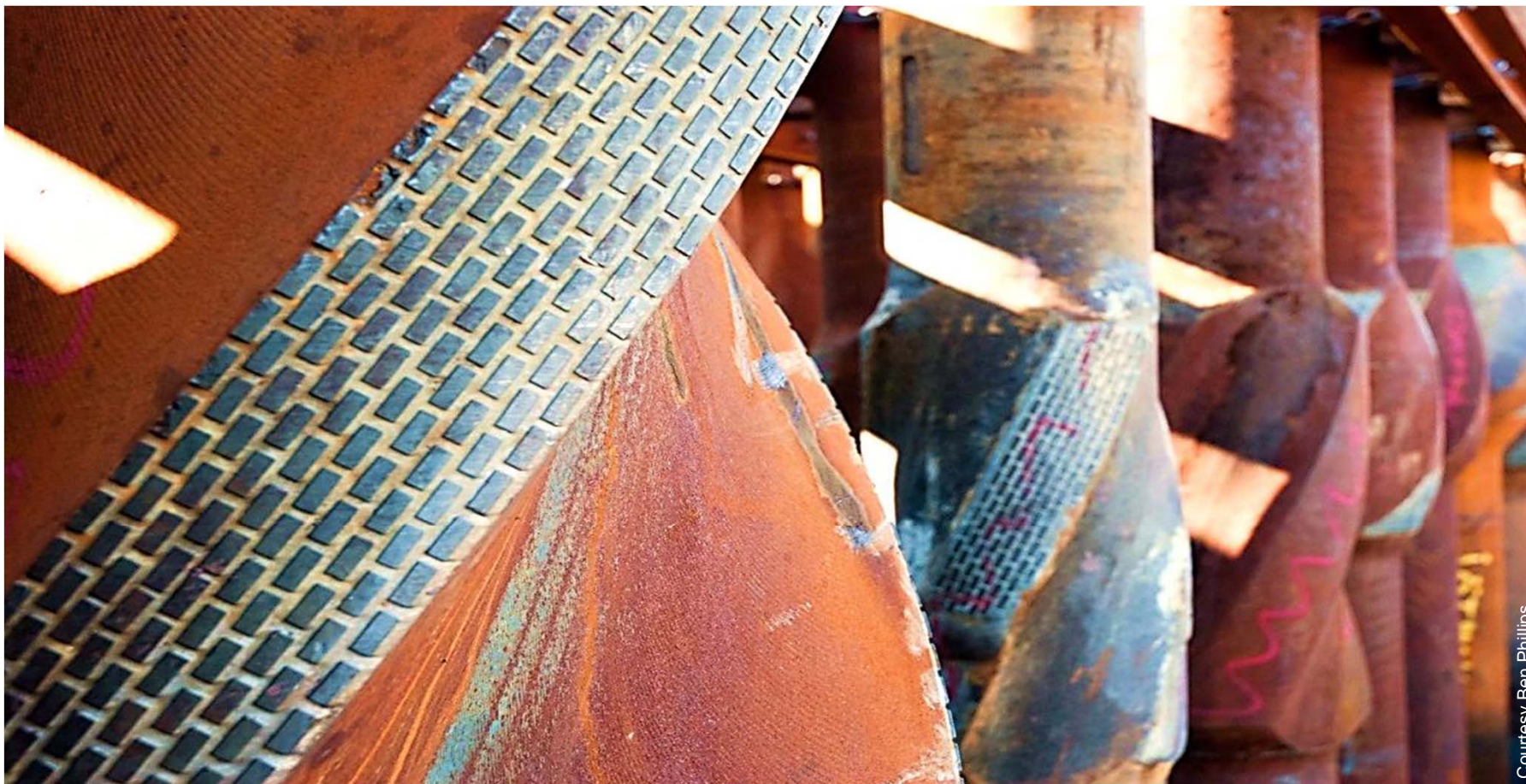


Geothermal Technologies Office

Next Generation R&D

U.S. DEPARTMENT OF
ENERGY

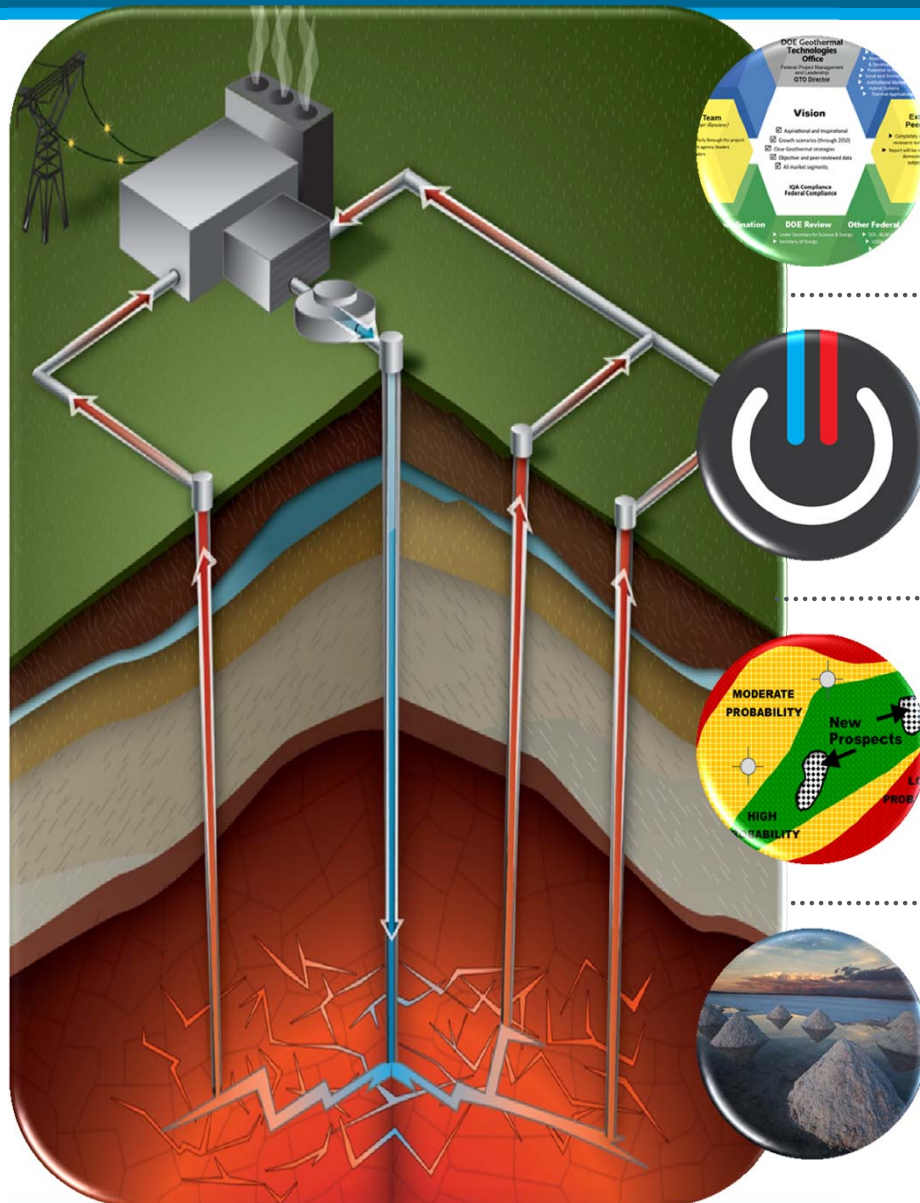
Energy Efficiency &
Renewable Energy



Courtesy Ben Phillips

Eric Hass
Hydrothermal Program Manager
Geothermal Technologies Office
May 4, 2016

Geothermal Technologies – FY16 & FY17 Major Initiatives



Systems Analysis • GeoVision Study

Enhanced Geothermal Systems

- Frontier Observatory for Research in Geothermal Energy (FORGE)

Hydrothermal

- Play-Fairway Analysis
- Subsurface Engineering Crosscut (SubTER)

Low Temperature

- Mineral Recovery
- Hybrid Systems
- Desalination

Subsurface Technology and Engineering Research (SubTER): DOE Cross-cut Initiative

Goal of SubTER is “*Adaptive Control of Subsurface Fractures and Fluid Flow*”

- 80% of the US energy supply comes from subsurface resources
- Critical for EGS, hydrothermal
- Also critical for oil & gas, carbon sequestration, safe disposal of nuclear waste, etc.
→ cross-cutting

Wellbore Integrity



Materials and technologies to ensure wellbore integrity over decadal timeframes

Subsurface Stress & Induced Seismicity



Characterization and control subsurface stress and induced seismicity

Permeability Manipulation & Fluid Control



Approaches to manipulate subsurface fractures, reactions and flow

New Subsurface Signals



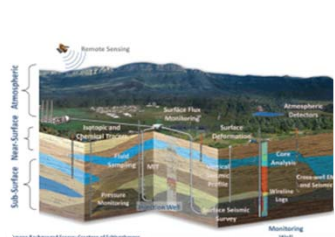
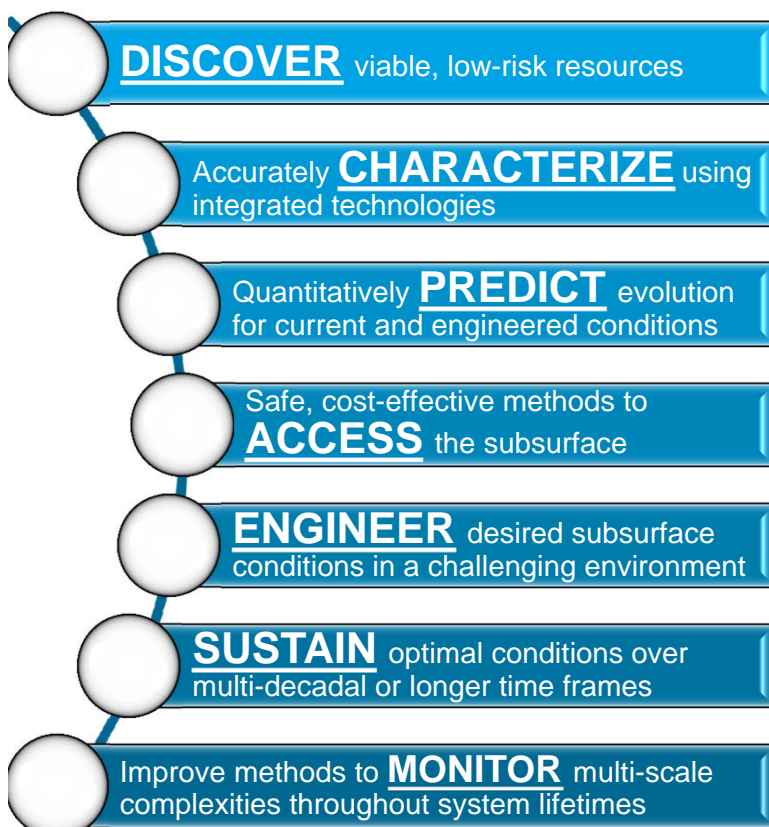
Sensors and algorithms to monitor subsurface dynamics and facilitate adaptive control

Subsurface Engineering Crosscut (SubTER)

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

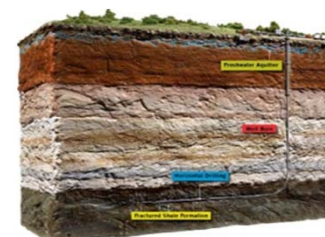
Address subsurface energy challenges common to multiple sectors



CO₂ Storage



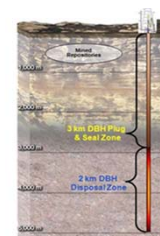
Geothermal



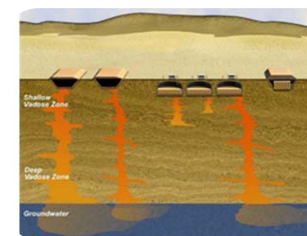
Oil and Gas



Energy Storage



Nuclear Waste Disposal



Subsurface Remediation

GTO has up to \$3 million available to
**Develop Novel Subsurface Imaging
and Characterization Technologies** as
part of a joint funding opportunity.
Applications are due by **May 5th**

Subsurface Technology and Engineering Research (SubTER): Lab Sapling Projects

Wellbore Integrity



**3D Acoustic
Borehole Integrity
Monitoring System
(LANL)**

**Ultrasonic Arrays
and Tomography
for Inspection of
Geothermal Wells
(ORNL)**

**Spectroscopy Stress Sensor for In-Situ Stress
(ORNL)**

Subsurface Stress & Induced Seismicity



Hydraulic Fracture Field Laboratory in a Deep Mine (LBNL)

**Measuring Stress
Away from the
Borehole (LANL)**

**MicroBayesloc
Location Method
(LLNL)**

**Imaging Fractures Using Crosshole Seismic
and Advanced Change Detection Algorithms
(SNL)**

**Big Data Analytics
for...**

New Subsurface Signals



**Borehole Muon
Detector for
Tomography of
Subsurface
Reservoirs (PNNL)**

**... Induced Seis.
(NETL)**

FORGE

(Frontier Observatory for Research in Geothermal Energy)

U.S. DEPARTMENT OF
ENERGY

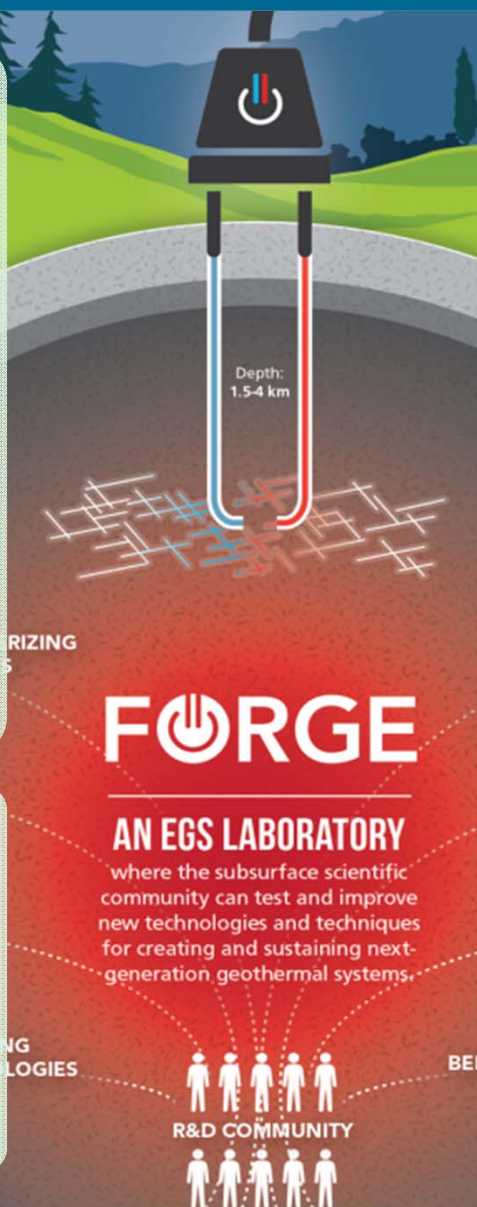
Energy Efficiency &
Renewable Energy

Federal Role:

- Test technologies/take **technical risks** not possible in private sector
High risk, high pay-off research and development
- Advance **innovation** – **domestic & international**
- Work under **aggressive timeframe**

Opportunity:

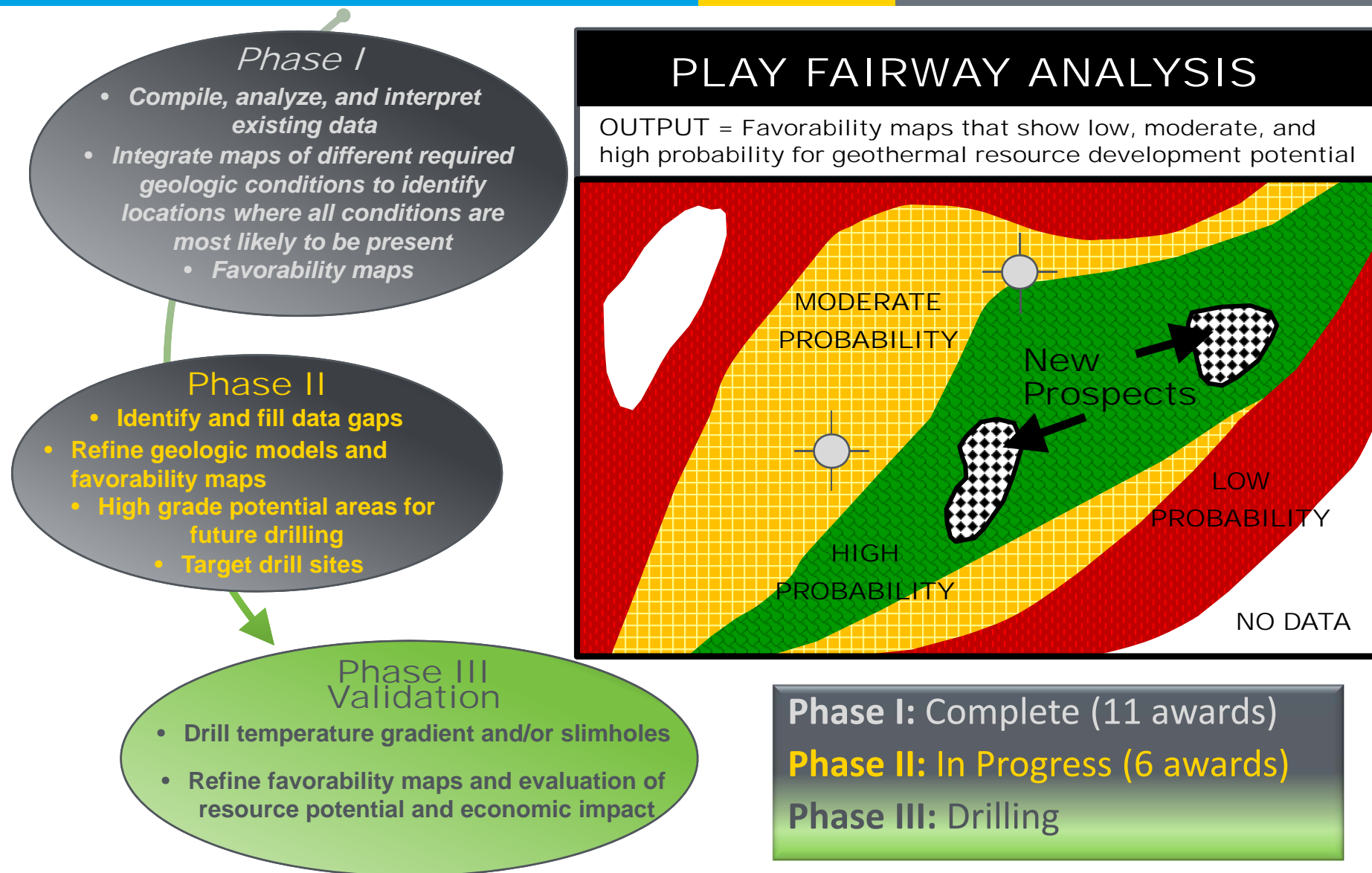
- Heat is present almost **everywhere at depth**
- USGS estimates the potential resource to be on the order of **100+ GWe**



Research Tenets:

- Gain a **fundamental understanding** of the **key mechanisms** controlling EGS success
- **Develop, test and improve** new **fundamental** and **techniques** in an ideal EGS environment.
- Make **Integrated comparison** of **technologies** and **tools** in a controlled environment
- Rapidly **disseminate technical data** and **communicate** to the research community, developers, and other interested parties.

Play Fairway Analysis



Geothermal Regulatory & Cost Barriers

GTO funded the National Renewable Energy Laboratory to develop a permitting roadmap for geothermal power projects at the federal and state level to enable projects to better understand and maneuver the current process.

Potential bottlenecks in the permitting process increase the cost and financial risk of a project. The impact of a single permitting delay may be small, but the cumulative impact of multiple, often independent, and sometimes conflicting regulations on geothermal power development projects can hinder new projects, or make them unprofitable.

- Regulatory and Permitting Information Desktop Toolkit (RAPID) Analysis Project, GTO Peer Review Presentation

The screenshot shows the RAPID website interface. At the top, there's a navigation bar with 'Wiki', 'Apps', 'Datasets', and 'Community' links. Below that, a search bar and 'Page', 'Edit', 'History' buttons are visible. The main header reads 'RAPID Regulatory and Permitting Information Desktop Toolkit' with a 'BETA' tag. A secondary navigation bar includes 'ABOUT', 'BULK TRANSMISSION', 'GEOTHERMAL' (highlighted), 'HYDROPOWER', 'SOLAR', 'TOOLS', 'CONTRIBUTE', and 'CONTACT US'. The 'RAPID / Geothermal' breadcrumb is shown. The main content area is titled 'Geothermal Regulations and Permitting' and contains a paragraph about the multi-year nature of geothermal projects. Below this is a map of the US with states color-coded: blue for Federal and grey for State. A legend at the bottom left of the map indicates 'Federal' (blue square) and 'State' (grey square). To the right of the map, there are two sections: 'Regulatory Processes' with a 'Go To Flowcharts' button, and 'Regulatory Information Overviews' with dropdown menus for 'Select a Topic' and 'Select a Jurisdiction', and a 'Go to Overview' button.



Low Temperature Efforts



- Ongoing effort in low-temperature **Mineral Extraction** - resource assessment and feasibility
- Upcoming opportunity in large-scale **Direct Use** of geothermal hot fluids for heating and cooling – technology development through commercial deployment
- Potential displacement of traditional baseload generation on site-by-site basis
- Targeted RD&D on innovative energy conversion, additional **revenue-stream creation** (e.g., **hybrid systems** & thermal **desalination**), and further development of power generation cycles

