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IMPLEMENTATION COMPLETION AND RESULTS REPORT

TF0A3726

ON A

SMALL GRANT

IN THE AMOUNT OF USD 1.78 MILLION

TO THE

Chilean International Cooperation Agency for Development (AGCID)

FOR

CL Technical Assistance for Geothermal Development in Chile (P152820)

June 16, 2022

Energy & Extractives Global Practice
Latin America And Caribbean Region

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ABBREVIATIONS AND ACRONYMS

AGCID	Chilean International Cooperation Agency for Development
CPS	Country Partnership Strategy
CSP	Concentrating Solar Thermal Power
CTF	Clean Technology Fund
ESMAP	Energy Sector Management Assistance Program
FM	Financial Management
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoCl	Government of Chile
GW	Gigawatts
ICR	Implementation Completion and Results Report
IDB	Inter-American Development Bank
IPF	Investment Project Financing
ISCI	Complex Energy Systems Institute (<i>Instituto Sistemas Complejos de Ingeniería</i>)
ISR	Implementation Status and Results Report
M&E	Monitoring and Evaluation
MiRiG	Geothermal Risk Mitigation Program
MoE	Ministry of Energy
MW	Megawatts
NCRE	Non-Conventional Renewable Energy
NDC	Nationally Determined Contribution
PDO	Project Development Objective
PP	Project Paper
PPA	Power Purchase Agreement
RF	Results Framework
SCD	Systematic Country Diagnostic
SIC	Central Interconnected System (<i>Sistema Interconectado Central</i>)
SING	Great North Interconnected System (<i>Sistema Interconectado del Norte Grande</i>)
SORT	Systematic Operations Risk Rating Tool
TA	Technical Assistance
ToRs	Terms of Reference

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DATA SHEET

BASIC INFORMATION

Product Information

Project ID	Project Name
P152820	CL Technical Assistance for Geothermal Development in Chile
Country	Financing Instrument
Chile	Investment Project Financing
Original EA Category	Revised EA Category

Organizations

Borrower	Implementing Agency
Chilean International Cooperation Agency for Development (AGCID)	Ministry of Energy

Project Development Objective (PDO)

Original PDO
Assist the Government of Chile to improve geothermal energy market conditions by removing key barriers, leading to sustainable investments in this sector.



FINANCING

	Original Amount (US\$)	Revised Amount (US\$)	Actual Disbursed (US\$)
Donor Financing			
TF-A3726	1,780,000	1,628,343	1,628,343
Total	1,780,000	1,628,343	1,628,343
Total Project Cost	1,780,000	1,628,343	1,628,343

KEY DATES

Approval	Effectiveness	Original Closing	Actual Closing
12-Oct-2016	24-Apr-2017	30-Jun-2020	31-Dec-2021

RESTRUCTURING AND/OR ADDITIONAL FINANCING

Date(s)	Amount Disbursed (US\$M)	Key Revisions
12-Feb-2020	0.98	Change in Loan Closing Date(s) Change in Implementation Schedule
27-Jan-2021	1.23	Change in Loan Closing Date(s) Change in Implementation Schedule

KEY RATINGS

Outcome	Bank Performance	M&E Quality
Satisfactory	Moderately Satisfactory	Modest

RATINGS OF PROJECT PERFORMANCE IN ISRs

No.	Date ISR Archived	DO Rating	IP Rating	Actual Disbursements (US\$M)
01	13-Dec-2016	Satisfactory	Satisfactory	0.00
02	15-Jun-2017	Satisfactory	Satisfactory	0.06
03	15-Nov-2017	Satisfactory	Satisfactory	0.21



04	05-Jun-2018	Satisfactory	Satisfactory	0.45
05	31-May-2019	Satisfactory	Moderately Satisfactory	0.71
06	28-May-2020	Satisfactory	Moderately Satisfactory	1.07
07	28-May-2021	Satisfactory	Satisfactory	1.39
08	27-Nov-2021	Satisfactory	Satisfactory	1.65

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I. PROJECT CONTEXT AND DEVELOPMENT OBJECTIVES

A. CONTEXT AT APPRAISAL

Country Context

1. **With almost 18 million inhabitants and a gross domestic product (GDP) of US\$240 billion in 2015, Chile had achieved an average annual economic growth rate of 3.5 percent during the previous twenty years.** Per capita income over this period had almost doubled in real terms. Chile's development accomplishments and challenges at the start of the Project were captured comprehensively in the World Bank's Systematic Country Diagnostic (SCD) of 2017.¹ Chile had achieved a strong track record of economic growth and poverty reduction due to four main factors: capable institutions, sound macroeconomic policies, productivity-oriented policies for public services and social protection, and a strong commodity endowment. Even so, inequality in access to economic opportunities and services remained an important challenge. Further efforts were needed to continue improving the quality of key social services and meet the demands of an aging population. In addition, managing water resources, natural capital, and climate change adaptation had become crucial to sustaining the gains in poverty reduction and shared prosperity. The SCD identified specific priorities for Chile under four main headings: (i) improving the quality of public services, especially in human development; (ii) enhancing innovation, diversification and energy sector modernization to boost productivity growth; (iii) boosting labor productivity (including female labor participation) and reducing labor market segmentation; and (iv) strengthening the management of environmental resources and climate change adaptation.

Sectoral and Institutional Context

2. **Chile's energy sector policies were (and still are) based on private sector-led investments, market determination of prices, and technological neutrality.** In 1982, Chile became one of the first countries to implement a comprehensive electricity sector deregulation. Generation, transmission, and distribution services were unbundled and privatized. Given the structure of the sector, electricity prices tended to fluctuate. To mitigate the hardship of price volatility for citizens and business, power price reduction and stabilization had become primary objectives for energy policy.²

3. **Chile's energy sector remains a key determinant of the country's socio-economic development.** At the time that the Technical Assistance for Geothermal Development in Chile Project (P152820) (hereafter "the Project") was approved, electricity demand had been increasing at around seven percent per year, a rate equal to doubling every ten years and outpacing economic growth. The Government of Chile (GoCl) estimated that electricity demand would continue to grow at about the same rate,³ requiring an additional eight gigawatts (GW) of power generation capacity by 2020.

4. **During Project preparation, the electricity system consisted of four networks operating in isolation from each other.** In 2017, the two main networks—the *Sistema Interconectado del Norte Grande* (SING) and the *Sistema Interconectado Central* (SIC)—were united into the National Electric System. There are two other small networks, *Magallanes*, and *Aysen*, which operate in the south. The country's unique geographical

¹ The Republic of Chile, Systematic Country Diagnostic (P157088), Transitioning to A Prosperous Society, June 6, 2017, Report No. 107903-CL.

² National Energy Strategy (2012-2030).

³ Government of Chile, National Energy Strategy (2012-2030) (Santiago: Government of Chile, February 2012).



characteristics, difficult terrain, and long distances to be traversed pose considerable engineering and accessibility challenges for interconnections.

5. **At the Project's inception, the principal energy sources for Chile's electricity production were hydropower and fossil fuels (including coal, oil, diesel, and natural gas).** Imported fuels made up almost 55 percent of total electricity generation, given that Chile has limited indigenous fossil resources. Renewable energy, mainly large-scale hydro, contributed 43 percent of Chile's power supply. Hydropower had decreased its share substantially and had been replaced by fossil fuels due to: (i) the severe drought of 2010 and multiple years of below average rainfall; and (ii) opposition to new hydropower development due to environmental concerns about the impacts on wildlife. Chile's energy supply vulnerabilities had been further exacerbated in 2006-8 by a series of disruptions in the significant amount of natural gas imported from Argentina. Despite a subsequent diversification of supply sources, reducing reliance on imported fuels was considered a high priority for the country's energy security.

6. **Chile made a commitment to develop its energy sector in a sustainable way, aiming to limit greenhouse gas (GHG) emissions.** Electricity generation accounted for a majority of Chile's GHGs, which were forecast to double by 2025 and were substantially higher per capita than for other countries in the Latin America region.⁴ The SING system had particularly high carbon intensity due to its substantial utilization of coal, to replace the decreased levels of natural gas and hydropower. The GoCI's Nationally Determined Contribution (NDC) for the 2015 Climate Agreement in Paris was to reduce its CO₂ emissions per GDP unit by 30% below the 2007 level by 2030.

7. **Chile's abundant geothermal resources had been identified as a key element in diversifying the country's power generation mix and improving energy security.** The northern and central parts of the Chilean Andes mountain range had been estimated to have a geothermal potential in excess of at least 3.8 GW.⁵ Geothermal energy was seen as uniquely beneficial among renewable energy systems for a number of reasons especially relevant for Chile, including:

- Unlike other renewable energy alternatives, such as wind and solar, geothermal is a non-intermittent source that can provide reliable baseload power on a 24/7 basis. This can also help complement wind and solar electricity generation, thus enabling Chile to integrate higher percentages of generation through these sources.
- Geothermal emits a fraction of the GHG emissions (CO₂) of other baseload options such as coal and does not emit local pollutants such as nitrous oxides (NO_x), sulphur dioxides (SO₂) or total suspended particulates (TSP).
- As a domestic and non-tradable resource, geothermal would promote national energy security.
- Once developed, geothermal energy can provide stable prices and serve as a natural hedge against the volatility of commodity-driven electricity prices.
- Geothermal energy offers the potential for direct applications such as heat for households (district heating) and agricultural and industrial applications.

8. **In the 15 years leading up to the preparation of the Project, the GoCI had taken a number of steps to develop Chile's nascent geothermal energy industry.** In 2000, the GoCI adopted the Geothermal

⁴ United States Energy Information Administration.

⁵ With some estimates suggesting the potential may be as much as 16 GW. Mesa de Geotermia: <https://energia.gob.cl/sites/default/files/documentos/informe-final-mesa-geotermia.pdf>



Concessions Law (Law 19.657) to mobilize investment in the sector. Subsequently, over 100 geothermal concessions were issued, with many developers securing multiple concessions. However, few investments were mobilized for risky early stage exploration drilling and resource confirmation, a prerequisite for advancing greenfield (new) projects. This experience revealed a number of bottlenecks, including the limited time afforded for test drilling under the terms of the concessions, 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, inadequate capacity within the GoCI to monitor and oversee the concession regime, and uncertainties for developers due to offtake and commercial issues and environmental concerns. To mitigate these problems, the Ministry of Energy issued a revised regulation in 2013 intended to ease some of the administrative constraints in applying the law.⁶

9. **In May 2014, the newly elected Government established an Energy Agenda⁷ designed to boost the utilization of non-conventional renewable energy (NCRE),⁸ reduce the marginal cost of electricity, and improve energy efficiency to reduce consumption.** The Energy Agenda very much guided the strategic orientation for the World Bank's Project as it included geothermal commitments in the following way:

- Boost the development of NCRE to meet 20 percent of demand by 2025
- Cut the marginal cost of electricity by 30 percent during the Government's term
- Improve the efficiency of energy use to reduce the foreseen consumption by 20 percent in 2025
- Submit a new draft geothermal concessions law for consideration by Congress
- Develop risk mitigation schemes for drilling geothermal production wells
- Launch a program for the direct use of low and medium enthalpy geothermal

10. **Challenges identified for geothermal when the Project was approved included:**

- *Geothermal resource risks.* Uncertainty surrounding the availability of a commercially exploitable resource in greenfield projects was understood to be an inherent hindrance to early-stage geothermal development. Although this risk is typical of a nascent sector, the country also lacked knowledge on widespread drilling resources. Investors were often unable to mobilize the US\$30 million or more in risk capital required for exploration drilling due to the risks and uncertainties involved.
- *Competitiveness.* Beyond the risks and costs inherent to any geothermal project, Chile faced higher capital costs of drilling than other countries. The mining sector in Chile competed with geothermal to attract scarce skilled experts and unskilled workers. Also, a lack of locally available drilling rigs required sourcing equipment from abroad, thereby doubling or tripling drilling costs. Moreover, high altitudes and low temperatures in many of Chile's geothermal fields made access to them difficult and costly, in some cases allowing only 3-4 months of work per year.
- *Integration of geothermal in the power market.* Typical power purchase agreements (PPAs) in Chile were for 7 to 10 years, whereas geothermal projects typically required amortization over 20 to 30 years. This mismatch hampered developers' ability to raise financing for projects. In addition, many geothermal fields are in remote locations, requiring the extension of transmission lines, adding

⁶ The original regulation had been issued in 2004.

⁷ Government of Chile, *Agenda de Energía. Un Desafío País, Progreso para Todos.* (Energy Agenda. A National Challenge, Progress for All) (Santiago: Government of Chile, May 2014).

⁸ NCRE includes solar, wind, biomass, small run-of-river hydro of less than 20MW, and geothermal energy sources.



significantly to project costs. One possibility to mitigate these problems, where appropriate, was to combine power generation with other commercial purposes such as heating (known as co-benefits or co-generation).

- *Environmental and social considerations.* There was widespread recognition that internationally compliant environmental and social practices are not only essential for safeguarding project-affected people and communities, but also to generate support for geothermal development and even to secure financing from commercial banks. Chile's policy framework for environmental and social safeguards was broadly aligned with international standards. However, there remained a need to increase awareness among developers and local communities as to how these policies applied to geothermal development and to inform communities about the risks and benefits of these developments. Controversy about the environmental, economic and social risks of geothermal energy had been awakened in Chile as a result of a blowout in 2009 at the *El Tatio* geothermal field in northern Chile. Sustainable scale-up of geothermal development would require more robust stakeholder engagement and consultation (including with affected indigenous people), tied to information about international best practices among developers.

11. The GoCl felt that international assistance was required to help overcome the barriers to geothermal energy development. The Government therefore secured US\$53 million from the Clean Technology Fund (CTF), channeled through the World Bank and the Inter-American Development Bank (IDB), to advance geothermal development in the country. Of the CTF funds, US\$50 million were allocated through the IDB to finance a risk mitigation facility. Of the remaining US\$3 million US\$1.22 million were allocated to the World Bank for a Bank executed advisory services activity and US\$1.78 million allocated to the GoCl for a recipient executed technical assistance to promote reforms and strengthen its capacity in geothermal energy. The World Bank's support was complemented by a US\$500,000 Bank executed advisory services initiative financed by the Energy Sector Management Assistance Program (ESMAP) to share with Chile the World Bank's global experience in the geothermal subsector.

Higher Level Objectives to which the Project would Contribute

12. The Project was expected to contribute, in conjunction with other ongoing initiatives, to enabling the development of Chile's domestic geothermal resources, thereby (i) helping to meet the country's growing energy demand; (ii) attenuating Chile's energy supply vulnerabilities by enhancing energy security; (iii) promoting environmentally sustainable development; (iv) helping the country to meet its goal for mitigating global GHG emissions; (v) helping to stabilize and reduce long-term electricity prices, which would contribute toward 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. In addition, the Project was aligned with the Country Partnership Strategy for fiscal years 2022-16(CPS FY11-16) at the time of appraisal., which aimed to boost economic growth and eliminate extreme poverty. Specifically, the Project was aligned with pillar 3 on promoting sustainable investment, in particular with strengthening regulation and supporting private sector investments.

Rationale for Bank Support through the Project

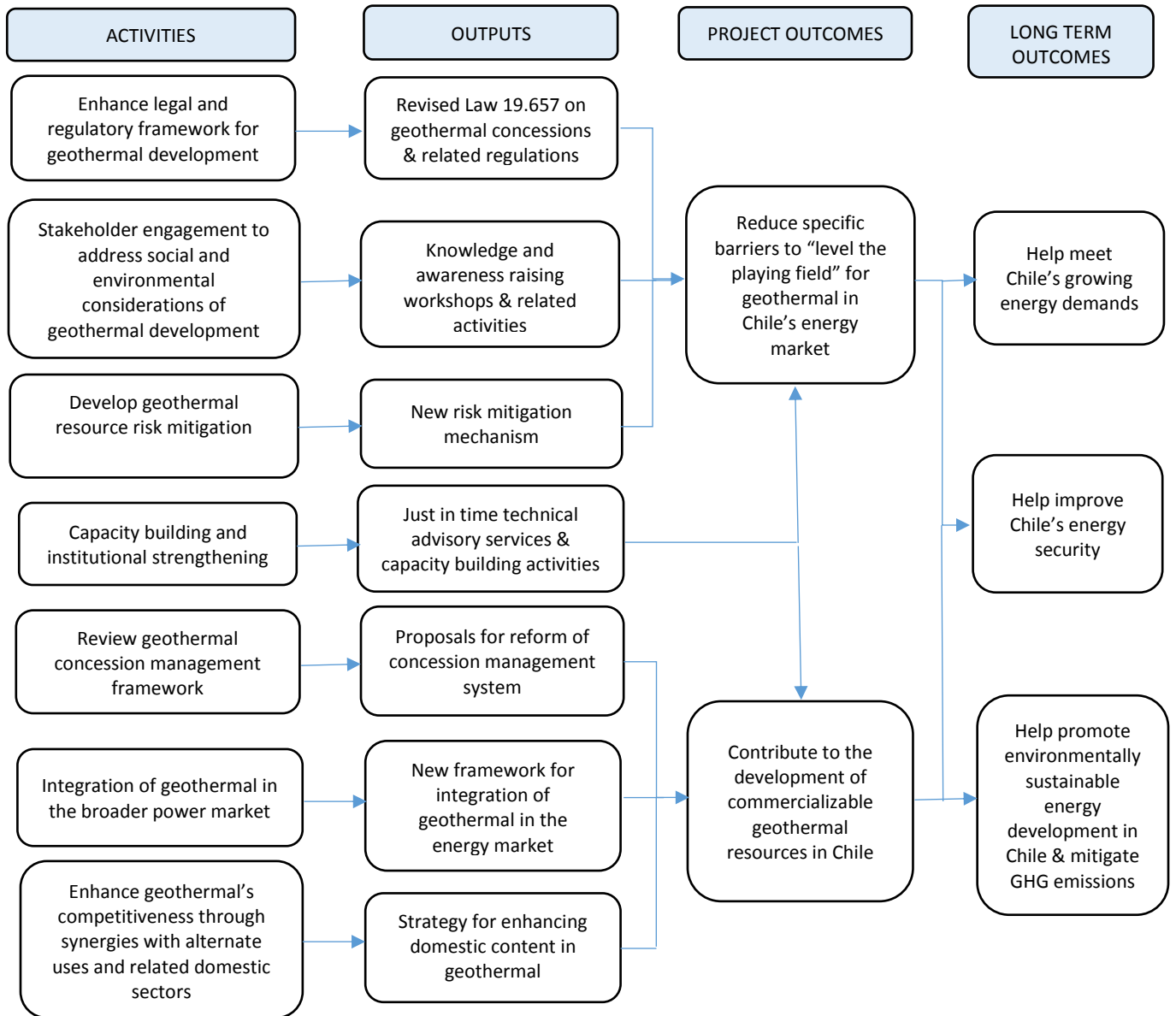
13. The GoCl sought the World Bank's support for the Project to benefit from the Bank's global expertise and knowledge of best practices in the energy sector in general and the geothermal sector in particular. This included the Bank's recognized knowledge of—and standards for—relevant environmental and social safeguards. It was expected that, by introducing the Bank's experience and practices, the Project would help boost the confidence of both developers and communities, to allow for greater investments in the geothermal energy sector in Chile. Also, the Bank's access to trust fund grant financing for technical



assistance from the Clean Technology Fund was a factor in materializing the Bank’s involvement.

Theory of Change

14. The following chart, prepared for this ICR, depicts the Project’s Theory of Change:⁹



Critical Assumptions:

1. Geothermal electricity prices remain competitive with other baseline sources
2. GoC energy policies remain as at Project appraisal
3. Resources are available to fund risk mitigation mechanism

⁹ The Project Paper did not include a Theory of Change.



Project Development Objectives (PDOs)

15. **PDO as presented in the PP and Grant Agreement:** To assist the Government of Chile 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 commercializable geothermal resources.

Key Expected Outcomes and Outcome Indicators

16. The Project’s Results Framework (RF) had three PDO level outcome indicators:

Indicator	Baseline	End of Project Target
Greater exploration of geothermal resources through the drilling of wells	7 wells	11-13 wells
Submission for Legislative approval of law and/or revised policies necessary for providing greater regulatory clarity to investors	None	Law submitted for Legislative approval
A framework designed to mobilize risk capital toward geothermal exploration	None	Framework adopted and under implementation

Components

17. The Project’s components, subcomponents, and activities as listed in the Project Paper and Grant Agreement were as follows:

(a) Component 1 Improve policy framework and strengthen management capabilities to help mobilize investments in geothermal energy.

1.A *Enhance legal and regulatory framework for geothermal development.* Inter alia: (i) drafting of the necessary legal and regulatory instruments; (ii) carrying out stakeholder consultations; and (iii) evaluation of the impact of the reforms to adjust the framework for optimal performance.

1.B *Review geothermal concession management framework.* Inter alia: (i) review of the GoCl’s internal concession management system to optimize operations; (ii) identifying steps to strengthen the monitoring of awarded concessions to ensure compliance with investment and related agreements; and (iii) evaluation of exploitation concession bids, management of award process, and oversight of concessionaire’s obligations.

1.C *Capacity building and institutional strengthening.* Inter alia: (i) provision of on-the-ground advisory support to the MoE to boost its existing capacity in the geothermal sector; (ii) support for the coordination of all activities related to the Project; (iii) identification of key evolving sector needs, just-in-time support, and additional capacity building; and (iv) facilitation of the means to address the needs mentioned under (iii).

1.D *Stakeholder engagement to address social and environmental considerations of geothermal development.* (i) consultations; (ii) awareness building activities including exchanges with other countries that have geothermal development and the incorporation of feedback arising from these



activities into the reforms implemented through the Project; and (iii) a stakeholder engagement strategy, informed by a social assessment, to improve engagement with affected communities and to increase knowledge and awareness of scientific, social and environmental aspects of geothermal development among stakeholders, including indigenous peoples.

(b) Component 2: Enhancing market conditions for promoting sustainable development of the geothermal energy sector.

2.A Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling. (i) design and preparation of a geothermal resource risk mitigation framework based on successful international experience and energy markets and (ii) revision of the legal and regulatory framework to support the geothermal risk mitigation options that will be implemented in Chile.

2.B Integration of geothermal in the broader power market in Chile. Design and develop an incentive framework for better integration of geothermal power in Chile's broader power market, including, *inter alia*, the rationalization of Chile's geothermal expansion plans through the harmonization of its overall development goals with the existing power market conditions, including the undertaking of the necessary reforms and the implementation of adequate incentives.

2.C Design of a strategy to enhance geothermal competitiveness in the long term by exploring synergies with alternate uses and related domestic sectors. *Inter alia:* (i) identification of the sectors best positioned in Chile to develop low and medium enthalpy resources in an economic fashion and (ii) design of the most appropriate schemes to promote the use of said resources and their implementation.

18. **The Project Paper highlighted the need for the Project to be adaptable**, noting, "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 that may arise during implementation."¹⁰

B. SIGNIFICANT CHANGES DURING IMPLEMENTATION

19. **PDO and Outcome Targets.** Neither the PDO nor key outcome targets were revised.

20. **Revised Components or Activities.** No formal changes were made in the components, subcomponents, or core activities. Some additional activities were added in 2018, 2019 and 2020 beyond those in the original Project Description.

21. **Other Changes.** In February 2020, the Project's closing date was extended by 12 months to June 30, 2021 in response to various factors that slowed implementation during the project's first three years (see Section III below). In January 2021, the closing date was extended a second time by six months to December 31, 2021, due to delays related to the COVID-19 pandemic. No other formal changes were made in the Project.

22. **Rationale for Changes and Their Implication on the Original Theory of Change.** None of the changes had any effects on the original Theory of Change.

¹⁰ Project Paper, paragraph 35.



II. OUTCOME

23. **Overall, the Project produced several significant results, with adaptations to changed circumstances, as explained in this section of the ICR.** Broadly, the Project's major contributions were in four areas. First, the Project was instrumental in revising the Law on Geothermal Concessions (Law No. 19.657) to facilitate the development of geothermal direct uses and improve safety standards for geothermal projects. Second, through the Geothermal Roundtable in 2016-18, the Project generated a broad foundation of common understanding among stakeholders in Chile and influenced the GoCl's energy sector policy, *Ruta Energética 2018-2022*. Third, the Project supported transformational advances in stakeholder engagement, knowledge and understanding of geothermal energy, especially among indigenous groups who live in areas across the country where the greatest geothermal potential is located, opening the door for improved government engagement and for direct uses of geothermal by local communities. Finally, the Project supported an extensive array of studies and pilot projects on the direct uses of geothermal energy, which have laid a foundation for scaling up to improve the living conditions for disadvantaged people and which constitute a major body of knowledge resources and a public good. The impact of the TA in the development of direct uses of geothermal can be seen through various examples, such as the government's approval of the pilots for heating school with clean low-enthalpy geothermal resource in two rural school within indigenous population; the sustained geothermal mapping efforts to map additional regions in the south where energy vulnerable population lives with a focus on low-enthalpy resource; and the inclusion of the results of the net-zero affordable housing study to be included as a new line in the MoE Energy Agenda 2022-26 to be launched by the end of June 2022. Overall, the well-documented activities supported by the Project form an essential reference and foundation for government officials, the private sector, civil society, and academia on the reduction of barriers to geothermal energy development and the advancement of commercial geothermal energy.

24. **This Project posed an unusual situation for the assessment of outcomes, due to the close integration of the GoCl executed and Bank executed parts.** The actual scope of the Project, as outlined in the Project Description and Annex 3 of the PP and Article II of the Grant Agreement—and as actually implemented—depended on complementary GoCl and Bank executed activities, with total trust fund financing of \$3.5 m. The GoCl executed part of the Project was defined by a US\$1.78 m. recipient executed grant from the CTF (plus US\$0.55 m. of counterpart funds). The Bank executed part was financed by US\$1.22 million in trust funds from the CTF and US\$0.5 million from the Energy Sector Management Assistance Program (ESMAP).¹¹ This blending of recipient and Bank executed elements was appropriate for a technical assistance project such as this one, in an advanced country where the subject matter was highly specialized, called for global knowledge inputs from the Bank, and required high levels of client technical capacity and policy formulation. The fusion of the GoCl and Bank executed elements not only was anticipated in the Project documents approved by the Board, but also was clearly reflected throughout implementation in the Bank's ISRs and Aide Memoires and in the GoCl's Progress Reports. Annex 4 of this ICR summarizes the Bank executed and GoCl executed activities of the Project, both planned and actual.

25. **According to the Bank's guidelines, an Implementation Completion and Results Report (ICR) is required for completed operations prepared and approved as recipient executed Investment Project**

¹¹ Actually there were three BE trust funds: TFOA5286 CTF approved 16 Jun 2017 \$1.08 m.; TFO18807 CTF 23 Dec 2014 – 31 Dec 2021 \$149.9K; and TFOA0164 ESMAP approved 16 Apr 2015, closed 30 Jun 2018 \$489K.



Financing (IPF).¹² ICRs are not required for Bank executed activities. However, in this case, it is impossible to assess the Project's outcomes based solely on the GoCI executed elements. The GoCI executed and Bank executed activities were interdependent parts of a single Project. Assessing only the GoCI executed part would produce a distorted and incomplete picture of activities implemented and outcomes achieved under the Project. Accordingly, the assessment of outcomes in this ICR takes into account the totality of both elements.

A. RELEVANCE OF PDOs

26. **Although the Project was narrowly focused on geothermal energy, it contributed towards key energy sector objectives as outlined in the World Bank's SCD, especially greater energy security, reliability, diversification, and environmental protection (SCD Priority area i).** In addition, by helping to improve the enabling environment for the safe use of geothermal resources in the context of Chile's plan to increase its reliance on NCRE, the Project supported Chile's program to become a more environmentally sustainable country (SCD Priority area iv). Similarly, the Project's objectives were aligned with the priorities of both energy policy documents *Energía 2050* (issued in 2015) and *Transición Energética de Chile (released for public comment in October 2021)*, namely: resilience, sustainability, efficiency, and a cleaner energy matrix. In addition, the Project directly supported the achievement of four key activities set forth in the energy sector roadmap *Ruta Energética* (issued in 2018) to promote the development of geothermal energy. Accordingly, **the Relevance of the Project's PDOs is rated High.**

27. **At the time of preparation of this ICR, the Government of Chile's official energy policy remained *Energía 2050*, which was issued in 2015.**¹³ This policy is centered on four key pillars:

- *Security and Quality:* Beyond the traditional concept of national energy security, this pillar extends to affordability, accessibility, flexibility, and resilience.
- *Energy as a driver of development:* This pillar focuses on the integration and promotion of energy with regional and local development, the incorporation of the views and expectations of local communities, equitable access, and affordability,
- *Sustainability:* The policy aims to increase the use of renewable resources and mitigate the local, national and global environmental impacts of energy use. It supports measures to bring renewable energy up to 60 percent of the national supply in 2035 and at least 70 percent by 2050. The policy also supports the transition to an energy matrix that is 30 percent less carbon-intensive by 2030. Hydro and solar electricity generation are highlighted explicitly as priorities. Geothermal energy is mentioned as an option among various renewables.
- *Efficiency and education:* This pillar supports measures to promote more efficient energy use among the various categories of consumers, underpinned by an appropriate legal framework. In addition, the policy supports the integration of energy use awareness in the educational curricula at all levels.

28. **The national administration that began its mandate in March 2018 prepared a new draft energy policy, *Transición Energética de Chile*, released for public comments in October 2021.**¹⁴ Although this policy

¹² Bank Guidance: Implementation Completion and Results Report (ICR) for Investment Project Financing (IPF) Operations, OPS5.03-GUID.161, December 9, 2021, paragraph 3.

¹³ *Energía 2050, Política Energética de Chile, Ministerio de Energía.*

¹⁴ *Transición Energética de Chile, Anteproyecto Política Energética Nacional, Actualización 2021. Ministerio de Energía, Octubre 2021.*



document remains a draft, it reflects the government's strategic thinking. The new energy policy is based on six principles: sustainability, resilience, inclusiveness, accessibility, efficiency, and respect. The major goals are (i) proactivity in addressing climate change; (ii) energy for a better quality of life; and (iii) a new productive identity for Chile through sustainable energy. Among the key targets of the new draft policy are: (i) 100 percent of energy generation with zero emissions by 2050 and 80 percent through renewables by 2030; (ii) a 60 percent reduction in greenhouse gases from the energy sector in 2050 relative to 2018, which would achieve carbon neutrality; (iii) 100 percent of all new building construction with net zero energy consumption; (iv) 6,000 MW in storage systems by 2050; (v) a 25 percent improvement in energy intensity of large consumers relative to 2021; and (vi) all new energy projects incorporate measures to safeguard ecosystems, such as net zero loss of biodiversity, among others. The projected major increases in energy sources are mainly in solar photovoltaic, concentrating solar power with storage (CSP), and wind. The new policy acknowledges that "While there have been considerable advances in the use of renewable energy sources, there is need to make further progress in the integration of other technologies that still have not been incorporated on a large scale, such solar CSP, geothermal, and energy storage in various forms."¹⁵

29. **The GoCI also developed in 2018 an Energy Roadmap (*Ruta Energética*) for 2018-2022.**¹⁶ It is the government's official short-term energy agenda.¹⁷ The *Ruta* was developed in part from meetings and workshops all over the country with a total of about 2,200 persons representing the public sector, civil society, academia, NGOs, environmental groups, community associations, labor, private enterprises, and indigenous groups. The process resulted in a program with the following seven "axes": (i) modernization, (ii) energy with a social orientation, (iii) energy development, (iv) energy with low emissions, (v) efficient transport, and (vi) energy efficiency. While the *Ruta* is consistent with *Energía 2050* in being technology-neutral, it commits to several measures concerning geothermal energy:

- Streamline procedures and shorten timelines through a single platform for granting concessions for geothermal and gas electricity generation (p. 22)
- Evaluate the factors that hinder the entry of technologies, such as storage, hydrogen, CSP, and geothermal, among others, that can provide flexibility to the system and have positive impacts on other sectors (p. 43)
- Collect information regarding the development of and market for renewable thermal technologies and implement selected programs such as direct uses of geothermal, solar thermal systems for housing, and biogas for industrial purposes (p. 44)
- Improve the legal and regulatory framework for renewable thermal energy, including the revision of Law 19.657 regarding concessions for geothermal (p. 44)

30. **The World Bank's last Country Partnership Strategy (CPS) for Chile was for the period FY11-16. Since then, the Bank has continued its engagement with Chile without a formal CPS.** As of March 2022, the Bank's active portfolio in Chile consisted of two Investment Project Financing (IPF) operations (one IBRD loan for higher education and one trust funded project on forest-related GHG emissions) and 23 analytical and advisory services (including six reimbursable advisory services) spanning a wide range of sectors including sustainable development, human development, statistics, urban development and housing, governance,

¹⁵ *Ibid.* page 23

¹⁶ *Ruta Energética 2018-2022 - Liderando la Modernización con Sello Ciudadano.* Mayo, 2018.

¹⁷ General elections in Chile held on November 21, 2021 brought a new administration to power in March 2022, but at the time of preparation of this ICR, the new government had not developed its own sector policies.



energy, digital development, and others. A new CPF is under preparation.

31. **The current Bank program is being guided by the 2017 Systematic Country Diagnostic (SCD),¹⁸ which identified the following priority areas to advance both productivity and equity in Chile:** (i) Improve the quality of public services (education, health care, and pensions); (ii) Enhance the conditions to boost productivity growth: innovation, diversification and energy sector modernization; (iii) Enhance labor productivity and reduce labor market segmentation; and (iv) Strengthen management of environmental resources and climate change adaptation (in particular water resources management and conservation of protected areas and biodiversity).

B. ACHIEVEMENT OF PDOs (Efficacy)

PDO OUTCOME #1: RESOLVE SPECIFIC BARRIERS TO IMPROVE GEOTHERMAL ENERGY MARKET CONDITIONS

Law on Geothermal Concessions (Subcomponent 1.A)

32. **Among the significant barriers to geothermal energy that the Project addressed was updating the Law on Geothermal Concessions (Law No. 19.657).** The original Law was conceived to enable the granting of concessions for geothermal exploration and exploitation, but it did not make distinctions between large electrical projects that tap high enthalpy geothermal sources and small, “direct use” projects that employ low enthalpy geothermal energy. The latter have completely different characteristics than electricity projects in terms of technical complexity, footprint, magnitudes of investment, environmental impact, area of influence, and security requirements. ***One of the Project’s three key PDO indicators was “Submission for Legislative approval of law and/or revised policies necessary for providing greater regulatory clarity to investors”.*** The Project devoted significant resources and efforts during its first three years to achieving this target. This was planned in the Project Paper to be carried out through the Bank-executed part of the Project. Subsequently, the *Ruta Energetica* 2018-2022 included updating Law 19.657 as a key action. Through the Project, technical assistance consultancies were commissioned in two main stages, the first in 2015-16 and the second in 2018-19. Thanks to this support, the Ministry of Energy formally submitted the revisions of Law 19.657 to Congress in April 2019. These covered three elements: (i) the establishment of a separate registration system for shallow, direct use projects; (ii) modification of the audit regime for such projects; and (iii) setting standards for safety and security in the exploitation of deep and shallow geothermal energy. The revisions were approved by the House of Representatives in January 2020 and are now awaiting approval by the Senate. The delay in action by the Senate reportedly is mainly due to the onset of the Covid-19 pandemic in early 2020. Despite the fact that the Law has not been fully enacted, ***the Project achieved this PDO indicator target***, thereby making a significant contribution toward eventually improving the enabling environment for geothermal energy development.

33. **Under the GoCI executed part of the Project, it was envisioned that support would be provided to develop regulations needed to implement the revised Law, together with stakeholder consultations and an evaluation of the impact of the reforms.** These activities were not carried out due to the fact that the Senate has not yet approved the revisions of the Law.

34. **In 2021, the Bank executed part of the Project financed three studies to support the preparation of new regulations under the updated version of Law 19.657 for geothermal power generation and direct use projects.** All of these studies were under the umbrella name, Study on the Regulatory Framework in Chile for

¹⁸ Systematic Country Diagnostic (P157088), Transitioning to A Prosperous Society, June 6, 2017, Report No. 107903-CL.



Geothermal Power Generation and Direct Use Projects.¹⁹

- “Report on Health, Safety, Environment and Sustainability for Electricity Generation and Deep Direct Uses” (*Informe sobre Salud, Seguridad, Medio Ambiente y Sostenibilidad para la Generación Eléctrica y los Usos Directos Profundos*), June 16, 2021. This study provided recommendations, pursuant to the pending Law 19.657 for regulations on health, safety and resource sustainability of geothermal electrical generation facilities, based on international best practices.
- “National Registry of Shallow Uses of Geothermal Energy” (*Registro Nacional de Aprovechamientos Someros de Energía Geotérmica*), July 14, 2021. This study recommended guidelines for the establishment, as called for in Law 19.657, of a national registry of projects using shallow geothermal resources that opt not to use a concession.
- “Report on Health, Safety, Environment and Sustainability for Shallow Geothermal Development Projects” (*Informe sobre Salud, Seguridad, Medio Ambiente y Sostenibilidad para los Proyectos de Aprovechamientos Geotérmicos Someros*), October 5, 2021. This report covered topics and recommendations similar to those addressed in the first report but focused on the development and operation of shallow direct use and heat pump systems.

35. After the changes to Law 19.657 are approved by the Senate and signed, the above studies will be used to develop the corresponding regulations.

Stakeholder Engagement on social and environmental considerations of geothermal development (Subcomponent 1.D)

36. **Unfavorable public perceptions of geothermal energy development had been identified as contributing to the slow progress of the subsector in Chile.** Some local communities, especially indigenous groups living in areas with geothermal resources, as well as other civil society organizations, had raised objections to geothermal projects in Chile due to (i) gaps in the legal and regulatory framework pertaining to indigenous communities’ rights to consultations and benefit-sharing and (ii) negative perceptions of the environmental impacts and risks of geothermal energy.

37. **The Project was designed to address these issues through stakeholder engagement.** To build knowledge and awareness, the Bank executed part of the Project planned to: (i) review MoE’s recent experience with community engagement and consultations and provide recommendations on related environmental and social safeguards to meet international standards, (ii) organize international knowledge exchanges, and (iii) carry out diagnostic studies, including identifying gaps between existing policy in Chile and international good practice. The GoCl executed part of the Project was expected to complement these activities by supporting (i) the implementation of consultations with stakeholder groups, (ii) other awareness-building activities including further international exchanges, and (iii) development of a stakeholder engagement strategy.

38. **A total of 15 local stakeholder engagement activities were carried out between 2017 and 2020 in areas with geothermal resources.** Four had been completed by May 2017, 13 by December 2018, and two more by May 2020. ***This far surpassed the Project’s intermediate indicator target of two engagement activities.*** Over 400 indigenous community leaders representing six groups (*Aymara, Quechua, Diaguita,*

¹⁹ *Estudio sobre el Marco Normativo en Chile para Proyectos Geotérmicos de Generación Eléctrica y Usos Directos*, JRG/Energy, for the Ministry of Energy, Government of Chile.



Colla, Mapuche, and Pueblos Australes) participated in the workshops. The program was implemented by the Center of Excellence in Geothermal Energy of the Andes (CEGA) of the University of Chile, which also helped create confidence in the process. The objective was to generate a dialogue to promote better understanding of geothermal energy in both electricity generation and direct uses. In the workshops, the questions and concerns of the local participants were addressed, and informational material, “Geothermal: Energy from the Earth/Dissemination Material for Indigenous Communities”, was distributed.²⁰

39. The Project also supported two educational tours for indigenous leaders. These aimed to promote *in situ* knowledge regarding the use of geothermal technology, its impacts, and project development. During project preparation, and with ESMAP funding, the project organized a study tour for Chilean indigenous leaders to visit an installed geothermal project in Nicaragua. During project implementation, the first visit was in 2017 for 10 indigenous leaders to the *Cerro Pabellón* geothermal plant. A second visit to *Cerro Pabellón* was carried out in 2019 with another group of indigenous leaders from the north of the country.²¹

40. These activities helped to improve indigenous leaders’ understanding of geothermal energy and to raise the Ministry of Energy’s awareness about indigenous peoples’ concerns, all of which contributed to reducing the barriers to geothermal energy development in several ways. Regarding geothermal electricity, the workshops provided feedback from local communities about: (i) a perceived lack of early involvement by the Government and private developers to address the concerns of local groups in the planning and exploration stages; and (ii) better sharing of benefits with local communities whose natural resources are being affected. With respect to direct uses, the workshops made such applications more visible, including ways in which geothermal resource development could contribute to community development, improve people’s quality of life, and serve as an alternative to firewood.²² This last notion was put to the test via a pilot activity (see below under the contribution of Subcomponent 2.C to the PDO). Throughout the process, indigenous peoples (IPs) and non-IPs government officials alike came to recognize the importance of a two-way dialogue underlain by a genuine desire to learn. Not only did the IPs’ fears of geothermal energy subside, but the officials developed a fuller understanding of traditional indigenous knowledge, in which such energy is often seen as yet another example of the living earth. To assist with the learning process on the government side, the PIU hired an Indigenous Peoples Specialist—another good practice feature of the project—who provided timely advice on operational matters, including on conducting consultations in a manner consistent with International Labor Organization, ILO 169.

41. The success of the stakeholder engagements led the GoCl to grant authority to the MoE to include new requirements in further geothermal concessions to ensure the informed consent of affected indigenous groups and adequate consideration of their claims over lands, water resources, and other matters of economic and cultural importance. A prominent example of this in practice was the inclusion in the GoCl’s Decree of December 2021 for the *Licanura 3* geothermal concession²³ of several relevant provisions, including (i) the exclusion from the concession of an area containing a water source used by a certain indigenous group; (ii) a clause requiring the concessionaire, before and during the development of the project, to implement good practices for relations with affected indigenous communities, in accordance with standards promoted by the Ministry of Energy; (iii) a requirement that the concessionaire prepare and

²⁰ “Geotermia: Energía de la Tierra/Material de Difusión para Comunidades Indígenas”, julio 2018.

²¹ A visit to Nicaragua for 5 indigenous leaders was held in September 2015, financed by ESMAP, before the Project became effective. This visit covered the Momotombo and San Jacinto geothermal plants, which use Flash and binary technology.

²² “Actividades Socio Indígenas en el Marco de la Asistencia Técnica para el Proyecto de Desarrollo Geotérmico Sostenible”, Banco Mundial/Ministerio de Energía, Agosto 2020.

²³ *Diario Oficial de la República de Chile*, no. 43.127, 14 de diciembre de 2021.



implement a Stakeholder Participation Plan; (iv) requirements that water resources be used in conformity with plans prepared in consultation with local communities, applying the best available technology to optimize the use of existing resources and minimize the negative effects; and (v) a requirement to perform feasibility studies of possible interventions of economic benefit to an affected local community. These types of obligations had not previously been applied to geothermal concessions but are now considered standard.

42. **According to officials of the MoE who were involved these activities, the work helped to dispel certain misperceptions among indigenous groups**, such as the idea that geothermal development is similar to mining in its impacts (e.g., earth and rock extraction) and that the resource is finite rather than renewable. For its part, the MoE institutionalized the principle that indigenous groups should benefit from the exploitation of the geothermal resource in their locations.

43. **Late in the Project's duration (November 2019 – August 2020), the Bank executed part of the Project financed a social and environmental assessment of geothermal and wind energy projects.** The assessment was extensive and comprised four major deliverables (Methodological Plan; Systematization of Socio-Environmental Impacts and Mapping of Stakeholders for Geothermal and Wind Energy; Analysis of Gaps between International Standards and the Chilean Reality; and Proposals for Good Practices for Participation in the Sustainable Development of Renewable Geothermic and Wind Energy Projects).²⁴ The geothermal aspect covered both electricity and direct use projects. The studies addressed an array of risks, impacts, and socio-environmental measures, taking into account documented global experiences, international standards such as those of the World Bank, the International Labor Organization, and current industry good practices. This has given the MoE a useful diagnosis of the gaps in existing laws and regulations and a road map for bridging these gaps in the future through further legal amendments, regulations, and concession agreements. The reports also provided recommendations on regulations, public management, and good practices for private companies, particularly in the context of indigenous populations, and proposed easy-to-implement measures in the short and medium term.

44. **Subsequently, the GoCI executed part of the Project financed an executive summary and communication material based on the preceding assessment** (produced May 2021 - December 2021), entitled "Challenges and Proposals for Improving the Management of Socio-Environmental Impacts of Geothermal and Wind Energy Projects".²⁵

Risk Mitigation Framework for Geothermal Projects (Subcomponent 2.A)

45. **Under this subcomponent, the Project aimed to address another barrier to geothermal energy development, the lack of funding for the high risks and costs faced by developers of geothermal electricity projects at the exploration stage.** At the time that the Project was prepared, it had been observed that exploration presented to developers an imbalance in the risk/reward ratio due to several factors, including: (i) the high capital costs of exploratory drilling, which can typically represent about US\$20 to US\$30 million depending on the specific topography and other circumstances; (ii) high uncertainty about whether there will be enough resources (in quantity and quality) to make the investment viable; and (iii) long periods of

²⁴ Espacio Público y Rubik. *Entregable 1: Ajuste Metodológico Propuesta Técnica*, 2 de diciembre 2019; *Entregable 2: Informe de Sistemización de Impactos Socioambientales y Mapeo de Stakeholders para Energía Geotérmica y Eólica*, 2 de abril 2020; *Entregable 3: Informe de Análisis de Brechas entre Estándares Internacionales y Realidad Chilena*, 1 de junio 2020; *Entregable 4: Informe de Propuestas de Buenas Prácticas desde la Gestión en la Participación para el Desarrollo Sostenible de Proyectos de Energía Renovables Geotérmicos y Eólicos*, 27 de julio 2020.

²⁵ "Desafíos y Propuestas de Mejora para la Gestión de Impactos Socioambientales en Proyectos de Energía Geotérmica y Eólica en Chile", Ministerio de Energía, AGCID del Ministerio de Relaciones Exteriores, Banco Mundial, 2020.



maturity of the investment.²⁶ As a result, developers were often unable to mobilize the US\$30 million or more in risk capital required for exploration drilling and geothermal resource confirmation, unless such risk could be mitigated through public sector mechanisms.

46. Support for the establishment of a risk mitigation mechanism to help mobilize capital for geothermal exploration for electrical power generation was a key Project activity under Subcomponent 2.A, and the creation of this mechanism was one of the Project's three PDO indicators. The intention was for the Project to build on a Geothermal Risk Mitigation Program (MiRiG) that had been developed during project preparation with support from the World Bank and was supported initially by the Clean Technology Fund (CTF) to be developed by IDB.²⁷ At the time, MiRiG was expected to underpin at least two specific geothermal projects in Chile, through short to medium term conditional loans to be repaid if the project was successful. In practice, MiRiG helped to incentivize development of Chile's first and only (to date) geothermal power plant, *Cerro Pabellón*, which started construction in 2015 and became operational in 2017.²⁸ MiRiG reportedly provided a US\$30 million loan for *Cerro Pabellón* project.

47. As a follow-up to this, it was envisioned that the Project's support for the risk mitigation framework was to occur under the Bank executed part through (i) reviewing global experience with risk mitigation for geothermal electricity projects; (ii) support for the GoCl in engaging existing and potential investors in Chile; (iii) evaluating the various risk mitigation approaches that have been applied globally;²⁹ and (iv) reviewing drilling practices in Chile and identifying ways to reduce costs. Under the GoCl executed part of the Project, support was to be provided for designing and preparing a geothermal resource risk mitigation framework and revising the legal and regulatory framework to support it.

48. In practice, the Project's support for a risk mitigation mechanism was channeled through the design of the risk financing facility and its financing of the Geothermal Roundtable (see below). During Project preparation the World Bank developed the design for the risk sharing facility, which was then implemented by the IDB in its MiRiG. Moreover, the risk sharing mechanism model was also used by the World Bank and IDB teams designing similar facilities in Nicaragua and Mexico, respectively. Thus, the risk sharing framework provided, through the replication of the design in other markets and serving as a reference to the LAC Global Geothermal Facility, reflect the public good of the risk sharing facility design. In addition, the Geothermal Roundtable conducted a detailed assessment of risks facing geothermal developers, and one of the 11 key proposals in its final report was the creation of a permanent risk mitigation mechanism as follows:

“A mechanism to institutionalize a model of financing between the Inter-American Development Bank (IDB) and the Government of Chile . . . in order to distribute the risks of the exploration stage and to incorporate the financial sector and private sector in the development of the geothermal industry. Similarly, [this would include] the granting of a letter of broad no objection for the financing of

²⁶ Related factors that contribute the high actual or perceived risk include time to commissioning; limited supply of value chain players and technical expertise in Chile; and the fact that most geothermal resources are far away from the grid where access is difficult and costly for much of the year, with harsh geographic and weather conditions.

²⁷ At the time of Project approval, some US\$47.7 million was available for MiRiG from the CTF.

²⁸ *Cerro Pabellón* was built by *Geotérmica Del Norte* - GDN, a joint venture between Enel Green Power Chile and the *Empresa Nacional del Petróleo*. The *Cerro Pabellón* plant is located on the high plateau of the Atacama Desert in the Antofagasta Region. It uses high enthalpy technology with a binary cycle. A third 33 MW generating unit is scheduled to come into operation by the end of June 2022, giving the plant a total power of 81 MW. The energy generated by *Cerro Pabellón* is injected into the national electrical system.

²⁹ This activity was carried out separately by ESMAP, which produced a study, “Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation - A Global Survey”, Energy Sector Management Assistance Program (ESMAP), World Bank, Knowledge Series 024/16, May 9, 2016.



geothermal projects by green financing agencies. What is being pursued is international cooperation to maintain an instrument such as the Geothermal Risk Mitigation Program (MiRiG) on a permanent basis.”³⁰

49. **However, after the completion of Cerro Pabellón, electricity market prices in Chile declined steeply, driven by the global cost reductions in solar and wind renewables, leaving geothermal electricity in not enough competitive terms to be auctioned in the electricity bids as had been the case for Cerro Pabellón.** As a result, most geothermal developers left the Chilean market and were no longer interested in accessing funds from the MiRiG. The CTF eventually decided to end Chile’s eligibility for this facility in 2019 as it was no longer an official development assistance (ODA) country.³¹ The GoCl executed part of the Project financed a consultant between late 2019 and March 2020 who worked on a “re-design” of the MiRiG, which was submitted to the CTF, but this came too late and was not approved.

50. **The Project’s Results Framework included a PDO indicator on risk mitigation.** It was stated as “a framework designed to mobilize risk capital toward geothermal exploration”, with the final target being “Framework under implementation”. The actual risk sharing facility was established and implemented by the IDB’s MiRiGs project, which was critical to fund the Cerro Pabellon geothermal project. However, the MiRiG was not operational at the time of Project closure and is thus not currently under implementation. Consequently, based on the wording of the indicator’s final target (referring to “under implementation”), **the Project did not achieve this PDO indicator target.**

51. **The RF also included an intermediate Indicator, “recommendation made for risk mitigation solutions based on global solutions tailored for Chile”.** The risk mitigation design prepared and the Geothermal Roundtable, financed by the Project, did assess and recommend the adoption of a risk mitigation scheme, as noted above. Thus, this, **intermediate indicator is deemed achieved.**

PDO OUTCOME #2: CONTRIBUTE TO THE DEVELOPMENT OF COMMERCIALIZABLE GEOTHERMAL RESOURCES

Geothermal Concessions Management Framework (Subcomponent 1.B)

52. **The Project intended to help facilitate investments in geothermal energy by improving the management framework for granting and overseeing geothermal concessions.** At the time of the Project’s preparation, a significant number of concessions had been granted that resulted in little or no investment. It was felt that shortcomings in the management framework—particularly in MoE’s limited capacity to monitor and manage developers’ obligations and take corrective actions to maintain progress—were one important reason for this. The Bank executed part of the Project planned to address numerous management issues in the concession cycle (see Project Paper, Annex 2, paragraphs 7-8).³² The GoCl executed part would then utilize this information and experience to undertake the necessary restructuring of its geothermal concession system and improve its oversight and management of the process.

53. **The Project documentation indicates that, in practice, the Bank executed part of the Project did not finance any activities related to this subcomponent, separate from what may have been done under**

³⁰ Geothermal Roundtable final report, July 2018, page 42.

³¹ In line with the OECD’s decision in 2018 to withdraw Chile’s eligibility for development grants due to its having surpassed the threshold of US\$12,500 GDP/capita.

³² These included (i) the eligibility criteria; (ii) the existing process to evaluate concession applications/bids; (iii) the milestones for exploitation concessions; (iv) the available governance tools to enforce policy; (v) the granting of concessions; (vi) the governmental monitoring process of concessions; (vii) the internal monitoring procedures; and (viii) the online-based information system.



subcomponent 1.A. This appears to have been due to the fact that, from 2017 onward, the pace of geothermal concessions diminished greatly due to market conditions, and further work on the GoCl's internal concession management system became a low priority.³³

54. **The GoCl executed part of the Project financed the development for the Ministry of Energy of a web-based platform for monitoring, registration and publication of geothermal concessions**, for both the Ministry's internal management and for the public (Aug - Dec 2021), in accordance with the presidential decree number 51 of 2020, that updated some of the regulatory framework of the geothermal La 19.657.³⁴

55. **The Project's Results Framework included an intermediate indicator for this subcomponent, "Review and recommendation report for geothermal concession framework", whose final target was "Completed"**. The final aim of this indicator was to improve the geothermal concession management system. Although a separate report on this topic was not prepared, recommendations to improve the concession framework were included in the "Study on the Regulatory Framework in Chile for Geothermal Power Generation and Direct Use Projects" mentioned above under subcomponent 1.A. Also, the studies on flexibility discussed under subcomponent 2.B below provided some additional recommendations related to concession management. In addition, the creation of a web-based platform for geothermal concessions, which was undergoing the final setup process at project closure, will allow for a quicker and transparent management of concessions. *Thus, the target for intermediate indicator 1 is considered partially achieved.*

Integration of Geothermal in the Broader Power Market in Chile (Subcomponent 2.B)

56. **The original intention under this subcomponent was for the Bank-executed part of the Project to support an assessment of the capacity of Chile's energy market to absorb geothermal, especially in terms of the constraints that limit its bankability and deter its expansion.** This was envisioned to center on Chile's two larger non-interconnected electrical networks, SING and SIC, which were seen as the primary off-takers for much of the expected geothermal generation capacity. Following this, the GoCl executed part of the Project was to finance the development of an incentive framework for better integration of geothermal power in Chile's broader power market. In fact, the bulk of what was intended under the Bank-executed part of this subcomponent was implemented through (i) the Geothermal Roundtable and (ii) several studies related to energy flexibility and capacity payments.

57. **The Geothermal Roundtable was the Project's major activity to address the integration of geothermal in Chile's overall power market.** The Roundtable was financed from ESMAP's contribution to the Project. Established by the MoE with the participation of representatives of over 35 institutions from government, the private sector, and the scientific and academic communities, the Roundtable was carried out over a 12-month period between December 2016 and December 2017. Its objective was to assess the technical, financial, and economic potentials, opportunities, and risks of geothermal energy within the unified electricity system in Chile. The Roundtable was limited to the use of geothermal for the generation of electricity from high enthalpy reservoirs. *Fundación Chile* acted as secretary and organizer, and the Energy Center of the University of Chile provided technical support. The Roundtable's final report,³⁵ released in July 2018, summarized the work accomplished through 11 plenary workshops, two technical meetings, and numerous analyses of technical information and quantitative modeling. In total, 216 CAPEX scenarios, 648 scenarios for the levelized cost of electricity (LCOE) for different typologies of geothermal projects, and 12

³³ Only two exploitation concessions were awarded by the GoC between 2017 and 2021.

³⁴ The web-based platform was still undergoing final testing at the time of completion of this ICR.

³⁵ *Mesa de Geotermia, Rol de la Geotermia en el Desarrollo de la Matriz Eléctrica Chilena; Centro de Energía de la Universidad de Chile, ESMAP, Fundación Chile; Julio 2018.*



energy matrices were modeled. The work was undertaken in three phases:

- Stage 1 focused on defining the current state and perspectives of development of geothermal projects in Chile. Based on the best information available on identified geothermal zones, the developable geothermal potential was estimated and the investment (CAPEX) and operating (OPEX) costs for possible typologies of geothermal projects was determined.
- Stage 2 concentrated on two main issues: (i) determining the levelized cost of electricity that geothermal power projects should reach to be economically efficient and competitive in the expansion of the electrical system and (ii) identifying potential benefits associated with the introduction of geothermal energy in the electrical system, in particular its impact on the operational costs of the system in the context of high participation of variable renewable sources.
- Stage 3 used the results of Stages 1 and 2 to analyze the competitiveness gaps of geothermal energy in the electrical system and to evaluate public policy actions to promote geothermal development in Chile.

58. **In addition to generating a broad foundation of common understanding among stakeholders in Chile, the Roundtable’s conclusions influenced the GoCl’s new energy sector policy, *Ruta Energética 2018-2022*.** Among the Roundtable’s key recommendations adopted by the *Ruta Energética* were (i) improving the information available on geothermal resources and their potential; (ii) strengthening the regulatory framework; and (iii) the creation of a transparent and accessible platform for the management of geothermal concessions. The findings of the Roundtable continue to be cited in policy discussions and analyses of different aspects of geothermal energy. The delivery of the Roundtable’s report ***fulfills the target of Intermediate Indicator no. 3, a study of the integration of geothermal in Chile’s electricity market.***

59. **A key theme addressed by the Project was the contribution of geothermal to flexibility in Chile’s electrical system.** Geothermal energy is a baseload electricity generation source. This means that geothermal plants produce electric power at a consistent rate at all times. In Chile, the power system integrates high levels of solar and wind, whose power outputs can be variable and uncertain, creating a fluctuating supply. Geothermal can provide operational flexibility—the ability of a power system to quickly and continuously match supply to demand—provided that the price of geothermal electricity is competitive with other available baseload sources. As observed in a 2018 note by a specialist of the Inter-American Development Bank:

“The Roundtable findings show that, based on the assumptions used for the simulation exercise, Chile’s main grid has enough flexible generation resources to enable low-cost variable renewable energy generation (wind and solar) to continue growing until ≈2025. The recent interconnection between the former Northern and Central grids has played a significant role in increasing this flexibility. However, thereafter the system will increasingly need either more baseload generation such as geothermal or coal-fired (that matches the flat load profile of the important mining sector) or flexible resources such as hydropower with storage. Given the difficulties faced by new large-scale hydropower and coal-fired projects, geothermal power, concentrated solar power with thermal storage, and electricity storage technologies are set to play a relevant role in the medium term. Therefore, even though geothermal power is unlikely to ever be competitive with wind or solar, it has a role to play as part of a pool of energy assets. In fact, it is by having recourse to a diversified pool of generation assets, including geothermal, that *Enel Generación Chile* was able to secure a PPA as a



result of an energy auction held in November 2017. This PPA will start in 2024, which coincides with the period where the modeling predicts an increasing role for geothermal power.”³⁶

60. **The Project addressed the issue of flexibility in Chile’s electricity system through five studies:**

- “Strategy for Development of Geothermal Energy in Chile” (*Estrategia para el Desarrollo de la Energía Geotérmica en Chile*), Castalia Strategic Advisers, 31 de julio 2018 [Bank executed]
- “Methodology to Determine Capacity Sufficiency in the Chilean Electrical System through ELCC/ECP” (*Metodología para la Determinación de Potencia de Suficiencia en el Sistema Eléctrico Chileno vía ELCC/ECP*), Instituto Sistemas Complejos de Ingeniería (ISCI), 27 de octubre de 2020 [Bank Executed]
- “Strategic Advisory for Improving Capacity Payments in the Chilean Electrical Market” (*Asesoría Estratégica para el Perfeccionamiento del Pago por Potencia del Mercado Eléctrico Chileno*), Daniel Olivares Quero, May 11, 2021 [Bank Executed]
- “Study to Assess Chilean Electricity Market Competitiveness Under a Bid-Based Pricing Scheme and Measures to Transition to this Scheme”, Vinken Dictuc, 25 de Agosto de 2021 [Bank Executed]
- “Study on Inclusion of Support for Flexibility in Electrical Supply Infrastructure through the Chilean Capacity Payment Mechanism” (*Estudio para Incluir el Aporte a la Flexibilidad de las Instalaciones del Sistema Eléctrico en el Mecanismo de Pago por Capacidad Chileno*), Entregable No. 3, Informe Final, Instituto Sistemas Complejos de Ingeniería (ISCI), 19 de noviembre de 2021 [GoCI Executed]

61. **The second, third, and fifth studies provided the basis for the adoption of a new GoCI regulation on capacity payments for power generation.** Mechanisms for capacity payments are important to ensure that sufficient generation capacity is available to meet peak electricity demand or make up for unexpected reductions in solar and wind electricity generation. A new Presidential Decree is under preparation that updates the current regulation for the Power Adequacy Mechanism and allows the national power system to incentivize cleaner, more efficient energy.³⁷ The Decree facilitates the incorporation of renewable energy and storage into the system by adequately valuing the “firm power” that suppliers can provide into the power system. It also establishes long-term market signals to encourage investment in technologies that provide flexibility for the electric power system. This would level the playing field and allow a fairer technical competition between renewable energy, traditional generation sources, and various storage technologies. It would also support the system’s stability, while enabling the secure integration of low-carbon technologies.

62. **The fourth study was commissioned to analyze the feasibility of transitioning from the existing marginal cost-based approach for contracting electricity generation to a bid-based scheme,** in the interest of achieving more market efficiency. This study is considered by the MoE as a first key step in a medium to long-term process, in consultation with stakeholders, to make the appropriate modifications.

63. **The implications of these activities for geothermal energy in Chile were considered positive.** The first study evaluated the extent to which geothermal could be a component of an optimized energy matrix in

³⁶ <https://pubdocs.worldbank.org/en/663711613892076714/PCTFCL222A-Comments.pdf>

³⁷ The GoC has finalized the consultation process to update the current regulation, and the Presidential decree is being processed in the Office of the Comptroller General (*Contraloría General de la República*).



Chile in the long term.³⁸ The study observed:

“Geothermal is likely to be an efficient component of Chile's optimal energy matrix in the long term. . . [The analysis] suggests the likelihood that geothermal could play an efficient role under the newly defined [flexible] operational model—possibly as low as Concentrated Solar Power (CSP) and less expensive than coal or even Combined Cycle Gas Turbine (CCGT).³⁹”

64. The second study concluded:

“It is to be expected that coal-fired plants will begin to go out of service in the next few years and that, at the same time, a massive input of variable generation is occurring, which can increase power sufficiency problems in the electrical system. In this light, it is expected that, if there is a greater insertion of geothermal generation in the future, this technology is capable of replacing part of the base generation of the system, given that it allows generation with high availability, at low operational cost, and without emitting greenhouse gases.”⁴⁰

Enhance Geothermal Competitiveness in the Long Term by Exploring Synergies with Alternate Uses and Related Domestic Sectors (Subcomponent 2.C)

65. **The Project was designed to explore options of geothermal energy beyond electricity generation.** Under the original scope of this subcomponent, the Bank executed part of the Project was to have financed “a strategy for enhancing domestic content in geothermal development through existing industries and service providers in Chile, including identification of suitable alternate applications of low and medium enthalpy resources for direct uses”. The GoCl executed part intended to follow this up by identifying the sectors best positioned to develop low and medium enthalpy resources in an economic fashion and designing appropriate schemes to promote and implement the use of such resources. In practice, the issue of enhancing domestic content in geothermal direct use applications was not addressed. However, with the drop in electricity market prices in Chile rendering geothermal electrical power less competitive in price per MW, the Project directed its efforts after 2018 toward a wide array of investigations of low and medium enthalpy applications.

66. **The GoCl executed part of the Project carried out the following activities under this subcomponent:**

- “Technical and economic feasibility analysis of the installation of geothermal heat pumps for self-consumption purposes in agricultural facilities in the Aysén and Magallanes regions” (Nov 2017 - June 2018). This activity tested technical and business models. It found that other energy sources were more economically viable for the uses studied (see below).
- “Dynamic simulations of thermal demand and analysis of thermal integration for district heating of the Aquatic Center of the National Stadium” (June - Nov 2018). These complementary activities were considered by the MoE as having a significant impact due to the opportunity to serve as a proof-of-concept in a high-visibility, high-level sports facility. The study also analyzed the potential energy integration with the surrounding neighborhood. It may inform the development of district heating opportunities in this and other neighborhoods throughout the country.
- “Evaluation of district heating for the Cities of Coyhaique and Puerto Williams” (Mar - Oct 2019). The study assessed technical and commercial viability, comparing geothermal with other energy

³⁸ The name of this study is misleading, as it did not present a strategy as such.

³⁹ Ibid, page 9.

⁴⁰ ISCI report October 2020, page 95.



sources. It found that the most financially and economically viable alternatives in the south of Chile for district heating were biomass and gas.

- “Preparation of low enthalpy geothermal favorability maps in the Los Rios and Los Lagos regions” (Sept 2020 - Dec 2021). This activity produced high-quality data aimed primarily at private developers. The maps indicate the most favorable locations for the installation of geothermal heat pumps (both open and closed loop) that would allow decision makers and key stakeholders to adequately assess low-enthalpy geothermal resources and thus enable the implementation of both private and public projects to take advantage of these resources. This work was considered of high impact by the MoE, which, given the relevance of the activity, will continue to map geothermal resources in additional regions where vulnerable population lives, with a strong focus on direct uses.
- “Evaluation of the impact of implementing geothermal heat pumps for heating and domestic hot water in intercultural rural schools of the Los Lagos region” (Feb - July 2021). From an initial set of seven schools, three schools in rural areas with indigenous populations were selected for these technical-economic evaluations. The socio-indigenous element was a decisive parameter in the selection. The government (Ministry of Finance and Ministry of Energy) have decided to move forward with a pilot to provide low-enthalpy heating to two rural schools in indigenous areas, which will have a positive demonstration impact.
- “Impact assessment for implementing geothermal heat pumps for heating and domestic hot water systems in the cities of Punta Arenas, Puerto Natales and Porvenir” (Apr-Aug 2021). Similarly to the study of Coyhaique and Puerto Williams, this assessment found that geothermal energy was not an economically viable alternative in the southern area of Chile, despite its technical feasibility, due to the availability of natural gas at subsidized prices and biomass.
- “Production and dissemination of videos, manuals, and brochures and implementation of seminars and workshops for different audiences on the uses of low enthalpy geothermal energy” (2017-21). Much of the material is on the MoE’s web site. This includes a micro-documentary on successful applications of geothermal heat pumps in different areas.

67. One additional related activity was implemented after the publication of the national net zero strategy under the Bank-executed part to help assess carbon neutral and sustainable heating in social housing. This was an “Assessment of the economic and environmental impact of implementing net zero geothermal heat pumps for social housing” (Aug-Dec 2021). The study analyzed the potential for achieving net-zero energy use for various kinds of social housing, comparing different energy efficient technology combinations and analyzing the potential for geothermal energy to fulfill most of the housing’s energy needs. Among the main findings was that, for each housing typology studied, net zero energy standard applications exist that can generate sufficient savings to make the investments in the envelope, self-generation system, and heating system profitable over a period of 20 years. The results of the NetZero affordable housing study will open a new line of work for the Ministry of Energy as it will be included in Chile’s *Energy Agenda 2022-2026*⁴¹, the main energy policy document to guide the efforts to be developed by the Ministry under this administration.

68. The Project’s Results Framework included an intermediate indicator on the production of a study on alternate uses of geothermal energy in Chile. While this was apparently envisioned to be a single broad study of the topic, such assessment was developed through eight studies of specific applications mentioned

⁴¹ The Energy Agenda 2022-2026 will be launched on June 28th, 2022.



above were carried out and documented. ***Thus, the target for intermediate indicator no. 5 is considered to have been achieved.***

69. **These studies as a whole added substantially to the body of knowledge and experience in Chile regarding the technical, financial, and economic viability of geothermal energy.** In this sense, they contributed to the PDO outcome of promoting the development of commercial geothermal resources. This substantial body of work sponsored by the Project had a major impact in terms of opening key sector stakeholders in Chile towards direct uses of geothermal energy, especially on their ability to contribute to greater equity and social development in the form of applications such as sustainable heating and hot water for rural schools and social housing, heating of greenhouses, and the operation of public sports facilities. It is important to note that the Project's geothermal direct use activities were implemented in the south of the country where poverty is heavily concentrated, very cold weather predominates, and many native and vulnerable populations have scarce and erratic access to modern and clean energy services. The direct use pilots implemented under the Project have the potential to be scaled up to contribute to improving social conditions in these areas. The documented experiences of these activities also represent a public good and knowledge-based impact for other countries.

70. **The Project included an ambitious PDO indicator, “greater exploration of geothermal resources through the drilling of wells”,** whose target was four to six additional wells drilled, above the 2016 baseline of seven wells, for an end-of-project result of 11 to 13 wells. The Project Paper defined the indicator as “new geothermal wells that are drilled by developers indicating improved market conditions for investment in [the] sector”. No distinction was made between exploration and exploitation wells. The end result for this indicator by the close of the Project was 17 wells drilled, as reported in the final ISR of October 2021. According to the Aide Memoire of August 2020, the 17 wells had been drilled as of December 30, 2019. In its Project Progress Report for January-June 2021, the MoE stated:

“The number of deep geothermal wells drilled as of July 1, 2020, in Chile reached 17: one in the El Tatio exploitation concession, two in the former San Gregorio exploitation concession, and 14 in the Apacheta exploitation concession.⁴² Of the wells drilled in Apacheta, six benefited from the MiRiG, operated by the Inter-American Development Bank within the framework of the Clean Technology Fund (CTF) grant. It is important to note that the MoE, through the [World Bank financed] Technical Assistance, participated together with the IDB in the supervision of the MiRiG and in its redesign.”

71. **There is no hard evidence to attribute these results directly to the Project.** It could be argued that the Project in its totality, through the design of the risk sharing mechanism, providing capacity building and supporting regulatory improvements, helped to create a more favorable environment for geothermal development, in the absence of which some of the additional drilling might not have been done. However, this is largely conjecture. As mentioned above, market conditions during the past five years have not been favorable to geothermal power. According to data from the MoE, of the nine currently active exploitation concessions, only three were granted after 2016. There is one active exploration concession, which was granted in 2017. ***Overall, although the target for PDO indicator #1 was achieved, this result cannot reliably be attributed to the Project and therefore does not carry weight in the assessment of Project outcomes.***

72. **Subcomponent 1.C, “Capacity building and institutional strengthening”,** supported the entire project in a cross-cutting way and was not directly related to any particular PDO outcome. The GoCl executed part of

⁴² The *Cerro Pabellón* Geothermal Power Plant is operating in the Apacheta concession.



the Project financed 10 specialists who worked on numerous activities.⁴³ This subcomponent also financed three study tours/workshops for MoE staff, one on social and environmental issues (2018) and two on direct uses (2018 and 2019).

73. **Table 1 summarizes the degree of achievement of the indicator targets** in the Project's Results

⁴³ Management coordinator, administrative coordinator, financial management specialist, procurement specialist, three socio-indigenous specialists, geologist, geophysicist, hydrogeologist.



Framework, including those under the Bank Executed and the Recipient Executed grants.

Table 1: Summary of Achievement of Indicator Targets

PDO Outcomes	Related Indicators	Indicator Type	Baseline	Target	Actual value end-of-project	Remarks
Resolve specific barriers to improve the geothermal energy market conditions	Submission for legislative approval of law and/or revised policies necessary for providing greater regulatory clarity to investors	PDO	None	Law submitted for legislative approval	Law 19.657 submitted to Congress in April 2019, approved by House of Representatives in January 2020, and awaiting approval by Senate	Target achieved
	A framework designed to mobilize risk capital toward geothermal exploration	PDO	None	Mechanism under implementation	Proposed mechanism not implemented	Target not achieved due to changes in market prices and lack of funding from CTF
	Recommendation made for risk mitigation solutions based on global solutions tailored for Chile	Intermediate	None	Completed	Recommendation made under Geothermal Roundtable	Target achieved
	Stakeholder awareness consultations held	Intermediate	0	2	15	Target surpassed
Contribute to development of commercializable geothermal resources	Greater exploration of geothermal resources through the drilling of wells (new commercial wells drilled)	PDO	7	11-13	17	Target surpassed, but this result cannot reliably be attributed to the Project, so this indicator does not carry weight in the assessment of PDOs
	Review and recommendation report for geothermal concession framework	Intermediate	None	Completed	No separate report on this was prepared, but some relevant recommendations made under other studies	Target partially achieved
	Study on integration of geothermal in electricity market completed	Intermediate	None	Study completed	Fulfilled by the report of the Geothermal Roundtable	Target achieved
	Study on alternate uses of geothermal in Chile	Intermediate	None	Report finalized	No single, broad study carried out; rather, eight studies of specific applications were implemented and documented	Target achieved



Summary of efficacy assessment

74. **The Project had mostly positive results in achieving the first PDO, resolving specific barriers to improve geothermal energy market conditions.** It supported the successful preparation and submission to Congress of the revised Law 19.657 on geothermal concessions. It also financed studies to provide the bases for new regulations under Law 19.657 dealing with the health, safety and sustainability of geothermal energy uses and a registry of shallow geothermal projects. The Project implemented an extensive program of stakeholder engagement focused on raising awareness about the social and environmental aspects of geothermal development—primarily for indigenous communities—which had a significant constructive impact. The Project was not successful in establishing a risk mitigation mechanism for geothermal electricity investments, due to (i) changes in market prices that rendered geothermal power uncompetitive in terms of cost per MW and (ii) a lack of funding for such a mechanism.

75. **The Project’s contributions toward the second PDO, fostering the development of commercializable geothermal resources, also were mostly positive.** The Project-financed Geothermal Roundtable laid an extremely important foundation for integrating geothermal in Chile’s electricity market by increasing knowledge among stakeholders in government, the private sector, the research community, and civil society. The five studies financed by the Project on energy system flexibility also made significant contributions to the future prospects for geothermal’s integration. The Project was highly successful in exploring alternate (direct) uses of geothermal energy through its support for eight studies/pilot subprojects. The Project was only partially successful in promoting the establishment of a geothermal concessions management framework. It supported the launch of a web-based platform, but other envisioned reforms were not implemented due to the aforementioned changes in market conditions.

76. Accordingly, the Project’s *achievement of its PDOs is rated as Substantial*.

C. EFFICIENCY

77. **Given that the Project was limited to technical assistance** and that, consequently, its prospective impacts on improving market conditions and reducing barriers for geothermal energy development were indirect, a quantitative cost-benefit analysis was not carried out at appraisal.

78. **The Project originally was designed to last slightly less than four years, from approval in October 2016 to closing in June 2020.** The closing date was extended twice, for a total of 18 months, due to delays arising from the changes in government administration in March 2018, evolving Chilean energy market conditions that significantly affected the role of geothermal energy, social unrest in the country that started in October 2019 and disrupted normal work, and the Covid-19 pandemic that caused office closures, national lockdown measures, and domestic travel restrictions.⁴⁴

79. **As mentioned in the Project Paper, it was anticipated that circumstances affecting the scope and priorities of the Project would probably change;** therefore, the Project was designed with flexibility to respond to challenges that could not be fully anticipated.

80. **The Project was not affected by procurement delays or cost overruns.** The Project documentation indicates that normal procedures were followed under World Bank and GoCI rules to ensure the cost-effectiveness of the technical assistance contracts.

81. Accordingly, the *efficiency of the Project in achieving its results is rated as Substantial*.

⁴⁴ Restructuring Paper, February 2020, para. 6; Restructuring Paper January 2021, para. 7.



D. JUSTIFICATION OF OVERALL OUTCOME RATING

82. Based on the Project's assessed High relevance, Substantial efficacy, and Substantial efficiency, the overall outcome is rated as Satisfactory.

E. OTHER OUTCOMES AND IMPACTS

83. None.

III. KEY FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOME

A. KEY FACTORS DURING PREPARATION

84. **The Project was complex and ambitious, especially in attempting a comprehensive approach to issues of geothermal energy.** The PDOs were challenging (see Section IV.A) but not unrealistic. The blending in one project of recipient executed and Bank executed elements was appropriate for Chile and the sector being addressed, but it was unorthodox in terms of World Bank procedures and created some awkwardness for this ICR, as only recipient executed IPF operations are subject to completion reports. The Results Framework had some flaws, including one PDO indicator (number of commercial wells drilled) that could not be attributed to the Project. The Project had some deficiencies of readiness at the time of effectiveness. Terms of Reference (ToRs) for studies under most subcomponents had not been prepared. Also, Terms of Reference of key staff of the Project Unit had not been developed. These gaps led to implementation delays during the first 12 months after effectiveness.

B. KEY FACTORS DURING IMPLEMENTATION

Subject to Control of Government and/or World Bank

85. **Effectiveness delay.** Project implementation was originally planned to start in October 2016; however, effectiveness was not reached until April 2017 because of the need for the grant package to be reviewed and approved by the *Contraloría de la República* prior to issuance of the required legal opinions.

86. **Lack of readiness.** ToRs for activities under most subcomponents were still being developed in late 2017. At that time, none of the four key positions in the Project Unit (Technical-Administrative Coordinator, Financial Analyst, Procurement Analyst, and Social-Indigenous Specialist) had yet been filled.⁴⁵ These staff were finally brought on board by October 2017.

87. **Reorientation of the Project as of 2018.** Following the steep decline of energy prices during 2016-2017 (see below), the GoCl and the Bank decided in early-mid 2018 to put on hold several Project activities under Component 2 (e.g., risk mitigation framework, integration of geothermal in the broader power market) until after the release of the results of the Geothermal Roundtable (in July 2018) and the completion of the transition to the newly elected government. In the event, the risk mitigation work was set aside, and the integration activities were subsumed under the already completed Roundtable work.

88. **Capacity limitations of MoE team 2018-19.** According to ISR #5 of May 2019, during the last quarter of 2018 and the first quarter of 2019, Project implementation slowed down because the team at the MoE was focused on preparing the proposal for modifications of Law 19.657 on geothermal concessions, a high priority for the GoCl at the time, and one of the main project objectives.

89. **Turnover of project staff.** Project implementation was slowed by turnover of some of the personnel

⁴⁵ Aide Memoire, September 2017.



working on the project at the MoE and AGCID (e.g., replacement of the socio-indigenous professional in January 2020, replacement of the technical administrative coordinator who resigned in April 2020, and hiring of an additional staff to support the Project Coordinator).

Outside the Control of Government and/or World Bank

90. **Changes in market conditions.** At the time of project preparation (2014-15), the potential of geothermal electricity was considered significant because contract market prices were high enough to make geothermal generation reasonably competitive. However, by 2017, market prices had dropped by more than half. The Restructuring Paper of February 2020 reported that “the Chilean energy sector has changed drastically since Project approval, with the introduction of generation auctions⁴⁶ and transmission reforms that have resulted in a significant increase of NCRE sources and drastic reductions in electricity market prices. This has led to the need for the Government to re-prioritize and redefine the scope of various Project activities.” The Castalia study (2018) stated, “The context in which this technical assistance was to take place has changed drastically since its initial conception. The Chilean electricity market has evolved from a situation characterized by limited security of supply and high prices to a situation of abundant supply of energy with a high share of renewable sources, in an interconnected system with very low prices.”⁴⁷ Accordingly, as described in earlier sections of this ICR, from 2018 onward the Project was increasingly focused on energy supply flexibility, stakeholder engagement, and low enthalpy direct uses of geothermal, all which were a priority for the sector and the government.

91. **Change of Government following general elections in November 2017.** Project implementation slowed during the first half of 2018 due to the change of government administration. The Project faced a need to define, with the new authorities, the remaining activities to be undertaken in alignment with the government’s priorities (established in the *Ruta Energética* 2018-2022). Some hiring processes for the Project were put on hold in late 2017 but resumed in April 2018.

92. **Social unrest starting in October 2019.** Protests began in Santiago in October 2019, triggered initially by increases in subway fares but rapidly expanding to encompass other issues. The protests spread to other cities and included not only peaceful demonstrations but acts of violence and vandalism. Protests and violence continued into the first months of 2020 but then declined considerably in scale and frequency as a result of the Covid-19 pandemic.⁴⁸ The unrest negatively affected the Project due to frequent government office closures during protests and halts in field work for geothermal resource assessment activities and stakeholder consultations.

93. **Covid-19.** Starting in March 2020, the Covid pandemic produced partial lockdowns in Chile, with the institution of homebased work for government employees and domestic travel restrictions. These led to suspensions and postponements of field work (e.g., geological/geophysical resource mapping for direct uses of geothermal), stakeholder and technical workshops, training events and study tours, and the contracting of some studies.

⁴⁶ Chile uses an auction system that allows electricity suppliers to bid on the basis of a mix of technologies, based on a daily timing cycle.

⁴⁷ *Estrategia para el Desarrollo de la Energía Geotérmica en Chile*, Castalia Strategic Advisers, 31 de julio 2018, p. 5

⁴⁸ In November 2019, Chile's National Congress approved the holding of a national referendum on rewriting the constitution. The pandemic led to the postponement of the referendum from April to October 2020, when Chileans voted in favor of a new constitution. In May 2021, voters elected the members of the convention to draft the new constitution.



IV. BANK PERFORMANCE, COMPLIANCE ISSUES, AND RISK TO DEVELOPMENT OUTCOME

A. QUALITY OF MONITORING AND EVALUATION (M&E)

94. **M&E Design.** Designing PDOs and indicators for technical assistance projects such as this is inherently difficult. The effects of technical assistance on concrete outcomes are typically indirect and highly dependent on factors outside the scope of the project. The PDOs for this Project were challenging to accomplish, although tempered by the words “assist” and “contribute”. The phrase in the PDO “improve the geothermal energy market conditions” was difficult; the Project could not affect the market, but, rather, the Project intended to “level the playing field” for geothermal within the existing market and the government’s technology-neutral energy policy. The Results Framework had some flaws, including one PDO indicator (number of commercial wells drilled) that was not attributable to the Project.

95. **M&E Implementation.** The indicators were simple and posed no methodological challenges for measurement or collection. The Bank’s ISRs and Aide Memoires reported regularly on the degree of achievement of the indicators. After the significant market changes that occurred from 2017, the PDO and Results Framework could have been modified to (i) replace the PDO indicator on wells drilled with another that was more attributable to the Project, (ii) replace the PDO indicator on the risk mitigation mechanism with another, more relevant one, and (iii) reflect the reorientation of the Project away from geothermal electricity generation and toward flexibility, engagement with indigenous communities, and direct uses. While these revisions were assessed by the team, it was considered that Project could continue implementation towards achievement of PDO without need to restructure.

96. **M&E Utilization.** ISRs and Aide Memoires showed a detailed focus on monitoring the implementation of technical assistance activities and the use of project funds. However, they paid little attention to how the products were utilized towards achievement of the PDOs. The ISRs did not address how the increase in the number of wells drilled could be attributed to the Project. The submission of the revised geothermal concessions law to Congress was reported, but there was no follow up on how the submitted law would contribute to the PDOs.

97. **Overall M&E rating.** Based on these factors, the Project’s overall M&E quality is assessed as **Modest**.

B. ENVIRONMENTAL, SOCIAL, AND FIDUCIARY COMPLIANCE

98. **Environmental.** The Project was classified as Environmental Category B. Although the Project financed only technical advisory services, with no support for physical investments or the implementation of any geothermal projects on the ground, it triggered then-applicable Operational Policies 4.01 Environmental Assessment, 4.04 Natural Habitats, 4.36 Forests, and 4.11 Physical Cultural Resources in case of possible downstream impacts, to ensure that the technical assistance would be consistent with the Bank’s environmental and social safeguards policies, and to integrate environmental and social objectives in the TA process. In the event, no negative environmental effects associated with the Project were encountered during implementation.

99. **Social.** On the social safeguards side, the Project triggered Operational Policies 4.10 Indigenous Peoples and 4.12 Involuntary Resettlement as a precaution in case of any downstream impacts. No adverse effects arose during Project implementation. As explained in previous sections of this ICR, the Project supported an extensive program of engagement with local communities and leaders in areas potentially affected by geothermal development. This element of the Project ended up being much more far-reaching than originally planned. The Bank fielded a safeguards mission in November 2018 that found that the Project’s efforts under



subcomponent 1.D (Stakeholder engagement to address social and environmental considerations of geothermal development) constituted good practices for the Latin America region.⁴⁹ Safeguards compliance was rated **Satisfactory** in all the eight ISRs produced over the duration of the Project.

100. **Financial Management (FM).** No problems were reported in any ISRs or Aide Memoires regarding compliance with the Bank's FM requirements for recipient executed grants. No late audits or negative findings from any audits were reported.

101. **Procurement.** Procurement plans were updated as needed during the implementation of the Project. A training session for AGCI staff on World Bank procurement processes was conducted in March 2017. A few cases of moderate delays in some procurement processes occurred; these were followed up and resolved by AGCI and the Bank team. No problems of compliance with the World Bank's procurement rules for recipient executed grants were reported.

C. BANK PERFORMANCE

102. **Quality at Entry.** The Project Paper reflected careful attention to the Project's strategic relevance and a coherent, selective approach to the Project's design. Technical, policy, and institutional issues of geothermal energy were systematically taken into account. Environmental and social aspects were appropriately dealt with, especially through the inclusion of a subcomponent specially devoted to social engagement with affected indigenous groups. For a technical assistance operation, the Project was complex and ambitious, but it was straightforward to implement in terms of technical oversight, contract management, FM, and procurement. The PDOs were challenging, though not unrealistic. As discussed above, the Results Framework had some flaws, and there were deficiencies of readiness at the time of effectiveness. The Project's risks were rated according to the Bank's Systematic Operations Risk Rating Tool (SORT), but the PP's risk assessment focused on the generic risks of geothermal energy development, not the risks of the operation itself. The risk ratings per the SORT were appropriate, with most risk factors rated as Moderate and only the Sector Strategy and Stakeholder risks as Substantial. The Bank designed the Project as a blend of recipient and Bank executed elements, which was appropriate for the country and sector context but unorthodox in that ICRs are only applicable to recipient executed IPF projects and not to Bank executed activities.

103. **Quality of Supervision.** The Bank carried out formal supervision missions at six-month intervals through 2018, but after those missions and reporting through ISRs and Aide Memoires became less frequent, at around one per year. The Bank was attentive to facilitating the adaptation of the Project to the significant changes that took place in Chile's energy market during 2017-2019 (see above). From early 2020, supervision was hindered by Covid-related restrictions on meetings and travel. After the mission of July 2019, there was a gap of 13 months until the next mission in August 2020, which was virtual. The documentation indicates no formal supervision missions after that. However, the Bank team maintained close contact with counterparts of the MoE and AGCID, including bi-weekly conference calls. Up to June 2018, ISRs were issued every 5-7 months, but after that the intervals between ISRs became 12 months, except for the last two in 2021 (May and November). The ISRs from 2018 onward complied with basic Bank requirements, but they did not provide "real-time" reporting, as these ISRs were issued between 6 and 10 months after the missions on which they reported. The Bank's Aide Memoires and ISRs show that the Bank's supervision focused on keeping track of the Project's relevance to the Chilean context and to the delivery of the Project's outputs. The Bank's ISRs and AMs monitored the status of the Project's results indicators, but there was a lack of attention to the meaning and relevance of the indicators for the achievement of the PDOs. If the Bank had focused during

⁴⁹ Aide Memoire, November 2018.



implementation on the relation between the Project's outputs and outcomes, it might have corrected the flaws of the Project's original Results Framework.

104. Overall Rating of Bank Performance. Based on the above, the Bank's performance is rated **Moderately Satisfactory**.

D. RISK TO DEVELOPMENT OUTCOME

105. The risk that the Project's development outcomes will not be sustained is judged to be minimal. The Project supported an extensive body of robust analytical work, capacity building, and stakeholder engagement on geothermal energy. The well-documented knowledge base from these activities will remain for many years to come an essential reference and foundation for government officials, the private sector, civil society, and academia on the reduction of barriers to geothermal energy development and the advancement of commercial geothermal energy.

V. LESSONS LEARNED AND RECOMMENDATIONS

106. Analytical work undertaken by the Energy Sector Management Assistance Program (ESMAP) after the start of the Project confirmed that the Project focused on the appropriate constraints to geothermal development in Chile.⁵⁰ The key challenges identified by ESMAP that are relevant to Chile were: (i) creating a supportive policy, legal and regulatory framework, (ii) achieving sufficient institutional capacity, (iii) overcoming the very high up-front financial risks of developing geothermal power generation, and (iv) proper management of environmental and social risks. Accordingly, the GoCI may consider prioritizing support for low enthalpy geothermal applications while not losing sight of the potential for large-scale, high enthalpy projects to complement variable renewable power generation and add resilience and flexibility to the electricity system, especially in light of the likely early retirement of coal power plants in the country.

107. The experience of the Project helped identify the opportunities for geothermal energy for the country. The current situation in Chile—where the electricity market has access to hydropower resources (although decreasing due to the extensive drought experienced by the country), moderately priced fossil fuels, and plentiful, low-cost and low-risk alternative renewable sources (mainly wind and solar)—makes it challenging for geothermal to be competitive in terms of the cost per MW generated, but could potentially have a space given the need to reach a net zero economy and support increased flexibility in the grid. As long as these circumstances persist, public sector financing would be needed to develop geothermal power if the Government wishes to do so to achieve its net zero objectives, promote energy diversification, and improve energy security. **The GoCI, together with its development partners, should continue to consider the viability of various approaches**, which may include: (i) government as part of a public private partnership, (ii) cost-shared exploratory drilling, (iii) resource risk insurance, and (iv) early stage fiscal incentives.⁵¹ In the meantime, **small to medium scale direct uses of geothermal may continue to be developed where such applications are commercially viable**, as suggested by the activities carried out under subcomponent 2.C of the Project. The final passage and enactment of the revisions to Law 19.657 should help to facilitate these types of projects.

108. The positive contributions of the Project to knowledge and awareness of geothermal energy's

⁵⁰ See "Opportunities and Challenges for Scaling Up Geothermal Development in Latin America and the Caribbean Region", Energy Sector Management Assistance Program (ESMAP), World Bank, November 19, 2018.

⁵¹ See "Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation - A Global Survey", Energy Sector Management Assistance Program (ESMAP), World Bank, Knowledge Series 024/16, May 9, 2016.



environmental and social aspects need to be followed up with other actions. In 2018, the Superintendency of the Environment (SMA), the national regulator, filed charges against the *Cerro Pabellón* geothermal plant for 16 violations of environmental legislation. These included the alteration of 31 archaeological heritage sites and the unauthorized consumption of water. The company in charge of the plant, *Geotérmica del Norte*, presented a compliance program with corrective measures. This allowed it to continue with its operations and an expansion plan.⁵² This experience indicates that **the GoCI needs to improve the framework for environmental assessments and compliance of energy projects (not only geothermal) and the work completed during the Project can help inform the GoCI's next steps.**

109. **The Project adapted to unanticipated changed circumstances** (i.e., the drastic drop in electricity prices) by setting aside certain originally planned activities and focusing more on others, within the general scope of the original PDO. However, more could have done to **change the Project's design or Results Framework.** However, perhaps because the Project was small in size, limited to technical assistance, and 50 percent Bank executed, this may have deemed too cumbersome, especially considering the difficulty in getting the Project approved by the National Comptroller's Office which in the case of a restructuring would take at least six months to a year. To preserve attributions of some of the Project's result indicators, the Project could have been formally restructured in 2018, although the national approval constraints may have deterred from going this route. **In the future, the Bank should take care to treat smaller TA projects approved as IPF the same way that it treats conventional IPF lending operations, as requirements for restructuring small TAs can be oversized. Also, indicators for TA projects should be carefully designed to rely on clear causal chains that ensure they are attributable to typical TA interventions, i.e., studies, technical support, and training.**

110. **The Bank should normalize technical assistance projects that use a blend of Bank executed and recipient executed funds in cases where this modality is appropriate.** For administrative purposes and to facilitate ex post evaluation, the Bank executed funding could be treated as a form of co-financing for recipient executed technical assistance projects funded by grants that are approved as Investment Project Financing.

⁵² *La energía geotérmica puede ayudar a Chile en su descarbonización*, March 19, 2021
<https://dialogochino.net/es/clima-y-energia-es/41513-la-energia-geotermica-puede-ayudar-a-chile-en-su-descarbonizacion/>



ANNEX 1. RESULTS FRAMEWORK AND KEY OUTPUTS

A. RESULTS INDICATORS

A.1 PDO Indicators

Objective/Outcome: Resolve specific barriers to improve geothermal energy market conditions

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Submission for Legislative approval of law and/or revised policies necessary for providing greater regulatory clarity to investors	Yes/No	N 12-Oct-2016	Y 31-Dec-2018	Y 30-Jun-2021	Y 26-May-2021

Comments (achievements against targets):

Target achieved. Revised Law 19.657 was submitted to Congress in April 2019 and passed by the House of Representatives in January 2020. It is awaiting passage by the Senate.

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
A framework designed to mobilize risk capital toward geothermal exploration	Yes/No	N 12-Oct-2016	Y 31-Dec-2019	Y 30-Jun-2021	N 26-May-2021



Comments (achievements against targets):

Target of having a mechanism under implementation was not achieved due to changes in market prices and lack of funding from CTF.

Objective/Outcome: Contribute to development of commercializable geothermal resources

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Greater exploration of geothermal resources through the drilling of wells	Number	7.00	11.00	11.00	17.00
		12-Oct-2016	31-Dec-2020	30-Jun-2021	26-May-2021

Comments (achievements against targets):

Target surpassed, but this result cannot reliably be attributed to the Project, so this indicator does not carry weight in the assessment of achievement of PDOs.

A.2 Intermediate Results Indicators

Component: 1.D Stakeholder engagement on social and environmental considerations of geothermal development

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Stakeholder awareness consultations held	Number	0.00	2.00	2.00	15.00
		12-Oct-2016	31-Dec-2019	30-Jun-2021	22-May-2020

Comments (achievements against targets):

Target surpassed.



Component: 2.B Integration of geothermal in the broader power market in Chile

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Study on integration of geothermal in electricity market completed	Yes/No	N 12-Oct-2016	Y 31-Dec-2019	Y 30-Jun-2021	Y 22-May-2020

Comments (achievements against targets):

Fulfilled by the report of the Geothermal Roundtable. Target achieved.

Component: 1.B Geothermal concessions management framework

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Review and recommendation report for geothermal concession framework	Yes/No	N 12-Oct-2016	Y 31-Dec-2017	Y 31-Dec-2021	Y 22-May-2020

Comments (achievements against targets):

No separate report on this was produced, but some relevant recommendations were made under other studies. Target partially achieved.

Component: 2.C Enhance geothermal competitiveness in the long term by exploring synergies with alternate uses and related domestic sectors

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
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Study on alternate uses of geothermal in Chile	Yes/No	N	Y	Y	Y
		12-Oct-2016	31-Dec-2019	30-Jun-2021	22-May-2020

Comments (achievements against targets):

No single, broad study was produced. Rather, eight studies of specific applications were implemented and documented.

Component: 2.A Risk mitigation framework for geothermal projects

Indicator Name	Unit of Measure	Baseline	Original Target	Formally Revised Target	Actual Achieved at Completion
Recommendation made for risk mitigation solutions based on global solutions tailored for Chile	Yes/No	N	Y	Y	Y
		12-Oct-2016	31-Dec-2019	30-Jun-2021	22-May-2020

Comments (achievements against targets):

Recommendation made through Geothermal Roundtable. Target achieved.



B. ORGANIZATION OF THE ASSESSMENT OF THE PDO

The assessment of outcomes and achievement of indicators considers the outputs of activities implemented both under the Bank Executed and the Recipient Executed grants.

Objective/Outcome 1: Resolve specific barriers to improve the geothermal energy market conditions	
Outcome Indicators	<ol style="list-style-type: none"> 1. Submission for legislative approval of law and/or revised policies necessary for providing greater regulatory clarity to investors. 2. A framework designed to mobilize risk capital toward geothermal exploration.
Intermediate Results Indicators	<ol style="list-style-type: none"> 1. Recommendation made for risk mitigation solutions based on global solutions tailored for Chile. 2. Stakeholder awareness consultations held.
Key Outputs by Component (linked to the achievement of the Objective/Outcome 1)	<ol style="list-style-type: none"> 1. Technical advisory services to support revisions to Law 19.657. 2. Three studies to support the preparation of new regulations under Law 19.657 for geothermal power generation and direct use projects. 3. 15 local engagement activities carried out between 2017 and 2020 in areas with geothermal resources with over 400 indigenous community leaders representing six groups. 4. Two educational tours for indigenous leaders to the Cerro Pabellón geothermal plant. 5. Social and environmental assessment of geothermal and wind energy projects comprising four major deliverables; also an executive summary document of these.
Objective/Outcome 2: Contribute to development of commercializable geothermal resources	
Outcome Indicators	<ol style="list-style-type: none"> 1. Greater exploration of geothermal resources through the drilling of wells (new commercial wells drilled).
Intermediate Results Indicators	<ol style="list-style-type: none"> 1. Review and recommendation report for geothermal concession framework.



	<ol style="list-style-type: none">2. Study on integration of geothermal in electricity market completed.3. Study on alternate uses of geothermal in Chile.
Key Outputs by Component (linked to the achievement of the Objective/Outcome 2)	<ol style="list-style-type: none">1. Web-based platform for monitoring, registration and publication of geothermal concessions, for both the Ministry's internal management and for the public.2. Geothermal Roundtable, Dec. 2016 – July 2018.3. Five studies on the issue of flexibility in Chile's electricity system.4. Eight studies/pilot projects related to low enthalpy direct uses of geothermal energy.



ANNEX 2. PROJECT COST BY COMPONENT

Components	Amount at Approval (US\$M)	Actual at Project Closing (US\$M)	Percentage of Approval (US\$M)
Total	0.00	0.00	0.00

Recipient Executed Project Costs

Breakdown by Project component of the Recipient executed funds

(US\$ million)

	Planned Budget	Actuals	Percentage Executed
<i>Component 1A</i>	<i>0.125</i>	<i>0.000</i>	<i>0%</i>
<i>Component 1B</i>	<i>0.200</i>	<i>0.069</i>	<i>35%</i>
<i>Component 1C</i>	<i>0.605</i>	<i>0.746</i>	<i>123%</i>
<i>Component 1D</i>	<i>0.400</i>	<i>0.187</i>	<i>47%</i>
<i>Component 2A</i>	<i>0.250</i>	<i>0.000</i>	<i>0%</i>
<i>Component 2B</i>	<i>0.000</i>	<i>0.090</i>	<i>-</i>
<i>Component 2C</i>	<i>0.200</i>	<i>0.537</i>	<i>269%</i>
TOTAL	1.780	1.629	92%

Bank Executed Project Costs¹

(US\$ million)

Trust Fund	Source	Amount at Approval	Actual at Project Closing	Percentage Executed
TF0A5286	CTF	1.08	1.08	100
TF018807	CTF	0.15	0.15	100
TF0A0164	ESMAP	0.489	0.489	100
Total		1.719	1.719	100

¹Breakdowns by Project component of the Bank executed funds are not available and is pending information from AGCI



ANNEX 3. RECIPIENT, CO-FINANCIER AND OTHER PARTNER/STAKEHOLDER COMMENTS

The Ministry of Energy (MoE) of Chile reviewed and provided comments to the ICR. The client generally agreed with the report, the storyline and the impacts highlighted, also helping clarify specific points. The MoE sent comments on May 31st, 2022, via email related to the fulfillment of the project indicators, the feasibility of restructuring the project, and the quality of WB supervision. The main comments are highlighted below.

The MoE considers that the risk mitigation framework indicator was met, since the Project supported the design of the risk mitigation framework, the framework was established, and it was able to finance an important project for the electricity sector⁵³. The comments highlighted that in 2017, with ESMAP funds, the Project developed a report detailing that a risk mitigation framework would help lift some of the most significant barriers to projects. In addition, the Project provided, through a specialist hired by the WB, a proposal for the development of a risk mitigation framework, and that even if, ultimately, the funds for this risk sharing facility were clawed back from the CTF, this was due to the fact that Chile was no longer an ODA country recipient and thus not eligible for the funds. The fact that the facility existed during the Project seems to the MoE enough to argue that the indicator was met and ultimately could say that it was partially met.

The MoE expressed that they considered the indicator regarding recommendations for improving the geothermal concession framework had been fulfilled. They mentioned that, considering the ultimate objective of the indicator was to improve the framework for managing geothermal concessions in Chile, they considered the indicator to have been fulfilled. This was since the activities implemented (*inter alia*, the creation of a digital platform for transparently and quickly managing concessions) proved an extremely useful tool and has helped make concession management much more systematized and efficient.

Regarding the ICR's statement that the project should have been restructured to make changes in the development objective indicators, the MoE expressed that although this was evaluated, the Project had gone through such difficulties with internal processes to get approved, that restructuring would have meant delaying implementation at least for a year. The restructuring assessment was made during 2018, but the MoE concluded that doing so represented a significant risk to project implementation, as they estimated getting internal approvals could delay execution for at least a year. Not only did AGCID and the MoE legal departments had to approve the restructuring, also the Comptroller's Office. In fact, project implementation was delayed partly to getting these internal approvals.

Finally, the MoE expressed that they considered WB supervision to be fully satisfactory. This was based on their close partnership developed with the WB team and consultants given their continuous and deep engagement in the Project. There were regular meetings between the WB and MoE teams, just-in-time WB support to quickly respond to ME needs, and overall collaboration through Project implementation despite the TA being implemented during two different governments with very different political affiliation.

⁵³ Cerro Pabellon



ANNEX 4. BANK EXECUTED AND RECIPIENT EXECUTED ACTIVITIES, PLANNED AND ACTUAL

	Bank Executed		Recipient Executed	
	Planned in PP	Actual	Planned in PP	Actual
Component 1 - Improve policy framework and strengthen management capabilities to help mobilize investments in geothermal energy				
1.A Enhance legal and regulatory framework for geothermal development	Conduct comprehensive review of the present Law on Geothermal Energy Concessions (No. 19,657), its implementing regulations, and other related policies	<p>Consultant services (in technical and security topics) to support the revisions of Law 19.657 on geothermal concessions (2015)</p> <p>Consultant services (in technical and security topics) to support the revisions of Law 19.657 for shallow geothermal uses (2018)</p> <p>Study on the Regulatory Framework in Chile for Geothermal Power Generation and Direct Use Projects (3 studies):</p> <ul style="list-style-type: none"> • Report on Health, Safety, Environment and Sustainability for Electricity Generation and Deep Direct Uses (June 2021) • National Registry of Shallow Uses of Geothermal Energy (July 2021) • Report on Health, Safety, Environment and Sustainability for Shallow Geothermal Development Projects (Oct 2021) 	Draft necessary regulations	



	Conduct a gap analysis, comparing domestic requirements with international standards, on the various associated legal and regulatory requirements in other sectors that impact geothermal development, with a particular area of focus being the environmental and social obligations for geothermal developers	See subcomponent 1.D	Carry out stakeholder consultations	
			Evaluate the impact of the reforms to adjust the framework for optimal performance	
1.B <i>Review geothermal concession management framework</i>	Evaluate the existing management framework for granting and overseeing the geothermal concession system, compare its suitability given the revised legal framework and identify shortcomings		Review GoCl’s internal concession management system to optimize operations	Development of a web-based platform for monitoring, registration and publication of geothermal concessions by the MoE (Aug-Dec 2021)
			Identify steps to strengthen the monitoring of awarded concessions to ensure compliance with investment and related agreements	
			Evaluate exploitation concession bids, management of award process, and oversight of concessionaire’s obligations	
1.C <i>Capacity building and institutional strengthening</i>	Provide advisory services including just-in-time support to help the GoCl address evolving needs that arise over the course of the project	“Just-in-time” technical advisory services through various international experts (2017-2021)	Provide on-the-ground advisory support and capacity building to the MoE in the geothermal sector in response to evolving sector needs	<p>“Just-in-time” technical advisory services through various international experts (2017-2021)</p> <p>Study tours for MoE professionals:</p> <ul style="list-style-type: none"> • Conference on Heat Pumps, the Netherlands (April 2017)



				<ul style="list-style-type: none"> • Workshop on social and environmental standards, World Bank (Aug 2018) • Workshop on Direct Uses of Geothermal Energy, Chile (Jan 2018) • Study tour on district energy, Copenhagen, Denmark (June 2019)
	Organize specific training sessions (including country exchanges) to develop capacity especially within the Ministry of Energy in Chile		Provide support for the coordination of all activities related to the Project	Technical/Management Coordinator, Financial Analyst, Procurement Analyst, Social Specialists, and other staff for the Project Unit (2017-2021)
1.D Stakeholder engagement to address social and environmental considerations of geothermal development	Review MoE’s recent experience with community engagement and consultations and provide recommendations on related environmental and social safeguards to meet international standards		Carry out consultations with stakeholder groups	15 workshops with over 400 indigenous leaders from six groups (<i>Aymara, Quechua, Diaguita, Colla, Mapuche y Pueblos Australes</i>) in regions with geothermal resources (2017-2020)
	Organize international knowledge exchanges		Carry out awareness building activities including exchanges with other countries that have geothermal development and incorporate feedback from these activities into the reforms implemented through the Project	Dissemination of informational material: “Geothermal: Energy from the Earth/Dissemination Material for Indigenous Communities” Two educational tours for indigenous leaders to the <i>Cerro Pabellón</i> geothermal plant (2017 and 2019)
	Carry out high-level diagnostic studies, including	Social and environmental assessment of geothermal and	Develop a stakeholder engagement strategy, informed	Executive summary of studies carried out through Bank



	identifying gaps between existing policy in Chile and international good practice	wind energy projects, comprising four major deliverables (Dec 2019-July 2020): <ul style="list-style-type: none"> • Methodological Plan • Systematization of Socio-Environmental Impacts and Mapping of Stakeholders for Geothermal and Wind Energy • Analysis of Gaps between International Standards and the Chilean Reality • Proposals for Good Practices for Participation in the Sustainable Development of Renewable Geothermic and Wind Energy Projects 	by a social assessment, to improve engagement with affected communities and to increase knowledge and awareness of scientific, social and environmental aspects of geothermal development among stakeholders, including indigenous peoples	executed side: Challenges and Proposals for Improving the Management of Socio-Environmental Impacts of Geothermal and Wind Energy Projects (May-Dec 2021)
Component 2 - Enhance market conditions for promoting sustainable development of the geothermal energy sector				
2.A <i>Geothermal resource risk mitigation framework to help mobilize investments in exploration and production drilling</i>	Review existing global experience and support the GoCI and actively participate in engaging existing and potential investors in Chile to identify specific challenges facing those looking to mobilize investments, especially in exploration and production drilling	Work related to this activity was carried out under the Geothermal Roundtable (see 2.B below)	Design and prepare a geothermal resource risk mitigation framework based on successful international experience and energy markets	
	Evaluate the various risk mitigation approaches that have been applied globally including identifying the various conditions under which some have thrived and others have been less successful			



	Review drilling practices in Chile and identify ways in which its overall costs can be reduced		Revise the legal and regulatory framework to support the geothermal risk mitigation options that will be implemented in Chile	
	Analyze and identify existing industries and service providers in Chile that could contribute domestically to the geothermal sector			
<i>2.B Integration of geothermal power in the broader power market in Chile</i>	Conduct an assessment centered on the two larger non-interconnected networks, SING and SIC, which are envisaged to be the primary off-takers for much of the expected geothermal generation capacity, to provide insights into the absorptive capacity for geothermal, its competitiveness in the power market, and financial and other constraints that limit its bankability and deter its expansion	<p>Geothermal Roundtable (Dec 2016-July 2018)</p> <p>Strategy for Development of Geothermal Energy in Chile (July 2018)</p> <p>Methodology to Determine Capacity Sufficiency in the Chilean Electrical System through ELCC/ECP (Oct 2020)</p> <p>Strategic Advisory for Improving Capacity Payments in the Chilean Electrical Market (May 2021)</p> <p>Study to Assess Chilean Electricity Market Competitiveness Under a Bid-Based Pricing Scheme and Measures to Transition to this Scheme (Aug 2021)</p>	Design and develop an incentive framework for better integration of geothermal power in Chile's broader power market	Study on Inclusion of Support for Flexibility in Electrical Supply Infrastructure through the Chilean Capacity Payment Mechanism (Nov 2021)
<i>2.C Design of a strategy to enhance geothermal competitiveness</i>	Prepare a strategy for enhancing domestic content in geothermal development through existing industries and service providers in	Assessment of the economic and environmental impact of implementing net zero geothermal heat pumps for social housing (Aug-Dec 2021)	Identify the sectors best positioned in Chile to develop low and medium enthalpy resources in an economic fashion	Technical and economic feasibility analysis of the installation of geothermal heat pumps for self-consumption purposes in agricultural facilities



<p><i>in the long term by exploring synergies with alternate uses and related domestic sectors</i></p>	<p>Chile, including identification of suitable alternate applications of low and medium enthalpy resources for direct uses</p>			<p>in the Aysén and Magallanes regions (Nov 2017 - June 2018)</p> <p>Dynamic simulations of thermal demand and analysis of thermal integration for district heating of the Aquatic Center of the National Stadium (June - Nov 2018)</p> <p>Evaluation of district heating for the Cities of Coyhaique and Puerto Williams (Mar - Oct 2019)</p> <p>Preparation of low enthalpy geothermal favorability maps in the Los Rios and Los Lagos regions (Sept 2020 - Dec 2021)</p> <p>Evaluation of the impact of implementing geothermal heat pumps for heating and domestic hot water in intercultural rural schools of the Los Lagos region (Feb - July 2021)</p> <p>Impact assessment for implementing geothermal heat pumps for heating and domestic hot water systems in the cities of Punta Arenas, Puerto Natales and Porvenir (Apr-Aug 2021)</p> <p>Production and dissemination of videos, manuals, and brochures</p>
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				and implementation of seminars and workshops for different audiences on the uses of low enthalpy geothermal energy (2017-21)
			Design the most appropriate schemes to promote the use of said resources and their implementation	