Overview of GEOPHIRES files for analysis of 2017-2019 DDU projects in United States

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1. Background Information

During 2017-2019, the U.S. Department of Energy funded six geothermal deep direct-use (DDU) projects to investigate feasibility of DDU for heating, cooling and thermal storage in the United States. In a follow-on study conducted at the National Renewable Energy Laboratory (NREL), findings of these six projects were reviewed and analyzed, and additional simulations were conducted using the simulator GEOPHIRES to explore technical performance and cost-competitiveness of DDU. The results of the NREL study were published in the paper "Evaluating the Feasibility of Geothermal Deep Direct-Use in the United States". The GEOPHIRES files developed in that study are included in this submission to the Geothermal Data Repository (GDR).

2. List of DDU Projects

Six DDU projects were studied:

- Cornell University (Cornell) studied geothermal district heating for its main campus in Ithaca, New York.
- West-Virginia University (WVU) studied geothermal district heating for its campus in Morgantown, West Virginia.
- Sandia National Laboratories (Sandia) studied geothermal district heating for the Hawthorne Army Depot, city of Hawthorne, and Mineral County in Nevada.
- University of Illinois at Urbana-Champaign (UIUC) studied geothermal district heating for the university agricultural research facility near Champaign, Illinois.
- National Renewable Energy Laboratory (NREL) studied geothermal for chilled water production using absorption chillers for turbine inlet cooling at a chemical plant near Longview, Texas.
- Portland State University (PSU) studied utilizing a geothermal reservoir for seasonal thermal storage of solar heat.

More information on each project is provided in the accompanying paper.

3. GEOPHIRES v2.0 Simulator

The geothermal techno-economic simulator GEOPHIRES v2.0 was applied to calculate capital and levelized costs for each DDU project. GEOPHIRES is an open-source simulator written in Python and can be download from the following GitHub folder: https://github.com/NREL/GEOPHIRES-v2. A user's guide and example cases are included in the GitHub folder. Background information on GEOPHIRES v2.0 can be found in the following paper: Beckers, K.F., McCabe, K. GEOPHIRES v2.0: updated geothermal techno-economic simulation tool. *Geotherm Energy* **7,** 5 (2019). https://doi.org/10.1186/s40517-019-0119-6.

4. List of Scenarios

For each of the six DDU projects, the following eleven scenarios were run in GEOPHIRES:

1. **Base case**: scenario with conditions as assumed by the teams

2. **Default financing**: uniform financing conditions (5% nominal discount rate, 30 year lifetime, no tax rate)
3. **Default costs**: uniform financing conditions, standard drilling costs, no exploration costs
4. **10% ITC**: investment tax credit of 10% on total capital cost
5. **20% grant**: grant of 20% on total capital cost
6. **30% grant**: grant of 30% on total capital cost
7. **Low discount rate**: nominal discount rate of 2.5% instead of 5%
8. **High utilization factor**: utilization factor of 95%
9. **Low drilling costs**: 30% reduction in drilling costs
10. **dGeo Technology Improvement ("TI") scenario**: cost and financing conditions as assumed by the dGeo TI scenario for the GeoVision study
11. **Subsurface only**: no surface equipment (and surface cost) assumed

For the PSU DDU project, scenarios 8 and 11 cannot be evaluated. Hence, a total of 64 GEOPHIRES cases were run. Additional information on each scenario and simulation results are provided in the accompanying paper.

5. Files uploaded

All 64 GEOPHIRES cases are uploaded to GDR in this submission. The files are grouped in six folders, organized by DDU project. Each folder contains the GEOPHIRES code (.py file), the input text files (.txt file), and the output files (.out file). The NREL simulations require the TOUGH2 executable to run, which is not uploaded as part of this GDR submission.