



A Research Observatory
for a Sustainable Future

Newberry Geothermal Energy: A Candidate Site for the DOE FORGE

Presented to the Oregon Geothermal Working Group April 8, 2016
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Frontier Observatory for Research in Geothermal Energy

- DOE initiative to develop a national site for EGS research and development
- FORGE's mission is *to enable cutting-edge research, drilling, and technology testing, as well as to allow scientists to identify a replicable, commercial pathway to EGS.*
- Strong focus on initiating and sustaining fracture networks in basement rock

FORGE
U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy | Geothermal Technologies Office

Natural Geothermal Systems

To generate power from natural geothermal systems you need:

- Abundant heat found in rocks at depth
- Fluid to carry heat from the rocks
- Small pathways to conduct fluid through the hot rocks

Problem

Despite the presence of heat, sometimes conditions are not ideal for power generation from natural geothermal systems. In these cases you have:

- Abundant heat found in rocks at depth
- Insufficient fluid to carry the heat
- Limited pathways to conduct fluid

ENHANCED GEOTHERMAL SYSTEMS

Solution

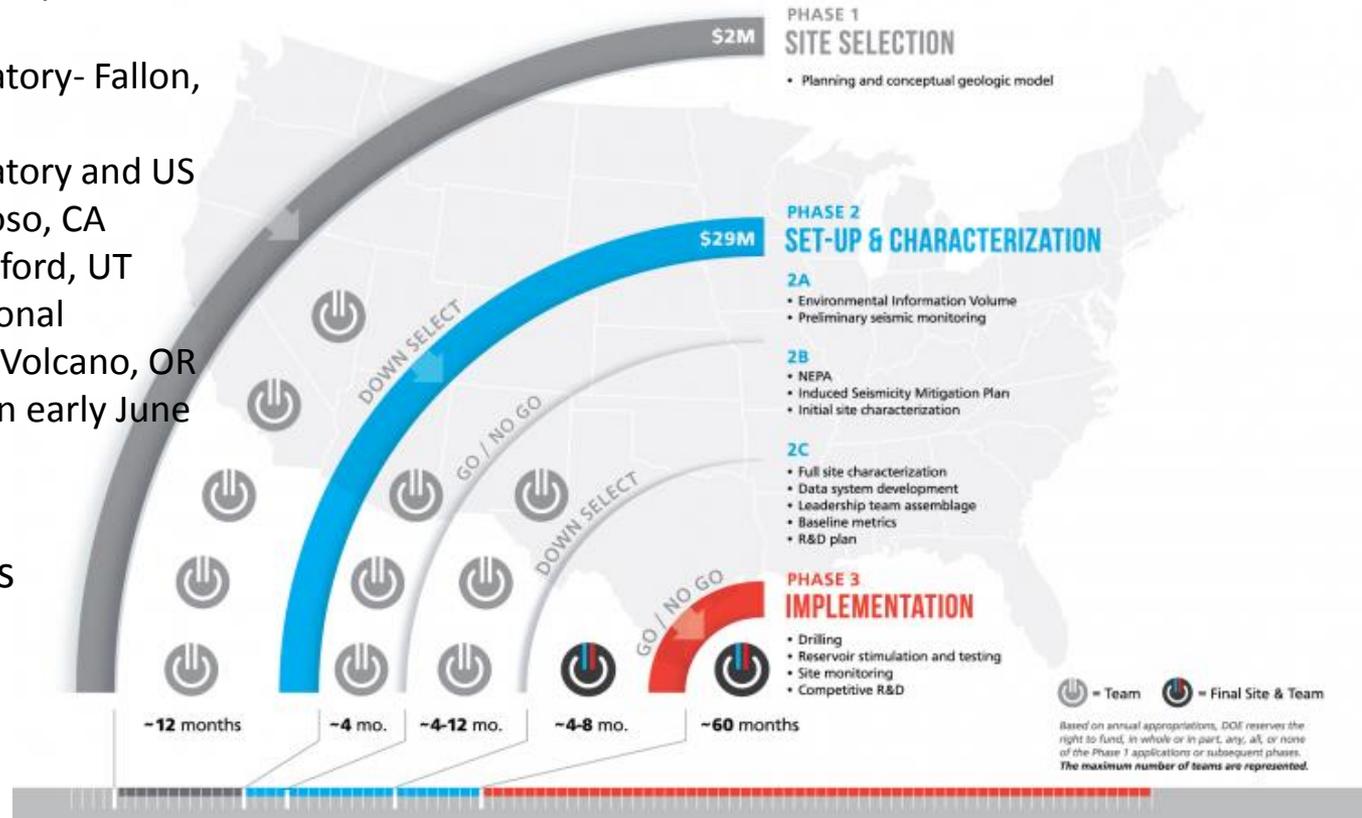
A man-made enhanced geothermal system (EGS) can extract the abundant heat resource tens of thousands of feet below the surface and put it to good use. This would require:

- What makes EGS?** An abundant, previously-stranded, heat source
- Fluid injected from the surface
- Permeable pathways enhanced by injected fluids

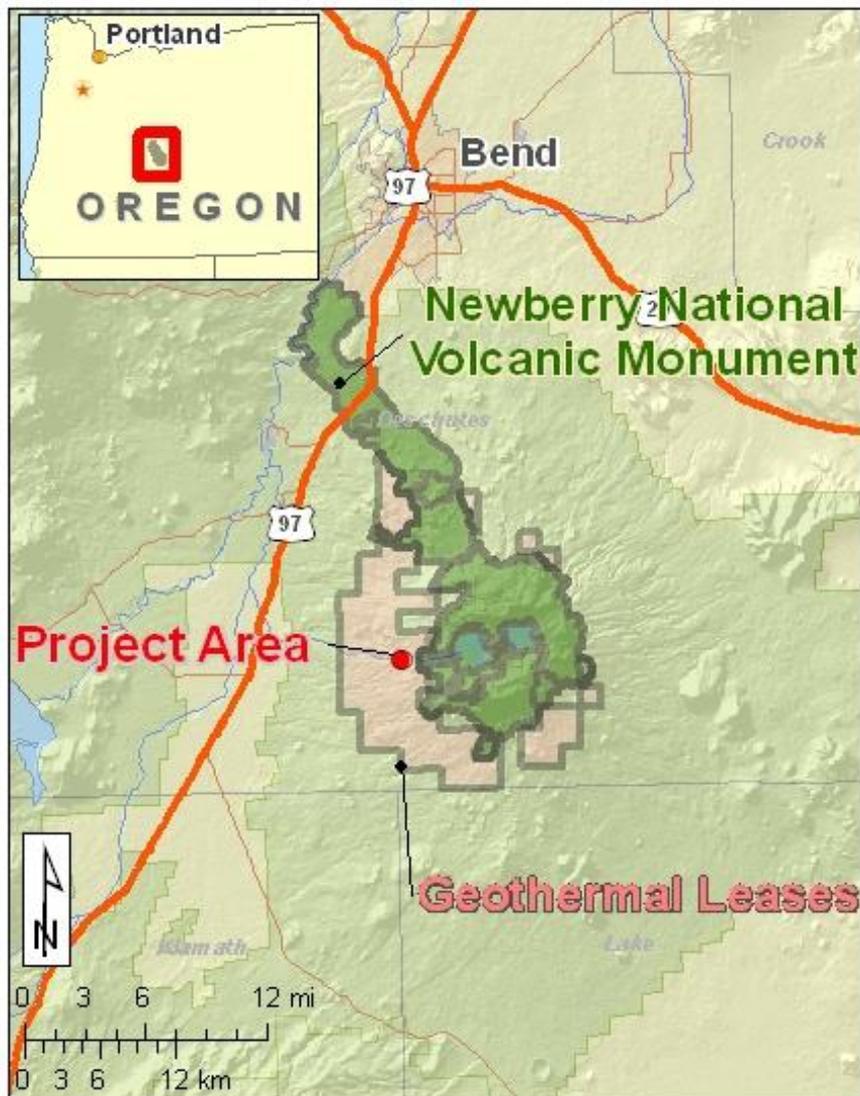
With an enhanced geothermal reservoir, you can generate power anywhere with hot rocks at depth!

Phases of FORGE

- Phase 1
 - Idaho National Laboratory- Snake River Plane, ID
 - Sandia National Laboratory- Fallon, NV
 - Sandia National Laboratory and US Navy- West Flank of Coso, CA
 - University of Utah- Milford, UT
 - Pacific Northwest National Laboratory- Newberry Volcano, OR
 - Presentations to DOE in early June
- Phase 2
 - Maximum of 3 sites
- Phase 3
 - Final FORGE site
 - Implementation



Newberry Geothermal Energy (NEWGEN) FORGE



- Consortium of partners
 - Pacific Northwest National Laboratory
 - Oregon State University
 - AltaRock Energy, Inc.
 - GE Global Research
 - Statoil
- Extended consortium
 - Academic
 - Industry
 - Government

Blade Energy, Inc., Cascade Volcano Observatory (USGS), Cornell University, Lawrence Livermore National Laboratory, Paulsson, Inc., Stanford University, University of Oregon



The NEWGEN FORGE Core Team

- Pacific Northwest National Laboratory- project lead
 - High-performance computing, high T/P geochemistry, materials development, large project management
- Oregon State University
 - Leading geosciences program, faculty knowledge of alternative energy and geophysics, extensive research facilities, large project management
- AltaRock Energy, Inc.
 - Full-service geothermal energy company with industry experience in greenfield development, stimulation technology, and wellfield management. Field experience at Newberry EGS Demonstration.
- GE Global Research
 - Hub of GE technology development with broad energy portfolio. Focus on delivering cleaner, more efficient solutions to every part of energy sector
- Statoil
 - International energy company with operations in 37 countries, 22,000 employees, and over 40 years of experience in oil and gas technology



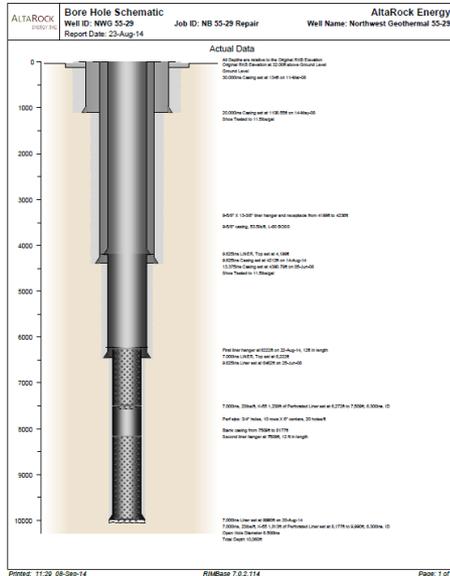
The NEWGEN FORGE Site



- 40+ years of existing background data from exploration and research
- Entire area meets FORGE standards for temperature and permeability at depth
 - 1750-2250 m, 175-225 C
- Three existing well pads
- Two existing 10,000 ft deep hot, dry wells



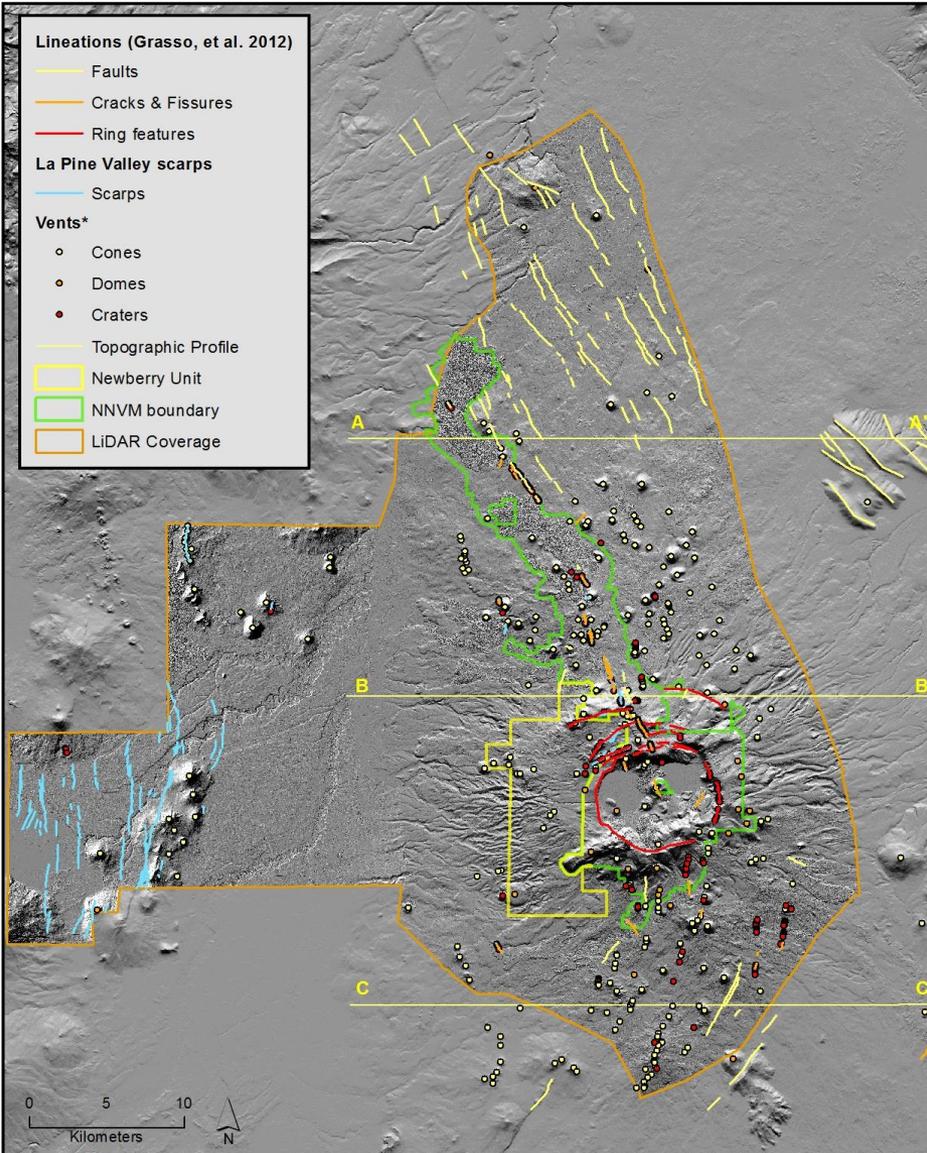
The NEWGEN FORGE Site



- Pad-29
 - Five acre gravel pad
 - Existing injection well and EGS reservoir
 - Existing sump
 - Productive water well on pad
- Pad-16
 - Five acre gravel pad
 - 11,599 ft hot dry well
 - CO2 cap with up to 550 psi WHP
 - Productive water well on pad
 - Existing sump
- Pad-17
 - 5 acre gravel pad
 - 800 ft TG well with seismic monitoring



Conceptual Geologic Model



- Combine 40+ years of data from exploration and research
 - Geology
 - Hydrology
 - Seismology
 - Geophysics (MT, gravity)
 - Light Detection and Ranging (LiDAR)
- Model in EarthVision software
 - Hosted at PNNL
 - Remote access available



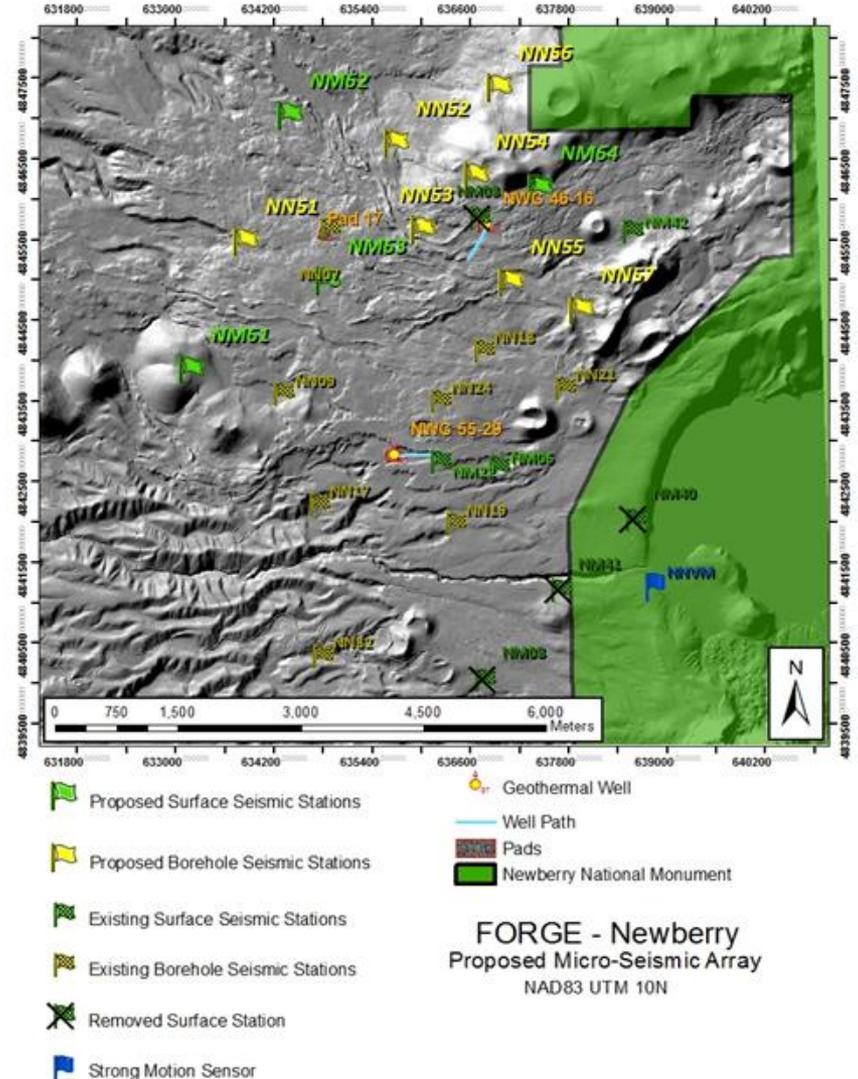
Research at NEWGEN FORGE

- Interested parties submit R&D proposals to NEWGEN team
 - Safety and transparency are primary importance
- Science Technology Analysis (STAT) Team selects projects
 - STAT: 30% DOE appointed proposal review team
 - Must maintain permit compliance
 - Fulfill Environmental, Safety and Health requirements
 - Technical reviewer and NEWGEN Directors and Core Capability teams comments
- Data dissemination and sharing plan
 - Timely release of data as appropriate considering IP rights & project participants
 - National Geothermal Data System



Environmental, Safety and Health at NEWGEN FORGE

- Comprehensive ES&H Plan being developed
- Induced Seismicity Mitigation Plan
 - Proposed expansion of MSA up to 23 stations
 - Magnitude and depth limits
- Environmental Monitoring
 - Groundwater protection
 - Invasive weed management



Event Level and Characteristics	Field Operation	Communication
Start <ul style="list-style-type: none"> Regulator approval MSA/SMS active 	<ol style="list-style-type: none"> 1) Initiate stimulation plan 2) Conduct step-rate test 	<ol style="list-style-type: none"> 1) Notify public 2) Initiate real-time data feed 3) Initiate daily report
Outlier Alert <ul style="list-style-type: none"> $r > 1000\text{m}$ $Z < 6000\text{ft}$ $\text{NNVM} < 500\text{m}$ 	<ol style="list-style-type: none"> 1a) $M > 2$ Apply diverter 1b) $M < 2$ Confirm, then apply diverter 2) No flow or pressure increase 3) Assess result for 24 hours 	<ol style="list-style-type: none"> 1) Issue outlier report
No Flow Increase <ul style="list-style-type: none"> $M 2.0$ to 2.6 within 3km 	<ol style="list-style-type: none"> 1) No flow or pressure increase 	<ol style="list-style-type: none"> 1) Issue trigger report
Decrease Flow <ul style="list-style-type: none"> $M 2.7$ to 3.4 within 3km $\text{PGA}: 0.014$ to 0.028g 	<ol style="list-style-type: none"> 1) Reduce flow to reduce pressure in 250psi steps 3) Wait 12 hours 	<ol style="list-style-type: none"> 1) Issue trigger report 2) All phone notifications 3) Implement USFS site restrictions 4) Solicit damage reports
Stop Injection - Flow Well <ul style="list-style-type: none"> $M \geq 3.5$ within 3km $\text{PGA} \geq 0.028\text{g}$ 	<ol style="list-style-type: none"> 1) Stop Injection 2) Flow to surface 	<ol style="list-style-type: none"> 1) Issue trigger report 2) All phone notifications 3) Implement USFS site restrictions 4) Solicit damage reports

Benefits and Support

- NEWGEN supporters
 - US Senators Jeff Merkley and Ron Wyden
 - Oregon Governor Kate Brown
 - Oregon Department of Energy
 - Economic Development for Central Oregon
 - Deschutes County Board of County Commissioners
 - Bend City Council
 - Bend Chamber of Commerce
 - City of La Pine
 - La Pine Chamber of Commerce
 - Sunriver HOA



Benefits and Support

- FORGE funding breakdown
 - Phase I: \$2M split among 5 teams
 - Phase II: \$29 M split among up to 3 teams
 - Phase III: funding subject to appropriations
- Research focused on improving EGS success
 - Advance EGS technology to compete with wind, solar, and fossil fuel power sources
 - Reduce cost of deployment
 - Improve ROI, encourage investment in EGS
- Benefits to Central Oregon
 - Jobs- construction, maintenance, operations
 - Visiting scientists will utilize local housing, restaurants, entertainment



Community Engagement

- Community outreach and education
 - Provide speakers for local events
 - Presentations to academic, industry and research groups
 - Staff booths at local festivals
- Encourage student engagement
 - Research projects
 - Internships
 - Field trips
- Information
 - Website
 - Blog
 - Facebook
 - Twitter
 - Community events



Summary

- NEWGEN is one of five sites competing to be selected for FORGE
- Consortium of partners with extensive knowledge in geothermal technologies, industry, practices, and project management
- NEWGEN has significant advantages for EGS R&D
 - Extensive site characterization
 - EGS reservoir already successfully created
 - Range of pad and well conditions will allow multiple projects at one time
 - Existing permits and infrastructure
 - Close access to competent local contractors and service providers
 - Supportive and engaged local community
 - DOE and AltaRock have already invested significantly at Newberry



Information

- NEWGEN FORGE Website www.newberrygeothermal.com
- NEWGEN FORGE Blog www.blog.newberrygeothermal.com
- NEWGEN FORGE Facebook www.facebook.com/newberryEGS
- NEWGEN FORGE Twitter @NewberryEGS

