Capturing the Heat of the Earth: How the Federal Government Can Most Effectively Encourage the Generation of Electricity from Geothermal Energy

*By Ben Tannen**

This Article examines federal policy directed at encouraging electricity generation from geothermal power, asserts that current policies are ineffective, and proposes a series of changes to promote the use of this valuable source of renewable energy. Increased reliance on geothermal could transform the landscape of American electricity generation. Geothermal resources are extremely abundant, and could theoretically generate well over three-quarters of the United States' current electrical capacity. Additionally, unlike many renewable energy sources, geothermal power plants could meet baseload, or everyday, demand, since geothermal plants can produce electricity almost constantly. Moreover, geothermal electricity is not overly expensive, with some studies estimating that it could be cost-competitive with electricity from coal by 2015. Finally, geothermal energy is extremely clean, with power plants emitting less than one percent of the carbon dioxide of a typical fossil fuel plant. Geothermal energy is thus a plentiful, reliable, and cheap domestic source of energy that could help slow climate change.

This piece examines why electricity generated from geothermal energy has remained roughly stagnant at only 0.4 percent of the country's total electrical capacity since the new millennium, arguing that insufficient federal attention to geothermal research and development (R&D), project financing methods, and federal lands leasing policy has limited geothermal's expansion. Part I will briefly introduce geothermal electricity production's technology and history, the major relevant federal statutes, and the existing literature on geothermal law and policy. Part II will analyze why the federal government's approach towards

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geothermal R&D has been inadequate, mostly due to limited funding, and will describe the hypothetical structure of an effective federal geothermal R&D regime. Part III will investigate why current federal geothermal project financing aid, mainly tax benefits, is insufficient, and will describe the elements necessary for a federal funding program to be successful. Part IV will study the federal geothermal leasing process, historically characterized by massive delays but which Congress overhauled in 2005, and see if the new changes are sufficient to encourage development or if they need supplementation.

INTRODUCTION

"The Congress hereby finds that. . .the advancement of technology with the cooperation of private industry for the production of useful forms of energy from geothermal resources is important. . .to protect the public interestFalse”[1] In passing the Geothermal Energy Research, Development, and Demonstration Act in 1974, which laid out the above findings,[2] Congress acknowledged geothermal energy’s promise. In retrospect, congressional recognition of geothermal’s potential to contribute to the nation’s energy security as a clean, renewable alternative to fossil fuels over forty years ago appears prescient.

The quest for a “secure energy future,” a key policy initiative of President Barack Obama’s first term in office, will remain a dominant issue on the national political landscape throughout his second term and long after his presidency ends.[3] One of the major elements of the Obama Administration’s energy security strategy is ensuring that America will be a leader in the “21st Century clean energy economy.”[4] The Obama Administration has framed this issue from a jobs-creation perspective, noting that foreign countries such as China have taken the lead in manufacturing wind and solar power equipment.[5] The Administration asserts that its investment in clean energy led to the creation of over 200,000 jobs by 2011 in the renewable energy arena.[6] While the Obama Administration has made a careful decision to frame its clean energy strategy in terms of economic goals, the threat of climate change has clearly been an unstated driving force behind that policy throughout his presidency.[7] Indeed, in recent months, President Obama has returned to emphasizing the need to combat climate change.[8]

1 Geothermal Energy Research, Development, and Demonstration Act of 1974, 30 U.S.C. § 1101 (2011).

2 This statute was actually the second major piece of geothermal-focused legislation in the first half of the 1970s. Congress had earlier passed the Geothermal Steam Act, 30 U.S.C. §§ 1001-1025 (2004), in December 1970.

3 This Article will not analyze other aspects of President Obama’s energy policy beyond job creation and climate change since they do not concern its focus on electricity generation. See THE WHITE HOUSE, BLUEPRINT FOR A SECURE ENERGY FUTURE 3-4 (2011) for an overview of President Obama’s energy policy.

4 THE WHITE HOUSE, *supra* note 3, at 3.

5 Keith Bradsher, *China Leading Global Race to Make Clean Energy*, N.Y. TIMES, Jan. 30, 2010, http://www.nytimes.com/2010/01/31/business/energy-environment/31renew.html?pagewanted=all.

6 THE WHITE HOUSE, *supra* note 3, at 33.

7 *See, e.g.*, Maxwell T. Boykoff, *A Dangerous Shift in Obama’s ‘Climate Change’ Rhetoric*, WASH. POST, Jan. 27, 2012, http://www.washingtonpost.com/opinions/a-dangerous-shift-in-obamas-climate-change-rhetoric/2012/01/26/gIQAYnwzVQ_story.html (describing the President’s strategic decision to focus more recent discussions of energy policy on clean energy instead of the related issue of climate change); Barack Obama, President of the United States, Remarks at United Nations Climate Change Summit (Sept. 22, 2009), *available at* http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-UN-Secretary-General-Ban-Ki-moons-Climate-Change-Summit (providing an example of President Obama’s earlier willingness to address climate change explicitly).

8 Barack Obama, President of the United States, Remarks by the President on Climate Change (June 25, 2013), *available at* http://www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change (describing President Obama’s climate change agenda for his second

The most direct way to fight climate change appears to be to reduce society's reliance on fossil fuels. The Intergovernmental Panel on Climate Change (IPCC) noted that "there is *very high confidence*" that human activity, "due primarily to fossil fuel use," has contributed to climate change.[9] The fossil fuel coal, the source of thirty-seven percent of American electricity in 2012, is a huge source of greenhouse gas emissions.[10] Evidence suggests that while the world's temperature will continue to rise, attempts to reduce greenhouse gas emissions can limit that increase in temperature.[11] Thus, policy debates surrounding the necessity of decreased reliance on fossil fuels for energy production, along with a corresponding use of clean, alternative energy sources to compensate for the energy previously generated from fossil fuels, will loom large on the national stage for decades to come. To date, those policy debates have focused on solar and wind energy, often ignoring the third major renewable source of energy used to generate electricity, geothermal.[12]

Increased reliance on geothermal energy could transform the landscape of American energy use, particularly in the electricity-generation sector. Geothermal resources are extremely abundant.[13] If fully used, the United States' geothermal resources could generate well over three-quarters of the country's current electrical capacity.[14] Additionally, unlike many renewable energy

term).

9 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007 SYNTHESIS REPORT: SUMMARY FOR POLICYMAKERS 5 (2007) [hereinafter IPCC].

10 *Electricity Explained: Electricity in the United States*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states (last updated Nov. 5, 2013); *see Natural Gas*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html#footnotes (last updated Sept. 25, 2013) (showing that coal produces twice the amount of carbon dioxide emissions on a per-unit of energy-generated basis than natural gas).

11 IPCC, *supra* note 9, at 21.

12 *See, e.g.*, Barack Obama, President of the United States, Remarks on American-Made Energy at The Ohio State University (Mar. 22, 2012), *available at* http://www.whitehouse.gov/the-press-office/2012/03/22/remarks-president-american-made-energy-0 (describing the role oil, natural gas, biofuels, wind, and solar power will play in the President's energy strategy but leaving out geothermal power).

13 However, these resources are unevenly distributed throughout the United States, with the most extensive resources found in the West. *Geothermal Explained: Where Geothermal Energy Is Found*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=geothermal_where (last updated May 20, 2013).

14 *See How Geothermal Energy Works*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html#The_Geothermal_Resource (last updated Dec. 16, 2009) (noting that a 2008 United States Geological Survey study's high-end estimates predicted that conventional and advanced geothermal technologies in thirteen Western states alone could produce up to 800,900 megawatts (MW) of electricity); *Table ES1: Summary Statistics for the United States, 1998 through 2009*, *in* U.S. ENERGY INFO. ADMIN., DOE/EIA-0348, ELEC. POWER ANNUAL 2009 9 (2011) [hereinafter U.S. ENERGY INFO. ADMIN., *Summary Statistics*] (noting that total American electrical capacity was 1,025, 400 MW in summer 2009).

sources, geothermal power plants could meet baseload, or everyday, demand, since geothermal plants can produce electricity almost constantly.[15] This reliability stands in stark contrast to wind and solar power, which depend on the amount of wind or sunshine present on a given day.[16] Moreover, geothermal electricity is not overly expensive, with some studies estimating that it could be cost-competitive with electricity from coal by 2015.[17] Finally, geothermal energy is extremely clean, with power plants emitting less than one percent of the carbon dioxide of a typical fossil fuel plant and low levels of traditional air pollutants.[18] Geothermal energy is thus a plentiful, reliable, and potentially cheap domestic source of energy that could help slow climate change.

Given this technology's potential, the sluggish pace of geothermal electricity development over the first decade of the new millennium is puzzling. During this time period, geothermal electricity generation in the United States remained fairly constant at 0.4 percent of total generation while electrical capacity of other renewable sources like wind increased dramatically.[19] A major reason for this lack of progress is that geothermal regulation over the past four decades by all levels of government has insufficiently addressed geothermal-specific project constraints. Geothermal power plants differ from many other commercially available renewable and conventional power plants since the viability of some aspects of geothermal technology still depends heavily on further research and development (R&D) efforts, capital costs of the plants are extremely high and

A power plant's capacity is defined as its "maximum electrical output." A megawatt (MW) is the unit of power in which power plant capacities are typically measured. One megawatt is equal to 1,000,000 watts (W). For purposes of comparison, a typical incandescent light bulb is 60 W and the average power plant's capacity is around 500 MW (meaning the average power plant could light up over 8.3 million average light bulbs, if it were powering nothing else). *See* A. FRIEDLAND ET AL., ENVIRONMENTAL SCIENCE: FOUNDATIONS AND APPLICATIONS 37, 324 (2012).

15 *See* Sylvia Harrison, *Geothermal Resources*, *in* THE LAW OF CLEAN ENERGY: EFFICIENCY AND RENEWABLES 438 (Michael B. Gerrard, ed., 2011) (noting that a geothermal plant can have a capacity factor, or ratio of actual generation to potential generation, of over ninety-five percent).

16 *See id.* (noting that wind and solar projects typically have capacity factors around thirty percent).

17 James Yearling, *Geothermal Energy, Power from the Underground*, *in* U.S. NATIONAL DEBATE TOPIC 2008-2009: ALTERNATIVE ENERGY 174 (Paul McCaffrey, ed., 2008).

18 *Geothermal Explained: Geothermal Energy and the Environment*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=geothermal_environment (last updated May 1, 2013).

19 *Geothermal Explained: Use of Geothermal Energy*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=geothermal_use [hereinafter U.S. ENERGY INFO. ADMIN., *Use*] (last updated Apr. 26, 2013). The United States' geothermal capacity actually decreased from 2,893 MW in 1998 to 2,382 MW in 2009. U.S. ENERGY INFO. ADMIN., *Summary Statistics*, *supra* note 14. For information on the growth of American wind power from under 2,000 MW to almost 35,000 MW over that same time period, see AM. WIND ENERGY ASSOC., AWEA U.S. WIND INDUSTRY ANNUAL MARKET REPORT FOR YEAR ENDING 2010 4 (2011), *available at* http://awea.files.cms-plus.com/FileDownloads/pdfs/AWEA%20U.S.%20Wind%20Industry%20 Annual%20Market%20Report%20Year%20Ending%202010_FINAL.pdf .

uniquely structured, and prime geothermal resources are overwhelmingly located on federal lands. Since policymakers can only properly address most of these geothermal-specific needs with substantial funds or federal permits, federal action and inaction, rather than state policy, determine the course of geothermal development even more so than for other sources of renewable energy. Thus, this Article will focus exclusively on the federal geothermal regulatory scheme in analyzing what can be done to capture the full potential of this valuable energy source. Federal geothermal policy can be most effective by expanding R&D support, providing more extensive financing tools for geothermal plant development, and simplifying the process for leasing federal lands in order to exploit geothermal resources.[20]

This Article will address the aforementioned barriers to geothermal electricity generation and will make specific recommendations for how the federal government can improve its geothermal R&D support, financing techniques, and federal lands leasing practices. Part I will briefly introduce geothermal electricity production's technology and history, the major relevant federal statutes, and the existing literature on geothermal law and policy. Part II will analyze why the federal government's approach towards geothermal R&D has historically been inadequate, mostly due to limited funding, and will describe the structure of a hypothetical effective federal geothermal R&D regime. Part III will investigate why current federal geothermal project financing aid, mainly consisting of tax benefits, is insufficient, and will describe the elements necessary for a federal funding program to be successful. Part IV will study the federal geothermal leasing process, historically characterized by massive delays but which Congress overhauled in 2005, and see if the new changes are sufficient to encourage development. Thus, this Article hopes to move the current national debate on energy policy forward by persuasively demonstrating how the federal government can best encourage the development of geothermal energy.

I. OVERVIEW OF THE GENERATION AND REGULATION OF GEOTHERMAL ELECTRICITY

Unlike other renewable energy resources such as wind and solar, which the

[20] This Article proceeds upon the assumption that the federal government should try to encourage the further development of geothermal electricity due to its wide array of positive attributes, unique among renewable energy sources. *See supra* text accompanying notes 13-18. However, reasonable minds may differ on the wisdom of building additional geothermal power plants. Counterarguments to my point of view would center around the high cost per unit of energy generated to build plants, the amount of time it takes to construct plants, and the environmental risks associated with geothermal power plants. See *infra* text accompanying notes 118-125 for information on geothermal plant capital costs and *infra* note 202 for the major environmental harms associated with geothermal power generation.

national news media routinely covers, geothermal energy is unfamiliar to many Americans. This Part will provide background information on the technology and history of geothermal electricity production as well as an introduction to federal geothermal regulation. It will conclude with a survey of the relevant literature in the field.

A. Introduction to Geothermal Energy

Geothermal energy is "heat energy stored in the EarthFalse"[21] Scientists have figured out how to take advantage of two different types of geothermal energy, the first of which is used in climate control systems in buildings and the second of which is used to generate electricity. In the first type of geothermal energy, the ground absorbs solar energy year-round, causing the temperature several feet below the Earth's surface in most locales to remain fairly constant at around 10 degrees Celsius (°C), no matter what the outside temperature is.[22] Developers can construct building heating and cooling systems that take advantage of this constant temperature.[23]

Geothermal electricity plants, on the other hand, draw their power from magma. This magma, located in the mantle, the layer below the Earth's crust, contains a great deal of heat mainly due to the continuous decay of radioactive materials.[24] Magma is not easily accessible since the Earth's crust ranges from three to thirty-five miles thick.[25] Power plant developers can exploit magma's energy when it is closest to the earth's surface, which occurs at geological "hot spots," where the crust's tectonic plates crash into each other.[26] Water can get trapped in these hot rock formations, either by the flow of rainwater and groundwater or by intentional injection of the water into the ground by power plant operators.[27] This water heats up and rises towards the Earth's surface, sometimes turning into steam on its way up.[28] If the hot water or steam rises close enough to the surface, developers can capture it in wells when it is still belowground or after it emerges aboveground and use it to generate electricity.[29]

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21 Energy Independence and Security Act of 2007, 42 U.S.C. § 17191(5) (2011).

22 UNION OF CONCERNED SCIENTISTS, *supra* note 14.

23 UNION OF CONCERNED SCIENTISTS, *supra* note 14. With the exception of this brief introduction to geothermal energy's use for building heating and cooling systems, this Article will focus exclusively on electricity generation from geothermal resources.

24 *Id.* This magma is unimaginably hot — up to 4,000°C at its deepest points. Mary H. Dickson & Mario Fanelli, *Geothermal Background*, *in* GEOTHERMAL ENERGY: UTILIZATION AND TECHNOLOGY 2 (Mary H. Dickson & Mario Fanelli, eds. 2003).

25 U.S. ENERGY INFO. ADMIN., *Use*, *supra* note 19.

26 *Id.*; UNION OF CONCERNED SCIENTISTS, *supra* note 14.

27 Harrison, *supra* note 15, at 423; UNION OF CONCERNED SCIENTISTS, *supra* note 14.

28 Harrison, *supra* note 15, at 423-24.

29 *See id*. at 423 (describing the process by which heated geothermal water can rise to the Earth's surface as hot springs or geysers); UNION OF CONCERNED SCIENTISTS, *supra* note 14

The two different types of geothermal electricity production are hydrothermal and enhanced geothermal systems (EGS).

1. Hydrothermal Electricity Technology

Conventional geothermal electricity generation is known as hydrothermal electricity since it requires two main inputs, water and heat.[30] It is the overwhelmingly dominant form of geothermal power generation today. Three main types of hydrothermal power plants exist. Dry steam plants take steam from within the Earth's surface and send it through a turbine to generate electricity.[31] Flash steam plants convert hot water from within the Earth to steam and then propel that steam through a turbine.[32] Binary cycle plants use hot water taken from inside the Earth to heat a second liquid, typically one that boils at a lower temperature than water, into steam to drive a turbine.[33] The water for these technologies usually must be from about 150°C to 370°C and the wells used to access this water are typically less than three kilometers deep.[34] Developers choose their plant technology based on the type of geothermal resource available; for example, in areas with somewhat cooler magma, binary plants are more appropriate.[35]

Power plant operators have used hydrothermal resources to generate electricity for decades, especially in areas where geothermal steam rises to the Earth's surface. Scientists built the first geothermal electricity plant using dry steam technology at Larderello, Italy, in 1904, and developers began drilling wells in 1921 at what would become the first American geothermal plant at the Geysers in California.[36] Despite this history, hydrothermal electricity production is still a niche business in the United States. Ninety-six percent of the low current nationwide geothermal electrical capacity of 3,386 megawatt (MW) comes from plants located in only two states, California and Nevada.[37] Today a complex of fifteen power plants northeast of San Francisco, the Geysers,

(discussing how power plant developers drill wells in the rock to access the underground steam).

30 *Geothermal Explained: Geothermal Power Plants*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/index.cfm?page=geothermal_power_plants (last updated Apr. 23, 2013).

31 *Id.*

32 *Id.*

33 UNION OF CONCERNED SCIENTISTS, *supra* note 14.

34 U.S. ENERGY INFO. ADMIN., *Use*, *supra* note 19.

35 *See* Harrison, *supra* note 15, at 424 (noting that binary plants are becoming more common because more geothermal resources exist at relatively cooler temperatures than at hotter temperatures).

36 Dickson & Fanelli, *supra* note 24, at 3.

37 GEOTHERMAL ENERGY ASSOC., ANNUAL U.S. GEOTHERMAL POWER PRODUCTION AND DEVELOPMENT REPORT 7 (2013) [hereinafter GEOTHERMAL ENERGY ASSOC., ANNUAL REPORT].

accounts for 725 MW of that capacity alone.[38] Nevertheless, the future of hydrothermal production is promising. In a 2008 survey of domestic geothermal resources, the United States Geological Survey (USGS) predicted that 8,000 MW to 73,000 MW of new capacity existed in thirteen Western states alone.[39]

2. Enhanced Geothermal Systems Technology

Even more promising is EGS, a comparatively new technology. The United States Department of Energy (DOE) has defined EGS "as engineered reservoirs that have been created to extract economical amounts of heat from low permeability and/or porosity geothermal resources."[40] EGS differs from hydrothermal technology in two main ways. First, EGS would potentially allow developers to use magma located three to ten kilometers below the Earth's surface, much deeper than the traditional hydrothermal resources.[41] Second, the developer of an EGS site must inject water into this magma by well, since unlike most hydrothermal resources, it usually lacks a natural water source.[42] These wells send water into this "hot, dry rock" at a high-enough pressure that the water creates fractures in the magma within which it can circulate.[43] Developers then drill production wells to capture the now-hot water and bring it to the surface.[44]

While EGS technology is still in an experimental phase, it is slowly but surely moving towards commercialization. DOE research into EGS began decades ago and today several test EGS plants exist worldwide and, for a time, one commercial EGS plant operated.[45] The technology continues to face sizeable challenges, ranging from drilling issues to excessive water loss within the magma.[46] Nevertheless, the potential payoff is enormous, as the USGS has

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38 *About Geothermal Energy*, THE GEYSERS, http://www.geysers.com/geothermal.aspx (last visited Dec. 4, 2013).

39 UNION OF CONCERNED SCIENTISTS, *supra* note 14.

40 JEFFERSON W. TESTER ET AL., THE FUTURE OF GEOTHERMAL ENERGY: IMPACT OF ENHANCED GEOTHERMAL SYSTEMS (EGS) ON THE UNITED STATES IN THE 21ST CENTURY 1-10 (2006). This study is referred to as the "MIT study" or "MIT report" throughout the Article.

41 *Id.* at 1-12.

42 *See* UNION OF CONCERNED SCIENTISTS, *supra* note 14 (noting that geothermal sites where conditions are such that natural water sources circulate to the Earth's surface make up less than ten percent of the planet's surface area).

43 *How an Enhanced Geothermal System Works*, GEOTHERMAL TECHS. OFFICE, http://www1.eere.energy.gov/geothermal/egs_animation.html (last updated Dec. 11, 2012); UNION OF CONCERNED SCIENTISTS, *supra* note 14.

44 UNION OF CONCERNED SCIENTISTS, *supra* note 14.

45 *See* Harrison, *supra* note 15, at 425 (describing how a commercial EGS plant in Switzerland closed down in 2006 for the foreseeable future due to fears that it had caused a minor earthquake); TESTER ET AL., *supra* note 40, at 1-23, 4-7 (describing early federal research into EGS and asserting that revolutionary drilling techniques could dramatically reduce EGS costs).

46 *See supra* note 45.

estimated that thirteen Western states alone could provide 345,100 MW to 727,900 MW of new EGS electrical capacity.[47] Developers will only realize the promise of both hydrothermal and EGS technologies, however, if a regulatory scheme conducive to their success is in place.

B. Current Federal Geothermal Regulatory Scheme

The modern federal geothermal regulatory regime, with a few exceptions, was born in two periods of congressional activity, the 1970s and the past decade. This Section will provide a non-exhaustive introduction to major federal legislation in this area.

1. Early Geothermal Legislation

The Geothermal Steam Act of 1970 (Steam Act)[48] was the first major piece of geothermal legislation. The Steam Act created the process for leasing federal land to exploit geothermal resources. It gave the United States Department of Interior (DOI) authority to issue leases on both DOI lands and lands operated by the United States Forest Service (USFS), which is part of the United States Department of Agriculture (USDA), through both competitive bidding and noncompetitive processes.[49] The Act also established lease term lengths, the lease renewal process, and lease size caps, among other provisions.[50] Although the Energy Policy Act of 2005[51] changed much of this leasing procedure, the basic structure vesting much of geothermal leasing authority in DOI still exists today.[52]

Congress followed up the framework for geothermal leasing policy by creating a federal geothermal R&D regime as well as limited funding incentives in 1974's Geothermal Energy Research, Development, and Demonstration Act (Demonstration Act).[53] Among other functions, the Demonstration Act created a federal geothermal R&D program focusing on evaluating the extent of the country's geothermal resources, improving drilling and exploration technologies, and demonstrating geothermal test projects.[54] The Demonstration Act also supported geothermal technology education programs and authorized a

47 UNION OF CONCERNED SCIENTISTS, *supra* note 14.

48 30 U.S.C. §§ 1001-1025 (2004).

49 *Id.* §§ 1002-1003.

50 *Id.* §§ 1005-1006.

51 Pub. L. No. 109-58, 119 Stat. 594 (codified in scattered sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.).

52 *See* 30 U.S.C. §1002 (2011) (stating, using almost exactly the same words as the 1970 act, that DOI still administers leases on both its lands and USFS lands).

53 30 U.S.C. §§ 1101-1164 (2011).

54 30 U.S.C. § 1121 (2011).

federal geothermal loan guarantee program.[55] Certainly very aspirational, the Demonstration Act fell somewhat short on details and failed to specify the amount of appropriations going to the R&D program.

The first era of major federal geothermal legislation came to a close with the Energy Tax Act of 1978 (Tax Act),[56] which created a variety of tax incentives for geothermal development. This law provided up to a ten percent business investment tax credit (ITC) for "energy property," which was defined as certain "equipment used to produce" electricity from geothermal energy.[57] The Tax Act also provided for deductibility of some geothermal well drilling costs.[58]

2. Recent Geothermal Legislation

The American Jobs Creation Act of 2004 (Jobs Act),[59] a broad tax statute, was the first piece of federal legislation to have a major impact on geothermal policy in the new millennium. The Jobs Act expanded the production tax credit (PTC) to include geothermal energy technologies.[60] This statute thus enabled geothermal developers to take advantage of a major tax incentive for renewable energy development, in existence since 1992 but which heretofore had only applied to wind and certain types of biomass technologies.[61]

One year later, the massive Energy Policy Act of 2005 (EPAct)[62] dramatically changed the American geothermal landscape. Provisions of the Act that encouraged renewable energy generally also boosted geothermal development, such as the creation of a federal loan guarantee program for projects using "new

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55 *See* 30 U.S.C. §§ 1126, 1141, 1164 (2011).

56 Pub. L. No. 95-618, 92 Stat. 3174 (codified as amended in scattered sections of 23, 26, 42 U.S.C.).

57 *Id.* § 301.

58 *See id*. § 402 (providing for the deductibility of geothermal well "intangible drilling and development costs" in a similar manner to how such costs are deductible for oil and gas wells); ELIZABETH DORIS, ET AL., POLICY OVERVIEW AND OPTIONS FOR MAXIMIZING THE ROLE OF POLICY IN GEOTHERMAL ELECTRICITY DEVELOPMENT 8 (2009) (describing the ITC and asserting that the level of impact it had on geothermal expansion was "uncertain").

59 Pub. L. No. 108-357, 118 Stat. 1418 (codified in scattered sections of 26 U.S.C.).

60 *Id.* § 710.

61 The Energy Policy Act of 1992, Pub. L. No. 102-486, 106 Stat. 2776 (codified in scattered sections of 12, 16, 25, 26, 30, 42 U.S.C.) first created the PTC. *See Renewable Electricity Production Tax Credit (PTC)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE), http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F [hereinafter DSIRE, *PTC*] (last viewed Mar. 22, 2014) (noting that the PTC provides developers with a tax credit, on a per kilowatt-hour (kWh) basis, for electricity actually generated by operational renewable energy plants). The Jobs Act expanded the PTC to include a variety of different renewable energy technologies in addition to geothermal, such as solar and landfill gas. *Id.* The kilowatt-hour (kWh) is a unit of energy equal to the amount of kilowatts of power generated or used over one hour. *See* FRIEDLAND ET AL., *supra* note 14, at 37.

62 Pub. L. No. 109-58, 119 Stat. 594 (codified in scattered sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.).

or significantly improved [renewable energy] technologies."[63] EPAct's Title II, Subtitle B was entirely dedicated to geothermal energy. This subtitle restructured the process for leasing public land for geothermal development and mandated a new federal survey of geothermal resources to replace the most recent one from 1978.[64] Other scattered provisions explicitly affected geothermal energy, such as Section 322's exemption of fluids used in hydraulic fracturing related to geothermal activities from regulation under the Safe Drinking Water Act.[65]

The Energy Independence and Security Act of 2007 (EISA) was yet another major recent piece of geothermal legislation.[66] Like EPAct, EISA has an entire subtitle, Title VI, Subtitle B, devoted to geothermal energy. It mostly encouraged educational and R&D efforts, such as a government partnership with industry to develop advanced drilling technologies and the establishment of a centralized repository of information about geothermal technology at a university.[67] EISA also required DOE to study a variety of peculiar applications of geothermal technology, such as its ability to help produce hydrogen and biofuels.[68] Perhaps most importantly, EISA appropriated $90 million annually from fiscal years 2008 to 2012 for DOE to carry out the Act's geothermal-specific provisions.[69] This appropriation was the first major infusion of federal funds into geothermal technology in decades.[70]

Finally, the American Recovery and Reinvestment Act of 2009 (ARRA)[71] was the most recent federal statute to have a huge impact on geothermal development. It dramatically increased federal geothermal R&D support, allocating $16.8 billion to DOE for "energy efficiency and renewable energy" projects, of which $400 million was devoted to the Geothermal Technologies

63 *Id.* §1703.

64 *See id.* §§ 221-236 (establishing a competitive leasing procedure for securing geothermal leases on federal lands and altering lease size, lease renewal processes, and lease duration, among other aspects of leasing).

65 *See id.* § 322 (excluding "the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities" from the regulated class of "underground [fluid] injection[s]"). This section, which may prove very useful to EGS plant developers, also provides one of the exemptions from federal regulation for natural gas hydraulic fracturing that is so controversial today.

66 Pub. L. No. 110-140, 121 Stat. 1492 (codified in scattered sections of 2, 15, 40, 42, 46, 49 U.S.C.).

67 *Id.* §§ 613, 618.

68 *Id.* § 621.

69 *Id.* § 623.

70 *See* GEOTHERMAL TECHS. PROGRAM, U.S. DEPARTMENT OF ENERGY, A HISTORY OF GEOTHERMAL ENERGY RESEARCH AND DEVELOPMENT IN THE UNITED STATES: ENERGY CONVERSION 1976-2006 118-19 (2010) [hereinafter GEOTHERMAL TECHS. PROGRAM, HISTORY] (discussing historical federal geothermal funding).

71 Pub. L. No. 111-5, 123 Stat. 115 (codified in scattered sections of 6, 19, 26, 42, 47 U.S.C.).

Program (GTP),[72] DOE's geothermal research arm.[73] ARRA also provided developers with financial support by extending the PTC's expiration date for geothermal energy from January 1, 2011 to January 1, 2014 and by allowing developers to take a Treasury Department grant in place of the PTC or ITC for projects beginning before the end of 2011 under certain circumstances.[74]

C. Introduction to Literature on Geothermal Law and Policy

While a few legal scholars have written about geothermal energy law and policy, such literature is rare and often focused on narrow issues of state law. More of these authors have analyzed the interaction between state water law and policies and geothermal energy than any other area involving geothermal energy. For example, several authors have focused on how best to modify state water laws and policies to encourage geothermal development.[75]

Experts at federal agencies such as DOE have written most, but not all, of the literature that touches more broadly on aspects of federal geothermal policy.[76] While extremely useful, most of these works summarize past efforts by the federal government to encourage geothermal energy production, rather than making recommendations for the future.[77] Likewise, Sylvia Harrison's chapter on geothermal resources in Michael Gerrard's *The Law of Clean Energy: Efficiency and Renewables* provides a concise overview of American geothermal law, but makes no policy recommendations.[78] In 2009, the DOE's National Renewable Energy Laboratory published one of the few papers to

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72 The Geothermal Technologies Program recently changed its name to the Geothermal Technologies Office (GTO). For purposes of consistency, after this initial reference the office is described as the GTO throughout this paper. However, the office is called by its original name, the "Geothermal Technologies Program," in citations to documents that it authored while still known as the GTP.

73 American Recovery and Reinvestment Act, div. A, tit. IV (2011); *The Department of Energy's Geothermal Technologies Program under the American Recovery and Reinvestment Act, OAS-RA-11,05*, DEP'T OF ENERGY, http://energy.gov/ig/downloads/department-energys-geothermal-technologies-programunder-american-recovery-and (last visited Mar. 22, 2014).

74 American Recovery and Reinvestment Act, div. B, §§ 1101, 1603 (2011).

75 *See, e.g.*, Kathleen Callison, *Water and Geothermal Energy Development in the Western U.S.: Real World Challenges, Regulatory Conflicts, and Other Barriers, and Potential Solutions*, 22 PAC. MCGEORGE GLOBAL BUS. & DEV. L.J. 301 (2010) (noting the role water policy plays in geothermal energy production and suggesting way for state water policies to aid geothermal development); Justin Plaskov, Comment, *Geothermal's Prior Appropriation Problem*, 83 U. COLO. L. REV. 257 (2011) (describing the method of how states allocate water resources, known as prior appropriation, and how this doctrine hampers geothermal development).

76 *But see* Jeremiah I. Williamson, *The Future of U.S. Geothermal Development: Alternative Energy or Green Pipe Dream*, 7 TEX. J. OIL GAS & ENERGY L. 1 (2011-2012) (describing broadly the variety of areas of law that affect geothermal development, from mineral law to tax law, but its content is more descriptive than analytical).

77 *See, e.g.*, GEOTHERMAL TECHS. PROGRAM, HISTORY, *supra* note 70 (describing federally sponsored R&D efforts on geothermal energy conversion over the past thirty years).

78 Harrison, *supra* note 15.

advocate for specific future federal policies. However, most of the authors' recommendations, such as feed-in tariffs, are different from those of this Article, and the authors do not describe their suggestions in detail since much of the paper is a survey of relevant current federal and state law.[79]

Thus, geothermal electricity generation exists today, and is regulated in the United States by an established legal regime. Although a range of authors has acknowledged geothermal energy's promise, few have focused on how the federal government can best encourage its further development. The next Part will begin to address that question through the lens of federal R&D support for geothermal electricity generation.

II. PAST, PRESENT, AND FUTURE FEDERAL R&D SUPPORT

The recent influx of federal funds into geothermal R&D through EISA and ARRA begs the question of whether or not the statutes described in Section I.B. have solved the historical problems with geothermal R&D. This Part will explore the traditional inadequacy of federal geothermal R&D support, look at current R&D needs, and suggest a path forward for geothermal R&D.

A. Past Federal Geothermal R&D Approach

On a superficial level, the federal government's geothermal R&D program has an impressive record. From 1976 through 2006, the government spent over \$1.3 billion[80] on geothermal R&D through DOE's GTO and predecessor organizations.[81] This R&D support likely enabled American geothermal generation to expand from 396 MW to 2,274 MW during that time period, with much of that growth occurring in the 1980s and early 1990s when GTO research was in full swing.[82] DOE conducted its own research at its national laboratories and geothermal-specific test sites in California, Idaho, and Texas and also supported research by industry and universities.[83] DOE research is responsible for a wide range of industry milestones, including the first use of a variety of binary plant technologies and the development of more inexpensive ways to protect plant equipment from corrosion from geothermal fluids.[84] DOE scientists from Los Alamos National Laboratory also conducted the first research on EGS technology, beginning in 1974 when they drilled an experimental deep well at

79 DORIS ET AL., *supra* note 58, at 25–27.

80 Unless otherwise noted, all R&D funding data is in current dollars, since DOE presented much of its relevant data in this format.

81 GEOTHERMAL TECHS. PROGRAM, HISTORY, *supra* note 70, at vii.

82 *Id.* at 5; U.S. ENERGY INFO. ADMIN., *Summary Statistics*, *supra* note 14, at 9.

83 GEOTHERMAL TECHS. PROGRAM, HISTORY, *supra* note 70, at 1.

84 *See id.* at 1-2, 4, 6 (summarizing GTO's contributions to geothermal R&D).

Fenton Hill, New Mexico.[85]

However, this record of over $1.3 billion showered on geothermal R&D is deceptive because it hides distributional trends. For example, GTO's budget over the six-year period from 1976 through 1981 included over $652.4 million of this total.[86] Thus, the government spent over forty-seven percent of its 1976 to 2006 geothermal R&D funding prior to 1982. During that thirty-year period, the GTO's budget peaked at $156.6 million in 1981 and never exceeded $37.8 million for any single year from 1990 to 2006, averaging closer to $26.7 million annually over that seventeen-year period.[87] In 2007, this decades-long downward trend in federal geothermal R&D expenditures culminated in a negligible GTO budget of just over $5 million.[88]

The decrease in overall federal funding for geothermal R&D since the early 1980s was accompanied by major structural problems in the government's approach to geothermal R&D. For example, in the early 1990s, DOE closed all of its geothermal test facilities, supporting R&D since then only through the national laboratories and by funding outside projects.[89] This closure likely limited its ability to control the direction of research. More importantly, for years DOE only minimally funded research into EGS technology. GTO funding for EGS prior to EISA and ARRA averaged only $4.5 million from 2000 through 2006.[90] Funding for EGS only again reached its 1979 historical peak of $15 million in 2012.[91] After years of flagging interest, DOE also stopped conducting EGS-related experiments at Fenton Hill entirely in 2000.[92]

The decline in federal geothermal R&D support through 2007 stands in stark contrast to DOE's approach towards other clean energy technologies. Federal wind R&D averaged about $4.7 million more per year than geothermal from 1990 to 2006.[93] Perhaps more importantly, wind R&D increased dramatically over that period, averaging almost $40 million annually from 2002 to 2006,

85 TESTER ET AL., *supra* note 40, at 4-3, 4-7.

86 *See id.* at 119 (listing the GTO and predecessor organizations' annual budget, broken out by category of expenditure, from 1976 to 2006).

87 *Id.*

88 *See* U.S. DEP'T OF ENERGY, THE GEOTHERMAL TECHNOLOGIES PROGRAM: BUDGET HISTORY (2009) (analyzing the GTO's annual budget over the past decade using graphs).

89 GEOTHERMAL TECHS. PROGRAM, HISTORY, *supra* note 70, at 4.

90 *Id.* at 118. As "hot dry rock" is an earlier term for EGS, all expenditures listed for "hot dry rock" from the 1970s through the 1990s are considered to be expenditures on EGS R&D.

91 *Id.*; *Geothermal Technologies FY14 Budget At-A-Glance*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEP'T OF ENERGY, http://www1.eere.energy.gov/office_eere/pdfs/budget/geothermal_ataglance_2014.pdf (last visited Dec. 4, 2013).

92 TESTER ET AL., *supra* note 40, at 4-11.

93 *See* ROSALIE RUEGG & PATRICK THOMAS, LINKAGES FROM DOE'S WIND ENERGY PROGRAM R&D TO COMMERCIAL RENEWABLE POWER GENERATION 115 (2009) (providing a summary of annual DOE wind R&D appropriations from 1978-2008).

when geothermal R&D was nearing its lowest level.[94] Likewise, from 2002 through 2007, DOE increased its solar R&D funding from $126 million to $203 million.[95] Thus, it is apparent that the federal government routinely underfunded geothermal R&D prior to EISA and ARRA.

B. Geothermal R&D Needs

However, low geothermal R&D funding levels and R&D program structural problems are only important because geothermal technology still needs substantial R&D to reach its commercial potential. While geothermal plants demonstrate their commercial viability every day, both hydrothermal and EGS technologies could benefit from additional R&D in a variety of ways.

Hydrothermal could still profit from a wide array of R&D support. Basic hydrothermal technology could use further R&D on techniques to map hydrothermal resources more accurately and extensively, technology that could lead to lower drilling costs, and more efficient energy conversion systems.[96] Advanced hydrothermal technologies with great potential also need more R&D to progress towards commercialization. These technologies include the use of low-temperature geothermal sources under 150°C and of hot water produced in oil and gas drilling to generate electricity.[97]

Not surprisingly, EGS's R&D needs are even greater. A 2006 MIT study on EGS concluded that a combined public and private R&D investment of $300 to $400 million over fifteen years is necessary to make EGS cost-competitive with other energy generation technologies, with an investment of closer to $1 billion over the same time frame needed to create 100,000 MW of capacity by 2050.[98] The GTO asserts that these numbers are "overly optimistic," with much greater expenditures required to make EGS viable in the United States.[99] Many specific technologies that will be necessary for EGS to become commercially viable do not yet exist. On the resource identification side, researchers have not yet

[94] *Id.*

[95] U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-08-102, FEDERAL ELECTRICITY SUBSIDIES: INFORMATION ON RESEARCH FUNDING, TAX EXPENDITURES, AND OTHER ACTIVITIES THAT SUPPORT ELECTRICITY PRODUCTION 19 (2007).

[96] *See* OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEP'T OF ENERGY, GEOTHERMAL TECHNOLOGIES PROGRAM PEER REVIEW PROGRAM 13 (2011).

[97] *See Low-Temperature and Co-Produced Geothermal Resources*, GEOTHERMAL TECHS. PROGRAM, http://www1.eere.energy.gov/geothermal/low_temperature_resources.html (last updated Feb. 12, 2014) (asserting the promise of these two technologies in both the direct-use heating and electricity generation contexts).

[98] TESTER ET AL., *supra* note 40, at 1-6. This 100,000 MW total is approximately ten percent of total American electricity generation and thus would make EGS a "major player as a domestic energy supply." *Id.* at 1-9.

[99] OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEP'T OF ENERGY, GEOTHERMAL TECHS. PROGRAM, AN EVALUATION OF ENHANCED GEOTHERMAL SYSTEMS TECH. 8 (2008) [hereinafter GEOTHERMAL TECHS. PROGRAM, EVALUATION].

developed satisfactory geological modeling techniques for predicting the feasibility of stimulating a particular deep well for EGS use.[100] Critical resource extraction technology is also in the early stages of development since sufficient methods both for tracking the flow of fluid injected into the deep rock and for adequately limiting fluid loss in magma at EGS depths do not yet exist.[101] Additionally, more research is necessary on a variety of potential EGS environmental issues, such as subsurface water contamination and induced seismic activity.[102] Finally, EGS fieldwork is sorely needed. As recently as 2006, researchers were only conducting three EGS field studies in the entire United States, none of which were representative of EGS's broad potential since they were all located on the edges of hydrothermal sites.[103] More recently, the GTO has funded additional demonstration projects at five new sites.[104] Thus, it is clear that for both hydrothermal and EGS technologies to move forward, more R&D support is necessary.

C. Recommendations for Future Geothermal R&D

As demonstrated by the MIT and GTO estimates of R&D investments needed for EGS alone, the current federal geothermal R&D approach is inadequate. While impressive, the recent, temporary boost in federal geothermal R&D funding has almost entirely dried up. EISA's geothermal appropriations expired in fiscal year 2012 and DOE has already awarded at least $368 million of the $400 million available under ARRA to support geothermal R&D.[105]

A more effective federal geothermal R&D program requires several key components. First, since DOE recognizes that even under the best of circumstances it will not attain many of its geothermal-related goals for years, the government must make a long-term commitment to geothermal R&D.[106] In

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100 *Id.* at 11.

101 *Id.* at 17, 20.

102 TESTER ET AL., *supra* note 40, at 8-6, 8-9.

103 *See id.* at 4-35 (describing the projects at Coso and the Geysers in California and Desert Peak in Nevada and their focus on areas which are not conducive to the natural permeability of water in the geothermal resource).

104 *See* GEOTHERMAL ENERGY ASSOC., GEOTHERMAL BASICS: Q&A 29 (2012) [hereinafter GEOTHERMAL ENERGY ASSOC., GEOTHERMAL BASICS] (listing new EGS demonstration projects currently funded by DOE at Newberry Volcano in Oregon, Naknek in Alaska, Brady Hot Springs in Nevada, New York Canyon in Nevada, and Raft River in Idaho). The current status of the Coso project mentioned in the MIT study is unclear, since more recent accounts of EGS research do not include it.

105 Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 623, 121 Stat. 1492 (codified in scattered sections of 2, 15, 40, 42, 46, 49 U.S.C.); DEP'T OF ENERGY, *supra* note 73.

106 For example, the agency anticipates that it will only be able to demonstrate hydrothermal's cost parity with other generation technologies by 2020 and EGS's by 2030. *See About the Geothermal Technologies Office*, GEOTHERMAL TECHS. OFFICE, http://www1.eere.energy.gov/geothermal/about.html (last updated Dec. 11, 2013) (detailing the GTO's main goals, including

order to ensure that the industry is on track to achieve these goals years down the road, the government must consistently support geothermal R&D each year for the next fifteen or so years. Second, this support must significantly exceed pre-2008 levels. Using the upper limit of funding for which the MIT analysis called,[107] annual federal EGS R&D funding of $50 million for a fifteen-year period may be a sufficient starting point. Adding $35 million, a rough average of recent DOE funding for hydrothermal and low temperature/co-produced resource R&D in post-2007 years, to the EGS amount gives an estimate of $85 million required annually for the next fifteen years as the minimum level of federal R&D funding.[108] Third, this R&D funding should focus on demonstration projects when possible. As the GTO itself notes, much information needed to move geothermal technology forward "can only be gained by experience from field demonstrationsFalse"[109] Finally, DOE should bring back some of its own geothermal test facilities. Having its own facilities would enable DOE to reduce agency costs and more effectively control the focus of research.

Within the larger R&D scheme, DOE should focus more of its hydrothermal R&D efforts on low temperature and co-produced resources projects. The USGS estimates that the United States has up to 120,000 MW of unused low temperature geothermal resources alone, which the GTO characterizes as "lower risk. . .near-term" resources, some of which can be used to generate electricity.[110] In contrast, the USGS believes that innovative exploration

reducing the levelized cost of production of electricity from both hydrothermal and EGS to six cents/kWh over the timeframes mentioned above).

[107] The MIT study called for up to $1 billion in combined public and private EGS R&D over a fifteen-year period. Assuming that this funding was evenly split between public and private investment, like many GTO EGS R&D projects, the government would have to provide $500 million of this total. However, since the GTO indicated that the MIT study substantially underestimated the amount of funding necessary, I have assumed an error rate of fifty percent, which brings the total amount of federal EGS R&D funding needed up to $750 million over fifteen years, which comes out to $50 million per year. *See* GEOTHERMAL TECHS. PROGRAM, EVALUATION, *supra* note 99, at 8 (asserting that the MIT study's estimate is very low); TESTER ET AL., *supra* note 40, at 1-6 (estimating the expenditures necessary for EGS technology to succeed and grow); *Projects*, GEOTHERMAL TECHS. PROGRAM, http://www4.eere.energy.gov/geothermal/projects (last visited Mar. 22, 2014) (providing links to GTO-funded projects state by state, the awardee and GTO expenditures of which are then given, demonstrating how DOE and the private developer typically divide up costs).

[108] *See* OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, *supra* note 96, at 24 (listing ARRA and GTO budget appropriations in 2010 and 2011 for R&D on hydrothermal and low temperature/co-produced resources). This $85 million annual expenditure does not seem unrealistic, considering that the office of which the GTO is a part, DOE's Office of Energy Efficiency and Renewable Energy, had a budget of $1.8 billion in 2011. DOUG HOLLETT, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, GEOTHERMAL RESOURCES COUNCIL 2011 ANNUAL MEETING 4 (2011).

[109] GEOTHERMAL TECHS. PROGRAM, EVALUATION, *supra* note 99, at E-1.

[110] OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, *supra* note 96, at 19.

technologies, while important, have the potential to discover only 30,000 MW of unidentified new hydrothermal resources.[111] Despite the seemingly imminent dividends that additional focus on low temperature and co-produced hydrothermal projects could pay, DOE has allocated just $18.7 million of the $368.1 million it has distributed from ARRA funds to these projects.[112] In contrast, it spent $97.2 million in ARRA funding on innovative exploration technique projects.[113] Devoting a greater percentage of its future annual budget to low temperature and co-produced hydrothermal R&D will help the GTO realize the immense benefits of these technologies over a shorter time period.

The GTO should also change the structure of its EGS R&D program. First, it should devote more funds to demonstration projects instead of general EGS research. Currently, the GTO funds around 130 non-test facility EGS research projects and only seven EGS demonstration projects.[114] While EGS is still a relatively new technology that needs extensive non-field research, the GTO could easily devote more funding to test facilities. A focus on demonstration plants would not be prohibitively expensive, especially if they are conducted in partnership with industry, since the GTO has spent under $10 million on five of the seven EGS test sites it currently supports.[115] Moreover, one of the benefits of EGS technology is that it could theoretically be feasible across the country, instead of just in the West, where hydrothermal resources are strongest.[116] However, none of the current EGS test plants are east of Idaho.[117] For EGS to reach its full potential, researchers should be conducting demonstrations in different regions across the country.

Thus, a decision by the federal government to fund geothermal R&D for a longer period of time, with larger sums of money, and by implementing the

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111 *Id.*

112 HOLLETT, *supra* note 108, at 9. Some additional funding may be allocated towards this research, as DOE has sent $111.9 million of ARRA funding to generic "cross-cutting R&D" projects, the focus of which is unclear. *Id.*

113 *Id.*

114 *See* ZIAGOS ET AL., A TECHNOLOGY ROADMAP FOR STRATEGIC DEVELOPMENT OF ENHANCED GEOTHERMAL SYSTEMS 19 (2013) (noting that "the current EGS R&D portfolio consists of 130 projects); GEOTHERMAL ENERGY ASSOC., GEOTHERMAL BASICS, *supra* note 104, at 29 (listing seven EGS demonstration projects currently funded by DOE).

115 *See Projects*, GEOTHERMAL TECHS. OFFICE, http://www4.eere.energy.gov/geothermal/projects?filter[field_project_area][0]=%2249%22 (last visited Mar. 15, 2014) (listing the seven EGS demonstration projects mentioned in footnote 115, at Newberry Volcano, Oregon, the Geysers, California, Naknek, Alaska, Brady Hot Springs, Nevada, Desert Peak, Nevada, New York Canyon, Nevada, and Raft River, Idaho, and providing individualized pages on each project which state the level of GTO funding for each particular project).

116 UNION OF CONCERNED SCIENTISTS, *supra* note 14. For example, while not quite as ideal as Western resources, Eastern areas such as New Hampshire's White Mountains and parts of northern Illinois could potentially house EGS plants. TESTER ET AL., *supra* note 40, at 2-36.

117 *See* GEOTHERMAL ENERGY ASSOC., GEOTHERMAL BASICS, *supra* note 104, at 29 (noting that the seven current test projects are in California, Nevada, Alaska, Oregon, and Idaho).

structural changes described above could enable developers to tap into much more of the country's vast geothermal resources.

III. REDUCING GEOTHERMAL POWER PLANT CAPITAL COSTS

In addition to geothermal R&D support, the federal government also needs to help geothermal companies in the next stage of development, plant construction, for plants to become widespread. This Part will first describe the unique capital cost structure of geothermal plants, which make funding support especially critical. It will then look at current federal funding aid. This Part will end by critiquing those methods as improperly tailored to geothermal's cost structure and by suggesting a funding framework that would likely be more effective.

A. The Unique Structure of Geothermal Capital Costs

Capital costs for geothermal plants are still extremely high on a per kilowatt (kW) basis. In 2010, DOE estimated that geothermal power plants costs could vary from $4,141/kW to $6,163/kW, depending on plant technology and size.[118] In comparison, base cost estimates as of 2010 were $980/kW for a 540 MW combined cycle natural gas plant and $2,400/kW for a 100 MW onshore wind farm.[119]

These capital costs are also spread out over an unusually long timeframe. For example, geothermal site exploration to determine if a certain area of land can support plant development can take up to ten years, which means that the period from exploration to finished operational power plant can take well over a decade.[120] In contrast, developers can bring combined cycle natural gas plants online within twenty to thirty months from issuing notices to proceed.[121]

Moreover, the companies incurring these high, long-term costs are much smaller than those in other sectors of the power industry. For example, U.S. Geothermal, which operates two plants, had total operating revenue of around $5.9 million in the year ending on March 31, 2012.[122] Ormat Technologies, which operates ten domestic geothermal plants and others abroad and is one of

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118 U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, UPDATED CAPITAL COST ESTIMATES FOR ELECTRICITY GENERATION PLANTS 16-3, 17-2 (2010) [hereinafter U.S. ENERGY INFO. ADMIN., CAPITAL COSTS]. These overall estimates are for 50 MW plants and can vary based on plant location. *Id.* at 4, 16-3, 17-2.

119 *Id.* at 5-3, 21-2.

120 *Renewable Energy Opportunities and Issues on Federal Lands: Review of Title II, Subtitle B of Geothermal Energy of EPACT; and Other Renewable Programs and Proposals for Public Resources: Hearing Before the Subcomm. of Energy and Mineral Resources of the H. Comm of Natural Resources*, 110th Cong. 26 (2007) (statement of Daniel Kunz, President and CEO, U.S. Geothermal, Inc.).

121 ROLF KEHLHOFER ET AL., COMBINED-CYCLE GAS & STEAM TURBINE POWER PLANTS 28 (3d ed. 2009).

122 U.S. Geothermal, Inc., Annual Report (Form 10-K), at 53 (Mar. 27, 2013).

the larger geothermal developers, reported total revenue of over $514 million for the year ending December 31, 2012.[123] These numbers stand in stark contrast to companies using other electricity generation technologies. For example, NextEra Energy, a large electric power company that owns the most wind capacity in the United States, reported total operating revenue of about $14.3 billion for the year ending on December 31, 2012.[124] Likewise, American Electric Power, the country's largest operator of fossil fuel-fired power plants in 2011, had about $14.9 billion in revenue for the year ending December 31, 2012.[125] Thus, the typical geothermal developer about to start a project is a small company about to incur high costs for a project that will not be operational for many years.

B. Current Federal Geothermal Funding Support

The federal government has supported post R&D-phase geothermal energy development through a variety of funding mechanisms including tax credits, tax credits that are convertible to grants, zero interest bonds, and loan guarantees.[126] This Section will briefly investigate each of these approaches.

1. Tax Credits

The two most critical tax credits for geothermal developers are the PTC, or the production tax credit, and the ITC, or the business investment tax credit. The PTC provides qualifying geothermal facilities with a tax credit of 1.5 cents/kWh of energy produced and sold, in 1993 dollars and adjusted for inflation.[127] While historically projects qualified for the PTC if they were completed by a certain date, the most recent version of the PTC, amended in January 2013, requires construction to have begun on a facility before January 1, 2014 in order for its owner to qualify for the credit.[128] The IRS has issued guidance on the types of actions an owner must have taken to satisfy the "started construction" requirement.[129] The credit generally lasts for up to ten years after a facility is

123 Ormat Technologies, Inc., Annual Report (Form 10-K), at 96 (Mar. 11, 2013).

124 NextEra Energy, Inc., Annual Report (Form 10-K), at 74 (Feb. 28, 2013); AM. WIND ENERGY ASS'N, AMERICAN WIND POWER: DELIVERING NEW POWER TODAY 10 (2011).

125 American Electric Power Co., Annual Report (Form 10-K), at 4 (Feb. 26, 2013); NATURAL RES. DEF. COUNCIL, BENCHMARKING AIR EMISSIONS 16 (2013), http://www.nrdc.org/air/pollution/benchmarking/files/benchmarking-2013.pdf.

126 Some of the subsequent analysis will cover funding mechanisms that expired during the past few years since they were important incentives for geothermal development and could serve as models for future funding techniques.

127 DSIRE, *PTC*, *supra* note 61. While still effective in 2013, the PTC was equal to 2.3 cents/kWh. *Id.* See 26 U.S.C. § 45 (2011) for more information on the PTC. The future of the PTC, which Congress typically reauthorizes and amends every few years, sometimes after letting it lapse, is uncertain. Congress allowed the PTC to expire on January 1, 2014. *Id.*

128 26 U.S.C. § 45(d)(4) (2006).

129 DSIRE, *PTC*, *supra* note 61.

online and is not fully available to developers receiving other federal funding support.[130] Additionally, through 2013, developers who were eligible for the PTC could instead have chosen to take a special thirty percent ITC, which is generally not available to geothermal project owners.[131]

The ITC provides geothermal developers with a tax credit that offsets some construction and equipment expenses. Developers who qualify for the ITC receive a tax credit equal to ten percent of the total that they spent on plant equipment prior to the point when the plant began generating electricity.[132] While projects must be in service to qualify, the geothermal ITC has no expiration date and no cap.[133] The ITC is less generous for geothermal than for other technologies, like solar energy, for which the credit is equal to thirty percent of qualifying expenses.[134]

2. Tax Grants

Developers can convert either the PTC or the ITC into a Treasury Department cash grant for geothermal projects as long as construction began prior to December 31, 2011.[135] For a project to be eligible for this grant, entitled a Section 1603 grant,[136] its developer must have started construction in 2009, 2010, or 2011.[137] The developer must have brought the project online by January 1, 2014 in order to receive a grant equal to thirty percent of the basis of the geothermal facility or bring it online by January 1, 2017 for a ten percent grant.[138] Developers who accept Section 1603 grants forgo their rights to the PTC or ITC for all subsequent years for the property for which they take the grant.[139]

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130 *Id.*

131 *Id.*; *Business Energy Investment Tax Credit (ITC)*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE), http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=0 [hereinafter DSIRE, *ITC*] (last updated Mar. 13, 2014).

132 DSIRE, *ITC*, *supra* note 131. See 26 U.S.C. § 48 (2011) for more information on the ITC.

133 *Id.*; Jenna Goodward & Mariana Gonzalez, *The Bottom Line on…Renewable Energy Tax Credits*, WORLD RES. INST., http://pdf.wri.org/bottom_line_renewable_energy_tax_credits_10-2010.pdf (last updated Oct. 2010).

134 DSIRE, *ITC*, *supra* note 131.

135 U.S. TREASURY DEP'T, PAYMENTS FOR SPECIFIED ENERGY PROPERTY IN LIEU OF TAX CREDITS UNDER THE AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 2 (2011) (defining these Treasury grants as "Section 1603" grants and outlining eligibility for the program as well as describing the program's history). See American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, div. B, § 1603, 123 Stat. 115 (codified in scattered sections of 6, 19, 26, 42, 47 U.S.C.) for more on Treasury grants.

136 *See* U.S. TREASURY DEP'T, *supra* note 135, at 2.

137 *Id.*

138 *Id.* at 5. Some projects are only eligible for one, not both, of these credits.

139 *Id.* at 2; *see also* 26 U.S.C. §48(d)(1).

3. No-Interest Bonds

Clean Renewable Energy Bonds (CREBs) support renewable energy developers who cannot take advantage of tax credits and grants. Congress created the initial CREBs program in 2005 and modified it in 2009's ARRA.[140] Under the updated scheme, $800 million was set aside for each of three categories of tax-exempt developers — government entities, cooperative utilities, and public power providers.[141] The IRS periodically solicits CREBs applications, and developers who receive authorization can then issue zero-interest bonds to investors.[142] The developer repays only the principal and the IRS gives the investor tax credits in lieu of interest, in effect enabling tax-exempt developers to secure debt financing more easily than they otherwise would have.[143] The IRS finished allocating the authorized amount of CREBs to government bodies and public power providers in 2009, leaving electric cooperatives as the only group still eligible.[144]

4. DOE Loan Guarantees

DOE's two loan guarantee programs also aid geothermal developers by making it easier for them to secure loans for what investors otherwise might see as risky ventures. DOE loan guarantees bind the federal government to pay all or part of a developer's loan obligations if the borrowing developer defaults.[145] In recent years, DOE has administered two major loan guarantee programs, the Section 1703 program, authorized by EPAct, and the Section 1705 program, authorized by ARRA.[146]

The Section 1703 program guarantees loans for projects that reduce air pollution, including greenhouse gas emissions, and "employ new or significantly improved technologies as compared to commercial technologies."[147] On its face, this program is generous — DOE can guarantee up to eighty percent of a

140 *Clean Renewable Energy Bonds (CREBs)*, DSIRE, http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US45F&re=1&ee=1 [hereinafter DSIRE, *CREBs*] (last updated Oct. 12, 2012). See 26 U.S.C. § 54 (2011) for more information on CREBs.

141 *See* John A. Herrick, *Government Nontax Incentives for Clean Energy*, *in* THE LAW OF CLEAN ENERGY: EFFICIENCY AND RENEWABLES 193 (Michael B. Gerrard, ed., 2011) (describing the structure of the 2009 CREBs program).

142 *Id.* at 192.

143 *Id.*

144 DSIRE, *CREBs*, *supra* note 140.

145 *Our* Mission, LOAN PROGRAMS OFFICE, U.S. DEP'T OF ENERGY, https://lpo.energy.gov/about/our-mission/ (last visited Mar. 22, 2014).

146 See American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, div. A, § 406, 123 Stat. 115 (codified in scattered sections of 6, 19, 26, 42, 47 U.S.C.) and Energy Policy Act of 2005, Pub. L. No. 109-58, §§ 1701-1704, 119 Stat. 594 (codified in scattered sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.) for more information about these loan guarantee programs.

147 Energy Policy Act § 1703.

project's estimated cost and loans can extend for up to thirty years.[148] However, DOE has construed the "commercial technolog[y]" requirement narrowly, which ends up excluding technologies that have been implemented three or more times in plants for over five years.[149] As a result, DOE currently has only two outstanding 1703 loan guarantees, only one of which was to a developer for a power plant project, which was not a geothermal one.[150]

Although eligibility for the program has since expired, the Section 1705 loan guarantee program was far more effective. Passed by Congress in February 2009, Section 1705 authorized loan guarantees for renewable energy electricity projects for which construction began prior to September 30, 2011.[151] DOE issued twenty-four 1705 loan guarantees over the program's short life.[152] However, only three of these partial or whole loan guarantees, supporting loans worth $545.5 million, went to geothermal projects, as compared to fourteen solar projects for over $11 billion.[153] Thus, the federal government has established a variety of techniques to fund renewable energy development generally. However, the critical question for the purposes of this Article is whether or not these tax credits, tax grants, no-interest bonds, and loan guarantees will help expand a geothermal industry defined by its unique attributes.

C. Funding Support Recommendations

While perhaps well-tailored to other clean energy technologies, current federal funding support for renewable energy is improperly structured for the geothermal power industry. First, federal renewable energy aid's tax-based approach is inadequate for the geothermal industry, which, as illustrated above, small companies with relatively low annual revenue currently dominate. In many cases, these companies will not have enough taxable income to take full advantage of the PTC or ITC and thus would have to enter into complex financing arrangements with larger entities to reap the benefits of these tax credits.[154] Second, production-based incentives are also inappropriate for

[148] Id. § 1702.

[149] 1703, LOAN PROGRAMS OFFICE, U.S. DEP'T OF ENERGY, https://lpo.energy.gov/?page_id=39 (last visited Mar. 22, 2014).

[150] See Our Projects, LOAN PROGRAMS OFFICE, U.S. DEP'T OF ENERGY, https://lpo.energy.gov/?page_id=45 [hereinafter U.S. DEP'T OF ENERGY, *Our Projects*] (last visited Dec. 8, 2013) (summarizing the guarantees made under both the 1703 and 1705 programs by listing the recipients of guarantees, the amounts of guarantees, and the technologies the guarantees supported). The one Section 1703 guarantee to a power plant went to a nuclear plant project. *Id.*

[151] American Recovery and Reinvestment Act, § 406.

[152] U.S. DEP'T OF ENERGY, *Our Projects*, *supra* note 150.

[153] *Id.*

[154] *See, e.g.*, PHILLIP BROWN & MOLLY F. SHERLOCK, CONG. RESEARCH SERV., R41635, ARRA SECTION 1603 GRANTS IN LIEU OF TAX CREDITS FOR RENEWABLE ENERGY: OVERVIEW,

geothermal power plants. Since geothermal power plants take much longer to construct than do other types of power plants, incentives dependent on when a plant comes online, like the PTC and ITC, may not be available to geothermal developers for many years. Likewise, geothermal's long lag time can also hurt it in cases where funding mechanisms are not explicitly conditioned on a plant coming into service but are still based on a short timeline. For example, the Section 1705 loan guarantee program's two-plus year existence may not have allowed geothermal developers sufficient time to conduct adequate site exploration, *de facto* rendering them ineligible for guarantees. Finally, other federal funding programs that are not tax- or production-based are too narrow in scope to be fully effective. For example, the CREBs program does not apply to for-profit enterprises and Section 1703 excludes most less-than-experimental technologies, hampering their usefulness in an industry dominated by private companies using a technology the essence of which is decades old. Therefore, a truly successful geothermal funding support program would have broad applicability, would not be tax-centric, and would not be tethered to production.

A federal grant program, not tied to a tax credit like Section 1603, is desirable since it would meet all of these criteria. Such a program would ideally be geothermal-specific, in which case it would require new legislation. It could also be applicable to all renewable energy technologies through the never-implemented EISA Section 803, which permits DOE to "use amounts appropriated under this section to make grants for use in carrying out renewable energy projects."[155] EISA's grant program applies to a broad range of utilities and contains several limitations, such as that the grant can only be up to fifty percent of a project's total costs.[156] EISA also allows DOE to condition grants on other requirements.[157] These optional requirements should include detailed financial projections providing reasonable assurance that the project will succeed and caps of $50 million to $100 million per grant to extend the life of the program.[158] If DOE makes grants early in the exploration or construction

ANALYSIS, AND POLICY OPTIONS 12 (2011) (describing the difficulties small solar companies have in taking full advantage of the ITC due to their limited revenue); *see also* JOHN P. HARPER ET AL., ERNEST ORLANDO LAWRENCE BERKELEY NAT'L LAB., LBNL-63434, WIND PROJECT FINANCING STRUCTURES: A REVIEW AND COMPARATIVE ANALYSIS (2007) (looking at these different types of financing structures in the wind industry).

However, even though tax credits arguably are poorly designed for the geothermal industry, it is important that the federal government provide a long-term extension of the PTC, which expired on January 1, 2014. Despite such credits' flaws, geothermal developers rely on their continued availability when plants come online in financing their plants.

155 Energy Independence and Security Act of 2007, Pub. L. No. 110-140, § 803, 121 Stat. 1492 (codified in scattered sections of 2, 15, 40, 42, 46, 49 U.S.C.).

156 *Id.*

157 *Id.*

158 *Id.* Using EIA estimates of plant costs ranging from $4,141/kW to $6,163/kW for 50 MW plants leads to a calculation of total plant construction costs of approximately $207 million to $308

process, it would provide geothermal power plants with much needed support.

A robust federal loan guarantee program would also greatly encourage the expansion of the geothermal electric sector by helping developers get capital from large investors traditionally wary of the industry.[159] This program must be open to applications for a lengthy period of time, such as five to ten years, so that developers can have sufficient time to conduct exploration and evaluate project costs, unlike under Section 1705. It would also have to cover non-experimental technologies, unlike Section 1703. Such a program would preferably be geothermal-specific but could also apply to all forms of clean electricity generation. A geothermal-specific loan guarantee program has actually existed in the past, from 1978 to 1982 under the Geothermal Energy Research, Development, and Demonstration Act of 1974.[160] A new geothermal loan guarantee program should provide guarantees for a majority of a project's costs, either seventy-five percent like the 1974 program or eighty percent like Section 1703, but with a total cost cap of several hundred million dollars per project so that guarantees for unusually expensive projects do not spiral out of control.[161] The program should apply to long-term loans for up to thirty years, like both the 1974 and Section 1703 programs, and should include a careful vetting process directed at ensuring a project's viability.[162] The program itself could be capped at several billion dollars. Although this cap seems like a substantial sum, it is still less than Section 1705 loan guarantees made to solar projects. It should not be available to beneficiaries of the federal grants described above in order to maximize the number of recipients of federal geothermal funding aid. Unlike the 1974 program, which was directed at all stages of geothermal development including R&D, loan guarantees should solely be aimed at exploration and construction costs.[163]

Such a program of federal grants and loan guarantees, ideally both geothermal-specific, would help the geothermal industry expand much more quickly than it will under the current federal funding regime.

million, so such a cap would still provide substantial support. See U.S. ENERGY INFO. ADMIN., CAPITAL COSTS, *supra* note 118, at 16-3, 17-2, for these per kW cost estimates.

159 *See* Nathanial Gronewold, *Growing Geothermal Industry Says It Gets Cold Shoulder from Wall Street, Washington*, N.Y. TIMES, Feb. 18, 2011, http://www.nytimes.com/gwire/2011/02/18/18greenwire-growing-geothermal-industry-says-it-gets-cold-82266.html (describing the lack of interest large Wall Street banks have in the geothermal industry).

160 30 U.S.C. § 1141 (2011) *see also* DORIS ET AL., *supra* note 58, at 8 (describing the 1978 through 1982 program, which provided loan guarantees to nine developers totaling over $100 million).

161 30 U.S.C. § 1141; Energy Policy Act of 2005, Pub. L. No. 109-58, § 1702, 119 Stat. 594 (codified in scattered sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.).

162 30 U.S.C. § 1141; Energy Policy Act § 1702.

163 30 U.S.C. § 1141.

IV. FEDERAL LANDS LEASING POLICIES AND GEOTHERMAL DEVELOPMENT

While proper financial support for geothermal R&D and plant construction is necessary for further geothermal development, the industry will expand only if developers have easy access to the land on which they can build projects. This Part will explore why public lands leasing policy plays a major role in geothermal development. It will then look at past and current federal geothermal leasing policy and make recommendations for streamlining the leasing process.

A. Geothermal Projects' Reliance on Federal Lands

The vast majority of American geothermal resources are on public lands, making federal lands leasing policy critical to geothermal development. The DOI's Bureau of Land Management (BLM) administers geothermal leases on BLM and USFS lands, which account for forty percent of the United States' current geothermal capacity.[164] The importance of federal leasing policy will only grow, as ninety percent of all geothermal resources exist on federal land.[165] The overwhelming concentration of geothermal resources on public lands stands in stark contrast to other renewable energy resources, for which federal lands leasing policy is far less important. For example, only 1.4 percent of current U.S. wind capacity is on federal lands and only eighteen percent of federal lands have high potential for wind power development.[166] Thus, while the vast majority of wind resources are on private or state-held land, geothermal developers have little choice but to build on federal land.

B. Geothermal Leasing Policy, Then and Now

The Steam Act of 1970 first established leasing procedures for geothermal resources on public land. It divided federal lands into Known Geothermal Resource Areas (KGRAs), where "geology, nearby discoveries, competitive interests, or other indicia" suggested geothermal development was economical,

[164] BUREAU OF LAND MGMT., U.S. DEP'T OF THE INTERIOR, RENEWABLE ENERGY AND THE BLM: GEOTHERMAL (2011), *available at* http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy.Par.74240.File.dat/Fact_Sheet_Geothermal_Oct_2011.pdf.

[165] *Renewable Energy Opportunities and Issues on Federal Lands: Review of Title II, Subtitle B of Geothermal Energy of EPACT; and Other Renewable Programs and Resources: Hearing Before the Subcomm. of Energy and Mineral Resources of the H. Comm of Natural Resources*, 110th Cong. 6, 7 (2007) (statement of Jim Hughes, Acting Director, Bureau of Land Management). It is unclear if this estimate includes only hydrothermal resources or also EGS resources.

[166] *See Explore the Issues: Public Lands and Wind Energy*, AMERICAN WIND ENERGY ASSOCIATION, http://www.awea.org/Issues/Content.aspx?ItemNumber=858 (last visited Dec. 8, 2013) (noting that only 800 MW of the country's over 60,000 MW of wind capacity through the end of 2012 were on public lands); BUREAU OF LAND MGMT., BLM/WO/GI-04/004+3100, AMERICAN ENERGY FOR AMERICA'S FUTURE: THE ROLE OF THE U.S. DEPARTMENT OF THE INTERIOR 4 (2004).
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and non-KGRAs.[167] The Steam Act instructed DOI to assign KGRA leases through competitive bidding, but to give the first applicant for a parcel of non-KGRA land a lease without an auction.[168] As of 2001, BLM managed "139 competitive leases (totaling 174,000 acres) and 148 non-competitive leases (totaling 173,000 acres)," showing both leasing processes were equally viable.[169] Each individual lease could be no larger than 2,560 acres and each developer could hold no more than 20,480 acres in a state.[170] Initial leases ran for ten years, with the right to extend a lease for forty years if the developer had begun to use the geothermal resource commercially during the ten-year period.[171] After that fifty-year period, developers had the preferential right to renew the lease for another forty-year term.[172]

Under the original Steam Act leasing procedures, developer lease applications were routinely subject to massive delays by BLM. From 1974 through 1979, BLM only approved 19 of 1,181 applications for leasing BLM and USFS lands in California.[173] If anything, BLM delays worsened as time progressed. From 1997 to 2001, BLM issued final decisions on only twenty geothermal lease applications throughout the entire United States.[174] By the time legislators were debating EPAct, over 194 lease applications remained unprocessed, some of which had been filed over a decade earlier.[175]

In 2005, EPAct dramatically altered the three-and-a-half decades-old federal lands geothermal leasing process. EPAct eliminated the KGRA/non-KGRA distinction, requiring competitive leasing in all circumstances except for a few rarely applicable exceptions.[176] Developers nominate desirable lands for which

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167 Geothermal Steam Act of 1970, 30 U.S.C. § 1001 (2004).

168 *Id.* § 1003.

169 *Geothermal Resources on Public Lands: Hearing Before the Subcomm. on Energy and Mineral Resources of the H. Comm. on Resources*, 107th Cong. 21, 22 (2001) (statement of Bob Anderson, Deputy Assistant Director, Minerals, Realty & Resource Protection, Bureau of Land Management). The large number of leases on non-KGRA land shows that KGRA designations did not include all public lands with high geothermal potential.

170 Geothermal Steam Act § 1006. However, the act gave regulators the right to increase the latter number to 51,200 acres starting in 1985. *Id.*

171 *Id.* § 1005.

172 *Id.*

173 *Omnibus Geothermal Energy Development and Commercialization Act of 1979: Hearing Before the Subcomm. on Energy Resources and Materials Production of the S. Comm. on Energy and Natural Resources*, 96th Cong. 98 (1979) (statement of James A. McClure, U.S. Senator from Idaho). While the precise reasons for these delays are not clear, government officials cited a lack of cooperation between BLM and USFS and lease size limits as contributing factors. *Id.* (statement of Frank Gregg, Director, Bureau of Land Management) at 98, 99-100.

174 *Renewable Energy Opportunities and Issues on Federal Lands: Review of Title II, Subtitle B of Geothermal Energy of EPACT; and Other Renewable Programs and Resources: Hearing Before the Subcomm. of Energy and Mineral Resources of the H. Comm. of Natural Resources*, 110th Cong. 7 (2007) (statement of Jim Hughes, Acting Director, Bureau of Land Management).

175 Harrison, *supra* note 15, at 434.

176 Energy Policy Act of 2005, Pub. L. No. 109-58, § 222, 119 Stat. 594 (codified in scattered

BLM then assigns leases through competitive bidding.[177] In order to reduce delays, the statute requires BLM to conduct auctions at least once every two years in states with pending nominations.[178] EPAct doubles the maximum lease size to 5,120 acres and increases the maximum number of acres a developer could hold in one state to 51,200.[179] It retains the initial ten year term for leases, but allows for two extensions of five years each even if a lease is not in commercial production if a developer is either willing to pay a fee or can show it conducted a satisfactory amount of work on the site.[180] Developers can extend leases over lands in production for an initial thirty-five year term and a subsequent period of fifty-five years.[181] Finally, EPAct required DOI and USDA to enter into a memorandum of understanding showing how the two agencies would "reduc[e] the backlog of geothermal lease application (*sic*) pending on January 1, 2005, by 90 percent" by August 8, 2010.[182] In response, BLM and USFS processed 139 lease applications between January 2005 and June 2007 and jointly issued a series of documents that eventually opened up 197 million acres of federal lands to geothermal leasing.[183]

The EPAct leasing regime is a vast improvement over the previous leasing system. In addition to clearing away the pre-2005 lease backlog as statutorily required, BLM has conducted fifteen competitive auctions since the EPAct geothermal leasing regulations became law in June 2007, providing developers with 378 parcels of federal land in five Western states and the federal government with over $76 million in revenue.[184] Since geothermal developers typically need thousands of acres of land to conduct adequate site exploration to find the best location to construct a plant, EPAct's expanded acreage limits for leases are positive.[185] Likewise, EPAct effectively expanded a leaseholder's ability to maintain possession of a non-productive lease on which the developer is still conducting exploration and construction from ten years to twenty

sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.). The most important way in which a developer can lease federal land for geothermal use noncompetitively is that lands which BLM puts up for auction but which do not receive any bids can then be leased noncompetitively within two years of the failed auction. 43 C.F.R. § 3204.5 (2011).

177 Energy Policy Act § 222.

178 *Id.*

179 *Id.* § 235.

180 *Id.* § 231.

181 43 C.F.R. § 3207.5 (2011).

182 Energy Policy Act § 225.

183 BUREAU OF LAND MGMT. & U.S. FOREST SERV., BLM-WO-GI-09-003-1800, FES-08-44, RECORD OF DECISION AND RESOURCE PLANNING MANAGEMENT AMENDMENTS FOR GEOTHERMAL LEASING IN THE WESTERN UNITED STATES 1-6 (2008); Harrison, *supra* note 15, at 434.

184 *See Geothermal Energy*, BUREAU OF LAND MGMT., http://www.blm.gov/wo/st/en/prog/energy/geothermal.html (last updated Nov. 30, 2013) (listing the number of land parcels sold in and revenue from each geothermal lease auction since 2007).

185 Harrison, *supra* note 15, at 438.

years.[186] It also increased the total time a developer could hold a lease from 90 to 110 years. Both of these changes are beneficial in an industry in which site exploration and construction take longer than for other types of power plants.

Nevertheless, BLM's flurry of activity from 2005 to 2010 could simply be a byproduct of its statutory obligation to reduce the pre-2005 lease backlog by 2010 and not a sign that the EPAct leasing regime is truly working well. In theory, BLM may have been able to speed up the auction process temporarily since it probably used similar resources in deciding to approve or reject pre-2005 leases as in auctioning off new leases.[187] In fact, since the backlog reduction deadline of August 8, 2010, the agency has only auctioned off forty-five parcels of land only worth around $730,000.[188] While it is too early to tell definitively if lease auctions will be less frequent post-2010 or if the EPAct regime is mostly a success, it is clear that a few changes could make the current leasing system even more effective.

C. Recommendations to Improve Current Federal Lands Geothermal Leasing Policy

One such way in which Congress could further improve the EPAct leasing regime would be to restore a robust noncompetitive leasing option. The current competitive bidding system does have advantages, such as the requirement to hold auctions in states with nominations. However, it forces developers who may have spent many years and much capital identifying particularly promising plots of federal land to then notify BLM of their interest in that land. Competitive leasing thus dramatically reduces a developer's incentive for conducting intensive research into a site's geothermal resources, since a different company that did no research can then swoop in and win the site by placing a higher bid in the auction.[189] Thus, some sort of noncompetitive leasing option is necessary to encourage exploration. One option would be to give developers the right to secure a lease parcel noncompetitively when they can demonstrate that they have spent a certain, large amount of money or time identifying a particularly promising site. Another option would be granting a noncompetitive lease to a company if BLM determines that so doing is in the

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186 *See* Geothermal Steam Act of 1970, 30 U.S.C. § 1005 (2004) (establishing initial lease term of ten years, to be extended only if lessee was using geothermal resource commercially); Energy Policy Act § 231 (allowing for successive five year extensions under certain circumstances even if the developer has not yet constructed a productive power plant).

187 However, even if this theory is true, EPAct still contains the requirement that BLM must hold auctions in states with nominated lands at least once every two years, which will speed up the leasing process from its pre-EPAct days. Energy Policy Act § 222.

188 BUREAU OF LAND MGMT., *supra* note 184.

189 *See* JOE LAFLEUR ET AL., WHAT WE HAVE LOST 2 (2007) (describing how top geothermal resources are usually concentrated in a small area of a larger site, making site exploration, and the adequate incentive to conduct it, essential).

public interest. A final approach would be adopting that of the Senate Committee on Energy and Natural Resource's recently proposed bill, the Geothermal Production Expansion Act, which permits negotiated leases when a developer has discovered a new resource.[190] No matter what approach Congress chooses, it is critical for geothermal developers to have the opportunity to lease federal lands outside of the competitive framework in order to encourage adequate site exploration.

The government could also speed up the leasing process by designating BLM as the lead agency for all tasks related to leasing. Congress could achieve this goal by statute or agencies could by delegating their authority in matters related to geothermal leasing to BLM when statutorily permissible.[191] Areas of regulation that lack a "primary regulator" often lead to "incomplete and arguably ineffective regulation."[192] Currently, the federal geothermal leasing process can involve the BLM, USFS, U.S. Fish and Wildlife Service (FWS), National Oceanic and Atmospheric Administration (NOAA), and National Park Service (NPS).[193] Three of these agencies (BLM, FWS, and NPS) are part of DOI, while USFS is part of USDA and NOAA is under the authority of the Department of Commerce. BLM is the logical lead agency for geothermal leasing because it actually conducts lease auctions. Since most relevant provisions of EPAct and the Steam Act explicitly instruct DOI,[194] as opposed to a smaller bureau within DOI, agencies such as the FWS that are within DOI can legally choose to delegate all of their leasing authority to BLM. For provisions where Congress has explicitly delegated authority elsewhere,[195] the respective agency in charge of this aspect of geothermal leasing can enter into a memorandum of understanding with BLM, permitting BLM to make recommendations to the agency regarding its geothermal authority, which that agency will always accept in practice. Such a regulatory scheme that concentrates almost all geothermal leasing power in BLM would only be advisable if other leasing agencies were certain that BLM has the expertise to carry out their former leasing tasks. If feasible, however, such a scheme would expedite geothermal leasing applications by ending unnecessary

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190 S.1149, 112th Cong. (2011). On December 15, 2011, the committee recommended moving this bill forward for consideration by the full Senate. *Senate Energy Committee Passes New Geothermal Legislation*, GEOTHERMAL TECHS. PROGRAM, http://www1.eere.energy.gov/geothermal/news_detail.html?news_id=17963 (Dec. 16, 2011).

191 See DORIS ET AL., *supra* note 58, at 27, for general comments on agency coordination.

192 William W. Buzbee, *Recognizing the Regulatory Commons: A Theory of Regulatory Gaps*, 89 IOWA L. REV. 1, 9 (2003).

193 BUREAU OF LAND MGMT. & U.S. FOREST SERV., *supra* note 183, at 2-9-2-11.

194 *See, e.g.*, Energy Policy Act of 2005, Pub. L. No. 109-58, § 222, 119 Stat. 594 (codified in scattered sections of 7, 15, 16, 22, 26, 30, and 42 U.S.C.).

195 *See, e.g.*, 30 U.S.C. § 1026 (2011) (giving the NPS the authority to monitor "significant thermal features" within the national parks to help ensure that they are not disrupted by geothermal leasing).

bureaucratization of leasing efforts, eliminating a major barrier for developers.

Thus, while EPAct has improved the public lands leasing process for geothermal development, the restoration of a noncompetitive leasing option and the designation of a lead agency for the leasing process could further promote geothermal development on public lands.

CONCLUSION

The years since 2005, when Congress began addressing geothermal energy in force again, have been good to the geothermal industry. After years of stagnation, with one DOE estimate noting that domestic geothermal capacity remained essentially level at just over 2,200 MW from 2001 through 2008, the industry is growing.[196] The Geothermal Energy Association (GEA), an industry trade association, reported that the United States had 3,386 MW of geothermal capacity as of February 2013.[197] Perhaps more importantly, the GEA claimed that as of April 2013, developers were in the midst of planning or constructing 175 geothermal projects in thirteen states accounting for 5,150 MW to 5,523 MW of new geothermal capacity, more than doubling current capacity.[198] While few of these projects are beyond preliminary stages of development, the sudden increase in planned projects bodes well for the industry and may be a sign of the positive impact encouragement from the federal government can have on geothermal development.[199]

Despite this positive trend, the federal government can do much more to encourage the construction of geothermal power plants. Geothermal energy is an extremely clean, promising source of baseload electricity in a country that recognizes the need to expand its reliance on renewable energy sources for climate change, energy independence, and job creation purposes.[200] This Article does not purport to be an exhaustive analysis of all of the issues facing geothermal development. For example, the federal and state governments must deal with transmission line constraints, which affect all new sources of electricity and are especially pertinent in the geothermal context, since plants are often relatively small and located in areas distant from major population centers.[201] Additionally, intensive study of geothermal's few significant environmental issues, especially those related to geothermal water sources and,

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[196] U.S. ENERGY INFO. ADMIN., *Summary Statistics*, *supra* note 14, at 9.

[197] GEOTHERMAL ENERGY ASSOC., ANNUAL REPORT, *supra* note 37, at 7. The GEA's estimates are somewhat higher than DOE's for corresponding years.

[198] *Id.* at 4, 14.

[199] *Id.* at 13.

[200] *See supra* text accompanying notes 13-18 for more information on the benefits of geothermal electricity generation.

[201] Harrison, *supra* note 15, at 438.

in the context of EGS, induced seismicity, is necessary.[202] Moreover, the current political culture is not conducive to new federal spending programs, especially in the arena of clean energy development. Nevertheless, it is clear that a historical lack of federal R&D support, ineffective federal funding aid, and a slow-moving public lands leasing policy have hampered the geothermal power industry's growth. By addressing these issues through the mechanisms this Article identifies, the federal government can ensure that geothermal energy no longer remains the often-ignored and underestimated "red-headed stepchild" of the renewable energy world.[203]

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[202] *See, e.g.*, Kamaal R. Zaidi, *Environmental Mitigation Aspects of Water Resources in Geothermal Development: Using a Comparative Approach in Building a Law and Policy Framework for More Sustainable Water Management Practices in Canada*, 23 GEO. INT'L ENVTL. L. REV. 97, 105-06 (2010) (noting that geothermal power plants can potentially contaminate local bodies of water in several ways, through effluent discharges, geothermal fluid spills, and contamination of the underground hot springs being used, and can also deplete local water resources). For information about fears of induced seismicity by EGS plants, see TESTER ET AL., *supra* note 40, at 8-9.

[203] Jeremy Shere, *The Vast, Maddening Promise of Enhanced Geothermal Energy*, RENEWABLE ENERGY WORLD.COM (June 1, 2011), http://www.renewableenergyworld.com/rea/blog/post/2011/06/the-vast-maddening-promise-of-enhanced-geothermal-energy.