GEOTHERMAL COSTS AND POLICY IMPACTS IN CHILE AND LATIN AMERICA

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ABSTRACT

Chile (and in its wake, many of the other Andean countries) has one of the largest unexploited geothermal potentials in the world. Geothermal exploration in Chile has been going on for more than 100 years. Although more than 60 geothermal exploration concessions have been granted, many fewer projects have progressed to receive exploitation concessions, and no project has achieved commercial production. At present the first project in Apacheta (Cerro Pabellón) is being developed for commissioning in 2017 (48 MWe).

Costs and regulation/policies are among the main barriers mentioned regularly. In contrast to countries like Indonesia (see Darma et al., 2016), Chile and Latin America have very liberal, market-oriented (geothermal) policies, with an emphasis on NCRE-credits, drilling insurance, and lowering of 'red tape' barriers. Little systematic modelling has been done on what the impact of these could be on geothermal costs.

This article provides detailed look at cost factors for geothermal in Chile, building on an economic model to calculate geothermal Levelized Costs of Energy (LCOE) against different scenarios of electricity prices and expected rates of return on investment. The main aim is to estimate the impact of policies at different levels of geothermal project development through a simple economic model.

The model therefore incorporates the different geothermal project phases, and emulates the monetary impact of different types of policies. The resulting model is compared with preliminary data the authors have gathered for Chile. A discussion follows what this type of modelling could mean, how the model and data could be improved and what lessons from the Chilean example could be applied to other Andean countries.

1. INTRODUCTION

The Andes has one of the largest unexploited geothermal potentials in the world. Chile contains the major part of this Andean potential and is the furthest explored, but despite more than 100 years and 3 waves of geothermal exploration, no geothermal electrical power has been generated as yet. An earlier article (Sanchez-Alfaro et al., 2015) gave a comprehensive overview of Chile's geothermal potential, exploration history and barriers to geothermal investment, including reporting on a survey of different stakeholders (for a brief summary see Section 2). This included a first review of exploration and development costs in Chile (compared to international) and a 'rough' sensitivity analysis.

Since the above article, geothermal regulation and incentives have changed: the (previous) Chilean government has introduced a new NCRE-measure (20/25) increasing the required percentage of NCRE-sources in the Chilean generation matrix. This was expected to increase the price of NCRE credits over time, from which geothermal could have benefitted substantially. However, due to an influx of other NCRE-projects (small-hydro, wind and especially solar) and simultaneous stalling of economic/demand growth, the reverse seems to have been happening and prices are dropping. On the other hand, a new government came in with more pro-active/interventionist plans regarding the energy sector in general and geothermal in particular (including risk mitigation mechanisms). This new government also blocked the ca 2 GWe Hydro Aysen project, which puts pressure on developing alternative sources of power generation (including geothermal). Finally, serious steps are being taken regarding extension of a core 'transmission highway' connecting areas closer to the Andes where geothermal and small-scale hydro resources are available. Recently the new Chilean government announced a carbon tax (the first of its kind in South America). Also KfW and IADB announced a US$ 1 billion geothermal exploration risk fund for Latin America, based on the experience in East Africa (Lima, November 2014).

In Chile (and the Andes at large) geothermal energy has huge potential as a renewable, base-load source of electricity generation, especially complementing other, existing (hydro-generation) and growing (wind and solar), but variable sources of renewable power generation in the region (Barbier, 2002; Goldstein et al., 2011).

Countries leading the use of geothermal resources often have had clear and direct policies designed to encourage geothermal development and in many cases state companies have made the major investment (Fridleifsson, 2001; Miethling, 2011; GEA, 2014). More recently, and in the Andes, energy sector development is more focused on private investors. Economic assessment against alternatives is critical in the business case to develop geothermal projects. Such a business case is heavily influenced by existing government policies for renewables (geothermal) in particular, but also general policy settings. That is the reason for the International Energy Agency to encourage governments to develop holistic geothermal policy frameworks that encompass economic considerations, regulation needs, market facilitation, and research and development support (IEA, 2009).

Chile is an excellent case to assess the potential impacts of geothermal incentives because: (1) it is an unexploited geothermal country where the private investors drive very active exploration for resources (2) the barriers and incentives for geothermal development have been recently reviewed (Sanchez-Alfaro et al., 2015) and (3) the government is contemplating different 'market based' incentives and policies.

The present article analyses costs, income streams and the peculiarities of the Chilean market using a detailed LCOE-model (sections 3 & 4) to estimate the life-cycle costs of geothermal energy generated and compares this to 'going market rates'. This model is then specifically used to evaluate the impacts of potential policy measures and their impact on final LCOE of geothermal generation in Chile. The data used is preliminary, but seems to fit observed market outcomes. Therefore this study contributes to assess the effectiveness in promotion from a geothermal development perspective.

2. REVIEW OF GEOTHERMAL EXPERIENCE AND BARRIERS IN CHILE

To adequately analyse the potential impact of policy measures on geothermal development in Chile, a better understanding of the barriers is needed. A systematic analysis of geothermal barriers was introduced by Coviello (2010) defining the following dimensions: Policies, Regulatory, Economic, Physical, Environmental, Technology, Organizational/Institutional, Educational, Social, and International.

In this study we concentrate on the Financial/Economic, Legal/Regulatory, Institutional, Educational and Social dimensions to analyse the impact of Chilean government policies. The physical (amount of resources), environmental, technological and international dimensions are considered to be less affected by public policies. Regarding these dimensions, the most important barriers identified for the Chilean case are listed in the sections below (Sanchez-Alfaro et al., 2015):

2.1. Financial and economic barriers

(a) The cost for geothermal exploration in unexploited geothermal countries as Chile is higher than in countries that have a history of doing so, and therefore despite the worldwide favourable and competitive cost for geothermal energy, proving a resource's viability in Chile is both expensive and risky. Therefore, few investors are willing to assume this risk in an unproven market and may require some level of additional assistance; (b) There are a few firms available that provide necessary exploration drilling equipment, but they charge very high prices for their services; (c) Many geothermal resources are in remote areas and there is a lack of access to the existing electrical grid.

2.2. Legal/Regulatory Barriers

(a) The existing regulatory framework has allowed many speculators to obtain geothermal concessions, thus delaying the development of viable prospects. (b) Lack of a clear and comprehensive legal framework to regulate disputes between geothermal developers and entities that own the rights to other resources within the concession; (c) Environmental impact studies are not uniform and create project delays. Those who conduct and evaluate the studies are often not geothermal experts.

2.3. Institutional Barriers

(a) The absence of clear medium-to-long term energy policies and a general lack of direction within the government in regard to geothermal resources; (b) Some government institutions are out of synchronization on geothermal issues; (c) Some concessions are granted only after a lengthy approval process, long beyond the period specified in the Geothermal Law. The reason is that there are few geothermal professionals working in government, and these experts are widely scattered.

2.4. Educational, Information, and Social Barriers

(a) Only a few universities in Chile have academic programs associated with geothermal energy and the existing research centres were recently created, and thus do not have a long history working with industrial partners; (b) Much data about exploration and resources remains in the hands of private companies, restricting the findings of prior research; (c) Due to lack of education and outreach, communities may consider geothermal exploration and exploitation as a threat.

3. METHODS: GEOTHERMAL BARRIERS-POLICIES-LCOE-IMPACT FRAMEWORK

To model and quantify the impacts of policy measures that are possible, we first conducted a detailed analysis of costs, income streams and LCOE of geothermal energy in Chile and then performed a sensitivity analysis by considering different scenarios of incentives to geothermal development.

This makes this approach different than many other papers/models, for instance the GETEM-2013 LCOE-model which is aimed at analysing (with some precision) the estimated LCOE of a single field/project. This unique approach means adapting an LCOE-model to incorporate different potential policy measures and including enough details to cover the various, relevant geothermal development stages, but enough generality to be able to derived 'guiding conclusions' for geothermal projects in the region.

3.1. Categorizing policy measures

Based on studies by Sanchez-Alfaro et al. (2015), Aravena et al. (2016) and other sources, it seems clear that Chile (and other Andean countries) have excellent physical geothermal resources, but also that there are many barriers. For each of these barriers, we have to estimate and quantify the potential effect on geothermal project economics, e.g. in terms of higher (capital) costs, risks (interest rates), project execution (time to operation & income), etc. The input costs and resulting LCOE have been cross-checked with data (and expert views) from real Chilean projects (Tolhuaca and Apacheta – see section 5) as a base case. Policies have been/will be discussed with government officials to validate the financial impacts of potential policies.

Many different policy measures could be implemented to stimulate renewable/geothermal electricity generation in Chile. Speer et al. (2014) and GEA (2014) provide excellent overviews of geothermal policies applied in different jurisdictions around the world. Not all policies would seem feasible in the Chilean context, which tends to favour market-type policy approaches. Hood (1986) introduces a simple, but useful general categorization of possible government policies (or 'tools of government')

- Authority: law-making; in the case of Chilean geothermal development, particularly regarding property rights, licensing and access regime and the conditions (e.g. anti-speculation, data sharing) and timeframes defined in these laws;

- Treasury: subsidies, co-investment, tax and risk measures;

- Organization: improve policies and streamline processes, train adequate qualified staff;

- Nodality: information, promotion;

The generic liberal orientation of the Chilean economic policy framework (as well as the fit with of our LCOE-analysis-framework), seem to make a focus for this article on 'Treasury' (market type) tools and instruments more to-the-point, addressing mainly financial/economic barriers. Recent publications by the World Bank (Gehringer and Loksha, 2012) and Asian Development Bank (ADB, 2015), as well as global initiatives (e.g. ARGEO/KfW in East Africa: Imolauer and Ueltzen, 2015) have focused on such financial/economic barriers to geothermal. The announced KfW/IADB fund aims to address those barriers to geothermal in Latin America as well.

Legal/regulatory and institutional barriers are normally addressed through legislation (Authority) and/or streamlining of procedures (Organization). Campen and Rai (2015) give a condensed overview of the different types of government regulations that can impact the viability of geothermal projects in different phases (e.g. consenting and environmental permitting) and compare such regulations for Chile, New Zealand, Philippines & Kenya). To quantify these regulatory barriers and policy measures in an LCOE-model the variables 'project time/delay' and 'risk (discount rate) seem most appropriate.

Of course there can be considerable overlap between the sets of tools and a combination of policy tools can often be very effective, e.g. policies to address electricity market issues could be a combination of legislation (Authority), Treasury and Organizational 'tools'.

Policies in the 'nodality' type tool-set are generally more useful to address education, information and social barriers. These will also be briefly discussed, but their impact is deemed more long-term and less easily quantifiable (but therefore not necessarily less important).

For our LCOE-analysis, the quantifiable impact of policy measures (on project economics) can then be further divided into those:

1. Affecting (lowering/increasing) capital costs (Treasury);

2. Affecting (lowering/increasing) risks / discount rates (Treasury);

3. Affecting (lowering/increasing) project time, e.g. preventing delays so project commissioning (and income) incur earlier (Organization);

4. Affecting (increasing) sales price of electricity/firm power/carbon or RE-credits, hence increasing income (Mixed tool-set).

3.2. LCOE-MODEL FOR CHILEAN ELECTRICITY MARKET AND POLICY IMPACT ANALYSIS

As mentioned, the aim of this article is to estimate/model the impact of potential policy measures on an average/model base case (50 MWe) geothermal power plant in Chile, comparing this to normal/expected electricity prices in Chile. Once this base case has been validated, the impacts of discussed policy scenarios can be modelled and discussed.

Our LCOE-model therefore incorporates the 'usual' capital costs, discount rates, annual O&M costs and income streams over project lifetime (see also: Pusschel and van Campen, 2012; Sanchez-Alfaro et al., 2015, Fuentes, 2013).

Some additional features were added to accommodate specific aspects of the Chilean electricity market and the policy impacts we wish to evaluate (these will be discussed further in the sections that follow):

- The project-time-to-market was entered as variable to model the impact of project delays (and hence postponed cash flow/income);

- Geothermal projects were split in 5 phases with each having their own investment, discount rate and project time frames, to be able to model the different risk phases and specific policy measures (e.g. drilling insurance) – see section 3.3.

- Extra income streams were added for capacity/firm energy payments, NCREs and a (potential) carbon tax to model some of the complexities of the Chilean electricity market – see section 4.

3.3. Geothermal phases, discount rates, project time-to-market

Like petroleum exploration and production projects, geothermal projects are characterised by high and risky up-front investments in exploration, drilling and production equipment, often resulting in long lead-times between first exploration and plant commissioning, first generation and – finally - income. Geothermal project feasibility is therefore very sensitive to such factors as capital costs, discount rates and project delays.

To incorporate this, the LCOE-model built for this article includes 5 phases:

1. Geoscientific exploration and pre-feasibility;

2. Exploration drilling, feasibility studies and consenting;

3. Production drilling;

4. Steamfield and generation plant + transmission construction and commissioning;

5. Long-term plant operation and maintenance (income).

Each phase can be defined in terms of investment/costs (and income), discount rate and length of project phase, to take account of different risk profiles per phase and potential delays, which can have significant impact on the final LCOE. (see section 5)

To create a base set of data for Chilean Geothermal Projects, several sources were used:

- International figures for Geothermal Investment and Project Pipelines (GEA 2005; Gehringer and Loksha, 2012; SKM, 2009);

- Project data from Tolhuaca and Apacheta (analysed in Fuentes, 2013)

- Report and data by the Chilean Advisory Commission for Electrical Development (CADE, 2011);

- Authors' calculations to match and consolidate input data;

A separate mention should be made of the choices of discount rates, as they have a huge impact on project economics, and several government (as well as international agencies) policies are aimed at reducing these risk rates (e.g. recently announced KfW, IaDB initiative for Latin America, and Chilean government initiative for Chile), which in turn will lead to lower discount rates. The sources for discount rates in this paper can be found in such publications as Mines (2013); Schlumberger (2008), and GEA (2014).

4. SPECIFIC CHARACTERISTICS OF CHILEAN ELECTRICITY MARKET: 'FIRM ENERGY' AND NCRE-PAYMENTS

The Chilean electricity market is organized as a mandatory pool with audited costs and financial bilateral contracts. All generators must submit their operational costs to the system operator (CDEC), who has to clear the market every hour at minimum cost, considering techno-economic constraints, namely reserve requirements, maintenance and outages of power plants, transmission limits, etc. In order to determine the opportunity cost of the water stored in the hydro-electric reservoirs, a long term optimization program is run continuously considering the future stochastic inflows of water to the systems for the next 2 years, resulting in a virtual cost of the energy generated by the turbines attached to the reservoirs.

With the previous information, it is possible to determine the set of generators that must be committed to supply demand at least cost, being the generator feeding the last unit of energy to the system the one -in general- that sets the marginal cost, at its injection node. The other injection nodes get a cost according to the transmission restrictions and losses. Theoretically, generators have no direct influence in the resulting dispatch, nevertheless, their investment plan and maintenance program have an impact on the price and they need to be monitored to avoid the exertion of market power.

The wholesale market in Chile is closed to the generators only. They sell energy according to their participation in the centralized dispatch and buy it in other nodes to satisfy their Power Purchasing Agreements or the blocks of energy awarded through the tenders for energy conducted by the distribution companies (regulated customers). So, the capacity of a generator to forecast its future in the dispatch and to sign contracts according to their expected generation will have a high impact on their profits. There is a capacity payment scheme, which corresponds to an additional payment to the generators to cover their investment costs and to encourage the development of new capacity, hence ensuring adequacy (Joskow, 2006).

Renewable energy regulations

Since 2010, the electric power market regulator in Chile created incentives for the development of renewable energy projects through the deployment of a Renewable Portfolio Standard scheme with renewable energy injection obligations and targets (called Energías Renovables No Convencionales or NCREs as an acronym for the English translation). These NCRE-obligations are calculated over the energy contracted (PPA/contracts from tenders) by any generator with either private or residential (regulated price) consumers. The amount that must be generated by the non-conventional technologies (excluding large-scale hydro power) is defined as a percentage of the contracted energy, starting at 5% at the beginning of 2010 and rising up to 20% in 2025 (recent changes in the regulatory framework have increased the target from 10% in 2024 to 20% in 2025). If the generation company cannot comply with the obligation through its production, renewable energy credits can be transferred bilaterally between companies with a surplus of energy from eligible sources to companies with shortfalls in relation to their quota. Penalties apply in case of breaching the percentage imposed (Palma et al., 2010), which are set at a maximum of US$ 25/MWh at present. These transfers account for an additional payment (NCRE credits) to non-conventional technologies (including geothermal) in the system.

Year	CLP/MWh	Exchange rate CLP/USD	USD/MWh
2010	6426.8	510.3	12.6
2011	6667.2	483.7	13.8
2012	6076.4	486.5	12.5
2013	5779.8	495.3	11.7
2014	4629.9	570.4	8.1
2015	3067.0	654.1	4.7

Table 1 Average value of NCRE-credits (Source: CDEC-SIC, 2016)

The effort to support renewable energy development has been successful; the decreasing value of the NCRE-credit shows that Chile might be experiencing an increasing surplus of renewable energy to cover the target associated to the NCRE scheme. The main reasons of the success are the high prices of energy experienced in the last 10 years and the reduction of investment cost among technologies, particularly solar PV. In fact, the country has been experiencing an explosive penetration of solar energy in the last 2 years, as shown in Figure 1. Wind and small-hydro are being deployed as well. This has led to important competition between renewable energy sources for the NCRE-credits. The important amount of renewable energy available (doubling the country's target) has led to decreasing prices of the NCRE-credits, as shown in Table 1.

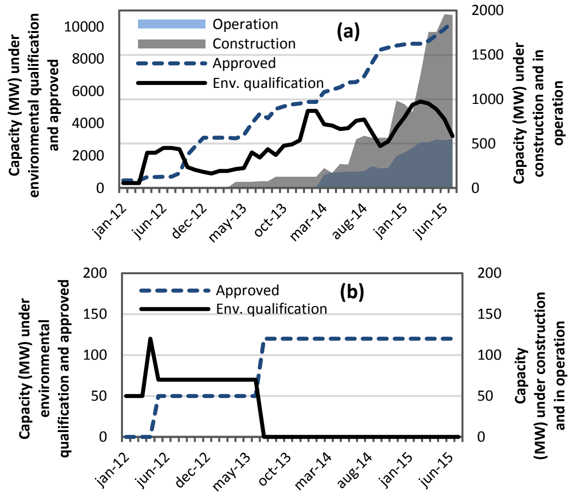

Figure 1 Recent environmental approval and construction of (a) solar PV and (b) geothermal in Chile (source: CER/CIFES, September 2015)

<u>Capacity payments</u>

A fixed price for 'firm' power is calculated every 6 months by the regulator considering the development of standard peaking capacity in the system. The consumers are charged that price according to their participation in the peak demand of the system. That capacity income is distributed along the generators on a pro-rata basis, using the firm capacity of every generator. This scheme avoids perverse incentives for excessive installation of capacity, since the pool of money to allocate depends only on the peak demand and the regulated price for power (P_P in USD/kW/month).

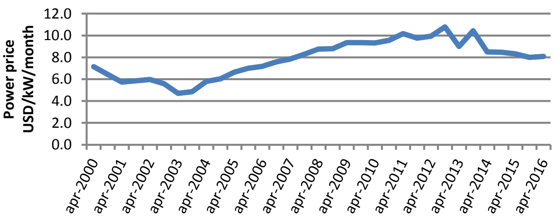

Figure 2 Power prices since April 2000 (Source: CNE, 2016)

The methodology to calculate the firm power of a generation unit involves a rather long set of steps, whose review is out of the scope of this document. After conducting a statistical analysis of the firm power that has been acknowledged to coal-fired power plants (base load with low cycling/maintenance, similar to geothermal units) the results have shown an average firm capacity factor (fcf) of 0.52 [firm capacity/installed capacity], with a minimum value of 0.48 and a maximum of 0.58. The yearly capacity income (CI) of a geothermal power plant with an installed capacity P (in MW) can thus be calculated as follows:

$$CI = P \cdot fcf \cdot 1000 \cdot P_P \cdot 12$$

For a 100 MW geothermal power plant facing a power price of 8 USD/kW/month and a firm capacity factor of 0.52, the expected capacity income for a given year is ca. 5 million USD.

<u>**Energy auctions and long term trend**</u>

The customers connected to distribution networks, whose power demand is below or equal to 2000 kW, acquire their energy through distribution companies and a tendering process coordinated by the regulator. Legally, distribution companies need to cover the long term energy requirements for their customers through the tendering process. Although the last tender was small in terms of the amount of energy at stake (1200 GWh/year), it resulted in competitive offers with prices down to 64.84 USD/MWh and with a weighted average price of 79.33 USD/MWh, as shown in Figure 3. The auction was divided in 3 daily blocks (370, 550 and 280 GWh/year), to be served in different periods of the day in the upcoming 20 years, starting in 2017.

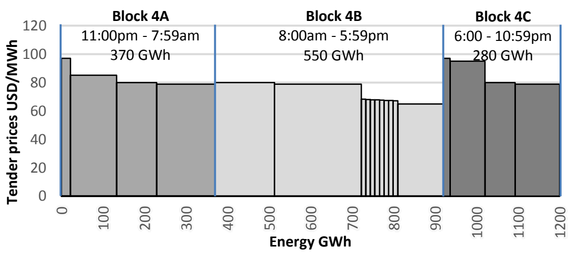

Figure 3 Results of the latest tender for energy in Chile to cover the requirements of energy of Distribution Companies. (Source: CNE, 2016)

5. RESULTING LCOE-MODEL AND PRELIMINARY ANALYSIS

The cash-flow analysis of the resulting LCOE-model looks as depicted in Annex 1. A first analysis of the base case scenario would result in an LCOE (Energy & Power in the Chilean market) of USD 109.9/MWh (see Table 2). NCRE income is presented as a separate source of income (like any carbon credit income would be).

With this base model several policy scenarios can be modelled for impact on LCOE. Based on the background presented in section 2, the following simple scenarios were modelled with GeoPIM (Geothermal Policy Impact Model - see Annex 1):

1. Reduction of exploration risk (e.g. by Drilling Risk Insurance as suggested in the KfW/IADB initiative for Latin America): discount rate for the exploration drilling phase lowers from 30 to 15%;

2. Lowered project-time-to-operation (e.g. by reducing consenting time and facilitating PPA negotiation): reduction of 2 years;

3. Increase the additional income from NCRE (or other secondary income like potential future carbon credits or tax): from US$ 5 to US$ 15/MWh;

Some other potential measures, e.g. reducing capital costs/government investment and government-initiated geoscientific exploration are not modelled for Chile, as this seems unlikely under its liberal policy framework. For other (Andean) countries, this could easily be modelled.

Scenarios	BaseCase	Policies			
	Mean Scenario	1. Lower Exploration Risk	2 Shorter Consent time	3. Extra Income from NCRE	Combine all 3
		Exploration Drilling discount rate from 30 to 15%	Consenting time down with 2 years	US$15/MWh, fully 'reliable' future price	
LCOE - Energy	USD 99.9	USD 93.5	USD 91.4	USD 89.9	USD 80.0
Firm Power Price	USD 10.0	USD 10.0	USD 10.0	USD 10.0	USD 10.0
Total LCOE Price	**USD 109.9**	**USD 103.5**	**USD 101.4**	**USD 99.9**	**USD 90.0**
NCRE income	USD 5.0	USD 5.0	USD 5.0	USD 15.0	USD 15.0

Table 2 Overview of Modelled Policy Impacts (source: authors' calculations)

Table 2 presents the initial results of the above-mentioned scenario modelling. This illustrates that that such policy measures/scenarios (on their own, but especially combined) can bring the LCOE of geothermal generation Chile within the range/margin-of-error around present market prices. Other scenarios can easily be modelled.

6. CONCLUSIONS AND FURTHER RESEARCH

As with the Sanchez-Alfaro et al. (2015) article, our basic conclusion from our modelling exercises is that geothermal projects in Chile are 'in range' of (almost) being economically feasible under present market circumstances. This seems to fit the present Chilean market situation, where several geothermal projects have been drilled with reportedly promising results, but none have made it to the commissioning phase yet. The first 48 MWe plant is currently under construction at Apacheta by ENEL/Ormat and is scheduled to be commissioned in 2017.

Our preliminary modelling results also show that several of the potential policy measures being considered for Chile (e.g. drilling insurance, streamlining of consenting and enhanced NCRE-regulation) can be modelled and shown to have significant impact on LCOE of geothermal projects, especially if considered in conjunction.

The project, cost and policy data would need to be verified further and other policy measures should be elaborated to improve the understanding of policy impacts on geothermal LCOE in Chile.

Lessons from Chile might be useful for other Andean countries that are just starting to develop their geothermal resources.

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Annex 1: Geothermal Policy Impact Model (GeoPIM)

1. Geoscience Exploration & pre-feasibility		
Cost Factor	**Mean Scenario**	**Mean Scenario**
Capital cost	USD 1,000,000	USD 1,000,000
nYears	3	3
Discount rate	30%	30%
NetValue @ End of Period	**$2,197,000**	**$2,197,000**
2. Exploration Drilling & feasibility/consenting		
Cost Factor	**Lower Drilling Risk**	**Mean Scenario**
Overflow Cost From Previous Phase	**$2,197,000**	**$2,197,000**
Capital cost	USD 30,000,000	USD 30,000,000
nYears	3	3
Discount rate	**15%**	30%
NetValue @ End of Period	**$48,967,612**	**$70,736,809**
3. Production Drilling		
Cost Factor	**Mean Scenario**	**Mean Scenario**
Overflow Cost From Previous Phase	**$48,967,612**	**$70,736,809**
Capital cost	USD 107,000,000	USD 107,000,000
nYears	2	2
Discount rate	15%	15%
NetValue @ End of Period	**$206,267,167**	**$235,056,930**
4. Steamfield, Power Plant, Transmission & Commisioning		
Cost Factor	**Mean Scenario**	**Mean Scenario**
Overflow Cost From Previous Phase	**$206,267,167**	**$235,056,930**
Capital cost	USD 225,000,000	USD 225,000,000
nYears	1	1
Discount rate	10%	10%
NetValue @ End of Period	**$474,393,884**	**$506,062,623**
Total Pre-Operation		
Plant size (Mwe)	50	50
Total Capital Cost (50 Mwe-plant)	USD 363,000,000	USD 363,000,000
USD/Mwe	USD 7,260,000	USD 7,260,000
Total Project Time to Operation	9	9
Total (Net Future) Value of Investments at Operation Start	**$474,393,884**	**$506,062,623**
5. Operation		
nYears	30	30
Discount Rate-Operation	8.00%	8.00%

Cash Flow		0	1	30
Production Degradation Factor				0.1%
Production [MWh]			371,577	360,951
Tariff Rate				
Energy tariff (Modelled rate required - US$/MWh)			**$100**	
Tariff from Power (US$ 9.5/kW.month; 50 Mwe; 90% avaliability)			**$10**	
Extra Income/ Tariff NCRE/CO2 per MWh			$5	
Revenue from Energy			$37,109,336	36,048,097
Revenue from Power			$3,715,773	3,609,511
Revenue from NCRE			$1,857,887	1,804,755
Total Revenue			$42,682,995	41,462,363
Total NPV	**USD 31,668,739**			
Expenses				
Operating Expense Inflation Factor			1.0000	1.0000
Fixed O&M Expense (Field + PE)			- 2,160,000	- 2,160,000
Overhaul each 3 years				-
Fixed Transmission Toll			- 1,750,000	- 1,750,000
Variable O&M Expense (Field + PE)			- 557,366	- 541,427
Insurance			- 300,000	- 300,000
Property Tax			- 4,614	- 4,614
Interests				
Depreciation Transmission Line & Pow	no depreciation			
Total Operating Costs			**- 4,771,980**	**- 4,756,041**
Total Operating Costs [US$/MWh]			12.84	13.18
EBITDA			37,911,015	36,706,322
Taxes	20%		- 7,582,203	- 7,341,264
EBITDA After TAX			45,493,218	44,047,586
Depreciation			-	-
Total Capital Cash Flow	**-USD 474,393,884**			
Total Cash Discounted Flow Operation	**USD 506,062,623**		**42,123,350**	**4,377,332**