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Using GeoRePORT to report socio-economic potential for geothermal development

Katherine R. Young*, Aaron Levine

National Renewable Energy Laboratory, United States

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ABSTRACT

The Geothermal Resource Portfolio Optimization and Reporting Tool (GeoRePORT, http://en.openei.org/wiki/GeoRePORT) was developed for reporting resource grades and project readiness levels, providing the U.S. Department of Energy a consistent and comprehensible means of evaluating projects. The tool helps funding organizations (1) quantitatively identify barriers, (2) develop measureable goals, (3) objectively evaluate proposals, including contribution to goals, (4) monitor progress, and (5) report portfolio performance. GeoRePORT assesses three categories: geological, technical, and socio-economic. Here, we describe GeoRePORT, then focus on the socio-economic assessment and its applications for assessing deployment potential in the U.S. Socio-economic attributes include land access, permitting, transmission, and market.

1. Introduction

The Geothermal Resource Portfolio Optimization and Reporting Tool (GeoRePORT) system was developed to address the need of the U.S. Department of Energy's (DOE's)[1] Geothermal Technology Office (GTO) to track and measure the impact of its research, development, and deployment funding for geothermal projects (Young et al., 2015a). Recently, however, interest has grown in the potential for applying the tool to other countries. Although other geothermal reporting systems exist—such as the Australian and Canadian Geothermal Reporting Codes (AGEA and AGEG, 2010; CanGEA, 2010) and the United Nations Framework Classification (UNFC) System (UNECE, 2016)—the GeoRePORT system is unique in providing a detailed system for reporting both the ***resource*** grade and the ***project*** readiness level. Also, it is particularly useful for describing early-stage exploration projects. GeoRePORT is comprised of three assessment tools—Geological, Technical, and Socio-Economic—and for each tool, an objective ranking has been developed for reporting both resource grade and project readiness.

The National Renewable Energy Laboratory (NREL) led the development of the GeoRePORT protocol in collaboration with Lawrence Berkeley National Laboratory, with support from GTO. Over a three-year period between 2013 and 2016, the concept was designed and the Geological (Young et al., 2015b), Technical (Young et al., 2016), and Socio-Economic (Levine and Young, 2016) Assessment Tools were developed with input from one-on-one phone calls with industry experts, and regular, repeated industry workshops to solicit targeted feedback.[2] GeoRePORT is designed to provide uniform assessment criteria for geothermal resource grades and developmental phases of geothermal resource exploration and development. This resource-grade system provides information on 12 attributes of geothermal resource locations (e.g., temperature, permeability, land access) to indicate potential for geothermal development. GeoRePORT was developed to provide consistency among the user community in *reporting*; it is neither a prescription for conducting exploration and field development, nor a replacement for expertise and conceptual or reservoir models.

The GeoRePORT protocol is a useful tool for distilling the massive amount of geothermal project data into a concise, communicable summary that can be understood by project experts (e.g., geochemists, permitting experts) and by those in management. It can be used to establish country baseline information, for project-specific reporting, or for summarizing project development portfolios. It can also be a useful tool for:

1. Project managers (e.g., leaders in the military looking to develop geothermal resources on military installations);

* Corresponding author at: 15013 Denver West Parkway, Golden, CO, 80401, United States.
E-mail address: Katherine.Young@nrel.gov (K.R. Young).

[1] Abbreviations used: DOE—U.S. Department of Energy; GeoRePORT—Geothermal Resource and Portfolio Optimization Reporting Tool; GTO—DOE Geothermal Technology Office; MW—megawatt; NREL—National Renewable Energy Laboratory; PHMA – Priority Habitat Management Area; RD&D—research, development, and deployment; SEAT—Socio-Economic Assessment Tool; USFS—U.S. Forest Service; U.S.—United States.

[2] For a list of industry workshops, see http://en.openei.org/wiki/GeoRePORT/Development.

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2. U.S. DOE GTO or States (e.g., California's Geothermal Resources Development Account, or GRDA) looking to fund research and development projects; and
3. Geothermal risk mitigation funds (e.g., Geothermal Risk Mitigation Fund in East Africa, Geothermal Development Facility in Latin America) or a bilateral or multi-lateral development entity (e.g., World Bank) looking to finance geothermal projects.

These protocols can be useful to help quantitatively ***identify*** the greatest barriers to geothermal development, ***develop*** measureable program goals that will have the greatest impact to geothermal deployment, objectively ***evaluate*** proposals based (in part) on a project's ability to contribute to program goals, ***monitor*** project progress, and ***report*** on project portfolio performance.

Previous publications have discussed the aims of GeoRePORT and the details of the protocol. For this *Geothermics* "Virtual Special Issue on Geothermal Environmental & Social Aspects," this article focuses only on the Socio-Economic Assessment Tool (SEAT) and provides examples of its application in the United States. Related research and draft protocol documents for all three tools can be found on the GeoRePORT website (http://en.openei.org/wiki/GeoRePORT).

This article discusses the following:

- Section 2: GeoRePORT Grades—discusses the structure of GeoRePORT grades, including attributes and sub-attributes, as well as character, activity, and execution grades.
- Section 3: GeoRePORT Project Readiness Levels—discusses the concept of project readiness levels, and details the objective criteria for assigning socio-economic project readiness levels.
- Section 4: Using GeoRePORT—describes three different ways to use GeoRePORT, including country-wide, project-specific, and portfolio-summary assessments.
- Section 5: Summary—summarizes the uses of the GeoRePORT tool and next steps in its development and evaluation process.

2. Resource grade

2.1. Geothermal resource attributes

Traditionally, a description of the grade of a natural resource includes a combination of multiple factors. For example, the grade of a mined ore is described as the ore's mineral concentration that can be technically recovered, and the grade of oil is described in terms of a combination of heavy to light and sweet to sour. We apply these concepts of grade to geothermal resources by identifying "attributes" specific to each of the three assessment categories (geological, technical, and socio-economic).

Each attribute is ranked on a scale of A (highest) through E. These grades can be displayed on a polar-area chart with A being the largest pie wedge and E being the smallest (Fig. 1).

An attribute grade of A is not necessarily the "best" value for a specific project goal. Some business models or plant designs may target grades lower than A for some or all of the attributes. Examples are given below:

- Some developers may be interested in average temperature resources (Temperature Grade = C) and poor fluid chemistry (Fluid Chemistry Grade = D–E) to take advantage of secondary mineral recovery potential from the geothermal brine.
- Near-field resources (resources located near operating plants) may have high temperatures (Temperature Grade = A), but low permeability (Permeability Grade = C) and may be candidates for applying Enhanced Geothermal System techniques.
- For some business models, a very high-temperature resource does not necessarily need to have a large volume to be economical; in fact, a small- or average-size, high-temperature resource could be a viable target.

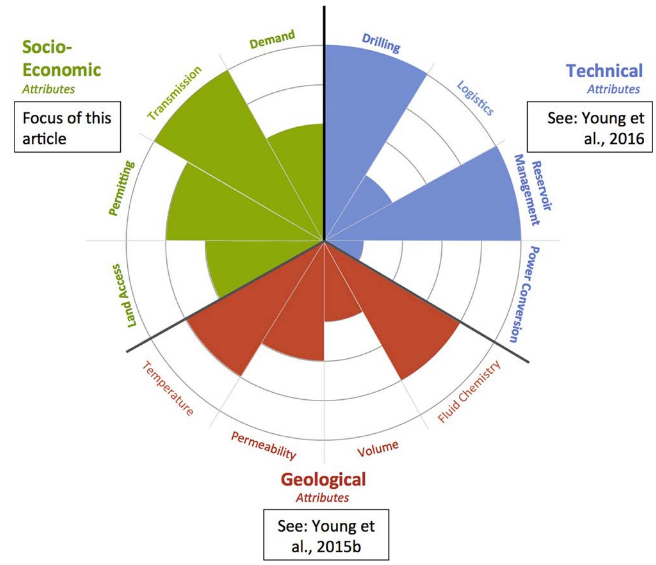

Fig. 1. Resource Grades. The grade of a resource can be described as a combination of intrinsic features of the resource that contribute to economic viability. The GeoRePORT system allows developers to assign grades to each of 12 attributes, providing a clear picture of the development potential and challenges at each location. The highest grade, A, is represented as a full pie wedge; the lowest grade, E, is represented as the smallest pie wedge. Sub-attribute grades, activity, and execution indices are not reported in this graphic.

As these examples indicate, developers must evaluate which grades are appropriate for their particular target business model. Resources with all attributes with grade A rarely exist.

By assessing the major characteristics of a geothermal resource, categorizing the techniques used, and evaluating how well the research techniques were implemented, users can report a ***resource grade*** covering multiple geological, technological, and socio-economic attributes that can be compared across play types and geothermal areas. The "grade" of each resource is intended to be refined, if needed, as new and better information is collected.

2.2. Socio-economic grade sub-attributes

Using this methodology, we can then further describe the four socio-economic attributes[3]: Land Access, Permitting, Transmission, and Market. These attributes are subdivided into sub-attributes, with a total of 16 SEAT sub-attributes. For example, the Land Access attribute is divided into six sub-attributes: (1) cultural and tribal resources, (2) environmentally sensitive areas, (3) biological resources, (4) land ownership, (5) federal/state lease queue, and (6) military installations (Table 1).

Each of these sub-attributes also has a carefully vetted grading scale. For example, for the biological resources sub-attribute, the grades are defined as shown in Table 2. There are 16 SEAT sub-attribute tables—one for each sub-attribute. All tables can be found in the SEAT protocol (Levine and Young, 2016).

Each sub-attribute (SA) is given a weight (wt), and the total sub-attribute-weighted sum is calculated as:

$$\text{sub-attribute-weighted sum} = SA_1*wt_1 + SA_2*wt_2 + SA_3*wt_3 + \ldots + SA_n*wt_n \quad (1)$$

[3] As discussed, the geological and technical assessment tools are beyond the scope of this article, but more information can be found in the protocol documents on the GeoRePORT website (http://en.openei.org/wiki/GeoRePORT).