Proceedings World Geothermal Congress 2020+1
Reykjavik, Iceland, April - October 2021

Key Elements to Growing the Global Geothermal Industry

Mike Allen

Geothermal New Zealand Inc, P O Box 37071, Parnell, Auckland 1141, New Zealand

mike.allen@xtra.co.nz

Keywords: Industry, growth, risk, mitigation, incentives, IPP, finance, equity, capital, promotion, associations

ABSTRACT

The geothermal industry is a key but relatively small-scale contributor to the world of renewable and sustainable energy. While its importance and value remain significant, international growth continues at only a modest pace. Efforts to engage the private sector in greenfield developments, especially in the emerging economies, remain a challenge. The competition from falling costs for PV and wind is introducing hurdles but solutions continue to be found to addressing the high early stage investment for geothermal.

There are a number of risk mitigation tools that have been proposed; these are considered alongside the more orthodox options of public finance for exploration and resource confirmation. The value of success with early investigations and developments are contrasted with private attempts to undertake these phases with limited access to equity funding. The importance of thorough, high quality and realistic resource investigations and assessments is considered with some case studies.

In the current environment, where geothermal has to demonstrate its benefits in energy scenarios that see constant competition from apparently lower cost options, that can be more quickly installed, the industry needs strong and convincing international representation and promotion. The role of domestic and international associations is being questioned; thoughts are presented on how they could deliver more for the industry and how international collaboration, amongst a relatively small group of specialists, is of increasing importance.

1. INTRODUCTION

This paper seeks to address some of the central challenges that face the geothermal industry. The focus is on the opportunities for growth in emerging economies, in particular where the shift to renewable energy has a number of driving factors, not the least of which are energy security and independence.

While much of what has happened in the industry to date has been led by public utilities and national agencies, internationally there is a natural move towards increased private sector developments. The global oil and gas industry has historically been seen as an example of how the private sector might participate in international geothermal expansion. There are however significant differences in that geothermal energy is not an internationally tradeable commodity and its identification and exploitation is moderately high risk and capital intensive. International O&G groups have been important players in geothermal developments, particularly were they have had parallel O&G activities; however, the modest returns of geothermal investments have seen a number withdraw from these operations as the returns from oil production have undermined their overall profitability.

A global scan of geothermal operations in emerging economies shows that there are in fact only a limited number of pure IPP activities. Public sector facilities still dominate and, with a possible re-emergence of concerns about the cost and duration of geothermal projects, this may not change markedly in the near future. A number of incentives are being offered to encourage geothermal development, but most do not address the need for substantial equity, perhaps as much as 40% of any financing structure.

There is no question that geothermal will continue to find support and new projects are being initiated with future opportunities planned. As a whole the industry has good support from those in the market and there are renewed efforts to promote geothermal for both power and non-electric purposes.

In parallel however the industry needs to be conscious that it is only a small part of the burgeoning renewable energy industry. It will require specific efforts to ensure that the geothermal industry's position remains strong and can offer commercially viable solutions in a rapidly changing energy environment.

2. THE ROLE OF THE PRIVATE SECTOR IPP IN EMERGING ECONOMIES

2.1 Fundamentals

As is well recognised by those in the industry there are some fundamentals for any geothermal resource identification and development:

- A willing government to allow and support geothermal development through policy, regulation and realistic pricing
- The presence of a resource with temperature, fluid properties and reservoir geology suitable for long term utilisation
- A quality programme of surface exploration to provide the highest possible level of confidence about resource potential before committing to any drilling activities
- A well-qualified team of scientists and engineers who can realistically evaluate the outcome of each stage of development and make dispassionate, commercial decisions at go / no-go points throughout the programme

Allen.

- Adequate, and immediately available equity funding to finance an uninterrupted programme of work that is accessible to management to meet the inevitable short term demands when difficulties are encountered
- Interconnection to allow power to be dispatched to a firm and reliable market

Perhaps the most critical element is that the project sponsor(s) need "deep pockets", an understanding of the complexities of a geothermal exploration and development project and an appreciation of the political, country and wider risks that such a venture may encounter. Ironically these points are often ignored – geothermal development is not for the faint hearted.

2.2 Key Enablers

What is often overlooked, or misunderstood, is that there are a number of key enablers that must be in place before a well structured and potentially commercially viable prospect should even be considered.

2.2.1 Concessions, PPA and Pricing

The issuing of geothermal concessions is still an evolving art; the duration of any project development programme is such that it may span two to three terms of government. This can lead to changes in energy policy, fiscal priorities and simple hesitation in decision making that stalls an already long period of development.

In many countries the granting of concessions has been ad hoc. Direct approaches to government, while perhaps seen as necessary to help open markets where geothermal has not been developed, can lead to arrangements that are challenged by subsequently elected officials. Multilateral agencies continue work to help build a legislative structure to back more sound arrangements but often this has led to long delays as a resolution is sought between new laws and "grandfathered" agreements.

Where political influence is brought to bear on concession awards it is not uncommon that this influence is not matched by sufficient sponsor resources – technical and financial – to ensure the completion of a viable project. Drawing on anecdotal experience from the broader mining industry, there is often an assumption that geothermal concessions will have a high value that can be on-sold to others; typically this is not the case as demonstrating the existence of a viable resource requires significant investment in geothermal, funds that are often not accessible to those who have acquired concessions on a speculative basis.

In parallel with the granting of concessions it is not uncommon that state owned entities will be working to build geothermal (or other fuel source) power facilities. This can lead to uncertainty about the rate at which competing generation may come on-line and, despite apparently secure power purchase agreements (PPA) being in place, may pose a potential threat from oversupply or lower priced competing power at the COD of the geothermal plant. It is common that there is a "single offtaker" for electricity and this presents its own challenges; there are few emerging economies where deregulation has allowed an open market which reflects real price options.

Typically, permission to proceed to the power plant development phase is predicated on an agreed PPA with an accepted price for energy; while this may be indexed once production starts, the base price is being set several years ahead of COD. This has always been challenging, increasingly so as generation costs drop for alternative renewable power sources. Utilities are seeing remarkably low prices for solar PV and, although this is not a baseload alternative, the opportunities for storage to offset solar intermittency are receiving increased attention.

Sovereign guarantees are often sought to underwrite the PPA, and at times the liquidity of the state utility; these are given only reluctantly so there has to be a strong case for their issue for a geothermal project that won't deliver power into the grid for several years from signing of the PPA.

2.2.2 Land Ownership and Access

An issue that is receiving increased attention across all development fronts is that of land ownership and access for project activities. State owned entities have in the past often acquired land under the guise of "public sector good" or similar statutes. With a heightened awareness of indigenous rights, and global interactions through social media, the presumption that this approach is acceptable is being frequently challenged.

Land ownership is often complex. Where land, including that required for general access, is clearly public then concession agreements should ensure unhindered rights of access and use. That held in "private" hands may be owned by a large number of individual stakeholders and even if there is an intent of agreement for access, the internal resolution from multiple owners is often slow and challenging. Claims over "public" land are of course not uncommon and the identification of a potential commercial development tends to heighten the interest in possible claims of ownership.

Sensitive project planning takes these issues into account and seeks to engage with local residents and stakeholders from the outset; it is critical to takes step to inform those who may have an interest or be affected by the project developments or operations.

Compensation to affected parties, whether landowners or not, has often taken the form of improved infrastructure, water supply, schooling, religious centres. While this may be well received at the outset, the scale of physical, social and cultural impacts from a large, multi-year engineering project, in what may have been a quiet rural backwater, is a different matter. In addition, the ongoing presence of a generation facility that is clearly dispatching power beyond, and perhaps with the exclusion of, local consumption, can raise a question of how equitable the whole undertaking has been.

New Zealand has a somewhat unique situation in that the landowner controls access to the geothermal resource below their property. Following some unacceptable earlier experiences with state owned developments, more recent projects have seen arrangements where the indigenous landowners hold a significant equity share in the full power facility. With a deregulated electricity market, this equity block trades independently of the utility co-owner who operates the total plant for both parties. This arrangement provides an ongoing income stream for the landowner, a more equitable outcome for the use of the resource that they control.

Efforts to build an equitable arrangement for all affected parties, whether landowners and/or those directly impacted by any development, is increasingly a key issue; those who ignore the importance of such considerations may do so at their own peril.

2.2.3 Funding and Finance

It goes without saying that finance is crucial; obvious but too often underestimated in importance.

Where geothermal developments have become of significance, often the first exploratory phases have been undertaken with public funds. Very early exploration was for example funded by UNDP in a number of countries, drawing on experience from Italy, New Zealand and the USA. As national interest grew and while state owned power generators persisted, bilateral funds were provided to extend these surveys; multilateral agencies were generally hesitant about renewables as such and reluctant to support the early surface drilling stages of development.

This has progressively changed but while multilateral financing is provided for public sector geothermal activities, the "private sector" arms of the multilateral groups have been less positive about co-financing / equity participation. The issue is perceived risk. This concern has in some cases been exacerbated but a poor choice of investment, or association with projects that have encountered what might well be considered typical hurdles during any geothermal development but that were not anticipated by funders.

Private IPP developers need access to substantial, readily available equity. Risk mitigation sources, such as the Geothermal Risk Mitigation funds in Africa and Latin America can help underwrite a share of risk in exploration and early drilling; the important point is that it is only a share. The project sponsor must be able to provide equal, if not more, in funds to have access to this support. The challenge for these funds is that often the sponsors do not have access to adequate finance and, while largely grant based surface exploration can be completed, financing for exploration (and confirmation) drilling is often unobtainable – the infamous "valley of death".

While funder's criteria vary, it is increasingly common that they expect a significant portion of steam to be proven "at the wellhead" before financing for the power plant will be released. This can often mean that almost 40% of the gross project expenditure needs to be available as sponsor equity. This requirement tends to defeat smaller scale development companies; larger projects are now often joint venture arrangements amongst trading entities, utility or generation companies and equipment suppliers.

2.2.4 Project Structuring and Contracting

As noted, the need for substantial equity funding is resulting in larger scale IPP activities being undertaken by consortia that bring project development, plant operations and steamfield management experience with a strong source of equity financing. While this can support the project through to the FEED stage, lenders will typically require that an experienced EPC contractor be engaged on a fixed price basis for the power plant and steamfield installations. Given that any EPC bidder will be evaluated against their financial strength and fiscal record, this process may well challenge national contracting capacity.

Ensuring substantial geothermal experience from the drilling contractor and efficient in-field operations is often not treated with the attention these deserve. The nature of geothermal reservoirs means that there are inevitable uncertainties about subsurface conditions, particularly for the first one or two wells in a concession. While there can be a temptation for less experienced sponsors to look to manage a portion of the procurement and logistics for drilling, a contractor engaged on an integrated contract is finding increasing favour. Under such a scheme drilling is typically paid on a day rate basis; procurement and the provision of all services, such as drilling tools, air drilling, casing, cementing etc, are the responsibility of the contractor. In this arrangement there is a sharing of risks. Difficult drilling conditions may expose the sponsor to higher costs per well but the frequent challenges around procurement, logistics and timely delivery to site are the contractor's responsibility and delays in these areas are at the contractor's cost

As with the need for an experienced and well-funded sponsor, underestimating the complexity of any geothermal project and attempting to carry out developments without appropriate technical support is often a road to project failure. The need for an "owner's engineer" may seem superfluous; those who have resisted engaging such support often later rue the day that they made this decision. This would seem to be an appropriate industry standard to establish; a number of poor experiences with public sector projects where inadequate project management and technical support has been engaged reinforces that this is an ill-chosen alternative.

There are opportunities to build a collaborative approach between national and international contractors that can bring significant win-win benefits. In New Zealand getting all parties "inside the tent" from an early stage led to projects that were completed ahead of schedule, under budget and exceeding predicted generation. This occurred as local knowledge balanced national standards, experience and approaches with more generic models proposed by the international EPC contractor and OEM providers; some relatively simple adjustments brought significant savings in time and costs.

Allen.

2.3 Incentives to Drive IPP Participation

In an attempt to attract and support private sector participation in geothermal developments there have been a number of approaches proposed and implemented with mixed results. The challenge is to provide incentives that actually offset the underlying difficulties in securing adequate finance throughout the project. As noted, irrespective of external support, there is a need for sponsors to have access to significant equity and this is unlikely to be provided through incentive schemes.

The incentives that have been considered do vary between those available in OECD and emerging economies, a reflection of market size, security and sophistication. Perhaps building on support that is typically offered to more generic infrastructure programmes, economic and tax incentives have been common. An overview of incentives offered for geothermal facilitation shows the following incentives that have been utilised:

Preferential pricing: Feed-in-Tariffs (FIT) to spur investment have been used in Turkey, Japan, Kenya, and Italy. These are seen to be a successful, if sometimes expensive, way to promote geothermal and some other countries are seeking to emulate them. There are risks that FIT availability drives unsustainable development. The current Japanese market model offering subsidies for exploration and very high tariffs for relatively small-scale installations is perhaps counterproductive to significant market growth? The significant growth in the Turkish market has stalled as the continuation of FIT support became uncertain.

Cost sharing with the private sector: The use of geothermal exploration funds (Indonesia, Iceland, Japan), data purchase (US), or issuing of subsidized service contracts (the Philippines). The Indonesian model is just being tested; there is a tension between providing at risk funds to the private sector when a portion of the financing is drawn from public resources. The presumption is also that the private sector can undertake the early exploration and drilling phases more cost effectively and expeditiously than public entities.

Loan guarantees: The government accepts the liability for a loan between a bank and an IPP. This allows IPPs to access cheaper financing than would otherwise be available. This has been used in the US and Japan. Although this has had some success, the requirement for the government to select the projects that are eligible for the guarantee hinders wide-scale adoption.

Tax credits: Reduces the tax bill of the IPP by a fixed amount per MWh. This has been used extensively in the US and is seen as very successful.

Tax holidays / lower income taxes: Tax holidays (i.e. no tax obligations) are usually implemented for a set time frame. The same incentives can be implemented, yet, in a weaker form, by lowering income taxes but not eliminating obligations. These measures can also be combined: for example, the Philippines have implemented tax holidays of seven years and after the seven years, income taxes of only 10% are required.

Duty free import of equipment: This incentive is designed to stimulate initial investment into geothermal projects and allows developers to import their equipment at a low cost and with ease. Duty free imports are applied by the Philippines, Indonesia, Kenya, and Turkey. This is especially important in countries where such equipment is not readily available locally.

Accelerated depreciation: Accelerated depreciation allows developers to depreciate the value of fixed assets faster. This allows developers to pay fewer taxes in current years, in exchange for higher taxes in future years. Accelerated depreciation helps to encourage developers to purchase new assets such as tools and machinery. This is used in the Philippines for example.

Exemption from value added taxes (VAT): There is no obligation to pay VATs or VATs are being refunded. This is used in the Philippines, Kenya, and Turkey.

Donor support: Many countries receive donor support when their geothermal sector is in its infancy. Donor finance/support can help in the structuring of a country's geothermal sector as well as can send initial positive signals to the private sector. It is especially helpful in countries with difficult investment climates. Interestingly, the challenges of financing initial exploration / resource proving are attracting something of a resurgence in donor funding.

Risk Mitigation Funds: There are two significant funds, in East Africa and Latin America, that draw on donor grant finance to fund surface exploration and 40 to 60% of the cost of drilling the first 2 or 3 exploration wells. While the level of finance committed by these funds is not insignificant, a large number of the projects supported have yet to progress beyond surface exploration. The issue is that the funds only finance a portion of the drilling costs; often sponsors struggle to attract the matching (equity) funding that is required to draw down this grant finance.

2.4 The Realities of the Geothermal IPP Environment in Emerging Economies

Often there is an understandable focus on what incentives could accelerate geothermal market growth; however, in all such markets there are a number of fundamental challenges which are often given only secondary consideration.

Experience globally has shown that, given the complexity, risk profile and lengthy development schedule, successful geothermal project execution can only be achieved if the project developer has the skills and significant financial resources that can address these challenges. Political and country risks that exist only exacerbate these issues.

It is often said that geothermal is risky and there are frequent "failures". Is this in fact true or is it more the case that there are a number of geothermal developments which have been attempted by those who are enthusiastic but underestimate the many challenges faced by such activities? In a number of cases the failures are more the fact that project proponents have limited appreciation of the technical requirements to complete high quality surface exploration and even if this is achieved they do not have the access to the equity required to undertake exploration drilling; without this capacity the resources are effectively unproven. As noted, even once the exploration phase is complete, additional drilling will require significant equity funding.

In West Olkaria the achievements by OrPower since 2000 are provided as an example of the potential success of IPP development in East Africa; it is still the only geothermal IPP operating in Africa. The existence of productive wells within their concession, drilled with public funds, are noted; what is however of key importance is that Ormat are one of the few companies internationally who have demonstrated they have the experience, financial resources and management capacity to execute such a project outside a domestic base. Even with these resources, securing project debt finance required a substantial effort on their part; a significant portion of the project was equity funded as the facility was expanded gradually from an initial 13MW over 6 stages to a current 150MW installation.

The Kenyan government established the Geothermal Development Company (GDC) in an attempt to bridge the risk gap between exploration and production. The concept, heavily supported by multilateral financing, focuses on GDC proving and agreeing to deliver an ongoing steam supply. IPP power production contracts would then be negotiated to build own and operate the generation facility. This has progressed slowly as the Menengai resource has proven complex – very high production temperatures and uncertainty about longevity of well performance. In principle this approach offers a good intermediate risk model; Kenya through GDC absorbs the resource risk, IPPs then provide a power plant on a BOO basis under a long term PPA.

A similar "tolling" model was one adopted in the Philippines and has continued, with mixed success, over many years. A comparable model is currently potentially to be tested in Djibouti where public sector funding has been used to complete three exploration wells. On the basis of the results of these wells, IPP partners will be encouraged to take the project through to production.

The saga of the Corbetti project in Ethiopia over the last 10 years is well documented. A negotiated project agreement stalled as a new government sought to establish a law to regulate geothermal exploration and development. This led to significant delays and a small scale first phase, perhaps as the difficulty in raising adequate capital for a significant greenfield development in Ethiopia became increasingly apparent. Further IPP ventures are being contemplated; the Ethiopia government has also re-engaged in the market with bilateral and multilateral funding, perhaps partially due to the challenges faced in consummating private sector deals?

In the Philippines and Indonesia there were early IPP developments undertaken by UNOCAL; with a background of domestic experience in the US, regional oil activities and a strong balance sheet they were able to explore and develop a number of geothermal resources (since acquired by Chevron – who have recently sold off these interests). Funding was drawn from equity and corporate finance sources. In the Philippines, as in Indonesia, there have been parallel state-owned developments. However, through a programme of privatisation key Filipino facilities are now privately owned by large national corporations but there is limited IPP activity foreseen in the near term.

More recent projects in Indonesia are led by strong consortia; typically a major Japanese trading house working with a significant industry player – Supreme Energy for example is a consortium between ENGIE and Sumitomo; the Sarulla development involves PT Medco Energi International (27.5%), Ormat Technologies (12.75%), Itochu (25%) and Kyushu Electric (25%). The new development at Baturraden has attracted a majority participation from STEAG of Germany. Even with these key organisations, the project developers have sought concessional funding from the multilaterals at various stages of their projects.

Turkey has been the exception in that a wide range of private entities have entered the geothermal market, resulting in a period of very rapid growth. This has been fuelled by the existence of attractive FIT rates; however, some of the development strategies and concession allocations are raising concerns about production sustainability.

Chile can lay claim to having its first, and only, operational geothermal plant developed by the private sector. ENEL has developed the 48 MW Cerro Pabellon geothermal power plant in the North of the country. This is an interesting example in that it is part of a wider programme under which ENEL will install a total of some 600MW of wind, solar and geothermal, after being awarded two substantial supply contracts for regulated customers; an opportunity to spread the risks across a substantial portfolio. As with many such developments, this project benefited from the support of multilateral funding, in this case the Climate Investment Fund and the Inter-American Development Bank.

Despite the various successes outlined above, the reality is that fully independent private sector development of geothermal plants remains challenging. The option of national participation in the resource risk, whether through subsidised funding or a long- term steam supply arrangements are yet to be demonstrated as appropriate alternatives but could offer a much-needed solution to underwrite positive and well-structured private sector led opportunities.

3. PUBLIC SECTOR LEADERSHIP IN EMERGING ECONOMIES

There is little doubt that the public sector, whether funded domestically or through bilateral or multi-lateral sources, has led the development of geothermal market growth in emerging economies.

Some would argue that it is a more natural fit for countries to accept the risks of resource exploration and confirmation. Unlike mineral production, geothermal energy is non-transportable; it has to be developed and used "on-site" and as such has a controlled and potentially limited market. It is easy to overlook the time that it has taken the leading geothermal countries to build even nascent IPP markets.

State utilities have built the leading geothermal markets and it is likely that this role will continue in the medium future, whether for full project execution or as steam suppliers to hybrid public private or IPP arrangements.

Government agencies in Indonesia, the Philippines, Mexico and Central America provided earlier demonstrations of the contribution that geothermal could offer and in Indonesia Pertamina and PLN continue with such projects. The Kenyan government, through KenGen and its predecessors, are continuing to demonstrate how important geothermal can be in some settings; geothermal provides more than 50% of the country's annual generation. They are however drawing on over 40 years'

experience; perhaps ironically the relative ease with which development has been stepped out across the Olkaria field has led neighbouring countries to underestimate the time and effort that needs to go into establishing a viable geothermal market.

The earlier scepticism of the multilateral agencies towards geothermal has gone and regionally based agencies, such as the African Development Bank, IADB and others are providing strong support to national government projects; equally, with bilateral support they are helping bridge the gap to a more substantial private sector participation.

The future of geothermal in the emerging markets will need both state and private sector engagement if the industry is to continue to grow in importance and value.

4. CONCLUSION: CONTINUED PROMOTION OF THE GEOTHERMAL INDUSTRY

Despite the commitment of the many individuals within the global geothermal industry, we often struggle to build a strong and well recognised "brand" internationally.

Over the last few years there have been a number of efforts to correct this situation:

- The International Geothermal Association (IGA) has been revitalised under new leadership, both at a board and executive level. With a very modest budget, considering its large international membership, much is being accomplished. There is an increased focus on non-electric use of geothermal resources, and this may be an important balance as we look to compete in a strongly renewable energy centric market. The WGC events provide a unique opportunity for the global market.

- The US Geothermal Resources Council (GRC) has also undergone some changes and is looking to play a stronger international role. Its annual conferences provide important points of contact for those active internationally.

- Under the auspices of IRENA, the Global Geothermal Alliance (GGA) has been established and continues to build its membership. A benefit of the GGA is that it can use IRENA's considerable convening power to attract the attention of Ministers and senior officials; the next step will be to ensure that it can build a credible and rational status for geothermal energy within the wider renewable energy portfolio the Agency promotes so effectively.

- Established in 2013, Women in Geothermal (WING) has rapidly built its membership and support internationally, now with over 1300 members. WING is an example of how the geothermal "message" can be central to raising awareness of non-technical issues; issues that are of key importance across the wider energy industry (and beyond). A recent announcement has seen the group that started Women of Renewable Industries and Sustainable Energy (WRISE) form a specific group for women working in the wind industry. The opportunity must surely exist for these bodies to help collaborate to reinforce each other's industries.

There are limited examples to highlight the long-term value and importance of geothermal energy more broadly. Iceland has a strong reputation with constant evidence of the importance of geothermal to the country, tourism and its economy both for power generation and non-electric uses; for others this is less obvious.

As noted, the global opportunities to use geothermal for industrial and domestic heating purposes are gaining growing support. This is important to the wider geothermal industry but in parallel efforts need to continue to address the challenges that remain for the geothermal power sector.

In the power sector there is now stiff competition from alternative renewable sources of generation. The geothermal industry has been challenged to demonstrate how it can move from a baseload image; solar and wind are answering the issue of intermittency through rapid progress in storage system.

As we look to consider more advanced forms of geothermal, such as EGS, there is a clear challenge to address the concerns of induced seismic activity. The ability to balance the secure access to natural surface flows for tourism and cultural activities with deep extraction for industrial / power use needs convincing arguments to placate those who remain opposed to such developments. Some supporters of gas generation have chosen to highlight the level of CO_2 emissions from some geothermal resources to challenge the industry's carbon footprint.

The opportunities for geothermal are considerable – we need to continue to build a strong and cohesive industry if we are to see geothermal emerge as a key element of the inevitable shift to renewable, sustainable energy utilisation.