



Development of a Web Portal for the EGI FORGE Team

Cooperative Research and Development Final Report

CRADA Number: CRD-19-00805

NREL Technical Contact: Jonathan Weers

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Technical Report
NREL/TP-6A20-80743
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National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

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Cooperative Research and Development Final Report

Report Date: August 16, 2021

In accordance with requirements set forth in the terms of the CRADA agreement, this document is the final CRADA report, including a list of subject inventions, to be forwarded to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: University of Utah, a body politic and corporate of the State of Utah on behalf of its Energy and Geoscience Institute

CRADA Number: CRD-19-00805

CRADA Title: Development of a Web Portal for the EGI FORGE Team

Responsible Technical Contact at Alliance/ National Renewable Energy Laboratory (NREL):

Jon Weers | jon.weers@nrel.gov

Name and Email Address of POC at Company:

Shirley Streff | sstreff@egi.utah.edu

Sponsoring DOE Program Office(s): Office of Energy Efficiency and Renewable Energy (EERE), Geothermal Technologies Office

Joint Work Statement Funding Table showing DOE commitment: No NREL Shared Resources

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	\$.00
TOTALS	\$.00

Executive Summary of CRADA Work:

NREL will work with the EGI FORGE team to design and develop data visualizations and pathways from the existing Utah FORGE website (<https://utahforge.com/>) to the FORGE DMS, to showcase and disseminate data generated by the EGI FORGE project.

Summary of Research Results:

To improve understanding of data resulting from the Department of Energy’s (DOE’s) Frontier Observatory for Research in Geothermal Energy (FORGE) project by the general public and to better link data within the DOE Geothermal Data Repository (GDR) to information on other FORGE sites, NREL worked with the University of Utah Energy and Geoscience Institute (EGI) FORGE team (Utah FORGE) to design and develop data visualizations and pathways between the existing Utah FORGE data in the GDR (<https://gdr.openei.org/>) and the Utah FORGE website (<https://utahforge.com/>), and to showcase and disseminate data generated by the Utah FORGE project. Coordinated modifications to both the GDR and the Utah FORGE web portal provided a cohesive experience for users of the sites and a comprehensive picture of the Utah FORGE project, including an interactive visualization of featured data and easy access to publicly available datasets. Users of both sites are now able to browse Utah FORGE datasets through an interactive data dashboard, search by keyword or facet, and seamlessly download selected data from the GDR without having to leave the site. NREL created a “featured project” page for Utah FORGE on the GDR (<https://gdr.openei.org/forge>) that showcases Utah FORGE data, provides links to relevant publications and other sites, and is home to an interactive visualization of Utah FORGE stimulation data. Additionally, NREL’s expertise in search engine optimization (SEO) improved discoverability of Utah FORGE data by major search engines and helped to disseminate DOE information on Enhanced Geothermal Systems (EGS) to the greater geothermal scientific community. Improved analytics were implemented on the GDR to gather metrics on number of downloads and are displayed in the interactive table of Utah FORGE data on the GDR.

Task 1. Integration with the EGI FORGE Web Portal

Description: NREL will assist the EGI FORGE team with the integration of data access points, visualizations, and featured data into the existing Utah FORGE website. Building upon the cloud-based framework used for OpenEI and leveraging NREL’s expertise in web portal development, the resulting site will provide visitors with the current status of the EGI FORGE project and easy access to project data, including visualizations of featured data and quick access to publicly available datasets.

NREL created a featured project page for Utah FORGE on the GDR (Figure 1) that showcases Utah FORGE data, provides links to relevant publications and other sites, and is home to an interactive visualization of Utah FORGE stimulation data (Figure 3). Improved analytics were implemented on the GDR to gather metrics on number of downloads and are displayed in the interactive table of Utah FORGE data on the GDR.

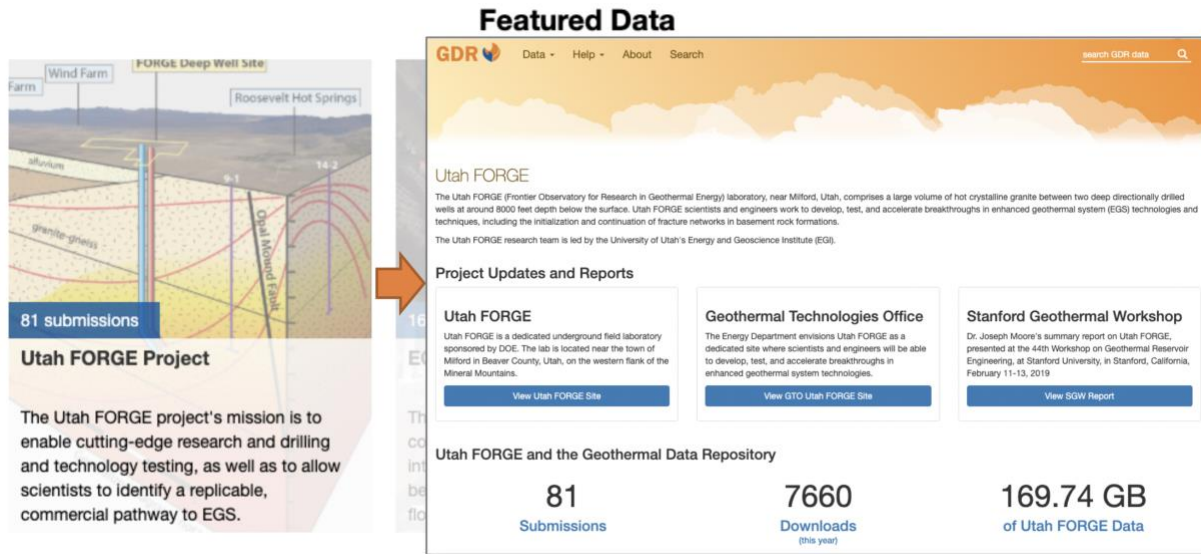


Figure 1 Utah FORGE Featured Project page (right) and link on the GDR homepage (left)

The featured project page for Utah FORGE, available at <https://gdr.openet.org/forge>, includes a general description of the Utah FORGE project, an interactive visualization of Utah FORGE stimulation data, links to project updates and reports including cross links to the main Utah FORGE and DOE FORGE websites, and an interactive table of Utah FORGE data submissions on the GDR with associated statistics on downloads showcasing the impact of individual Utah FORGE data submissions. Download statistics are shown in monthly totals and year-to-date totals to allow users to get a sense of trending datasets as well as and overall impact. The name of each submission in the table hyperlinks directly to the data submission’s landing page on the GDR allowing users quick and easy access to Utah FORGE data.

Task 2. Integration with the Collab DMS and the GDR

Description: The web portal will be integrated with the Collab DMS and the GDR, leveraging these existing systems for storage, data provenance, curation, and public dissemination of EGI FORGE data. Users of the portal will be able to browse EGI FORGE datasets through an interactive data dashboard, search by keyword or facet, and seamlessly download selected data from the GDR without having to leave the site.

NREL’s Data Foundry, the secure collaborative data management system formerly called the Collab DMS, was integrated with the GDR to allow Utah FORGE team members to easily collaborate on their data products and “publish” them to the GDR by pressing a single “Send to GDR” button (Figure 2). This integration provided the bridge from the Data Foundry’s secure collaborative environment for project teams to the GDR’s public data dissemination platform, allowing researchers and scientists working on the Utah FORGE project to seamlessly transition select information to public access.

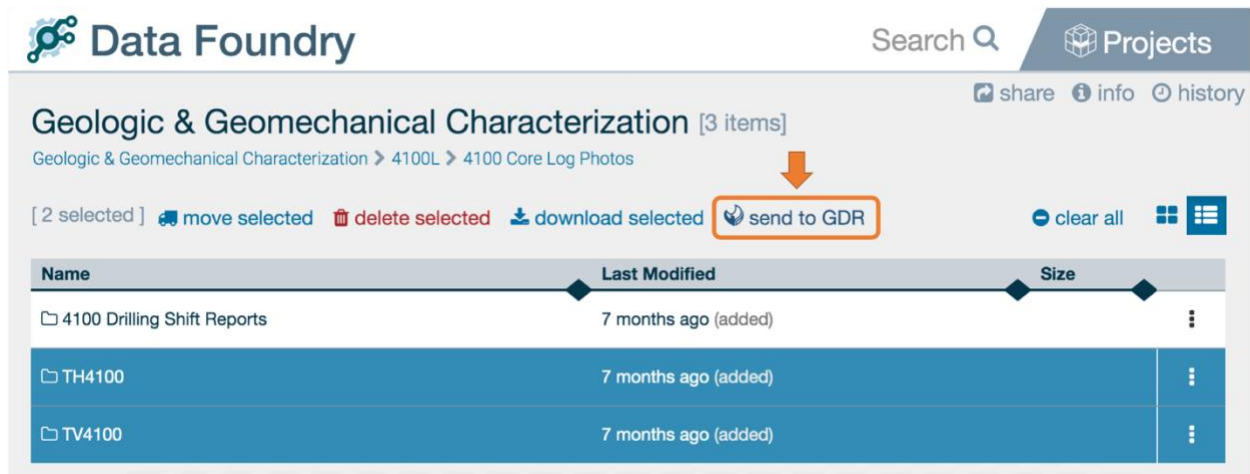


Figure 2 The "Send to GDR" button in the Data Foundry sends selected datasets to the GDR for public dissemination.

Task 3. Data Visualization

Description: NREL will work with the EGI FORGE team to identify key information to showcase selected data on the web portal using interactive visualizations designed to improve understanding of featured datasets.

The primary goal of the visualization is to showcase Utah FORGE datasets in the GDR and to improve understanding of the data by general audiences through the development of an interactive visualization that allows users to explore Utah FORGE data and promote discovery. NREL and Utah FORGE worked together to develop and refine a visualization of Utah FORGE stimulation data to be featured on the GDR's Utah FORGE featured project page. The visualization (Figure 3) allows users to select the phase and cycle of the upper perforation stimulation experiment performed at the Utah FORGE site, and then play through the stimulation progress for each phase and cycle to watch the pressure, temperature, and flow data from the stimulation experiment (Figure 3, left) and witness microseismic events detected at the site (Figure 3, right).

Upper Perforation Stimulation

Phase 1 2 3
Cycle 1 2 3 4 4-2 7 8 9

[▶ Play stimulation progress](#)

Interpret data with caution: Microseismic event locations have a very high uncertainty.

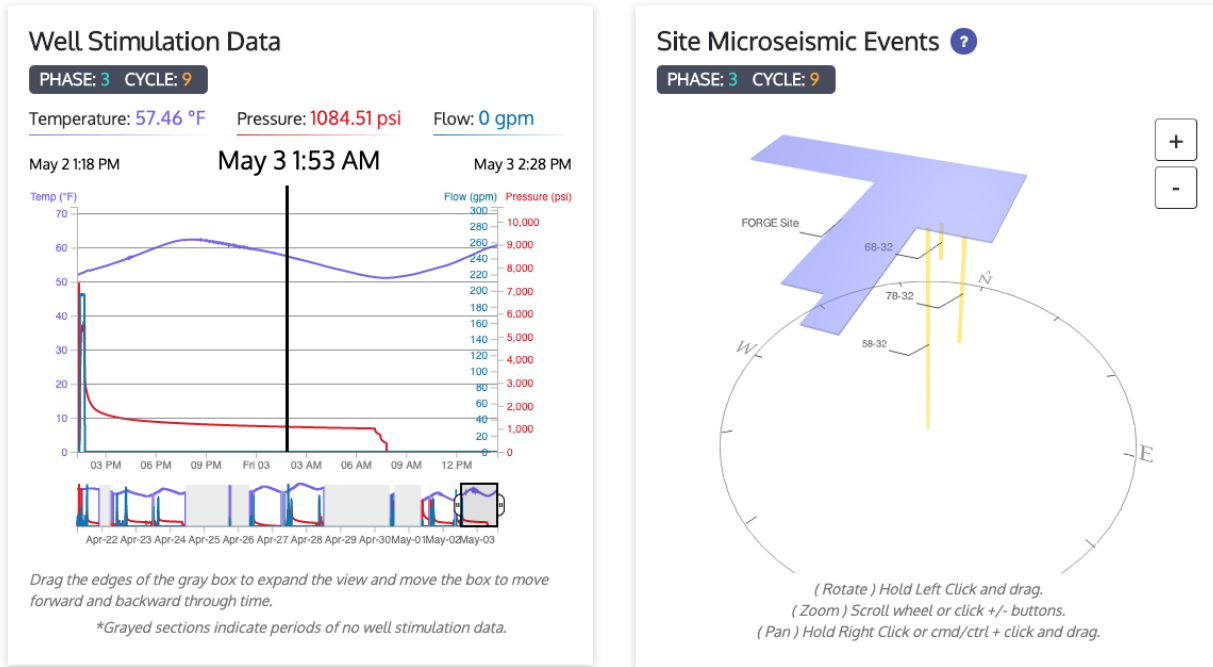


Figure 3 Interactive visualization of Utah FORGE stimulation data on the GDR

The “Well Stimulation Data” panel shows the temperature, pressure and flow readings for the time interval under the current play head, represented by the vertical black line in the middle of the panel. Users can drag the panel left and right or click the “Play stimulation progress” button to advance the play head and move the data stream forward in time. Additionally, the master timeline at the bottom of the panel serves as an interactive map of the entire dataset and allows users to quickly jump to a point in time by dragging the gray selection box to highlight a specific time range within the data.

The Site Microseismic Events panel features a simplified, interactive, three-dimensional (3D) model of the Utah FORGE test site. The surface representation of the site appears in purple and the primary borehole (58-32) as well as accompanying monitoring wells (68-32 and 78-32) are represented by the vertical yellow lines descending below the surface. Users can rotate, zoom, and pan the visualization allowing them to view stimulation events from any angle in three-dimensional space. To improve the visibility of the subterranean events, the ground has been removed from the 3D model.

Links directly below the visualization allow users to quickly access the underlying data on the GDR, showcasing the data used in the interactive visualization and helping users to better understand it.

Task 4. Information Dissemination

Description: NREL will work with the EGI FORGE communications teams to provide easy, streamlined access to EGI FORGE data that has been curated and approved for public consumption. NREL will provide expertise in search engine optimization (SEO) to ensure discoverability of EGI FORGE data and better disseminate EGS information to the greater geothermal scientific community.

NREL worked closely with the Utah FORGE team to create linkages between the Utah FORGE website and Utah FORGE data stored on the GDR. Initial attempts at linking directly to the GDR search page with FORGE content prefiltered produced results that mixed Utah FORGE data with data from other FORGE sites and created a confusing result for users seeking Utah FORGE data. Coordinating with the Utah FORGE team, NREL refined the metadata model used to identify data through search results to better differentiate between the Utah FORGE project and the other, preselection FORGE projects. After several iterations, the new metadata model was retroactively applied to every submission in the GDR data catalog by the GDR curation team at NREL. The new metadata model was mapped to improved GDR search facets that also differentiated between the various FORGE projects and highlighted the Utah FORGE work (Figure 4).

The screenshot shows the GDR Search page with the following elements:

- Navigation:** GDR logo, Data, Help, About, Search.
- Search Bar:** "Search GDR Data" with a search icon and a search input field containing "search GDR data".
- Results Summary:** "Showing results 1 - 50 of 81." and "Utah FORGE x".
- Order by:** Relevance (selected), Most Recent.
- Availability:** All Results (selected), Public Only.
- Show:** 50 results per page.
- Filters:** Clear All Filters x. Technologies: Direct Use and District Heating, Deep Direct Use (0), Direct Use (0), District Heating (0), Heat Pumps (0), Thermal Energy Storage (0), EGS (79), Hydrothermal, Conventional Hydrothermal (2), Coproduced Resources (0), Low Temperature (0). Featured Projects: FORGE, Utah FORGE (81) x, Other Candidate Sites, Fallon, NV (23), Newberry, OR (2), Snake River Plain, ID (4), West Flank Coso, CA (25), Play Fairway Analysis.
- Search Results:**
 - Utah FORGE: Preliminary Monitoring, Analyses, and Impact Assessment**
Preliminary monitoring and analyses for the Utah FORGE Milford Site. Includes a report detailing the seismic monitoring goals and results, a detailed techno-economic infrastructure assessment with an analysis, a budget, schedules, and cost summaries, and a summary of environmental...
Pankow, K. Energy and Geoscience Institute at the University of Utah
Feb 09, 2017
3 Resources
Publicly accessible
 - Utah FORGE: TEM and Gravity Data**
This submission includes a gravity data in text format and as a GIS point shapefile and transient electromagnetic (TEM) raw data. Each text file additionally contains location data (UTM Zone 12, NAD83) and elevation (meters) data for that station. The gravity data shapefile was l...
Hardwick, C. and Nash, G. Energy and Geoscience Institute at the University of Utah
Feb 05, 2018
3 Resources
Publicly accessible
 - Utah FORGE: X-Ray Diffraction Data**
This dataset contains X-ray diffraction (XRD) data taken from wells and outcrops as part of the DOE GTO supported Utah FORGE project located near Roosevelt Hot Springs. It contains an Excel spreadsheet with the XRD data, a text file with sample site names, types, and locations in ...
Nash, G. and Jones, C. Energy and Geoscience Institute at the University of Utah
Feb 07, 2018
3 Resources
Publicly accessible
 - Utah FORGE: Logs and Data from Deep Well 58-32 (MU-ESW1)**
Data, logs, and graphics associated with the drilling and testing of Utah FORGE deep test well 58-32 (MU-ESW1) near Roosevelt Hot Springs.
Nash, G. and Moore, J. Energy and Geoscience Institute at the University of Utah
Apr 11, 2018
6 Resources
Publicly accessible
 - Utah FORGE: Deep Well 58-32 (MU-ESW1) Core Data**
These datasets, images, and graphics were derived from core drilling and core that was extracted from Utah Forge deep well 58-32 (originally called MU-ESW1), near Roosevelt Hot Springs.
Nash, G. and Moore, J. Energy and Geoscience Institute at the University of Utah
Apr 11, 2018
5 Resources
Publicly accessible
 - Utah FORGE: Observation Well Data**
This archive contains temperature data for Roosevelt Hot Springs observation wells OH-1, OH-4, OH-5 and OH-7. There are also mud logs for OH-4. These are old datasets obtained from Rocky Mountain Power for use in the Utah FORGE project. Temperature data were collected in the 1970s...
Nash, G. Energy and Geoscience Institute at the University of Utah
Feb 22, 2018
1 Resources
Publicly accessible
 - Utah FORGE: Regional Well Locations**
This archive contains a GIS point feature shapefile that shows the locations of wells in the general region of the Utah
Feb 22, 2018

Figure 4 GDR Search page with Utah FORGE data preselected

The improved GDR search interface was redesigned to feature search facets and filters identified by geothermal researchers and industry experts to better serve the geothermal scientific community. The “Technology” and “Featured Projects” facet categories allow users to quickly focus their search on specific geothermal technologies or high-profile projects like FORGE. The search interface functionality was enhanced by the NREL team to support direct linking to GDR search page with the Utah FORGE data facet preselected. This allowed the Utah FORGE communications teams to modify the Utah FORGE website to link directly to a preselect, prefiltered list of Utah FORGE data on the main GDR search page. Users can now quickly and easily access a searchable, filterable list of Utah FORGE data from both the GDR homepage and the Utah FORGE website.

Conclusion:

The improvements made to both the GDR and the Utah FORGE websites as part of this cooperative research agreement have improved the discoverability and accessibility of Utah FORGE data from both sites, improved the understanding of Utah FORGE data, provided a clear path to the data for users, and enhanced the functionality of both sites. Improvements to search engine optimization (SEO) have increased the visibility of Utah FORGE data to major search engines, increased the discoverability of Utah FORGE across the internet, and have helped to better disseminate data and information from the Utah FORGE project to the geothermal industry, the greater scientific community, and the general public.

Subject Inventions Listing:

None

ROI #:

None