



Geothermal in Alberta – The importance of creating a regulatory environment conducive to supporting the growth of a geothermal industry

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Summary

Alberta No. 1 (ABNo1) is a conventional deep geothermal project that has been moving forward since 2018. Terrapin Geothermics Inc is the Edmonton based owner of ABNo1. Work on the project started in 2017, and in 2019, the project was awarded a Natural Resources Canada (NRCAN) grant through the Emerging Renewable Power Program (ERPP). The grant of \$25.4M was announced in August of 2019 and the project timeline anticipated spudding and completing its exploration wells at the end of Q1 2020. However, continued delays related to finding matching funding for the ERPP grant as well as regulatory hurdles have delayed the project. Conditions of the grant are that it is to be matched by project investors. However, raising funds through investors (and debt financing) has been a challenge in the Alberta marketplace.

As ABNo1 has discovered there are many hurdles to a commercially successful project in Alberta such as: (1) low electrical prices; (2) limited existing market for thermal energy (i.e., competition with low-cost Natural Gas (NG) and an already in place distribution infrastructure); and (3) inability to show project returns similar to oil and gas (O&G) returns. This last point is important, because projects are perceived to have high up-front drilling risk (similar to O&G), but don't have the potential for similar financial returns due to the much lower commodity value of heat and electricity compared with O&G. On the supportive side (in the context of the Alberta marketplace) are offset carbon credits under Alberta's emissions offset program. ABNo1's financial modelling (based on the Alberta marketplace) estimates a 16% ROI with revenues from sale of heat, and power as well as tier and offset (voluntary) carbon credits, each accounting for approximately 1/4 of the project's revenues.

As a priority, in order to support the growth of a geothermal industry in Alberta the Government (GA) focused on creating a regulatory framework within which the province's geothermal resources could be developed. This regulatory framework, the Geothermal Resource Development Act (GRDA) received Royal Assent December 31, 2021. Several pieces of regulation that underpin the Bill are being rolled out. The first of these was issued January 25 (Mineral Rights Information Bulletin MRIB 2022-02) and outlined the procedure for applying for a geothermal resource lease under the new Act. A key piece of the regulations – the directive surrounding drilling of wells is expected to be released in April or May. Until that directive is released, ABNo1 has been advised that it can't move forward on applying for a drilling licence or surface rights.

The government states "This framework establishes a clear path forward for geothermal projects, while ensuring the resource is developed responsibly and in the best interest of Albertans." Although ABNo1 welcomes the certainty that a regulatory framework (and the attendant

directives) provides, the legislation is not supportive of a stand-alone geothermal industry as outlined in this paper.

Alberta No. 1 Development

ABNo1 is a geothermal project located south of the City of Grande Prairie in the Municipal District of Greenview. The project was officially announced in August of 2019 and since then has been making steady progress in understanding the subsurface of Alberta and its suitability for geothermal energy extraction (Hickson et al. 2020). Although the Province has widespread resources in the 30 °C to 110 °C range at depths of less than 4 km, resource temperatures higher than 110 °C at less than 4.5 km depth are more limited in arial extent. The western and northern regions of the province are most prospective for electrical generation. For this reason, combined with the cooperation and support received from the Municipal District of Greenview, the project chose development south of the Wapiti River (Figure 1).

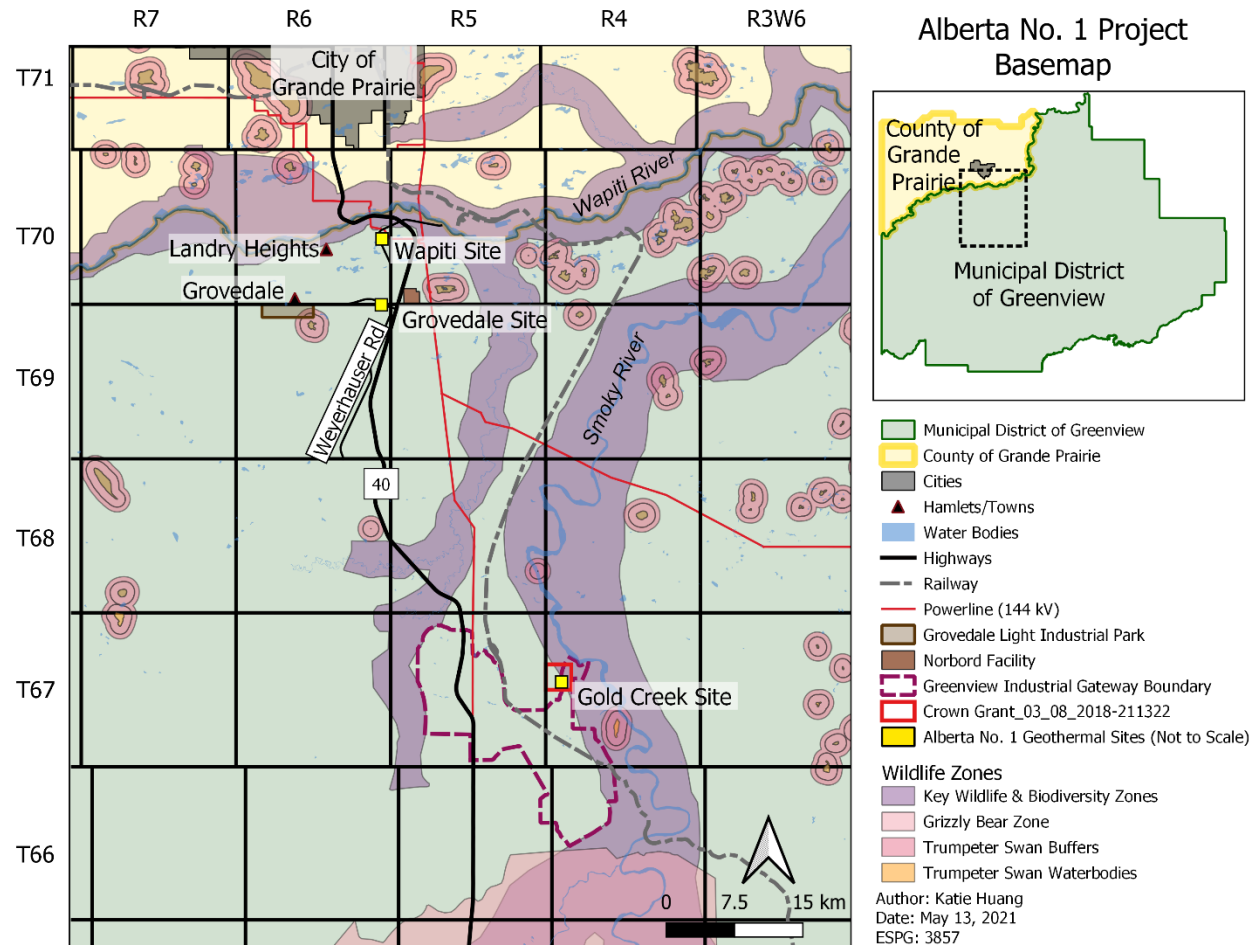


Figure 1: ABNo1 project is located south of Grande Prairie in the Municipal District of Greenview No. 16. The project has moved forward on acquiring geothermal resource leases surrounding two of its sites - Wapiti Site and Gold Creek Site. ABNo1 has one crown granted section at Section 19-067-04W6.

In addition to favourable geology for high temperatures (~120°C@4000m; Huang et al. 2021) and anticipated high flow rates from deep stratigraphic sections, the area is located near the Grovedale light industrial park and the Greenview Industrial Gateway (Figure 1), 20 km farther south. Both industrial settings provide opportunity for heat offtake industrial uses and sale of green renewable power.

After identifying a region where it was possible to co locate industrial users within a 10 to 15 km radius, coupled with proximity to transmission, work began on the well prognosis and drilling program. A vertical well drilled in the target zones of 177.8 mm (7in) in diameter is planned with a TD of 3,800m – 4,000m. The well will likely be drilled slightly deeper to sample and test the basement rocks for their suitability as a geothermal reservoir and for testing their potential for carbon sequestration, however, it is anticipated that production and sequestration will come from the deep strata of mixed carbonates and sandstones above the basement. Units such as the Leduc, Slave Point., Watt Mountain., Gilwood, Muskeg, and Granite Wash formations are anticipated to flow substantial quantities of fluids.

Offset Carbon Credits and Co-produced Commodities

Geothermal energy extraction in the context of Alberta's deregulated power market and low-cost natural gas needs a commercial boost. (Hickson et al. 2021) (Figure 2) discussed the holistic value chain for geothermal energy as a way of encouraging investment in geothermal. This holistic value chain advocates the production and extraction of co-produced commodities such as O&G and metallic and industrial metals if such commodities were co-mingled in the geothermal reservoir fluids. Another value-added industrial operation has come in the form of carbon “credits” through sequestration and production of carbon zero power and heat. These carbon credits provide geothermal projects with three cash flow streams – heat, power, and carbon credits (Figure 2).

For those holding the hydrocarbon rights, any co-produced petroleum and natural gas (PNG) could be extracted and provided back to the rights holders with compensation for the CAPEX invested to drill the wells. The same is true of the metallic and industrial minerals (MIM). With significant emphasis being placed on Lithium extraction from oil field brines, if a geothermal project were situated in an area where higher Li values were found, negotiating with companies focused on direct extraction for Li from brines may prove a favourable avenue for commercial investigation. Perhaps the greatest synergies can be established between blue hydrogen producers and geothermal companies. In addition to providing hydrogen generating companies with renewable, base load (firm) power, ABNo1 is investigating the feasibility of co-injection of CO₂ through partnerships with the University of Alberta and CanMet Energy (Shokri et al. 2022, Shokri et al. 2022).

Co-location of these various facilities and industries creates even greater synergies as the industrial cluster will be a concentrated force to reduce greenhouse gas emissions and create a more sustainable eco-industrial complex. If feasible, CO₂ sequestration combined with geothermal production, would make geothermal energy extraction not just the greenest of the green renewable energy sources, but also make projects carbon negative, thereby supporting other extractive industries in the quest for Carbon Zero by 2050. The regulatory framework should support such an extractive multi-commodity framework.

The holistic view

Depending on local geological conditions, an integrated industrial cluster (resource park) is possible.

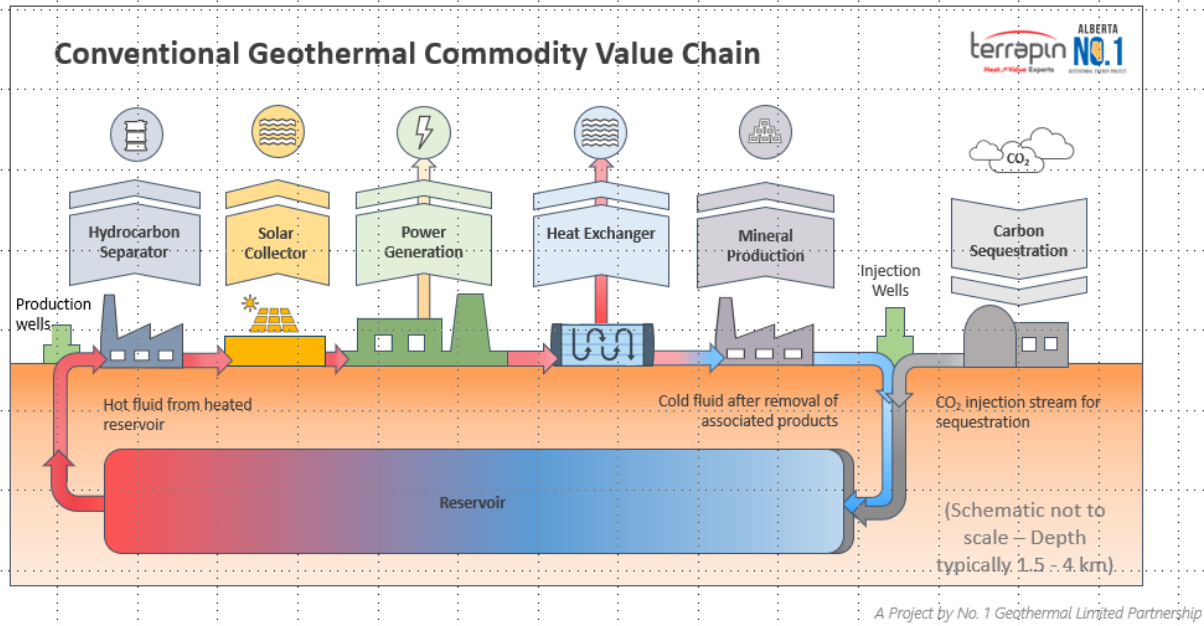


Figure 2: A holistic view of conventional, deep geothermal development. (From (Hickson et al. 2021))

Geothermal Resources Development Act (Bill 36)

The expressed intent of Alberta's newly created regulatory framework is to establish "a clear path forward" for geothermal projects and ensure that the development of geothermal resources is done responsibly through its entire life cycle to final clean up. The geothermal resource framework (GRDA) aligns with other resource development activities in the province in protecting the rights of surface landowners and mineral owners. The framework also ensures that the province will receive direct economic benefits through fees and royalties as well as indirect economic benefits such as job creation.

A detailed analysis of various aspects of early versions of the GRDA were prepared by The Environmental Law Centre (Powell 2020 a & b), they made the following comments based on these early versions:

1. No legal definition of geothermal resources.
2. A lack of clarity as to ownership of geothermal resources. As well, there is no process for obtaining tenure (in the case of Crown ownership) and access to geothermal resources.
3. No licensing system specifically enabling exploration for and development of geothermal resources.
4. Aside from those mentioned above, no provisions addressing environmental regulatory matters such as environmental assessment, and abandonment, reclamation, and remediation requirements.



5. The interface between geothermal resource development and O&G development promises synergy in terms of co-production and reworking of wells, and shared data and technical knowledge. However, it also brings significant legal challenges around subsurface conflicts and liability which are not addressed by Alberta's current regulatory system.

Point (3) was addressed with the January 25, 2022, issuance of MIFB 2022-02 which outlines the process to obtain tenure and it is anticipated that the comments of Powell (2020) for points 4 and 5 will be addressed when the directive is released later this year. Another discussion of the ownership and rights situation was provided by Bankes (2020). Both Powell and Bankes express concern that the Act makes no express declaration of ownership nor is it clearly retroactive.

The authors of this paper were recently involved in a geothermal regulatory review for the Government of the Northwest Territories (GNWT). The document is an internal document to GNWT prepared by a team from the School of Public Policy, Extractive Resource Governance Program, University of Calgary. On behalf of the GNWT, several provincial and international regulations were reviewed. In the context of this work, Alberta's new regulations were chosen for review. The following summary and comments are based on findings prepared for the GNWT report and are based on the full text of the GRDA, rather than earlier versions commented on by Powell (2020) and Bankes (2020).

Legislative Framework

Mines and Minerals Act

Alberta Geothermal Resource Tenure Regulation

Energy Mineral Rights Information Bulletin 2022-02 (Administration of Geothermal Resource Tenure)

Crown Mineral Agreement Holder Eligibility Guide

Geothermal Resource Development Act

Geothermal Resource Development Regulation

Oil and Gas Conservation Act

Key Geothermal Framework Elements

Geothermal Resource Definition

Geothermal Resources in Alberta are defined in both the Mines and Minerals Act and in the Geothermal Resource Development Act "the natural heat from the earth that is below the base of groundwater protection". This is consistent with the definitions proposed for "geothermal" by Hickson et al. (2022) and differentiates between geoexchange and geothermal systems. Of note in this definition is the reference to natural heat from the earth and exclusion of any reference to subsurface fluids produced from a subsurface reservoir and any constituents dissolved in those produced fluids. Further, the geothermal resource as defined in Alberta occurs only below the base of groundwater protection. This excludes surface thermal springs and as will be described later; this definition creates a distinction between geothermal resource and shallower geothermal exchange schemes that are regulated by Alberta Environment and Parks. Shallow geothermal exchange systems are not included within the scope of this review (Hickson et al. 2022).



Geothermal Resource Ownership

Geothermal resource ownership in Alberta is established in the Mines and Minerals Act as: “The owner of the mineral title in any land in Alberta has the right to explore for, develop, recover and manage the geothermal resources associated with those minerals and with any subsurface reservoirs under the land.”

In Alberta, the Crown owns slightly more than 80 percent of the mineral titles with the remainder owned by freehold mineral title holders.

Access to the Resource

Geothermal Resource Tenure

Geothermal resource tenure is requested by application (as compared to the commonly used posting request and public offering system used for most petroleum and natural gas rights). Geothermal rights may be granted pursuant to the Geothermal Resource Tenure Regulation. The tenure process is described in Mineral Rights Information Bulletin 2022-02 (Administration of Geothermal Resource Tenure). The Alberta Energy administers geothermal resource tenure.

The Geothermal Resource Tenure Regulation sets out that a geothermal lease conveys the non-exclusive right to explore for, develop and recover geothermal resources in the location of the lease. Further, the geothermal lease does not grant the right to any minerals as defined in the Mines and Minerals Act.

As of late January 2022 (January 25, 2022, issuance of MIFB 2022-02), a prospective geothermal resource explorer / developer can make an application to Alberta Energy for a geothermal resource lease (geothermal lease). A geothermal lease is required for any stand-alone geothermal operation that would occur below the base of groundwater protection. The maximum size of a geothermal lease is nine sections, all of which must be laterally or diagonally adjoining and not separated by more than one intervening section in which the rights are either freehold or already disposed.

Any set of geothermal resource rights may be requested – surface to basement, surface to a specified zone, from a specified zone to basement, or for a specific zone. (Note that when Crown rights are issued from the surface, only geothermal resources below the base of groundwater protection would be included in a geothermal lease). The Alberta Energy will handle applications on a first-in, first-out basis. If multiple applications are received for the same rights and location, Alberta Energy will work with applicants that submit applications subsequent to the first-in to amend their applications if possible.

The following illustrates the information required and fees for an application for a geothermal lease.

- Overview of proposed project
- Type of technology to be used
- Legal land description and rights being requested
- Target formation



- Identification of other agreements (mineral, geothermal, carbon capture and storage), subsurface activities or Crown Mineral Activity Authorizations located near the location of the geothermal rights being requested and if any potential conflicts exist, mitigation strategies to reduce conflicts.
- Identification – registered lessee(s), percentage ownership(s), designated representative (if more than one lessee) and official address to receive notifications. (Note: geothermal leases can only be issued to those who meet the eligibility requirements set out in the Mines and Minerals Act as described in the Crown Mineral Agreements Holder Eligibility Guide.)
- A non-refundable application fee of \$625 is required
- Payment of the first year's annual rental of \$3.50 / hectare must be included

If an application for a geothermal lease is approved, it will be given a five-year initial term. The objective of the initial term is for the lessee to undertake sufficient activities within the lease to enable the preparation of the “Geothermal Assessment Report” that will form the substantive content of a subsequent application to continue the lease for a second five-year term - the intermediate term. The lessee may make an application for the continuation to the intermediate term at any time during the initial term of the lease.

The expectation for granting an intermediate term is evidence of physical work undertaken to demonstrate the geothermal resource and technical feasibility to produce geothermal energy. Examples of geothermal assessment activities to be conducted on the lease include:

- Drilling a well(s)
- Re-completing or deepening existing wells
- Testing and logging wells
- Fluid sampling and temperature measurement
- Surface infrastructure / equipment supporting the extraction of heat or generation of power

Information submitted as part of the Geothermal Assessment Report will be considered by Alberta Energy to be confidential.

If a lease continuation application is successful, the lease will advance to the five-year intermediate term. By the end of the intermediate term, the lessee must be able to demonstrate that the lease is productive – that it is generating energy derived from geothermal resources.

An application for indefinite continuation can be made during the final year of the intermediate term (or earlier with consent of Alberta Energy). The application must include a discussion of the geothermal project with technical and operational data as well as the record of heat and/or energy generation from the project. If Alberta Energy considers the lease to be productive, the lease will move to an indefinite continual term. Alberta Energy may consider a lease, or portions thereof to be not productive in which case the lease, or portions thereof would be terminated with geothermal rights reverting to the Crown.

The Mines and Minerals Administration Regulation allows for an agreement to be transferred (total, partial, division and consolidation) with notification to Alberta Energy.



Surface Access

Access to the surface for well sites, pipeline right-of-way and facility sites must be obtained by lease from the surface owner – the Crown on public land or private landowner. Where the surface is privately-owned, the lease is obtained through negotiation. A distinction made between surface access for a stand-alone geothermal well or facility and a similar well or facility for O&G production is that the Alberta Surface Rights Board will have no jurisdiction for geothermal. This means that a surface lease must be successfully negotiated between parties with no backstop arbitration process available to resolve an impasse.

Geothermal Resource Fiscal Elements

As noted in the tenure section above, an application fee of \$625 is payable to the Government with an application for a geothermal lease.

A geothermal resource lease requires payment of an annual rental fee set at \$3.50 / hectare of lease area.

In the Mines and Minerals Act, the Government establishes its entitlement to, and its authority to determine the amount payable and its administration, for the exploration for and the development and recovery of geothermal resources that are owned by the Crown in right of Alberta.

At the time of writing, it does not appear that the Government has created a geothermal resource royalty regulation nor will impose a royalty on geothermal energy production in the near future. The Government may choose to determine royalties on a case-by-case basis in geothermal resource tenure agreements.

Regulation of Geothermal Development

The Geothermal Resource Development Act (GRDA) assigns authority for regulation of a geothermal development project through its life cycle to the Alberta Energy Regulator (AER). This includes licenses and approvals for geothermal wells and associated facilities and regulation of operations.

The purposes set out in the GRDA, and which determine the AER's regulatory responsibilities are aligned with the intent of the Oil and Gas Conservation Act.

- Provide for economic, orderly, efficient, and responsible development in the public interest of the geothermal resources in Alberta.
- Secure the observance of safe and efficient practices in the public interest in the development of geothermal resources in Alberta.
- Provide for the responsible management of wells, facilities, well sites and facility sites throughout their life cycles.
- Manage the development of geothermal resources as between licensees and in relation to the development and conservation of other energy resources in Alberta.
- Control pollution and ensure the protection of the environment and public safety in the development of geothermal resources in Alberta.



- Provide for the timely and useful collection, appraisal, and dissemination of information regarding geothermal resources in Alberta.

A notable addition to the purpose of the GRDA is the management of development of geothermal resources between licensees and in relation to the development and conservation of other energy resources. This purpose anticipates a possible need for regulatory involvement to manage potential effects of multiple projects developing the same geothermal resource and/or potential effects of geothermal resource development on hydrocarbon resources or other minerals.

AER is currently developing rules under the Geothermal Resource Development Act and a supporting directive that will set out detailed approval and application requirements as well as life-cycle operational requirements (scheduled for Spring of 2022). Following on the similarities in the Acts, these are likely to have a similar design as the Oil and Gas Conservation Rules administered by the AER. Rules will be designed to address geothermal development risks, both those common to O&G such as well control and any risks unique to geothermal. For example, assessment of, and mitigation measures for induced seismicity should it be deemed necessary (Hager et al. 2021). As well, O&G regulation typically contains requirements related to conservation and prevention of waste. For geothermal resource development, the issue may be design and operating practices that ensure long-term sustainability of the heat operation in the geothermal reservoir. This should align with the objectives of geothermal developers, but external factors may influence operating practices that damage sustainability, essentially over-production of the heat energy contained in the resource (heat and/or fluid extraction exceed the reservoir's capacity to regenerate). The regulator may need to consider performance-based tools to encourage sustainable operating practices.

Government Department / Agency Roles / Processes

- Alberta Department of Energy – Policy, rights management and tenure, royalties, or other fiscal programs
- Alberta Energy Regulator – Licensing and regulation of geothermal development activities and operations, full life-cycle – pre-drilling exploration to closure and reclamation.

Observations

Because parts of Alberta's geothermal resource framework are either brand new or not quite yet in existence, and only now beginning to be used (tested) it is too early to tell if it will be viewed as workable for the geothermal sector and/or the existing O&G sector. Alberta Energy is currently considering the first applications made for stand-alone geothermal projects but has yet to issue an exploration license under the new regulations.

Some areas of concern that may exist for the geothermal sector are resource definition restricted to heat only. The exclusion of minerals contained in geothermal fluids and petroleum and natural gas if it is encountered may limit opportunities for the geothermal sector and also result in the need for additional drilling and handling facilities to recover other substances of value. On the other hand, because much of Alberta's mineral rights are already held by O&G developers, the number of rights remaining available for geothermal developers could be severely constrained.

The non-exclusivity characteristic of Alberta's geothermal leases are of concern for developers. While it appears to offer open access for many developers, it may appear to impose an additional risk for investors in potential projects. Additionally, since the heat is not a unique commodity (being carried in the formation fluids), if drilling for O&G or other minerals were to take place within the geothermal lease, the extraction of these products, separate from a heat extraction facility, may significantly impact the geothermal resource.

Under the new Geothermal Tenure Regulation, consent of other mineral rights-holders is not required to obtain a geothermal exploration permit or production lease. However, as with O&G, the exploration permit does not authorize the drilling of a well – such authorization must be obtained from the Alberta Energy Regulator, whose process allows for parties that believe they may be adversely affected by a decision of the regulator to lodge an objection. This potentially opens the door for another right-holder to oppose a geothermal development. Because this has not been tested to date, there is little to go on in terms of understanding how an objection would be assessed and criteria for making a decision. For geothermal developers, this may be viewed as an unknown risk to investment.

Alberta's decision to not provide for the ability of the Surface Rights Board (SRB) to issue an entry order is another deviation from O&G regulation. This may preclude development of good geothermal prospects because surface-rights holders are able to prevent necessary surface access. It is also potentially adds cost to developers, as they have to negotiate directly with the landowners, and don't have access to adjudication through something like the SRB. Landowners may be predisposed to a particular perspective (either negative or positive) due to their experience with O&G development. Also, the commodity value of geothermal must be considered and compensation sought consistent with the potential future sale.

Incentivizing the geothermal industry

Governments who wish to grow or incentivize a geothermal industry within their jurisdictions, must provide support for early adopters and first-in-kind projects to help these companies prove that an industry is possible and scalable. This support must include a regulatory framework that is clear, transparent and helps projects move along quickly without getting bogged down in a regulatory morass. Geothermal companies do not have the technical or financial resources that oil, and gas companies have. An important aspect to understand is the financial reality of "pure play" geothermal projects is that these projects are capital constrained. The high CAPEX and upfront drilling risks makes attracting investors challenging and primary investment is often only sufficient to get the project off the ground. Any technical or regulatory challenges can jeopardize the project, especially in the early phases.

As noted above, the authors of this paper provided a regulatory review to the Government of NWT as they consider geothermal development in their jurisdiction. As part of the review, interviews with geothermal developers from several jurisdictions were carried out. The following is a compilation of suggestions from developers that would help incentivize development in the relevant jurisdictions:

1. Clear and transparent process.

2. Direct communication with regulators to respond to questions or queries, especially in jurisdictions with no or limited previous experience with conventional geothermal development.
3. Streamlined and efficient progression through the permitting process from subsurface to surface to installation of facilities, with all permits and license requirements clearly charted.
4. Ability to work with regulators to modify or adjust to specific circumstances of a geothermal development (especially in jurisdictions with no or limited previous experience with conventional geothermal development, and where existing O&G and/or water regulations are being modified to adjust to geothermal development)
5. Time frames for review of applications that are consistent and expedient.
6. Pathway to adjudicate disputes in an expeditious manner without resorting to legal resolution (i.e., avoiding costs of legal representation and protracted settlement timelines)

Conclusion

It should be noted that “pure play” geothermal companies are usually small with limited in-house technical staff, simply because the commodity values for geothermal have never been sufficient to support large technical staffs. Specialized experts are usually brought into projects for a limited time to help solve a specific problem, and university researchers have been heavily relied upon to help with innovation, research, and development (R&D). Government funding has been critical in supporting (R&D), especially in the USA, but there has been growing support here in Canada, at the federal level, for geothermal R&D. The geothermal industry has also borrowed heavily from the technology advances of the O&G industry.

The adaptation of technologies from other industries along with a sense of comradery and cooperation are the hallmarks of the geothermal industry. Whether it be from borrowing a downhole tool or a giant ESP pump (because yours failed and you don't have the money to buy another one) or the time of a colleague to puzzle out a problem; this small industry has been successful against all odds. They as individuals and companies have installed 1000s of megawatts of renewable energy – sustainable, base load power across the globe. Geothermal is hard. It is hard to raise capital, hard to get over early CAPEX challenges and to keep projects going through adversity. Government support is critical to make projects work, and it goes far beyond a supportive regulatory framework.

Failed wells or marginal producers need a “Plan B” to deal with the financial consequences. Innovation, such as using underperforming wells for carbon sequestration and/or oil field fluid disposal provide important safety nets for investors, but the current regulatory framework makes it hard for projects to pivot if unsuccessful. Long delays are foreseen when existing rights holders challenge geothermal projects, and someone must pay for costly technical studies to show that the concerns are unfounded (or not).

If developers are faced with significant costs negotiating with existing PNG or MIM rights owners, or long delays in arguing their case before a judicial body, the development is unlikely to occur. Worse still is the potential of having to acquire existing rights for a project to move forward. PNG rights holders have often paid significant sums to acquire and hold their rights; sums that are just not in the realm of possibility of a geothermal company. In this regard Alberta's GRDA does give



the nod to existing rights holders, so maybe these O&G companies will turn their interests to geothermal as co-production projects, as Razor Energy has done with its Future Energy spin off in the Swan Hills. Hopefully this project will pave the way for successful co-production as well as open the doors to pure play projects in Alberta.

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