U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Geothermal Technologies Office

Quarterly Update: January 23, 2020

Dr. Susan Hamm, Director

Image: Calpine

Q1 2020 Agenda

Webinar topics or suggestions? Contact us at: DOE.geothermal@ee.doe.gov

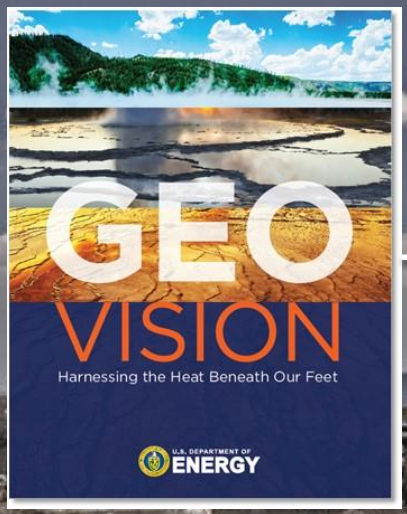
Topic	Speaker
FY 2020 Strategic Priorities	Susan Hamm
EERE Energy Storage Grand Challenge	Alejandro Moreno, Director, WPTO
Play Fairway Analysis: Retrospective	Greg Rhodes, Geothermal Analyst, NREL
Additive Manufacturing for Geothermal	Sean Porse, DMA Manager
Q&A	Submit your question via WebEx chat

Since we last met...

GeoVision – What's New

energy.gov/geovision

Updates are underway to the GeoVision Scenario Viewer: https://openei.org/apps/geovision



Action Area 4: Improve collaboration, education, and outreach.
Status: GTO is actively touring the country, giving talks about geothermal research and its potential at universities, associations, industry groups, and government agencies.

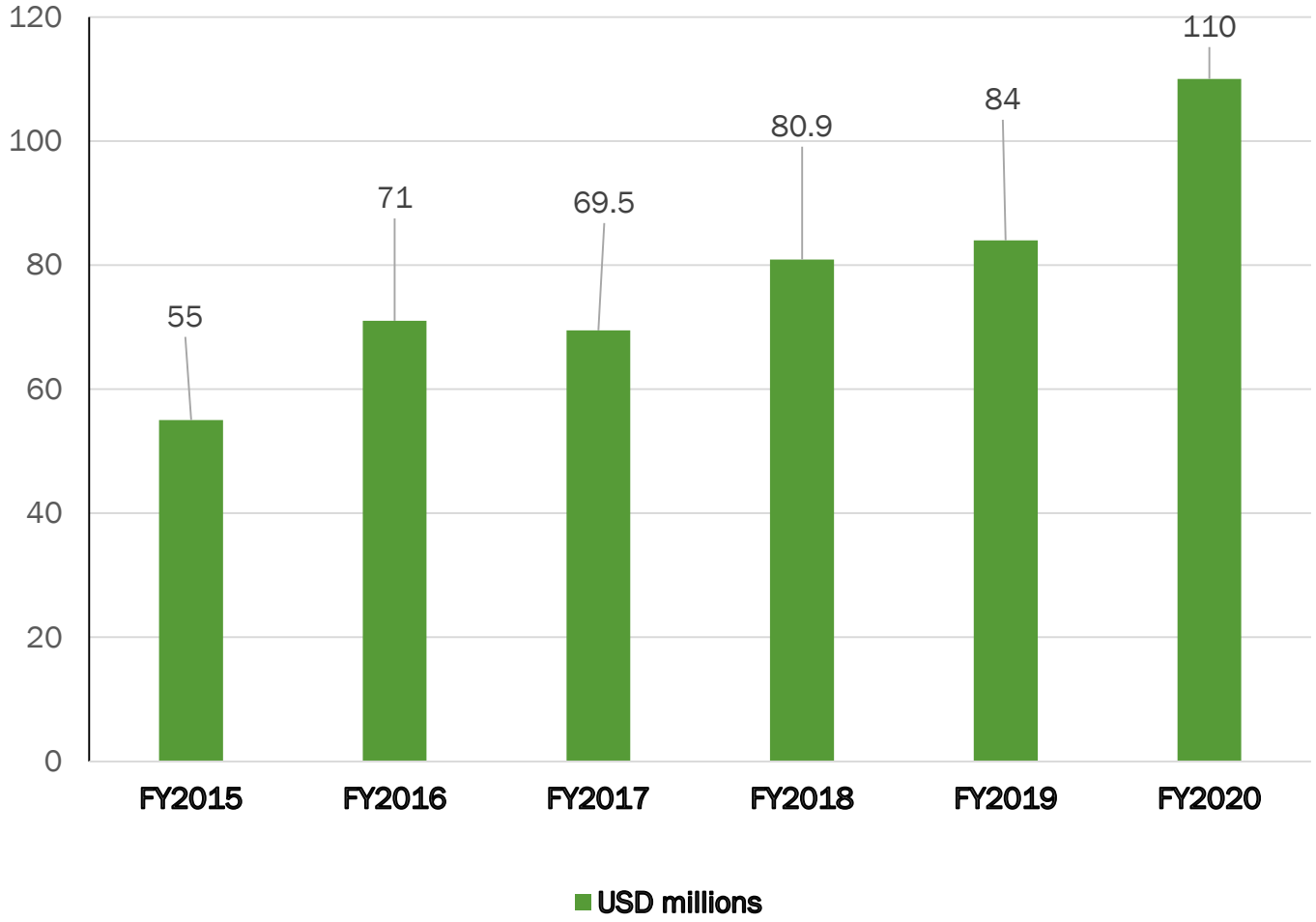
Image: *GeoVision* Report

Congressional Authorization Bills

- S. 2657 – Advanced Geothermal Innovation Leadership Act of 2019 (AGILE)

- HR 5374 – Advanced Geothermal Research and Development Act

Budget Snapshot



From Congressional report language:

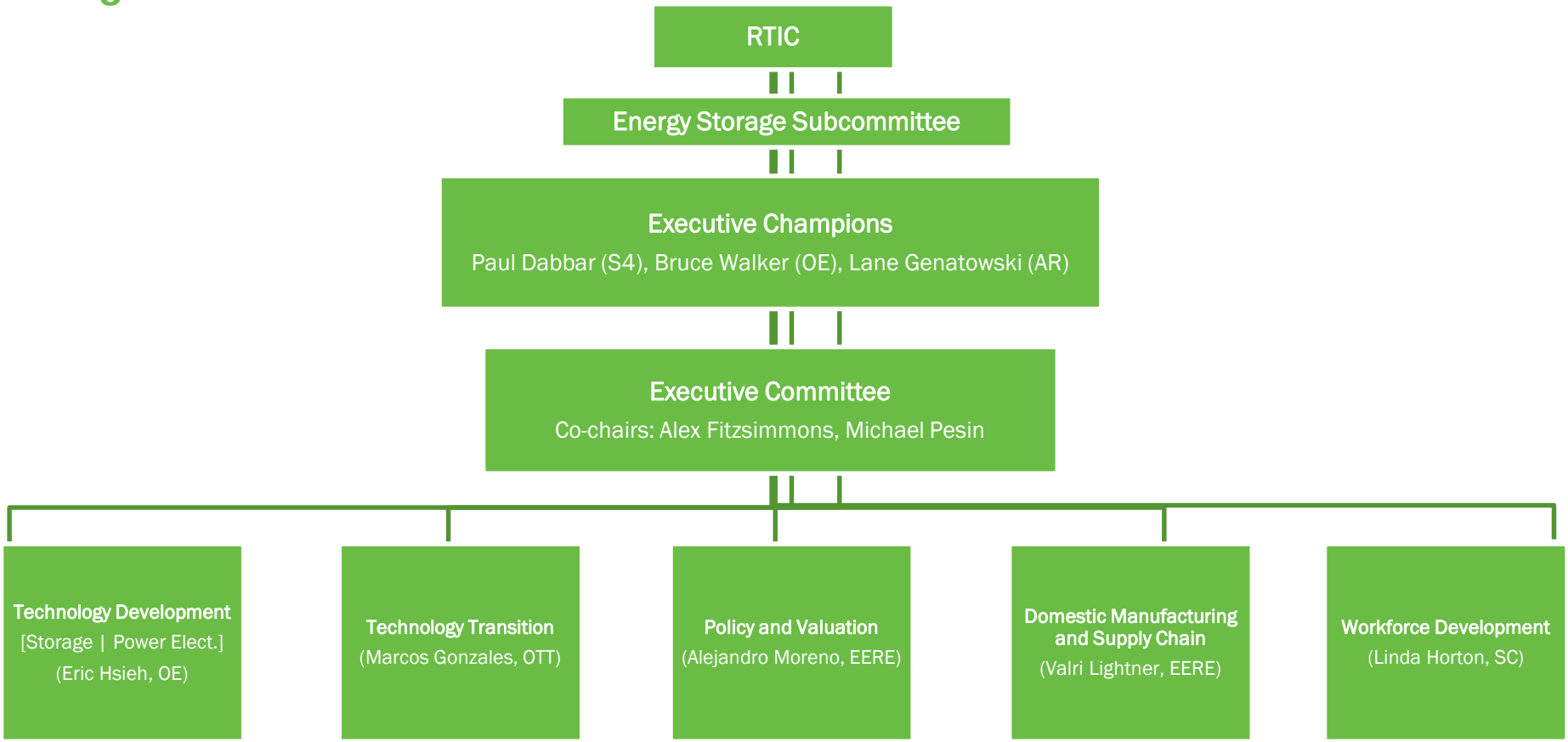
- The agreement provides $20,000,000 for the Frontier Observatory for Research in Geothermal Energy (FORGE), with activities to include ongoing novel subsurface characterization, full-scale well drilling, and technology research and development to accelerate the commercial pathway to large-scale enhanced geothermal systems power generation.
- The Department is encouraged to issue a solicitation for near-field enhanced geothermal systems demonstrations.
- The Committee further recommends not less than $10,000,000 for the Wells of Opportunity program.
- Within available funds, $10,000,000 is provided to fund at least one demonstration project in an area with no obvious surface expression.
- Awards for geothermal exploration activities, including test drilling, should recognize the diversity of geologic terrains, resource depths, and resulting exploration costs across the United States.
- The Committee encourages the Department to work with the Department of Interior on opportunities to improve geothermal permitting.
- The Department is further directed to fund at least one demonstration of geothermal technologies for innovative distribution of heat through ground-source heating and cooling of district heating.

Advanced Energy Systems Initiative

Alejandro Moreno, Director
Water Power Technologies Office

Organizational Structure

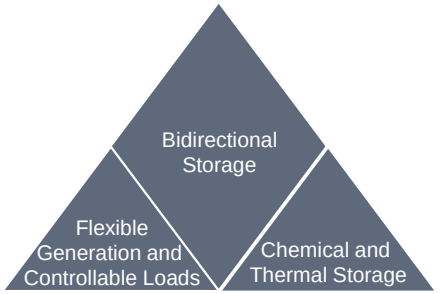
Storage Century Challenge Organizational Structure



FY21: Energy Storage Grand Challenge

Research and Technology Investment Committee, implementing the Department of Energy Research and Innovation Act (Pub. L. 115-246, 2018):

- *Identify strategic opportunities for collaborative research, development, demonstration, and commercial application of innovative science and technologies;*
- *Coordination and consolidation of DOE's existing activities and programs;*
- *Prioritization of activities that use domestic resources*



Science

ARPA-E

EERE

OE

NE

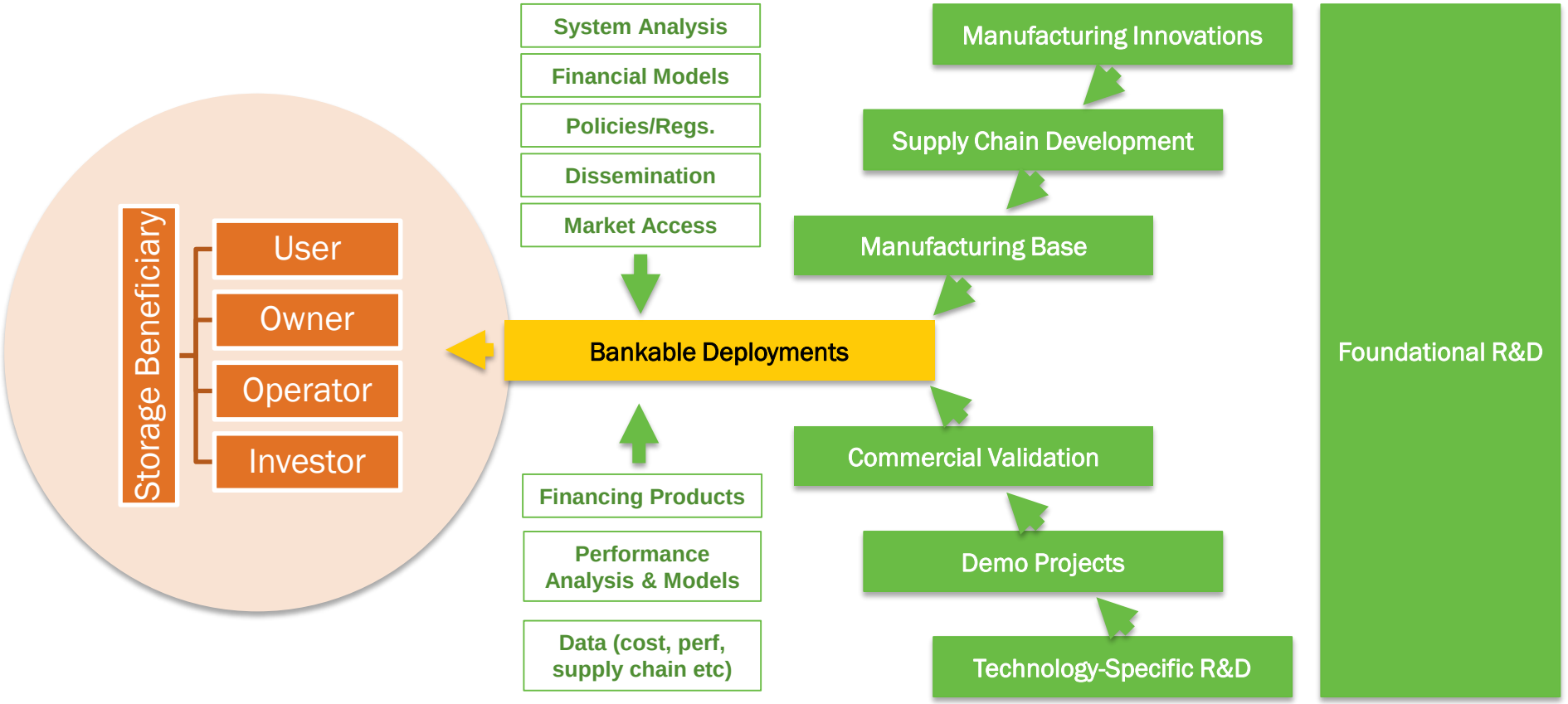
FE

OTT

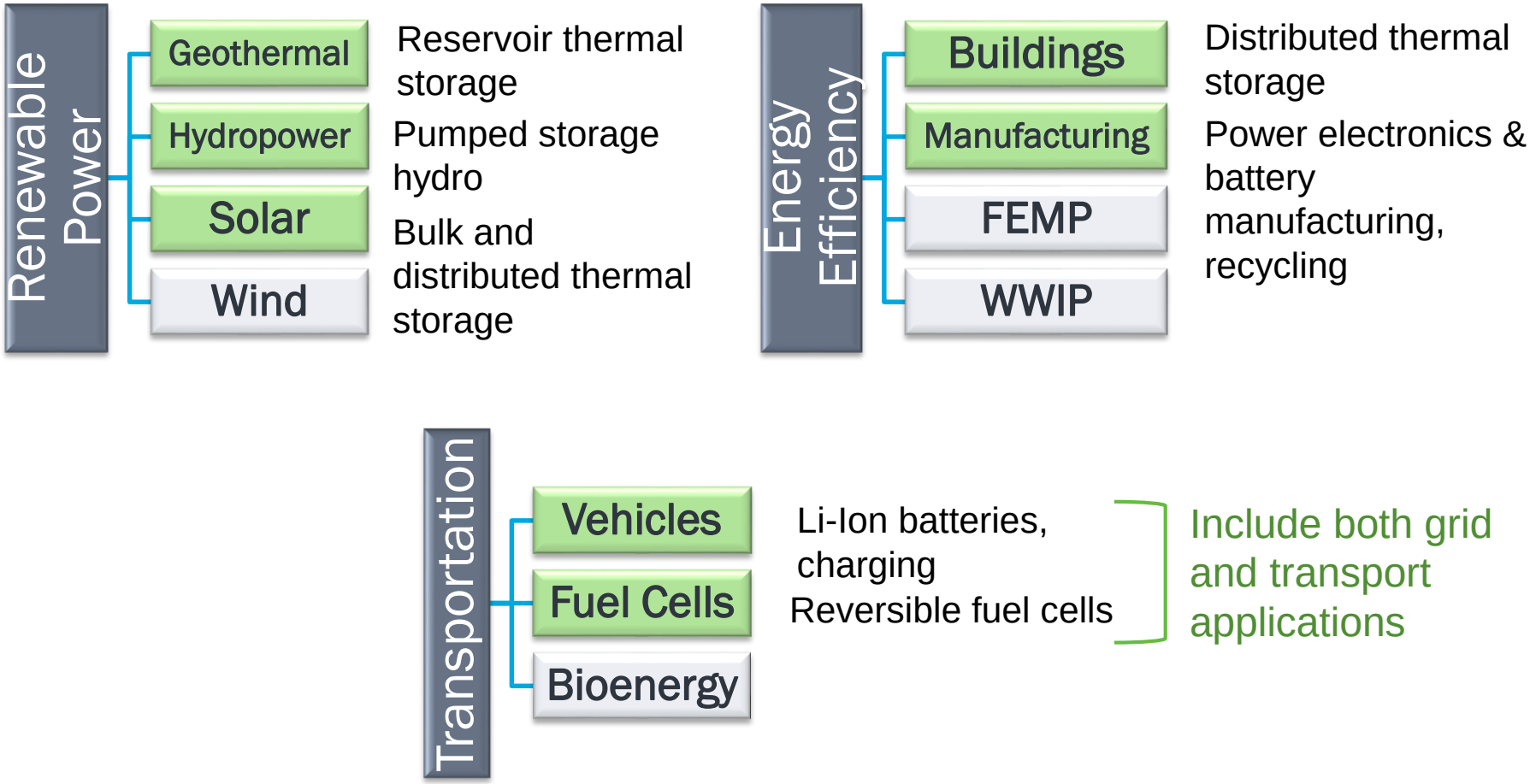
LPO

Basic Science Research & Discovery → Application Driven Materials Development → Applied Device and System R&D → Cost & Performance Metrics, Targets → Demonstration and Performance Validation → Systems Analysis and Valuation → Commercialization Strategy

The Storage Challenge: A User-Focused Storage Strategy



Storage in Energy Efficiency and Renewable Energy

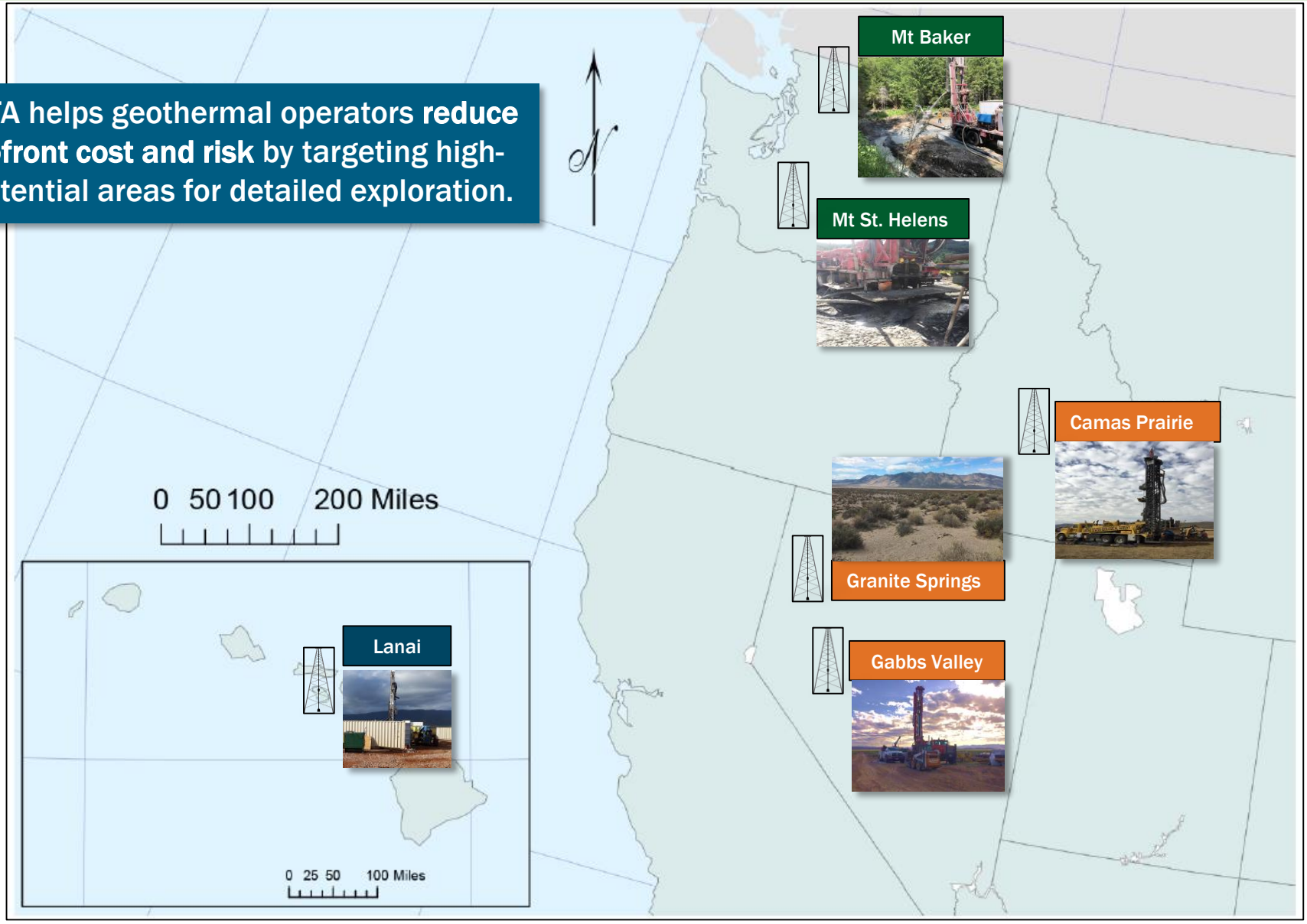


Play Fairway Analysis Retrospective

Greg Rhodes, Geothermal Research Analyst
National Renewable Energy Laboratory

Play Fairway Analysis

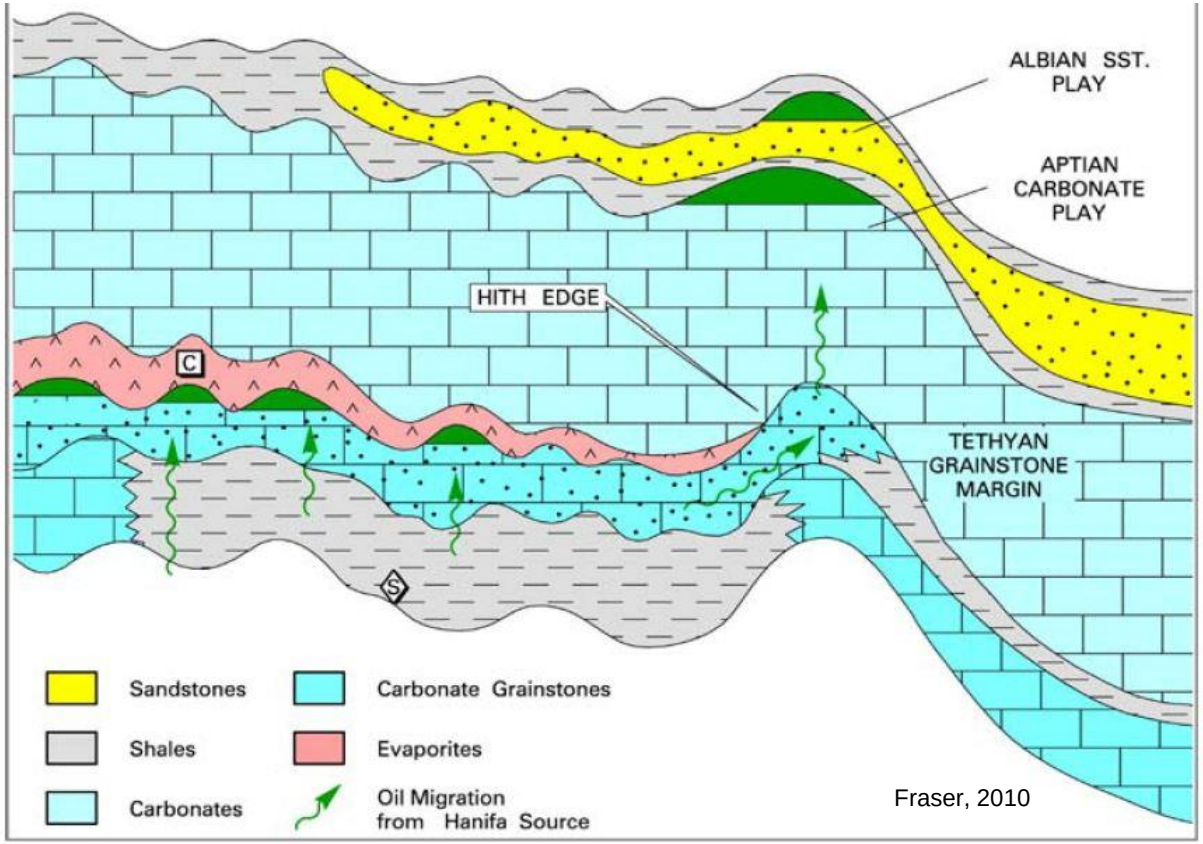
PFA helps geothermal operators **reduce upfront cost and risk** by targeting high-potential areas for detailed exploration.



PFA Background

PFA is used in oil and gas exploration

- Systematic favorability assessment of risk factors or resource controls.
- Regional to basin scale.
- Hydrocarbon source, reservoir (±charge), seal.



Fraser, 2010

Geothermal PFA

- Adapted for geothermal
  - Heat source, heat storage (primary or secondary permeability), ±seal
- Resulted in DOE's GTO multi-year geothermal PFA program over 3 phases
- >100 publications/presentations and counting…
- Identification and leasing of undiscovered geothermal sites and prospective areas for additional analysis

PFA Retrospective

- 11 different projects applied PFA over variable spatial extents, geologic settings, and technical approaches.
- Resulted in disparate data inputs (>20 parameters), data products, and reporting.
- This retrospective aims to synthesize and analyze the PFA projects.

PFA Tasks

- Evaluate metrics for measuring and valuing exploration knowledge
- Apply NREL's standardized resource assessment and reporting tools to PFA prospects
- Determine project impact and measure success
- Assess remaining gaps in publicly available exploration data
- Develop an optimized PFA methodology
- Publish PFA best practices report

PFA Goals

- Significance & impact:
  - Enhance geothermal exploration practices
  - Improve rate of discovery of hidden geothermal resources
  - Understand how data reduce exploration risk
  - Support future PFA programs

PFA Collaboration

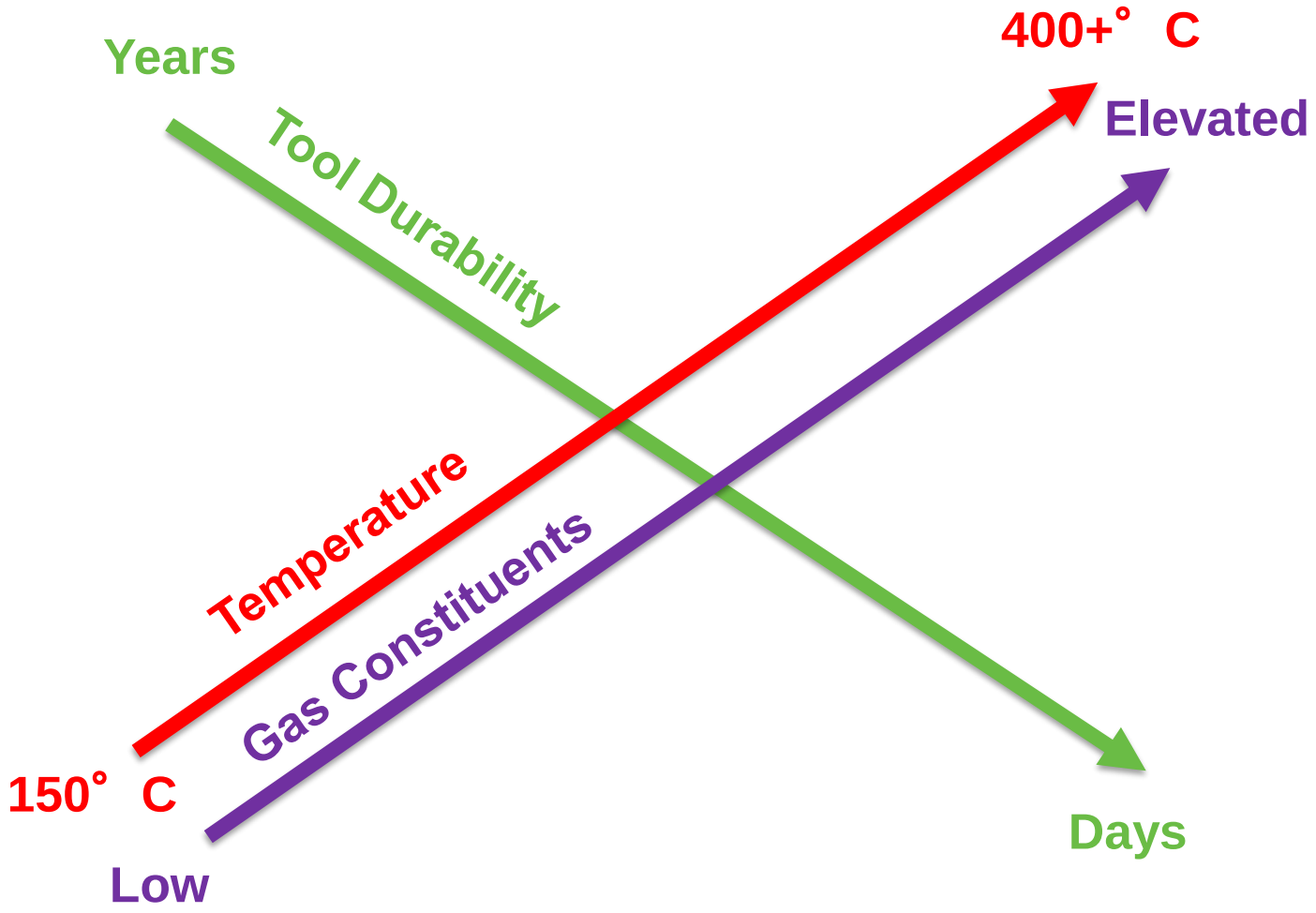
- Upcoming PFA workshops with PIs and broader geothermal community to discuss:
  - Findings
  - Lessons learned
  - Adjustments for various geologic settings
  - Necessary data, disciplines, and analyses
  - International applications

Additive Manufacturing and Geothermal

Sean Porse, Lead Analyst
Geothermal Technologies Office

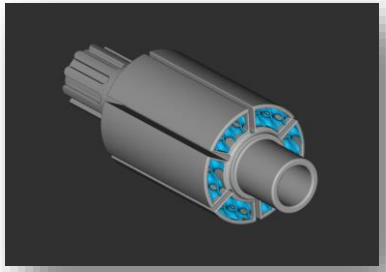
Challenges in Geothermal Energy

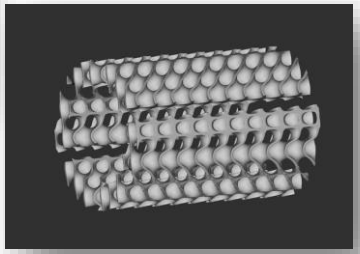
TEMPERATURE AND CHEMISTRY



Additive Manufacturing and Geothermal

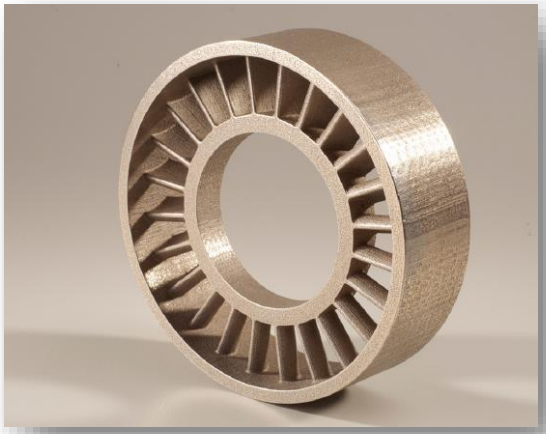
✓ Complex Geometries





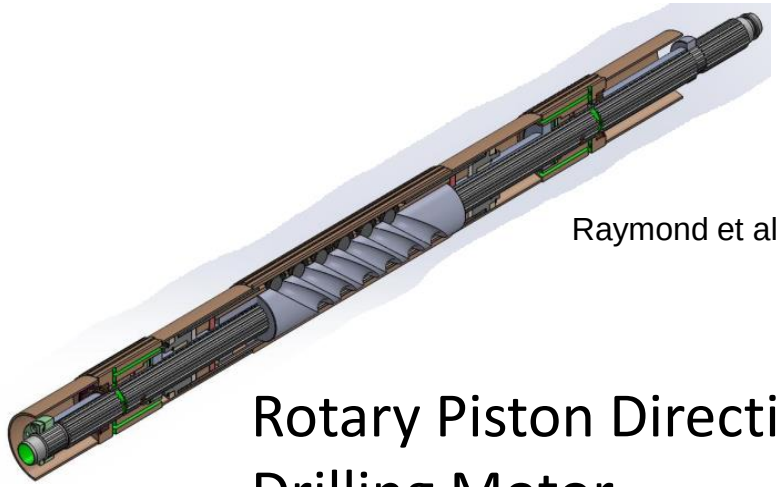
✓ High Grade Metals

✓ Rapid Prototyping



ExOne, 2015

✓ Cascading Cost Savings



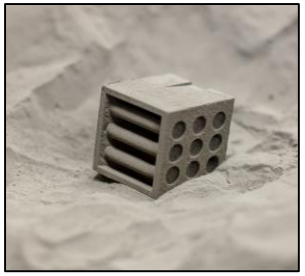
Raymond et al., 2017

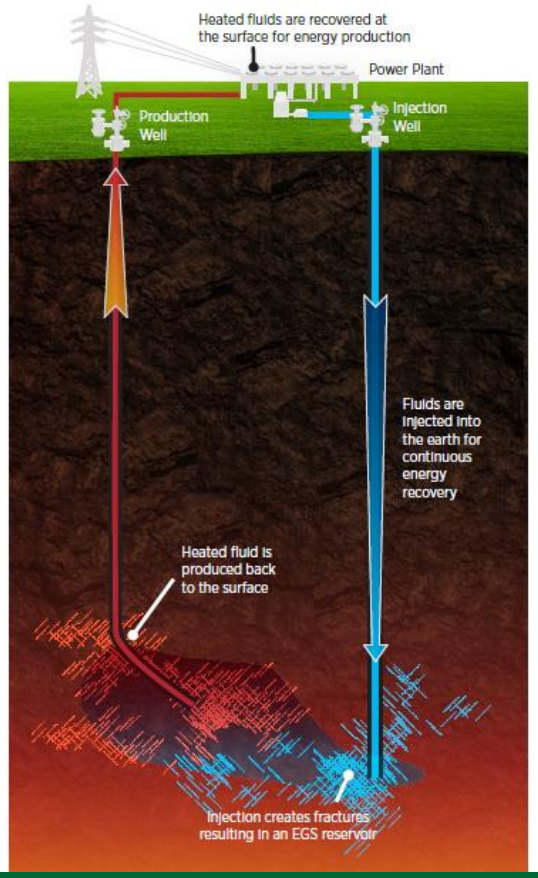
Rotary Piston Directional Drilling Motor

Background

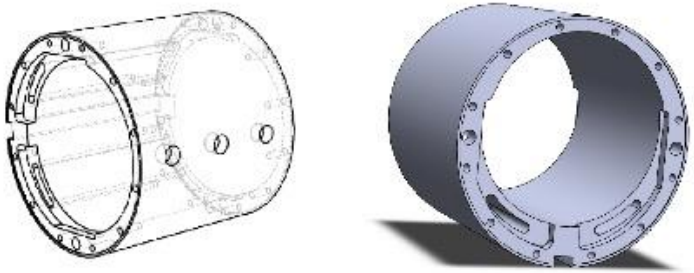
Study of Additive Manufacturing (AM) Applications to Geothermal Technologies

- **Task 1:** Identify candidate technologies for AM
- **Task 2:** Assess feasibility of part/assembly manufacturing using AM
- **Task 3:** Economic comparison of conventional manufacturing versus AM fabrication approaches
- **Task 4:** Industry/stakeholder workshop

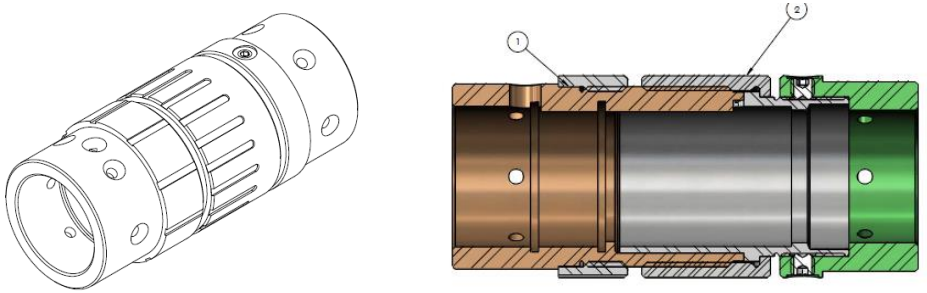




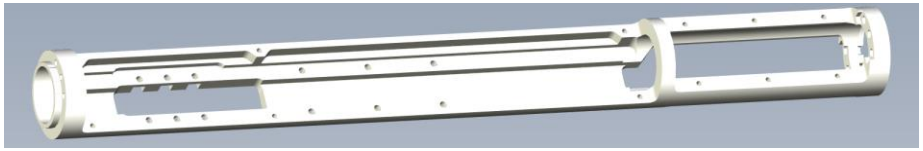
Examples of Evaluated Parts

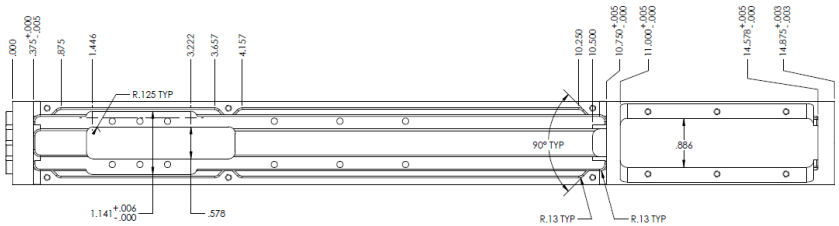


Parts with flow passages

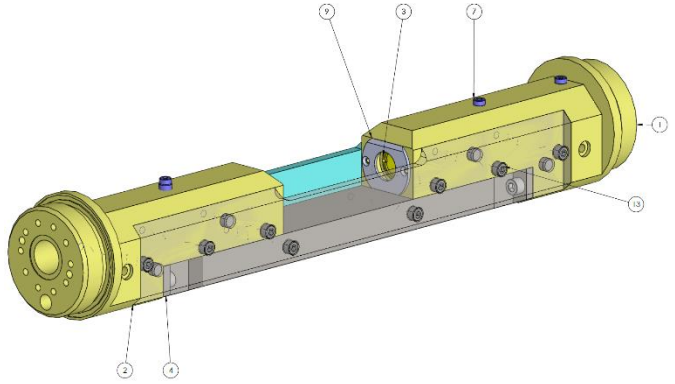


Connector assembly





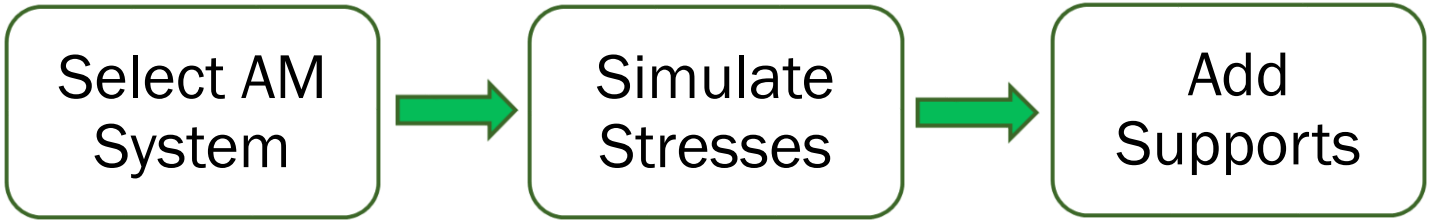
Downhole tool chassis



Motorized tool assembly housing

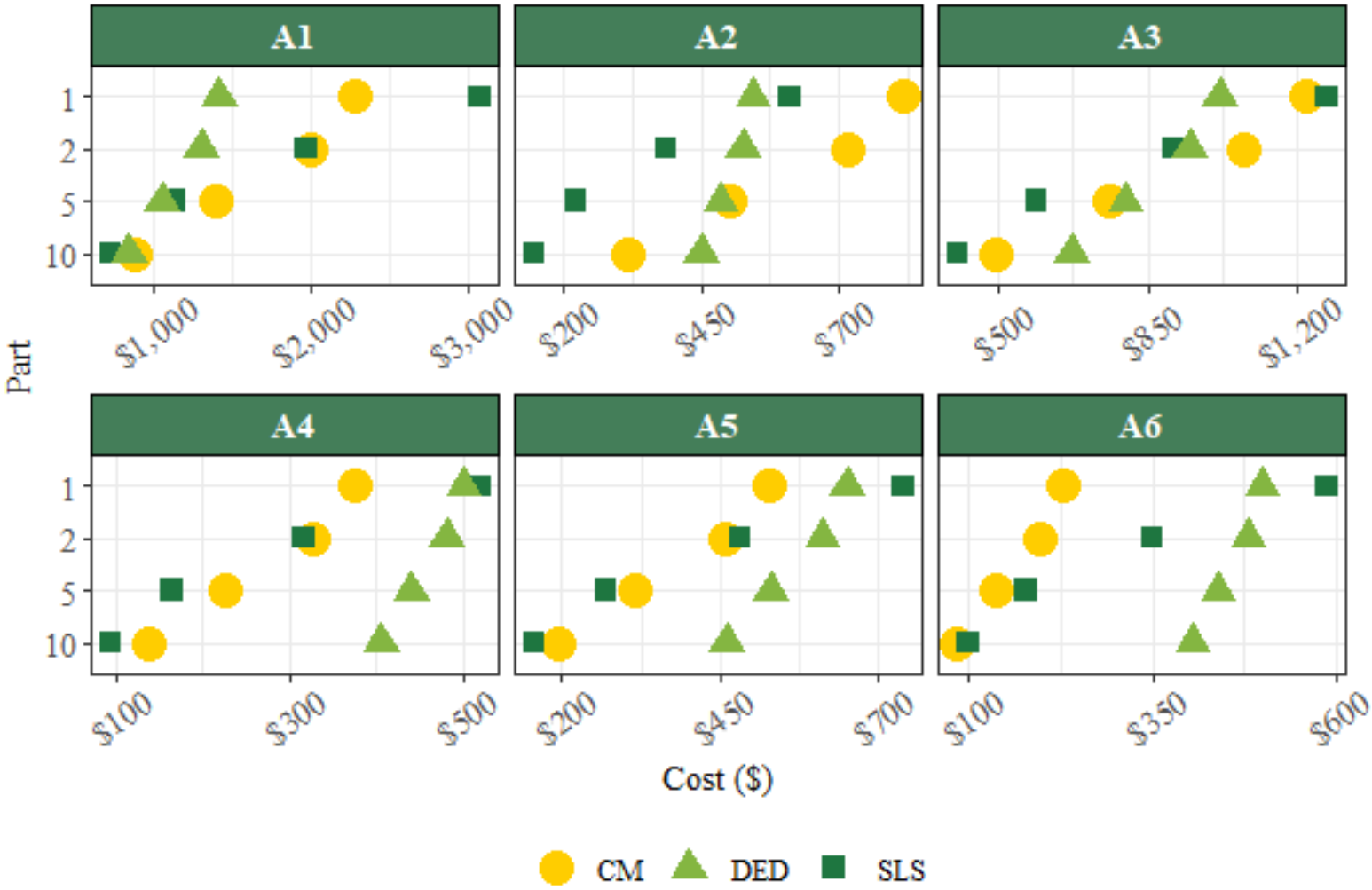
Manufacturability Assessment Conclusion Highlights

- Material availability can be an issue for many geothermal applications
- Selection of AM system process is critical
- Dimensional tolerances are important (tolerances <+/- 0.005 in. require post-build machining)
- Design of part is critical component of manufacturing method selection

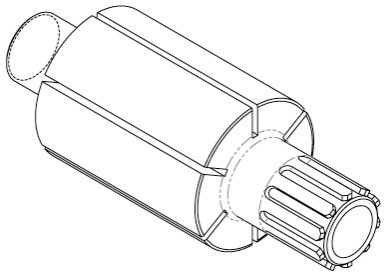


- There can be significant lead time savings and simplified manufacturing benefits using AM when parts are designed appropriately

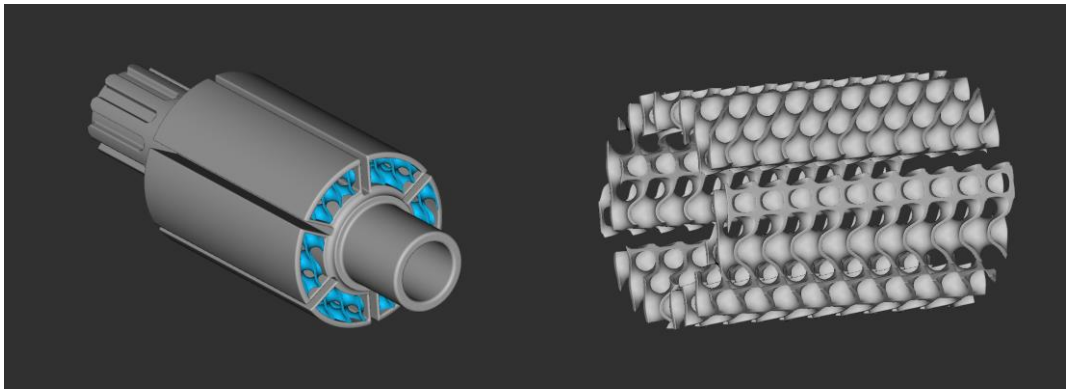
Cost Comparison Summary for Selected Parts



Rotor Redesign Example



Original Part



Topologically Optimized Part

- Topological optimization enables significant improvement in performance characteristics of part
  - ~40% reduction in moment of inertia
  - 25% improvement in maximum rotational speed of part
  - 5% increase in maximum rotational speed of assembly

*Total system improvements would require redesign of other components in drivetrain

PI: Dr. Yarom Polsky, polskyy@ornl.gov

GTO Contact: Sean Porse, sean.porse@ee.doe.gov

Questions?

We always welcome your feedback.
DOE.geothermal@ee.doe.gov

The **Geothermal Technologies Office (GTO)** works to reduce the cost and risk associated with geothermal development by supporting innovative technologies that address key exploration and operational challenges.

By advancing the value stream for grid (electricity) production and deep direct-use, GTO aims to make geothermal energy a cost-competitive, widely available, geographically diverse component of the national energy mix.

Visit us at: www.energy.gov/eere/geothermal