Breakout Session Structure

- SESSION 1: Breakthroughs in instrumentation
  - High-temperature downhole electronics
  - Remote sensing tools
- SESSION 2: Precision reservoir design and management
  - Controlled stimulation techniques
  - Advancing from simulation to field
  - Supercritical EGS

- Questions that permeate both sessions:
  - How to leverage oil & gas knowledge base and infrastructure
  - Optimal ARPA-E program structure and outcomes

Breakout 1a: Instrumentation

The focus of breakout 1 is to discuss potential breakthroughs in EGS instrumentation.

1. What emerging techniques could be used to identify promising features at EGS depths?
   - *E.g. Acoustic nonlinearity, gravimetry from nano-satellites, seismic while drilling*
2. What components/techniques could enable radical reductions in drilling cost?
3. What is measured downhole today (parameter & resolution) and where does that measurement need to be in terms of spatial and/or temporal resolution?
4. What are the most urgent needs in hardening/miniaturizing existing sensor technologies?
   - *E.g. smart proppants, chemical tracers, NMR relaxometry, neutron logging*
5. What can we currently not measure that would be impactful?
6. What sort of communications infrastructure needs to be in place to make these tools impactful?

Across categories:

How much would the areas discussed lower the cost or uncertainty of the EGS development cycle?

Are there dependencies between components we need to consider?

Breakout 1b: Potential program structure

- Which areas from the ones discussed today should ARPA-E focus on for a program? Which should ARPA-E avoid?
- What funding level per project is appropriate? $100k? $1M? $10M?
- What value propositions for EGS-related tools could incentivize their deployment?
- What are realistic timeframes and metrics for new EGS tools?
- What are the “laugh test” limits for how low costs can go?

Breakout 2a: Precision reservoir design and management

The focus of breakout 2 is precision reservoir design and management.

1. How do we improve control over stimulation techniques? What new methods could be brought to bear on reservoir design?
   - *E.g. Directional fracturing, microdrilling, mixed-mechanism stimulation*
2. Assuming the optimal reservoir design is known, what are the next steps toward achieving it?
   - *E.g. Testing in lab, at FORGE, or somewhere else*
3. What is the state of the art in monitoring reservoir decline over time? Is it possible to improve upon this without extreme intrusiveness?
4. What knowledge can be transferred from oil & gas? How do EGS needs deviate from oil & gas needs?
   - *E.g. AI/big data, data from well-characterized oil fields*
5. What practical changes come into play at the brittle-ductile transition zone? Do we know enough to pursue EGS in these areas?
6. What would it take to use supercritical CO_2 as the working fluid?

Breakout 2b: Potential program structure

- Which areas from the ones discussed today should ARPA-E focus on for a program? Which should ARPA-E avoid?
- What funding level per project is appropriate? $100k? $1M? $10M?
- What value propositions for EGS-related tools could incentivize their deployment?
- What are realistic timeframes and metrics for new EGS tools?
- What are the “laugh test” limits for how low costs can go?