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Double Dipping: Utilizing Oil Wells for Geothermal Energy

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DOUBLE DIPPING: UTILIZING OIL WELLS FOR GEOTHERMAL ENERGY

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INTRODUCTION

The United States' dependence on fossil fuels presents many concerns. First, there is the specter of global climate change, resulting from the emissions produced by the use of fossil fuels.[1] Additionally, the price of oil continues to rise and shows no sign of coming down any time soon, if ever.[2] Since the majority of this resource is imported from abroad, and more importantly since it is imported in large part from a very unstable area of the world, the United States' national security as a whole is potentially at risk.[3] Because of these risks, alternative energies that can compete in the energy supply market in the United States that replace or reduce U.S. dependence on fossil fuels are sure to grow in importance and desirability to the American energy industry.

Geothermal energy is a promising form of alternative energy in the quest to reduce the United States' reliance on fossil fuels. Geothermal energy comes from heat that is naturally produced deep beneath the Earth's surface.[4] While utilization of this resource has been going on for quite some time in the United States, it has a vast potential that is not

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[1] *See Key Findings*, U.S. GLOBAL CHANGE RES. PROGRAM, http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/key-findings (last visited Mar. 24, 2013).

[2] *See* Alex Lawler & Dmitry Zhdannikov, *Analysis: BP, Rivals Signal Rising Oil Prices over Long Term*, REUTERS (Oct. 27, 2011), http://www.reuters.com/article/2011/10/27/us-oilmajors-prices-idUSTRE79Q4BE20111027.

[3] *Oil Dependence Is US 'Achilles Heel,'* DEFENCEMANAGEMENT.COM (Nov. 2, 2011), http://www.defencemanagement.com/news_story.asp?id=17909.

[4] MASS. INST. OF TECH., THE FUTURE OF GEOTHERMAL ENERGY: IMPACT OF ENHANCED GEOTHERMAL SYSTEMS (EGS) ON THE UNITED STATES IN THE 21ST CENTURY (2006) [hereinafter MIT REPORT], *available at* http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf.

as of yet utilized to the fullest.[5] However, even if energy producers in the United States were to begin harvesting geothermal energy in earnest today, the potential benefit and output of the resource would be limited by the current legal structure.

There are laws in existence that regulate geothermal energy resources on federal and state levels.[6] At the federal level, the Geothermal Steam Act classifies geothermal resources as mineral rights and sets up a system to distribute and regulate federally controlled geothermal resources.[7] Many states also have laws controlling the geothermal resources under their control.[8] Some of these states, such as Arizona, treat geothermal resources as mineral rights as well,[9] while some, such as Colorado, handle them by regulating the geothermal resource according to its heat transfer mediums, namely groundwater.[10] Other states, such as Idaho and Washington, abandon such categories in favor of a *sui generis*[11] classification for geothermal resources.[12] For several reasons, these laws are not efficiently designed to handle a promising potential source of geothermal energy production: the conversion of oil and gas wells to geothermal wells.[13]

An economically efficient way to produce geothermal energy is by utilizing oil and gas wells.[14] While common methods of geothermal energy production utilize existing groundwater as a transfer medium,[15] this method collects geothermal energy through a foreign liquid medium

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[5] *See* TEX. COMPTROLLER OF PUB. ACCOUNTS, THE ENERGY REPORT 281 (2008) [hereinafter TEXAS ENERGY REPORT], *available at* http://www.window.state.tx.us/specialrpt/energy/pdf/96-1266EnergyReport.pdf; MIT REPORT, *supra* note 4, at 1-4.

[6] *E.g.*, Geothermal Steam Act, 30 U.S.C. §§ 1001–1027 (2006).

[7] *Id.*

[8] *E.g.*, ARIZ. REV. STAT. ANN., §§ 27-651 to 27-677 (2011); Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. §§ 37-90.5-101 to 37-90.5-108 (West 2011); Idaho Geothermal Resources Act, IDAHO CODE ANN. §§ 42-4001 to 42-4015 (West 2011); Geothermal Resources Act, WASH. REV. CODE ANN. §§ 78.60.010 to 78.60.900 (West 2011).

[9] ARIZ. REV. STAT. ANN. §§ 27-651 to 27-677.

[10] COLO. REV. STAT. ANN. §§ 37-90.5-101 to 37-90.5-108.

[11] *Sui generis* is defined as "of its own kind or class" or "unique" or "particular." BLACK'S LAW DICTIONARY (9th ed. 2009).

[12] IDAHO CODE ANN. §§ 42-4001 to 42-4015; WASH. REV. CODE ANN. §§ 78.60.010 to 78.60.900.

[13] *See* Margaret Allen, *Geothermal Heat: Will Earth's "Hot Rocks" Become New "Texas Tea"?*, SMU RESEARCH BLOG (June 15, 2009, 10:54 AM), http://blog.smu.edu/research/2009/06/geothermal_heat_will_earths_ho.html.

[14] *See id.*

[15] *How Geothermal Energy Works*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/technology_and_impacts/energy_technologies/how-geothermal-energy-works.html (last visited Mar. 24, 2013).

supplied by the producer.[16] This method can be operated within fully depleted or even currently producing oil wells through some of the existing infrastructure.[17] Logically, the use of an existing infrastructure will at least in part reduce the start-up costs of this type of geothermal venture, not to mention create value in infrastructure resources that may have otherwise been abandoned. For these and other reasons, this option could soon attract interest from U.S. oil producers and energy companies in places such as Texas.[18] However, in order to encourage these companies to undertake these conversions for wide-scale public energy supply, geothermal energy regulations should be modified to maximize the value of those ventures.

To encourage the production of geothermal energy from existing oil and gas production facilities, laws and regulations specifically designed to accommodate the uniqueness of geothermal heat resources will need to be created. Firstly, the definition of a geothermal heat resource will need to be tuned to best protect ownership interests given the unique properties of heat. Secondly, a system for efficiently assigning geothermal grants to oil and gas producers needs to be created to encourage geothermal energy production in this fashion. Thirdly, these laws will need to be modified to account for the fact that the transfer medium is supplied by the producer rather than mined. And finally, these laws should seek to efficiently control the energy output of geothermal plants so that the geothermal heat resource is not exhausted. A law designed with these factors in mind will not only encourage geothermal heat utilization and production efficiency, but will also make sure these resources remain viable and renewable for a long time.

This Note explains the desirability of geothermal heat production and the applicable resource management laws on the books, and attempts to solve the problems those laws fail to address when dealing with the method of producing geothermal energy from oil wells. Part I of this Note provides a basic background for geothermal energy: what it is, where it comes from, and why it matters. Part II discusses the relevant legal background including subterranean resource ownership, and the existing federal and state laws applicable to those resources. Part III introduces in detail the method of geothermal resource utilization from oil wells and how it compares with common geothermal energy production methods.

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[16] *See* Allen, *supra* note 13.
[17] *Id.*
[18] *Id.*

Finally, Part IV identifies the problem areas in existing geothermal resource law concerning the enabling and encouragement of this production method and suggests modifications to existing laws to help administer production more efficiently.

I. GEOTHERMAL ENERGY—THE BASICS

A. What Is It and Where Does It Come From?

Geothermal energy is energy produced by utilizing natural sources of heat deep below the Earth's surface.[19] Scientists believe that "the ultimate source of geothermal energy is radioactive decay occurring deep within the earth," as well as the natural magma pockets deep under the surface.[20] This heat is held within the surrounding rock and transferred throughout the Earth's crust through fractures and pores bearing natural fluids such as water or superheated vapor.[21]

This geothermal heat energy may be accessed multiple ways, the first and easiest being from hot springs.[22] These essentially exist where the heated fluids and steam flow all the way to the surface of the Earth.[23] In common parlance, this form of geothermal energy would include both hot springs (in liquid form) and geysers (in gaseous form).[24]

The next method of accessing geothermal heat is to drill a well in order to access deep deposits of heated fluids.[25] This requires a reservoir of natural fluids, preferably porous enough to allow the fluid supply to build back up.[26] This fluid is withdrawn either using pumps (for liquids) or vacuums (for gases).[27]

The final method of accessing geothermal heat is direct fluid injection.[28] When hot rock formations underground are no longer or have never been surrounded by fluids that would allow the heat to be carried

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[19] MIT REPORT, *supra* note 4, at 1-9.
[20] *What Is Geothermal?*, GEO-HEAT CENTER (Jan. 1, 2008), http://geoheat.oit.edu/whatgeo.htm.
[21] MIT REPORT, *supra* note 4, at 1-9.
[22] *How Geothermal Energy Works*, *supra* note 15.
[23] *Id.*
[24] *See id.*
[25] MIT REPORT, *supra* note 4, at 1-10.
[26] *Id.* at 1-11.
[27] *What Is Geothermal?*, *supra* note 20; *How Geothermal Energy Works*, *supra* note 15.
[28] *See* MIT REPORT, *supra* note 4, at 1-10.

to the surface, wells may be drilled to allow for fluids to be pumped below the surface and returned once heated.[29]

Once the heat is brought to the surface using one of the three aforementioned methods, its heat energy may be utilized either directly or converted into electricity.[30] Direct geothermal heat use involves simply pumping the heated fluids to a final destination in order to physically heat something, for instance, a building.[31] Alternatively, the heated fluids can be pumped to a power plant where they are used to power a standard steam turbine, which in turn creates electricity.[32]

B. A History of Geothermal Heat Use

Heat is one of the oldest and most basic energy sources known to man.[33] One need look no further than the classic image of a cave-man's fire to know that men have been utilizing the power of heat to create light, cook food, and keep warm for as long as history can remember. When man began to create machines to harness the energy for other purposes, steam engines were among the first, appearing in various forms as early as ancient Alexandria and featuring prominently in the Industrial Revolution.[34]

But while those heat energy sources are perhaps the most recognizable, man has been utilizing geothermal energy for almost as long. Centuries ago, the Romans and other ancient civilizations were using naturally occurring geothermal energy (in the form of naturally heated underground springs) for bathing and other purposes.[35] The United States is no stranger to using geothermal heat for commercial heating, with service providers appearing as early as 1890 and continuing into the modern day.[36] As for electricity production, a limited use was first recorded in 1904 in

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[29] *See What Is Geothermal?*, *supra* note 20; *How Geothermal Energy Works*, *supra* note 15; Allen, *supra* note 13.
[30] *How Geothermal Energy Works*, *supra* note 15.
[31] *What Is Geothermal?*, *supra* note 20; *How Geothermal Energy Works*, *supra* note 15.
[32] *Id.*
[33] *See generally A Short History of Energy*, UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/clean_energy/clean_energy_101/a-short-history-of-energy.html (last visited Mar. 24, 2013) (explaining that methods of using heat to generate power date back to ancient Alexandria).
[34] *Id.*; James C. Williams, *History of Energy*, THE FRANKLIN INST. (Apr. 25, 2006), http://www.fi.edu/learn/case-files/energy.html.
[35] TEXAS ENERGY REPORT, *supra* note 5, at 281.
[36] *Id.*

Italy, followed by the world's first full-blown geothermal electric plant in 1913.[37] By the 1920s, the United States had started using geothermal heat to produce electricity as well.[38]

Originally, geothermal electricity production in the United States was centered around existing surface-level sources. The first production of geothermal electricity in the United States was in the area surrounding The Geysers in northern California.[39] This field had long been used by local Native Americans as a geothermal heat source, as well as by later settlers and tourists for spa-related purposes; however, it was not until the early 1930s when the first geothermal electric plant was successfully built and operated on site by John Grant.[40] Grant's electric plant utilized a turbine run by the steam produced from an earlier shallow ninety-seven-meter-deep well drilled into a naturally occurring "dry steam" field.[41] However, despite an early attempt to export the electricity to a nearby city, the plant was only ever used locally to produce electricity for The Geyser's homes and hotels.[42] While the earliest geothermal electricity production was localized in use, new technologies would allow geothermal harvesting to expand in quantity and geography.

Several advances in geothermal technology have allowed for increased production, not necessarily centered around natural surface access to geothermal heat.[43] In The Geysers, during the late 1950s, dedicated power companies began drilling beyond 400 meters to pump out hot water and steam from deeper geothermal heat deposits not accessible through the surface fields.[44] In addition to the deeper drilling depths, area operators also began pumping wastewater into the wells to be heated, rather than relying on existing subsurface water alone as a means of increasing the wells' output capacity.[45] The development of binary systems, which can produce geothermal energy from cooler underground sources, would allow production to expand across the United States.[46] These advances

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[37] *Id.*; John W. Lund, *100 Years of Geothermal Power Production*, GHC BULL. (Sept. 2004), at 11–12, *available at* http://geoheat.oit.edu/bulletin/bull25-3/art2.pdf.
[38] Lund, *supra* note 37, at 11, 14.
[39] *Id.* at 14.
[40] *Id.*
[41] *Id.*
[42] *Id.*
[43] *See* Lund, *supra* note 37, at 14.
[44] *Id.* at 14–15.
[45] *Id.* at 11, 15.
[46] Brent Barker, *Expanding the Footprint of Geothermal Energy*, EPRI J., Summer 2011, at 14, 15–16, *available at* http://mydocs.epri.com/docs/CorporateDocuments/EPRI_Journal/2011-Summer/1023458_GeothermalEnergy.pdf.

would allow geothermal energy production to move beyond these surface-accessible geothermal heat resources to deeper deposits found elsewhere in the United States.

With the ability to reach deeper and cooler geothermal heat deposits, geothermal electric plants have spread further through the United States.[47] Currently, there are active commercial geothermal electric plants in California, Nevada, Utah, and Hawaii at a total of nineteen locations.[48] Other states are also beginning to explore potential geothermal electric usage.[49] For example, Idaho, Oregon, and New Mexico have shown interest in pursuing geothermal electricity production.[50] Additionally, Texas is currently exploring geothermal electricity options and believes that "these emerging technologies hold considerable promise for the state."[51]

Finally, many places in the United States have active access to geothermal resources, but are using them for non-electric purposes.[52] For example, eleven states utilize geothermal heat for commercial aquaculture and fisheries, and nine states utilize it for greenhouse heating.[53] Geothermal deposits are currently used for various direct building and home heating applications in Oregon, Nevada, California, South Dakota, and Idaho.[54] Geothermal deposits are even being utilized in several Midwest, mid-Atlantic, and southern states to cool homes with heat pump technology.[55]

C. Is It Renewable?

Geothermal energy is often classified and discussed as a renewable energy resource.[56] While it is certainly true that geothermal energy

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[47] *See, e.g.*, John W. Lund et al., *Geothermal Energy Utilization in the United States—2000*, GEO-HEAT CENTER, http://geoheat.oit.edu/pdf/tp106.pdf (last visited Mar. 24, 2013).
[48] *Id.*
[49] *E.g.*, John W. Lund et al., *The United States of America Country Update*, WORLD GEOTHERMAL CONGRESS 2005, 2 (Apr. 24–29, 2005), *available at* http://www.osti.gov/geothermal/servlets/purl/895237-Vp8ett/895237.pdf.
[50] *Id.*
[51] TEXAS ENERGY REPORT, *supra* note 5, at 281.
[52] *See* Lund et al., *supra* note 49, at 5–6.
[53] *Id.*
[54] *Id.* at 5.
[55] *Id.* at 6.
[56] *See, e.g.*, *Geothermal Energy Facts*, RENEWABLEENERGYRESOURCE.NET, http://renewableenergyresource.net/renewable-energy-sources/geothermal-energy/geothermal-renewable-energy-facts (last visited Mar. 24, 2013); *Geothermal Basics*, U.S. DEP'T OF ENERGY: ENERGY EFFICIENCY & RENEWABLE ENERGY, http://www1.eere.energy.gov/geothermal/geothermal_basics.html (last visited Mar. 24, 2013); *Geothermal Energy Basics*, NAT'L RENEWABLE

is a clean energy,[57] and at the very least sustainable,[58] it seems apparent that geothermal energy is not, in fact, entirely renewable.[59]

While it appears that the naturally occurring heat within the Earth is renewable, the natural fluids used to "transport" that heat are not.[60] Since those fluids are the resource captured to actually produce geothermal energy,[61] if they run out so does the natural geothermal energy production capacity. But the important question is how quickly does this depletion occur, and is it reversible?

One major example of the potential for geothermal depletion can be found in the United States.[62] It appears that the United States' first geothermal electric plants in The Geysers[63] are currently suffering from diminished production capacity.[64] Electricity production at The Geysers has dropped from 2098 MW in 1989 to 936 MW in 2004; that is a loss of more than half of The Geysers' peak capacity.[65] This reduction is in part due to the decommissioning of several of the production units, but "a reduction in steam production due to 'too many straws sucking from the reservoir' and only about 20% of the produced fluid being injected back into the reservoir" is the main culprit.[66] However, part of the problem may reveal the solution.

Since the depletion of geothermal resources results from the depletion of existing hot fluid reservoirs, electricity producers have begun pumping their own fluids down into the empty reservoirs to be heated.[67] This process involves simply injecting water into the natural reservoirs

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ENERGY LABORATORY, http://www.nrel.gov/learning/re_geothermal.html (last visited Mar. 24, 2013).

[57] *See Geothermal Basics*, *supra* note 56; TEXAS ENERGY REPORT, *supra* note 5, at 285 (explaining that "geothermal energy produces no air emissions other than steam").

[58] *See Geothermal Basics*, *supra* note 56; *Texas' Renewable Energy Resources: Geothermal*, INFINITEPOWER.ORG, http://www.infinitepower.org/resgeothermal.htm (last visited Mar. 24, 2013).

[59] *See Geothermal Energy*, ALTERNATIVE ENERGY, http://www.altenergy.org/renewables/geothermal.html (last visited Mar. 24, 2013).

[60] *How Geothermal Energy Works*, *supra* note 15.

[61] *See supra* Part I.A.

[62] *See* Lund, *supra* note 37, at 11, 15.

[63] *See supra* Part I.B.

[64] Lund, *supra* note 37, at 15.

[65] *See id.*

[66] *Id.*

[67] *See* Rashmin C. Gunasekera, G.R. Foulger, & B.R. Julian, *Reservoir Depletion at The Geysers Geothermal Area, California, Shown by Four-Dimensional Seismic Tomography*, 108 J. OF GEOPHYSICAL RES. 2134, 2-2 (2003), *available at* http://www.dur.ac.uk/g.r.foulger/Offprints/GunasekeraJGR.pdf.

and fractures where the original fluids were contained and allowing the hot rocks to heat it up.[68] One example of the process is currently being employed at The Geysers, where owners have created the Santa Rosa Geysers Recharge Project, which brings in treated wastewater and pumps it underground to replenish the fluid reserves of the geothermal field.[69] However, while this method may be used to replenish lost resources, producers may still need to be careful about how often they employ this tactic. While geothermal heat is nearly infinitely renewable over time, even the hot rock formations in existence could be depleted if too much cool water is pumped below the surface to be heated.[70]

Additionally, since it is apparent that geothermal heat may be accessed by pumping fluids artificially into the surface of the Earth, it is also theoretically possible to pump fluids into hot rock formations where heated fluids previously did not exist.[71] Indeed, this process is exactly what some energy providers are beginning to employ.[72]

D. The Potential of Geothermal Energy

To understand why developing an efficient management system for geothermal resources may be important, it helps to know the vast potential of geothermal energy resources in the United States. According to a 2006 Massachusetts Institute of Technology study, the estimated amount of recoverable geothermal energy is somewhere above 200,000 exajoules.[73] To give a sense of scale, this amount of energy production would be "about 2,000 times the annual consumption of primary energy[74] in the United States in 2005."[75] Of course, this estimate is only inclusive of what geothermal energy is economically efficient to recover.[76] When you take into account the full estimated U.S. geothermal resource base of

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[68] MIT REPORT, *supra* note 4, at 1-10.
[69] *How Geothermal Energy Works*, *supra* note 15.
[70] TEXAS ENERGY REPORT, *supra* note 5, at 285.
[71] *See* MIT REPORT, *supra* note 4, at 1-10, 1-11.
[72] *See* Allen, *supra* note 13. For further discussion of this process and its implications, refer to the discussion, *infra* Part III.A.
[73] MIT REPORT, *supra* note 4, at 1-4.
[74] Primary energy is defined as "the energy embodied in natural resources prior to undergoing any human-made conversions or transformations." Andy Kydes, *Primary Energy*, THE ENCYCLOPEDIA OF EARTH (Oct. 6, 2011, 8:21 PM), http://www.eoearth.org/article/Primary_energy. This includes fossil fuels, sunlight, wind. *Id.*
[75] MIT REPORT, *supra* note 4, at 1-4.
[76] *See id.*

13 million exajoules, it is estimated that normal advances in technology could expand the economically viable recovery of geothermal energy tenfold or more.[77] Therefore, with a resource base as potentially impactful as geothermal energy ripe for the taking in the United States, it becomes apparent that the legal infrastructure for managing such an important resource deserves some attention.

While the numbers are certainly encouraging, it is important to know where this geothermal energy resource is available, because an energy resource is useless if it cannot be provided to energy users. In the short term, it appears that most of the United States' geothermal energy utilization will continue to be found in California, Utah, Nevada, and Hawaii, where the resource is located closer to the surface.[78] However, geothermal use continues to expand; Arizona, Idaho, New Mexico, Oregon, Texas, Washington, and Wyoming are all beginning to explore and utilize more advanced geothermal production technologies and methods.[79] There is no reason to believe that production cannot expand further around the U.S. since average subsurface temperatures can provide adequate energy production using existing heat pump technology.[80] Additionally, with thirty percent of the world's total geothermal capacity located on U.S. soil, not only could geothermal energy be used to help satisfy energy demands around the country, but it can do so with the added benefit of reducing our reliance on fluctuating energy prices stemming from energy importation from outside the country.[81]

Geothermal energy also has the potential to reduce the environmental impact of energy use in the United States in a variety of ways. Firstly, it appears that no carbon dioxide is produced as a by-product of geothermal energy production;[82] indeed, if used as the transfer fluid, carbon dioxide could actually be reduced through sequestration in geothermal production facilities.[83] Additionally, the land required to utilize a geothermal resource is much less than other methods of energy production, freeing up that additional land for other uses.[84] All of this contributes

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[77] *Id.*
[78] TEXAS ENERGY REPORT, *supra* note 5, at 283.
[79] *Id.*
[80] *See id.*
[81] Allen, *supra* note 13; MIT REPORT, *supra* note 4, at 1-4.
[82] MIT REPORT, *supra* note 4, at 8-16.
[83] *Id.*
[84] *Id.*

to making geothermal energy production "the most environmentally benign means of generating base-load electricity."[85]

Finally, while geothermal energy is not the only renewable energy source available, it does have one distinct advantage over solar and wind energy production methods. While solar energy requires the sun to be shining, and wind energy requires the wind to be blowing, geothermal energy is available around the clock and calendar year.[86]

All these facts combined with the projected energy output discussed previously make geothermal energy an attractive option for energy supply in the future.

II. CURRENT LAWS AND THEIR IMPACTS ON GEOTHERMAL ENERGY PRODUCTION

A. Who Owns the Resource?

Before examining the laws and regulations specifically relating to geothermal heat resources, it may be beneficial to first briefly solidify an understanding of exactly who might hold the title to this subsurface resource. Theoretically, an owner's property extends from the base of his surface property all the way down to the center of the Earth.[87] And while this may be true in fee simple ownership of a property, it is also possible for subsurface mineral rights to be severed from the surface estate and owned separately.[88] However, this may not always be true in practice.

In instances where geothermal heat resources are managed as groundwater resources, the law in some states may not actually assign ownership to the owner of the surface property rights.[89] Reasonable use

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[85] *Id.* at 8-17.

[86] *Geothermal Energy: Tapping the Earth's Heat*, NAT'L GEOGRAPHIC, http://environment.nationalgeographic.com/environment/global-warming/geothermal-profile/ (last visited Mar. 24, 2013).

[87] *See* John G. Sprankling, *Owning the Center of the Earth*, 55 UCLA L. REV. 979, 991–92 (2008).

[88] *See Landowners and Oil and Gas Leases in Pennsylvania*, PENN. DEP'T OF ENVTL. PROTECTION, http://www.shalereporter.com/legislation/pdf_4cbebd04-67e3-11e1-8da9-0019bb30f31a.html (last visited Mar. 24, 2013).

[89] *See, e.g.*, Nebraska Groundwater Management and Protection Act, NEB. REV. STAT. § 46-702 (2011) (stating that "the Legislature finds that ownership of water is held by the state for the benefit of its citizens, that ground water is one of the most valuable natural resources in the state, and that an adequate supply of ground water is essential to the

doctrine rejects the concept of ownership for right to access and capture-style ownership, and further limits it by stating that it may not be used in certain, often wasteful, ways.[90] Additionally, in some states, statutes may even vest original ownership of groundwater in the state itself.[91] In both of these cases it appears that complete ownership of geothermal resources in general, when regulated as groundwater, is not always so straightforward.

In instances where geothermal heat resources are defined as minerals, the law can also result in the surface owner not actually owning the rights to the subsurface resources under his land.[92] Extralateral rights doctrine under federal law, where applicable, assigns ownership of the subsurface minerals to whichever property owner is lucky enough to have surface access to the mineral, even if the mineral extends beneath another property once underground.[93] Additionally, some state and federal laws may restrict access to these subsurface minerals altogether, even if they are technically on private properties.[94]

Classification of geothermal resources may have a profound effect on the ownership of those resources. To ensure a fair and clear result, it will therefore be necessary for any geothermal energy law to clearly define ownership and control of the resource from the outset, whether this is done under an existing resource classification or not.

B. Federal Laws

Under federal law, geothermal resources appear to fall under the heading of a "mineral" resource, and many geothermal resources are therefore subject to the control of the U.S. government under relevant federal law. The Supreme Court has not ruled directly on the question of geothermal resource classification, but it noted in *Watt v. W. Nuclear, Inc.* that geothermal steam had been classified by the Ninth Circuit as a mineral.[95] This designation has also been used to address geothermal resources more recently in *Rosette Inc. v. United States*, which held that

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general welfare of the citizens of this state and to the present and future development of agriculture in the state").

[90] Sprankling, *supra* note 87, at 1007.

[91] *Id.*; *see, e.g.*, NEB. REV. STAT. § 46-702.

[92] Caddo Minerals, *Mineral Rights Law,* http://www.caddominerals.com/mineral-rights-law.aspx (last visited Mar. 24, 2013).

[93] Sprankling, *supra* note 87, at 1011.

[94] *Id.* at 1011–12.

[95] Watt v. W. Nuclear, Inc., 462 U.S. 36, 52 (1983) (citing United States v. Union Oil Co. of Cal., 549 F.2d 1271, 1273–74 (9th Cir. 1977)).

geothermal resources were mineral resources for the purposes of federal law.[96] Considering the fact that the Supreme Court denied cert in *Rosette*, specifically addressing this issue, it appears that for now this is a permitted interpretation of the resource's classification.[97] This classification has also allowed the U.S. to retain control over geothermal resources beneath certain privately owned tracts of surface land (such as that distributed under the Stock Raising Homestead Act of 1916) located in areas associated with geothermal potential, such as New Mexico.[98]

In an effort to promote the development of geothermal resources controlled by the United States government, Congress passed the Geothermal Steam Act of 1970.[99] The Geothermal Steam Act gives the Secretary of the Interior the authority to lease government geothermal holdings for energy production purposes.[100] Geothermal holdings as defined include both geothermal rock formations and the fluids associated with them.[101] In determining the scope of the associated fluids subject to this federal control, there appears to be some confusion over whether state rules are controlling in certain instances, but this note will assume federal control for federal holdings.[102] It should also be noted that the Geothermal Steam Act establishes that a geothermal lease can coexist simultaneously with other types of mineral leases on the same plot of land.[103] Additionally, the Geothermal Steam Act includes provisions directing the Secretary of the Interior to create rules that prevent waste and conserve the geothermal resources being leased, as well as rules requiring maintenance of water quality and other environmental qualities.[104]

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[96] *See* Rosette Inc. v. United States, 277 F.3d 1222 (10th Cir. 2002), *cert. denied*, 537 U.S. 878 (2002).
[97] *Id.*
[98] Steven R. McNutt, Rosette Inc. v. United States*: Is the United States Full of Hot Air When It Comes to Reservation of Geothermal Resources as a "Mineral?"*, 8 GREAT PLAINS NAT. RESOURCES J. 44, 44 (2003); *see, e.g.*, *Rosette Inc.*, 277 F.3d 1222 (holding geothermal resources in this New Mexico property reserved to the U.S. under the Stock Raising Homestead Act). *See generally* Barker, *supra* note 46, at 14, 16 (showing a map of the United States' geothermal resource base).
[99] McNutt, *supra* note 98, at 47; *see* Geothermal Steam Act, 30 U.S.C. §§ 1001–1027 (2006).
[100] 30 U.S.C. § 1002 (2006).
[101] *See id.* § 1001(c).
[102] Kathleen Callison, *Water and Geothermal Energy Development in the Western U.S.: Real World Challenges, Regulatory Conflicts and Other Barriers, and Potential Solutions*, 22 MCGEORGE GLOBAL BUS. & DEV. L.J. 301, 309 (2010). State rules and their implications are discussed separately. *Infra* Part II.C.
[103] Geothermal Steam Act, 30 U.S.C. § 1016 (2006). This will be relevant when discussing utilization of geothermal heat from depleted oil wells. *Infra* Part IV.
[104] *Id.* § 1023(a), (b), (i).

Even though the leasing guidelines under the Geothermal Steam Act apply only to federally controlled geothermal resources[105] and therefore not those on privately owned land, it plays a large part in the management of many of the United States' geothermal resources.[106] This is because, as a simple fact of geography, "[a]pproximately 90 percent of geothermal resources in the Western United States are located on federal lands."[107]

In determining exactly what property is leased, the Geothermal Steam Act does not provide much guidance, merely stating that "a geothermal lease for the direct use of geothermal resources shall cover not more than the quantity of acreage determined by the Secretary to be reasonably necessary for the proposed use."[108] In terms of quantity, the Geothermal Steam Act allows geothermal leases of up to 5120 acres.[109] These leases are auctioned off to the highest bidder, or if the potential geothermal resource coexists within an existing mineral lease, may be converted to a geothermal lease subject to a non-competitive leasing process.[110]

Additionally, the Geothermal Steam Act contains a specific provision dealing with hot dry rock based geothermal energy.[111] Hot dry rock is a reference to those geothermal energy deposits beneath the surface that do not already contain readily available pockets of fluid, but rather are artificially broken up and supplied with fluids as a transfer mechanism for the heat stored in the formation.[112] This section of the Geothermal Steam Act recognizes a difference between this and other geothermal energy production methods where the fluid transfer medium, or even spaces available to contain that medium, already exist. It also mandates that the government go through a specialized leasing process involving environmental impact studies before the grant of the lease.[113]

Finally, recognizing the potential for depletion of a geothermal resource, the Geothermal Steam Act contains a specific provision mandating that "the lessee will, in conducting his exploration, development, and producing operations, use all reasonable precautions to prevent

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[105] *See id.* § 1002.
[106] Mark D. Detsky, *Getting into Hot Water: The Law of Geothermal Resources in Colorado*, 39 COLO. LAW. 65 (2010).
[107] *Id.* (citing U.S. Bureau of Land Management ("BLM"), *Comprehensive Strategic Plan for Geothermal Management* 7 (2005)).
[108] Geothermal Steam Act, 30 U.S.C. § 1003(g)(1) (2006).
[109] *Id.* § 1006.
[110] *Id.* § 1003(b).
[111] *Id.* § 1028.
[112] *How Geothermal Energy Works*, *supra* note 15.
[113] Geothermal Steam Act, 30 U.S.C. § 1028 (2006).

waste of geothermal resources developed in the lands leased."[114] Indeed, this provision is so integral to leasing under the Geothermal Steam Act that it specifically enumerates that all geothermal rights under government owned lands are only acquired in accordance with this provision.[115] It is worth noting, however, that neither a provision for clear reasonable use guidelines, nor an inspection method to ensure compliance are outlined in this provision, although the Secretary is empowered to terminate a geothermal lease (after notice and a period to allow for corrections) for violations of any regulations.[116]

C. State Laws

States have taken a variety of different paths to attempt to define and regulate geothermal energy. Some states appear to treat geothermal energy as a mineral resource, such as Arizona which places its relevant laws in the same Title as minerals and same Chapter as oil and natural gas, while specifically exempting it from water laws.[117] Other states, such as Colorado, classify geothermal resource rights generally within the bounds of water law.[118] Finally, some states, such as Idaho and Washington, perhaps recognizing how inexact either of these definitions are in describing the unique character of geothermal heat, declare geothermal resources *sui generis*, being neither a mineral nor a water resource.[119] However, even in instances of a *sui generis* declaration, different states still file their geothermal resource laws under either their mineral rights laws (i.e., Washington), or their water rights laws (i.e., Idaho).[120] To understand the particulars of how each system of classification uniquely

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[114] *Id.* § 1022(a).
[115] *Id.* § 1022(b).
[116] *Id.* § 1011.
[117] *See* ARIZ. REV. STAT. ANN. §§ 27-651 to 27-677 (2011) (generally exempting geothermal resources from water laws).
[118] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. §§ 37-90.5-101 to 37-90.5-108 (West 2011). Note, the statute does differentiate hot dry rock, classifying it more under mineral rights ownership terms. *See id.* § 37-90.5-104(2).
[119] *See* Idaho Geothermal Resources Act, IDAHO CODE ANN. §§ 42-4001 to 42-4015 (West 2011); Geothermal Resources Act, WASH. REV. CODE ANN. §§ 78.60.010 to 78.60.900 (West 2011).
[120] *See* Geothermal Resources Act, WASH. REV. CODE ANN. §§ 78.60.010 to 78.60.900 (West 2011) (located under Title 78: Mines, Minerals, and Petroleum); Idaho Geothermal Resources Act, IDAHO CODE ANN. §§ 42-4001 to 42-4015 (West 2011) (located under Title 42: Irrigation and Drainage—Water Rights and Reclamation).

affects geothermal energy production, it helps to examine each method in detail, using the aforementioned laws as examples.

1. Geothermal Energy as a Mineral Resource

Arizona classifies its geothermal resources categorically as minerals, but specifically includes within its definition: the products of geothermal processes; fluids naturally contained or artificially injected within geothermal formations; the heat itself stored in a formation; and any other minerals other than fossil fuels contained within the formations.[121] However, despite this encompassing definition, the statute for the most part discusses geothermal resource plots in terms of leasing land or rights of access associated with the ground beneath the land, much like a mineral right.[122] Arizona's statute does contain a provision that extends the applicability of general water laws when the geothermal resource is comingled with groundwater, but otherwise fails to discuss specifics within the statute.[123] It should also be noted that this provision only discusses the situation whereby groundwater is "obtained," rather than injected.[124]

The Arizona statute does seek to account for potential resource spillover from geothermal resource production when that resource extends into land not owned by the producer.[125] Despite defining a geothermal resource in a multitude of ways,[126] this section of the statute does not clearly establish how to determine when a geothermal resource extends into the property of others beyond implicitly leaving it up to the Commission.[127] When such an instance occurs, the Commission is empowered to ensure

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[121] ARIZ. REV. STAT. ANN. § 27-651(6)(a)–(d) (2011).
[122] *See, e.g.*, *id.* § 27-651(5) (defining a "geothermal area" as a "general surface area which is underlain or reasonably appears to be underlain by one or more formations containing geothermal resources"); *id.* § 27-671(E) (defining lease contents in terms of acreage).
[123] *Id.* § 27-667.
[124] *Id.* § 27-667(B) (stating "In the development of geothermal resources, any well drilled to obtain and use groundwater, as defined in § 45-101, shall be subject to the water laws of this state."). The statute does discuss water injection but only within the context of reinjection of the groundwater resources extracted. *See id.* § 27-652(D) (stating "whenever the commission finds that it would be in the interest of maintenance of the underground geothermal resource, prevention of subsidence of the land surface or maintenance of the quality of surface and other ground waters, the commission may require reinjection of the geothermal effluent or injection of other water supplies into the producing zones").
[125] *See* ARIZ. REV. STAT. ANN. § 27-666 (2011).
[126] *See id.* § 27-651(6)(a)–(d).
[127] *See id.* § 27-666(A) (2011) (mentioning the ability of the Commission to "pool" the resource between owners for, among other reasons, the "protection of correlative rights").

that the neighboring owners have an "opportunity to recover or receive" their fair share of the geothermal resource, or alternatively the Commission may require that the operator collect proceeds for an owner in default.[128] Thus, the statute appears to not only assign right of access to neighbors similar to riparian water rights, but also a right to receive a fair portion of the proceeds from the operator who actually produces the resources.[129] Based on this provision, it is worth wondering whether the statute is truly handling geothermal resources as mineral resources or whether it is actually handling the resource as a groundwater-like resource, at least in this instance.

As for regulatory control of the resource, the Arizona statute empowers the Oil and Gas Conservation Commission to supervise the mining of the geothermal resource, much like the Federal statute empowered the Secretary of the Interior.[130] The Commission is empowered by Arizona to:

> encourage the greatest ultimate economic recovery of geothermal resources, to prevent damage to and waste from underground geothermal reservoirs, to prevent damage to or contamination of any waters of the state or any formation productive or potentially productive of fossil fuels or helium gas, and to prevent the discharge of any fluids or gases or disposition of substances harmful to the environment by reason of drilling, operation, maintenance or abandonment of geothermal resource wells.[131]

Thus, the statute gives the Commission the flexibility to seek the goals of efficiency and the prevention of waste and environmental contamination in whatever methods it sees fit.[132]

Finally, when establishing a well for the production of geothermal energy, the Arizona statute requires that an application be filed with and approved by the Commission before production begins.[133] This provision applies to three situations: the creation of a new well, the entering of an

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[128] *Id.* § 27-666(A)–(B).
[129] *Id.* § 27-666(A).
[130] *Id.* § 27-652; *see supra* Part II.B (discussing the role of the Secretary of the Interior in geothermal resource management under the control of the federal statute).
[131] ARIZ. REV. STAT. ANN. § 27-652(A) (2011).
[132] *See id.*
[133] *Id.* § 27-659. The particulars of the application are not laid out within the statute, but rather left to the Commissioner to define. *See id.*

"abandoned" well, and the deepening of an "abandoned" well.[134] Because of the term "abandoned," it is unclear within the statute as to whether such uses may coexist with oil and gas wells still in operation if the producer wants to apply for the permit after the oil or gas well has been drilled, but it seems safe to assume that under the Commission's general grant of powers this would certainly be a possibility.[135]

2. Geothermal Energy as a Water Resource

Colorado's geothermal statute primarily discusses the resource categorically as a water resource.[136] While it defines the geothermal resource as including the "natural heat of the earth,"[137] the Colorado statute places a heavy emphasis on the water rights issues associated with geothermal energy production.[138] Despite this water rights focus, the Colorado statute does take account of "hot dry rock" formations, or those lacking existing fluid for geothermal energy transfer, and handles them separately.[139]

As for ownership of the resource, the Colorado statute generally assigns ownership of the fluid geothermal resource (associated with tributary groundwater) to the State, and recognizes no correlative property right in the land owner.[140] Indeed, the statute specifically states that the doctrine of prior appropriation which Colorado generally identifies with its water rights should be modified to allow for economic development of the geothermal resource.[141] While it appears to some extent that private citizens may still claim ownership of certain geothermal fluid reservoirs according to standard water rights acquisition methods,[142] access to that geothermal resource is restricted and requires the prior approval of the

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[134] *Id.* § 27-659.
[135] *See* ARIZ. REV. STAT. ANN. § 27-652(A) (2011). This could likely be achieved under the ability to "encourage the greatest ultimate economic recovery of geothermal resources." *Id.*
[136] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. §§ 37-90.5-101 to 37-90.5-108 (West 2011).
[137] *Id.* § 37-90.5-103(3).
[138] *See, e.g.*, *id.* § 37-90.5-107; *see also* Detsky, *supra* note 106, at 65 ("Under Colorado law, geothermal resources are considered water resources and are governed by the Geothermal Resources Act."). Also, to highlight the difference in emphasis placed on water rights, *compare* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-107 (West 2011) (a long provision discussing water rights and use issues in detail), *with* ARIZ. REV. STAT. ANN. § 27-667 (2011) (a much shorter and less detailed provision dealing with water rights issues in the primarily mineral rights focused Arizona law).
[139] Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-103(4) (West 2011).
[140] *Id.* § 37-90.5-104(1).
[141] *Id.* § 37-90.5-102(1)(c).
[142] *See* Detsky, *supra* note 106, at 67.

State Engineer, along with the Colorado Water Quality Control Commission and Colorado Oil and Gas Conservation Commission.[143] As for apportionment of the resource between multiple owners who might have access to the geothermal fluid, the statute does not go into too much detail, but does state that the State Engineer should ensure that the application to access the geothermal resource does not "materially injure" other valid rights to the fluid.[144] As for the categorically distinct "hot dry rock" formations briefly mentioned in the statute, ownership of that geothermal resource is vested as a mineral right, controlled by the surface owner, or other owner if the mineral rights were previously severed.[145]

Regulatory control of Colorado's geothermal energy resources is vested primarily in the State Engineer.[146] The State Engineer is empowered to "protect the public health, safety, and welfare and the environment and to prevent the waste of any geothermal resource."[147] It is empowered to accomplish this by establishing "geothermal management districts" that outline such factors as permissible quantity for extraction and reinjection requirements.[148] Additionally, the State Engineer will need to consult with both the Colorado Water Quality Control Commission and Oil and Gas Conservation Commission when certain conditions accompany the request to produce geothermal energy.[149]

Finally, Colorado requires that an application be filed with the State Engineer "prior to constructing a geothermal resource exploration, production, or reinjection well," to receive a permit to access the resource.[150] It should be noted that the Colorado statute's addressing of "reinjection" refers to the replacing of prior existing fluid resources during geothermal heat production for sustainability purposes.[151] Nowhere in the statute is

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[143] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-106 (West 2011).

[144] *Id.* § 37-90.5-107(3). "Material injury" is defined as:

> any diminution or alteration in the quantity, temperature, or quality of any valid, prior water or geothermal right; except that, with regard to a geothermal right, "materially injure" and "material injury" include a diminution or alteration in the temperature of water only if the diminution or alteration adversely affects the valid, prior geothermal right.

Id. § 37-90.5-107(8).

[145] *Id.* § 37-90.5-104(2).

[146] *See id.* § 37-90.5-106(1)(b).

[147] *Id.* § 37-90.5-106(1)(b).

[148] *See id.* § 37-90.5-108.

[149] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-106(1)(b)(2) & (4) (West 2011).

[150] *Id.* § 37-90.5-106(1)(b).

[151] *See id.* § 37-90.5-106(3).

artificial fluid injection discussed or directly controlled, although it may imply its control through the mentioning of "hot dry rocks," which do not contain geothermal fluids.[152]

3. Geothermal Energy Classified as a *Sui Generis* Resource

Recognizing that geothermal energy does not fit perfectly into either mineral or water resource categories, states such as Idaho and Washington have declared their geothermal resources as unique *sui generis* resources.[153] For example, Idaho defines geothermal resources as "being neither a mineral resource nor a water resource, but . . . closely related to and possibly affecting and affected by water and mineral resources in many instances."[154] Based on the Arizona and Colorado statutes discussed previously,[155] it would appear that this method might allow legislatures a way to solve any problems that accompany the pigeonholing of geothermal resources into existing resource categories. However, it appears that this classification, "although arguably the most accurate, is also the most impractical because it leaves unanswered the issue of which legal regime to use in allocating the resource."[156]

Lacking an existing method of assigning ownership to the geothermal resource, *sui generis* geothermal classification statutes tend to fall back on methods of ownership applied to mineral and water resources. For example, Washington, despite classifying geothermal resources as *sui generis*, places its geothermal resource statute in the same Title as its "Mines, Minerals, and Petroleum" laws, and explicitly states that the resource is "hereby declared to be the private property of the holder of the title to the surface land above the resource," giving it a *de facto* mineral rights classification in terms of ownership.[157] Meanwhile Idaho, a prior appropriation state,[158] fails to specifically address ownership in its statute, but implies that standard water rights ownership methods apply because the statute is located in the statutory Title section as "Water

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[152] *See id.* § 37-90.5-103(4).
[153] Idaho Geothermal Resources Act, IDAHO CODE ANN. § 42-4002(c) (West 2011); Geothermal Resources Act, WASH. REV. CODE ANN. § 78.60.040 (West 2011).
[154] Idaho Geothermal Resources Act § 42-4002(c).
[155] *See supra* Part III.C.1–2.
[156] Laura MacGregor Bettis, *In Hot Water: Can Idaho's Ground Water Laws Adequately Govern Low Temperature Geothermal Resources?*, 39 IDAHO L. REV. 113, 121 (2002) (quoting Thomas A. Starrs, *Solar, Wind, and Geothermal Energy*, *in* SUSTAINABLE ENVIRONMENTAL LAW, 735, 789 (Celia Campbell-Mohn et al. eds., 1993)).
[157] Washington Geothermal Resources Act § 78.60.040.
[158] Bettis, *supra* note 156, at 130.

Rights and Reclamation."[159] Idaho allows the Water Resource Board to handle permit consolidations and requires standard applications to appropriate public waters.[160]

As for regulation of the resource, both Idaho and Washington approach the goals of geothermal resource management in a similar fashion. Idaho empowers its Department of Water Resources to prevent waste and ensure no harm comes to people or resources in the surrounding sub- and above-surface areas;[161] Washington empowers its Department of Natural Resources to do the same.[162]

Finally, as with Arizona's[163] and Colorado's[164] statutes, both Idaho and Washington's statutes require that applications be filed and permits received before geothermal resource production can begin.[165] Washington's statute requires that an application be submitted to its Department of Natural Resources, which provides a copy to the Department of Ecology.[166] After both have time to examine the application, a hearing is then held before permission is granted to drill or redrill an abandoned well.[167] Idaho's statute requires an application to be submitted to (and approved by) the Department of Water Resources, along with a separate public waters appropriation application if public waters are involved.[168]

However, in addition to this common method, Idaho is unique in that it allows a separate application procedure when an injection well is proposed.[169] The Idaho statute defines an injection well as a:

> special well, converted producing well or reactivated or converted abandoned well employed for injecting material into

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[159] *See* Idaho Geothermal Resources Act § 42-4006.
[160] *See id.* § 42-4003(4).
[161] *See id.* § 42-4003(8) (allowing the designation of "geothermal areas" for the purpose of preventing waste of the resource); *id.* § 42-4010(d) (empowering the director of the Water Resource Board to correct or stop practices that threaten "damage to life or property or subsurface, surface, or atmospheric resources").
[162] Washington Geothermal Resources Act § 78.60.050(1) (directing the Department "to prevent damage to and waste from underground geothermal deposits, and to prevent damage to underground and surface waters, land or air that may result from improper drilling, operation, maintenance or abandonment of geothermal resource wells").
[163] *See* ARIZ. REV. STAT. ANN. § 27-659 (2011).
[164] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-106(1)(b) (West 2011).
[165] Idaho Geothermal Resources Act § 42-4003(1)–(2); Washington Geothermal Resources Act § 78.60.070(1), (2).
[166] Washington Geothermal Resources Act § 78.60.070(1).
[167] *Id.* § 78.60.070(2).
[168] *See* Idaho Geothermal Resources Act § 42-4003(2), (4).
[169] *See id.* § 42-4003(c)(2).

> a geothermal area to maintain pressures in a geothermal reservoir, pool, or other source, or to provide new material or to serve as a material medium therein, or for reinjecting any material medium or the residue thereof or any by-product of geothermal resource exploration or development into the earth.[170]

In such an instance, the Idaho statute requires a lesser application fee than with a standard well for geothermal energy production.[171] Additionally, if an owner of an oil or gas well encounters a geothermal resource in the course of its operation and seeks to exploit it, the application fee is waived.[172] Thus, unlike the federal statute and other three state statutes discussed, the Idaho statute takes into account the possibility of geothermal resources coexisting with other resource deposits, such as oil and natural gas, and makes some small attempt to ease the use of one system of infrastructure for multiple types of energy resource production.

III. GEOTHERMAL ENERGY AND OIL WELLS

Having now examined the varying ways in which the federal and state governments have attempted to control the development and utilization of geothermal resources, the focus shifts to a unique method of geothermal energy production that seems ill-addressed within those statutes but appears ripe with potential: Enhanced Geothermal Systems ("EGS"), which allow the production of geothermal energy from lower temperature rock formations and are often associated with existing oil and gas wells.[173]

A. What Is It and Where Can It Be Used?

Enhanced Geothermal Systems are defined as "engineered reservoirs that have been created to extract economical amounts of heat from low permeability and/or porosity geothermal resources."[174] In other words, EGS collect geothermal heat energy by artificially pumping and circulating

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[170] *Id.* § 42-4002(j).
[171] *Compare id.* § 42-4003(5)(a) (setting the standard well application fee at $200), *with id.* § 42-4003(5)(b) (setting the injection well application fee at $100).
[172] *See id.* § 42-4003(10).
[173] *See* Joshua P. Fershee, *The Geothermal Bonus: Sustainable Energy as a By-Product of Drilling for Oil*, 85 N.D. L. REV. 893, 894 (2009).
[174] MIT REPORT, *supra* note 4, at 1-10.

a foreign fluid into subterranean rock formations, either with preexisting minimal fluid retention capacity or manmade fractures to allow for fluid retention.[175] This is as opposed to aforementioned standard geothermal resource collection methods which either utilize existing hot fluid reservoirs or which reinject and recirculate fluid into those same reservoirs to be reheated.[176] Additionally, EGS technology may be coupled with geothermal energy technologies that allow production from much cooler rock formations than normal, thus expanding the potential exploitable resource base.[177]

While EGS wells may be used in a variety of locations, a special opportunity exists to utilize EGS technology alongside existing oil and natural gas mining infrastructure.[178] Geothermal energy may be produced from this existing infrastructure simultaneously with oil and natural gas production from natural fluid byproducts or artificially injected fluids already used in the process of mining oil and natural gases from deep underground.[179] This is particularly useful, as the location of oil and gas production in the United States coincides quite well with the availability of geothermal heat resources.[180]

B. The Potential Benefits

The main benefit to encouraging production of geothermal energy with EGS employed in oil and natural gas wells is that means of utilizing EGS are already largely in place. Little additional investment is required to start up the system, as the piping infrastructure and drilling required to operate these systems will have already been completed as a part of the existing oil wells.[181] Because of this reduced investment cost, and with

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[175] *See id.* at 1-10 to 1-11.
[176] *See supra* Part I.B.
[177] *Compare* Fershee, *supra* note 173, at 897 (stating that the typical temperature range required for geothermal energy production is between 150 and 300 degrees Celsius), *with id.* at 898 (stating that new technology can produce geothermal energy with subsurface temperatures as low as 90 degrees Celsius).
[178] *See* MIT REPORT, *supra* note 4, at 1-10.
[179] *See* Allen, *supra* note 13, at 2.
[180] *Compare* MIT REPORT, *supra* note 4, at Fig 2.2, *with Oil and Gas Production in the United States*, U.S. GEOLOGICAL SURVEY (Feb. 25, 2012, 2:13 PM), http://certmapper.cr.usgs.gov/data/noga95/natl/graphic/uscells1msmall.pdf (showing the distribution of oil and natural gas resources production in the United States).
[181] *See* Fershee, *supra* note 173, at 898–99 (quoting Will Gosnold et al., Presentation on The Potential Impacts of Co-Produced Geothermal Waters (2007), http://www.und.nodak.edu/org/ihfc/AAPG08.ppt).

the added savings of low-temperature resource utilization, this method of energy production can become cost competitive.[182] In this way, it is possible that companies already drilling for oil or natural gas, given the right legislative encouragement, could be easily convinced to produce geothermal energy for sale on the market. This would promote the most efficient use of a potentially sustainable energy source.

One place where such systems could be utilized effectively is Texas, where there already exists an extensive network of oil and natural gas wells.[183] Indeed, researchers at Southern Methodist University in Dallas, Texas, have estimated that there is as much as 921,085 exajoules available in the existing mining systems, with as much as two to ten percent of that being recoverable.[184]

Additionally, or perhaps alternatively, this method of energy production could be used to reduce the costs of American produced oil. Firstly, the energy gathered through this method could be used to power the oil and natural gas mining operations themselves, resulting in lower production costs.[185] Secondly, the introduction of fluids injected with EGS can improve the extraction methods and yields of oil and natural gas wells, allowing for more efficient production (and through efficiency, lower costs).[186] Therefore, the American consumer could be benefited not only by the added supply of alternative energy, but also the potential for cheaper domestic oil.

IV. FIXING AN IMPERFECT LEGAL SYSTEM TO ENCOURAGE THE PRODUCTION OF GEOTHERMAL ENERGY FROM OIL AND GAS WELLS

There are four main problems with the combination of legal apparatuses that currently exist to govern geothermal resource production.[187]

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[182] *Id.* at 898 (quoting Will Gosnold et al., Presentation on The Potential Impacts of Co-Produced Geothermal Waters (2007), http://www.und.nodak.edu/org/ihfc/AAPG08.ppt).
[183] *See* Allen, *supra* note 13, at 2 (stating that there are "thousands" of oil and gas wells suitable for geothermal energy production).
[184] *Id.* at 2–3.
[185] *See id.* at 2.
[186] *See How Geothermal Energy Works*, *supra* note 15.
[187] The four problems exist outside of the legal uncertainties that have to do with an oil company forced to deal with multiple different federal and state methodologies for managing the resource. *See generally* Kaveh Badiei, *Geothermal Energy: Is It Attractive Enough to Draw Investors for Construction of Geothermal Electric Plants?*, 7 HASTINGS W.–N.W. J. ENVTL. L. & POL'Y 109 (2001). Of course this problem would be corrected by adoption of a uniform-style policy like the one outlined in this Note.

These include an inconsistent definition of resource type, an unclear means of dealing with geothermal resources straddling multiple owners' properties, a cumbersome regulatory apparatus, and lack of a specific provision dealing with the conversion of an oil and gas lease to allow for simultaneous geothermal energy production.[188] To encourage producers to use EGS geothermal production alongside oil and natural gas, these four problems will need to be addressed.

A. The Problems with Current Legal Systems

Existing geothermal energy laws are too often inconsistent in classifying the geothermal resource, and their differing methodologies may fit one geothermal energy production method but not another.[189] This problem is straightforward: as previously discussed, the federal government,[190] as well as states like Arizona,[191] handle geothermal resources as a mineral; other states, such as Colorado,[192] handle geothermal energy under laws resembling water regulations; and finally some states, such as Idaho and Washington,[193] purport to handle geothermal resources *sui generis*, while in reality treating them more like a mineral or water resource. This has the potential to get complicated and confusing for oil and gas companies who may have properties spanning multiple state and federal controls.[194] Additionally, the geothermal-as-water laws would appear not to even apply to manual injection methods at all, seeing as they regulate the resource as if it involved state-controlled water reservoirs and other resources,[195] and the oil well production method does not access that resource at all.[196] The *sui generis* distinction seems useless because laws using that distinction seem to primarily operate under mineral or water rights methods.[197]

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[188] *See id.*
[189] *See supra* Introduction.
[190] *See* Rosette Inc. v. United States, 277 F.3d 1222 (10th Cir. 2002).
[191] *See* ARIZ. REV. STAT. ANN. § 27-651(6)(a)–(d) (2011).
[192] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-107 (West 2011).
[193] Idaho Geothermal Resources Act, IDAHO CODE ANN. § 42-4002(c) (West 2011); Geothermal Resources Act, WASH. REV. CODE ANN. § 78.60.040 (West 2011).
[194] *See, e.g.*, *Lower 48*, CONOCOPHILLIPS.COM, http://www.conocophillips.com/EN/about/worldwide_ops/l48-la/Pages/Lower48.aspx (last visited Mar. 24, 2013).
[195] *See, e.g.*, Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-104(1) (1983).
[196] *See supra* Part III.A.
[197] *See supra* Part II.C.3.

Current laws are insufficient to protect the property rights of state and private land owners. This problem stems from the issue discussed in the previous paragraph: it may not be clear as to whether one owns a physically and geographically defined mineral estate[198] or a right of access such as that which accompanies water rights doctrines such as prior appropriation.[199] If a party is unsure about exactly what they own, they cannot be sure when what is rightfully theirs is being taken from them without compensation.

The regulatory systems in place become cumbersome when dealing with conversion of existing oil and gas leases. While some statutes (such as the federal statute) assign one government office to the geothermal permit process,[200] others (such as Colorado) require consultation with multiple government commissions before a geothermal permit may be granted.[201] Indeed, some analysts believe that one of the primary reasons for the lack of geothermal development in the United States (aside from cost efficiency) is the long and arduous permit process and other required testing procedures present in the federal geothermal statute,[202] which is similar or more straightforward than many of the above named state statutes.[203]

Finally, few statutes even seem to comprehend this method of production, and therefore they fail to address it adequately. Some of the statutes address an injection-related scenario by mentioning hot dry rocks,[204] while one specifically talks about reinjection only,[205] which may or may not apply to manual injection. Of those statutes discussed previously, Idaho is the only state with a statute that seems to envision the possibility of geothermal energy from existing oil wells. The only provision Idaho included was an elimination of the application fee for a geothermal permit.[206]

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[198] *See, e.g.*, ARIZ. REV. STAT. ANN. § 27-666 (2011), and discussed *supra* Part II.C.1.
[199] *See, e.g.*, Idaho Geothermal Resources Act, IDAHO CODE ANN. § 42-4003(2) (1987) (requiring standard water appropriation style permits); Bettis, *supra* note 156, at 130 (identifying Idaho as a prior appropriation state); *see also* discussion *supra* Part II.C.3.
[200] *See* Geothermal Steam Act, 30 U.S.C. § 1002 (2006); *see also* discussion *supra* Part II.C.2.
[201] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-106 (2003); *see also* discussion *supra* Part II.C.2.
[202] *See* discussion *supra* Part II.C.2.
[203] *See* Energy Digital, *U.S. Geothermal Industry Could Be Given a Boost by Congress*, OILPRICE.COM (Aug. 3, 2011, 1:33 PM), http://oilprice.com/Alternative-Energy/Geothermal-Energy/U.S.-Geothermal-Industry-Could-Be-Given-A-Boost-By-Congress.html.
[204] *See, e.g.*, Geothermal Steam Act, 30 U.S.C. § 1028 (2006).
[205] *See* Colorado Geothermal Resources Act, COLO. REV. STAT. ANN. § 37-90.5-106(1)(b) (2003).
[206] *See* Idaho Geothermal Resources Act, IDAHO CODE ANN. § 42-4003(10) (2012).

B. Designing Geothermal Energy Statutes to Incentivize EGS Accompanying Oil and Natural Gas Wells

To streamline a statutory system well-suited to handle the production of geothermal energy from existing oil wells, the classification of geothermal energy produced through this method needs to be clarified. The ideal scenario would be to choose one overarching classification for all geothermal resources so that an oil and gas producer would not have to go to the trouble of modifying its production process to fit the realities of multiple means of classifying the resource. The optimal designation would likely be that of a mineral resource, because it would be simultaneously defined with oil and gas leases, which themselves are handled using a system of mineral rights.[207] By defining geothermal resources as minerals, producers whose business systems and employees are familiar with the standard legal rules associated with mineral resources would be more able to understand the nuances of how to work best within that style of regulatory system. Additionally, since the transfer fluids in an EGS system are not already present but artificially injected, from a scientific point of view this system best characterizes the existing geothermal legal definition where no existing state water resources are affected: the hot dry rock classification.[208]

A method of clarifying ownership rights to geothermal energy systems involving manual fluid injection is needed. By classifying geothermal resources as mineral deposits, clear geographical lines could be drawn as to who owns what with respect to geothermal resource deposits.[209] Indeed, because oil and natural gas resources share this mineral designation,[210] the ownership of the geothermal resource could be defined concurrently and precisely with the existing ownership of oil and natural gas reserves. By removing these possibly time-consuming legal questions of ownership from the equation, and because they will already own the mineral rights to that geothermal area, producers will likely be further incentivized to produce. Additionally, if a scenario were to occur where there was a risk that the water injected by a producer might find its way

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[207] *See Mineral Rights: Basic Information About Mineral, Surface, Oil and Gas Rights*, GEOLOGY.COM (Jan. 13, 2013, 7:27 PM), http://geology.com/articles/mineral-rights.shtml.
[208] *How Geothermal Energy Works*, *supra* note 15.
[209] *See, e.g.*, Geothermal Resources Act, WASH. REV. CODE ANN. § 78.60.040 (1979) (stating that "hereby declared to be the private property of the holder of the title to the surface land above the resource").
[210] *See Mineral Rights*, *supra* note 207.

into a neighbor's geothermal heat deposits, and the legislature believed that such a process took what was rightfully the neighbor's property, a system could be used like that in the Arizona statute discussed above. It envisions the divvying up of income in proportion to the percentage of the neighbor's land actually accessed by the producer.[211] This would allow for the producer to continue its mining operations normally; the only true inconvenience would be the calculation of a percentage and the writing of a check, which should not be enough to dissuade the producer.

The regulatory system could be streamlined to ease the application process for the owners of existing oil wells. To help solve this problem, perhaps the maintenance and regulatory controls of a geothermal lease may be left to the primary authority in controlling geothermal resources within a jurisdiction in order to maintain the commonly stated interests of prevention of waste and harm to the surrounding area,[212] while the face of the application process is shifted to the oil and gas commission that controls the producer's primary oil and gas lease.[213] Instead of requiring a standard and separate geothermal permit application, one could provide a section on an oil and gas permit application which inquires directly about whether the producer would like to attach a geothermal lease to the oil and gas lease. By including a section on the standard application for a permit the state would in effect be able to advertise and promote the geothermal production option to all oil and gas producers as they are preparing to begin energy exploitation of a mineral estate. Additionally, by consolidating the application process, there would be no additional transaction costs (such as the preparing of a separate permit application) to scare off those who might potentially utilize the geothermal option in concert with their oil and natural gas mining operations.[214] That is to say, an oil and gas producer would not need to interact with a new and foreign agency for the leasing process; it could interact with the oil and gas commissioner, with whom the producer is already comfortable.[215] By utilizing these methods, geothermal energy production from oil and gas wells could not only be eased, but promoted by statute at the beginning of the oil and gas mining process.

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[211] *See* ARIZ. REV. STAT. ANN. § 27-666(A)–(B) (2011).
[212] *See, e.g.*, Geothermal Resources Act, WASH. REV. CODE ANN. § 78.60.050(1) (1974).
[213] *See, e.g.*, WASH. REV. CODE. ANN. § 79.14.020 (2003).
[214] *See* Phil Taylor, *Oil and Gas Industry Sitting on 7,200 Drilling Permits*, N.Y. TIMES (Mar. 25, 2011), http://www.nytimes.com/gwire/2011/03/25/25greenwire-oil-and-gas-industry-sitting-on-7200-drilling-21290.html.
[215] *See Senator Pushes to Cut "Cozy" Ties Between Oil Industry, Regulators*, CNN (May 26, 2010), http://edition.cnn.com/2010/POLITICS/05/26/oil.industry.regulation/index.html.

Finally, a specific provision for the scenario at issue could be included within existing geothermal resource laws to handle the conversion of existing oil and gas permits to allow for geothermal energy production. A proposal to modify the existing federal geothermal legislation has been presented to the U.S. Senate already, and reads as follows:

> (4) Land Subject to Oil and Gas Lease.—Land under an oil and gas lease issued pursuant to the Mineral Leasing Act (30 U.S.C. 181 et seq.) or the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351 et seq.) that is subject to an approved application for permit to drill and from which oil and gas production is occurring may be available for leasing under subsection (c) by the holder of the oil and gas lease—(A) On the determination that—(i) geothermal energy will be produced from a well producing or capable of producing oil and gas; and (ii) the public interest will be served by the issuance of such a lease; and (B) in order to provide for the coproduction of geothermal energy with oil and gas.[216]

This proposed amendment would handle the situation of concurrent production reasonably well, however it may be beneficial to modify its language to read "from which oil and gas production is occurring *or has occurred*," to account for subsequent production from abandoned oil and gas well infrastructure.[217] By adopting a modification such as this, and coupling it with the other proposals previously discussed, a statute could more easily outline a mission to encourage this method of geothermal energy production.

Looking past these legal modifications, the results of the new system are beneficial in that they would mean little actual change in the day-to-day relationship and operations of regulatory agencies or oil and gas producers.[218] The government entity in charge of efficiently controlling the geothermal resource and ensuring waste and environmental standards are met would still monitor and control existing geothermal leases owned by oil and gas producers, along with other geothermal lease owners, although in this instance they would not be handing out the actual permit themselves.[219] The oil and gas producer will still only need to

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[216] S. 916, 112th Cong. § 102 (2011).
[217] *See, e.g.*, ARIZ. REV. STAT. ANN. § 27-659 (addressing abandoned wells explicitly).
[218] *Supra* note 212 and accompanying text.
[219] *Id.*

interact with the oil and gas commissioner for the acquisition process and would not need to substantially modify their land acquisition practices.[220] The oil and gas commissioner would not have any added regulatory responsibilities; they would simply need to modify their permit forms slightly.[221] Finally, because the status quo is often cheap and easy for everyone, this reality would be a further incentive for oil and gas producers to participate in geothermal resource utilization.

To sum up these modifications and their benefits, by defining geothermal resources for EGS production as mineral resources, the system of legal controls and ownership could be effectively clarified, simplified, and made more operable. Additionally, by transferring the permit process from the geothermal to the oil and gas regulatory authority, and creating a special statutory provision to allow for the ease of geothermal leasing in concurrence or sequentially with oil and gas production, the accessibility of geothermal leases could be increased and their use incentivized for both oil and gas producers and other mineral rights owners.

CONCLUSION

In the public sphere there has been much focus on utilizing sustainable energy resources, and while it will not solve our dependence on fossil fuels, geothermal energy does present one promising option for lessening society's dependence on oil and natural gas.[222] The federal government and numerous states, recognizing the promise of geothermal energy, have enacted a variety of legal systems to regulate geothermal resources.[223] However, while these existing legal systems might be able to handle geothermal resource production when it is accomplished using existing subterranean fluids, they are ill-equipped to handle production methodologies utilizing fluid injection and existing oil and gas wells.[224]

A few alterations or modifications to existing geothermal resource laws can help solve the problem in these situations.[225] By designing a statutory system which classifies "hot dry rock" geothermal resources as minerals, the controlling regulatory and ownership principles will become more accurate and clear. By placing oil and gas commissions in

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[220] *Id.*
[221] *Id.*
[222] *See supra* Part I.D.
[223] *See supra* Parts II.B–C.
[224] *See supra* Part IV.A.
[225] *See supra* Part IV.B.

charge of the conversion/application process for producing geothermal energy from oil and gas mineral rights grants, it becomes less of a hassle for oil producers to secure geothermal rights, incentivizing their utilization of that resource. And finally, by creating statutory mechanisms that specifically allow for the easy addition of a geothermal production permit to an oil and gas permit, oil companies will not have to worry (and be dissuaded by) extra hoops and unclear statutory methods of such conversions. Indeed, by enacting these few simple changes to the way laws regulate geothermal energy, the U.S. can boost its geothermal energy production by incentivizing parties who already have the means to produce geothermal energy to begin producing.