Geothermal Technologies Office

SMU Geothermal Conference

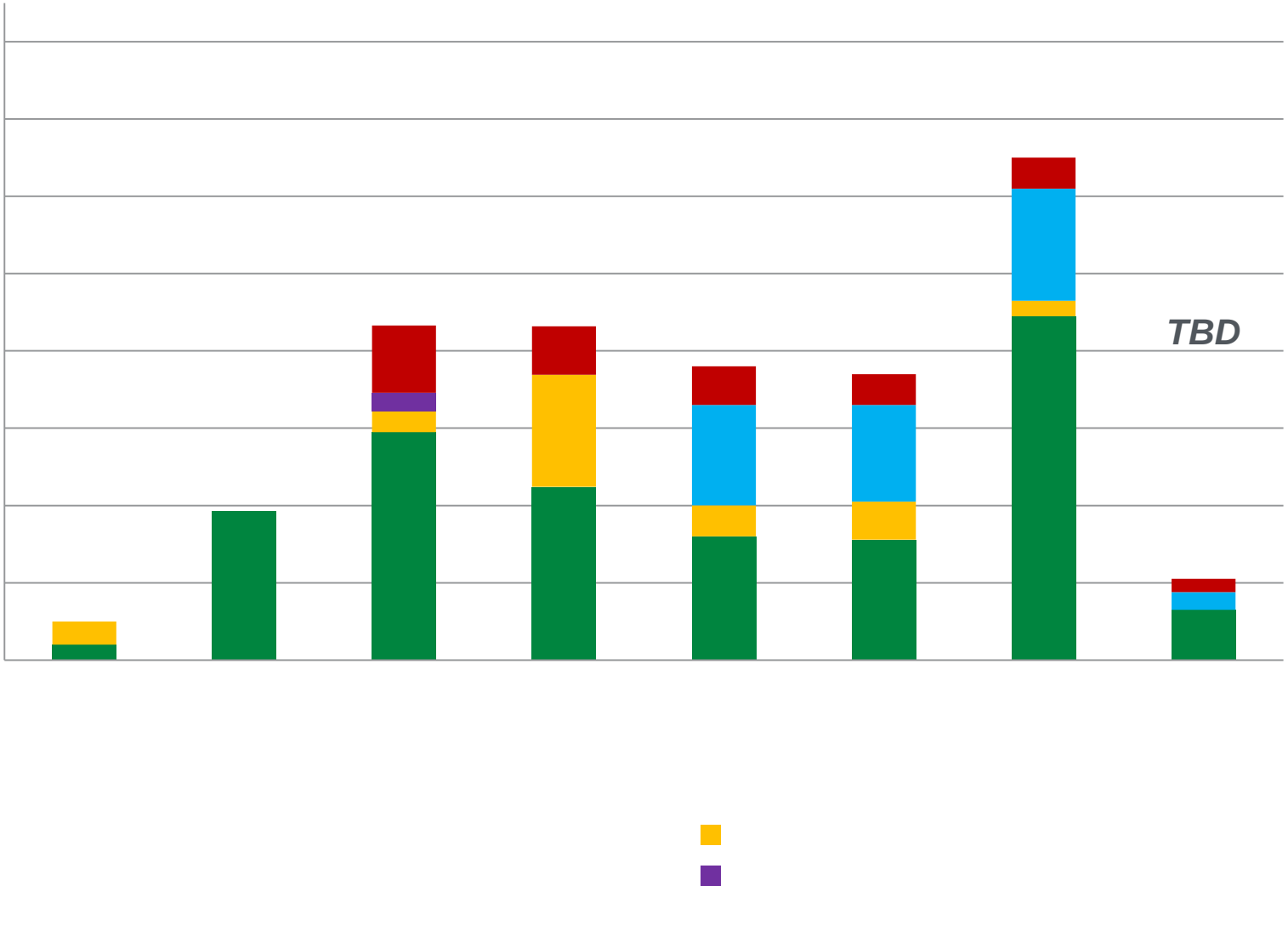
March 13, 2013

Doug Hollett, Director

Geothermal Program: Key Goals and Objectives

Budget Overview

Challenging but a good path forward



Geothermal Power Plants

2011-2012

Geothermal power plants brought online/expanded in 2012-13 (154 MW)

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Geothermal Projects

Technology as the Pathway to Growth

Accomplishments in 2011-2012

Low Temp | Co-Production | Blind Hydrothermal | In-Field EGS | Greenfield EGS

- Beowawe Power: Beowawe, NV 2.5 MW added
- TerraGen Sierra Holdings: Dixie Valley, NV 6 MW online

- Simbol Materials: Lithium extraction plant groundbreaking expected 2013
- Deploying two binary systems in operating O&G fields.

- ~150+ MW of new hydrothermal capacity
- 26 wells drilled to date

- IN-FIELD: Ormat: Desert Peak, NV
- NEAR-FIELD: Calpine: The Geysers, CA - 5 MW
- GREENFIELD: AltaRock: Newberry, OR

Baker Hughes

Polycrystalline Diamond Compact Drill Bit

- CSI Technologies /AltaRock- Diverters
- Baker Hughes Ultrasonic Fracture Imager
- Sandia National Lab PDC Bits

Recent Project Successes

Low Temperature Portfolio

Beowawe Power, LLC

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Low temp / co-production going forward

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what are the challenges to deployment?

- DOE investment is increasingly mature
- Technical risks? Technology?
- Upfront costs/capital requirements; opex?
- Regulatory or permitting uncertainty?
- Fundamental economics, or how communicated?
- Need for complementary revenue streams?
- Financing?
- Do we need more demonstration projects?

Do we have a clear understanding, or roadmap, of the costs, issues, barriers and best practices which industry can use to make informed decisions?

When can we expect broader adoption of low temp and co-production?

Core Program Focus

EGS Demonstration Projects

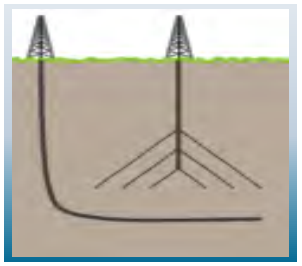
Current EGS Demo Schedule

Spring 2013 status

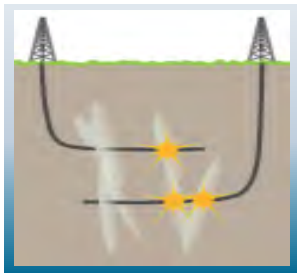
EGS Field Observatory

Vision and Objectives

WHY?



Reservoir Access



Reservoir Creation

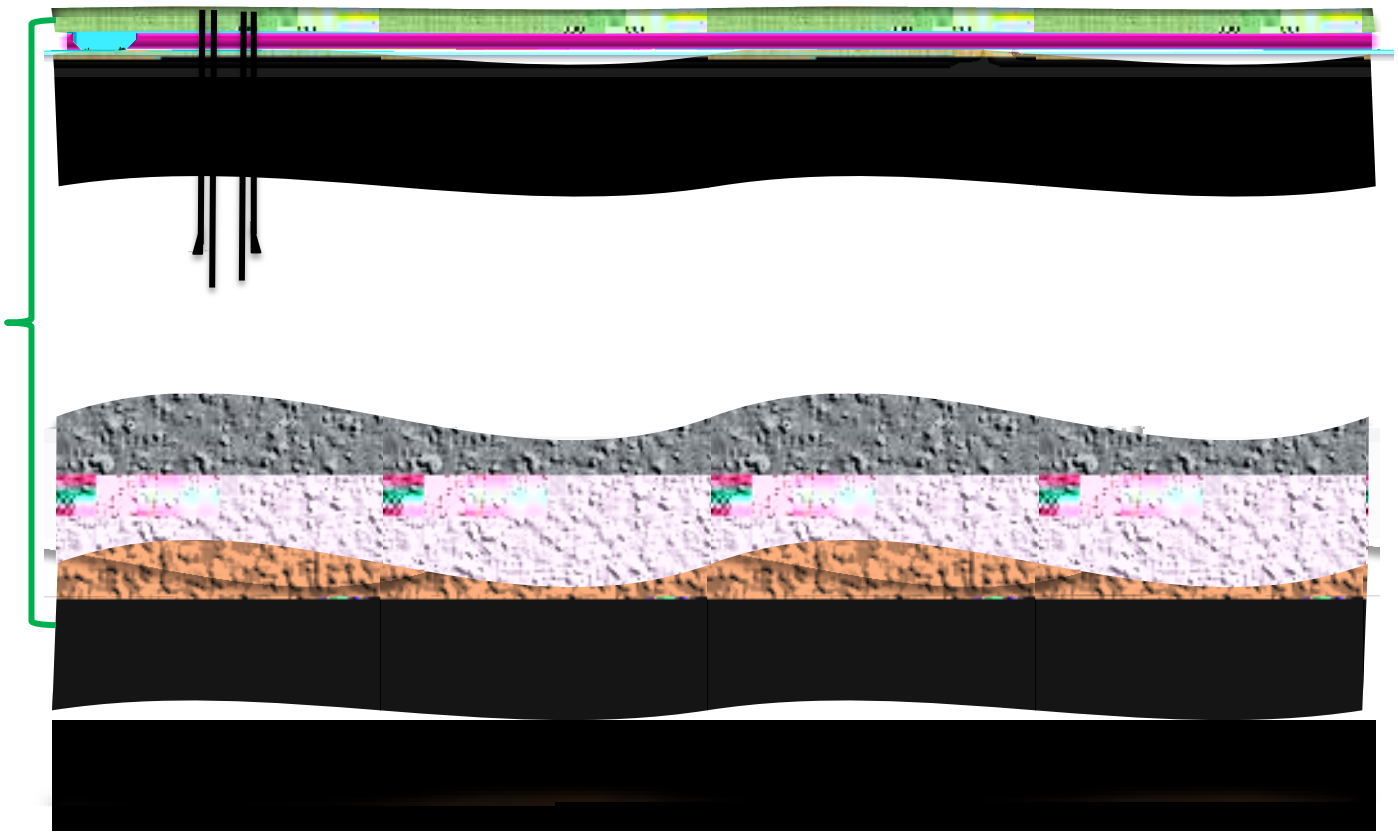
Productivity

Sustainability

Challenges | **Innovative Solutions**

Barriers

1. High Cost of Drilling
2. Creating a Reservoir
3. Subsurface Characterization
4. Sustained Reservoir Production
5. Risk Management & Mitigation



EGS Field Observatory Names?

What is descriptive, accurate, does not imply permanence, and is acceptable to a diverse constituency?

- Geothermal Experimental and Operational Development Site (GEODES)?
- Federal Observatory for Research in Geothermal Energy (FORGE)?
- Subsurface Research for Geothermal Energy Lab (SURGE Lab)?
- Underground Field Observatory (UFO)?

What's next for EGS?

Growth sequence

Immediate / Primary Focus

- Progressive adoption based on demonstration successes
- Accelerated in-field use
- Advance into field extension applications

Subsequent Focus

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- Pathway to significant sector growth

Future?

- Lower Temp EGS?
- Deployment into non-traditional basins/regions?
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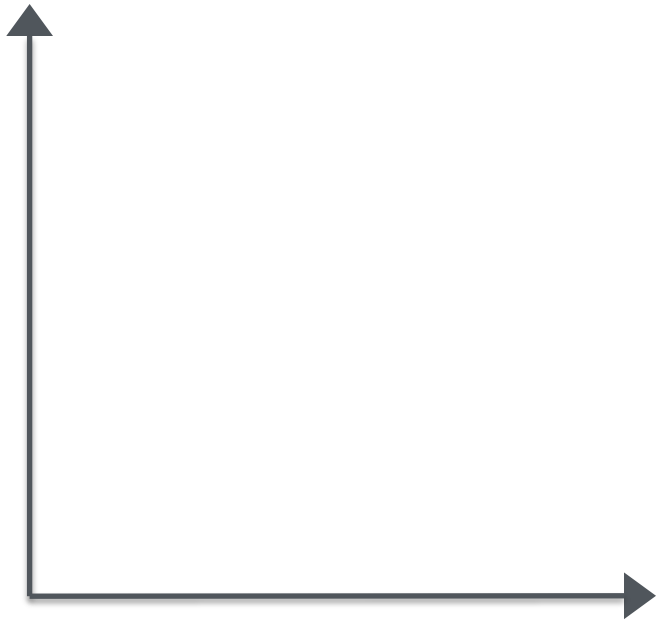
  mining?

Possible game changers?

- Innovative exploration technologies: new imaging, measurement technologies for geothermal environments
- Radically new drilling technologies
- Innovative ways to map/identify prospective geothermal targets
- Determine how to fully advance larger-scale low temp, co-production and direct use deployment
- Exploring new rock systems geothermal in traditional sedimentary basins
- Horizontal drilling in geothermal systems; multi-stage stimulation, adapted for geothermal environment
- Integrated technologies: cascading systems; gas densification + geothermal coproduction; low temp + direct use; geothermal + solar

Pathway to Transformative Change

Shale Gas: Technology Innovations Spawned Sector Transformation



Sources: Lippman Consulting, Inc. 2011. Technology advances from King, 2012 (SPE 152596)