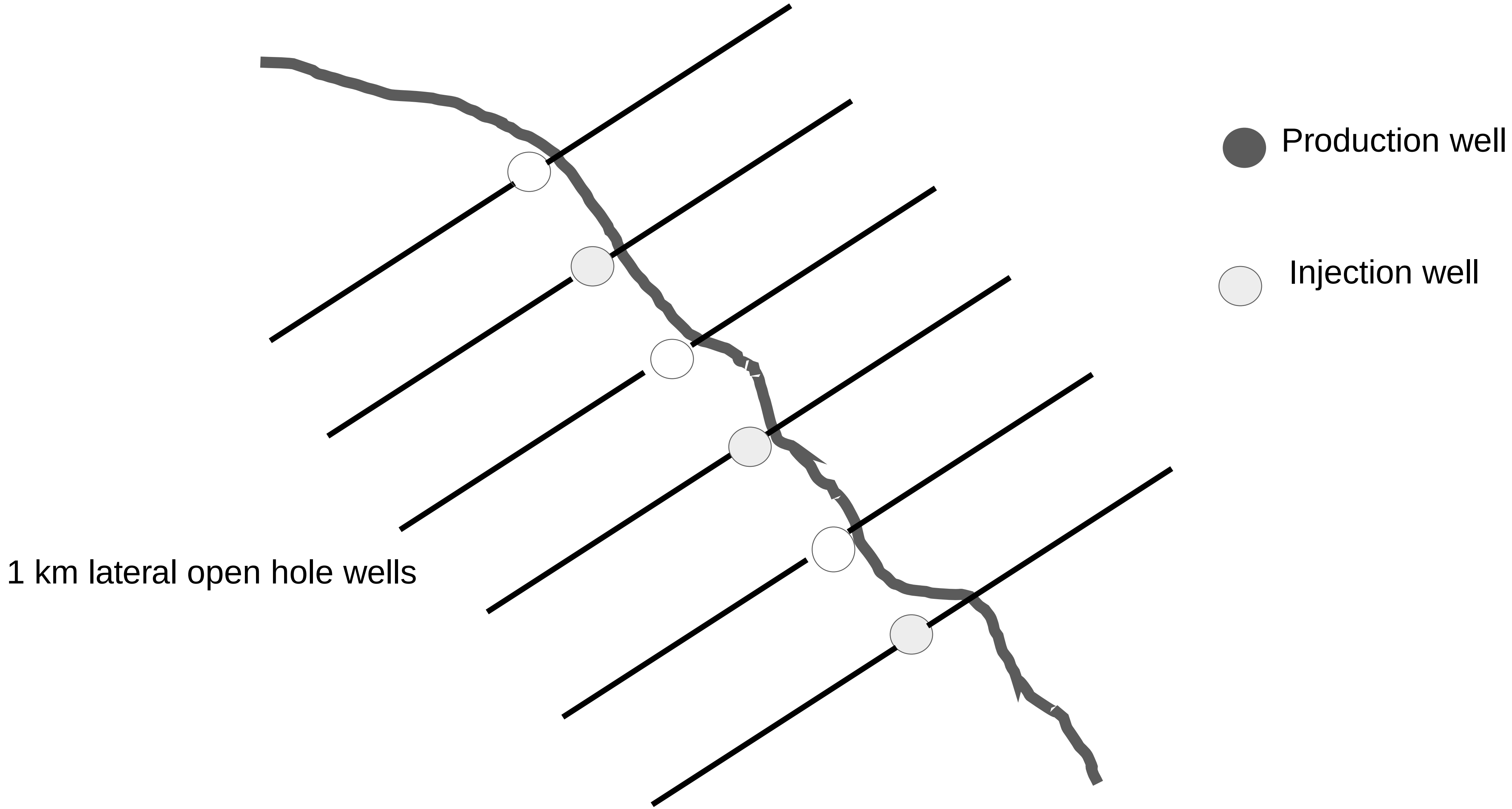
The Distributed Power Corridor Concept

WHY IS DEVELOPMENT NOT HAPPENING?

- The oil industry is not interested.
- The electric power industry does not envision replacing 3,355 MW of power with geothermal.
- We need someone who sees geothermal as a promising energy source and who has the will and means to start development.
- An opportunity has presented itself!

Communities:

- Four Bears Village
- Mandaree
- New Town
- Parshall
-



Production well
Injection well
1 km lateral open hole wells

Science and engineering yet to be determined

- Formation temperature logs
- Formation permeability
- Water quality
- Well spacing
- Well orientation

Summary

- The Williston Basin contains six geothermal aquifers having temperatures ranging from 80°C to 165°C depending heat flow
- Access to Missouri River water for cooling is conceptually ideal for distributed, binary power development.
- The temperatures, depths and hydrologic properties of the geothermal resource are well documented.
- The efficacy of horizontal drilling for high-volume water production in the basin has been
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