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PROJECT PAPER

FOR

SMALL RETF GRANT

(US$ 3.5 MILLION EQUIVALENT)

TO THE

GOVERNMENT OF CHILE

FOR A

TECHNICAL ASSISTANCE FOR SUSTAINABLE GEOTHERMAL DEVELOPMENT PROJECT

May 10, 2015

CURRENCY EQUIVALENTS

(Exchange Rate Effective as of 23rd April, 2015)

Currency Unit: US Dollar
USD1.00 = CLP 614.60
CLP 1.00 = USD 0.0016

FISCAL YEAR
January 1 – December 31

ABBREVIATIONS AND ACRONYMS

AGCI	*Agencia de Cooperación Internacional*
CPS	Country Partnership Strategy
CTF	Clean Technology Fund
ESMAP	Energy Sector Management Assistance Program
GDF	Geothermal Development Facility
GGDP	Global Geothermal Development Plan
GHG	Greenhouse Gas
GoC	Government of Chile
GW	Gigawatts
IDB	Inter-American Development Bank
IP	Investment Plan
KfW	*Kreditanstalt für Wiederaufbau* - German Development Bank
LNG	Liquified Natural Gas
MiRiG	Geothermal Risk Mitigation Program
MoE	Ministry of Energy
MW	Megawatts
NCRE	Non-conventional Renewable Energy
OECD	Organization for Economic Cooperation and Development
PMR	Program for Market Readiness
PPA	Power Purchase Agreement
SE4ALL	Sustainable Energy for All
SIC	*Sistema Interconectado Central*
SING	*Sistema Interconectado del Norte Grande*
TSP	Total Suspended Particulates

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CHILE
TECHNICAL ASSISTANCE FOR SUSTAINABLE GEOTHERMAL DEVELOPMENT PROJECT

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DATA SHEET

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Small RETF Grant Project Paper

LCR

GEEDR

Basic Information

Date:	May 10, 2015	Sectors:	Other Renewable Energy (100%)
Country Director:	Alberto Rodriguez	Themes:	Climate Change (50%) Infrastructure services for private sector development (50%)
Practice Manager:	Malcolm Cosgrove-Davies	EA Category:	B
Project ID:	P152820		
Instrument:	Investment Project Financing		
Team Leader(s):	Migara Jayawardena, Mariano González		

Recipient: Agencia de Cooperación Internacional – Ministerio de Relaciones Exteriores (AGCI)

Executing Agency: Ministerio de Energía

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Project Implementation Period: Start Date: September 30, 2015 End Date: June 30, 2019

Expected Effectiveness Date: October 31, 2015

Expected Closing Date: June 30, 2019

Project Financing Data(US$M)

[ ] Loan	[X] Grant	[ ] Other
[ ] Credit	[ ] Guarantee	

For Loans/Credits/Others

Total Project Cost :	4.05M	Total Bank Financing :	3.5M
Total Cofinancing :	(50M)	Financing Gap :	0

Financing Source	Amount(US$M)
BORROWER/RECIPIENT	0.55
ESMAP	0.50
Clean Technology Fund	3.00
CTF IDB complementary financing	(50.00)
Total	54.05

Expected Disbursements (in USD Million)

Fiscal Year	2016	2017	2018	2019					
Annual	0.7	1.5	1.5	0.35					
Cumulative	0.7	2.2	3.7	4.05					

Project Development Objective(s)

The development objective of the Technical Assistance for Sustainable Geothermal Development project is to assist the Government of Chile (GoC) in resolving specific barriers to improve the geothermal energy market conditions. By addressing key legal, social and market barriers, this technical assistance will contribute to the development of commercializeable geothermal resources.

Components

Component Name	Cost (USD Millions)
Component 1- Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal	2,650.000
Component 2 – Enhance market conditions for promoting sustainable development of the sector	1,400,000

Compliance

Policy

Does the project depart from the CPS/CPF in content or in other significant respects?	Yes [ ]	No [X]
Does the project require any exceptions from Bank policies?	Yes [ ]	No [X]
Have these been approved by Bank management?	Yes [ ]	No [ ]
Is approval for any policy exception sought from the Board?	Yes [ ]	No [X]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X]	No [ ]

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment OP/BP 4.01	X	
Natural Habitats OP/BP 4.04	X	
Forests OP/BP 4.36	X	
Pest Management OP 4.09		X
Physical Cultural Resources OP/BP 4.11	X	
Indigenous Peoples OP/BP 4.10	X	
Involuntary Resettlement OP/BP 4.12	X	
Safety of Dams OP/BP 4.37		X
Projects on International Waters OP/BP 7.50		X
Projects in Disputed Areas OP/BP 7.60		X

Legal Covenants

Name	Recurrent	Due Date	Frequency

Description of Covenant

Team Composition

Bank Staff

Name	Title	Specialization	Unit	UPI
Migara Jayawardena	Senior Energy Specialist	Task Team Leader	GEEDR	170640
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Peter Lafere	Social Development Specialist	Social Safeguards	GSURR	315881
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Mariana Montiel	Senior Counsel	Lawyer	LEGLE	202290
Gevorg Sargsyan	Program Manager	Peer reviewer	GEEDR	214859
Pierre Audinet	Sr. Energy Economist	Peer reviewer	GEEES	273615

Non Bank Staff

Name	Title	Office Phone	City
Paolo Bona	Geothermal Resource Specialist Consultant		
Subir Sanyal	Geothermal Specialist Consultant		
John Armstong	Energy Policy Specialist Consultant		
Manlio Covielo	Chief	Peer reviewer	Natural Resources & Energy Unit, ECLAC UN
Jim Lawless		Peer reviewer	

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments

I. STRATEGIC CONTEXT

A. Country Context

1. **Chile is one of the most stable economies in Latin America with steady growth rates mainly driven by commodities export.** With almost 17 million inhabitants, and $277 billion GDP in 2013[1], the country recorded an average annual growth rate of 3.5 % while per capita income over the past 20 years has almost doubled in real terms. The effects of steady growth on employment and income have significantly reduced poverty rates, although earnings and labor productivity have been distributed unevenly. Chile's economy is characterized as being open and heavily dependent on natural resources and foreign trade with the mining sector accounting for 60% of the country's total exports. The industrial sector (including value added in the mining sector), which is energy intensive, and services account for 37% and 60% of the GDP with agriculture making up the rest. Despite being a mature economy, GDP growth forecasts for Chile for 2014-18 are around 4% per year, almost twice the OECD average (2-2.3%).[2]

B. Sectoral and Institutional Context

2. **The energy sector is a key determinant of economic growth in Chile.** Electricity demand in Chile has been out pacing economic growth, at around 7 percent per annum, doubling every 10 years. This reflects the relative energy intensity that is driving economic growth, especially in the industrial as well as service sectors. In order to sustain growth, address poverty, and expand prosperity throughout the country; it will be essential to ensure the availability of reliable and low cost electricity to fuel the productive sectors of the economy. The Government of Chile estimates that electricity demand will continue to grow at 6% - 7%[3] per year through 2020, which will require an additional 8 gigawatts (GW) of power generation capacity and associated infrastructure.

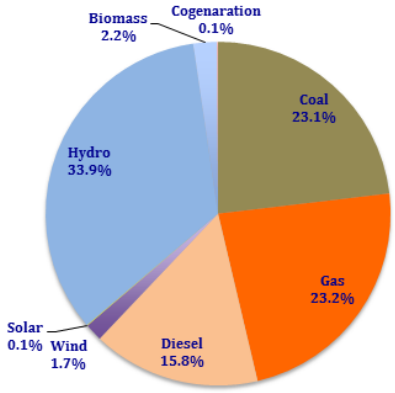
3. **Chile's power system is primarily comprised of two major electricity networks, which are shaped by the country's unique geographical characteristics.** The total installed power generation capacity in the country is 17.7 GW, in four separate non-interconnected networks that stretch through its 4300 km long and 175km wide geographic area: Sistema Interconectado del Norte Grande (SING), Sistema Interconectado Central (SIC), Magallanes and Aysen. Nearly all of the installed capacity is concentrated in the two large networks of SIC and SING, with only 150 megawatts (MW) of installed capacity in the other two systems. The largest system is SIC covering the central and central-southern portion of Chile has an installed capacity of 13.8 GW covering 90% of the population including the Santiago metropolitan area, which is the largest load center in the country. SING is located in the northern part of Chile covering 25% of the country's geographical area, and has an installed capacity of 3.7 GW. While SING supplies only about 6% of the population, the large concentration of the mining industry in the region drives over 90% of the electricity demand in the system. The extended length of the power systems in Chile and the terrain create considerable challenges, including high costs and accessibility issues for extending the transmission network in the country including the potential inter-connection of the SIC and SING that could produce synergies.

4. **Electricity in Chile is predominantly produced from thermal and hydro resources.** In 2013, thermoelectric installed capacity accounts for 64% of the total power generation mix in Chile while hydropower makes-up 34%, wind contributes 1.6%, and solar power provides just 0.4% of the total installed capacity in the country (see figure below). All the hydroelectric capacity, with a few small exceptions, is located in the SIC representing 43% of the total installed capacity of the system. The remainder is comprised

[1] The World Bank
[2] Economist Intelligence Unit, Country Report, October 2013
[3] National Energy Strategy 2012-2030

of coal, natural gas and diesel, each with a share in excess of 15%. In the SING system, where most of the energy–intensive mining industry is located, power generation is dominated by fossil fuels. Over half of the generation capacity in the system is based on coal, while natural gas makes up a significant 38% and diesel has a 9% share.

Power Generation Capacity in Chile by Technology (2013)



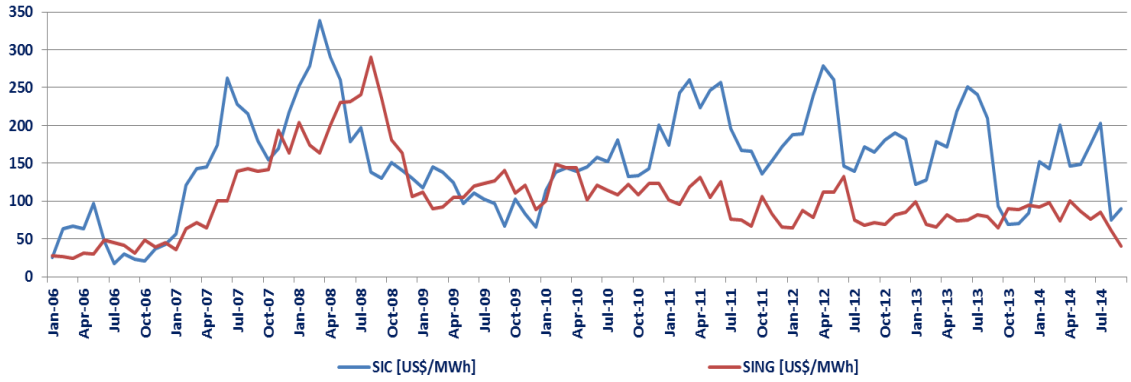
SOURCE: Ministry of Energy, Government of Chile

5. **Chile has had some difficulty in reliable operation of existing power plants as well as strategically expanding new power generation capacity.** The large scale hydropower plants have had reduced availability due to vulnerability to extreme weather resulting in the severe drought of 2010 in Chile and multiple years of below average rainfall. In addition, the development of new hydropower capacity is facing opposition due to civil society concerns such as potential for flooding, impact on wildlife, and effects on small population groups. Chile's energy supply vulnerabilities were clearly evident when there were a series of disruptions in the significant amount of natural gas supplies imported from Argentina between 2004 and 2008. This situation created severe constraints, including impacting power generation, which was later alleviated through diversification of supply sources and the construction of two LNG terminals for domestic storage and regasification. Nonetheless, reducing excessive reliance on imported fuel supplies through the development of alternate indigenous power generation options continues to be an imperative for strengthening the energy security of the country.

6. **Chile manages the energy sector primarily through a "laissez faire" approach with policies that promote private sector led investments and prices determined primarily through market-based principles.** Chile was one of the first countries to implement comprehensive electricity sector deregulation, dating back to 1982. As a result, generation, transmission and distribution services were unbundled and are now in private hands. Generation has been structured as a competitive market with independent power producers, while *transmission* remains a natural monopoly and *distribution* is arranged through distribution companies that are regulated as monopolies to sell electricity within their concession areas. Given the structure of the sector, electricity prices are mostly determined through market forces. Therefore, electricity prices have fluctuated, reflecting various factors including volatility in fossil fuel prices, availability of hydro, and shortages created by the disruption of gas supplies from Argentina. The figure below illustrates this volatility, where average spot prices for power have ranged from less than US$25/MWh to more than $US/300MWh. Although electricity prices have moderated somewhat, in 2014, prices still ranged from $90US/MWh to about $200US/MWh. Fluctuations in electricity prices in the SIC have been particularly significant, making it less predictable for investors and consumers alike. Since the uncertainty in prices

undermines business competitiveness and creates hardship for people, thus, the GoC has made reducing prices and stabilizing volatility in the power sector a primary objective for the energy sector[4].

Marginal Cost of Electricity in SIC and SING



SOURCE: Ministry of Energy, Government of Chile

7. **Chile is also determined to develop the energy sector in a sustainable manner that limits global greenhouse gas (GHG) emissions.** Chile's greenhouse gas emissions, which are expected to double by 2025, are primarily from the energy sector. The CO_2 emissions per capita have increased from 3.6 metric tons in 2000 to 4.6 metric tons in 2011, substantially higher than the average for other Central and South American countries[5]. The SING system has particularly high carbon intensity due to the substantial utilization of coal for power generation. Redirecting the emissions trajectory is an important objective for the Government of Chile, especially since, as an OECD country, it may face commitments to reduce emissions as a part of a future global agreement on climate change. Thus Chile is making efforts to reduce its dependency on fossil-based electricity and diversify its generation mix. It is already a signatory to the Copenhagen Accord where Chile agreed to take mitigation measures to deviate by 20% its business-as-usual emissions trajectory. On October 1, 2014, Chile implemented a modest yet important carbon tax of $5/ton of CO2 emissions from power plants that are larger than 50 MW, sending a clear signal to the market to consider shifting towards cleaner sources of energy. The GoC has also secured international assistance of $220M[6] through the Climate Investment funds (CIF) to promote renewable energy development in the country.

8. **Expanding renewable energy as a part of a better diversified generation mix will also have considerable local environmental benefits, if developed prudently in compliance with safeguards requirements**. It will reduce pollutants such as sulfur dioxide (SO2), nitrogen oxide (NOx), and total suspended particulates (TSP) that are a common bi-product of fossil-based power generation. However, as with all power generation technologies, there is a need for incorporating prudent measures that mitigate any negative environmental, social, and safety issues that can arise during construction and operation. In Chile, there has been considerable opposition by civil society towards hydropower development due to concerns such as potential for flooding, impact on wildlife, and effects on small population groups. Similar issues may arise from the development of other technologies as well, which will need to be carefully and conscientiously addressed consistent with local and international standards, if Chile is to scale-up the utilization of renewable energy.

[4] National Energy Strategy (2012-2030), Chile.
[5] US Energy Information Administration (EIA).
[6] Including CTF funds allocated to Chile through the Global Geothermal Development Plan.

9. **Chile's latest "Energy Agenda" and long-term strategy seek to boost the utilization of renewable energy as one key solution for addressing the challenges facing the sector.** In March, 2014, the newly elected administration in Chile established an "Energy Agenda" that aims to address some of the key issues facing the sector. Consistent with its long-term National Energy Strategy 2012-2030, some of the strategic objectives are to boost the utilization of non-conventional renewable energy (NCRE), reduce the marginal cost of electricity, and improve energy efficiency to reduce consumption. The unique geography of the country has endowed Chile with an abundance of hydro, wind, solar, and geothermal resources that can be developed to diversify and optimize the power generation mix. Recognizing this need as well as the opportunity to increase its utilization, the GoC, in 2008, established a NCRE target of 10% by 2024, which, in 2013, was increased to 20% by 2025[7]. To meet this goal, it is estimated that between 3,500-4,000 MW of NCRE generation capacity will need to be installed in the next 10 years[8]. While Chile has kept up with similar targets previously, some NCRE technologies will face greater hurdles in scaling-up than others.

10. **Chile's abundant geothermal potential provides a good renewable energy option to further diversify the country's power generation mix, reduce price volatility, and improve energy security.** The mountainous eastern backbone of Chile is the Andes Range that comprises almost 3,000 active and dormant volcanoes. There are good indications that the entire northern and central parts of the Andes have excellent geothermal energy potential. Studies indicate that the geothermal power generation potential can be in excess of 3 GW[9]. Geothermal energy stands out among renewable energy systems for a number of beneficial reasons that address some of the key challenges facing the energy sector in Chile. In particular: i) unlike other renewable energy alternatives, such as wind and solar power, geothermal is a non-intermittent source[10] that can provide reliable base-load power on a 24/7 basis; ii) it is a clean source of energy emitting a fraction of the GHG emissions (CO_2) compared with other baseload options such as coal, and none of the local pollutants such as nitrous oxides (NOx) and sulphur dioxides (SO_2), and total suspended particulates (TSP); iii) as an indigenous and non-tradable resource, it will enhance the energy security that has been of concern in Chile; iv) once developed, it can provide stable prices and serve as a natural hedge against the volatility of other commodity-driven electricity prices; and v) it offers the potential to provide for direct applications such as heat for households (district heating), and agricultural and industrial applications.

11. **The GoC has made a concerted effort to develop the nascent geothermal industry in the country.** In 2000, the GoC promulgated the Geothermal Concessions Law (Law Number 19.657), with the objective of issuing geothermal development concessions to mobilize investments in the sector. Many developers including a number that were internationally reputable clamored to enter the Chilean market resulting in over 100 geothermal concessions being issued (with many securing multiple concessions). Despite what appeared to be a promising start, very little investments were mobilized in a small number of fields for the risky exploration drilling investments and resource confirmation efforts that are necessary before advancing green field development. A number of reasons stymied investments in exploration including the limited time afforded for test drilling, uncertainty regarding follow-on development, excessive concessioning given the globally modest number of qualified geothermal developers, lack of exit clauses for those not meeting development objectives, and inadequate capacity within GoC to monitor and oversee the concession regime. Offtake and commercial issues related to the overall power sector with regards to integrating geothermal as well as environmental concerns have also created uncertainty for developers. The GoC issued a revised regulation in 2013, to ease some of the administrative constraints in adequately applying the law, which has led to a few developers making some progress. However, despite these efforts and the large potential, presently there are no geothermal power plants in operation in Chile.

[7] Law 20,698, commonly referred to as the 20/25 Law
[8] Center for Economic Load Dispatch (CDEC)
[9] With some estimates suggesting that the potential may be as much as 16GW.
[10] The other presently available renewable technology is hydro with storage.

12. **There are a number of key barriers that need to be addressed in addition to enhancing the policy and regulatory framework in order to sustainably develop geothermal as a viable base-load generation option.** There is an immediate need to rationalize the scale and pace to which geothermal can be realistically developed for the Chilean market, so that a commensurate revision can be undertaken to upgrade the policy and regulatory framework. This would include the need to resolve any impasses related to concessions and ensuring capacity within GoC for adequate oversight and pro-active management of concession areas throughout the development process. However, reforms to the policy and regulatory framework alone will not address some of the additional key barriers that are impeding the progressive development of geothermal in Chile. They reflect challenges related to the technology as well as the circumstances specific to the Chilean energy market:

- Geothermal resource risks. The uncertainty surrounding the availability of a commercially exploitable resource in greenfield projects is a major barrier inherent to early stage geothermal development. In the Chilean market, the risk is perceived by many developers to be greater since the sector is nascent and widespread drilling results and information is not available. Therefore, investors are often reluctant to mobilize the $20-$30 million in risk capital required for exploration drilling and geothermal resource confirmation.

- Integration of geothermal in the power market. There is a need to rationalize the scale and time frame for geothermal expansion in Chile; and ensure that the power markets in the country can adequately integrate geothermal into the respective systems. At present, power purchase agreements (PPAs) in Chile typically extend from 7 to 10 years whereas geothermal projects are often amortized over 20 to 30 years. This mismatch hampers developers' ability to raise financing for projects. In addition, many geothermal fields are in remote locations that will require the extension of the transmission lines to evacuate power, which can be costly and difficult to coordinate in the case of many projects.

- Environmental and social considerations. Chile's policy framework for environmental and social safeguards is broadly aligned with international standards. However, there is a need to ensure that there is broad awareness with developers as well as local communities as to how these policies are applied towards geothermal development. While most of the civil society opposition has been directed towards development of hydro power, recent events such as a well-blow out at the El Tatio geothermal field can negatively alter perceptions about geothermal development. Therefore, strong stakeholder engagement/consultation (including with affected indigenous populations) as well as the need to raise the awareness of developers with regards to compliance are essential for sustainable scale-up of development in the sector.

- Long-term competitiveness of geothermal. Based on the few fields where there has been drilling, there is evidence that initial investments in geothermal can be costly on a financial basis. This is especially the case with drilling, particularly due to the rugged terrain, limited duration of drilling due to weather conditions, and the remote location of many sites. There may be existing industries in the country that can suitably provide services to the geothermal sector at lower costs. Combining other purposes such as direct use of geothermal for heating can also enhance the overall viability of geothermal projects by taking advantage of co-benefits of the technology. While long-term, addressing some of these constraints will help transform a nascent market into a more robust one, and provide a more sustainable environment for investing in geothermal energy in Chile.

13. **The GoC is intensifying its efforts to address critical challenges in order to advance geothermal, and is seeking international assistance to help achieve its goals.** The GoC recognizes that while developing a nascent industry into a robust one will take time, it is also important to progressively develop geothermal as a viable alternative energy option in Chile for meeting its NCRE targets as well as

achieving the country's development needs over an even longer term. This is especially the case for supplying stable base load power, since most renewables are intermittent. Therefore, the GoC's Energy Agenda already includes a number of reforms specific to promoting geothermal development that include: a) the preparation of a new geothermal law, b) design of risk mitigation schemes to mobilize investments in exploration drilling, and c) launch a program to promote the utilization of low and medium enthalpy geothermal for direct uses such as heating. The initial goals are in a range of modest to moderate in ambition with targets that range from 200MW[11]-800MW[12] by 2025. This reflects the infant state of the industry and resulting uncertainty of how the sector will actually develop and evolve in Chile. A catalytic effort to kick-start the sector could lead to a more robust outcome over time exploiting the significantly larger geothermal potential that has been estimated to exist in the country. In order to achieve such an outcome, it will be essential to successfully implement the proposed GoC reform agenda for geothermal as well as address other key barriers to sector development. Therefore, the GoC has sought international assistance from its development partners. The GoC has secured $53 million from the Clean Technology Fund (CTF) that is being channeled through the World Bank and the Inter-American Development Bank (IDB) towards advancing geothermal development in the country. Of the CTF funds, $50 million is allocated through IDB to facilitate financing for several geothermal projects where field exploration (drilling) is sufficiently advanced. The GoC is seeking the benefit of the World Bank's extensive global experience in supporting geothermal development, to help implement a complementary set of reforms in parallel that would progressively address the key barriers to sector development. CTF funds of $3 million along with an additional $500,000 from ESMAP administered GGDP are allocated towards technical assistance through the World Bank so that Chile could implement a set of reforms and strengthen its capacity in the geothermal sector that reflect accepted industry practices and meet international standards. The proposed technical assistance is expected to have an immediate impact by strengthening the existing architecture for facilitating financing from IDB and other sources for exploratory activities towards the development of commercializable steam fields; and also address barriers that will progressively enhance the market conditions for the sustainable development of geothermal in the longer-term.

C. Higher Level Objectives to which the Project Contributes

14. **The Technical Assistance for Sustainable Geothermal Development project in Chile is fully consistent with the World Bank's Country Partnership Strategy (CPS).** The CPS aims to support Chile's vision for eradicating extreme poverty and achieving high-income developed status by 2018, for which a major strategic pillar is promoting sustainable investments in infrastructure in sectors such as energy. The GoC's strategy calls for improving the business climate to attract private sector investments, including in renewable energy projects. Additionally, the strategy calls for supporting options that make a positive contribution to climate change. The steps taken by the new administration in Chile, including issuance of the Energy Agenda, confirm that geothermal development is a national priority that is consistent with its long-term development objectives. The reallocation of $33 million[13] within its CTF Investment Plan (IP) and seeking international assistance in support of geothermal development is another confirmation of GoC's commitment to reforming the sector. The proposed project and its associated activities will contribute to promote private investments in geothermal towards achieving Chile's development goals.

15. **The proposed project is also consistent with higher level global development objectives.** It supports the Sustainable Energy for All (SE4ALL) initiative led by the United Nations, which, among other things, aims to double the share of renewable energy in the global mix. Furthermore, the World Bank

[11] *Agenda de Energía, Un Desafío País, Progreso para Todos;* Mayo 2014 (Energy Agenda of the Government of Chile)
[12] IDB Geothermal Risk Mitigation Program (MiRIG)
[13] Since augmented by another $20 million, for a total of $53 million in CTF funds towards geothermal development.

through its Energy Sector Management Assistance Program (ESMAP) is spearheading the Global Geothermal Development Plan (GGDP), which aims to mobilize and channel investments through development partners into high risk drilling activities to advance and unlock the potential of geothermal green fields. Finally, the World Bank is working with KfW and other development partners to establish the Latin America Geothermal Development Facility (GDF), to channel funds towards geothermal exploration and development. Chile is expected to be a key market for the GDF, if it can reform the sector and transition towards a vibrant and sustainable market for geothermal development.

16. The ultimate objective of the project is to mobilize investments in the geothermal sector in Chile by addressing some of the key barriers described in paragraph 12. This is in line with the IDB and the CTF objectives and the project is part of and contributes to the common endeavor towards enhancing the investment environment for the geothermal sector in the country. Utilization of Chile's indigenous renewable resources will: i) contribute to meeting the growing energy demand, ii) attenuate Chile's energy supply vulnerabilities by enhancing energy security, iii) promote environmentally sustainable development by reducing local pollution, iv) mitigate global GHG emissions and help the country in meeting its goal in this regard, v) help stabilize and reduce long-term electricity prices that will contribute towards further boosting the country's economic competitiveness and ease burdens on residential consumers, and vi) promote investments in remote rural areas where poverty is more concentrated.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

17. The development objective of the Technical Assistance for Sustainable Geothermal Development project is to assist the Government of Chile (GoC) in resolving specific barriers to improve the geothermal energy market conditions. By addressing key legal, social and market barriers, this technical assistance will contribute to the development of commercializeable geothermal resources.

Project Beneficiaries

18. There are a number of beneficiaries from the proposed project. Primarily, energy consumers in Chile stand to benefit through this project as lower and more stable energy prices along with utilization of geothermal for alternate purposes. These benefits will accrue to business, industries and residential consumers. In addition, those living in project areas, including those who are of indigenous origin, will also benefit from industrial services, employment and better connectivity, other co-benefits associated with sector development; and from greater awareness that would enable them to influence the sector. Greater utilization of clean energy in Chile will also have largely positive environmental impacts that will lead to local and global benefits in terms of reduced pollution and GHGs.

PDO Level Results Indicators

19. The successful achievement of the development objective of the proposed project will be evaluated through the following indicators:

- Strengthened legal and policy framework based on issuance of law and/or revised policies
- Establishment of a framework for mobilizing risk capital towards geothermal exploration
- Greater exploration of geothermal resources through the drilling of wells

III. PROJECT DESCRIPTION

A. Project Components

20. The proposed project forms a complementary part of a package of initiatives being undertaken by the GoC with the assistance of development partners through CTF support. As previously noted, the CTF has approved Chile's revised Investment Plan, which allocated a total of $53 million[14] in funding towards a concerted and catalytic effort to advance geothermal development in Chile to begin to exploit its large estimated potential. The private sector arm of the IDB will be channeling $50 million combined with its own financing to support at least two geothermal projects that have advanced exploration through slim hole or full diameter drilling towards resource confirmation. For this effort to succeed, it will be important to bolster existing market conditions so that developers can make immediate investments with confidence in early stage geothermal development. Therefore, it is vital that some of the key barriers with the policy framework and concession management are simultaneously addressed while attempting to catalyze investments. This would kick start the geothermal program. These reforms should also help prepare the groundwork beyond the initial stage of riskier resource confirmation. Consideration should be given to the investment climate necessary for the multiple stages that encompass the full development of geothermal operations from surface reconnaissance through to operating power plants, with a view towards the progressive scale-up of development of the sector sustainably over the long-term. It is with these intentions that the GoC has requested the World Bank to bring to bear its' global experience to assist the GoC undertake a number of key reforms. The aim is to improve the market conditions and facilitate greater immediate as well as long-term investments in the sector, so that geothermal can eventually become a key pillar in a diversified power generation mix. CTF funding of $3 million has been allocated to support these key policy, regulatory, institutional, and market reforms to promote sector development. Given the importance of this work, the GGDP managed by ESMAP has agreed to provide an additional $500,000 in Bank executed trust fund support for the proposed project.

21. The proposed Technical Assistance for Sustainable Geothermal Development project will entail a number of activities designed to address immediate sector bottlenecks and also develop the market conditions for mobilizing scaled-up and sustained investments in geothermal development. The World Bank through the proposed project will advise the GoC in designing strategies and identifying specific solutions informed by international experience to address the key barriers to geothermal development in the Chilean context. The proposed project will also help strengthen GoC's capacity to oversee and manage the development of geothermal and support the implementation and operation of the identified reforms. The activities in the proposed project will be carried out under the two components summarized below with the intention of comprehensively addressing several key barriers to geothermal development in Chile. A more detailed description of the project components and activities are included in Annex 2.

22. **Component 1- Improve policy framework and strengthen management capabilities to help mobilize investments in geothermal (Total $2,650,000, of which ESMAP $250,000; CTF $2,050,000; GoC in-kind $350,000).** This component will assist the GoC in addressing potential legal, regulatory and administrative burdens that are undermining market confidence and hampering the development of the geothermal sector. The goal will be to debottleneck some key constraints that have prevented investments from being mobilized into the substantial number of geothermal concessions that are in place.

(a) *Review and reform geothermal concession management framework*: A significant number of geothermal concessions remain in place with limited or no investments being made in

[14] The initial reallocation of funds for geothermal development was $33 million in November, 2013, but this amount was later augmented with an additional $20 million from the CTF private sector window as a part of the GGDP; for a total allocation of $53 million.

exploration. To address this bottleneck, the geothermal concession regime including its eligibility criteria, terms and obligations, compliance and oversight, monitoring and evaluation procedures, and transparency and information dissemination aspects will be reviewed and necessary reforms identified. Subsequent support will be provided to the GoC to implement key revisions to the concession management framework.

(b) *Enhance legal and regulatory framework*: A comprehensive review will be carried out on the present Law on Geothermal Energy Concessions (No. 19,657) and its implementing regulations as well as other related policies and regulations that impact geothermal development; with the aim of identifying key shortcomings that are contributing to the slow pace of investments in geothermal development. Modification will be made through revisions to the appropriate legal and regulatory instruments in order to create incentives and provide greater certainty for investing in the sector. Revisions will be sought in related policy frameworks that are identified as being critical to the successful development of the geothermal sector.

(c) *Capacity building and institutional strengthening*. Given the nascent state of geothermal development in Chile, there is limited capacity within MoE to support the evolving needs in developing and overseeing the sector. Therefore, the project will mobilize specialist with global expertise in geothermal development, including a full-time Technical Advisor, who will work with MoE to enhance its institutional capacity. Additionally, the MoE will be supported from global geothermal specialists associated with the World Bank, on an as-needed basis to meet evolving sector needs. This pool of experts will cover a broad spectrum of expertise, including legal, technical (exploration, drilling, power), economic, financial, social and environmental areas. There will also be a provision for ad-hoc, just-in-time support in order to address unanticipated issues, providing sufficient flexibility in mobilizing international expertise in support of the proposed reforms. The overall CTF Grant is being administered by the World Bank. An administrative fee (Multilateral Development Bank - MDB fee) of 5% of the Grant amount, (US$ 140,000), will be used to cover the costs for this administration, such as Project Management, Procurement, Financial Management and Safeguards supervision.

(d) *Stakeholder engagement to address social and environmental considerations of geothermal development.* A stakeholder engagement strategy, informed by a Social Assessment, will be developed to increase knowledge and awareness of geo-scientific, social and environmental aspects of geothermal development among stakeholders, including indigenous communities, and to improve engagement with affected communities. Activities will include, inter alia, facilitating knowledge exchange, the development of communication materials and guidance notes and the strengthening of consultation processes through facilitating independent expertise to stakeholders.

23. **Component 2 – Enhance market conditions for promoting sustainable development of the sector (Total $1,400,000, of which ESMAP $250,000; CTF $950,000; GoC in-kind $200,000).** The sustainable, long-term development of geothermal would depend on successfully facilitating the multi-stage development process from exploration to power plant operation. Therefore, in order to scale-up and sustain development, it will be important to continue to mobilize risk capital beyond the support of CTF, expand the overall market size of the sector to achieve economies of scale, and better integrate geothermal into the overall power sector in Chile. Component 2 undertakes several key reforms with an eye to the longer-term, sustained development of the sector. These activities include:

(a) *Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling.* Design and preparation of a geothermal risk mitigation framework, based on successful international experience, and customizing that framework for implementation under the specific circumstances in the Chilean geothermal and energy markets. It

will identify the most suitable ways in which risk capital can be mobilized towards early stage drilling, and help design an incentive framework to catalyze developer action in line with the GoC development goals. The proposed project will also support the establishment of the geothermal risk mitigation framework. The IDB developed a program (MiRiG) which will support at least two specific projects with the objective of providing initial demonstration over the technical, financial and commercial viability of this technology in Chile, while this proposed project will address the broader scheme, benefitting the geothermal sector, in Chile, as a whole.

The Geothermal Risk Mitigation Program (MiRiG)

The Geothermal Risk Mitigation Program (MiRiG) is part of the CTF geothermal support to Chile to scale-up investments in geothermal development. Approved in April 2014, it was designed by the IDB in consultation with the Ministry of Energy of Chile to support geothermal projects during the high-risk drilling phase, with the objective of stimulating additional investment in the sector, which will in turn eventually lead to the construction of Chile's first geothermal projects. Currently, US$47.7 million in CTF resources are available to support geothermal projects, which can be structured as short-to-medium term loans or guarantees, as well as long-term project finance debt, depending on the particular risk and cost barriers of each project. MiRiG is expected to contribute to the development of approximately 100-150 MW of installed capacity. Following a preliminary review conducted by the IDB of the most advanced geothermal projects in Chile, four projects are presently being considered for support, with two expected to be selected to participate in the first round of MiRiG funding. Financial closure of at least one of them is expected towards the end of 2015. The proposed technical assistance project supported by CTF and ESMAP funds by the World Bank will complement MiRiG by addressing some of the key shortcomings developers face in the sector. In turn, the experience of MiRiG will also create a feedback loop and inform the design of a Risk Mitigation Framework for Geothermal that is being developed by the GoC with the support of the World Bank for the sustained expansion of the sector.

(b) *Integration of geothermal power in the broader power market in Chile.* There is a need to rationalize the scale and time frame for geothermal expansion in Chile; and ensure that the power markets in the country can adequately integrate geothermal into the respective systems. This is essential in order to provide sufficient incentives for geothermal developers to invest through the multiple stages of upstream and downstream development. This activity will carry out a comprehensive analysis of the two large power markets in Chile, its bidding and PPA conditions, potential non-rewarded externalities of geothermal and social justification for deploying an incentive framework and propose incentives for expanding geothermal development that is commensurate with the development goals of the country. The proposed project will help the GoC implement the selected reforms in order to promote geothermal development.

(c) *Design of a strategy to enhance geothermal competitiveness in the long term by exploring synergies with alternate uses and related domestic sectors.* Based on the few fields where there has been drilling, there is evidence that initial investments in geothermal can be costly on a financial basis. This is especially the case with drilling, particularly due to the rugged terrain, limited duration of drilling due to weather conditions, and the remote location of many sites. There may be existing industries in the country that can suitably provide services at lower costs, if they are sufficiently developed to support geothermal development. Combining other purposes, such as direct use of low and medium enthalpy geothermal, can also enhance the overall viability of geothermal projects by taking advantage of co-benefits of the technology. An industrial analysis and a study on the uses of low and medium enthalpy geothermal will be carried out with a view to identifying necessary approaches and incentives that may be required to promote such activities in order to expand geothermal markets and capture the benefits of cost reductions and greater economies of scale. Such efforts will contribute towards transforming the current nascent geothermal sector into a robust one over time.

B. Project Financing

Instrument

24. The proposed project will be funded by two grants totaling $3.5 million. The grants include $3 million from CTF and $0.5 million from ESMAP's GGDP. The ESMAP GGDP grant and part of the CTF grant will be executed by the World Bank, to directly provide advisory support by mobilizing various international expertise based on its global experience with geothermal development. Part of the CTF grant will be executed by the MoE where the GOC is well placed to directly secure expertise in support of its reform program. The CTF and ESMAP funds that are directly executed by the World Bank will be front-loaded within the project, as the GoC will rely on the World Bank's global experience to develop strategies and identify key solutions that can be implemented within the context of Chile. While the GoC executed CTF funds will also be activated at the same time, part of its disbursements will be back-loaded in the overall project to be available to support the important implementation and operation of the reform. A more detailed breakdown of the different uses of the two grants are included in the detailed description in Annex 2.

Project Cost and Financing

25. The following table provides a breakdown of costs per project component:

Project Components	Project Costs	Funding Sources (US$ millions)			
		ESMAP	CTF		GoC*
		WB executed		*GoC executed*	
1. Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal.	**2.65**	0.25	0.72	1.33	0.35
2. Enhance market conditions for promoting sustainable development of the sector.	**1.40**	0.25	0.50	0.45	0.20
Total Project Costs	**4.05**	**0.50**	**1.22**	**1.78**	**0.55**

* GoC contribution will be in-kind.

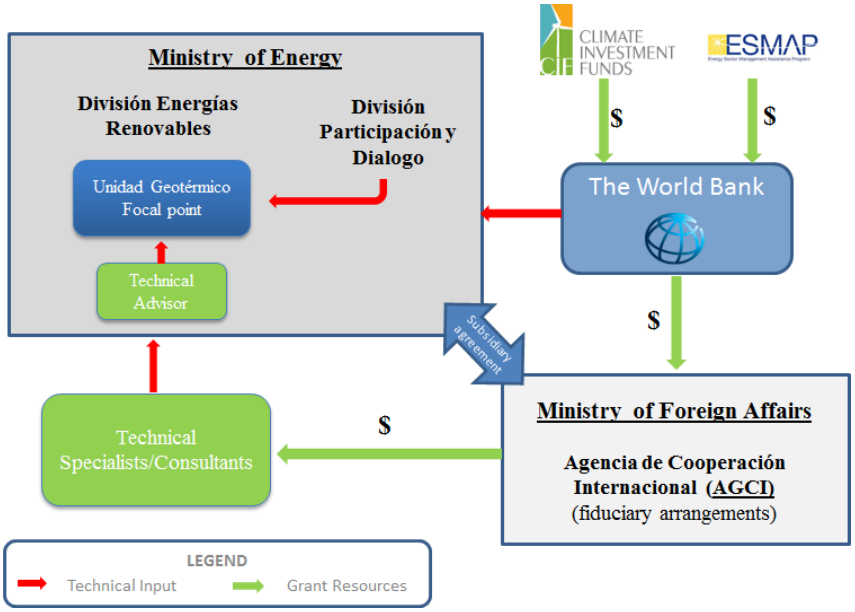
IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

26. The project will be jointly implemented by the GoC and the World Bank. The GoC has requested the World Bank to directly execute (i.e. Bank executed) advisory activities where they are seeking the World Bank's global experience in the sector, especially during the early part of the proposed project where they are keen to identify best-practice solutions. Many of the follow-on activities and those that focus on preparation and implementation of policy as well as sector oversight initiatives will be executed directly by the GoC (i.e. client executed); much of it beginning during the second year of project implementation.

27. Within GoC, the lead implementation agency regarding technical matters, overall oversight of the project as well as day-to-day supervision will be the Ministry of Energy (MoE); while the recipient of the funds along with fiduciary responsibilities will be with the Agencia de Cooperación Internacional (AGCI)

within the Ministry of Foreign Relations. A Subsidiary Agreement is expected to be signed between AGCI and the MoE outlining their respective obligations and arrangements for the proposed project. Both MoE and AGCI have prior experience working with the World Bank, and a similar arrangement is currently in place for implementing the grant funds for the ongoing Program for Market Readiness (PMR).



28. The specific institutional roles for implementing the project are as follows:

(a) Ministry of Energy (MoE): Given its mandate and organizational structure, the MoE is well positioned to oversee the overall implementation of the technical activities included in the proposed project; engage various stakeholders in consultations and implementation; and directly implement the client-executed activities. Within the MoE, the proposed project will be implemented under the Directorate for Renewable Energy's Geothermal Unit. In addition to their specialized staff, the Geothermal Unit would secure the services of an experienced Technical Advisor, who will coordinate the mobilization of other specialists required to carry out specific tasks. The Geothermal Unit will also coordinate very closely with the MoE's Division for Participation and Dialog, who oversee the social aspects of the sector including the stakeholder consultation and engagement with indigenous peoples. The MoE's specific tasks and responsibilities will include: (i) identifying the specific scope of work necessary for carrying out specific project activities and selecting appropriate specialists (in coordination with AGCI) to assist them on client-executed tasks; (ii) preparing project's budget, operational annual plan and procurement plan in coordination with AGCI; (iii) reviewing/approving products/services before authorizing payments; and (iv) controlling and monitoring of overall project implementation.

(b) Ministry of Foreign Relations: As the recipient of the funds, the Agencia de Cooperación Internacional (AGCI) within the Ministry of Foreign Relations, will execute the client-executed part of the grant funds and carry out all related fiduciary functions. AGCI will coordinate all of its activities related to the proposed project with MoE. The specific responsibilities of AGCI include: (i) managing the Designated Account and a local currency account to process payments; (ii) processing and recording project transactions; (iii) managing procurement and contracting processes; (iv) preparing and submitting withdrawal application requests; (v) preparing annual and interim project financial statements; and (vi) coordinating audit reviews. Details of its main duties and responsibilities will be specified in the Project Operational Manual

(c) The World Bank: The World Bank will be responsible for deploying the funds from ESMAP and CTF; implementing the Bank-executed advisory activities; and provide implementation support for the client-executed aspects of the proposed project. The World Bank, will establish the necessary trust funds to channel the ESMAP and CTF funds; and transfer the client-executed CTF funds to the GoC on the basis of a grant agreement. The World Bank, in consultation with MoE, will also deploy expertise through international and local specialists to provide the advisory services designated for Bank-execution, towards achieving the objectives of the proposed project. It will also carry out project implementation support missions at least once each year to evaluate the overall implementation of the proposed project. The World Bank will also liaise with ESMAP and CTF on behalf of GoC with regards to the proposed project.

B. Results Monitoring and Evaluation

29. The MoE Focal Point is responsible for overall day-to-day supervision of the implementation of the project tasks and will be also responsible for the overall collection of data and reporting on the progress of the project. The World Bank team will provide support to the GoC for the execution and implementation of the Grant activities as needed.

30. Project monitoring and evaluation will include the following:

(a) *Project Results Framework:* PDO and Intermediate Results Indicators as contained in Annex 1.
(b) *Status Reports*: The Geothermal unit will prepare status reports on the progress of their Grant activities. The form, content and periodicity of this reporting will be determined in the Operational Manual. The goal of status reporting is to ensure timely support and feedback from the Bank on the activities outlined in the Grant Agreement.
(c) *Completion Report*: Implementing Countries are required to prepare a completion report to ensure objectives outlined in Grant Agreement are met and that there is a plan for their sustainable continuation.
(d) *Financial Statements*: Implementing Countries are required to prepare financial statements that reflect the operations, resources and expenditures related to the activities detailed in the Grant Agreement. Periodic, independent auditing of financial statements will be included in the Grant Agreement.

V. KEY RISKS AND EXPLANATION

A. Systematic Operations Risk-rating Tool

Risk category	Rating
1. Political and Governance	L
2. Macroeconomic	M
3. Sector Strategies and Policies	S
4. Technical Design of Project or Program	M
5. Institutional Capacity for Implementation and Sustainability	M
6. Fiduciary	M
7. Environment and Social	M
8. Stakeholders	S
OVERALL	**M**

B. Overall Risk Rating Explanation

31. The development of market conditions to facilitate investments in a nascent sector will always include a certain degree of risk. This is the case for geothermal development in Chile. However, the proposed project attempts to directly address some of these risks while the complementary activities carried out by IDB through CTF also play an important role. As such, the overall risks of the project, including, the key ones highlighted below, are manageable

- Cost and risks of geothermal. A particular set of risks are related to the costs and risks with geothermal development. The inherent resource risks are a barrier with all geothermal developments, and the nascent state of the market in Chile exacerbates this uncertainty. The CTF supported work through IDB's investment support and the preparation of a risk mitigation framework is directly designed to address this key constraint in a manner commensurate with Chile's geothermal development goals. There is also some concern that the financial cost of geothermal in Chile could be high, eroding its competitiveness with other technologies. This is substantiated by initial evidence that suggests drilling costs in Chile are considerably higher than in other countries, primarily due to accessibility, terrain, challenges to mobilizing rigs, and accessibility to remote locations. Some of these risks would be reduced as the market progressively develops. The proposed project also looks to enhance the long-term competitiveness of the sector by exploring compatible domestic industries and promoting projects that utilize geothermal beyond power generation. Finally, the GoC has begun to reconcile some of the environmental externalities that can cause alternate technologies to be more competitive on a financial basis, including through the carbon tax; which will lead to environmentally friendlier options such as geothermal being more competitive.

- Adequacy of policy and regulatory framework to mobilize investments in the sector. The previous policy measures that were undertaken by the GoC managed to attract many developers, yet the investments that followed in sector development were limited and not

widespread. The same risk could be present in the next round of reforms, especially given that there is a need to resolve some of the impasses with existing concessions. The upcoming reforms by the GoC will benefit from the World Bank's global experience and other international expertise, which they can access through the proposed project. The proposed project is also designed to help the GoC ensure that the policy and regulatory framework will not only promote upstream development of geothermal, but better integrate the sector in the electricity market, providing a long-term incentive for developers to enter and invest in the market. Chile's already attractive overall investment climate will also be a key feature that will appeal to investors to enter the market by investing in the sector.

- Environmental considerations and social acceptance. Geothermal development could also run into civil society opposition similar to what the hydropower sector is facing in Chile based on environmental and social concerns. The recent well blow-out at the El-Tatio geothermal field that stopped development at the site is only likely to contribute to potential concerns. It is in anticipation of this specific risk that the GoC has included activities within the proposed project to raise greater awareness within communities, and ensure that developers are well informed about compliance requirements and that concerns of local communities are addressed in advance so that geothermal can be developed in Chile in a sustainable manner.

- Unanticipated reform requirements. A reform of this nature, while it has a clear set of activities that is commensurate with its overall objective, is almost certain to present unanticipated challenges that will require adjustments in order to keep the reforms on track. This is particularly the case due to the nascent state of the sector in Chile with many new developers that are new entrants to the domestic geothermal market. In anticipation, the project will be designed to be flexible and responsive to emerging needs so as to maintain focus on the overall development goal of the country.

32. While a reform of this nature will always be challenging to implement and make sure it takes hold in a sustainable manner; the actual design of the proposed technical assistance is straight forward to implement, selective in areas of focus, and can be adapted to meet evolving needs. Therefore, there is very moderate risks to the implementation of the selected activities.

VI. **APPRAISAL SUMMARY**

33. The proposed project is designed to provide technical assistance to the GoC to address barriers whereby market conditions will be improved for developing geothermal resources in Chile. Since the implications and the impacts of addressing the identified barriers are indirect and far reaching, a typical cost-benefit analysis is not an appropriate instrument to evaluate the proposed project as impact are difficult to measure at a practical level. However, the World Bank, with the assistance of specialists who have experience in geothermal, financial markets, the development circumstances in Chile, and environmental and social safeguards have carried out due diligence on the project design, confirmed that the identified barriers are appropriate, and indicated that the overall activities proposed as reforms are consistent with industry practices and meet international standards. It is also noted that the proposed project includes sufficient flexibility to meet evolving needs and circumstances in the sector, and can dynamically respond to address most challenges that cannot be anticipated at present, but may arise during implementation.

34. Some of the key barriers that the proposed upstream TA project will help address, include those that indirectly have bearing on social and environmental management issues relating to the geothermal resource exploration and power generation. Therefore, the World Bank Environment and Social Specialists will review Terms of Reference (ToRs) for all studies prepared as part of the proposed project, to ensure that all environmental and social concerns related to geothermal exploration in Chile are adequately addressed. A Social Assessment will be prepared to ensure that potential downstream positive and adverse impacts on Indigenous Peoples are evaluated and to ensure that technical advice provided under this project is consistent with the principles of the OP 4.10 policy.

35. Downstream geothermal activities are regulated by existing country guidelines (including but not limited to the *Guía para la Evaluación de Impacto Ambiental de Centrales Geotérmicas de Generación de Energía Eléctrica,* prepared in 2012, which serves as a guideline for Environmental Impact Assessment for geothermal energy generation and is generally consistent with the World Bank Group Environment, Health and Safety (EHS) Guidelines on Geothermal Power) and legislation referenced below, will be used as a basis. Environmental evaluation of the majority of infrastructure projects is managed by the *Servicio de Evaluación Ambiental*, an agency that is based within the MMA, (*Ministerio de Medio Ambiente*). The procedure followed in determining the requirement for a full Environmental Impact Assessment is largely in line with OP 4.01, with the one exception that project alternatives are not explicitly considered within the scope of the EIA. However, given that the development of geothermal energy is entirely linked to the existence of the resource in a specific location, the project alternative would be not to proceed with development of the project.

Annex 1: Results Framework and Monitoring

Chile: Technical Assistance for Sustainable Geothermal Development Project

Project Development Objective (PDO): The development objective of the Technical Assistance for Sustainable Geothermal Development project is to assist the Government of Chile (GoC) in resolving specific barriers to improve the geothermal energy market conditions. By addressing key legal, social and market barriers, this technical assistance will contribute to the development of commercializeable geothermal resources.

PDO Level Results Indicators*	Core	Unit of Measure	Baseline	Cumulative Target Values**				Frequency	Data Source/ Methodology	Responsibility for Data Collection	Description (indicator definition etc.)
				YR 1	YR 2	YR3	YR 4				
Indicator One: Greater exploration of geothermal resourcess through the drilling of wells	☐	Number of commercial wells drilled	7			9-10	11-13	Yearly	MoE/Geothermal Developers	MoE	New geothermal wells that are drilled by developers indicating improved market conditions for investment in sector
Indicator Two: Submission of law and/or revised policies necessary for providing greater regulatory clarity to investors	☐	Yes/No	No new law/policy issued	Draft prepared	Submitted for approval			Yearly	MoE	MoE	Indicates strengthened policy and regulatory framework necessary for developers to proceed with field development
Indicator Three: A Framework designed to mobilize risk capital towards geothermal exploration	☐	Yes/No	No mechanism for geothermal risk mitigation	Draft Framework prepared	Framework issued	Framework under implementation		Yearly	MoE	MoE	Architecture in place to catalyze risk capital towards mitigation of risks associated with early stage geothermal development
INTERMEDIATE RESULTS											
Intermediate Result (Component One): Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal											
Indicator One: Review and recommendation report for geothermal concession framework	☐	Yes/No	No	Completed				Yearly	MoE/Bank	MoE	Review to determine existing bottlenecks in concession framework, in order to inform reforms to policy and regulatory framework
Indicator Stakeholder Awareness consultations held	☐	Number	0	1	2			Yearly	MoE	MoE	Consultations carried out to better inform affected people regarding geothermal development including environmental and social aspects
Intermediate Result (Component Two): Enhance market conditions for promoting sustainable development of the sector											

Indicator Study on integration of geothermal in electricity market completed	☐	Yes/No		Draft prepared	Study completed			Yearly	MoE	MoE	Study to evaluate bottlenecks in power market that specifically impact geothermal development, in order to identify solutions to address barriers
Indicator Two: Recommendation made for risk mitigation solutions based on global solutions tailored for Chile	☐	Yes/No		Draft prepared	Completed			Yearly	MoE	MoE	Design of risk mitigation framework to facilitate sustained mobilization of funding especially towards early stage geothermal development
*Indicator Three***:** Study on alternate uses of geothermal in Chile	☐	Yes/No		Report drafted	Report finalized			Yearly	MoE	MoE	Identify alternate uses for geothermal energy in Chile

Annex 2: Detailed Project Description

Chile: Technical Assistance for Sustainable Geothermal Development Project

1. The sections in this Annex provides a detailed descriptions of the proposed project's components and major activities. It is important to note that, while specific activities can be discreet, there are interconnections amongst activities, which, when brought together, are expected to significantly enhance the market conditions to better facilitate investments in the expansion of the geothermal sector in Chile. It is also worth noting that, while the key barriers that are identified have been confirmed, a reform of this nature especially in a nascent industry will require flexibility in design as the specific needs and solutions are certain to evolve as the sector and the proposed project progresses.

2. **Component 1- Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal.** This component will assist the Government of Chile (GoC) in addressing potential legal, regulatory and institutional challenges that are hampering the development of the geothermal sector. The assistance will be provided through the following four key activities:

3. *C1.1. Enhance legal and regulatory framework for geothermal development:* The current Law on Geothermal Energy Concessions was passed in December 1999 and was developed primarily around the legal framework for the mining and extractive industry. While there is an extractive nature to geothermal, it requires a distinctly different policy framework for successful development. This is partly reflected in the facts that: (i) investments have been mobilized in only a very limited number of fields over the past fifteen years; (ii) there is no installed geothermal generation capacity to date in Chile; and (iii) scant efforts to develop alternate uses including low and medium enthalpy resources. Therefore, a review and reform of the legal and policy framework is critical to provide greater certainty for investors towards advancing geothermal development, and thus is a key item in the GoC's Energy Agenda.

4. An important element of the reform will be to first, and foremost, rationalize the scale and timeframe for expanding the geothermal sector in Chile and develop consensus around these objectives so that any modifications to the legal and policy framework is commensurate with these policy priorities and goals. This vitally important consensus building will be informed by several other activities, such as the *integration of geothermal in the power market*, as well as global and regional experiences that may be applicable in the context of Chile. The activity will also include a comprehensive review of the present Law on Geothermal Energy Concessions (No. 19,657), its implementing regulations and other related policies that impact the development of the geothermal sector. This would enable the identification of gaps and inconsistencies within the legal framework, given the GoC's overall geothermal development objectives leading to the design of the reforms necessary to address these shortcomings. Depending on the legal reforms sought, the GoC would then carry out additional intergovernmental and broader stakeholder discussions to obtain feedback, as well as generate consensus around the proposed changes. The GoC will then proceed to drafting the new legal framework including any new/revised laws with the support of the proposed project. There will be a final round of discussions and consultations that will be supported through the proposed project prior to the revised legal framework being submitted to Parliament for final approval. On the basis of the approved legal framework, the GoC will then develop the regulatory framework and secondary instruments such as permits, licenses, warrants, etc., whose design and implementation the proposed project will support.

5. While the proposed review will include various associated legal and regulatory requirements in other sectors that impact geothermal development, a particular area of focus will be the environmental and social obligations for geothermal developers. It is common for inconsistencies to arise between laws across sectors, or some obligations to not be adequately incorporated in nascent sectors such as geothermal.

Existing guidelines in Chile for Environmental Impact Assessment for geothermal energy generation (including the Guía para la Evaluación de Impacto Ambiental de Centrales Geotérmicas de Generación de Energía Eléctrica, prepared in 2012) is generally consistent with international standards and the World Bank Group EHS Guidelines on Geothermal Power. Nevertheless, a gap analysis will be carried out comparing domestic requirements with international standards, which will form the basis for follow-on reforms that is expected to be supported by the project. This work will complement and also benefit from the related activity on *stakeholder engagement and awareness raising.*

6. The revised legal and regulatory framework will create greater legal certainty for developers as well as GoC, improve market conditions, and enhance investor confidence in the geothermal sector in Chile. An improved concession regime will reduce costly delays and high transaction cost faced by qualified developers, and also provide a legal basis for GoC to managing the concessions to ensure progress towards its development goals. The reforms of associated sectors that impact geothermal, in particular to ensure good-practice in environmental and social considerations, as well as to eliminate cross sectorial inconsistencies, will facilitate overall development of the sector and enable developers to invest with confidence in geothermal.

7. *C1.2. Review and reform geothermal concession management framework*: The GoC had at one time issued over one hundred concessions to various developers, which has now been whittled down to 31 active ones. Many of them saw little or no investment mobilized, while development rights were relinquished by developers in other sites. While the responsibility for overseeing the concessions rests with MoE, it has had limited capacity to monitor and manage developers' obligations, taking corrective actions as necessary to maintain progress towards its goals. Therefore, in order to scale-up investments across a wide array of existing and potential new concessions, it has become vital to review and reform the geothermal framework and the capacity necessary to manage it in the context of the legal reform to the concession law described in the previous activity.

8. This activity is designed to evaluate the existing management framework for granting and overseeing the geothermal concession system, compare its suitability given the revised legal framework, identify shortcomings commensurate with GoC's goal, and design and help implement necessary reforms so that investments can me mobilized towards developing commercializable geothermal resources in Chile. It will entail the evaluation and potential reform of: *(i) the eligibility criteria,* to ensure fairness and effectiveness in the process for granting concessions (i.e. concessions will be awarded to the most qualified applicant, through a transparent and standardized process); *(ii) the existing process to evaluate concession applications/bids,* with special focus on the technical capacity, the understanding of the geothermal developmental process, and the financial capability perspectives; *(iii) the milestones for exploitation concession,* to address the GoC's well-placed concern that the concessionaires make the best use of the geothermal resources, including the proposal of regulatory enforcement tools to compel the concessionaires to meet certain milestones in order to retain its concession rights; *(iv) the available governance tools to enforce policy*, like fees, taxes, regulations and bonds, examining the possibility of enforcing fees for the use of geothermal resource land or security in the form of bonds or letters of credit to assure that the concessionaire is motivated to perform in a timely fashion without dampening investment motivation; *(v) the grants of concessions*, the rights these concessions grants and what it must do to maintain them throughout the period of any concession, as well as the requirement for the holders of concessions to obtain secondary permits from various governmental agencies at the local, provincial and national levels; *(vi) the governmental monitoring process of concessions* in its two-fold purpose of creating an environment conducive to renewable resource project development, as well as a police role in ensuring that concessionaires are complying with the spirit and the letter of regulations, recommending substantive improvements, if appropriate; *(vii) the internal monitoring procedures,* ensuring that there is adequate personnel capacity in the government to digest and regulate the information flow between the concessionaire and the government; *(viii) the online-based information system,* with a threefold approach:

a developmental outreach function that informs prospective investors of opportunities, an educational function that informs the general public as to the scientific nature of geothermal resources, as well as the policy, regulatory, financial, environmental and economic issues that underlie the governmental policy of developing the country's geothermal resources, and to facilitate the exchange of information between the public and the governmental sectors.

9. *C1.3. Capacity building and institutional strengthening:* The MoE which is mandated with overseeing the development of the geothermal sector in Chile, relies in its Renewable Energy Directorate to manage the sector. A dedicated Geothermal Unit has been established, but operates with limited capacity and geothermal development experience given the nascent state of the sector in the country. The MoE has made considerable efforts to bolster its capacity, including training and participating in international initiatives, such as the Global Geothermal Development Plan. The mobilization of CTF funds is another effort through which the MoE proposes to strengthen its capacity in key areas related to geothermal development so that it can benefit from international experience and apply industry standards to the development of the sector in Chile. This strengthened capacity will be vital, especially during the upcoming years where the GoC is making a concerted effort to reform the sector and advance development. The support provided by the proposed project will be as follows: a) a Geothermal Technical Advisor with in-depth knowledge of the sector and international experience to help guide the MoE's reform program, liaise with developers and related industry groups, assist with the management of the concession framework, provide quality control for the technical and analytical work carried out under the proposed project, help coordinate activities with various stakeholders, and provide project implementation support as necessary; b) deployment of specialists to provide specific expertise related to particular areas of reform that will include a spectrum of subject areas, such as technical (including geothermal resources, drilling expertise, power engineering), economic (including policy and regulatory), financial (including deal structuring and project finance), and environmental and social areas (including gender and indigenous peoples); and just-in-time assistance that will be deployed to provide expertise to the MoE on an ad-hoc basis to address evolving reform needs in a flexible manner. The deployment of specific specialists and just –in-time support will be provided through a combination of experts hired directly by the MoE and direct advisory support by the World Bank, given its global experience with geothermal development. It is expected that the assistance provided by ESMAP and CTF support will strengthen the MoE's capacity during the crucial years of implementing major reforms, and also transfer knowledge for the longer-term sustainable management of the sector as it is scaled-up.

10. The overall CTF Grant is being administered by the World Bank. An administrative fee (Multilateral Development Bank - MDB fee) of 5% of the Grant amount, (US$ 140,000), will be used to cover the costs for this administration, such as Project Management, Procurement, Financial Management, Safeguards supervision.

11. *C1.4. Stakeholder engagement to raise awareness regarding geothermal development taking into account environmental and social considerations:* An evolving legal and regulatory framework on indigenous communities' rights to consultations and benefit-sharing, as well as negative public perceptions of the environmental risks related to it, have been identified as contributing to slow progress in the sector. For geothermal energy to become a socially and environmentally sustainable source of energy in Chile, a better understanding of the social and cultural context, improved stakeholder engagement at national, regional and local levels, and a practical application of regulatory requirements will be required. This subcomponent focuses on two main areas.

12. The first focus-area is to develop a stakeholder engagement strategy, based on a participatory Social Assessment in which key issues, concerns and perceptions of all stakeholders, including affected indigenous communities, will be identified. The activity will review the Ministry of Energy's recent experience with community engagement and consultations, facilitate knowledge exchange with international geothermal

development projects on community engagement and consultations, and will develop practical culturally-appropriate consultation toolkits and/or guidance for different stakeholders in Chile. The activity will also develop awareness materials that address key social and environmental concerns from both a geo-scientific and engineering perspective and from the cultural and socio-economic context in which geothermal will be developed. It will develop a platform for systematized citizen feedback and monitoring of public perceptions.

13. The second focus-area is to build the capacity of the Ministry of Energy and Indigenous Communities in particular on the consultation processes. This activity will include (i) strengthening the Ministry of Energy's capacity to support and accompany the consultation process from an early stage, and (ii) facilitating indigenous communities to build their own capacity with independent experts on geothermal energy, consultation mechanisms and social and environmental impacts.

14. All TA activities, recommendations, and advice of the component 1 will be consistent with the objectives and requirements of all World Bank environmental and social safeguard policies – including with OP 4.10 on Indigenous Peoples. The Bank will review Terms of Reference (ToRs) for all studies prepared as part of the Project, and will also review the resulting documents, to ensure that all environmental and social concerns related to geothermal exploration in Chile are adequately addressed.

15. Component 2 – Enhance market conditions for promoting sustainable development of the sector.

16. *C2.1. Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling:* Risks to developing geothermal in Chile have become a major barrier for advancing progress in the sector. These risks arise primarily due to the fact that it is a nascent market where there is no geothermal power generation capacity in operation, inherent uncertainty regarding the resource availability and its commerciality, significantly high drilling costs, and subsequent downstream off-take in the power market. If Chile is to develop geothermal as a long-term, viable renewable base load energy option, it will be vital to address these barriers, especially the ones which have demonstrated to be challenging for the private sector to handle, i.e. confirming the upstream geothermal resource availability and capacity. This will be particularly vital to advancing the large number of geothermal fields that have been concessioned, but has seen little or no activity in investments in exploration and development.

17. The goal of this activity is to develop a geothermal resource risk mitigation framework, based on successful international experience that is customized for implementation under the specific circumstances in the Chilean geothermal and energy markets. The activity will review existing global experience and also engage existing and potential investors in Chile to identify/validate specific challenges facing those looking to mobilize investments, especially in exploration and production drilling. This activity would have the benefit from global work already carried out by the World Bank in resource risks mitigation, and will also create an opportunity for information exchange and close coordination with the IDB on its CTF funded geothermal development activities to mobilize investments. These lessons and insights will inform the design of a framework for risk mitigation for the Chilean geothermal sector. Once consensus is reached around the design, subsequent work will include the development of the implementation protocols and arrangements for the risk mitigation framework and secure funding commensurate with the established goals (including coordination with the multi-partner supported LCR Geothermal Development Facility (GDF) that is expected to be in operation at the time; and the global Green Climate Fund). The proposed project will also support the initial set-up and operation of the geothermal risk mitigation framework. When successfully implemented, the Risk Mitigation Framework will help systematically facilitate the mobilization of risk capital, especially into the exploration, as well as for production drilling of highly uncertain green field developments; whereby, unlocking the resource potential in these geothermal fields in Chile.

18. *C2.2. Integration of geothermal power in the broader power market in Chile through an adequate incentive framework:* There is a need to rationalize the scale and time frame for geothermal expansion in Chile and ensure that the power markets in the country can adequately integrate geothermal into the respective systems. In general, competitive markets fail to reward positive externalities embedded in Renewable Energy technologies (RETs) or address technology specific barriers to make RETs competitively comparable. Therefore, identifying and implementing appropriate incentives that will create an "even playing field" for geothermal to complete and even flourish will be important complement to the other reforms by the GoC, since most geothermal developers' financial incentives will be strongly linked to the power sector.

19. The preliminary focus of the activity will be to carry out a detailed evaluation of the existing power market in Chile with a view to integration of geothermal under various scenarios in the future. The assessment will center around the two larger non-interconnected networks, Sistema Interconectado del Norte Grande (SING) and Sistema Interconectado Central (SIC) – which are envisaged to be the primary off-takers for much of the expected geothermal generation capacity. The evaluation will include: (i) an assessment on the supply side, including the economic levelised cost of energy (LCoE) of the existing capacity in the system, firm and variable capacity, and planned capacity additions; (ii) a medium to long-term demand analysis and forecast, including current and expected capacity gaps; (iii) analysis of maximum integration of RETs in the main networks, including a stress analysis in the most unfavorable conditions of the relevant seasons; (iv) dispatch restrictions and PPA conditions for RETs; (v) cost of spinning reserves/back-up capacity; (vi) base load capacity; (vii) system costs; and (viii) technical restrictions of the grid, considering frequency and voltage security standards and grid code. The evaluation will provide insights into the absorptive capacity for geothermal including its competitiveness in the power market under the current contracting regime in the absence of any equalizing factors. Once some business-as-usual scenarios are identified, the analysis will assess the various economic benefits including externalities that arise due to geothermal as well other generation technologies that would otherwise not be internalized in investment incentives and decision making. It will also take into account other parameters such as dispatchability, security of supply, diversification of the generation matrix, co-benefits, and reduction on oil and gas imports and impacts on the countries balance of payments. Taken together, it would provide insights into the integration of geothermal under fair competition in the Chilean power market, helping identify the financial and other constraints that limit the bankability of geothermal investments that deter expansion of the sector in Chile. The MoE would utilize this evaluation to then identify, design, and implement an incentive framework that would enhance the overall "bankability" of geothermal developments in Chile, and create a more favorable environment for investments in the sector commensurate with the GoC's development goals.

20. *C2.3. Design of a strategy to enhance geothermal competitiveness in the long term by exploring synergies with domestic sectors and medium and low enthalpy uses:* Based on the performance of the drilling activities in the few fields that have been explored, there is evidence that geothermal development can face significant logistical challenges and high financial costs. The location of most geothermal projects in the high cordillera implies dealing with complex logistics in very remote sites, and rugged terrain and harsh climatic conditions often result in limited seasonal operational timeframes. In addition, most of the equipment and services required for geothermal drilling are at present unavailable domestically in Chile and need to be imported and adapted to specific local conditions, national regulations and commercial requirements. Another factor that poses challenges for geothermal development is the relatively small size of the market. At present, even the limited funding that has flowed is primarily focused on power generation, and there is scant efforts to expand markets to other direct uses for geothermal, which can improve the economies of scale for drilling operations. Many existing developers have indicated that expanding the market where they could do year around drilling at a larger scale would help reduce the overall cost of geothermal drilling operations. This would enhance the competitiveness of geothermal and enhance project viability.

21. The primary purpose of this activity is to identify existing industries and service providers in Chile that could contribute domestically to the geothermal sector. The evaluation will be addressed towards the identification and assessment of key elements and actions needed to be articulated and stimulated to provoke the transformation/adaptation of the domestic industrial capacity to support the geothermal industry. Promoting domestic industries to provide specific services and goods required by the geothermal sector could contribute to facilitate the development and bring down cost of geothermal projects over the long-term. This benefit may be of especial relevance at early exploration phases, given the high impact of drilling on project costs when resource availability risk is still very high. The analysis will be focused on elements that could promote the creation of a national drilling industry for geothermal purposes or associated industrial sectors, such as steel or turbine manufacturers, that could adapt their products to meet the specific needs of the geothermal industry. Once industries are identified, the assessment will include an evaluation of the technical necessities and commercial incentives that could be put in place to direct the industries towards contributing to the geothermal industry with domestic products. The MoE will prepare a strategy on the basis of this work for enhancing domestic content in geothermal development, which would be implemented through a series of reforms. The proposed project will support the MoE implement the necessary reforms to create the market incentives for greater support to geothermal development by domestic industries and service providers.

22. The identification of suitable alternate applications of geothermal energy, including the use of low and medium enthalpy resources for direct uses, will be an important part of this effort. Both low-mid temperature resource uses and downstream developments of geothermal-electric projects will be analyzed. Besides the high temperature geothermal resources associated to recent volcanic areas in the high Andean Cordillera, Chile is also endowed with low-mid temperature geothermal resources, which are located in less remote and more populated regions than the high cordillera. These resources provide potentially interesting opportunities for residential and commercial space heating applications and use of geothermal heat in industrial processes. The evaluation of these opportunities require an assessment of both the potential of these resources and geolocation, and the size and location of the potential demand. This will identify and classify specific regions where an articulation of specific geothermal developments could be promoted. This assessment will provide the basis for identifying potential development options and actions required to promote direct use of geothermal heat, and help design of a strategy that MoE could implement to develop previously identified areas. The ultimate goal of this strategy would be to broaden the geothermal market and industry, and enhance viability of, and synergies with, potential power projects, by promoting multiple uses of geothermal resources.

#	Components/Key Activities	WB Direct Advisory Support		GoC implemented		Total Cost
		ESMAP	CTF	CTF	GoC In-kind	
Component 1- Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal.						
1.1	*Enhance legal and regulatory framework for geothermal development*	170,000	150,000	125,000	75,000	565,000
1.2	*Review and reform geothermal concession management framework*	-	135,000	200,000	50,000	385,000
1.3	*Capacity building and institutional strengthening*	10,000	345,000	605,000	140,000	1,055,000
1.4	*Stakeholder engagement to raise awareness regarding geothermal development taking into account environmental and social considerations*	70,000	90,000	400,000	85,000	645,000
Sub-Total		*250,000*	*720,000*	*1,330,000*	*350,000*	*2,650,000*
Component 2 – Enhance market conditions for promoting sustainable development of the sector.						
2.1	*Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling*		500,000	250,000	120,000	870,000
2.2	*Integration of geothermal power in the broader power market in Chile through an adequate incentive framework*	100,000	-	-	20,000	120,000
2.3	*Design of a strategy to enhance geothermal competitiveness in the long term by exploring synergies with domestic sectors and medium and low enthalpy uses*	150,000	-	200,000	60,000	410,000
Sub-Total		*250,000*	*500,000*	*450,000*	*200,000*	*1,400,000*
Total		**500,000**	**1,220,000**	**1,780,000**	**550,000**	**4,050,000**

Annex 3: Clean Technology Fund

Chile: Technical Assistance for Sustainable Geothermal Development Project

NOTE: The proposed technical assistance project will not directly increase installed capacity for power generation, reduce CO2 emissions, and/or leverage financing but rather help overcome barriers and develop market conditions for greater geothermal development in Chile.

Indicator	Units	I Short-Term Impact contributed to by CTF Intervention		II Scaled-up phase, with Increased Impact	
Contribution to increased installed geothermal capacity for power generation	MW	50 - 100*		250** - 800***	
Contribution to renewable energy generated annually	GWh/Yr	373 - 745		1,863 - 5,960	
Contribution to tons of GHG emissions reduced or avoided		**Low******	**High**	**Low**	**High**
- Annual	$KtCO_2e$/Yr	145	600	728	4,805
- Lifetime (Min. 30 years life)	$MtCO_2e$	4.4	18	21.9	144
Contribution to leverage financing through CTF funding	US$	251-500			
CTF investment cost effectiveness	US$/$tCO_2$	0.68	0.17		
Other Co-benefits					
▪ Enhanced energy security in the country due to utilization of an indigenous resource ▪ Expansion of domestic associated industries to support geothermal sector ▪ Local environmental benefits from lower pollution from thermal power generation ▪ More inclusive development due to better stakeholder engagement and awareness, including with indigenous peoples, at national, regional and local levels					

* Estimated installed capacity is consistent with IDB's MiRiGs program

** Estimated installed capacity by 2025 according to GoC 2014 Energy Plan

*** Potential based on estimate of 5% development of 16GW geothermal potential, consistent with the IDB's estimate

**** Low scenario: if all power plants are installed in SIC network; High scenario: if all are installed in SING network

I. INTRODUCTION

A. Country and Sector Context

1. **Chile is one of the most stable economies in Latin America with steady growth rates mainly driven by commodities export.** With almost 17 million inhabitants, and $277 billion GDP in 2013[15], the country recorded an average annual growth rate of 3.5 % while per capita income over the past 20 years has almost doubled in real terms. The effects of steady growth on employment and income have significantly reduced poverty rates, although earnings and labor productivity have been distributed unevenly. Chile's economy

[15] The World Bank

is characterized as being open and heavily dependent on natural resources and foreign trade with the mining sector accounting for 60% of the country's total exports. The industrial sector (including value added in the mining sector), which is energy intensive, and services account for 37% and 60% of the GDP with agriculture making up the rest. Despite being a mature economy, GDP growth forecasts for Chile for 2014-18 are around 4% per year, almost twice the OECD average (2-2.3%).[16]

2. **To sustain economic growth and protect the gains in poverty reduction, the energy sector will need to keep pace.** Electricity demand in Chile has been out pacing economic growth, at around 7 percent per annum, doubling every 10 years. It reflects the energy intensity that is fueling economic growth. The GoC estimates[17] that an additional 8 GW of power generation capacity along with associated infrastructure improvements are needed to meet demand. This expansion will also need to be from a sufficiently diversified mix of generation options, including renewable energy, in order to optimize system reliability and efficiency as well as produce low and reliable prices while improving the local and global environment. Recognizing the need to diversify, the Government of Chile's (GoC's) Energy Agenda established a non-conventional renewable energy (NCRE) target of 20% or about 2,500-4,000 MW by 2025. Geothermal is envisaged as an important part of this target, especially for meeting base-load renewable energy needs.

3. **Chile's abundant geothermal potential provides a good renewable energy option to further diversify the country's power generation mix, reduce price volatility, and improve energy security.** There are good indications that the entire northern and central parts of the Andes have excellent geothermal energy potential. Studies indicate that the geothermal power generation potential in Chile can be in excess of 3 GW with some estimates suggesting that the potential may be as high as 16 GW[18]. . Geothermal energy stands out among renewable energy systems for a number of beneficial reasons that address some of the key challenges facing the energy sector in Chile. In particular: i) unlike other renewable energy alternatives, such as wind and solar power, geothermal is a non-intermittent source[19] that can provide reliable base-load power on a 24/7 basis; ii) it is a clean source of energy emitting a fraction of the GHG emissions (CO_2) compared with other baseload options such as coal, and none of the local pollutants such as nitrous oxides (NOx) and sulphur dioxides (SO_2), and total suspended particulates (TSP); iii) as an indigenous and non-tradable resource, it will enhance the energy security that has been of concern in Chile; iv) once developed, it can provide stable prices and serve as a natural hedge against the volatility of other commodity-driven electricity prices; and v) it offers the potential to provide for direct applications such as heat for households (district heating), and agricultural and industrial applications.

4. **While some renewable energy technologies have increased its utilization in Chile, others such as geothermal have faced greater hurdles in scaling-up.** While most renewable energies provide intermittent supply, hydropower with storage and geothermal are technologies that are well suited for meeting base load needs. With most hydropower projects hampered by environmental concerns and many prime sites being already developed, geothermal has emerged as an important option. However, geothermal is a nascent industry in Chile with no operating power plant to date. Despite a large number of concessions being issued, very limited investments have been mobilized for developing many of these fields. There are a number of reasons for this outcome as many potential investments in geothermal are held back due to the upfront resource risks of developing green fields, clarity in the legal and regulatory framework for geothermal as well as power offtake, the relatively high costs of drilling and the modest scale of the current domestic market in the country, and more inclusive development considerations concerning environmental and social aspects of the technology. Therefore, if Chile is to develop geothermal as a viable alternate source of energy in a sustainable way, it will be important to address some of these specific key barriers,

[16] Economist Intelligence Unit, Country Report, October 2013
[17] National Energy Strategy 2012-2030
[18] IDB Geothermal Risk Mitigation Program (MiRIG)
[19] The other presently available renewable technology is hydro with storage.

so that a nascent sector can progressively scale-up towards a transformational and impactful end.

B. Chile's CTF Investment Plan

5. The GoC's commitment to clean energy development for achieving energy and environmental goals is reflected in its energy agenda; and it is taking considerable action to tap global knowledge and experience through development partner support. In this regard, Chile secured the endorsement of the Clean Technology Fund (CTF) in May, 2012 for its initial Investment Plan (IP) that included a CTF contribution of $200 million. The CTF IP proposed projects in concentrated solar power, large scale photovoltaic, and efforts to promote self-supply of renewable energy and energy efficiency. While the CTF IP was being successfully implemented, it became evident that international experience and financial support would also be needed to address barriers and develop its nascent geothermal sector as, despite issuing a large number of concessions, progress has been stymied. When GoC was able to realize a savings in the CTF IP of $33 million, it became timely to utilize the freed-up funding to support the geothermal sector. In September, 2013, the GoC submitted and secured endorsement of a revised CTF IP, which included $33 million in funds earmarked for geothermal development implemented through the Intern-American Development Bank (IDB) and the World Bank. Later, an additional $20 million was secured from CTF for the same purpose through the effort by the Global Geothermal Development Plan (GGDP) that is led by the Energy Sector Management Assistance Program (ESMAP) at the World Bank. Of the total CTF allocation of $53 million for geothermal, $50 million is allocated through IDB to facilitate financing for several geothermal projects where field exploration (drilling) is sufficiently advanced and there could be a quick impact. The GoC is seeking the benefit of the World Bank's extensive global experience in supporting geothermal development, to help implement a complementary set of reforms in parallel that would progressively address the key barriers to sector development. CTF funds of $3 million (along with an additional $500,000 from ESMAP through GGDP from non-CTF sources) are allocated towards technical assistance through the World Bank so that Chile could implement a set of reforms and strengthen its capacity in the geothermal sector that reflect accepted industry practices and meet international standards. The proposed technical assistance is expected to have an immediate impact by strengthening the existing architecture for facilitating financing from IDB and other sources for exploratory activities towards the development of commercializable steam fields; and also address barriers that will progressively enhance the market conditions for the sustainable development of geothermal in the longer-term. Taken together, it is expected to be catalytic and will contribute to a transformational outcome.

C. Project Description

6. The proposed project forms a complementary part of a package of initiatives being undertaken by the GoC with the assistance of development partners through CTF support. As previously noted, the CTF has approved Chile's revised Investment Plan, which allocated a total of $53 million[20] in funding towards a concerted and catalytic effort to advance geothermal development in Chile to begin to exploit its large estimated potential. The private sector arm of the IDB will be channeling $50 million combined with its own financing to support at least two geothermal projects that are at various stages of resource confirmation. For this effort to succeed, it will be important to bolster existing market conditions so that developers can make immediate investments with confidence in early stage geothermal development. Therefore, if GoC is to achieve its geothermal development goals, then it is vital that some of the key barriers with regards to the policy framework and concession management are simultaneously addressed while attempting to catalyze investments in existing concessions; and a participatory approach is utilized to raise awareness about this nascent industry amongst the broader population as well we potentially impacted people as a

[20] The initial reallocation of funds for geothermal development was $33 million in November, 2013, but this amount was later augmented with an additional $20 million from the CTF private sector window as a part of the GGDP; for a total allocation of $53 million.

result of future sector development. While these efforts will help kick-start the geothermal program, market conditions for sector development will need to be further and continuously enhanced in order to achieve a sustainable scale-up in the longer-term. Therefore, the activities in the proposed project will also help prepare the groundwork beyond the initial stage of riskier resource confirmation; and help support development over the multiple stages through which investments are necessary before an operational power plant is commissioned. It is with the intention of addressing the full project development cycle that the GoC has requested the World Bank to bring to bear its' global experience to assist the GoC undertake a number of key reforms.

7. The objective of the proposed project is to assist the Government of Chile (GoC) in resolving specific barriers to improve the geothermal energy market conditions. By addressing these key legal, social and market barriers, the proposed technical assistance will contribute to the development of commercializeable geothermal resources. CTF funding of $3 million has been allocated to support these key reforms to promote geothermal development. Given the importance of this work, the GGDP managed by ESMAP has agreed to provide an additional $500,000 in Bank executed trust fund support for the proposed project. Overall, it will complement the $50 million in CTF funding through IDB as well as the associated additional private financing; and beyond. At its conclusion, the aim is to determine the potential for commercializing geothermal development in Chile and contribute towards the progressive scale in order for the sector to become a key pillar in a diversified power generation mix in the country.

8. The proposed Technical Assistance for Sustainable Geothermal Development project will include a number of related activities designated under two project components. A detailed description of the project components and activities can be found in Annex 2. They are summarized below:

9. **Component 1- Improve policy framework and strengthen management capabilities to help mobilize investments in geothermal.**

a) Review and reform geothermal concession management framework:
b) Enhance legal and regulatory framework:
c) Capacity building and institutional strengthening.
d) Stakeholder engagement to address social and environmental considerations of geothermal development.

10. **Component 2 – Enhance market conditions for promoting sustainable development of the sector**

a) Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling.
b) Integration of geothermal power in the broader power market in Chile.
c) Design of a strategy to enhance geothermal competitiveness in the long term by exploring synergies with alternate uses and related domestic sectors.

Project Components	**Project Costs**	**Funding Sources (US$ millions)**			
		ESMAP	**CTF**		**GoC***
		WB executed		***GoC executed***	
1. Improve policy framework and strengthen management capabilities for mobilizing investments in geothermal.	**2.65**	0.20	0.72	1.38	0.35
2. Enhance market conditions for promoting sustainable development of the sector.	**1.40**	0.30	0.50	0.40	0.20

Total Project Costs	**4.05**	**0.50**	**1.22**	**1.78**	**0.55**

* GoC contribution is in-kind.

II. ASSESSMENT OF PROPOSED PROJECT WITH CTF CRITERIA

A. Potential for GHG Savings

11. ***Emissions Reduction Potential Contributed to by Intervention***: The combined installed capacity for Chile's two main power systems – the SIC and SING - in December 2013 was 17.6GW, and is expected to grow by 39% to about 24.4GW by 2025. In the Government of Chile's Energy Agenda for 2014, the country is committing to have 45% of the newly installed capacity come from renewable sources, so as to have 20% of the whole network come from renewable sources by 2025. Geothermal has a low emissions factor, and for calculation purposes a power plant operating capacity factor of 85% was used to estimate the GHG emissions reduction[21]. The expected operational life of the power plants is 30 years. Given that the proposed project is entire technical assistance to remove specific barriers to geothermal development, and therefore, indirectly facilitate investments in the sector, it is estimated to contribute towards the expansion initially 50 MW or more; and then could unlock geothermal potential in the longer-term that could reach 800 MW or about five percent of the higher end estimates or geothermal potential in Chile of about 16 GW. For this range, the overall GHG savings is estimated to be from a low of 4.4 $MtCO_2e$ to 144.0 $MtCO_2e$ if the higher end of the potential target is achieved. The range is even greater than expected due to the differences in the SIC and SING grids (whereby SIC is much less reliant on fossil fuels), and thus affected by two main factors: (1) the uncertainty of the location of possible plants; and (2) the significant difference in emission factors (SIC at 0.391 $KgCO_2e/kWh$ and SING at 0.806 $KgtCO_2e/kWh$). In the Government's Energy Agenda, it estimates an installed capacity of 250 MW by 2025, which would give a range of GHG savings between 21.8 $MtCO_2e$ and 45 $MtCO_2e$.

12. ***Technology Development Status:*** Geothermal is a proven technology that is commercially available around the world for both power generation as well as other uses such as heating. The directional drilling techniques that are commonly utilized in geothermal are similar to that of on-shore oil and gas exploration, although the challenging terrain in many geothermal development areas in Chile could lead to further innovation and additional lessons learned that could benefit the overall industry. While the technology is at a nascent state in Chile, a number of internationally reputable firms specializing in geothermal have acquired geothermal concessions in Chile. They could contribute significantly to the development of the sector in Chile if some of the key obstacles they are facing can be addressed, as the proposed project aims to do. In doing so, there will likely be considerable knowledge transfer that will benefit the expansion and the sustainability of the domestic market.

B. Cost-Effectiveness

13. The cost-effectiveness of the CTF intervention of USD3 million has been estimated to be between 0.68 USD/tCO_2 and 0.17 USD/tCO_2 for an installed capacity of up to 100 MW. This estimate is based on an

[21] While a plant capacity factor of 0.85 is conservative in the case of most geothermal project that often operate at over 90 percent, the assumption in the analysis reflects the nascent state of the geothermal sector in Chile and it is also consistent with the assumptions made in the IDB estimates for the MiRiG project.

expected GHG avoidance in the range of 4.4 and 18 $MtCO_2e$ depending on the grid locations of these power plants. This significant CO_2 emissions reduction would be reached through the sustainable geothermal development, as a result of the implementation of the project. In the absence of this renewable power, generation would most likely be met from fossil fuel based generating plants, not only producing more GHG emissions, but also other local pollutants such as nitrous oxides (NOx) and sulphur dioxides (SO2).

C. Demonstration Potential at Scale

14. ***Scope of the avoided GHG emissions through replication:*** The proposed project will have an immediate impact in particular through the reforms to the legal and policy framework, concession management system, and stakeholder engagement – all of which will help catalyze investments for primarily the expansion of existing concessions including the ones supported through CTF by IDB. This could lead to the reduction of anywhere from 145,000-600,000 tons of CO_2 per year depending on the grids where the power plants are located. This would be equivalent to 4.4-28 million tons on a life-time basis. However, if the reforms had long-term success and progressively improved the market conditions for geothermal development, then the related scale-up in investments help achieve the GoC's target in the Energy Agenda of 250 MW to even 800 MW or beyond. This would result in 728,000-4,805,000 tons of avoided CO_2 or 22-144 million tons of CO_2 over the lifetime of the project.

15. ***Transformational potential:*** The proposed project will have a transformational impact since it will be supporting a set of market enhancing reforms that will impact the investment climate underlying the entire geothermal sector. By doing so, it will *kick-start a nascent industry* and contribute to progressively transforming it towards a more mature, commercially viable and sustainable industry that will enhance the overall energy sector in Chile. It will support economic growth and help sustain the gains in poverty alleviation in the country.

16. *Develop new generation option for diversification of energy matrix:* The proposed project will contribute to establishing geothermal as a viable alternative in Chile's power generation mix with an additional renewable base-load option. At present, of the renewable energy technologies, only hydropower has the capability to provide non-intermittent, base-load supply, but has faced challenges to expand further. Developing geothermal as a reliable power generation source will provide greater flexibility and optimally diversify the generation mix in Chile.

17. *Informed development of a risk mitigation framework for geothermal:* The proposed project will help design a risk mitigation framework for geothermal in Chile in order to address in a sustainable way a significant up-front barrier that is being faced by developers to advance geothermal development. While the risk mitigation framework will be developed with the benefit of global experience through an international survey of different schemes and approaches, it will need to be customized to be effective in the local context in Chile. In this regard, the work that is being carried out by IDB in MiRiG with CTF support as well as the World Bank engagement in the sector will provide valuable information that will help shape and define the approach that will be implemented in Chile. This feedback loop of on-the-ground investment experience that will inform the framework designed under the proposed project will significantly improve its applicability and success in Chile.

18. *Catalyze expansion of domestic industry:* The development costs, particularly for drilling, is quite high in Chile, and a concerted effort will be made by GoC through the proposed project to identify areas within domestic industries that could be incentivized to play a larger role in geothermal development. While the high costs are due to a number of reasons, developers in Chile often need to import drilling rigs and associated services and routinely undertake costly re-mobilizations due to seasonal variation. By catalyzing greater participation of domestic industries to locally provide services associated with geothermal development, it will not only lead to improving the prospective of these associated sectors but will help

progressively reduce the cost of developing geothermal due to greater domestic content.

19. *Promote informed and inclusive development of geothermal industry:* Since the large scale development of geothermal is relatively new in Chile and operational power plants are yet to be commissioned, it provides an opportunity to develop the sector through informed and inclusive awareness and consensus from the ground-up. The proposed project will undertake a campaign to raise the overall awareness of geothermal development, its benefits and how any potential risks will be mitigated; for the benefit of all Chileans. It will also undertake specific efforts to consult and raise awareness amongst people in potential geothermal development areas including indigenous populations; to take into consideration their views in overall policies for promoting geothermal development in Chile.

20. Ensure compliance with industry and international standards: When developing a nascent industry, it is important to ensure that good industry practices are followed and international standards are met; and this will enable geothermal to be developed in Chile in a safe and sustainable manner. One specific reason for GoC's request for World Bank support was to ensure that it could benefit from global experience and internationally recognized practices can be put in place in Chile. The proposed project provides an opportunity to ensure that the policy and regulatory framework obliges the industry to meet industry standard while the various incentive mechanisms that will be developed through the project can also promote good practices in sector development.

D. Development Impact

21. *Help meet the needs of increasing demand to support economic growth:* the primary beneficiaries of the impact of the proposed project are energy consumers in Chile as it will help meet their growing energy needs. In doing so, geothermal will contribute towards economic growth in a country where economic growth is strongly correlated to the availability of efficient, reliable and affordable supply of energy. While the overall economy will gain from the proposed interventions, it is also important to note that people living in project areas, including those who are of indigenous origin, will also benefit from the availability of electricity and geothermal for alternate uses, and other co-benefits associated with sector development.

22. *Enhance the energy security of the country:* Increasingly, Chile has had to rely on imports of primary energy resources for power generation as the energy mix has shifted away from domestic resources such as hydropower. This has created vulnerabilities and energy security concerns, which were confirmed when several years ago, gas supply arrangements from Argentina were rescinded. It plunged Chile into an energy crisis, to necessitate the urgent construction of several liquefied natural gas (LNG) terminals and contracting alternate supplies. And even with the LNG terminals, security of supply is contingent upon adherence to the new contractual arrangements. By utilizing greater indigenous resources such as geothermal, the power generation mix would be diversified more towards non-tradable options enahcing the energy security of the country.

23. *Contribute to stabilizing and lowering electricity prices:* The increase in the utilization of fossil base fuels in Chile for power generation has also resulted in considerable volatility in electricity prices due to fluctuations in international commodity prices. This is particularly the case in the largest system, SIC, and is reflected in the volatility of spot prices for electricity. In addition, the relatively high commodity prices in recent times have led to electricity prices that are also quite high in Chile. The high volatility in prices create significant uncertainties for businesses making their planning and business decisions unpredictable. The high electricity costs, which geothermal could reduce in some cases, can also undermine economic competitiveness of the country. Both factors also create hardship for household consumers as well. By contributing to long-term stable and competitive electricity prices, geothermal will contribute to the growth in the Chilean economy.

24. *Confer local and global environmental benefits:* Chile's greenhouse gas emissions, which are expected to double by 2025, are primarily from the energy sector. Its CO_2 emissions per capita is substantially higher than the average for other Central and South American countries[22]. The GoC is committed to re-directing the emissions trajectory, and the greater utilization of geothermal, which typically emits about 10 percent compared with an equivalent coal-fired power plant, will contribute to this goal. The progressive development of the geothermal sector will work hand-in-hand with the recent introduction of a carbon tax in Chile that has the same shared goal. Geothermal will also contribute to the reduction of local pollution since it will reduce pollutants such as sulfur dioxide (SO2), nitrogen oxide (NOx), and total suspended particulates (TSP) that are a common bi-product of fossil-based power generation. The reduction in these pollutants will also result in health benefits to the local population.

E. Implementation Potential

25. ***Public Policies and Institutions:*** The proposed project is designed specifically to impact policies and schemes that will address barriers and help internalize economic externalities to guide a predominantly laissez fair market into investing in a beneficial technology to a more optimal level. The overall effort is guided by the GoC's Energy Agenda, with the proposed project providing critical support to the MoE's efforts to reform the policy and regulatory framework for geothermal in order to level the playing field with other technologies. Connecting geothermal policy to the conditions of the broader power market will also be a critical linkage since serving electricity consumers with an additional reliable, clean energy options is a primary goal. The proposed interventions also go hand-in-hand with the GoC's overall efforts to be a good custodian of the environment through efforts such as the recently introduced carbon tax, which is designed specifically to more accurately cost the impact of pollution and promote clean energy sectors such as geothermal.

26. MoE is the key institutional that is mandated with overseeing the energy sector and the implementation of the GoC's Energy Agenda. The proposed project will specifically strengthen the capacity within the MoE and its Geothermal Unit within the Renewable Energy Directorate to better oversee sector development, implement the necessary policy and regulatory reforms, and more effectively manage the concession regime to ensure outcomes that are consistent with the GoC's overall geothermal development goals. Furthermore, the MoE will also coordinate closely when necessary with the Ministry of Environment to coordinate related policies that impact geothermal development.

27. ***Sustainability of Transformation:*** Sustainability of geothermal development over time is a major aspect of the proposed project. While component 1 along with the IDB MiRiG project is intended to give an immediate boost to the geothermal program, component 2 is primarily aimed at improving the long-term market conditions that will help identify the extent to which geothermal can be commercially exploited in country and progressively and sustainably facilitate the scale-up of this nascent industry in Chile. Initially, proving the first geothermal operations in the country will demonstrate the viability of the sector and enhance investor confidence unlocking the potential to begin exploiting the large estimated geothermal potential. This will be aided by the IDB MiRiG support to further de-risk some of the geothermal projects that are more advanced, and also help inform the establishment of a geothermal risk mitigation framework with the assistance of the proposed project, which will facilitate the mobilization of risk capital towards drilling in the years to come. Better integration of geothermal in the broader power sector will also not only have an immediate impact, but is essential for the long-term sustained off-take and bringing additional geothermal projects online. The identification of domestic sectors that can be incentivized to contribute to geothermal development locally and expanding the market for drilling and other associated services by supporting alternate uses of geothermal will enhance the long-term competitiveness of geothermal contributing to the sustainability of the sector. Finally, the proposed project's support to raising awareness

[22] United States' Energy Information Administration (EIA).

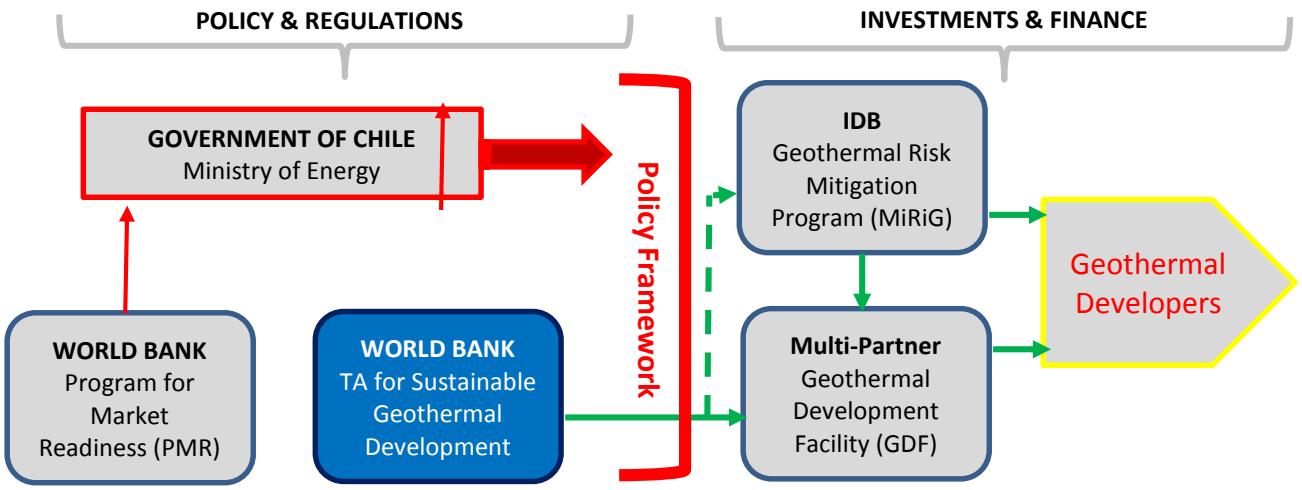
and acceptance of geothermal with the broader population will also bolster social support for sustaining sector development.

28. ***Leverage:*** Since the proposed project is entirely technical assistance, its design intentions are specifically to leverage and mobilize financing into geothermal investments. While it does not directly fund investments, the proposed project will provide the policy and institutional foundation that will facilitate immediate and future investments in the sector. A number of activities under the proposed project will complement the IDB's CTF support of $50 million for geothermal development in Chile. These investments are expected to further leverage private investments as well, leading anywhere from 50-100 MW of geothermal short-term geothermal capacity in the country. At a cost estimate of about $5 million per MW, and assuming 50:50 debt/equity ratio that can be common in geothermal financing, private funds of some $125-$250 million could be mobilized in the near to medium term.

29. ***IFIs and Donor Coordination:*** The proposed project is part of a coordinated effort between the World Bank and IDB to assist the GoC through CTF support. The proposed project and IDB supported MiRiG were envisaged originally and designed to be complementary in support of the GoC's geothermal development goals. While MiRiG will mobilize direct investment support, the proposed project will strengthen the policy and institutional foundation upon which immediate and sustained investments in geothermal can mobilize with the greater confidence.

30. Chile's CTF supported geothermal activities are also designed to better place geothermal developments in the country to access the Latin American Geothermal Development Facility (GDF), which is a multi-donor scheme to support geothermal energy development in the region. Its preparation is being led by KfW in cooperation with a variety of other donors and financiers, including the World Bank and IDB. The GDF for Latin America is foreseen to include: 1) a Risk Mitigation Fund to support early exploration drilling stage; 2) Investment Financing Windows to provide tailored financing for subsequent investments during the crucial production drilling and construction stages; and 3) a Technical Assistance Forum to coordinate existing and planned technical assistance programs of participating donors and financiers. The goal is to facilitate an initial set of projects that could access the GDF.

31. The World Bank, which is also providing support to the GoC through MoE with a Partnership for Market Readiness (PMR) so that Chile can better access carbon financing through future bilateral or global mechanisms. Since geothermal is a clear climate mitigation investment option, the coordinated efforts between the PMR work and the geothermal reforms supported by the proposed project will be complementary.



F. CTF Additionality

32. The proposed project is critical to help provide the necessary market conditions to scale-up and sustain geothermal development in Chile. Evidence suggests that a nascent industry that is also bound with inherent risks significantly challenge the appetites of private investors to mobilize risk capital at the scale that is envisaged and needed. By introducing greater global experiences and international standards that will be customized to the Chilean context, the proposed project will help boost the confidence of developers to make greater investments in the geothermal sector in Chile. In a country where there is greater adherence to laissez fair principles, enhancing the investment climate to facilitate financing, including critical risk capital, towards geothermal development will be essential of the sector is to thrive and the GoC to achieve its development goals established in its Energy Agenda.

G. Implementation Readiness

33. The proposed project is ready to implement. In fact, recognizing the urgency of the GoC, the World Bank, with ESMAP support, has already begun providing some of the critical assistance to identify some of the specific reforms that will be designed with CTF funds. Therefore, the approval of the proposed CTF funds will be timely so that the reforms can be quickly and efficiently put in place, especially those that will support and clear the path for several projects that had made considerable advances to identify geothermal resources, but have faced difficulty moving further forward.