# Department of Energy – Office of Energy Efficiency and Renewable Energy Geothermal Program

## Geothermal Risk Mitigation Strategies Report

February 15, 2008

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# 1.0 Executive Summary

Renewable energy is among the fastest growing markets in the world today, with over $100 billion invested in 2007[1] in renewable energy projects and technology worldwide. Unfortunately, geothermal energy has not attracted much investment, garnering less than 1% of the pie last year. Geothermal power generation, which is a zero-emission, scalable, cost competitive source technology that provides a stable base-load power output, must overcome several challenges and perceived barriers to capture a larger market share.

This report provides an overview of general financial issues for renewable energy investments; geothermal energy investment barriers and risks; and recommendations for several incentives and government instruments that should be considered to stimulate increased investment in geothermal energy development. The recommendations have been developed with the following criteria:

- Lowest risk to the U.S. government
- Least cost to the taxpayer
- Greatest impact on the industry

Based on the defined stages in the project development process – Identification, Exploration, Drilling, and Production – our report focuses on the risks and other challenges that have limited the broad adoption of geothermal energy as a base-load power source. While certain technology risks apply heavily to geothermal development, this report focuses on the financial and investment risks and barriers to the industry. Suggested risk mitigation strategies are presented with proposed high-level cost estimates as well as a prioritization of the strategies, with a focus on those instruments that will deliver the greatest potential return for attracting investors and developers.

The recent limited interest that has begun to develop in geothermal energy has been driven by government policy, in the form of tax incentives and regulatory mandates, which creates returns large enough to support the current risk profile of these investment projects.

This report analyzes the market for geothermal energy investment, focusing on the risks and challenges that arise during the lifecycle of geothermal development. As with other renewable power sources, geothermal energy faces several barriers and obstacles to gain market acceptance and application. In addition to some of these general challenges, such as a perception of higher levelized costs and a small base of experienced professionals and equipment, the report identifies four specific challenges, which while not unique to geothermal development, are the critical hurdles for wide-spread adoption of geothermal power:

1. Access to transmission infrastructure,

[1] UNEP, SEFI. "Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries. 2007.

2. A lack of reliable resource information,
3. A lack of risk mitigation, or risk sharing, mechanisms available during the early stages of development, and
4. A lack of policy continuity and clarity.

While we identify these risks and challenges, we also take into consideration the Department of Energy's role and ability to work with industry. We have provided recommendations and prioritization of mitigation strategies that we believe will stimulate increased interest and investment in both conventional and EGS geothermal energy resources. They are:

1. Energy Transmission Infrastructure Programs
2. National Geothermal Database
3. Geothermal Resource Classification System
4. Structured Co-Funded Exploration Drilling Program
5. Structured Loan Guarantee Program Supporting Early Investment

# 2.0 Introduction

Geothermal energy in the United States remains a largely undeveloped energy resource with enormous potential. In the current climate change and energy security environment, it is an especially interesting power generation resource option as it bridges both the conventional feedstock and renewable energy options for electric power generation rather uniquely. This is due to the fact that geothermal powered electric generation is able to provide base-load generation allowing it to compete with other base-load feedstocks such as coal, natural gas and nuclear. At the same time, geothermal energy is a clean, renewable resource that competes with other renewable energy options such as wind and solar. This unique position makes it an attractive option for reliable and scalable generation while satisfying renewable energy voluntary or mandatory portfolio standards. Figure 1 below identifies the strengths and weaknesses of geothermal energy.

***Figure 1: Geothermal Strengths & Weaknesses***

| Geothermal Energy | |
|---|---|
| **Strength** | **Weakness** |
| • Clean, Renewable Energy<br>• Base-load Energy Source<br>• Inexpensive<br>• Reliable source | • Relatively long lead time from concept to production<br>• Large Entry Barriers<br>  – High upfront cost<br>  – High upfront risk<br>  – Lack of pre-drilling feasibility assessment<br>• Remote location and siting restrictions |

Common to other renewable options, geothermal energy faces market penetration barriers and obstacles such as:

- lack of resource information
- perceived high cost
- small base of experienced professionals and equipment
- high upfront costs
- geographic distance from population centers and transmission infrastructure

The potential geothermal energy resource available for electric power generation from conventional hydrothermal resources is enormous, and when the additional potential resource from Enhanced Geothermal Systems (EGS) is added to the overall resource potential in the United States, the overall potential contribution of geothermal energy to the electric power mix is extraordinary.

This Geothermal Risk Mitigation Strategies Report will focus on the identified impediments and risks to developing this largely untapped resource. Through numerous conversations with industry experts and primary research, our analysis reveals three primary challenges to expanding the potential of geothermal energy:

1) Reliable and available resource information,
2) Access to transmission infrastructure, and
3) Lack of policy continuity creating an ambiguous view of economic certainty

While we recognize these risks, we must also take into consideration the Department of Energy's role and ability within a commercial industry. We have provided recommendations and prioritization of mitigation strategies which we believe will stimulate increased interest and investment in both conventional and EGS geothermal energy resources.

# 3.0 Investment Landscape

In the post-war era, regulated companies have dominated the U.S. energy industry through expansions and ensured that energy services are delivered at cost-competitive prices.

For decades renewable electric generation technologies filled little more than niche markets in U.S. electric generation. Significant changes in the conventional perception of environmental and geopolitical costs have changed the economic fundamentals of global energy costs. Combined with rapid and potentially sustained price escalation, investments in renewable generation are made significantly more attractive.

As investment in renewable energy has been on a relatively small scale compared to conventional electric generation, investors have commonly been small developers. While there have been historical exceptions to the renewable small developer, investment in renewable generation has attracted the attention of large traditional investors in recent years.

The current industry landscape is transformational in nature and presents new investment opportunities and challenges as climate change and energy security influence decision-making. This new political landscape has opened the floodgates for new clean energy options, while regulations, investors and government entities endeavor to provide the essential infrastructure and services to develop and deploy new energy technologies. With $70.9 billion of new investments in renewable energy technology projects in 2006[2] and $117.2 billion in 2007[3], this is no longer just an interesting alternative, but a large scale transformation in global energy markets.

While the worldwide scale of available investment capital for renewable energy in 2006 is robust, the geothermal share of that capital was conspicuously small at less than 1%, or about $66 million.[4] Figure 2 below illustrates the worldwide renewable energy investment market and geothermal's room for improvement.

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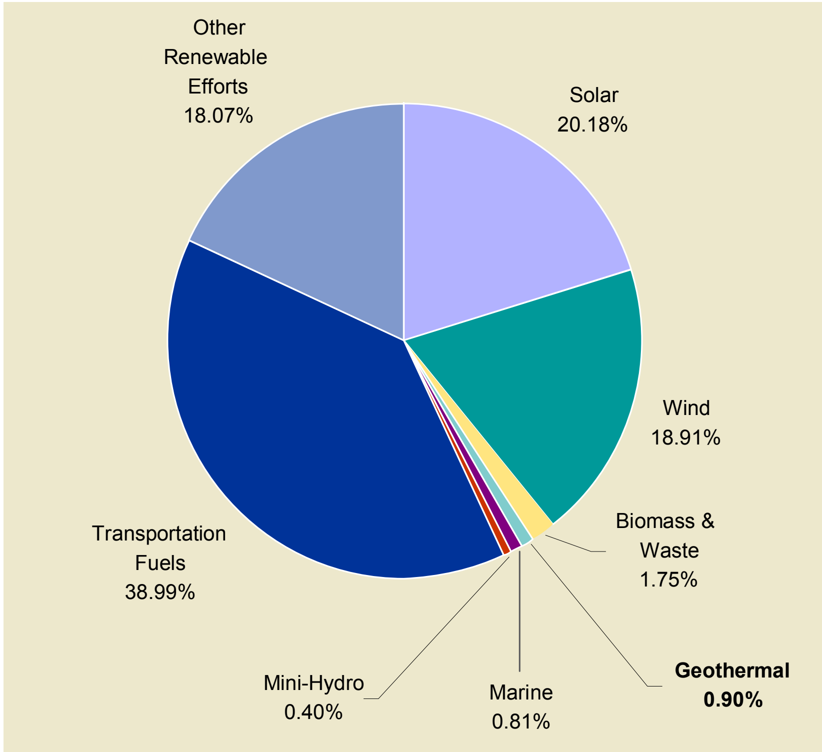
[2] UNEP, SEFI. "Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries. 2007.
[3] New Energy Finance, Ltd. "Clean energy investment breaks the $100bn barrier in 2007".
http://www.eere.energy.gov/news/news_detail.cfm/news_id=11564
[4] Ibid

*Figure 2: Share of Renewable Energy Investment in 2006*[5]




## 3.1 Evaluating Risk

When evaluating industry risk it is important to know the investor type. The two primary categories of investors engaged in the renewable energy arena are:

1. Large, traditional energy service companies that have the ability to finance renewable energy investments in technology or projects off of their balance sheets, and
2. Developers seeking investors for technology R&D and/or project finance

These investors evaluate projects and risks somewhat differently. An established independent power producer will have different risk tolerances than a small project developer, and these risk considerations can be far different than those of a regulated utility. What they have in common is a requirement for access to infrastructure and the need to generate a minimum return on invested capital.

This issue poses challenges for geothermal energy resources, which are different then those faced by other renewable energy options. Principally, investment in geothermal (conventional or EGS) has significant upfront costs that must be spent prior to determining the viability of the resource basin. This investment requirement raises the

[5] UNEP, SEFI. "Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries. 2007.

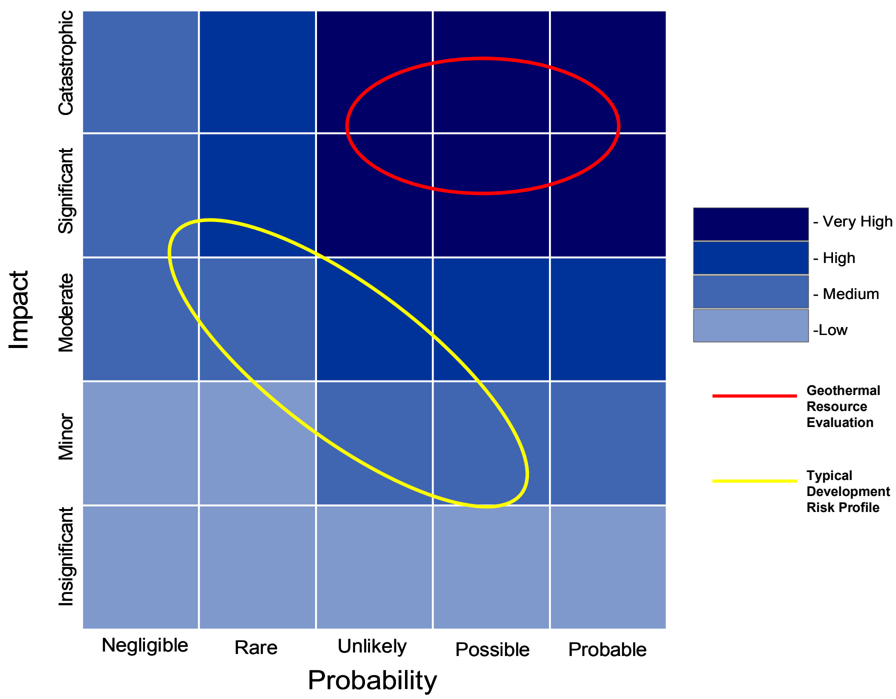
stakes for investors who must commit capital without a clear understanding on the return profile. In fact, at this very early stage of evaluating an investment opportunity, there are fundamental risks that investors must consider, represented in Figure 3 below. These risks require further evaluation based on the likelihood of occurrence and the perceived impact on the investment project.

***Figure 3: Renewable Energy Industry Risk Overview***

| Investment Risk Overview | Duration of Risk |
|---|---|
| **Finance** | |
| Credit Risk | Initial |
| Resource Viability Risk | Initial |
| Transmission Access | Initial |
| Tax Credits | Constant |
| **Regulatory** | |
| Permitting | Initial |
| Rate Allowance | Periodic |
| Environmental | Periodic |
| **Market** | |
| Netback | Initial |
| Power Purchase Agreements | Initial / Periodic |
| Competition | Constant |

Figure 4 below illustrates a traditional risk matrix where the upper-left sector represents those events that have the greatest likelihood of occurrence with the highest impact. Risks that cannot be realistically avoided have the reputation of increasing the cost of capital or raising the required rate of return. In the case of a geothermal investment, the likelihood of drilling a dry hole might carry a high probability and consequently put the project at a higher risk. Investments in geothermal are typically located in the upper right quadrant in a risk matrix, while the risk profile of typical generation development is in a more moderate area

*Figure 4: Risk Matrix for Investment*




## 3.2 Criticality of Government Incentives and Regulation

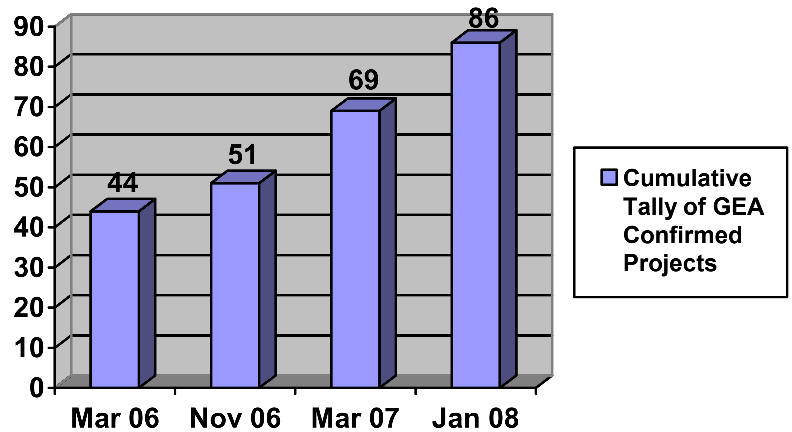
The economic viability of most renewable generation projects, specifically including geothermal electric production, continues to be dependent on the financial support created by national and state-level energy policy. In both the near- and long-term, these policy-based supports will be necessary to produce any level of investment in all but a select group of fringe projects.

### 3.2.1 Production Tax Credits (PTC)

Over the past several years the single most important program supporting renewable generation in the U.S. has been the federal production tax credit (PTC), which pays 1.5 cents/kWh for electricity produced and sold in the U.S.[6] Figure 5 below illustrates the increase of geothermal development since March 2006. In less than two years, the number of geothermal projects has increased by nearly 100%. Prior to the PTC, geothermal electricity generation was growing at a rate of only 15%.[7]

[6] The credit is indexed for inflation and currently pays 2.0 cents/kWh, additionally certain technologies are allowed only ½ of the available credit.
[7] The International Journal of Geothermal Research and its Applications (Elsevier), Vol. 34, No. 6, December 2005.

*Figure 5: Geothermal Projects In Development*[8]




Production Tax Credits as a subsidy are a vital aspect to the financing of these projects. In conjunction with related accelerated depreciation, the amount of a subsidy's worth is more than 60% of capital project costs. In the absence of some similar level of support, either as an incentive or through regulation, significant investment in all renewable technologies will decline sharply.

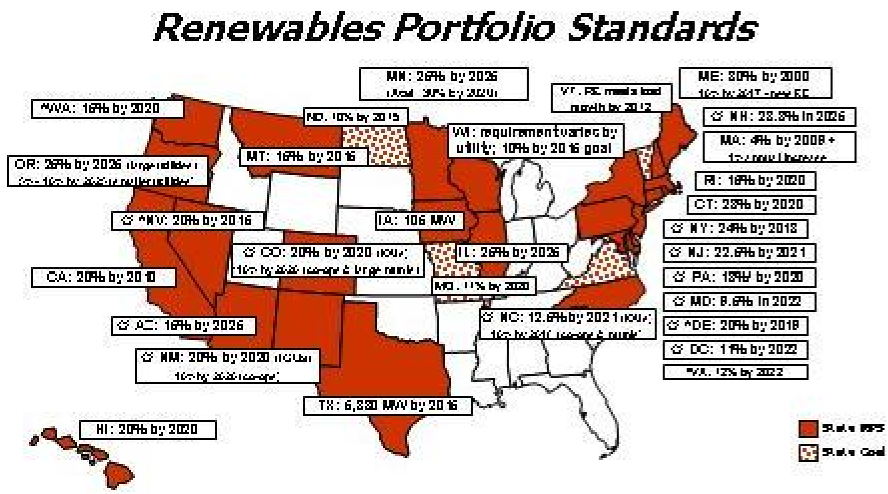
Despite the short durations of known PTC availability, the PTC has had a significant impact on investment in renewable electric generation. Notably, while this impact has been significantly larger for projects with short project timelines, such as wind installations, other long-term projects are benefiting as well. Based on the number of current geothermal projects in production, it would appear, however, that the expectation of a PTC extension has eased some of the uncertainties for investors about future availability as well as the short periods of credit availability.

### 3.2.2 Renewable Energy Credits (RECs)

In addition to the PTC, 33 states have adopted regulatory mandates or targets for set portions of electricity to be sourced from renewable generation (Figure 6). These programs range from setting easily reachable goals that will not likely have a material impact on the value of renewable investment, to programs that have already created separate, and substantial, sources of revenue and economic support.

[8] Geothermal Energy Association [GEA], Update on US Geothermal Power Production and Development. 16 January 2008.

*Figure 6: Renewable Portfolio Standards by State*[9]




In the aggregate these programs call for an increase of more than 320 TWh of renewable sourced electric generation by 2020, accounting for roughly 9% of the participating states electricity needs.[10] Based on these programs alone, investment in renewable energy will necessarily have to increase in order to keep up with demand.

In addition, there have been a series of proposals in Congress over the past two years to establish a national renewable energy standard (RPS). A national RPS would have set requirements that as much as 25% of all electricity sold in the U.S. be sourced from renewable generation by 2020.[11]

In many situations, the challenges of intermittency and output capacity from wind and solar resources will create increased demand for renewable sources, specifically geothermal, that can provide base-load generation. Figure 7 below illustrates the capacity factors involved with both conventional and renewable energy sources. If renewable energy consumption is set to increase in the coming future, geothermal's high capacity factor makes a strong argument to elevate itself above other renewable options as a logical leader.

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[9] Database of State Incentives for Renewables & Efficiency, www.Dsireusa.org
[10] "RPS Analysis". Deloitte Consulting, LLP. 2007
[11] http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=235300&Month=5&Year=2007&Party=0

*Figure 7: Capacity Factors of Conventional and Renewable Technologies*[12]

| Technology | Expected Capacity Factor (%) |
|---|---|
| Coal | 71 |
| Nuclear | 90 |
| Geothermal | 86-95 |
| Wind | 25-40 |
| Solar | 24-33 |
| Natural Gas Combustion Turbine | 30-35 |
| Hydropower | 30-35 |
| Biomass | 83 |

### 3.2.3 Carbon Limitations

Already a significant economic driver of projects in other parts of the world, future carbon and greenhouse gas restriction policies have already begun to have an impact on the economic analysis of electric generation development. Either by pricing carbon emissions into the cost of electricity or through the production of carbon offsets via emission-free electric generation,[13] there will be an additional layer of economic return from renewable energy projects, which some investors have begun to model into return expectations.

### 3.2.4 Energy Independence and Security Act of 2007 (EISA)

The recently enacted Energy Independence and Security Act of 2007 (P.L. 110-140) contained several provisions designed to further encourage renewable energy. EISA specifically highlighted geothermal energy expansion with $95 million for both conventional and enhanced geothermal research.[14] Not included in the 2007 Energy Act was an extension of the PTC, which is scheduled to expire on December 31, 2008.

While geothermal electric generation projects still have access to a 10% investment credit upon expiration of the PTC, this represents a significantly smaller subsidy for these projects. There will be a precipitous drop in investment in geothermal energy if the PTC is not extended or some equivalent funding mechanism is not put in place. Despite much of the technology having been available for some time (due, in part, to the very high levels of risk in the early stages of project development), the geothermal industry is still challenged to develop economically viable projects with financial support.

[12] Geothermal Energy Association, 2006. "A Handbook on the Externalities, Employment, and Economics of Geothermal Energy". Alyssa Kagel
[13] This assumes a cap and trade based GHG-limitation program, which would likely include the concept of additionality limiting the production of green attributes to either RECs or CO2 offsets.
[14] http://www.whitehouse.gov/news/releases/2007/12/20071219-1.html

## 3.3 Financial Instruments Used by Investors

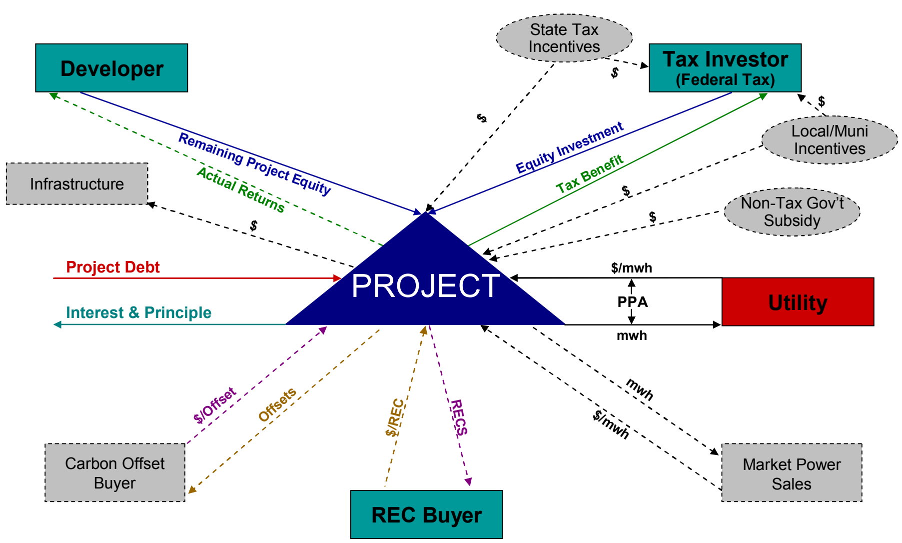
Key to every electric generation investment is the projected return based on the sale of electricity. That return could be in the form of rates charged to a vertically integrated utility's consumer base, as a defined stream of payments for electricity under a power purchase agreement, or as revenue from spot sales made in the merchant power markets.

The conventional capital structure for financing a project would be based on an equity investment by project owners as well as leverage either secured against a project or issued into the debt markets. If a project was supported by a power purchase agreement, the value of that forward sales contract could also be used as a financial support in raising project capital.

The substantial value associated with the PTC, combined with the limited tax appetite of most investors in renewable generation projects to date, led to the adoption of structured tax financing arrangements. In these transactions an outside investor with an appetite for tax credits and losses will make an equity investment in a project and will extract its equity contribution, plus a desired rate of return, primarily through the use of the tax attributes created by the project.

In addition, both forward renewable energy credits and carbon dioxide offset streams have been monetized to create project capital to finance development and construction of a project. Figure 8 below illustrates the aspects of financial sources for a project.

*Figure 8: Renewable Electricity Generation Capital Sources*



Assuming the current focus of energy policy remains constant, that is expanding regulation aimed at limiting GHG emissions and energy independence, the expected growth and total eventual market for renewable energy is enormous. The break-down of investment among technologies will depend on the underlying economics of those technologies as electric generation sources.

# 4.0 Geothermal Project Phases

Defining the phases of a geothermal energy project focuses the appropriate attention on the critical importance of each project phase and serves as the foundation for the risk analysis in subsequent chapters. Based on industry analysis we have identified five decision points spanning four phases throughout a geothermal project development. Figure 9 and Table 1 below, illustrate the breakdown of development.

*Figure 9: Deloitte's Geothermal Development Breakdown*

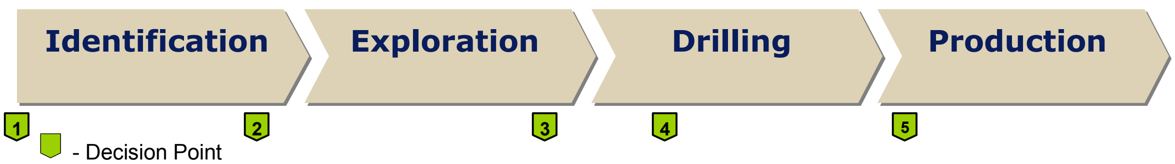



*Table 1: Major Decision Points in Project Development*[15]

| Stage | Question Answered | Investment at Decision Point |
|---|---|---|
| Pre-Identification Analysis 1 | How does geothermal compare with other generation options; nuclear, coal, natural gas, wind, solar, etc.? | --- |
| Identification Decision 2 | Does initial data research and site evaluation support further time and development? What business model serves this investment and will the project meet rate of return requirements? | ~ $1 Million |
| Exploration Decision 3 | Did the exploration drilling produce a positive resource assessment and feasibility? | ~ $9 Million |
| Drilling Decision 4 | Is the confirmation well successful and able to prove production capacity? | ~ $15 Million |
| Production Decision 5 | Do capacity, financial investment, permitting, time delays and external factors outside project control merit production? | ~ $60 Million |

## 4.1 Pre-Identification Analysis

Prior to embarking on an investment for a power generation project, an investor must first evaluate geothermal as an option that meets its goals and business model against other

[15] Cost figures were estimated based on research of 50 MW plants. Geothermal Energy Association, 2006. "A Handbook on the Externalities, Employment, and Economics of Geothermal Energy". Alyssa Kagel

generation options.  Typically, the investor-developer profile is a company that recognized a demand for base-load electricity (or zero-emission base-load electricity) in a market with known (or perceived) geothermal resources.  From this initial basic decision, the analysis is entirely driven by economic considerations.

Developing a geothermal facility has a unique set of considerations.  While these considerations present specific technical concerns, and there are undoubtedly technological and process improvements that could facilitate geothermal investment, it is the mitigation of risks and cost that will lead to widespread deployment of geothermal production as an electric source.

Developing economic projections has been further clouded by the relatively short known windows for the PTC combined with long project development times; especially as compared to some of the other technologies for which the PTC is available.  If the economic viability of a project is dependent on the availability of the PTC, and there is uncertainty as to whether the credits will be available when the project goes on-line, the decision making process is made more difficult and financing options are limited for that project.  This set of problems only adds to the underlying challenges with geothermal development.

At each of the identified decision points the analysis conducted determines whether the expected return on the investment will be adequate when measured against the required capital and risk.

## 4.2 Geothermal Project Phase Activities

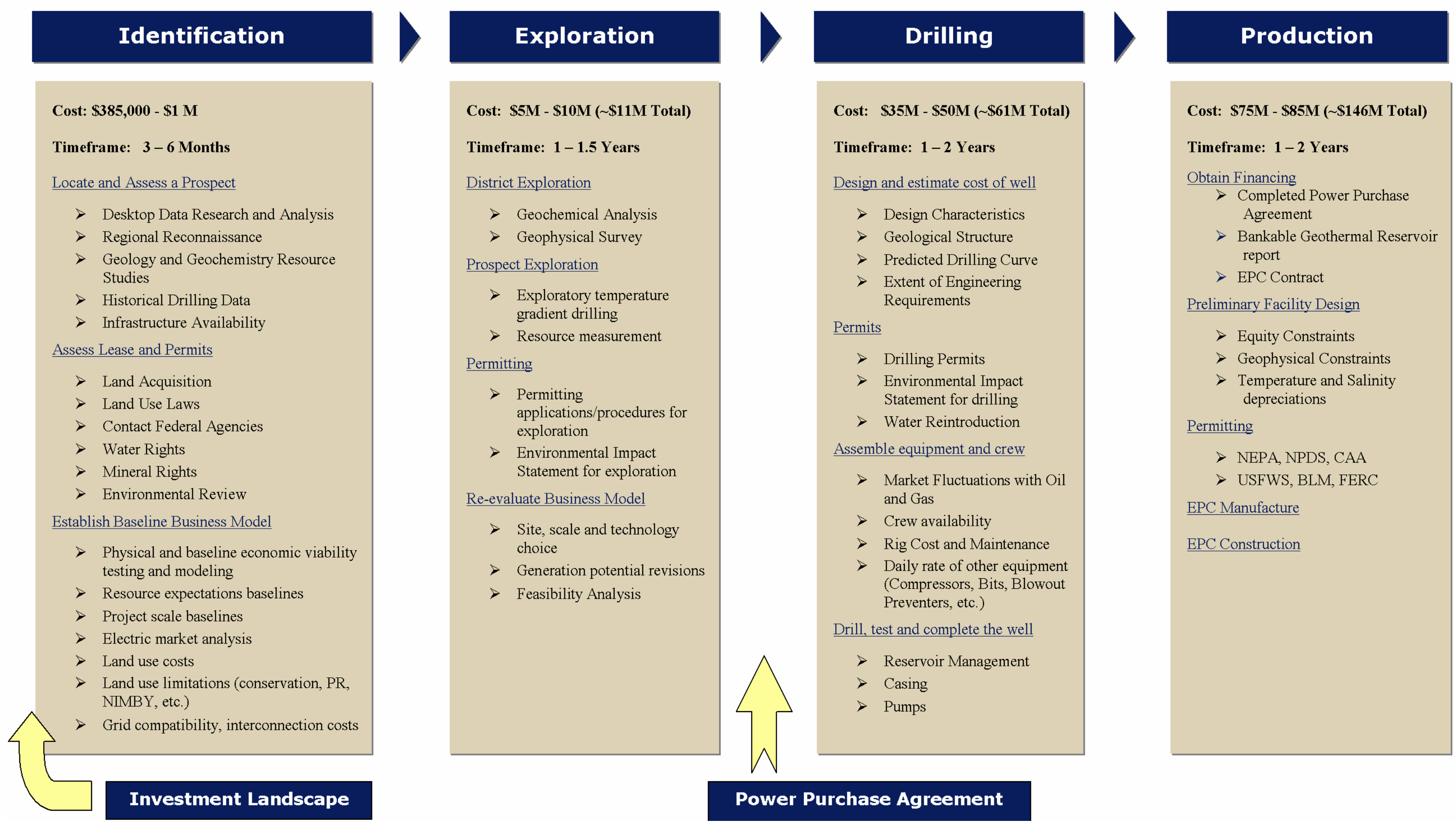
Many in industry have described the various phases of geothermal development.  Based on an analysis of these approaches, this report proposes a 4-stage breakdown: Identification, Exploration, Drilling, and Production.[16]

- **Identification** – Initial Research & Reconnaissance
- **Exploration** – Prospect Permitting, Studying Data & Exploratory Drilling
- **Drilling** – Project Feasibility, Initial Delineation Drilling & Production Drilling
- **Production** – Financial Close, Facility Design & Construction

The four phases illustrated in Figure 10 highlight the time, cost, and activities carried out during each phase of project development.

[16] Geothermal Energy Association [GEA], Update on US Geothermal Power Production and Development. 16 January 2008.
GRC 2007 Annual Meeting.  "Debt Financing for Geothermal."  Glitnir Bank.  Powerpoint. 1 October 2007.
Sinclair Knight Merz (SKM). "Moving a Geothermal Project from Concept to Commercial Reality".  Peter Barnett. 2006

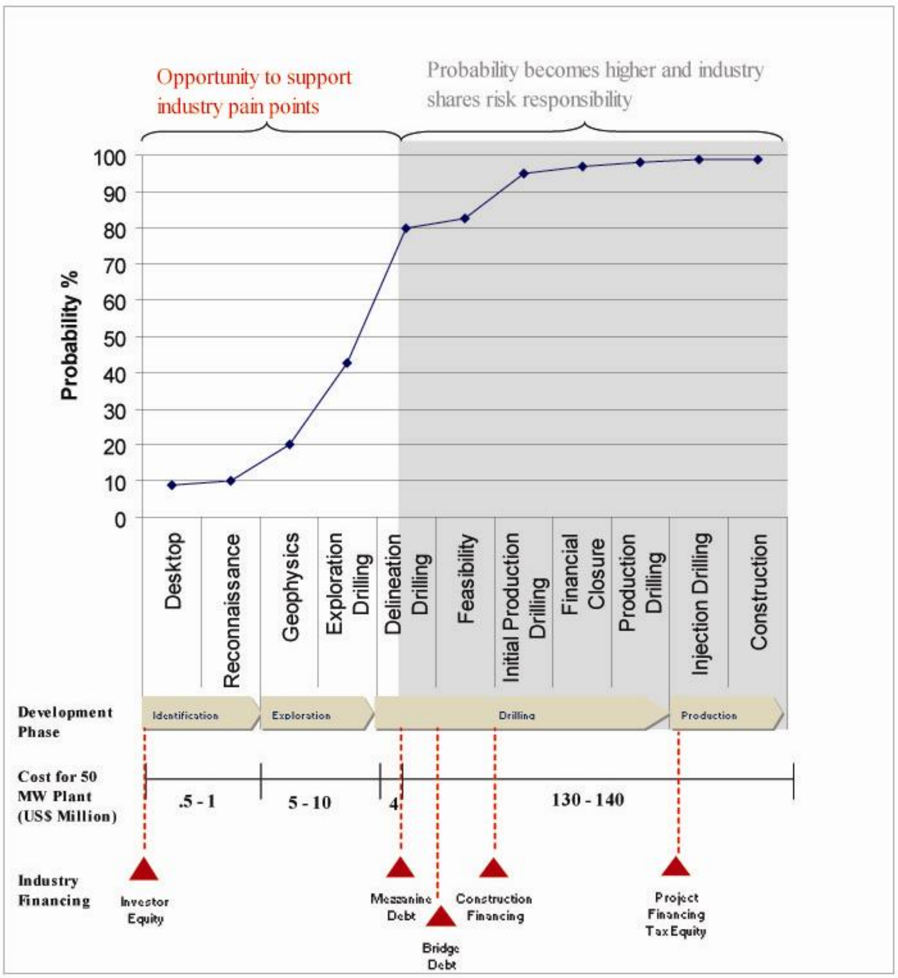
*Figure 10: Phases of Geothermal Development*



# 5.0 Risks Specific to Project Phases

With cost and activities evaluated in phases, it is possible to assess the impact each phase has on the success or failure of a geothermal development project. Figure 11 illustrates the probability of success for a geothermal investment based on current data for geothermal project success at each phase of project development.

*Figure 11: Probability of Success at Each Phase of Project Development*[17]

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[17] Geothermal Energy Association [GEA], Update on US Geothermal Power Production and Development. 16 January 2008.
GRC 2007 Annual Meeting. "Debt Financing for Geothermal." Glitnir Bank. Powerpoint. 1 October 2007.
Sinclair Knight Merz (SKM). "Moving a Geothermal Project from Concept to Commercial Reality". Peter Barnett. 2006

In addition to the phase, cost, and probability of success, Figure 11 illustrates where industry is currently able to obtain capital. Notice that most, if not all, capital prior to the development's proven feasibility is done through equity and not debt. Due to the high risk involved with Exploration, banks are not funding development with loans until much later in the development process. Generally, investment comes from seed capital, venture capital, or equity financing for a geothermal developer to explore a site.

The reason why geothermal developments do not currently receive loans from the open market is illustrated in the probability of the phase activities. The probability of success is low in the early stages of development. Indeed, while its only 6 to 8% of the overall development investment, the risk is too great for traditional lending. The risk factors involved with early identification, exploration, and partial drilling demand that roughly $12 to $15 million be invested (generally) from equity in order for a 50 MW plant to be developed.

The point that should stand out clearly from this illustration is that there is a gap in available financing that correlates to the highest risk period of project development. This gap creates two significant challenges for a developer. First, there is no risk-sharing mechanism, therefore the developer must bear a disproportionate share of project risk compared to other generation investments. Second, there is effectively a "money gap" created as a result of this risk construct. These two issues together create a significant barrier to entry. The investor-developer must have access to adequate capital to move a project into the later stages of development, but it must be willing to put that capital at significant risk. This pairing of risk and the money gap, which essentially multiplies risk, necessitates extremely high returns on projects, or development capital will flow to either lower-risk or higher-return projects.

Recommendations for each phase are identified in Figure 12.

# 6.0 Recommendations Specific to Phases

*Figure 12: Phase Recommendations*

**Identification**

Identification Recommendations:

- Partner with Interior and State/Local agencies to develop and maintain a national database of existing geothermal data.
- Partner with private industry to gain access to historical drilling information.
- Purchase proprietary information from private industry.
- Develop co-funded drilling programs that own the proprietary geothermal exploration information.

**Exploration**

Exploration Recommendations:

- Consider development of a federal program that pre-empts state and local regulations by establishing federal standards for permitting and approval of site activities.
- Develop an intelligent analysis system for determining the probability of success based on exploratory information.
- Support the development of emerging and new technologies.
- Develop a national database of available technologies and equipment, including lessons-learned regarding operational successes and shortcomings.

**Drilling**

Drilling Recommendations:

- Create and maintain a database of costs associated with geothermal resource development, with data to be collected as a condition of federal grants, loans, or loan guarantees.
- Couple with Universities to invest in geothermal research and education programs to further develop the industry.
- Develop incentives for utilities to enter long-term PPAs from geothermal sources.
- Streamline permitting process.
- Continue to examine the feasibility of geothermal co-production from oil and gas wells

**Production**

Production Recommendations:

- Streamline approval process for transmission lines to connect with the power grid.
- Consider extension of the NIETC program to geothermal projects.
- Support the development of alternative approaches to power plant design and operation unique to the use of geothermal resources.
- Develop a system of tax incentives that apply to capital development and to O&M activities.

# 7.0 Recommendations Specific to Risk

## 7.1 Energy Transmission Infrastructure Strategies

**Barrier: Geothermal Resources are remote from load centers and transmission infrastructure**

**Recommendation: Western States Electric Transmission Investment**

In the electric generation sector, a sound investment requires that demand exist and that there will be access to that demand in the form of available transmission capacity. The infrastructure requirements for electric generation have traditionally favored conventional generation sources such as coal and natural gas, which can be sited near both transmission corridors and demands centers. This has proven to be a major constraint for geothermal investment, as many of the identified resources are remote from both load centers and transmission infrastructure.

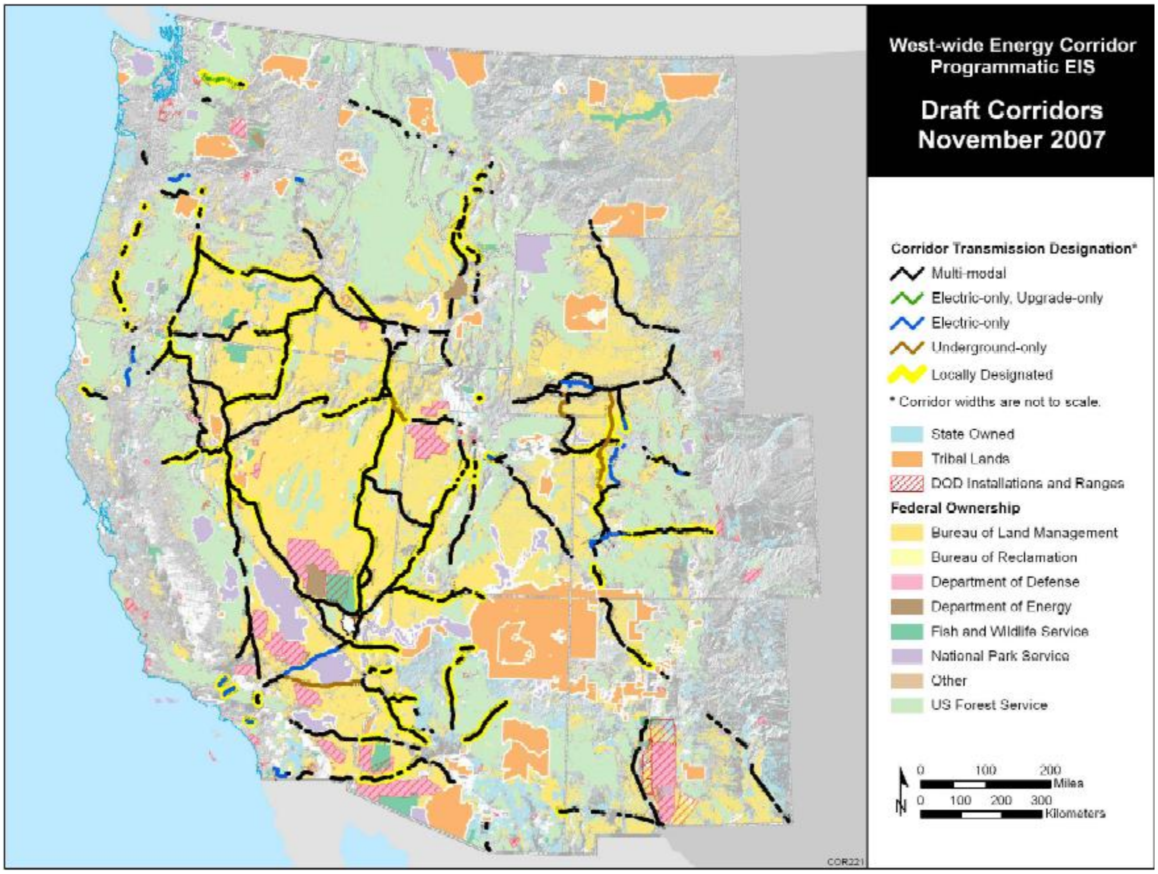
Section 368 of the Energy Policy Act 2005 (P.L. 109-058), heretofore referenced as EPACT 2005, required the Secretaries of Agriculture, Commerce, Defense, Energy, and Interior to designate energy transmission corridors on federal lands to help meet the Nation's future energy needs. EPACT 2005 addresses the issue of electric transmission infrastructure and the specific challenge of designating energy transport corridors on federal lands in 11 western states. The Draft Programmatic Environmental Impact Statement report (PEIS), a direct result of this legislation, was prepared and made available for public comment during the period November 16, 2007 to February 14, 2008. PEIS identifies transportation corridors and provides detailed maps in a GIS database that allows users to layer data, which is an especially valuable tool for investors contemplating energy generation investments on federal lands. It is particularly important to geothermal energy investors, as 84% of the identified corridors are on federal lands managed by the Bureau of Land Management (BLM), and a significant share of geothermal development will be on or near BLM managed land.

### 7.1.1 Energy Infrastructure Loan Guarantee

The siting and permitting issues that are, or will be, addressed by the PEIS may have a significant impact on geothermal investment as much of the proposed infrastructure is focused in a region where geothermal resources can be exploited. This offers a unique opportunity for the Department of Energy to leverage existing energy policy by establishing a loan guarantee instrument to support the construction of additional transmission infrastructure that would alleviate one of the primary hurdles to geothermal energy investment. A potential additional benefit could be the expansion of other renewable energy development through the creation of "energy farms" on western federal lands where geothermal, solar and wind facilities may be co-located.

Figure 13 below depicts an overview of the PEIS energy corridors. Analysis should be undertaken to correlate suspected or known geothermal basins along the proposed corridors.

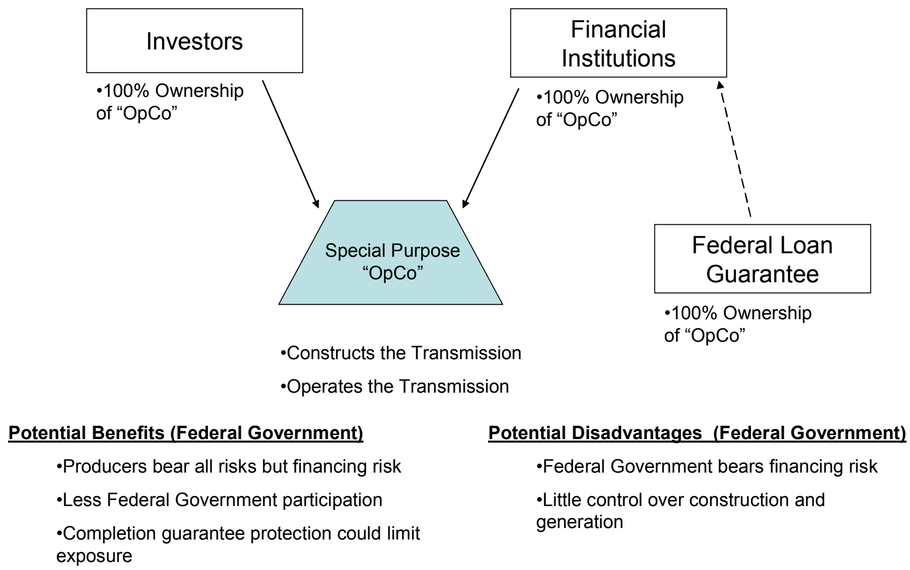
***Figure 13: PEIS Energy Corridor Map***




The concept of establishing a loan guarantee instrument for energy transportation infrastructure has previously been undertaken by the U.S. government. The Alaska Natural Gas Pipeline Act provided that 80% of the estimated cost of the pipeline or $18 billion could be guaranteed by the U.S. government. This loan guarantee program would offer considerable opportunity for alternative energy expansion in the U.S., specifically including both conventional geothermal power and EGS.

A loan guarantee program for electric transmission infrastructure expansion would support large scale capital investment and would serve as a cost reduction and risk mitigation tool. Figure 14 below illustrates a possible commercial structure utilizing a federal loan guarantee instrument.

*Figure 14: Proposed Loan Guarantee Model*




## 7.1.2 Federal Corporation Transmission Infrastructure Program

A hypothetical Federal Corporation model, with a corresponding risk analysis, is presented as another approach that the U.S. government could utilize to support energy transmission infrastructure projects on the identified corridor in the Western States, as identified in the PEIS, to aide in the development of geothermal resources.

This is an alternative ownership vehicle for the energy transmission infrastructure under which a Federal Government Corporation (Fed-Corp) would combine the financial assurance of a government agency with the flexibility of a private corporation to provide significant value to the public. A Fed-Corp acts as an agent of the federal government to perform a market oriented public service. Existing Fed Corps are operational across the full spectrum of both size and service; some are household names while others are virtually unknown. Some well-known examples of Federal Corporations include the United States Postal Service, Amtrak, and the Tennessee Valley Authority (TVA). A Fed-Corp can be wholly owned by the federal government or include private sector ownership. For the purposes of this review and simplicity, this report focuses on a wholly government-owned entity that would be legally independent of the federal government.

The charter for each Fed-Corp is created through individual and unique enabling legislation passed by Congress. There is no general definition, boilerplate language, or legislation precisely defining or outlining what constitutes a Fed-Corp. Though no standard formula exists for establishing a Fed-Corp, the Federal Government Corporation Control Act of 1945 provides guidance for organizations covered by this act. Other than the obvious considerations relevant to government ownership, this proposed Fed-Corp would be structured much like a private corporation for operational purposes. Characteristics of a Fed-Corp are shown below.

| Federal Corporation Characteristics |
|---|

- Created by an “Act of Congress”
- Distinct legal entity
- Does not have legal immunity
- Employees are not necessarily part of Federal Civil Service
- Organization structure can be specific to business mandate
- Acts as agent of Federal Government to perform market oriented public service

The TVA functions like a private sector energy company and is not regulated by the Federal Energy Regulatory Commission (FERC). The TVA was established by the U.S. Congress in 1933, primarily to reduce the risk of flood damage, improve navigation on the Tennessee River, provide electric power, and promote “agricultural and industrial development” in the region. Significantly, the TVA is not regulated by the Federal Energy Regulatory Commission (FERC). This may have important implications for the transmission infrastructure envisioned on Federal lands and will require additional legal evaluation to determine if the FERC would have jurisdiction on transmission owned by a Federal Corporation. An overview of the TVA is shown below.

The advantages, disadvantages, and risks associated with a Fed-Corp are similar to any corporation. One fundamental advantage for a Fed-Corp is access to lower-cost debt because of association with the Federal government (e.g., better rates for state and municipal tax exempt bonds). The TVA appears to benefit from this situation, even though it has a large debt\equity ratio, and is able to provide very competitive rates to its electricity consumers.

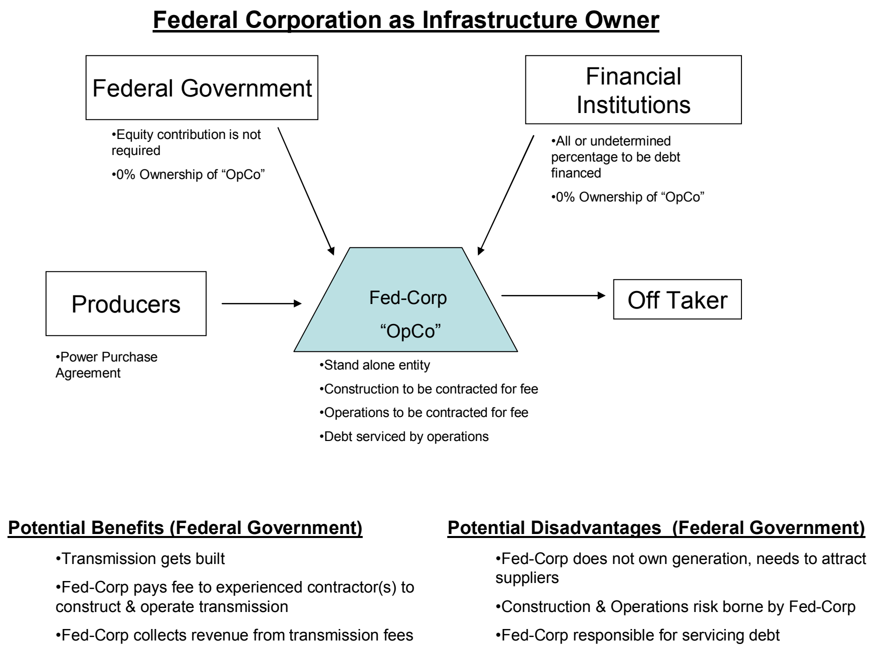
| Preliminary Assumptions |
|---|

- Debt/equity ratio 80/20
- Debt is obtained from commercial financial institutions
- Long term (10 year or longer) PPA negotiated with 85% of transmission capacity committed
- Rate of Return will be 10-13%
- Loan Guarantee role undetermined for all roles but private sector, but assumed to be available means of financing for all roles
- Project timeline is 10 years
- All transmission operations will be contracted to a 3rd party

Corporate ownership of transmission is typically structured through the creation of special purpose subsidiaries that actually own the transmission asset. Then a separate entity would be established to operate the transmission, referred to as an “OpCo”. In the proposed model, the construction and later operations of the transmission would be contracted to experienced contractors. In effect, the Fed-Corp would act as a contract manager in a holding company. The primary risks to the Fed-Corp include construction delays and cost overruns.

The model assumes that the Federal Government creates, through enabling legislation from Congress, the required Federal Corporation to participate in the investment. Furthermore, this model assumes that before the Fed-Corp undertakes transmission construction, purchase agreements and development assurances between producers and end users would be in place.

*Figure 15: Proposed Fed-Corp Infrastructure Model*




**Impact:**

The construction of transmission infrastructure in the Western States, using the PEIS designated corridors, would have the immediate impact of removing the current disadvantage that geothermal and other renewable energy options face, which is access to transmission. With federal government participation in either of the aforementioned options, there would be certainty with regard to the transmission infrastructure being built and the investment and development appeal of conventional geothermal power and EGS would increase dramatically.

**Cost:**

Current estimates for transmission infrastructure are, on average, $1 million per mile, which includes permitting and siting requirements. This figure might be high for the suggested corridors on federal lands but should be used as an investment guide. Identifying priority corridors for a phased construction might provide a managed risk approach while at the same time ensuring that the infrastructure gets built. These investment costs would be recouped over time through transmission use charges collected from power producers and buyers.

## 7.2 National Geothermal Database

**Risk: Availability of reliable and accurate geothermal resource information.**

**Recommendation: National Geothermal Database**

While there have been a series of attempts at, and plans for, organizing existing data on geothermal resources in the U.S. and specifically across western states, the accuracy, reliability and general availability of the information remains disjointed, haphazard or unavailable.

As with any investment decision, the availability of additional information reduces uncertainty and increases investor confidence. Based on numerous interviews and research, in addition to limited access to transmission infrastructure, the availability of reliable and accurate resource data and information is a critical deterrent to potential geothermal investors.

The goal of a developer during the critical Identification Phase is to obtain as much information as possible about potential resources while investor costs are low in order to mitigate future cost and risk during Exploration, Drilling and Production. More information available about the potential resource provides a developer with a stronger foundation for decisions on actual exploration and project development. Additionally, a more accurate and robust Identification stage will add certainty to the development process and encourage greater levels of investment for both current and future projects.

We propose the creation of a formal National Geothermal Database that would serve as a central depository for geothermal resource data. Efforts to address this challenge have experienced "on again, off again" funding, resulting in some data coordination gains and data management accomplishments, but well short of the desired outcome. A study conducted in 2000 for NREL revealed that over a 25-year period, numerous geothermal research efforts were conducted with state and federal funding. Despite these efforts, the analysis and information contained in those research documents is difficult to access without significant research efforts. That same study cited that much geothermal resource attribute data also exists but is distributed among numerous locations and often stored in boxes, without any data index or organization.[18]

In 2006, Geo Hills Associates produced a study on historical exploration and drilling data. The study found published exploration and drilling data from 22 geothermal power generation projects and at least 315 geothermal prospects in the western United States compared to the 140 geothermal resource sites examined in the Western Governors' Association Geothermal Task Force Report of 2006. [19] The findings of these studies

[18] Entingh, D. Princeton Energy Resources International, LLC. "Geothermal Studies and Analyses: Report 6A. Status of DOE Geothermal Technical Report Collections".
[19] Combs, J. 2006. "Historical Exploration and Drilling Data from Geothermal Prospects and Power Generation Projects in the Western United States". Geo Hills Associates, Reno NV.

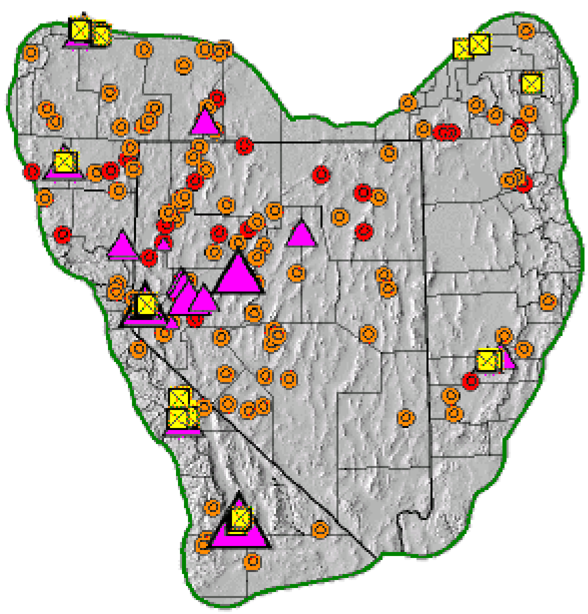
illustrate that data exist but can be difficult to find and use and certainly are not available in one national database.

Data available in public records include many information attributes on geothermal resources that are extremely beneficial for use by developers. Though not currently available in a central database, these pockets of information include critical geothermal attribute information such as:

- Temperature at depths
- Fractures
- Seismicity & Microseismicity
- Hydropressure
- Deep drilling data
- Permeability data

This data should be made available to the public on a centralized web application to encourage both investors and developers to access information. The image in Figure 16 shows the results of work currently stored at the University of Nevada-Reno that layers various sources of information to determine favorability of sites in the Great Basin. This is a strong start to establishing a National Database and might serve as a model for development.

*Figure 16: Great Basin Favorability Image from UNR Database Information*



**Impact:**

Information and knowledge increase resource certainty and reduce risk, which allows for better access to capital, as well as a more accessible and manageable base from which to develop a portfolio of projects or manage speculation across several leases. A well-documented geothermal database that is readily available to potential investors will provide adequate resource certainty to attract significantly more investors and capital to both conventional and EGS development.

The potential to charge a higher "rent" on leases also exists, especially in areas of well-documented resources, providing an additional return on investment, albeit back to the U.S. Treasury (albeit not directly to the DOE).

This database would be significant for conventional geothermal by reducing both investor uncertainty and upfront risk. It would be absolutely critical for the future EGS for the same reasons in addition to creating a foundation for a knowledge management system and success in the future.

**Cost: $5 million - $7 million**[20]

[20] Estimate provided by Susan Petty, AltaRock Inc.

## 7.3 Geothermal Resource Classification System

**Risk: A lack of standardized methodology which classifies potential geothermal resource sites for use with developers and investors.**

**Recommendation: Geothermal Resource Classification System**

DOE should fund the development of a standard classification system that addresses the probability of risk based on a standardized set of geothermal resource criteria and attributes. The classification system would be developed by industry experts to determine a scaling that organizes possible geothermal resource areas into four classifications using a favorability basis. The classification system would correlate strongly with data in the National Geothermal Database.

Currently, the University of Nevada, Reno (UNR) publishes a Geothermal Favorability Mapping System for the Great Basin Center for Geothermal Energy. The site contains interactive maps citing areas with data on location, geothermal, geophysical, geologic, geodetic, groundwater, and overall favorability for sites throughout the Great Basin.[21] As this information has been integrated for sites in the Great Basin, clearly this integration can be expanded regionally and nationally. Industry experts currently assessing sites for geothermal development noted that the Favorability Mapping System is an extremely valuable tool that draws interest to the area because of the classification system and well managed data[22].

Another potential classification for geothermal resources was developed for the Department of Energy in 2004.[23] The proposed system classified geothermal resources into seven categories based on temperature: non-electrical, very-low, low, moderate, high, ultra-high, and steam fields. The scheme used temperature due to the fact that it can be approximated from geochemical exploration and heat flow studies long before a field is confirmed by drilling or considered for commercial development.

**Impact:**

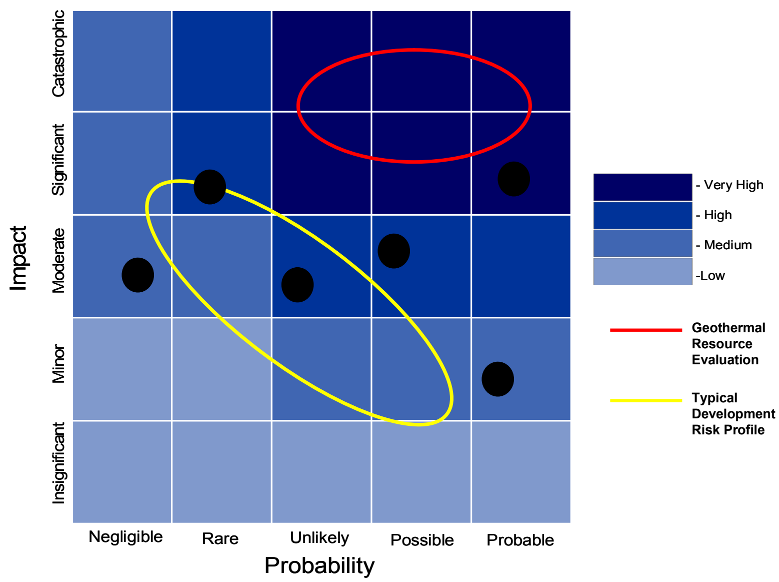
A Geothermal Classification system would provide industry a clearly defined framework to evaluate both Greenfield and Brownfield prospects and establish a common industry language for potential sites whether conventional or EGS. Additionally, this classification system would provide developers and potential investors with more information and a tool for resource valuation, allowing for the development of risk-balanced portfolios. Building from the 2004 DOE study and UNR, DOE could build an interactive mapping system for showcasing sites for geothermal resources with a clearly defined classification system. Implementing a classification system would support

[21] http://www.unr.edu/Geothermal/interactive_maps.htm
[22] Based on conversation with Susan Petty.
[23] Sanyal, S.K., 2005 "Classification of Geothermal Systems - A Possible Scheme" Thirtieth Workshop on Geothermal Reservoir Engineering. Stanford University.

balanced portfolio investments in various geothermal resource basins, which could substantially increase the attractiveness of investment in this abundant resource

Referencing the risk matrix in Figure 4 in Section 3.1, Figure 17 illustrates an ideal situation of diversified risk investments used by investors to plot a portfolio approach for geothermal investment.

***Figure 17: Geothermal Classification Scheme***




**Cost: $1-2 Million**

## 7.4 Co-Funded Exploration Drilling Program

**Risk: The only information of real value for project success is with the high cost of drilling subsurface.**

**Recommendation: Co-funded drilling program focusing on industry value-added**

Borrowing from DOE's Industry-Coupled Drilling, Geothermal Resource and Exploration Definition (GRED), and the United Nation's Partial Risk Guarantee (PRG) program, a government grant or fund for mitigating the risks of exploration offers significant potential to encourage geothermal investment. With the PTC potentially expiring at the end of 2008, a federal policy will almost certainly need to be in place in order to continue to stimulate growth in geothermal power. Even with an extension of the PTC, as is recommended in this report, a government cost-sharing program for exploratory drilling would be a critical method for managing the high level of risk during the early stages of project development.

If the National Geothermal Database and Classification System can be put in place, a focused exploration drilling program can help populate the database, solidify the classification system, and ultimately fuel the industry. The terms of the program would have stipulations on both project success and failure in order for the government to achieve maximum value for all outcomes.

It is imperative to evaluate developers applying for exploratory drilling cost-sharing in order for the program to receive the maximum value on investment. Upon application for government funding, an evaluation of the developer's resource site and ability to successfully develop and finance the project should be prerequisites for funding under the program.

A review committee would be required to review applications for co-funded drilling programs in order to evaluate proposed companies for their overall business and technical capabilities. The council would consist of geothermal experts at DOE as well as experts in financial risk and renewable energy investment.

Identification and Exploration Phase assessments would take into consideration three activities related to early development:

1. **Desktop Geothermal Resource Study** - literature review of available information directly related to geothermal energy (hot springs, fumaroles, etc.), regional geology and geophysical studies, results of mineral and hydrocarbon exploration, groundwater and geohazard investigations, aerial photographs, and satellite imagery;

2. **Field Reconnaissance Surveys and Investigations** - environmental and social issues, local infrastructure availability, and possible project sites and transmission routes; and

3. **Detailed Geothermal Exploration Surveys** - geophysical techniques which may be able to provide deeply-penetrating measurements that can be used to delineate a potential geothermal reservoir and assist in the designation of probable exploration drilling targets.

Cost-sharing coverage will vary depending on the amount of risk assessed from important geothermal estimates such as wellhead temperature, wellhead flow rate, estimate of permeability, geochemical analyses of geothermal fluid, and non-condensable gasses. In addition, the companies' overall risk profile, history, and business plan would be taken into consideration.

Should a development well prove successful, the loan would be repaid to the federal government with interest. Should a hole come up dry, no repayment of funding will be necessary; however, the identification and exploration information gained from drilling would be turned over to the geothermal resources database and classification system to be used as public information.

**Impact:**

Co-funded drilling would offer developers assistance with some of the very high risk early-stage costs associated with resource identification and exploratory drilling. This would result in the availability of more capital for a wider range of projects as well as potential additional capital from investors not currently willing to take on the risk associated with geothermal development.

In order to maximize the value of a government-funded drilling program, returns must be taken from all outcomes so that the program can have lasting and meaningful impact in the industry. Interest returned on successful exploration will return some actual cash value. In addition, information obtained from co-funded drilling would support the database and classification system, enabling it to continue to grow and become an increasingly valuable tool for both conventional geothermal and EGS. Eventually, resources will be mapped and classified well enough to reduce the inherent risk in the early stages of development and encourage investors to confidently develop geothermal resources. The increase in investors will eventually remove the need for a co-funded exploratory drilling program.

**Cost:**

The cost of a co-funding drilling program is dependent on the amount allocated by DOE and the risk of loss for the guaranteed loans. However, average exploratory drilling for slim holes is about $1.5 million per well drilled. Assuming a cost-sharing of 30% per well, a revolving fund of $50 million would support 100 exploratory wells. This cost-sharing would also offer a larger test environment on current technology applications and provide insight into new technology or exploratory techniques.[24]

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[24] Geothermal Energy Association, 2005. "Factors Affecting Costs of Geothermal Power Development". Cedric Nathanael Hance.

## 7.5 Structured Investment Aggregator Loan Guarantee Program

**Risk: Early development cost is too risky for traditional lending**

**Recommendation: Loan Guarantee Program Directed at Investment Aggregator**

The relatively small investors that have driven much of the expansion in renewable electric generation during the early years of technology adoption lack the scale to support most risk management products. While some facets of the risk management industry are taking shape in the renewable space, there remains a significant gap in developed, available tools. The limitations in risk management products are partially mitigated through high return margins supported by the current incentive and regulatory frameworks. This risk management challenge is magnified in the context of geothermal development due to the extremely high risk of loss during the identification, exploration, and delineation drilling phases of project development.

This high probability of loss in the early stages of development makes supporting geothermal development through the creation of a novel risk mitigation product very challenging. We propose one alternative to address this need as loan guarantee structure.

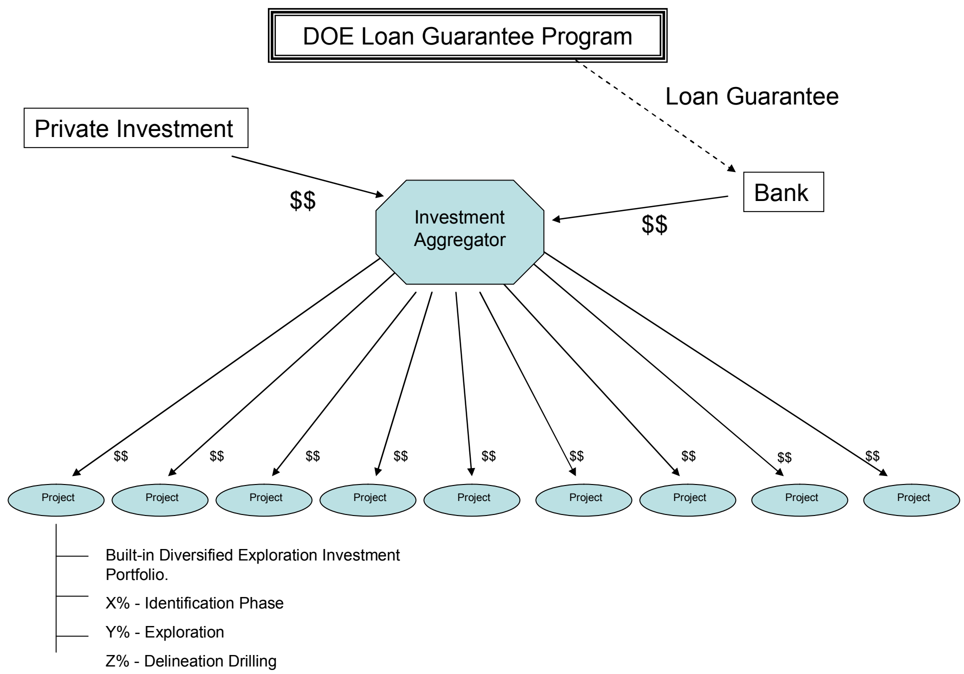
Loan guarantees are extremely costly support vehicles in activities that carry significant failure rates – as is the case with the early stages of geothermal development. As a result, direct loan support would amount to little more than a direct subsidy to these activities.

We propose the loan guarantee program be directed at an entity (Investment Aggregator, or "IA"), or a group of entities, that would make direct equity investments and loans to geothermal projects in the identification, exploration, or delineation drilling phases of development.

The IA would establish a pool of investment funds from debt guaranteed by the U.S. government, as well as from other sources (i.e. banks). The blended cost of capital, due to a portion of the funds for this enterprise being guaranteed, would be significantly lower than the cost of capital to support this activity obtained solely from private debt and equity markets.

Investments would be made under a determined set of criteria, designed to limit loss exposure within single projects, geographies, and activity types. The goal of the structure, depicted in Figure 18, would be to ensure as broad a portfolio of geothermal development investments as possible to produce statistically certain returns on an aggregate basis.

*Figure 18: Example of Structured Loan Guarantee Program*




In order to maximize the value of the loan guarantee for overall geothermal development, value must be built into all outcomes so that the program can have lasting and meaningful impact in the industry. Successful loan payment will be based on most other government-backed loan policies, however, should a funded project phase be unsuccessful, the identification and exploration information gained from drilling will be public information to be used in the National Geothermal Database and Classification System.

With information obtained from the failed exploration drilling, the database and classification system will continue to grow to be a valuable tool for both conventional geothermal and EGS. The intention will be to eventually increase mapped and classified resources well enough in order to reduce the inherent risk in early stages of development and encourage an independent investment market.

**Impact:**

This program will drive significant funding into the high risk period of geothermal development, when the limitations on capital sources currently impinge the number of sites being investigated and developed. Absolute impact will be dependent upon the scale of loan guarantees made available to the IA(s).

Coupled with the National Geothermal Database and Classification System, a value-driven loan guarantee program can be used to help populate the database, formulate a national resource classification system, and ultimately fuel the industry.

**Cost:**

The cost of a loan guarantee program is the risk of loss for the guaranteed loans. This structure will mitigate the potential risk of loss while injecting significant funds into the early stages of geothermal development. Risk of loan default will be limited through the investment criteria with which the IA will be required to comply prior to investing or lending to a project. By ensuring a broad investment portfolio, which, if properly managed, will result in net success rates and in limiting loss exposure in any one area or to any one project, the likelihood of an IA default on its guarantee obligation will be low. Additionally, by requiring additional, subordinate sources of funding for the IA, there will be an economic risk of loss that will drive sound business practice in terms of the IA's approach to actuarial planning and project and developer due diligence.

The absolute cost will be determined by the scale of the project, as well as the level of restriction placed by DOE on the IA's ability to act freely in the market.

## 7.6 Additional Recommendations

We offer three additional suggestions for supporting geothermal development, which are not directly under DOE's control. The first two (expanded below) are royalty relief and streamlining the permitting process under the National Environmental Protection Act (NEPA). These are essentially revenue neutral proposals that would have a positive impact on geothermal development.

Finally, policy continuity and clarity with respect to the Production Tax Credit (PTC), as well as state-based regulatory mandates, will provide critical support for geothermal development. In the near-term, as the various regulatory programs related to renewable energy and carbon emissions develop, the continuation of the PTC will be critical to supporting measurable investment interest in geothermal power as an electric generation source.

### 7.6.1 Royalty Relief

Under current BLM rules, there is a ten-year period during which certain geothermal projects qualify for royalty relief in the form of a 50% reduction in the royalty paid from electric production from geothermal resources, from 3.5% to 1.75%. The royalty reduction program is valid for new and expansion projects that are placed in commercial operation by August 8, 2011.

Our proposal is to expand royalty relief to all geothermal production activities and to establish the program as a clearly defined long-term support for geothermal development, with an open period for projects reaching commercial operation through at least 2017. Program certainty, as well as the availability of the incentive program for a longer period of time, is critical in increasing investment decisions in geothermal development. Typical projects can take more than three years to reach commercial operation, and as such, longer incentive periods provide clarity that the incentives can be factored into economic return models.

**Impact:**

By expanding the royalty relief program, an investor/developer will be able to extract a greater amount of revenue at the early stages of electric production. This in turn produces a higher return, making geothermal investment more attractive as a power source.

**Cost:**

Based on results of earlier royalty relief programs, these programs have been nearly revenue neutral, as lower royalty rates have led to increased resource development. Over the life of a project royalty revenue produced will be lower; however, an increased number of active projects will produce additional royalty revenue.

### 7.6.2 NEPA Categorical Exclusions

Under the National Environmental Protection Act, a federal agency must consider environmental impacts before granting permits for drilling and resource extraction. Permitting processes under NEPA can be time consuming and burdensome. Under EPACT 2005 a series of categorical exclusions (CX) from NEPA were implemented for certain oil and gas exploration and extraction activities. By adding certain types of geothermal exploration and drilling activities to the CX list, the permitting process could be shorted significantly.

**Impact:**

Shorter project periods would reduce project costs and enhance returns. Additionally, shorter project periods would reduce uncertainty for policy and market dynamics when modeling economic returns.

**Cost:**

To be determined, but the expectation would be revenue neutral or positive returns based on greater lease and royalty returns.

# 8.0 Conclusion and Next Steps

The findings of this Geothermal Risk Mitigation Strategies Report reveal that Federal Government participation could have a significant impact on encouraging investment in geothermal energy resources. Historically, the U.S. government has spearheaded the construction of significant infrastructure projects to ensure that the American public received essential services and enjoyed economic security. More recently, the U. S. government has introduced programs that provide investment incentives to the energy industry to alleviate potential risk and support the development and deployment of technology critical to the Nation's economic future.

This report is not meant to be an exhaustive review and analysis of all possible U.S. government instruments or incentives that might encourage investment in geothermal energy resources, but rather it is intended to identify strategic options that offer the highest impact to the industry, the least risk to the government, and the lowest cost to the taxpayer.

The recommendations contained in this report have the additional benefit of functioning both as individual instruments and together as an incentives package. Moreover, most of the recommendations build on existing legislation or mirror other U.S. government programs already in the marketplace. For example, a DOE Loan Guarantee program currently exists to support alternative energy development and deployment, which might be an existing program to use for the loan guarantee recommendations in this report. In addition, EPACT 2005 already identified the need for an energy transportation corridor in Western States; therefore, building on the investment already made is a prudent next step.

The following represent our Recommended Next Steps:

1. **Electric transmission** – The potential to capture synergy with the recently released Draft PEIS identified energy corridors is substantial and every effort should be undertaken to evaluate the suitability of the corridors for electric transmission from geothermal resources. We believe this promises to deliver a substantial positive impact for the investment community exploring renewable energy options, most particularly those seeking to invest in geothermal energy, because of the Western States concentration and the use of federal lands for the transportation corridor. In the immediate near term, existing geothermal resource maps should be overlaid onto the GIS map product in the PEIS to pinpoint the priority areas of opportunity.

2. **Energy transportation infrastructure** – Evaluating the suggested energy transportation infrastructure investment options should take an equally high priority. We believe both the loan guarantee and the Federal Corporation option are viable tools for supporting this essential investment. A project evaluation for an electric transmission line is a necessary first step, referencing the above-named maps as an initial guide for the corridor analysis.

3. **National Geothermal Database** – Of equal importance is the creation of the National Geothermal Database. The collected data, once digitized, can be overlaid and correlated to the above mentioned maps to reveal the highest priority geothermal basins and for siting the infrastructure in the corridor that captures the most geothermal energy resource. Even without this correlation, the impact of the database will be substantial, and its importance will be significantly enhanced with the addition of a Classification System that will provide developers and investors with a much-needed framework for investment evaluation.

4. **Cost sharing** – Cost sharing, either in the form identified for exploratory drilling or the more formal loan guarantee structure, offer to potential investors a risk mitigation instrument that encourages risk taking in a very managed structure. The benefit of either option is that the U.S. government will receive the collected data, which in turn will aide in continuing to build the National Geothermal Database. Both options should be evaluated and analyzed from the ease with which they can be implemented and managed as well as for their potential to encourage investment.

## References:


Combs, J. 2006. "Historical Exploration and Drilling Data from Geothermal Prospects and Power Generation Projects in the Western United States". Geo Hills Associates, Reno NV.

Database of State Incentives for Renewable and Efficiency (DSIRE). “Renewable Energy by State”. www.dsireusa.org

Deloitte Consulting, LLP. “RPS Analysis”. November 2007.

Entingh, D. Princeton Energy Resources International, LLC. “Geothermal Studies and Analyses: Report 6A. Status of DOE Geothermal Technical Report Collections”.

Geothermal Energy Association [GEA], “Update on US Geothermal Power Production and Development”. 16 January 2008.

Geothermal Energy Association, 2005. "Factors Affecting Costs of Geothermal Power Development". Cedric Nathanael Hance.

Geothermal Energy Association, 2006. "A Handbook on the Externalities, Employment, and Economics of Geothermal Energy". Alyssa Kagel

GRC 2007 Annual Meeting. "Debt Financing for Geothermal." Glitnir Bank. Powerpoint. 1 October 2007.

New Energy Finance, Ltd. “Clean energy investment breaks the $100bn barrier in 2007”. February 2008.

Sanyal, S.K., 2005 "Classification of Geothermal Systems - A Possible Scheme" Thirtieth Workshop on Geothermal Reservoir Engineering. Stanford University.

Sinclair Knight Merz (SKM). "Moving a Geothermal Project from Concept to Commercial Reality". Peter Barnett. 2006

The International Journal of Geothermal Research and its Applications (Elsevier), Vol. 34, No. 6, December 2005.

The International Journal of Geothermal Research and its Applications (Elsevier), Vol. 34, No. 6, December 2005.

The White House – Office of the Press Secretary. “Fact Sheet: Energy Independence and Security Act of 2007”. December 2007. http://www.whitehouse.gov/news/releases/2007/12/20071219-1.html

UNEP, SEFI. “Global Trends in Sustainable Energy Investment 2007: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency in OECD and Developing Countries. 2007.

United States Senate Committee on Natural Resources. "An Outstanding Show of Support for RPS". May 25th, 2007.
http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_id=235300&Month=5&Year=2007&Party=0

University of Nevada-Reno. Great Basin Center for Geothermal Energy.
http://www.unr.edu/Geothermal/interactive_maps.htm

US Department of Energy. "Clean Energy Investment Exceeds $117 Billion in 2007." February 06, 2008 http://www.eere.energy.gov/news/news_detail.cfm/news_id=11564

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