Developmental Barriers vs. Policy Incentives in Geothermal Power

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ABSTRACT

Policymakers and legislators are being encouraged to create and pass policy legislation that supports the specific needs of the geothermal industry. This position has been introduced in research literature in recent years, but there remains a question of what would best serve the geothermal industry. By providing findings from an extensive literature review on the subject, this paper will provide an identification of common barriers to geothermal development. It will also provide a discussion of the gap in contemporary policy applications that supports the need for more geothermal specific incentives when compared with developmental barriers.

Introduction

Developing geothermal power projects is not said to be certain, especially under today's political climate. To survey those involved in the industry as to what barriers are the most disruptive to geothermal power development, a range of issues and barriers is presented. These issues and barriers are likely dependent on the respondent's role or position in the industry and the specific obstacles related to their position. These barriers may range from financial accessibility to permitting and structuring of royalty payments. Therefore, the barriers that are represented are often representative of specific industries. This leads to some uncertainty on the part of policymakers, as to which of these barriers are most important.

In addressing both the policy gap and the range of actual geothermal developmental barriers, this paper will provide a review of developmental barriers as presented in contemporary literature. It is not a true literature review, as the content is quite extensive, but is a documentation of the process and findings of that review of the literature. By design this process will collect, catalog, and categorize barriers to geothermal development to better aid policy makers and industry leaders in a more concise understanding of the variety of barriers that the industry confronts. This paper is structured to provide an overview of the method of collection, cataloging, and categorization of barriers from 18 published sources. The findings of this study are represented in a table, which gives the results in a synchronic order based on publication frequency. The conclusions of this paper draw from the identification of gaps in applied policy and developmental barriers.

Collection, Cataloging, and Categorization

Through a process of identifying the distribution of barriers, it is clear that certain barriers occur with greater frequency than others, but the terms of defining them vary amongst the selected authors. Slight variations are present in how specific barriers are defined and/or identified. This, therefore, suggests that for proper analysis, a method of categorizing developmental barriers needs to be applied. Some barriers carry across multiple stages of development, such as "government support". In this case, the identification of government support is quite broad, but offers a range of policies from local to federal application. Ultimately, the need for support lies within the recognition by policy makers, that geothermal development will need similar attention as has already spurred development in sister renewable energies, such as wind and solar.

Describing this approach will briefly, but concisely, offer a progressive method in assessing the relevant barriers to geothermal development. Before detailing the process fully, the following steps are used in the process to accurately identify the most frequently published developmental barriers to geothermal power.

1. Identify the barriers in each publication. (Collection)
2. Group barriers into concept topics. (Cataloging)
3. Link like barriers and denote overlapping terminologies. (Categorization)
4. Determine frequency of use for each barrier. (Frequency)

For the course of analysis, each of the publications is cataloged. The cataloging process defines a terminology of categories for each of the challenges documented. The analysis itself is the process of identifying those barriers based on frequency. If one were to utilize that position in the formulation of policy, it would need to be proven that the current needs are not in line with the current state of policy structuring. For this reason, the study provides a measurable output of barriers to development and then relates that to a specific area of policy design to correlate whether or not the position can be claimed in relation to policy incentives.

In the preliminary log of the sources and their subsequent barriers, there is a substantially longer list of topics. The logging of each source is done in a chronological order, representing newest sources first. Included in the preliminary information is also an identifier of each source based on its respective source topic and can be determined as: investment, development, policy, and non-technical. As each source is added, the specific challenges are added to the list and identified for that source specifically.

The next step in the analysis process is to define groupings of barriers. Since each of the initial barriers may share characteristics with another barrier, or may be stated differently by each author representing the same ideal, it is now important to identify and recognize those similarities. For this, each of the barriers was identified into common categories. The following is the list of informal parent categories initially used: Risk, Cost, Technology, Policy, and Other. It is important to realize that there is potential for overlap in each of these categories. For example, "investment security" could be interpreted as an issue of "Risk", but for this model it is more appropriately identified in the "Cost" category.

- "Risk" is defined in terms of geologically related risks.
- "Cost" barriers or challenges are directly associated with the developmental cost.
- "Technology" categorizes challenges that are related to engineering and technical processes.
- "Policy" identifies any challenges that are legislative or regulatory in nature.
- "Other" includes all barriers that cannot otherwise be categorized within a previous definition.

With each of the categories being identified, the listed barriers are then categorized. The following breakdown is intended to give a more general view of the systematic process of categorization.

Table 1. Barriers to Development.

Risk:	Cost:	Policy:
Exploration Risk	High Capital – Up Front	Lead Time
Drilling Risk	Investment Cost	Equivocal Legislation
Geological Risk	Long Payback	Administration Requirements
Early-stage Risk	Investment Security	Geothermal Definition
Limited Sitting Opportunities	Perceived High Cost	Resource Ownership
Lack of Mitigation Tools	Financing Gap	Political Will
Developmental Risk	Relative Policy Incentives	Stable/Clear Policy
	Drilling Cost	Permitting
Technology:	Access to Financing	Life-cycle Support
Transmission Access		Federal Land Rights
Reliable Resource Data	**Other:**	Developmental Timelines
Inadequate Technology	Industry Size	
Access to Rigs	Public Opinion	
Technological Maturity	Environmental Issues	
	Workforce Development	

For the categorized list of barriers that have been identified, the next step requires further division within the categorization. Each category is discussed as it relates to the barriers that have already been assigned. The goal of this process is to create the appropriate grouping under each heading.

Risk: The definition of "Risk" relates to risks of a geological nature. Those barriers that have been identified under the heading of "Risk" noted in Table 1. Of these it is clear that the majority can be grouped into the premise of early developmental risk, and includes all but the limited siting opportunities. While addressing the issue of financing, Salmon et al. (2011) focus on what is defined as "early-stage" by recognizing the developmental tasks involved. For the purposes of their reporting they have included: resource identification, resource evaluation, and test well drilling (Salmon et al., 2011). Islandsbanki (2011) and GEOFAR (2009) identify a similar grouping of developmental stages by recognizing exploration, pre-feasibility, and feasibility as the sections of the developmental timeline before the reservoir has been proven (Richter, 2008) (Richter, 2009). Therefore, although exploration and drilling risk, for example, are very much different, there is a shared state of development of both, as the level of perceived investment risk has not reached production viability (Islandsbanki, 2011). Therefore, to group the different barriers defined under "Risk", the perceived investment threshold is used to validate the grouping. The remaining barrier that fails this grouping of risk is then identified individually as a geographical barrier to development, "limited siting opportunities".

Cost: There are ten barriers that have been included in this category. The same perspective is applied to identify grouping structures within the "Cost" designation. There are common themes among certain barriers and through initial observation, two can be readily identified: initial cost and financing. Continuing with the same process as was done for "Risk" we find that under the heading of initial cost, three barriers are identified. These barriers are: high capital costs – up front, high-perceived costs, and drilling costs. Under the alternate identification heading of financing, all but one, of the remaining barriers can be grouped. This includes the following: investment cost, long pay back, investment security, financing gap, and access to financing. The idea behind this method of grouping is that, by identifying a more generalized barrier, the process of applying a solution will have both direct and indirect impacts on a variety of barriers. This is preferred in this study, since a very isolated approach may only be able to address one very isolated barrier. The remaining barrier that does not align with initial cost or financing is listed in "lower relative policy incentives". It is possible to also categorize this under the "Policy" category. However, for the purposes of this study it was important to focus on the cost component listed within the barrier.

Technology: These barriers cover a range of topics from informational to grid access. This range is the core reason why the "Technology" category requires more than two areas of separation. In this case, it is felt, that the scale and type of the application is an accurate method of justifying each meta-barrier. To recognize scale, the barriers can be identified as either macro-level or micro-level. Transmission access, although site and project specific, is a macro-level application. The remaining barriers are more project specific, therefore, "transmission" is defined as a general barrier. Of the remaining barriers there is a clear distinction between informational technology and engineering technology. This allows the grouping to be made according to those that are of one or the other. "Technological Competiveness" will include the engineering technology barriers, while "Resource Data" will address informational resource barriers.

Policy: Due to the variety of issues that are related to "Policy" there are cases where a selected barrier may be cross-listed for multiple categories. For the purposes here, that is believed to have a potential to alter the results of the study based on the design. Therefore, any barriers that have the potential to be cross-listed will be identified in a sole general barrier. This can also be the case within the category of "Policy", since a general designation of "Government Support" will be used to recognize all barriers that do not fit squarely within an alternate policy barrier. Given the list of identified barriers, it appears that there are multiple barriers that address "time" or specifically "permitting". For this reason each will be used to form specific policy barriers, with the remainder being identified as "government support". The barrier of "Time" will include: lead-time and developmental timeline, while "Permitting" will include: administration requirements, geothermal definition, resource ownership, permitting, and federal land rights. In the case of permitting, much of the discussion relates to the functionality of the process, wherein the definitions relating to the process of permitting have created a need for streamlining. The remaining policy barriers are more general and relate directly to the macro-level policy framework and its support of geothermal power.

Other: To include unique, but worthy, barriers that should not be grouped, or are not able to be grouped, "other" is used. Because only four barriers remain, each is identified independently in the study. Briefly each will be discussed. Multiple authors identify industry size as a limiting factor for the geothermal sector (Doris et al., 2009) (Islandsbanki, 2011). Islandsbanki specifically identifies that the size of the industry is restrictive to external investments (Islandsbanki, 2011). Public opinion is also discussed by one third of the authors as an issue of industry and technological knowledge and comfort with geothermal power. This is disruptive to bridging the gap in perceived and real developmental risk (Islandsbanki, 2011) (Deloitte Development LLC, 2008). Project developments and plans also have barriers due to environmental constraints, and can involve a wide range of variables. The last barrier to be categorized is that of workforce development. One in six publications identify the need for qualified personnel for the industry to grow. This model of categorization allows the study to identify barriers as general themes, while acknowledging those that are more specialized.

Frequency

After defining the barriers above, each of the barriers is categorized appropriately and the frequency of each is determined. For this study, the method of determining frequency is simply: $f_i = \frac{\eta_i}{N}$, wherein η_i is the number of references for each barrier and N is the sum of reference items. The criterion for frequency reflects how often each is referenced in the literature review given the process of categorization. Review Table 2 for the results of this process.

As it is presented in the table, each of the barriers is ranked from left to right in order of frequency. While Curtis was the only author to reference "policy incentives", the process of categorization supported much higher frequencies for the other barriers. Reflecting solely on policy incentives, the fact that it was not a shared concern by any of the other authors reviewed would indicate an overall level of indifference or content with the state of the incentives at the time of each publication. This could be seen as counterintuitive to this process of study, since policy incentives are to be specifically correlated with the results of the barrier analysis. Although this may be an interpretation, a more important question to be asked is: If there is a higher level of indifference or contentment with the policy incentives in place, with what developmental barriers are they interacting with?

Table 2. Frequency Output.[1]

Barriers and Obstacles to Geothermal Development -Literature Review	Year	Resource Risk	Initial Cost	Time	Technological Competiveness	Government Support	Financing	Permitting	Public Opinion	Environmental Issues	Transmission	Resource Data	Workforce Development	Geographical	Industry Size	Policy Incnetives
Islandsbanki (2011)	2011		■	■											■	
NREL (2011) - Policymaker's Guide	2011	■		■	■											
Salmon et al. (2011)	2011	■		■				■								
Jennejohn (2011)	2011	■		■	■			■		■	■		■			
Geothermal Technologies Program (2010)	2010		■		■	■				■	■	■	■			
Curtis (2010)	2010	■	■	■	■		■	■		■	■			■		■
GEOFAR (2009) - Financial Instruments	2009	■	■				■									
Richter (2009)	2009	■				■	■		■							
Doris et al. (2009)	2009	■	■		■	■		■	■						■	
GEOFAR (2009) - Europe	2009	■	■			■	■	■	■	■						
Geothermal Technologies Program (2008)	2008		■		■	■					■			■		
Richter (2008)	2008				■	■						■	■			
Bloomquist (2007)	2007	■	■													
Fleischmann (2007)	2007			■				■	■	■		■				
Deloitte LLP (2007)	2007	■	■			■	■				■	■				
Combs (2006)	2006	■	■	■			■									
NREL (2004)	2004	■	■	■	■				■			■				
Battocletti (1999)	1999	■	■						■							
Frequency (%):		72%	67%	44%	44%	39%	39%	33%	33%	28%	28%	28%	17%	11%	11%	6%

Compiled 01/11/2012

Nearly all of the barriers are referenced two or more times in the collection of publications, and although there is a certain level of frequency for each, only two barriers are referenced with a frequency greater than 50%. None of the barriers, as defined, is unanimous in their selection, but this is suspected to be relative to variations in themes throughout the collection of sources. Using 50% as a threshold, the two most common barriers listed are "Resource Risk" and "Initial Cost", with 72% and 68% frequency respectively. Each of these barriers was established, as a grouping of like barriers, and thus it is understandable that they would be more frequently referenced. But with this point aside, individual authors directly address their respective importance. For example, Doris et al. (2009) finds that geothermal development incurs high initial cost and risks for initial investors over a longer timeframe (Doris et al., 2009). An important take away from this analysis is that the barrier "resource risk" is only relevant for geothermal when compared to other renewable energy applications, and is shared when considered with oil and gas. Battocletti's statement referenced in the summary of her report identifies "resource risk" as being unique and unknown in comparison to traditional developmental methods (Battocletti, 1999). This creates a strong identity between geothermal power and resource risks. It can also be said that these risks are also directly represented in the financing and cost structures found in geothermal development, and are therefore linked to high initial costs. It is important to recognize that each barrier is part of an intricate network of factors that impede development and industry growth.

Policy Incentives

The purpose of this study is to assess the identification of developmental barriers. It also suggests that there should be a discussion of current policy implications. Policy includes a variety of applied options and subject areas. Legislative and regulatory policy structures traditionally focus on the process of permitting and leasing land rights, but also include tax incentive options. It also includes environmental statutes for maintaining the rights of citizens and the protection of species and ecosystems. The purpose of implementing policy is to address a need. Policy incentives are very specifically designed and used in the valuation of a product or service in a market setting. Karl Mallon wrote, that "markets are good at doing what they are designed to do …… governments have a fundamental role, perhaps responsibility, to establish the market conditions" (Mallon, 2006). The role of policy incentives, therefore, is a necessary one for the positioning of a good or service in the market and enabling the conditions to achieve maturity. This is not intended to be the foundation for policy incentives themselves, but more so the recognition of how the factoring of market conditions are representative of the state of development for industries, like geothermal power. Using this position, the relationship between the market and geothermal development should be administered through the use of policy incentives. Doris et al. find that the key policies in place for geothermal development are the Production Tax Credit (PTC), state Renewable Portfolio Standards (RPS), and other financial incentives (Doris et al., 2009), which supports further the comparative value of policy incentives relative to other policy options.

With the identification of core barriers, I would like to bring attention to the existing gap in applied policy incentives for geothermal development. The following is a selection of contemporary policy incentives, which include: the PTC, 1603 Cash Grant, and RPS.

In reviewing the policy incentives, each is arguably complex enough to warrant individual books. For simplicity, however, let us review them within the context of defining developmental barriers by only discussing "resource risk" and "initial cost". An important consideration for this discussion is also the respective positioning of benefits within the developmental timeline of geothermal power.

Production Tax Credit (PTC)

Federal production tax credit (PTC), opened to geothermal energy in 2004 for a portion of the wind credit and to the full credit in 2005 (Doris et al., 2009). This has allowed a tax credit to be issued to geothermal electric projects at a rate of US$ 0.022/kWh for the first 10 years of each project. Renewal periods for the PTC can impose limits, as the applicable timeframe is often shorter than the developmental horizon new geothermal projects. Current time constraints only allow projects placed in service prior to December 31, 2013 to qualify. Salmon et al. (2011) further find that this constraint gives less applicability in the geothermal sector, since project developmental timeframes are typically 4-7 years. Expanding on these numbers, ideal projects would have been started between 2006 and 2009. This restricts the PTC option for nearly 150 projects (> 5000 MW installed potential), in various stages of development, within the United States (Geothermal Energy Association, 2012). Although not all would be prohibited, it would seem that only Phase IV projects (confirmed resources) (Geothermal Energy Association, 2012) would have any possibility of meeting the current service date, without legislative renewal.

If the discussion of PTCs is refined to only the two barriers defined above, resource risk and initial costs, their strengths diminish. The first observation that can be applied to any tax credit option is the need for someone with an adequate tax liability for which the PTC would be beneficial. Although a Power Purchase Agreement (PPA) can be put in place to marginalize the investment risk in projects, the actual fulfillment of the PTC, can only come once production of power has been proven. This requires that the developer rely on alternative investment options to support the project from inception to production. Since the impacts of resource risk and initial cost barriers are in the early stages of development, there is an observable lack of alignment between the selected barriers and the timing of the PTC. John McIlveen makes a parallel statement finding that the front and back-end loading of costs versus incentives is comparatively different for geothermal than other renewables (McIlveen, 2011). Since the PTC is a "back-end loaded" subsidy it fails to address the factors that are directly relevant to geothermal.

1603 Cash Grants

Extension of the 30% investment tax credit (ITC) to new geothermal energy projects is, in some cases, allowing developers to apply for a cash grant in lieu of the ITC (Holm et al., 2010) or PTC. This is because, in some cases, project owners are unable to use tax credits, due to limited tax liability, and must sell the credits at a discount and use the Treasury Cash Grant to pay off upfront costs. These grants are attractive by being: quick, complete payout, and not limited by tax liability (Salmon et al., 2011). Incentive levels for geothermal projects do vary by qualified plant costs (30%) or developmental equipment (10%) (Doris et al., 2009) (Salmon et al., 2011). In addition, Salmon et al. discuss the relative deadlines that are applicable to cash grant deployment, with the current policy remaining until January 1, 2017 at the 10% incentive. The 30% incentive will remain until January 1, 2013 mirroring both the PTC and ITC policies. Most importantly the cash grant incentives elevate the need for an equity investor to absorb the tax credits through an appropriate tax appetite (Salmon et al., 2011).

Growing on the strength of tax credit incentives in the development of other renewables, the issues of tax liability appetite, among others, pushed a need for a more direct subsidy option. The benefit of using a cash grant, in lieu of the tax credits, is one of timing. It has been well recognized that the initial costs of geothermal development are a leading barrier to development. Enabling a direct subsidy option that introduces funding in the cash flows earlier in the project is a substantial benefit when dealing with the comparatively longer developmental timelines of geothermal. There is, however, a remaining problem where this occurs in the developmental timeline. Like, both the PTC and ITC, the cash grant options are only available once production has been established. This limits the sensitivity of the barriers, resource risk and initial cost, to mechanisms, like the 1603 Cash Grant.

Renewable Portfolio Standards

As of June 2011, 29 states had enacted policies for a Renewable Portfolio Standard (RPS). At the state level these policies are a driving force for promoting the use of renewable energy for Electric Utilities. State RPSs augment risk-reduction effects created through PURPA (Doris et al., 2009). Salmon et al. discuss the impacts of these policies as an equity base for financing geothermal development. They define Renewable Energy Credits (RECs), issued through an RPS, as "the value of environmental attributes associated with a unit of energy produced by a renewable energy facility" (Salmon et al., 2011). Establishing a market for RECs can be a significant revenue stream for geothermal projects, with voluntary markets ($1-10/mWh) having lower valued RECs than compliance markets[1] ($3-60/mWh) (Salmon et al., 2011). These RECs can then be sold and traded, based on market demand, but are dependent on RPS rules regarding eligibility of projects, borrowing, banking, alternative compliance payments, and carve-outs. Each of these influences the pricing of RECs within the market (Salmon et al., 2011).

Clearly the state method of assessing the roles of renewable energy, and especially geothermal power, is different than that at the federal level. This provides an opportunity to review potential sensitivities to the selected barriers in application. Since RPS policies direct each respective state to utilize a certain percentage of power from renewable sources, there can be support to further growth in development of qualified projects. This does, however, present a problem for geothermal, since the developmental timeline is considerably longer than other renewables. In addition, only a portion of states in the U.S. currently have viable geothermal resources, making most RPSs ineffective toward further development. Salmon et al. suggest that a RPS carve-out would benefit geothermal development (Salmon et al., 2011). However, only New Mexico has achieved this, in part as a carve-out with biomass for 10% (Fleischmann, 2007). Associated with RPSs, REC programs are a great source of revenue generation, but like the case brought against the tax credits and cash grant, the viability of RECs is based on actual production of power. Without delving into the same discussion again, the same challenges in the developmental timeline are also present.

Conclusions

Although there is much more that can be interpreted from this study when one applies a boarder approach to policy, the focus relies on the specific policy options, in the form of incentives for development of geothermal power.

The first key point that results from the analysis is that the existing energy policy tools, or financial incentives, offered are directed primarily toward having a market commodity. The energy sector uses the kWh, and the production of this commodity can be supplied through a variety of sources. The Investment Tax Credit, Production Tax Credit, and other financial incentives are specifically tailored to having an equitable commodity, but lack effectiveness for developmental costs prior to resource definition.

Following this, a standardized commodity for which to base financial incentives fails to account for variations in developmental time, risk, cost, and plant life cycle. In each of these cases geothermal power is unparalleled to any other energy source. Exploration and discovery components are likened to the petroleum and mining sectors; load capacity is competitive with nuclear, coal, and hydropower; and the emission and environmental benefits are in line with other renewable energies. This puts geothermal in an isolated position, wherein it shares much with both renewable and non-renewable energy technologies.

Lastly, existing financial incentives benefit the successes of taking developmental risk, but fail to encourage early adoption of such development. McIlveen also suggests this by stating that, "current subsidies are not appropriate incentives to stimulate new project development" (McIlveen, 2011, p. 1). This restricts market entry and limits the competitive benefits, which lower costs. When energy technologies are compared, on a basis of levelized cost, geothermal is competitive. However, further cost reduction and

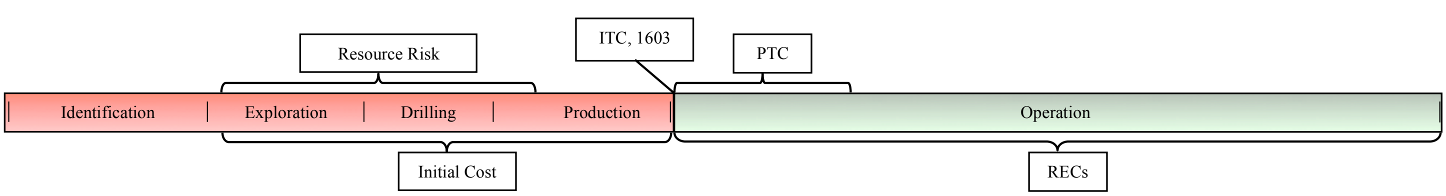

Figure 1. Policy vs. Barrier Timeline.

developments are necessary to invoke change where electricity originates.

The intent of this inquiry is to offer a direction in identifying where policy lacks in offering any resulting change through financial incentives. It is clear that developmental goals are focused on the production and sale of electricity, but are lacking in recognizing barriers during early-stage development. The resulting lack of incentives for exploration and pre-feasibility stages limits the potential of geothermal by also failing to recognize that this early-stage development is unique to geothermal. The difficulties of the geothermal sector to secure financing are not unlike those of oil and gas, or even other renewable energies, but the associated resource risk places a burden that is unconnected to existing financial incentives.

It is fair also, to conclude that there is a link between the uniqueness of "resource risk" in geothermal and the "initial cost". In establishing that the two barriers are not mutually exclusive, it appears that the initial cost is directly dependent on resource risk. Thereby creating the position that mitigation of geothermal resource risk will also have a mitigating effect on the initial costs for geothermal development.

The takeaway that is offered in light of this comparative research is that "geothermal development is unique". It shares similar components with other energy technologies in exploration, but not in production, environmental benefits, or initial capital investments. These unique qualities are not easy to overcome. However, when one considers the base-load capacity and competitive levelized cost of energy, there are many reasons to focus more attention on the policies that are capable of alleviating barriers of cost and risk. The potential is discoverable, but policy incentives, which are focused on exploration risk and cost, would suggest an alternative way of supporting clean energy. Geothermal incentives should be molded to better geothermal development and recognize its most notable barriers, resource risk and initial cost.

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[1] This table and the supporting methodology are part of ongoing dissertation research by the author, at the University of Delaware's Center for Energy and Environmental Policy.

[2] Compliance markets are directly tied to statues in Renewable Portfolio Standard legislation. It is through these types of RECs that utilities are able to meet their respective RPS requirements. Voluntary markets are driven by consumer confidence, wherein compliance markets are driven by legislation and penalties.