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Hot Rocks Part IV:
The Policy Interventions that Could Boost Geothermal

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Introduction

Over this series, we've examined the technological advances in drilling that created the shale revolution. Next, we studied the public policy that accelerated those advances. And in our last piece, we evaluated the current state of next-gen geothermal energy.

What are the optimal policy interventions for commercializing next-gen geothermal?

Lessons for Policy Design

Despite some interest from commercial investors, next-gen geothermal has a capital problem. At a critical juncture, the infusion of additional capital could be transformative.

As we described in our piece on the policies that led to the shale revolution, concrete policy interventions worked over time to drive commercialization through iteration and repetition. To push next-gen geothermal from theoretical potential to widespread utility-scale deployment, policy efforts must shift from primarily supporting research and development to facilitating project deployment. Policy design should emphasize getting more "shots on goal" — that is, more utility-scale projects deployed.

Of course, next-gen geothermal projects have unique financial needs, influenced by location, geology, and technology. Risks associated with identifying and characterizing the subsurface resource, coupled with technological uncertainty, drive gaps in the capital stack. Luckily, public investment and regulatory policies can be tailored to mitigate these risks, reducing the hurdle rates for a technologically risky investment.

Our proposal has two planks: (1) Congress should provide funding to the Office of Clean Energy Demonstrations (OCED) to support next-gen geothermal; and

(2) Congress should pass permitting reform that makes it easier to reduce resource risk for next-gen geothermal projects.

Understanding the Gap in the Capital Stack

Over time, deployment of clean energy has relied on a diverse set of funders. Three types of funding make up the bulk of the stack for clean energy projects: traditional equity investors, lenders, and tax-equity investors. The equity players, (typically venture capital funders or occasionally private equity) are less likely to be deterred by the technological risk, but bias heavily towards asset-light, low capital-intensity investments. Given the longer development timelines of first-of-a-kind next-gen projects, VC investors are unlikely to invest sufficient capital, a challenge intensified in a high-interest rate environment. This limits the pool of equity investors, who typically make up only a small portion of a project's capital stack.

The majority of a clean energy project's capital stack typically comes from lending and tax equity[1]. Tax equity investors provide a portion of capital upfront, and receive both a return from the ownership stake and an allocated portion of the project's tax credits. For wind and solar, tax equity can make up around 35-65%.

Unfortunately, tax equity investors are unlikely to participate in a next-gen geothermal deal. Tax equity deals are legally complex, which limits the base of potential investors to those with the capital for compliance, like big banks. A recent report by Credit Suisse found that just three banks accounted for more than half of US tax equity investments. These players are generally unwilling to finance risky tech bets. Furthermore, it can be difficult to overcome the high hurdle rates. The same dynamic applies to another emerging climate technology, carbon capture. Last year in the Clean Energy Finance Forum, before carbon capture had received a tax equity deal, several authors wrote:

> ***"The primary driver [behind the lack of investment]is the high return threshold for tax equity investors that can instead focus on getting double-digit returns for traditional solar and wind projects. Carbon capture projects, with less stable cash flows and greater inherent technology risk, present additional downside risks for tax equity investors."***

Debt from private lenders is also unlikely to make up a significant portion of next-gen geothermal's capital stack. Financiers are simply too risk-averse to invest heavily in new technology, particularly in a high-interest rate environment. As we documented previously, the large wave of debt allocated into the shale sector came in the late 2000s and early 2010s, amid low interest rates, and long after the technological risk had waned and thousands of successful rigs had been drilled.

Why Most Investors Won't Fill The Capital Stack

Investors, whether tax-equity investors or bankers, are reluctant to invest in next-gen geothermal technology for several reasons. First, energy projects like next-gen geothermal carry a heightened resource risk. For conventional geothermal, resource risk is binary: either heat, fluid, and permeability come together in a location, or they don't. Identifying geothermal resources carries more risk than identifying wind or solar resources. By contrast, characterizing next-gen resources is a more uncertain prospect, more akin to cost risk. We know heat resources exist throughout the crust, but before they are characterized, it's difficult to know how much it is worth spending to access them.

Another deterrent for investors is next-gen geothermal's lack of historical data or proven track record. Investors typically prefer well-established technologies to assess risk and return, but the absence of commercial-scale projects in this sector makes it challenging to gauge reliability. Additionally, lenders and investors often lack the specialized expertise required to finance next-gen geothermal projects, further hindering investment opportunities.

Furthermore, returns on geothermal projects have longer payback periods than traditional commodities. While some major oil and gas players invest in the sector, they primarily take equity positions in the companies rather than directly finance projects, and they view geothermal as an electricity play, rather than a commodity play. The returns are perceived to be more limited, in what is typically a heavily regulated market.

A related challenge is the role that utilities play in the sector, both as potential "offtakers" that can crowd in investment and as investors themselves in energy projects. They are a key part of the ecosystem, but are cost-constrained and face difficulties financing or entering into agreements for new technology. Uncertain costs may mean uncertain impacts on ratepayers, particularly for jurisdictions with a flat or declining customer base. The need to spread fixed costs over a stagnant customer base heightens concerns about adopting long-term, cost-uncertain capital structures that could lead to increased rates. While a power purchasing agreement (PPA) can be a useful tool to shield ratepayers from the uncertain costs associated with development or technology risk, PPAs can cease to be viable for both parties — consider the recent withdrawal of NuScale and the Utah Associated Municipal Power Systems (UAMPS) from their PPA in response to surging costs.

As investors themselves, utilities find it challenging to finance emerging tech. Determining the "rate base," the value of a property on which the utility is allowed to earn a return by regulation, is more straightforward for investments in conventional resources. Those investments have a clear path to cost recovery even when returns are regulated, which helps manage rate pressure expectations. By contrast, emerging tech raises questions over stranded cost risk or cost escalation. A predictable increase is more easily accepted by customers and stakeholders.

Additionally, utilities need to maintain favorable bond ratings, which are crucial for raising capital, managing the cost of refinancing activity, and which ultimately affect rate pressure. Bond rating agencies require strict financial discipline, which can limit a utility's ability to invest in innovative technologies.

Consider Avista, a utility company that covers parts of Washington State, Oregon, and Idaho, and its most recent Integrated Resource Plan, which assesses future electricity demands and creates a plan to meet them. As it describes the costs of conventional geothermal (which presently costs less to develop than next-gen), it notes:

> ***"Geothermal energy often struggles to compete economically due to high development costs stemming from having to drill several holes thousands of feet below the earth's crust with no guarantee of reaching usable geothermal resources."***

Over time, next-gen geothermal should benefit from declining cost curves that should support competitive power purchasing agreements. But for now, the costs are prohibitive.

As the Avista IRP describes another high-cost technology, nuclear plants:

> ***"but given the uncertainty of their economics, regional political issues with the technology,… Avista is unlikely to select a nuclear project in its preferred portfolio…***
>
> ***The limited amount of recent nuclear construction experience in the U.S. makes estimating construction costs difficult. Cost projections are from industry studies, recent nuclear plant license proposals and the small number of projects currently under development. Modular nuclear design could increase the potential for nuclear generation by shortening the permitting and construction phase and making these traditionally large projects a better fit to the needs of smaller utilities."***

Although Avista did include an option for a small-scale nuclear power plant, the high cost means the investment is unlikely to play a meaningful part in meeting Avista's customers' future electricity demand. Even in that plan, the investments are much further out than than our decarbonization efforts require.

In its integrated resource plan, Idaho Power included SMRs, another risky technology, in addition to geothermal investments in some of its resource portfolios. However, its "most preferred" portfolio (on a cost basis) does not include SMRs and includes just 30MW of geothermal (whether it's conventional or next-gen is not specified).

For cost-sensitive utilities, financing or entering into PPAs with emerging energy producers is a difficult proposition, shrinking the scale of private investment available for new technology like next-gen geothermal.

Recommendations

These challenges are not insurmountable. Targeted policy reforms can fill gaps in the capital stack and meaningfully reduce resource risk. We propose two key reforms: (1) providing a grant to the Office of Clean Energy Demonstrations (OCED) to support next-gen geothermal; and (2) regulatory reform to reduce resource risk by creating a categorical exclusion for geothermal exploration.

A New Authorization and Grant for the Office of Clean Energy Demonstrations

Since the passage of the American Rescue Plan, Infrastructure Investment and Jobs Act (IIJA), the CHIPS and Science Act, and the Inflation Reduction Act (IRA), there are a host of programs being used for clean energy deployment.

As we laid out in the previous piece, current policy is not particularly well-suited for next-generation geothermal. The requirement of a "reasonable prospect of return" at the Loans Program Office is too onerous for a technology that has yet to produce a commercial scale project. Beyond mature technology like wind and solar, tax-equity investors are unlikely to take advantage of the Production Tax Credit or Investment Tax Credit. Next-gen geothermal needs a federal program that can deploy flexible financing to fill the stacks in the capital stack for technologically risky and novel programs. Fortunately, such a program already exists — the Department of Energy's Office of Clean Energy Demonstrations.

OCED was created in December 2021 with more than $20 billion in funding through the Bipartisan Infrastructure Law. The goal of OCED is to provide financing for innovative technologies and demonstration projects that deliver clean energy solutions. It focuses on funding projects that could ultimately reach broad market adoption and deployment, but that operate in underinvested markets that face challenges with commercialization. These technologies include advanced nuclear, "carbon capture, utilization, and storage," hydrogen, and long-duration energy storage. But whether OCED can succeed in making new technologies commercially viable depends on how effectively it can use its funding to encourage private investment.

Fortunately, OCED is taking an innovative and market-friendly approach to financing. It is utilizing "other transaction authority" (OTA) to ensure it has a broad range of tools. DOE announced a $1 billion "demand-side commitment" to boost the hydrogen industry, for which it sought feedback from a wide group of stakeholders on how to best structure it. In its improvements in rural or remote areas (ERA) portfolio, the office issued an RFI for advice on how to implement the program. In the RFI, OCED outlined a draft strategy, which highlighted that the office was considering the use of OTA to provide support for eligible projects. The ERA program was appropriated $1 billion over a five-year period to advance energy resiliency and grid modernization, increase energy efficiency, and improve the overall cost-effectiveness of energy generation and transmission systems in rural or remote areas.

We celebrate this approach. The federal government has trouble deploying capital for emerging technologies, particularly when the needs of the industry run ahead of the language of the law. Furthermore, agencies can be hampered by bureaucratic hurdles like the Federal Acquisition Regulation (FAR). While the FAR does promote worthwhile goals of transparency and accountability, it makes it hard to deploy capital to support goals like innovation at the technological frontier. In contrast, OTA offers a flexible, robust tool for encouraging private investment in green energy without additional legislation.

An OTA can provide creative financing terms for critical projects and can better target OCED appropriations. By using OTAs, OCED can effectively showcase promising clean energy technologies and intervene in less mature markets to propel them to scalability. All available authorities should be on the table to meet the nation's ambitious climate goals. OCED comprehends the potential of OTAs, and the time is ripe to put them into action.

There are two fundamental ways the federal government can intervene in markets to incentivize private actors — push mechanisms and pull mechanisms. Innovation in any industry can be supported either by incentivizing supply or by generating demand. Push tools typically provide financial incentives that encourage supply, like tax credits or research and development grants. When tax credits are offered for the production of a good, firms are more likely to increase the supply of the good. When the federal government provides push incentives, they are using federal dollars to directly subsidize upfront costs — "pushing" products to the market. Alternatively, pull policy tools drive innovation by securing demand for the product and indirectly justify the upfront costs — "pulling" products to the market.

Advancing decarbonization requires all policy tools in the tool belt. The federal government should start to utilize more innovative pull mechanisms — some of the most successful public-private partnerships to date used creative incentives, like milestone payments. Milestone payments are one way to structure a payment contract through an OTA. Simply put, milestone payments are "a series of payments, each of which is made upon the accomplishment of defined objectives." Unlike performance-based payments through the FAR, milestone payments can be flexibly structured, and work as a management tool, not simply as a method of financing a project. When establishing a payment schedule for an OTA, using a milestone structure allows the government to create specific benchmarks for a company to reach in order to receive financing. Benchmarks can be established for a range of activities like the successful development of a technology, the discovery of a mineral deposit, or even the engagement of a specified number of stakeholders.

Milestone payments are a valuable tool because they can be used flexibly to set standards for success that both parties want to achieve. For instance, using an OTA, NASA created a milestone contract with various commercial space companies through the Commercial Orbital Transportation Services (COTS) program. NASA structured the contract to require companies to receive independent financing, ensuring they had another stream of capital to support their development costs. By requiring outside financing, NASA avoided shoveling out extensive amounts of federal dollars and could back out of projects that didn't hit financing requirements along with other predefined milestone benchmarks. The COTS program was a success, and the milestone OTA both saved NASA millions of dollars and spearheaded the first successful private rocket launch into space with the Falcon 9 from SpaceX. Similar to NASA, the Department of Defense and the Department of Health and Human Services were able to creatively structure milestone payments in an OTA contract with pharmaceutical companies to develop COVID-19 vaccines.

Milestone payments through OTA provide the federal government with the unique opportunity to fail without failing. Milestone contracts are typically structured so that technical achievements must be met before companies can access financing; if a company fails to meet the achievement, then the government does not bear the costs, and can look at other avenues to achieve the expected benchmarks. Richard Dunn, who pioneered the use of OTA at DARPA, notes that a milestone OTA allows you to fail early and ask questions to learn from the mistake. This critical point should motivate agencies like the DOE and OCED to intervene in emerging industries in the early stages of development.

To decarbonize the most carbon-intensive industries, the DOE needs to take advantage of pull incentives like milestone OTAs. It can use them to make technological advancements in clean energy technologies like geothermal, which have great potential but little support. A milestone OTA in geothermal exploration and production would allow for the identification of successful practices, and would serve as a platform to uncover areas that require further advancement. And it can ensure that federal resources are optimally allocated to drive innovations in geothermal technology and sustainable energy solutions.

Importantly, a milestone-based support system would allow OCED to approach next-gen geothermal in a technology-neutral manner. Rather than highly-technical milestones specific to EGS, closed-loop, or supercritical systems, OCED could provide staggered support dependent on the level of technological feasibility demonstrated by the company. Using metrics like "Technological Readiness Level" at the technological development stage, or more traditional project development performance metrics after the technology has demonstrated viability, the scope and scale of funding could grow based on the milestones met by the company. One hypothetical early milestone could be a design along with any necessary regulatory approvals. Another could be a successful test project producing up to a certain amount of MW of energy. OCED could also consider certain private sector benchmarks to determine viability — much like LPO requires equity investments before providing loans or loan guarantees. And of course, the funding could be scaled up to accelerate the technology to utility-scale deployment.

Right now, companies like Eavor and Fervo which have demonstrated success in their technologies through test projects. Eavor completed the drilling of "Eavor-lite," a closed-loop system, to a depth of 2.4km, and Fervo now produces 4MW from its recently completed "Project Red" site in Nevada. Companies that can demonstrate power generation capabilities through small projects could then be eligible for more substantial cost-sharing for a larger project. The milestone approach focuses on results — rather than *just* potential.

Another useful form of flexible financing could be a risk mitigation program to boost exploration and reduce resource risk. OCED could take a cue from Kenya, which generates nearly half of its electricity from conventional geothermal energy. Over the past decade, Kenya has expanded available access to financing for exploration through the "Geothermal Risk Mitigation Facility for East Africa" (GRMF) — which provides cost-sharing support in the exploration phase for companies to identify geothermal resources. By cost-sharing for exploration, the Kenyan government takes on significant portions of the cost-risk of exploration, incentivizing firms to explore. Funnily enough, the GRMF is funded by the United States government — it certainly seems worthwhile to consider here at home.

The GRMF may not be perfectly suited for next-gen geothermal resource risk (when risk is not binary but more about the uncertain tradeoff between cost and resource characterization), but OCED has the legal flexibility to adapt the model to mitigate the risk and design a "resource characterization insurance program." OCED could make such a program cost-neutral by recovering costs from successful projects — offering protection against cost overages while financially participating in the upside. Such a program could be paired with regulatory reform to further reduce exposure to resource risk.

Regulatory Reform: Reducing Exposure to "Resource Risk"

Since perceived resource risk is a barrier to financing energy projects, mitigating that risk would help considerably. Of course, modern technology limits resource risk for technologies like wind and solar (as does the ability to avoid subsurface exploration). But the administration and Congress could take tangible steps to reduce resource risk for next-gen geothermal projects. The best way to do this is to make it easier to permit exploration projects under the National Environmental Policy Act (NEPA). If regulatory costs were lowered, geothermal companies could refine their techniques for exploration and get more "shots on goal" by more easily identifying viable locations.

Currently, the success rate for next-gen exploration projects is about 60%[2]. With iteration, this number should increase, much like shale's success rate did. Policy can enable more exploration projects by lowering the regulatory costs through a categorical exclusion under NEPA.

Congress should create a legislative categorical exclusion. Under Section 390 of the Energy Policy Act of 2005, oil and gas receive categorical exclusions (CEs) for activities requiring fewer than five acres of surface disturbance, and for drilling on locations that received an approval under NEPA within the last five years. These exclusions streamline approvals for exploration for oil and gas developers. At the very least, geothermal energy, a clean baseload source of power, should receive parity with oil and gas. Congress could amend the Energy Policy Act of 2005 to include geothermal energy in the Section 390 CE.

If Congress was inclined to go a step further, **it could create a separate legislative categorical exclusion for geothermal exploration**. There are strong reasons to go beyond the scope of the 390 CE for geothermal exploration. The technology and exploration process is different, and a new CE could cover the unique technological constraints of geothermal exploration while still protecting the environment and limiting environmental impact. Furthermore, we have commitments to decarbonize that suggest geothermal should be given expedited regulatory treatment.

Congress should ensure that the CE enables the specific use of seismic surveys or other methods like gravimetry, magnetotelluric, or even aero-magnetic surveying. Temporary road construction would be necessary to allow the vehicles on the land, and also may require an expansion of the CE beyond five acres, to eight or ten acres. A geographical expansion could be justified if paired with reasonable mitigation or restoration measures.

Seismic surveys revolutionized the oil and gas industry and became the “primary tool” of exploration for U.S. companies. By analyzing the time it takes for the seismic waves to reflect off of subsurface formations and return to the surface, a geophysicist can map subsurface formations and anomalies. In fact, these methods are currently being deployed across the whole of Denmark to map the potential geothermal resource. Specifically including these types of techniques in legislation would add certainty to an often opaque regulatory process.

The most important requirement for a legislative CE would be allowing developers to drill an exploration well, the most surefire way to confirm a geological resource. Allowing an exploration well to be drilled to depths of 5 to10 km necessary to identify the full heat resource would be a major improvement over the current permitting regime. Pairing this with reasonable mitigation and restoration measures would dramatically improve the outlook for next-gen geothermal energy.

We advocate a high degree of specificity for an important reason: permitting is a place where bright-line rules are preferable to vague signals that can be misconstrued or limited by federal agencies. However, specificity creates a challenge: a common rule of statutory interpretation is the rule of “expressio unius” — the negative implication canon. Put simply, it reasons that when Congress is highly specific about a set of conditions, it typically intends to include only those which it specifies. Therefore, if Congress specifies that techniques like seismic surveys or gravimetry are included, it may unintentionally exclude future survey techniques that are less invasive. Congress can mitigate this concern by listing specific techniques, with a final list item allowing the relevant agency head (in this case, the BLM Director) the discretion to add other techniques.

An Executive Categorical Exclusion: If Congress won’t act, the administration can, by adopting an executive CE. Under NEPA, agencies can adopt categorical exclusions for activities that do not have a significant impact on the environment. The Biden Administration has categorically excluded a host of surface-level development on “previously disturbed” lands.

It recently announced a series of categorical exclusions to accelerate clean energy deployment. The Departments of Transportation and Homeland Security adopted DOE’s CE for “the installation, modification, operation, and removal of electric vehicle charging stations, using commercially available technology, within a previously disturbed or developed area.”

More recently, DOE proposed a CE that clarified an existing CE for upgrading and relocating transmission lines that may be relocated “within an existing right of way or within otherwise previously disturbed or developed lands." It also proposed a new CE allowing the construction, operation, or upgrade of an energy storage system "within a previously disturbed or developed area or within a small area contiguous to a previously disturbed or developed area." Attorneys from Perkins Coie noted that the rule did not define small area but instead explained that DOE would "consider whether a contiguous area is 'small' on a case-by-case basis in the context of each particular proposal, by looking at its proposed location, its size in relation to industry norms, the relationship of the proposed action to similar types of development in the vicinity of the proposed action, and the expected waste or emissions output."

The Bureau of Land Management could follow the model of the energy storage system and create a categorical exclusion for surface-level exploration on already disturbed or developed areas, with a small contiguous area attached. While hardly the transformational policy necessary to supercharge geothermal deployment, it would at least open some of the vast amount of federal lands for more geothermal exploration without significantly disturbing or impacting the environment.

Conclusion

Advancing next-generation geothermal technology is a complex endeavor, and will require concerted efforts from various sectors. The challenges of capital investment, technological uncertainty, and policy design must be addressed comprehensively.

Investors play a crucial role in advancing a technology, by turning theoretical and experimental projects into real-world deployment. Congress should enable investors to do that work on next-gen geothermal by bridging the gaps in project financing, reducing resource risk, and tailoring financial solutions to the unique needs of individual projects. By fostering a favorable environment for geothermal development, we can unlock the potential of this sustainable energy source. Geothermal can be a key player in the renewable energy sector, if policy makers can unleash American investment and technology.

Footnotes

1 - Another small percentage is financed through non-traditional sources, like state tax credits and development grants.

2 - This estimate is based on our conversations with industry professionals.