Chapter 12

Policy, Advocacy, & Regulatory Considerations

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The private sector is poised to launch the geothermal industry in Texas, but it needs policy support from the Texas legislature to ignite the geothermal decade.

I. Introduction

Texas has a long history of successfully supporting the development of energy industries, from early and present day support of the oil and gas industry, to more recent efforts to support the wind and solar industries. This Chapter describes the history and influence of Texas policy-making on the energy industry, and policy and societal hurdles facing the geothermal industry. It further offers recommendations to address hurdles that will empower large-scale development and commercialization of geothermal technologies in Texas, leveraging private markets, competition, and the core competencies of the Lone Star State.

Below, we explore five hurdles to the growth and scale of geothermal in Texas, and offer recommendations to address them. The five hurdles are:

1. Lack of familiarity with geothermal technologies and applications among both lawmakers and the general public;
2. A lack of policies that would incentivize geothermal energy;
3. An insufficient workforce transition and training structure;
4. The need for improvement in State government coordination; and
5. Regulatory obstacles that hinder the commercialization and scaling of geothermal energy in the State.

Throughout our exploration of these five hurdles, we identify how civic leaders, and the Texas legislature can support the geothermal industry by: 1) becoming

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geothermal education and policy champions, 2) proposing geothermal specific legislation relevant to their districts and regions, 3) facilitating access of geothermal technologies to capital, 4) increasing opportunities for geothermal companies to access public and private finance, and 5) fine-tuning regulation that would support the quick scaling of geothermal in the State.

II. Texas Policy-makers' Role in Building the Texas Energy Economy

A. Building Texas' Oil and Gas Industry - Then and Now

For over 100 years, policy-makers in Texas have supported the growth and development of the State's energy industries. This support began when the State legislature gave the Texas Railroad Commission ("RRC") jurisdiction to regulate the production of oil and gas in 1919. When the global price of crude oil dropped dramatically in the 1930s, the RRC intervened with producer quotas to maintain price levels, and to quell violence that had broken out in the East Texas oil fields. Under the leadership of Ernest O. Thompson, who served as a RRC commissioner from 1932 to 1966, the RRC championed and oversaw rules and regulations that further empowered the oil and gas industry and the Texas economy. The RRC played an instrumental role in navigating the oil and gas industry in Texas through tumultuous energy shocks of the 1970s, increased competition from other hydrocarbon entities, such as the Organization of Petroleum Exporting Countries and Russia, the 2008 to 2009 financial crises, and most recently the economic and supply chain challenges caused by the COVID-19 pandemic. The RCC, with the support of the Texas legislature, has profoundly shaped, empowered, and supported the oil and gas industry over the past century. As Texas historian David Prindle writes, "The domestic petroleum industry was enmeshed in a web of State regulations specifically designed to shield it from the ravages of the market." With support of the RRC, oil and gas became the largest industry in Texas, and one of the most powerful hydrocarbon production industries in the world.

In the early 2000s, hydraulic fracturing (more commonly known as frac'ing), and innovations in horizontal drilling led to a new era of oil and gas development in the United States, with Texas once again leading the way. It also ushered in a new era of State level support for the oil and gas industry, including a tax credit program for high cost gas wells designed to support the commercialization and scaling of the Texas gas industry. Originally passed in 1989 under the Administration of Republican Governor Bill Clements, and made permanent in 2003 by Republican Governor Rick Perry, this credit program was used to support 61 percent of gas wells in the State by 2009. The tax credit cost the State of Texas $1.5 billion a year before factoring in Federal research and demonstration appropriations from the U.S. Department of Energy during the Administration of Republican U.S. President George W. Bush, a former Texas governor. The support from the Federal government helped to underpin the development of hydraulic fracturing innovation in Texas, further driving progress. Benefits were compounded by Texas' comparatively low levels of regulation on oil and gas development, and severance tax incentives (Ong & Munson, 2018).

More recently, during the 2021 State legislative session, several bills were proposed and designed to protect the oil and gas industry in the face of headwinds from the international financial system, as well as Federal and international efforts to address the climate crisis. In sum, both historically and on an ongoing basis, local and public support from policy-makers and political champions, targeted policies, and industry-specific efforts has empowered the oil and gas industry throughout its globally and economically impactful 100-year history in Texas.

B. Building the Texas Intermittent Renewable Energy Industry

The intermittent renewable energy industry in Texas found its footing in 1999 through the deregulation of the State's power market, and the passage of a renewable portfolio standard to establish 2,000 megawatts of electricity capacity from renewable energy by 2009. These policies were enacted by the Texas legislature, signed into law by Republican Governor George W. Bush, and amplified in 2009 to 10,000 megawatts of capacity during the Administration of Republican Governor Rick Perry. In addition, the Perry Administration launched the Competitive Renewable Energy Zone ("CREZ") program, a $7 billion project connecting the wind farms of West Texas with the population centers in the eastern half of the State (Gould, 2018; Lasher, 2008). In that effort, the Public Utility Commission ("PUC") authorized companies to negotiate with private landowners and use eminent domain to acquire land on which private companies constructed transmission lines across the State, facilitated through the CREZ program. The actions of these two Administrations ushered in the dramatic growth of the renewable energy industry in Texas. CREZ is discussed in more detail in Chapter 11, Geothermal, the Texas Grid, and Economic Considerations.

For much of the past 25 years, State support for the oil and gas industry has run in parallel with intended and unintended support for renewable energy. In more recent years, however, conflict between these two energy industry giants has begun to arise and become politicized. During the 2021 Texas legislative session, conducted in the wake of Winter Storm Uri, much of the legislation proposed pitted the intermittent renewable (wind, solar) and nonrenewable (oil, gas, nuclear) energy industries against one another. This conflict is likely to continue in the 2023 legislative session.

Geothermal offers a potential "third way" policy solution for Texas policy-makers. It will require support and empowerment from the Texas legislature, the Governor of Texas, and the RRC to chart a path forward that emboldens a largely proven, accelerating, but underutilized energy technology. Geothermal is poised to amplify and support the oil and gas industry, while also providing firm, reliable, and clean power to the grid that complements the intermittency of renewables like solar and wind.

The next Section explores tools available to policy-makers that will help commercialize and scale the geothermal industry in Texas.

III. Supporting Growth of the Texas Geothermal Industry: A Policy-Makers Handbook

In this Section, we identify hurdles to the growth of Texas' geothermal industry, and identify areas where policy-makers can support the industry. As discussed above, the growth of geothermal in Texas faces five major hurdles:

1. Lack of familiarity with geothermal technologies and applications among both lawmakers and the general public;
2. A lack of policies that would incentivize geothermal energy;
3. An insufficient workforce transition and training structure;
4. The need for improvement in State government coordination; and
5. Regulatory obstacles that hinder the commercialization and scaling of geothermal energy in the State.

We consider each hurdle in turn, with an eye to the five primary avenues that elected leaders and the Texas legislature can utilize to support the industry: 1) becoming geothermal education and policy champions, 2) proposing geothermal specific legislation relevant to their districts and regions, 3) facilitating access of geothermal technologies to capital, 4) increasing opportunities for geothermal companies to access public and private finance, and 5) fine-tuning regulation that would support fast scale for geothermal in the State.

A. Lack of Familiarity With Geothermal Technologies and Applications

In the case of solar and wind, both intermittent renewables experiencing accelerating growth, decades of generous support, and a strong advocacy apparatus at Federal and State levels have driven down cost. This strong advocacy apparatus helped brand these renewable sources in public perception as the future of energy, and have catalyzed a flood of private investment into global commercial-scale development (Ahmed, et al., 2021; Culhane, et al., 2021; Kim, et al., 2021; Liu, et al., 2019; Polzin, et al., 2018; Pacheco, et al., 2014; Lyon & Yin, 2010; Chandler, 2009). Indeed, all energy generation technologies, including hydro, solar, hydrocarbons, nuclear, biofuels, and wind, receive tens of billions of dollars each year from states and the Federal government to develop a path to widespread use (EIA, 2018). This support has encouraged fast growth and scale of wind and solar in Texas, which private markets have amplified, and we can see the results of that fast growth along the Interstate 35 corridor in West Texas. For example, before CREZ was enacted in 2005, Texas had the capacity to produce less than 1,400 megawatts of electricity from wind power. In 2022, the State has an installed wind energy capacity of 37,422 megawatts, with 4,418 megawatts of wind projects under construction (DOE, 2022c).

Figure 12.1. Wind farms in West Texas experienced rapid private market investments after the creation of the Competitive Renewable Energy Zone and the Texas Renewable Portfolio Standard. *Source: Daxis/Flickr (CC BY-ND 2.0).*

Developing and often nascent technologies that are perceived as "new" or "innovative," such as direct air carbon capture, the hydrogen "rainbow," major advances in intermittent renewables, small modular nuclear, and long duration storage, are at the forefront of public debate and policy discussions. They frequently appear on the world stage at annual events like the Conference of Parties ("COP") and World Economic Forum. Fusion, for example, a technology that has attracted billions of dollars of investment despite a long and still uncertain development roadmap, is the subject of breathless strategic consideration, investment, and celebration (Barbarino, 2020; Merriman, 2015).

On the other hand, traditional geothermal technologies have a long and proven track record of generating electricity and providing heating and cooling, which is an obstacle to the perception of geothermal as a new technology worthy of active consideration and discussion. Policy-makers rarely hear about the geothermal opportunity, not only in Texas, but in the world due to a lack of a cohesive and coordinated geothermal advocacy apparatus. The promising and potentially impactful future of next-generation geothermal technologies is simply not on the minds of policy-makers, investors, media, the public, and other stakeholders.

Currently lagging behind intermittent renewable incumbents like solar and wind, geothermal needs abundant, focused, and determined policy attention to drive technology development, support new deployments, and empower investors and markets to engage. In other words, geothermal will need to play catch-up if it is to have a significant role in the energy transition. But Texas is in a uniquely powerful position with regard to geothermal to lead the world, as it did to support the nascent oil and gas industry a century ago, into an energy future that leverages the core competencies and industries in the State, while driving a decarbonized, reliable, and secure energy future.

Recommendation #1: Convene Geothermal-Specific Committee and Subcommittee Hearings

Geothermal ecosystem members need time in front of policy-makers to showcase applications, benefits, risks, and potential impact. Texas' geothermal resources are distinct from the mostly hydrothermal (i.e., highly visible and easy to identify) geothermal resources available in other states such as Nevada, Idaho, and California. Research is underway in Texas, to develop geothermal heat and power from hot sedimentary basins, and novel technologies like supercritical CO2 power plants. But these next generation geothermal technologies are largely nascent, and further investment in research, development, and field deployment ("RD&D") of pilot projects is needed.

During the 2021 Texas legislative session, Democrat Representatives Bobby Guerra, Oscar Longoria, and Sergio Jr. Muñoz proposed House Bill ("HB") 3576 to expand access to finance for geothermal projects through the development of an equity-based strategic geothermal investment fund managed by the RRC. One obstacle for geothermal developers in gaining access to finance is meeting the cash requirements of many lending institutions, which according to one expert interviewed, typically require developers to raise $3 of equity for every $1 they plan to borrow, a particular problem for geothermal which has very high capital expenditure costs. The House Committee Report for HB 3576 from the 2021 legislative session would have funded research on how Texas might support the geothermal industry, and sought to be a strong first step toward placing geothermal onto the policy agenda in Texas. More hearings building from this foundation initiated by Representative Guerra are critical to familiarizing Texas policy-makers with geothermal technologies and applications (Guerra, 2022).

To further educate and inform the public, policy-makers, and the media, former Texas RRC Commissioner and past chairman of the Public Utility Commission of Texas, Barry Smitherman, founded the Texas Geothermal Energy

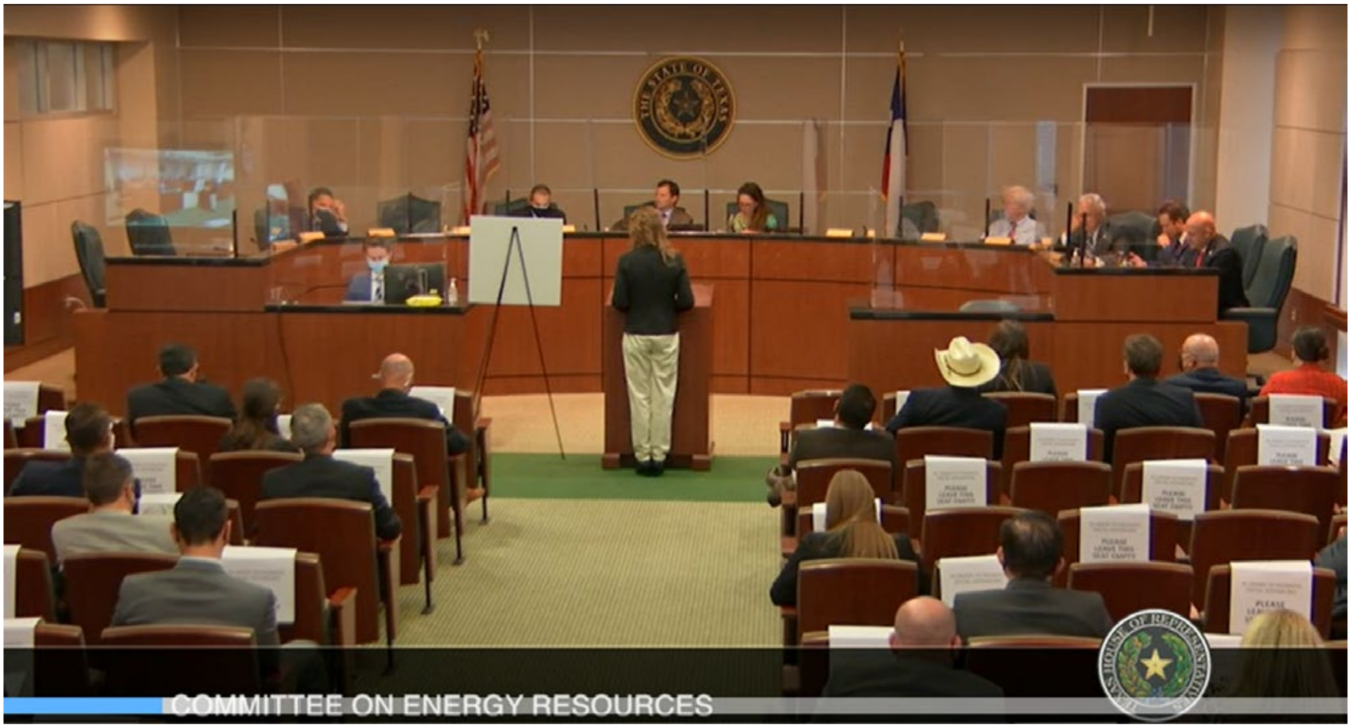

Figure 12.2. Sage Geosystems CEO Cindy Taff speaking at the April 12, 2021 public hearing of the House Committee on Energy Resources relating to the authority of the RCC to study geothermal energy and associated resources as proposed in HB 3576. *Source: Sage Geosystems, 2022.*

Alliance ("TxGEA") in 2022 to promote the geothermal industry in Texas. TxGEA is a Texas-based, Texas-led advocacy organization that aims to support the transfer of technology, knowledge, and workforce from the oil and gas industry to the geothermal industry in Texas.

Recommendation #2: Learn About the Benefits of Geothermal and Visit the Entities Leading the Way in Texas

Geothermal has wide ranging applications that could meet key Texan agricultural, industrial, commercial, and residential needs, including oil and gas refining and chemical processing, aquaculture farming, dairy production, processing pulp and paper, mineral recovery, desalination, heating and cooling for residential and commercial structures, and zero-carbon electricity generation, to name a few. Geothermal technologies include Geothermal Heat Pumps for heating and cooling, as well as power production technologies like Engineered (Enhanced) Geothermal Systems, Advanced Geothermal Systems, and other system types.

A recent study showed that only a quarter of Americans in western states, where utility-scale geothermal energy is already deployed, were "familiar" or "very familiar" with geothermal, and a third of respondents said they were "not familiar" with geothermal (Karmazina & Steel, 2019). However, Texas voters who are knowledgeable about geothermal express high levels of favorability toward the energy source. Polling data from Conservative Texans for Energy Innovation showed that Republicans, Democrats, and Independents all support a greater emphasis placed on geothermal energy technologies, and view geothermal as a part of the future energy mix in Texas (CTEI, 2021).

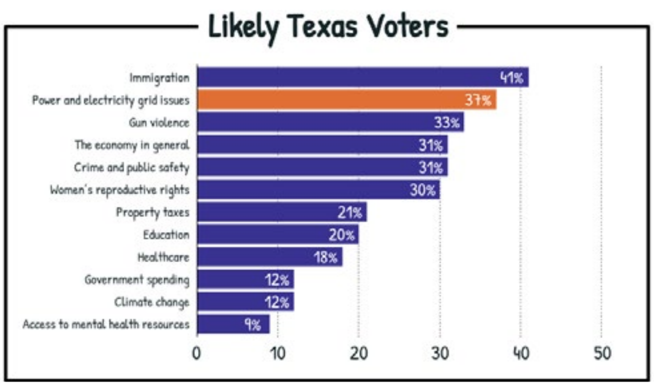

Figure 12.3. Top policy concerns for Texas voters during the 2022 midterm elections. Concerns about the electrical grid in Texas are second only to immigration as top of mind for Texas voters. *Source: Adapted from DFP, 2022.*

Further, Federal mid-term 2022 polling data from Data for Progress found that Texans place power and electricity grid issues as the second most important policy issue for State lawmakers to address (DFP, 2022).

Recently, the Western Governors Association ("WGA") expressed interest in geothermal energy. WGA comprises the governors of all 19 states west of the Mississippi River, including Texas. The 2022 chair was Republican Governor Brad Little of Idaho, and the 2023 chair is Democratic Governor Jared Polis of Colorado. Both Governors Little and Polis have made investigating geothermal a priority for the WGA. States like Idaho, Colorado, Alaska, California, and Nevada are researching and inquiring if their states can take the geothermal baton and become the vanguard of the geothermal industry in the United States. The WGA is preparing a report on the potential of geothermal in the western United States, to be released in the summer of 2023.

B. Policies that Support Clean Baseload Energy Sources

As discussed in Chapter 11, Geothermal, the Texas Grid, and Economic Considerations of this Report, geothermal development creates high quality local job opportunities that align with the skill sets of the Texas workforce. However, there are some hurdles to growth in Texas for geothermal, including the lack of rewards or incentives for producing clean (i.e., low or zero-carbon) or baseload energy. The Electric Reliability Council of Texas ("ERCOT") is mandated to purchase the cheapest source of power, and Texas long ago exceeded the minimum amount of renewable energy on the grid required by Texas' Renewable Energy Portfolio Standard, last increased during the Administration of Republican Governor Rick Perry.

Recommendation #3: Tax Incentives for Clean Baseload Energy Sources

Texas could adopt a tax credit that targets only clean and baseload energy sources, using a market maturity approach. The Federal Investment Tax Credit and Production Tax Credits sunset too often and offer support with time periods that are ill-suited for geothermal development, which make them difficult for geothermal power developers to utilize (Sherlock, 2020; Speer & Young, 2016; Lund, at al., 2012). Texas could adopt a tax credit that targets only clean and baseload energy sources, using a market maturity approach, or an approach more attuned to the development and investment cycles of geothermal. Instead of the tax credit sunsetting after two, five, or ten years, a Texas focused and market-driven approach could be for the tax credit to sunset in phases once a technology reaches a certain level of market maturity. One suggestion might be for adoption of an investment credit of 3.5 percent, or a production credit of 2.6 cents per kilowatt that sunsets when the clean and baseload energy technology reaches 12 or 15 percent of market share in Texas, or begins to ramp down in phases after the technology reaches 8 or 10 percent of market share on the ERCOT grid. Renewable energy tax incentives provided in the Inflation Reduction Act of 2022 were drafted with intermittent energy and battery storage in mind. However, the exact levels of support (tax credit) to be provided and market penetration for the beginning of the sunset period need further study and should be prioritized in supporting geothermal research.

Recommendation #4: Value-based Compensation for Grid Resources

The Texas legislature, in collaboration with RRC and ERCOT, could consider other metrics instead of relying solely on a levelized cost of electricity ("LCOE") valuation. One such metric to consider is the levelized avoided cost of electricity ("LACE") valuation. The LACE represents a power plant's value to the grid, whereas LCOE considers only the capital and operational costs of a power plant (EIA, 2018). The goal of using a more integrated set of metrics would be to incentivize and compensate resources based on their value to the grid. Depending upon timing and location, geothermal's high capacity factor greater than 90 percent and low land use footprint would add to the economic attractiveness and value delivered to the grid by geothermal. LACE creates a comparable apples-to-apples valuation among different energy generation technologies.

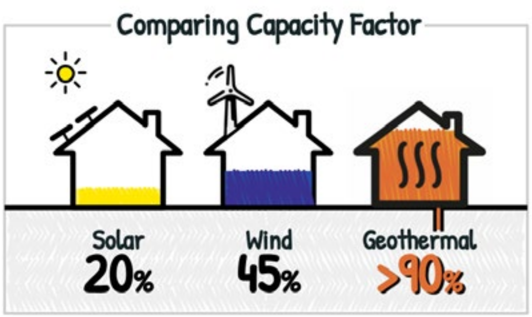

Figure 12.4. Capacity factor comparison for renewable energy technologies. Capacity factor is the percentage of time that a plant is generating electricity. *Source: Adapted from EIA, 2014.*

Recommendation #5: Create a Geothermal Energy Portfolio Standard

The energy portfolio standard created during the Administration of Republican Governor George W. Bush, and updated during the term of Republican Governor Rick Perry can be revised to incorporate a goal, for example, of 5,000 megawatts of electricity capacity by 2030 that specifically applies to clean and baseload renewable energy technologies, which would apply to geothermal, and also other baseload sources, such as nuclear.

A report on the future of Texas climate jobs published by the Workers Institute at Cornell University notes that a policy decision to encourage the installation of 5,000 megawatts of geothermal electricity capacity in Texas will create 62,500 direct jobs and 53,750 indirect jobs over ten years (Skinner, et al., 2021; Pollin, et al., 2014). This is significant because geothermal jobs offer six figure salaries, are eligible for participation in a number of labor unions, and value subsurface skills and knowledge. Additionally, the Texas climate jobs report notes the importance of making existing buildings more efficient, and the role geothermal can play in reducing costs and decarbonizing buildings. The report notes however that in Texas, the "lack of policy drivers hinders the State's energy efficiency initiatives and blocks substantial energy savings" (Skinner, et al., 2021, p. 30).

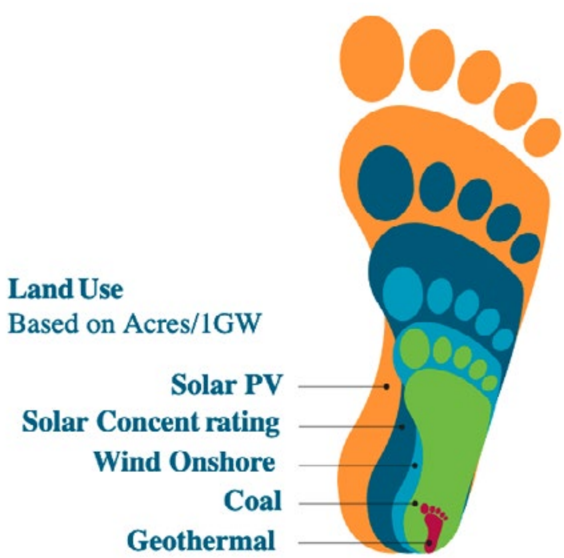

Figure 12.5. The project footprint, acre for acre for one gigawatt of generating capacity, is smallest with geothermal. *Source: Geothermal Engineering, 2022 and adapted from NREL, 2022c.*

The Texas legislature is in a position to support policies that will encourage the production of clean, always-on, and weather resilient electricity generation as well as heating and cooling, particularly in the wake of Winter Storm Uri. These are key technological advantages of geothermal, along with its small surface footprint compared with all other energy sources, black start ability, dispatchability, and local sourcing, positioning it well to potentially provide secure supply chains and Texas based jobs (NREL, 2022; Skinner, et al., 2021).

With its own electricity grid, Texas is in a unique position to support geothermal, simply by rewarding energy sources serving the grid for offering what the Texas grid needs. This could take several forms, including feed-in tariffs, pricing dispatchability and reliability of resources offered on the grid, clean and baseload renewable energy credits, and tax rebates for the off-grid use of geothermal energy. Another existing mechanism by which Texas could incentivize geothermal energy growth is to extend rebates for high cost gas wells to include geothermal wells. Presently, gas wells receive tax rebates to offset their risk. This incentive, if it is allowed to continue, could also cover high risk geothermal wells.

C. Insufficient Workforce Transition and Training Structure

As geothermal scales, policy-makers and other State stakeholders may have a role to play in defraying geothermal labor costs by supporting the pivot of oil and gas workers into geothermal. The Texas oil and gas workforce is already primed for geothermal development. Expertise in drilling, reservoir management, geoscience, and power plant management are all critical for the growth of geothermal. Texas can support that transition through skills-building programs, retraining subsidies, and labor-focused advisory programs. It can draw on the strength of and work with its oil and gas trade, industry, and professional associations to build these programs.

Recommendation #6: Build Community College Geothermal Course/Training Offerings

With appropriations from the Texas legislature, community colleges can build upon and expand existing programs, such as drill rig crew member training programs like that at Houston Community College, and cooling/heating apprenticeship programs such as those at Tarrant County College and Tyler Junior College, all community colleges in Texas.

Community colleges and Texas research institutions need to build geothermal capabilities into curricula, and deepen the knowledge of professionals who install, sell, market, and manufacture geothermal products and technologies.

Recommendation #7: Provide Support to Build the Future of Geothermal Higher Education, Research, and Development

The Texas legislature should consider potential options and develop support mechanisms to fund geothermal curriculum development at Texas universities, as well as research and development of geothermal technologies and applications incubated and launched from within Texas' premier engineering and subsurface academic programs.

Declining enrollment in petroleum engineering programs across Texas could be addressed with the establishment of geothermal engineering schools of the future, with robust, interdisciplinary research programs funded through these support mechanisms, such as the Permanent University Fund ("PUF"). The PUF is managed by The University of Texas Investment Management Company, a 501(c)(3) corporation charged with overseeing PUF investments to support the The University of Texas System and The Texas A&M University System. See Chapter 13, State Stakeholders for greater detail about opportunities to use the PUF to develop and deploy geothermal in Texas. Texas has a unique opportunity to turn the clean energy transition into an energy expansion that benefits all Texas' core competencies and areas of legacy expertise, and that values the State's existing skill sets and workforce in the hydrocarbon industry.

Recommendation #8: Explore the Opportunity of Geothermal Development on State and University Owned Lands

As explored in Chapter 13, State Stakeholders of this Report, State owned lands, like University Lands, are a great place to demonstrate and take advantage of geothermal applications, such as Direct Use and power production technologies. Lands owned by University Lands can be used for applications like Oil and Gas Well Reuse to produce geothermal energy, to provide Direct Use heat to nearby agriculture and ranching operations, to heat and cool buildings, and many other uses. Further, given the growing trend among colleges and universities, as discussed in further detail in Chapter 2, Direct Use Applications of this Report, to install district Direct Use heating and cooling systems to heat and cool campuses, Texas should incentivize adoptions of these geothermal systems across institutions in the State. Finally, lands owned by University Lands could be future sites of geothermal electricity production, helping generate revenue for the PUF.

Examples of universities in other states utilizing geothermal energy include Boise State University in Boise, Idaho; Colorado Mesa University in Grand Junction, Colorado; Cornell University in Ithaca, New York; and North Dakota University in Grand Forks, North Dakota, to name a few. Universities that switched to geothermal energy, such as Ball State University in Muncie, Ohio are saving millions of dollars in operational costs and reduce thousands of tons of carbon from annual operations (Lowe, et al., 2010).

D. Resolve Regulatory Hurdles and Improve Coordination Among State Agencies

There is little coordination among government entities in Texas with regard to geothermal energy, which is regulated, according to the Department of Energy's OpenEI project, by the General Land Office, RCC, the Public Utility Commission of Texas ("PUC"), and the Texas Commission on Environmental Quality ("TCEQ"). This lack of coordination creates regulatory, mineral and water rights, and permitting uncertainty among government agencies in Texas.

Recommendation #9: A Single Geothermal State Agency

Consolidate authority to release and monitor rules and regulations for geothermal exploration, development, and deployment under a single government agency, whether an existing agency such as the RCC, the PUC, the TCEQ, or a new agency.

Generally, Texas is a regulatorily friendly State in the realm of subsurface energy production. In pursuit of clearing the regulatory path, Texas should consider establishing a State-level goal for the development of geothermal, designating a State agency supported by adequate staff, tasked with organizing resources across agencies to prioritize that goal. Part of this team's responsibilities might be to examine the State's regulatory stance toward geothermal energy. The permitting process for geothermal developers is spread across multiple state agencies, with no single agency responsible for overseeing the development of geothermal projects.

One regulatory step that Texas can take is to create a clear set of definitions and clarify associated ownership rights of geothermal energy, which will be explored in more detail in Chapter 14, Who Owns Heat? Legal Considerations for Texas Geothermal Developers. Until this issue is settled legislatively or by the courts, it will hinder geothermal development in Texas, as it creates uncertainty for developers and financiers alike.

Recommendation #10: Resolve Who Owns Subsurface Heat

The Texas legislature should clarify if ownership rights to geothermal heat and energy should belong to the surface estate, or if they belong to the mineral estate.

Because next generation geothermal technologies create new capabilities, like the ability to recover only heat from the subsurface, without the production of water, they also present novel legal issues that few, if any, states have tackled to date. This is an area of fast moving innovation where Texas can lead by coordinating policy development with technology development, much of which is occuring in the State.

Other states have taken steps to make clear how geothermal resources are classified. Nevada, for example, classifies geothermal resources as minerals, though it is managed as a water resource. Many other western states, such as Idaho, have a temperature gradient to distinguish between resource type, typically between 97-121°C (207-250°F), above which water is regulated as a mineral and below which as water.

Recommendation #11: Clarify Water Rights by Geothermal Technology System

Enact legislation clarifying rights to energy produced from water-source geothermal, as well as by waterless closed loop systems. This would materially reduce risk and cost for geothermal developers.

There are over 7,000 abandoned oil and gas wells ("AOGW") in Texas that no longer have a responsible entity to oversee or operate them, referred to as orphaned wells (RCC, 2022; Malewitz, 2015). Current law allows for AOGW with no responsible operator to be adopted, but only for continued oil and gas purposes. This is a missed opportunity for the private sector that the geothermal industry could leverage.[1]

Recommendation #12: Allow Geothermal Companies to Adopt Orphaned Wells

Revise and/or clarify current Texas law regarding the adoption of orphaned oil and gas wells to present an opportunity for the geothermal industry to build a new market, reduce liability for the State, and reduce the number of wells without a responsible owner.

Land use is another major cost to geothermal energy producers. Relative to other states, a small percentage of Texas is Federally-owned land (roughly five percent) putting Texas in the bottom five states in the country (CRS, 2020). This means that in addition to building transmission infrastructure, geothermal developers on private land must pay for leases and royalties. An analysis to identify how and whether land use policies might defray these costs should be performed.

Though this is less relevant in the geothermal context than in the intermittent renewables space, since the State's geothermal resources are largely co-located with the State's major population areas as discussed in detail in Chapter 4, The Texas Geothermal Resource, there may be infrastructure projects that could lower the cost of transmission to high load areas, in the spirit of CREZ. Further, tax credits for grid interconnects for geothermal projects might be considered. The State may also be able to play a role in subsidizing geothermal energy development through incentives for conservation and restoration of land around geothermal plants, which could overlap with oil and gas producing areas, agriculture, manufacturing, as well as intermittent renewable energy farms.

E. Government Programs to Empower Private Markets

Texas has a rich history of long-term investments in game-changing technologies with support for research, development, and the demonstration ("RD&D") of new technologies. Geothermal offers multiple areas for potential RD&D support, through research grants or tax credits. Drilling, subsurface characterization, reservoir creation and operation, and Direct Use for heating and cooling are all areas where technology is being developed and could be supported.

[1]The RCC recently published a tool that allows the public to search and locate well plugging activities funded by a grant from the U.S. Department of Interior in 2022. Consideration should be made to assure that geothermal candidate wells are not prioritized to be plugged under this initiative (RCC, 2023).

Recommendation #13: Heating and Cooling Agriculture and Manufacturing Grants

The Texas legislature can support geothermal development by creating a grant program for agricultural and industrial manufacturing processors to install and deploy geothermal Direct Use, both for industrial heat, and heating and cooling systems for buildings. This could also be set up as a tax credit that could include housing and commercial developers to incorporate geothermal Direct Use heating and cooling systems.

Figure 12.6. Houses in the Whisper Valley subdivision are heated and cooled with Geothermal Heat Pumps. Photo taken during Winter Storm Uri. *Photo credit: O.Nealio.*

Private companies and developers need incentives to transition from legacy and incumbent operations. This is particularly true given that geothermal projects require a supply chain that is quite different from the upstream oil and gas industry. Instead of pipelines, refineries, and ships shuttling a liquid commodity around the globe, geothermal projects require utility grid connections, electricity off-takers, and power purchase agreements. Further, operating a geothermal project requires operating entities to become or behave more like electricity generators.

Recommendation #14: Geothermal Utilities Grants for Electricity

A Texas inspired geothermal utilities grant program could assist geothermal power developers in partnering with municipalities, electric or energy cooperatives, and public utilities to produce electricity for ERCOT.

Geothermal energy, generally located closer to population centers than Texas' primary wind resources, will not require hundreds or thousands of miles of transmission lines in order to grow and scale. But the PUC could support private projects, and especially the ability for geothermal developers to recoup costs over time through taxes similar to benefits received by gas, petroleum, wind, and solar developers. Policy-makers can look to the success of the Cancer Prevention & Research Institute of Texas ("CPRIT") as an example of how the State can support the growth of a new industry of strategic importance to the State through public-private development of infrastructure and RD&D. CPRIT is now a $6 billion, 20-year initiative, and the second largest cancer research and prevention program in the world. A geothermal fund would seek similar objectives to CPRIT, such as investments in the State's research university systems with world leading expertise in subsurface engineering, as well as the State's community colleges, expansion of geothermal energy in the State, and empowerment of innovation and technological breakthroughs leveraging the State's legacy industries, such as those discussed in Chapter 8, Other Strategic Consideration for Geothermal in Texas of this Report.

Geothermal requires large, long-term capital expenditures, the type of capital that State governments are well situated to support. Loan guarantees, insurance entities to mitigate risk, risk mitigation funds, and strategic investment funds are all potential methods to stimulate capital flows into the geothermal industry, particularly for demonstration projects and pilots, which is a top priority. As discussed in detail in Chapter 6, Oil and Gas Industry Engagement in Geothermal of this Report, piloting was the preference of 87 percent of industry participants interviewed. An early draft of Texas House Bill 3576, introduced in 2021 by Democrat State Representatives Bobby Guerra, Oscar Longoria, and Sergio Jr. Muñoz lays out another approach to expanding access to finance, through the development of an equity-based strategic geothermal investment fund managed by the RCC.

Recommendation #15: Risk Mitigation Funds

The Texas legislature can create a risk mitigation fund to provide loans to cover a portion (e.g., 60 percent) of the drilling cost for geothermal pilots and projects, that can be converted into grants if development of the geothermal field is unsuccessful. To minimize losses, a premium can be charged to ensure a positive return based on risk, and limits set on total wells covered and monetary claims to limit losses.

Risk mitigation funds were used successfully in the United States in the 1980s through the Public Utility Regulatory Policies Act of 1978, of which the program has since sunsetted, and more recently through financing models that have supported dramatic growth of geothermal power in Germany, Denmark, Kenya, Turkey, Costa Rica, Switzerland, France, Iceland, Indonesia, and the Netherlands (Gehringer, 2017; Ngugi, 2014; Lund, at al., 2012; Robertson-Tait, et al., 2008; PURPA, 1978).

Continuing with the topic of the capital-intensive aspect of geothermal development, Chapter 313 of the Texas Economic Development Act helped Texas school districts attract high-capital intensive industry to local communities, many of them rural (Texas Comptroller, 2022). This tax program works by discounting local school district property taxes for corporations, but was not renewed during the 2020 legislative session.

Recommendation #16: Consider Reviving Texas Chapter 313

Inclusion of clean and baseload energy in a revived Chapter 313 tax program could enable the geothermal industry to commercialize and scale, while supporting Texas industry, and local schools. Careful study of the pros and cons of reviving Texas Chapter 313 for the benefit of the geothermal industry and local schools and communities should be a priority area for supporting research in geothermal.

IV. Geothermal and Opportunity to Build Bipartisan Coalitions

Geothermal sits in a rare political and social space in an increasingly polarized political and policy climate. It is on the precipice of gaining significant political support from policy-makers across the ideological spectrum, who see specific aspects of interest for their constituents, in which their values can be realized through the development and deployment of geothermal technologies. The predicament for the geothermal industry is how to balance its desired attributes, while avoiding polarization and partisanship.

Organizations such as the Environmental Defense Fund, the National Audubon Society, Clean Air Task Force, the Natural Resources Defense Council, as well as labor unions increasingly recognize the climate, environment, economic, and societal benefits of geothermal technologies and applications (Audubon, 2022; CATF, 2022; NRDC, 2022; EDF, 2021). This new recognition provides the geothermal industry with the opportunity to weave through the polarization of energy policy, as it offers a path forward for both sides of the aisle.

The oil and gas industry supports geothermal because it leverages the skillsets, technologies, intellectual property, and assets of the industry, and provides a just transition for workers within their existing core competencies in drilling and subsurface science. In Texas, terms such as resilience, energy independence, national security, drilling, black start, and baseload are used to describe the attributes of geothermal. Oil and gas is increasingly viewing geothermal as a global market in which they can play an outsized role, and with increasing development and scale comes increasing visibility. (Beard, 2020) This creates the need for outreach and collaboration with environmental organizations if we are to avoid the friction and conflict that resulted from the shale boom.

Environmental organizations, on the other hand, are attracted to geothermal because it is a clean, ubiquitous, small footprint, and limitless source of renewable energy that could be deployed to help achieve climate and environmental goals. Environmentalists point out that geothermal doesn't require mineral extraction, or need vast amounts of critical minerals for manufacturing. Further, it advances decarbonization goals, reduces the need to construct additional long-distance transmission infrastructure, and creates opportunities to advance environmental justice and equality goals in disadvantaged communities.

In climate impact circles, phrases such as climate mitigation, decarbonization, renewable energy, green baseload, and diversity, equity and inclusion are often associated with geothermal. Climate activists seek to address the existential and global threat caused by the climate crisis, which requires a coordinated international response using technologies that are quickly deployable at impactful scale.

These narratives describe the same unique energy source, but with different political and cultural constituencies using different languages, narratives, and terminologies to describe why they support it. This presents a rare and unique political and policy opportunity for geothermal, where even the most polarized political adversaries may find themselves both in support of the same geothermal effort.

There is an active negotiation occurring in geothermal currently, on all levels, between the oil and gas industry to startups, red states and blue states, Democrats and Republicans, challengers and incumbents, and everywhere in between - all seeking to capture the geothermal narrative (Jones, 2022). But all stakeholders have the same end goals: to see geothermal grow. The challenge over the coming years, which will impact the trajectory of geothermal development, will be for all entities to find the political courage to stand together inside the same tent.

The next three Sections of this Chapter widen the perspective of geothermal industry growth and RD&D outside of Texas and into a global market.

V. An Opportunity for the U.S. to Lead the Geothermal World, From Texas, Through a Dedicated Federal Geothermal National Laboratory

Due to the nascency of the geothermal industry, and the period of growth and innovation that it is experiencing, much of it emerging from Texas, there is currently no world leader in the geothermal field. Some countries and regions are better known for their deployment of geothermal technologies than others, but a clear vanguard has yet to be identified. With purposeful leadership, Texas is poised to take on this role as the global epicenter of the oil and gas industry, and its transferable skills, workforce and assets. Establishing a dedicated national lab with a singular focus on geothermal and related technologies and applications will require a consortium of geothermal champions, including the Texas legislature, Texas Federal and State congressional delegations, and the Texas governor, in cooperation with the Federal government, private sector, and other organizations.

The study of geothermal energy technologies and applications is currently fragmented in the United States. Geothermal research is conducted individually across U.S. government agencies and DOE national labs such as Idaho National Lab, Sandia National Labs, National Energy Technology Lab, Lawrence Berkeley Lab, U.S. Geological Survey, Geothermal Technologies Office, National Renewable Energy Laboratory, Brookhaven National Lab, Bureau of Land Management, U.S. Forest Service, Argonne National Lab, and Oak Ridge National Lab, among others. Additionally, there are research universities across the country individually studying geothermal, and pursuing research consortia on the subject.

Texas can initiate a Federal and State partnership to locate a geothermal specific lab in West Texas, which could be modeled after CPRIT. A geothermal lab could consolidate and coordinate the many parallel and disorganized research efforts from across the nation to refocus, streamline, and empower a vision for the future of geothermal RD&D in the United States. The research authorities of this lab could include geothermal, but perhaps also carbon capture, usage, and storage ("CCUS"), as well as the recovery of critical minerals from geothermal brines such as lithium, manganese, zinc, potassium and boron (Jones & McKibben, 2022; McKibben, et al., 2021). Both CCUS and mineral recovery from brines, lithium in particular, are related to both geothermal and the subsurface. These technologies could thus provide force multipliers for the work of the proposed lab. The advancement and study of the composition of geothermal brines, engineered Working Fluids for geothermal projects, and advanced surface equipment for geothermal plants might also be within this lab's purview.

Currently, the United States must import processed lithium to meet demand related to energy storage, and most lithium is mined from geopolitical rivals or countries with authoritarian governments such as Russia, China, and the Congo. Further, many of the lithium mines in Australia and Chile are owned and managed by the Chinese government. A geothermal national lab in West Texas might explore, research, demonstrate, and develop technology and tools to address challenges such as how to increase U.S. lithium production through the deployment of geothermal.

VI. Building Public-Private Partnerships Between Industry and State Government

There are some circumstances where the most effective and efficient way to advance a complex and multi-disciplinary goal is within the cooperative structure of a public-private partnership ("P3") between the government and private industry. Perhaps the most notable recent example of the upside of such endeavors is the partnership between NASA and Space-X to shuttle people and cargo to the International Space Station, and more recently, collaborations supporting deep space exploration.

Through these partnerships, the government benefits from the speed, nimbleness, and specialized expertise of industry partners, while saving money, and the industry partner is able to pursue internal programs of strategic interest with a wide berth to incorporate innovation, commercializing and scaling new markets, and "out of the box" approaches. Geothermal development offers exactly that type of mutually beneficial P3 arrangement, with the promise of speeding development, deployment, and commercialization, and getting first of their kind projects into the field and prepared for scalability by private industry. Governments at the Federal or State level will need to create finance tools and appropriate funds that facilitate, encourage, and increase private investment into geothermal technologies.

1. What Would the Geothermal P3 Look Like?

There remains a large government role in P3s to create the foundation for a new industry such as geothermal, and facilitate an expansive and expensive deployment of energy infrastructure. There are two main components to a P3: 1) government financing and 2) government funding to leverage private sector know-how, cost mind-set, and optimization.

Reducing financial hesitancy from the private sector can be achieved through risk mitigation tools, the first component of a P3. Sound policies and innovative risk mitigation mechanisms are helpful. Risk mitigation tools can target early phases of geothermal projects, which is crucial to unlock investment in industry. A risk mitigation fund, for example, with the authority to issue loans of up to $4 billion, if enacted by the Federal government, or $750 million in mitigation authority, as a Texas initiative, specific for district cooling/heating and electricity drilling and exploration projects. A risk mitigation fund will need to have proper operational, due diligence, execution, and evaluation support. In Texas, such a program could be administered through the RCC or another State agency.

Governments can look to geothermal industry associations, national labs, research universities, and geothermal companies to determine what aspects and quantities the geothermal risk mitigation fund would cover for drilling and exploration costs (Gehringer, 2017; Ngugi, 2014; Lund, at al., 2012; Robertson-Tait, et al., 2008). For unsuccessful geothermal wells, the loans would convert into grants, thus be forgiven. Successful well explorations repay loans through a success fee or premium. An example could be 130 percent repayment of the cost of a geothermal exploration project or well. Parameters will need to be established for levels of loan repayment and forgiveness for successful, unsuccessful, and partially successful exploration projects or wells. Definitions and parameters will need to be agreed upon upfront with developers and government agencies.

Risk mitigation tools, in various forms, have a proven track record, and have proven to be a catalyst for geothermal development in countries such as Germany, Denmark, Kenya, Turkey, Costa Rica, Switzerland, France, Iceland, Indonesia, and the Netherlands (Gehringer, 2017; Ngugi, 2014; Lund, at al., 2012). The GEORISK Project in Europe, the GREM Project in Indonesia, the GRMF for eastern Africa, and the GDP in Turkey are all various risk mitigation programs designed for geothermal development in those locations. Financing support to mitigate early-stage exploration risk is a critical hurdle to address if geothermal is to scale, and this is where a P3 offers unique leverage.

The second component of a P3 is securing appropriations from the Texas State legislature to help build a marketplace and initial demand for geothermal technologies. Funds will need to be appropriated to government agencies to provide loans and grants to agriculture, manufacturing, commercial, electric utilities, and industry to transition from hydrocarbons to geothermal. One example is grant programs administered by state departments of agriculture to dairy farmers, greenhouses, or food dehydration companies to pivot to geothermal heating and cooling systems (i.e., thermal systems). Another example is state departments of commerce grants for rural and urban communities to install district thermal systems or for rural municipalities to partner with geothermal electricity developers to build power plants and enter into purchase power agreements with utilities. Geothermal specific grant programs established through existing government agencies and programs will build a marketplace around geothermal that the private sector can then amplify.

Both components can be tied to market maturity; as market maturity shifts from emerging markets to mature markets, the risk mitigation program scales down and eventually sunsets. This could happen when the geothermal market share reaches, for example, 10 percent in the electricity market and 40 percent in the heating and cooling market for the agriculture, commercial, and industrial economic sectors. Other market maturity levels could be established by megawatts of electricity on the grid, or megawatts of thermal energy produced rather than market penetration.

VII. An Opportunity to Lead the World in Subsurface Environmental Policy

As discussed in detail in Chapter 10, Environmental Considerations and Impact of this Report, among available energy technologies, geothermal has the smallest lifecycle carbon impact, smallest land footprint per megawatt of energy generated, and lowest use of minerals required to build and operate power generation facilities and Direct Use applications.

As a leader in subsurface energy extraction, and leveraging the environmental health and safety, process and protocol development, standardization, and seismicity monitoring knowledge base of the oil and gas industry, Texas has the opportunity to take the lead on environmental policy related to the growth and development of geothermal energy technologies.

Every energy technology creates a carbon footprint and causes harm to the climate and environment; solar, wind, and geothermal included. However, some energy technologies have greater environmental consequences and greenhouse gas emissions than others. Decisions about what energy technology to deploy may be best decided at regional or local levels taking into account geography, weather, climate, population, load centers, and other important factors.

The proposed West Texas geothermal focused national lab, in partnership with Texas research institutions and universities, might explore the climate and environmental offsets caused by geothermal, such as seismicity, drilling noise, and the use of frac'ing for Engineered (or Enhanced) Geothermal Systems. Better understanding of climate and environmental impacts of energy technologies could become part of the mission of a West Texas geothermal lab.

Additionally, a national lab focused on geothermal can research other environmental concerns, as well as social license and community engagement issues before they become impediments to geothermal development. A recent lawsuit by the Burning Man Project to prevent Ormat Technologies from exploring northwestern Nevada for geothermal resources is an example of the need to address community engagement and other social license and environmental concerns before they delay or stop developments (Mindock, 2023). A national lab could help with this and research other environmental, social license, and community concerns such as in the case of the endangered green horned frog (Malo, 2021), debunking misinformation about geothermal technologies, and respecting and observing the spiritual and religious uses of geothermal resources by indigenous populations in the United States (Grandoni, 2022).

VIII. Guide to Becoming a Geothermal Policy Champion

As has been mentioned throughout this Chapter, there are few geothermal policy champions in Texas, or indeed in the United States currently. Because of this, geothermal fails to be placed on policy agendas. There is a disparity between the way geothermal is viewed and treated in the policy process, versus the maturity of geothermal technologies in the field, and the accelerating innovation that is occurring in the geothermal startup ecosystem and oil and gas industry.

The policy process as shown in Figure 12.7 views geothermal as if it was in a stage one level of development. This first policy development stage is for technologies or concepts that are unproven or have never been studied, lack a skilled workforce with technical expertise, and/or are nascent concepts with no previously installed infrastructure. Examples might include the hyperloop to transport people in individual pods below ground to relieve traffic aboveground, or lifting giant blocks of cement with a crane as a form of mechanical energy storage to be used later to create electricity.

However, the reality of geothermal is more complex, and in many ways much more mature. Geothermal systems such as Direct Use, Conventional Hydrothermal Systems ("CHS"), and even some Engineered Geothermal Systems ("EGS") concepts, are far beyond the first stage of the policy development process. Policy-makers need to catch up and move to stage two and three. This third stage of the policy process is to scale and commercialize already proven geothermal technologies using the power and capabilities of the private sector. Stage two is to

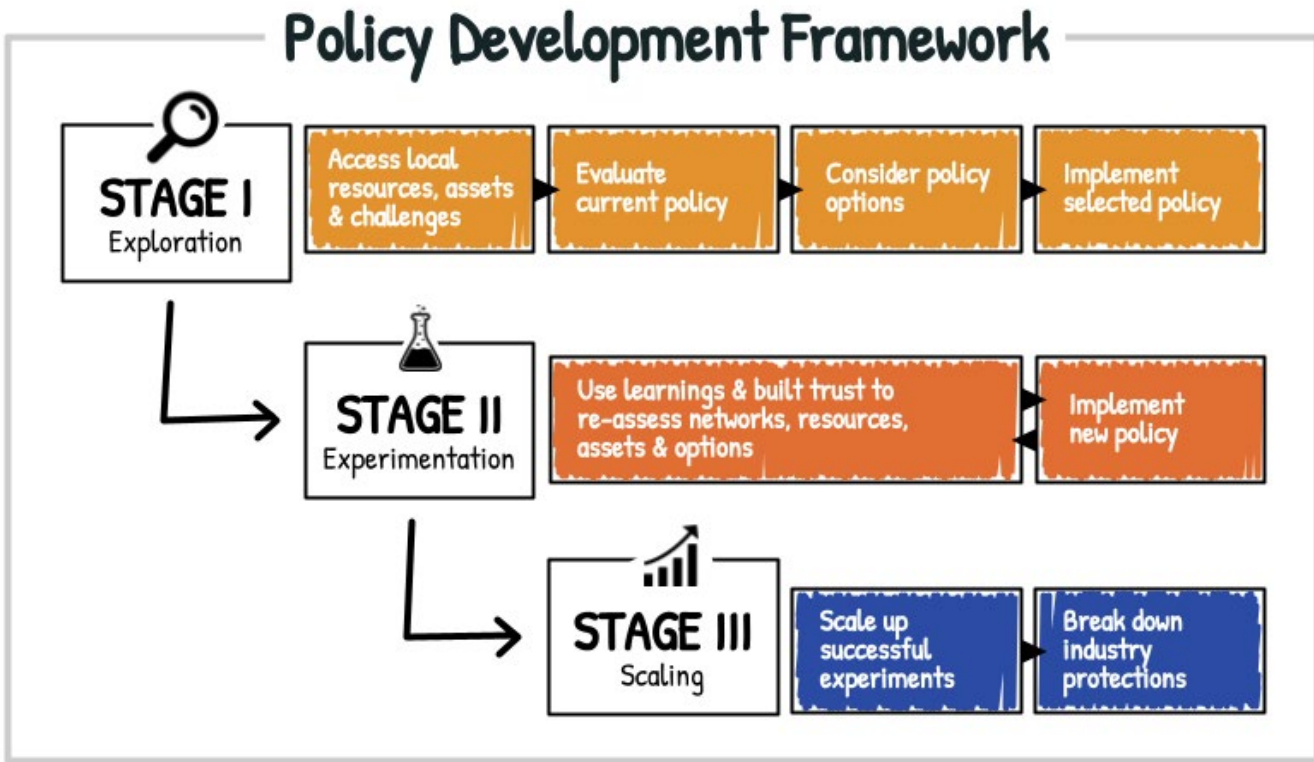

Figure 12.7. The policy stage where the geothermal industry currently sits does not align with the proven, demonstrated, and deployed technology stage of the geothermal industry. *Source: Future of Geothermal Energy in Texas, 2023.*

support demonstration and pilot projects of innovative geothermal concepts, such as SuperHot Rock and AGS/ Closed Loop Geothermal Systems in Texas.

To remedy this hurdle, policy-makers in Texas have the opportunity to leverage a skilled existing oil and gas workforce, supportive subsurface policies and regulations, existing and proven hydrocarbon technologies, and deep cultural ties to subsurface energy production to promote and launch a geothermal industry in Texas. By shifting attention to the second and third policy stages, Texas policy-makers can knock down policy and regulatory hurdles, scale up successful demonstration and pilot projects, and launch the next generation geothermal industry in the heart of Texas.

IX. Conclusion

This Chapter explored the vast potential for geothermal technologies in Texas and the role of the State government. A world leader of the growth and scale of next generation geothermal development has yet to appear on the world stage. Texas, through its State and Federal policy-makers, is poised to grab the reins and become that champion, if it adopts a position of bold action and leadership. Texas legislators, officials from State government, the media, and Texan citizens are therefore encouraged to increase their engagement and become familiar with geothermal technologies and applications. State policy-makers are encouraged to debate, hold hearings, make site visits to pilot geothermal projects, and to learn more about how geothermal can serve constituencies throughout the State. By championing geothermal technologies and building the required policies and supportive regulatory environment, Texas can accelerate the launch of geothermal globally, as it did for the oil and gas industry 100 years ago.

Conflict of Interest Disclosure

Bryant Jones serves as the Head of Education and Policy at Project InnerSpace, a 501(c)(3) organization that works on issues within the subject matter of this manuscript, and is compensated for this work. He is also a full-time Ph.D. candidate at Boise State University where he researches at the nexus of policy studies, science and technology studies, and energy transition studies. Outside of this role, Bryant Jones certifies that he has no affiliations, including board memberships, stock ownership and/or equity interest, in any organization or entity with a financial interest in the contents of this manuscript, and has no personal or familial relationship with anyone having such an affiliation or financial interest.

Mark Hand serves as a visiting lecturer in the Political Science Department at Southern Methodist University, and is compensated for this work. Outside of this role, Mark Hand certifies that he has no affiliations, including board memberships, stock ownership and/or equity interest, in any organization or entity with a financial interest in the contents of this manuscript, and has no personal or familial relationship with anyone having such an affiliation or financial interest.

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