Final Evaluation

Technical Cooperation IDB-GEF ATN/FM-X-CH; CH-X1007

GEF ID: 4136

"Promotion and Development of Local Solar Technologies in Chile"

Independent Evaluator: Victoria Galeano (PRISSMA LLC)

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I. Basic Report Information

Project Title:	Promotion and Development of Local Solar Technologies in Chile
GEFSEC Project Id:	4136
Region and countries included in the project:	Chile
GEF Operational Focal Area:	Climate Change
Strategic Program:	CC-SP1 and CC-SP3
GEF Agency(ies):	IADB
GEF Replenishment period:	GEF-4
GEF Grant amount (Initial Indicative)	US$ 2,727,273
GEF Grant amount executed:	US$ 2.244.892
Co-financing at CEO Endorsement:	US$ 45,900,000
Co-financing materialized at project's closure:	US$ 35,028,028 (Local Financing)
Implementing Partner:	Ministry of Energy
Date of Project Start:	11/05/2021
Date of Project End:	05/05/2020
Date of MTR Report:	08/30/2016
Date of Final Evaluation Report	10/29/2021
Evaluator:	Victoria Galeano (Renewable Energy and Climate Finance Specialist, PRISSMA)

II. Acronyms and Abbreviations

CDT	Centro de Tecnología (Technology Development Corporation)
CORFO	Corporación de Fomento de la Producción (Corporation for the Productive Development)
CSP	Concentrated Solar Power
DG	Distributed Generation
ECLAC	Economic Commission for Latin America and the Caribbean
GoCh	Government of Chile
LPG	Liquefied Petroleum Gas
MINENERGIA	Ministry of Energy
NCRE	Non-Conventional Renewable Energy
PTSP	Public Solar Rooftops Program
PV	Photovoltaic
RE	Renewable Energy
SEC	Superintendencia de Electricidad y Combustibles (Superintendency of Electricity and Fuels)
SME	Small and Medium Enterprises
SEN	Sistema Eléctrico Nacional (National Electric System)
SIC	Sistema Interconectado Central (Central Interconnected System)
SING	Sistema Interconectado del Norte Grande (Interconnected System of Norte Grande)
SWH	Solar Water Heating

I. Executive Summary

The objective of this work is to present the Final Evaluation Report of the IDB-GEF Technical Cooperation ATN/FM-X-CH, GEF 4136, "Promotion and Development of Local Solar Technologies in Chile" and document the findings, conclusions and recommendations of the project implementation.

The project execution period was initially from November 5, 2013 to November 5, 2017. However, two extensions were approved by Letter CSC / CCH / 508/2017, extending the Execution Term to November 5, 2018 and the Disbursement Term to May 5, 2019, and by letter Letter CSC / CCH / 158/2019 extending the execution and final disbursement to May 5, 2020. Project delays occurred due to a number of reasons, including (i) institutional changes at MINENERGIA delayed project elegibility and initiation of activities, ii) the corporate crisis of the EPC contractor of the CSP plant selected in 2016, and iii) the social outburst in 2019. GEF funds were not fully used due to the latter plus the Covid-19 pandemic in 2019. Nonetheless, all programmed activities were finalized using local counter part funding.

The general objective of the project was to support the Government of Chile (GoC) and the Ministry of Energy (MINENERGIA) to develop a solar industry for the three new clean technologies: solar water heating (SWH), Photovoltaic (PV) Power Generation, and Concentrated Solar Power (CSP).

The specific objectives of the project were to: (i) promote technology transfer, institutional strengthening and capacity building in solar technologies; (ii) develop pilot projects using solar technologies (SWH and power generation) and (iii) support the design of incentives, financial mechanisms and a public awareness campaigns to promote solar projects with SWH and power generation technologies.

In Chile, there was virtually no solar power generation at the beginning of this project, although solar power was slowly increasing. This was especially evident in the SING (Spanish for Interconnected System of Norte Grande,) where the best solar radiation is found. Until 2017 there were four interconnected systems that operated in isolation from the others, but that year the two main ones, the Central Interconnected System (SIC) and the Norte Grande Interconnected System (SING), joined the National Electric System (SEN). The SEN is joined by the Aysén System (SEA) and the Magallanes System (SEM), which operate in the southern part of the country. Fossil fuels then still dominated the power generation matrix, with more than 60% of the matrix, while NCRE contributed only with a 3%[1]. Today, as of September 2021, power generation from NCRE has reached 26% from a total of 7,047Gwh in the SEN[2].

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[1] "Chile-EU - statistics on energy", by Eurostat (http://ec.europa.eu/eurostat/statistics-explained/index.php/Chile-EU_-_statistics_on_energy)
[2] CNE, Reporte Sector Energético, September 2021.

while the net installed capacity reaches 29,9% of the total energy mix installed capacity (with 8,023 MW) [3].

The project execution had a delay of approximately fours (4) years, due to several factors including a corporate crisis of Abengoa, the EPC contractor that was publicaly awarded the construction, operation and maintenance of the CSP plant in the Atacama desert in 2016 and the social outburst in 2019. Nonetheless, the project successfully encouraged the development of a solar industry in Chile in the two main objective technologies SWH and PV power generation systems, moreover, it was very successful developing local industry value chains and a labor market with high technical skills associated to the installation, operation and maintenance of the technologies, both almost inexistent prior to the implemation of the project. In the case of CSP, GEF resources were instrumental for the MINENERGIA to acquire international knowledge and institutional capacity, lacking previously in Chile, to design and implement a bidding process for CSP technologies, leading to the development of the first CPS plant in Latin America "Cerro Dominador".

This project, along with other important government initiatives oriented to accelerate the introduction of the Non Conventional Renewable Energies (NCRE) in Chile, in particular those promoted by MINENERGIA, have been determinant in the development of a solar industry, with the use of the new technologies.

In terms of outcome results, the project brought important benefits to Chile:

- first, the new local industry markets associated to the whole value chains born from the introduction of these three technologies (SWH, CSP and PV), including a new labor market of technicians and engineering firms and professionals, and new skills academic programs.
- second, the institutional capacities acquired by the GoC in the design, implementation and supervision of: i) the franchise tax credits, incentives, remueval of barriers and associated laws and regulations for the introdution of these technologies, ii) the public tenders associated with the installation of solar PV projects in the Public Solar Rooftops Program, and selection of the CSP plant EPC contractor in the Atacama desert, iii) the training programs for the installation of SWH systems in different country regions, and iv) the development of competence profiles and training plans for technical careers associated with these technologies, developed along with teachers of technical schools.
- third, cost reductions and the foundations for a market in PV, and SWH. PV went down gradually as a result of the public bidding put together by the GoC, from US$4.00/Watt in the first tender to US$1.00/Watt in the fourth tender.
- fourth, the project will contribute to lifetime direct GHG emissions avoided of 7,664,155 tonnes CO2eq and Lifetime Indirect GHG emissions avoided of 15,328,310 CO2eq (bottom-up) – 6,190,479.25 CO2eq (top-down).

[3] Reporte Mensual ERNC, Octubre 2021, pg.3

Evaluation findings are summarized in the following table of ratings:

Section	Indicator	Rating Scale[4]
Outcomes	Relevance	HS
	Effectiveness	HS
	Efficiency	HS
Sustainability	Likelihood	L
Quality of Monitoring and Evaluation		
Design	Level of Quality	HS
Implementation	Level of Quality	HS
Quality of Implementation	Level of Quality	HS
Quality of Execution	Level of Quality	HS

[4] GEF Guidelines use the following 6-point scale to rate the above components of the evaluation:
Highly Satisfactory (HS), Satisfactory (S), Moderately Satisfactory (MS),
Moderately Unsatisfactory (MU), Unsatisfactory (U), or Highly Unsatisfactory (HU).
Sustainability ratings use the following four-point scale:
Likely (L), Moderately Likely (ML), Moderately Unlikely (MU), Unlikely (U), Unable to Assess (UA).

II. Introduction

This report presents the final evaluation report (FE) with findings, conclusions and lessons learnt of the IDB-GEF Technical Cooperation ATN/FM-X-CH, (GEF ID: 4136 /IDB Project No. CH-X1007), "Promotion and Development of Local Solar Technologies in Chile", contracted by the GEF unit at the Inter-American Development Bank´s Energy Division.

This GEF project was one of the three largest grant projects awarded to Chile by GEF, under GEF-4 Projects in Climate Change. Therefore, this project was part of a wider GEF and IDB sector strategies for supporthing the GoC in the promotion and establishment of solar and energy efficiency markets, with IDB-GEF technical cooperations "Encouraging the Establishment and Consolidation of an Energy Service Market in Chile" (GEF ID: 4176), "Promoting and Strengthening an Energy Efficiency Market in the Industry Sector" (GEF ID: 3599), and "ATACAMATEC-Support for large scale solar power in northern Chile" (IDB ID: CH-T1122).

This FE follows the Guidance for "Conducting Final Evaluations of UNDP-Supported GEF-Financed Projects" and focuses on the results achieved up to date by the project, according to the initial Results Framework. Section III. presents a project description and background context, section IV. shows the findings and progress of the project outputs under each project component, and section V. presents the conclusions and recommendations of the evaluation.

The FE includes a technical evaluation of the project results and a general review of the financial and fiduciary performance of the project, however, it does not constitute a project audit and therefore it does not provide an expert opinion with regards to the management of the project financial accounts, according to the International Standards on Auditing.

III. Project Description and Theory of Change

- Development Context:

After an extended period of growth, Chile has experienced an economic slowdown. Chile's growth averaged 4.7% from 2004 to 2013. Nevertheless, the economy slowed from 2014 to 2017, with average GDP growth coming in at just 1.7%, below the world's growth rate over this period, and less than the 5.3% in the previous four-year period. This deterioration occurred in an adverse external context, characterized by falling copper prices (which sank from US$4 per pound in 2011 to an average of US$2.7 per pound in 2014-2017), and declining business and consumer expectations. These factors had a negative impact on investment, which fell by 6.8% between 2014 and 2017[5].

This economic growth combined with little use of energy efficiency throughout the economic sectors, has resulted in an energy demand that has achieved growth rates higher than Gross Domestic Product (GDP) growth. This is in contrast to country members of the Organization for Economic Co-operation and Development (OECD) countries (Chile is a member of the OECD), where the intensity of energy consumption has decoupled from GDP growth since the 1980s.

Chile's electricity demand grew from 33,226 GWh in 1998 to 56,848 GWh in 2008, and to 77,787GWh in 2021, an increase of almost 134% in the last 20 years. The sector has not only grown in capacity and demand, but has also gone through a number of reforms, beginning with its privatization in the 80's which separated the sector into three (3) distinguished businesses: generation, transmission and distribution. Today over 432 generating companies, 116 transmission companies and over 21 distribution companies are connected to the SEN, many of which are part of large corporate conglomerates.

In Chile, the monthly installed gross electricity generation capacity as of September 2021 amounts to 26,737 MW[6]. Of these, 26,555 MW (99.3%) correspond to the SEN. The remaining 0.6% is distributed among Medium Electric Systems. During 2019, gross electricity generation in the National Electric System reached a total of 77,090 GWh, which represents 99.3% of the total generated throughout the country. This total is made up of 56% thermoelectricity, 24.6% conventional hydraulic and 19.4% NCRE. The systems as a whole (including the SSMM Aysén, Magallanes and Los Lagos) reached a total of 77,637 GWh, which represented an increase of 1.9% compared to 2018, with a compound annual growth rate of 3.3% during the last 10 years.

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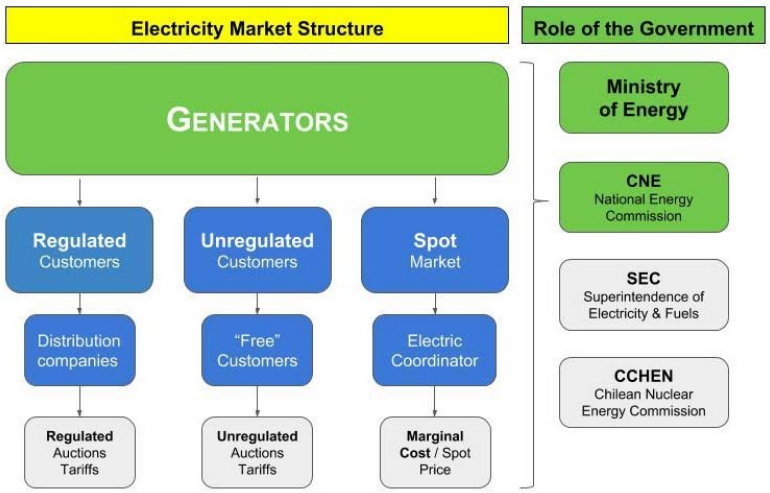
[5] CHILE IDB GROUP COUNTRY STRATEGY WITH CHILE 2019-2022 FEBRUARY 2019
[6] Reporte Sector Energético, September 2021 https://www.cne.cl/wp-content/uploads/2021/09/RMensual_v202109.pdf

Figure 1. Structure of the Chilean Electricity Market and Regulation



Source: IAEA

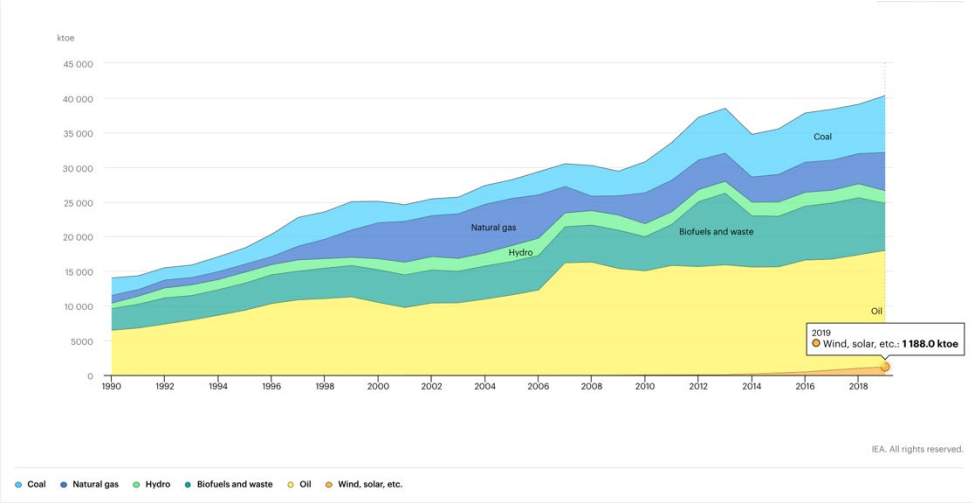
Chile's energy policy has evolved dynamically in recent years. In response to changes in the domestic and international environments, significant institutional and policy reforms as well as major infrastructure projects have been carried out. The National Energy Policy 2050 was adopted in 2015, following an exceptionally inclusive public consultation. The electricity sector, in particular, has developed quickly.

A second review of Chile's energy policies by the IEA found that the country has emerged as a world-class destination for solar and wind energy developers. New legislation encourages investment in generating capacity across the electricity sector. The expanded role of the state in energy planning has helped to boost project development, especially in electricity transmission. The country now also has an interconnected national electricity system. Integrating growing shares of variable renewable energy requires a flexible power system. More transmission infrastructure, storage, and demand-side response are needed. The government should now ensure that the electricity market design and infrastructure facilitate the integration of solar and wind power. By exploiting its vast renewable energy potential, Chile can help reduce electricity prices and dependency on fuel imports. Renewables and energy efficiency can also help limit carbon emissions and air pollution.

Chile should make more use of mandatory energy performance standards for products, equipment, vehicles and buildings. Efficient and clean use of firewood and alternative heating technologies

can be supported through policies, regulation and financial incentives. Energy and climate aspects should also be an integral part of the long-term policies for transport and urban development[7].

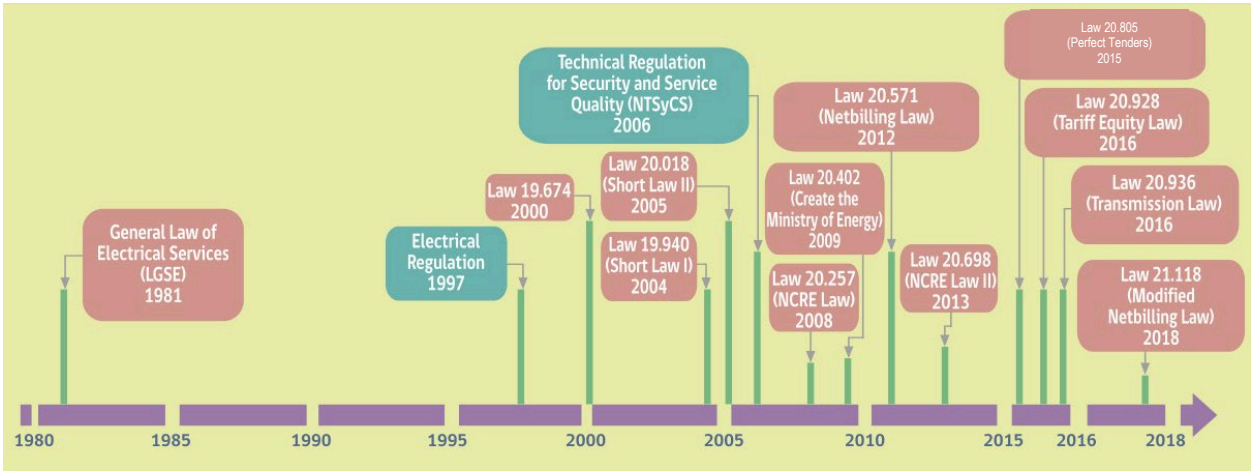
Graph 1. Total energy supply (TES) by source, Chile 1990-2019



Source: IEA

In the last years, the increase of energy prices and the technological development of Non-Conventional Renewable Energy (NCRE) technologies along with the removal of barriers by the GoC have fostered the development of new projects in the country. Additionally, the GoC has improved the regulatory framework of the electrical market and has developed a series of initiatives to diversify the country's energy matrix and accelerate the introduction of NCRE in the energy sector, including:

Graph 2. Chronology of the Regulation of the Electricity Sector



Source: NCRE In the Chilean Electricity Market, MINENERGIA 2018

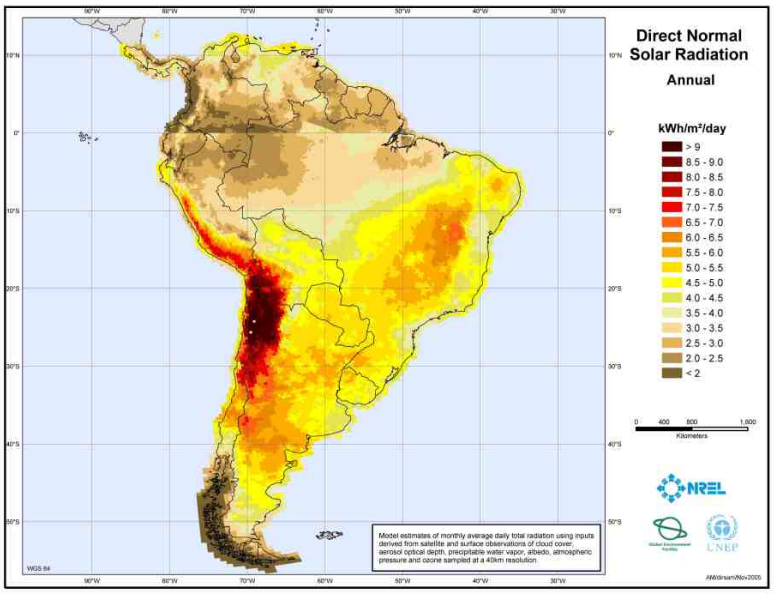
[7] Energy Policies Beyond IEA Countries: Chile 2018 Review

- **Law N° 4 of 2010**, which amends **Law N° 1 of 1982** General Law of Electrical Services (LGSE, acronym in Spanish). The LGSE regulates the production, transportation, distribution, concessions and tariffs of electrical energy
- **Law N°19.940 of 2004**, the main objective of which was to increase the levels of quality of the electricity supply and to equip the sector with a modern and efficient regulatory framework
- **Law N°20.018 of 2005**, that aimed to ensure the reliability, service quality and price stability of energy supply
- **Law N°20.257 of 2008** passed to promote electric generation through NCRE
- **Law 20.365 of 2009**, which establishes a tax exemption on Solar Water Heaters (SWH) systems in new dwellings
- **Law No. 20.402 of 2009**, which creates MINENERGIA in charge of designing and coordinating plans, policies and standards for the proper functioning and development of the sector
- **Law N°20.571 of 2012**, of the Distributed Gerneration, allows connection to the grid and sale of energy, for installations up to 100 kWp, to the electric distributions company.
  It regulates the Payment of Electricity Rates for residential generators. In the same way, technical instructions and resolutions issued by the Superintendency of Electricity and Fuel related to requirements for the design and execution of solar installations, among others, were also created, the Renewable Energy Unit was created in the Superintendency of Electricity and Fuels in order to establish a complete monitoring of the implementation of the law.
- **Law 20.698 of 2013**, also known as Law 20/25, Chile's Non-Conventional Renewable Energy Law requires that companies with more than 200 MW of installed capacity generate 20% of electricity from renewable sources by 2025.
- **Law 20.805 of 2015** perfects the system of regulated tenders and establishes a series of modications and improvements to the system of regulated tenders to make them more competitive, and **Law 20.928 of 2016**, which establishes equity mechanisms in electricity service rates.
- **Law 20.936 of 2016** Law of Transmission and Independent Coordinator of the National Electric System: significant reform to the electricity market in Chile. It introduces very profound changes to the remunation and planning of the transmission network and also creates a new Coordinator replacing the old Economic Load Dispatch Centers (CDECs).
- **Law No. 21,118 of 2018**, modified aspects of the Distributed Generation Law, mainly increasing the maximum installed capacity per customer from 100 kW to 300 kW, in addition to allowing community systems.

World-wide maps of solar radiation show the north region of Chile as a top area of solar radiation in the world, with availability up to 90%. MINENERGIA together with the German Development Agency (GTZ, acronym in German) confirmed measurements in Northern regions of the country,

particularly in the regions of Arica and Parinacota, Tarapacá and Antofagasta, with radiation levels of 3000 kWh/m2/year or 8,0 kWh/m2/day, considered high values by international standards.

Graph 3. Solar Potential in Chile



Source: National Renewable Energy Laboratory, 2005

- Context of the Economy and the Electric and Renewable Energy Sectors:

The National Electric System in Chile has an installed generation capacity of 26,737 MW, as of September 2021, which corresponds to more than 99% of the national installed capacity (mediums systems such as Aysén and Magallanes and isolated systems are less than 1%), with 46,8% thermoelectricity, 23.2% conventional hydroelectricity and 30% NCRE[8]. Of the total installed capacity, nearly 50% corresponds to generation based on renewable energy sources, particularly large scale hydroelectric, solar PV, wind, biomass, mini-hydroelectric and geothermal, and the oher 50% corresponds to natural gas, coal, or petroleum derivatives power plants. The installed NCRE power capacity represent 30% (8,023 MW)[9] of the country's total installed generation capacity of 26,737 MW, with 150 Non-Conventional Renewable Energies (NCRE) projects under construction, adding 4,261 MW of renewable energy power to the system. In terms of generation, the injection of NCRE plants into the grid during the month of September 2021 was 2,077 GWh, which corresponds to 31.8% of the total generation.

Chilean legislation on electricity describes "renewable energy" or "clean energy" by using the term "non-conventional renewable energy" (NCRE). Chile's legal framework defines this concept as the electrical energy generated by non-conventional renewable means of generation, which are

[8] Reporte Sector Energético, September 2021, pg 6
[9] Reporte Mensual ERNC, Octubre 2021, pg 3

those whose primary source is biomass energy, hydraulic energy below 20MW, geothermal energy, solar energy, wind energy, ocean energy and other means of generation determined by the National Commission of Energy that use renewable energies for the generation of electricity, contribute to diversify the sources of energy supply in the electrical system and cause low environmental impact.

In Chile, a quota system established by law requires electrical companies that have an installed capacity of more than 200MW and that withdraw energy from the electrical systems for trading with distribution companies and final consumers to certify that a certain percentage of their energy withdrawal comes from NCRE sources. The law mandates that this percentage should increase every year, to reach 20% in 2025. However, this goal was already attained in 2020, almost five years ahead of the legal deadline.

Further, the government recently launched its Long-Term Climate Strategy (LTCS), which sets a roadmap to carbon neutrality aiming to completely replace coal with other sources of energy by 2050, when 100% of the country's energy will come from NCRE. This process involves decarbonizing the matrix, removing all the coal plants, plus incorporating more renewable energy, greater energy efficiency, and green hydrogen.[10].

- Project Objective:

The main objective of this BID-GEF project was to promote solar technologies, namely SWH, CSP and Distributed Generation (DG) with PV applications, and support the design and installation of the CSP commercial plant in the northern part of Chile.

DG is an approach of power generation that reduces the amount of energy losses in transmission because the electricity is generated very near where it is used, reducing the size and number of power lines that must be constructed. For the introduction of this mechanism (Net-billing), it is necessary to define a set of technical regulations and price compensation mechanisms that will allow the seller to inject energy into the grid and be compensated for it, at the equivalent energy cost price. In many countries DG is already a reality and countries that have developed such systems have fostered their development through long-time government plans.

Concentrated Solar Power (CSP) has many advantages, on one hand CSP stations occupy a smaller area than other generation plants such as wind or hydro and can be built in isolated areas without land competition. Currently, CSP has a very high upfront cost that ranges between 2,5 to 3,5 times the cost of a conventional thermal generation, but it is one of the RE technologies that can provide firm capacity to the electrical grid, with a capacity factor up to 70% depending on the chosen technology. CSP pilot projects have been installed in different countries, such as EEUU, Spain and

[10] Carbono Neutralidad en el Sector Energía Proyección de Consumo Energético Nacional 2020

with capacity up to 15 MW and now many countries such as EEUU are looking for the installation of commercial plants.

SWH was a very incipient market, if not inexistent in Chile prior to this project. There were only about 30 SWH system company providers. According to the Technology Development Corporation (CDT), 75% of Collectors Solar Thermal (CST) are imported and only about 7.000 m2 had been installed. According to the Census of 2002, only 57% units of the individual residential sector had hot water systems, being natural gas or LPG gas the main energy source for the use of sanitary hot water. This clearly pointed out the potential for the installation of SWH systems, which could only be achieved by accompanying tributary incentives, coupled with local market capacities streghtening programs.

This BID-GEF project was critical in the design and roll out of successful government incentives for the promotion of these new technologies, including tax franchise credits, price reduction measurements, technical training, quality certifications, and regulation updates, among others.

- Problems that the project sought to address:

At the onset of this project, electricity demand in the northern part of Chile was increasing mainly due to mining activities, yet, due to geological conditions, no hydro potential is available in that region. Within that scenario, and given the assessed wind and solar potentials in the region, a CSP technology that could provide base load capacity,was highly attractive at the moment, and the GoC was committed to test it and avoid the environmental impact of coal, in light of the electricity generation expansion underway.

Despite its potential, Chile was experiencing many different barriers thatwere contributing to hinder the introduction of solar power, namely:

Lack of quality control of solar equipment. Absence of quality control procedures for solar equipments, components or systems; no voluntary norms and no certification requirements for the installation of SWH or PV applications. Mandatory standards for performance or installation of energy systems apply only to devices based on fuel and electricity, which are audited by the Superintendencia de Electricidad y Combustibles (SEC) in order to ensure quality and safety.

Perception and awareness barriers. An entry barrier to the promotion of solar technologies in Chile is the lack of knowledge and mistrust from potential customers of this technology as a result of poor experiences in the past. In view of this situation, there appears to be a consensus that the industry urgently needs to develop standards for the product.

Financial and market barriers. There are limited sources or mechanisms for the promotion of solar technology in Chile. Most financial institutions and commercial banks are not very familiar with RE investments and cannot adequately evaluate the benefits and risks of entering into this market niche. Law 20.365 establishes tax exemption on SWH systems in new dwellings.

Commercial and industrial enterprises do not receive public incentives to promote the installation of this technology. No incentives for CSP or DG with PV technologies have been developed. Given that there is no experience and knowledge regarding CSP in Latin America and the Caribbean (LAC) no investors might be able to take the risk under the current legal and regulatory framework since it does not provide any guarantee of electricity prices in the long term.

Professional and technical capacity barriers. Overall, there is limited knowledge in Chile with respect to renewable energies including: characteristics, applications, benefits, operations, and environmental and sustainability advantages with respect to other self-generation alternatives (e.g., diesel-fueled electricity generators). There is a shortage of technical capabilities for the design, execution, monitoring and maintenance of Solar Projects. Engineers and technicians from public and private sector have virtually no experience with solar technologies. Solar technologies manufacturers based in Chile are still small, undercapitalized and have very limited marketing capabilities. Therefore, the ability of manufacturers to expand production is also restricted. In contrast, several companies are seeking to import solar technology.

Moreover, there is no formal training program resulting in a lack of trained technicians able to develop new projects, operate the systems, and provide adequate technical service. Some initiatives have been carried out in this field, but most of them have been focused on providing simple solar solutions mainly at the household level.

- Project Description and Strategy

Due to the higher technical complexity of SWH projects and PV systems, this initiative has been focusing on the development of demonstration projects in areas with high solar potential and sectors with high saving potential, support while strengthening the local capabilities of engineering and small companies for manufacturing, designing and maintenance of solar systems. In addition, this GEF Project focuses on transferring and developing new CSP capacities both on private and public stakeholders in order to ensure that this technology can be applied successfully within the local context.

SWH is a mature technology but there is evidence that the market in Chile requires technical support to be able to provide the local market capacities to boost the quality of its services and products. On PV and CSP there is even less local experience since DG has been recently implemented and CSP is a highly innovative and new technology.The general objective of this project is to support the GoC and the Ministry of Energy (MINENERGIA) to develop a solar industry for SWH, PV and CSP technologies.

The specific project goals are to: (i) promote technology transfer, institutional strengthening and capacity building in solar technologies; (ii) develop pilot projects using solar technologies (CSP, PV and SWH) and (iii) support the design of incentives, financial mechanisms and a public awareness campaign to promote solar technologies (PV, CSP and SWH).

The overall project was originally structured in three (3) components, complementary to each other, as described below:

Component 1: Promote transfer of technology and capacity building in solar technology

This component aimed to promote transfer of technology and capacity building in solar technologies by assessing the economic and technical potential of the different technologies, and prioritizing and defininining a pipeline of projects with optimal locations. It also aimed to strengthen the local capacities of firms by defining the standards and monitoring protocols and providing training activities. The activities under this component included:(i) assess the potential for development of Concentrated Solar Power (CSP) and for PV for DG in SING and SIC; (ii) assess the economic, environmental and legal requirements for the implementation of PV and CSP plants in SIC and SING; (iii) draft standards and guidelines for the designs and installation of PV systems; (iv) define of a PV-CSP energy pipeline project development; (v) develop a pre-investment study for the deployment of at least 5 MW of CSP or PV plant; and (vi) provide training activities for implementing PV and CSP projects through technical missions and local seminars.

Component 2: Development of demonstration projects using solar technologies

This component aimed to allow to assess the quality of the ex-ante and the requirements and costs of operation and maintenance. The information obtained from this assessment process aimed to be used for information and dissemination purposes. The second subcomponent aimed to (i) develop solar demonstrative projects: PV for DG for residential, commercial and/or industrial applications using the know-how and upgraded skills funded through component 1 and a CSP plant in the northern part of Chile, (ii) strengthen local capacities in terms of design and assembly, among other aspects, in order to improve the quality of solar water heating systems[11]; and (iii) carry out the monitoring and evaluation assessment of operational variables and ex-post results of the projects through the installation of monitoring systems to assess the ex-post benefits.

Component 3: Design and implementation of financial mechanisms, incentives and public awareness campaign.

The objective of this component is to replicate solar–based technology and ensure its long-term sustainability. The activities under this component are: (i) identify and assess financial and other incentive mechanisms, including credit schemes and tax incentives to promote solar technologies based on international experience (CSP, PV and SWH); (ii) assess the international experiences on rules and technical regulation for CSP and PV-DG; (iii) ; the creation of a fund, so that financial institutions and/or financial intermediation corporations of autonomous state administration, in or through the local bank grant subsidies to reduce credits, in terms of interest rate and/or concessional terms to micro and small companies for the implementation of projects that include

[11] Upon Modificatory Agreement, subcomponent ii. changed from "to upgrade SWH manufactures in order to improve local product quality of SWH".

solar technology; and (iv) design and implement a public awareness and education campaign to promote and replicate solar technology projects including information dissemination within the private and public sector.

- Project alignment the strategic priorities of GEF and the Government

This project is fully consistent with Chile's national energy strategy. Enacted laws for the promotion of NCRE are a concrete evidence of this fact. The project promotes solar power generation and energy savings, through a CSP pilot project, DG and SWH systems. In addition the project aims to develop a local industry of solar technologies by developing projects and local capacities that increase the mid-term product and service quality. The project aims to increase awareness of the benefits of solar technologies by disseminating the results of the CSP plant, PV-DG and SWH systems designed and constructed by this project.

The proposed GEF financing is consistent with the objectives laid out by the Poznan Strategic Program on Technology Transfer. As such, the project identifies the technological bottlenecks to develop a successful local solar industry, by promoting the implementation of pilot projects as well as by strengthening the capacity of local manufacturers to produce certified solar panels and systems for the local market. The proposed project is consistent with the GEF Climate Change focal area under the Strategic Program 3 "***to promote market approaches for RE***", given that it promotes solar technologies such as CSP, PV, and SWH systems; and the GEF Strategic Program 1 "***Promote EE in residential and commercial Buildings***", by introducing more SWH as an option for energy efficiency . The project was innovative for Chile, because in spite of its large solar potential, solar generation was virtually nonexistent at the onset of this project.

- Project Implementation Arrangements:

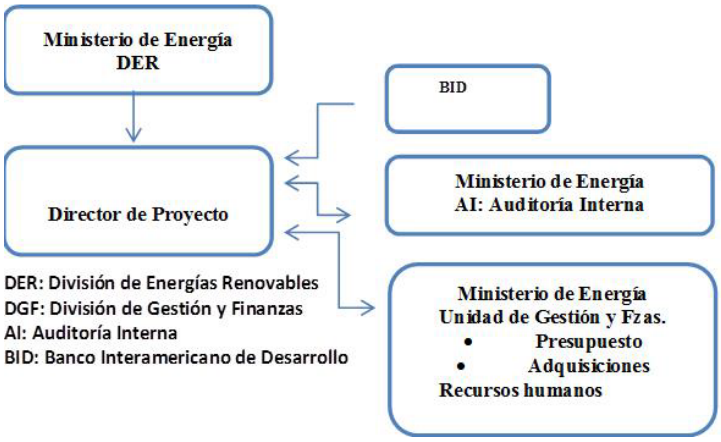
a) Institutional Arrangement:

MINENERGIA is responsible for the entire energy sector development in Chile, including the promotion of alternative energy resources. Thus, MINENERGIA is responsible for developing and coordinating plans, policies and rules to ensure the functionality and energy sector development in a competitive, sufficient, high quality, economically viable and environmentally sustainable way. MINENERGIA, created in 2010 and reorganized twice, in (2018 and 2020), arriving to the current organizational structure that includes seven technical divisions: i) energy and environmental policies and studies, ii) electrical markets, iii) project development, iv) participation and community development, v) fuels and new energy, vi) access and social development, and vii) sustainable energies. In addition, six more offices support the ministry level activities.

The GoC, through MINENERGIA has requested IDB support for the promotion and development of the thermal and photovoltaic solar industry. IDB priorities for Chile call for explicit support to facilitate and develop opportunities based on RE, EE, rational use of energy and improvements of the regulatory framework as a direct contribution to mitigate climate change.

b) Project Implementation Arrangement:

Figure 2. Project Implementation Arrangement



Source: Project Document

Executing Agency (EA): MINENERGIA is the Executing Agency (EA) of this GEF project. The EA reports to the IDB on the technical and administrative matters of the project, prepares and presents progress reports, controls and supervises the fund's administration, requests disbursements, and maintains the communication channels with the IDB.

Project Operational Guidelines (POG) was agreed to be defined between the IDB and MINENERGIA in order to establish the responsibilities and obligations for the execution of the project, as well as the monitoring and evaluation activities. It was agreed that the POG were a condition prior to the second disbursement. The POC ordered the definition of the responsibilities and commitments of the Economic Commission for Latin America and the Caribbean ECLAC as part of the management institution for subcomponent 1.2 and 2.2. However, upon the Modificatory Agreement, ECLAC was not part of the institutional arrengement anymore.

Executing mechanism: A Project Manager (PM) was hired to provide technical oversight, coordination and supervision for the project. The PM is located in MINENERGIA. Selection and appointing the PM was another condition prior to first disbursement.

Execution period and disbursement schedule: The execution period was initially set at 48 months and the disbursement period at 54 months, however two extensions were made, resetting the execution period at 84 and 90 months respectively.

Procurement and program implementation readiness: IDBs policies established in documents GN-2349-7 and GN-2350-7 apply for the procurement of goods and services and the selection and

contracting of consultants. Ex-ante review of procurement procedures only apply to contracts whose costs exceed the ICB thresholds established by the IDB.

Technical and basic responsibility: Technical and basic responsibility for the project rests with MINENERGIA. The IDB Country Office in Chile (CSC/CCH) and the Energy Division based in headquarters (INE/ENE) conduct technical supervision and provide additional support. This includes supervision of the procurement of studies commissioned with contribution resources, technical supervision of the Terms of Reference (TOR), and review of the technical quality of all studies financed under this project, regardless of the source of financing.

IV. Assessment of Project Results

A. Project Strategy

This consultancy involved the review of primary and secondary information, including studies and documents developed by the GoC as part of this project, along with a series of interviews to project stakeholders from the MINENERGIA, the Superintendency of Electricity and Fuel, technical training schools and progam beneficiaries, among others. Based on such review the consultancy confirms that:

- There was pertinence in the project strategy and instruments proposed to support the GoC and the MINENERGIA to develop a solar industry for SWH, PV and CSP technologies.
- There was a proper identification of the challenges and risks facing the development of the solar market and the main barriers for companies to enter the market.
- The need to develop market oriented incentives and financial mechanisms to encourage entrance to the market and development of solar market services.

Although the project stakeholders, with a GEF modificatory agreement, decided to emphasize its efforts to design and install PV solar pilot projects over installation of SWH system projects, such a decision was based on the results of a thorough technical analysis performed under Component 1, whose analysis concluded the importance to prioritize those technolgies. Despite this change, the project, along with other government initiatives, has been successful in terms of removing barriers and developing the right incentives to grow and consolidate an initially nascent solar industry. The updated project strategy was appropriate in the sense that it contributed to strengthen institutional and private sector capacities not present in the country for the introduction of PV, SWH and CSP technologies.

B. Project Implementation

Financial Execution:

Total project execution took over six (6.5) years, from November of 2013 to May of 2020. The start of execution of some project components was challenging due to institutional changes at MINENERGIA that delayed project elegibility and initiation of activities. In addition, there were other contributing factors that delayed the execution of some project components, including the corporate crisis of Abengoa, the EPC contractor of the CSP plant in 2016, the social outburst in 2019 and the Covid-19 pandemic in 2019.

- Budget Execution by Component

Table 1. Budget Planning

		GEF Financing				Local Financing	
Component	Component Name	Indicative GEF Financing Initial Fin Agreement (pg 35)[12]	Indicative GEF Financing Modificatory Agreement (pg 4)[13]	Indicative GEF Financing Upon Approved Modification Letters[14]	GEF Budget Expenditure[15]	Indicative Local Financing	Local Budget Expenditure
Component 1	Promote transfer of technology and capacity building in solar technology.	172,273	172,273	561,159	493,201	1,270,000	470,000
Component 2	Development of demonstration projects using solar technologies.	2,190,000	690,000	1,086,505	859,395	30,040,000	34,360,765
Component 3	Design and implementation of financial mechanisms, incentives and public awareness campaign	82,000	1,582,000	660,975	525,465	140,000	140,000
Project Management		253,000	253,000	360,962	345,022	300,000	57,263
Auditory		30,000	30,000	57,672	21,808	0,00	
Total		2,727,273	2,727,273	2,727,273	2,244,891	31,750,000	35,028,028

The project had one Modificatory Agreements made on March 17 of 2015 which approved prioritization of resources to the installation of PV pilot projects in DG, and reallocated US$1.5 million from Component 2 to Component 3. Then, upon approved modication letters in 2017 and 2019, the budget was revised and realloated according to column 5 of the above table.

[12] CONVENIO DE F1NANCIAMIENTO NO REEMBOLSABLE DE INVERSIONES DEL FONDO PARA EL MEDIO AMBIENTE MUNDIAL (FMAM) No. GRT/FM-13501-CH

[13] CONVENIO MODIFICATORIO Del Convenio de Financiamiento No Reembolsable de Inversiones del Fondo para el Medio Ambiente Mundial (FMAM) N° GRT/FM-13501-CH

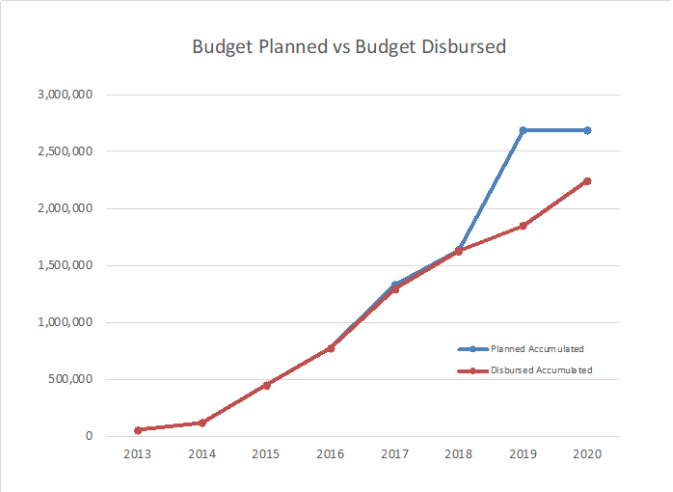
[14] (2017) The budget was modified by request Letter 571 from the MEN and approved by letter 508 from the IDB / (2019) The budget was modified by request Letter 263 from the MEN and approved by letter 314 from the IDB.

[15] Convenio GRT/FM-13501-CH. Rendición SN23, pg 4

- Budget Execution and Financial Disbursements

Table 2. Financial Disbursements

Year	Planned Accumulated	Disbursed Accumulated
2013	54,266	54,266
2014	118,685	118,176
2015	447,710	447,710
2016	775,906	775,906
2017	1,329,207	1,294,920
2018	1,635,469	1,624,679
2019	2,687,321	1,848,701
2020	2,687,321	2,244,893



Although the indicative GEF financing was initially $2,727,273, the MINENERGIA didn't request the 2020 corresponding advance of $39,952, bringing the final GEF financing to a new value of $**2,687,321**. In terms of budget execution, the MINENERGIA returned **US$442.429** and performed efficiencies by using local resources to complete some project activities, bringing final execution value disbursed down to **$2,244,893**.

C. Economic, Social and Environmental Benefits and Safeguards

This project contributed to the sustainable development process of Chile with quantifiable benefits in the economic, social, environmental and economic development dimensions. It helped to diversify the energy matrix, promoted the transfer of new solar technologies, supported the adoption of new financial and fiscal incentives, contributed to develop a professional technical training qualifications framework for the energy sector and had a positive impact on the environment and the economy. The following, outlines the main benefits and ecobenefits of the project accounted for so far.

On the energy sector side: the project helped to diversify the Chile's energy matrix, highly dependent on thermoelectricity, by introducing a financial and technical framework for the adoption of solar technologies, while bringing environmental benefits with a reduction of CO2 emissions. As of September 2021, Chile's energy installed capacity was 26,737 MW, with 46,8% thermoelectricity, 23.2% conventional hydroelectricity and 30% NCRE. Of the total installed capacity, nearly 50% corresponds to generation based on renewable energy sources, particularly large scale hydroelectric, solar PV, wind, biomass, mini-hydroelectric and geothermal, and the oher 50% corresponds to natural gas, coal, or petroleum derivatives power plants. The installed NCRE power capacity represent 30% (8,023 MW)[16] with 150 Non-Conventional Renewable Energies (NCRE) projects under construction, adding 4,261 MW of renewable energy power to the system. In terms of generation, the injection of NCRE plants into the grid during the month of September 2021 was 2,077 GWh, which corresponds to 31.8% of the total generation.

In terms of new energy generation from NCRE sources, the project added a thermal energy generation capacity of 70.334.058 kWh/year (with a total of 416.947.694 kWh for the years of the Tax Franchise), displacing other energy sources such as natural gas, liquid gas, electricity and biomas totaling 588.210.433 kWh/year.

This GEF project also supported the Solar Rooftops Program by installing a total of 300 kW in the following regions:

- (2015) Teletón Calama, SFV 40 kWp.
- (2015) Teletón Santiago, SFV 70 kWp.
- (2016) Teletón Copiapó, SFV 40 kWp
- (2016) Teletón Iquique, SFV 25 kWp
- (2017) Teletón Arica, SFV 25 kWp.
- (2017) Teletón Talca, SFV 20 kWp.
- (2018) Escuela Gabriela Mistral Tocopilla, SFV 20 kWp.
- (2018) Complejo Educacional Pedro Prado, SFV 60 kWp.

On the environment side: An estimated reduction of 5,712 tCO2 emissions achieved since the beginning of the Solar Public Roofs Program in 2015, while approximately 135,000 tCO2[17] were avoided from 2010-2019 as a result of SWH projects installed within the framework of the tax franchise. In addition, the CSP Plant, Cerro Dominador, will have emission reductions of 200,000 of CO2 per year.

Overall, the project will contribute to lifetime direct GHG emissions avoided of 7,664,155 tonnes CO2eq and Lifetime Indirect GHG emissions avoided of 15,328,310 tonnes CO2eq (bottom-up) –

[16] Reporte Mensual ERNC, Octubre 2021, pg 3
[17] Informe 2 Sistemas Solares Térmicos, Pg. 18

6,190,479.25 tonnes CO2eq (top-down). See Annex 5. for GHG emissions reductions calculations according to the GEF Mitigation Tracking Tool Methodology.

On the economic development side: the project also contributed to the economic development of Chile by fostering the creation and growth of new solar industry service related markets that were inexistent before the project. For example, a new cluster of companies linked to the new quality certification requirements and normativity established by the Government for the import of SWH and PV equipment florished and created new supply chains that remain today and continue to grow and to strenghthen the local industry of solar technologies. While at project start solar technologies were almost inexistent, by project end there were about 200 certified international brands and over two (2) million SWH sytems imported for installation. Companies also gained technical capabilities and new lines of business. While at project start, there was little local knowledge on the functioning and installation of these solar technologies, one that was initially performed by climatization companies.

On the social side: the project also had positive social effects as the project allowed the installation of SWH over social dwellings in different regions in Chile, many of which previously lacked hot water during winter season, and where the use of fosil fuels and electricity prices were higher. There were: 74,279 dwellings under the Tax Franchise, 70,360 social dwellings under the 3PF Program (Hogar Mejor), and 5,608 dwellings under the Reconstruction Program, for a total of 150,247 dwellings with SWH installations, between 2010 to 2020. The implementation of SWH implied savings in the beneficiary dwellings, where the average savings per dwelling nationwide as a result of the implementation of the tax franchise was aproximatly USD189.19 per year, with total annual savings in the range of USD15 million dolares per year and a Social Net Present Value (social NPV) of USD107 million. Dwellings with the new SWH systems served as demostrative projects to communities, many members who learned about the cost benefits and increased demand of the technology.

The project was critical for the transfer of technology and knowledge of SWH, CSP and PV systems in Chile. It supported the GoC in the update and acquisition of new technical skills by bringing top notch international industry knowledge that was trickled down to remote regions in Chile through a well designed and disciplined skills training program. The PV pilot projects not only served as demonstrative business cases but were also used as training labs for trainers and new installators. With project resources, the MINENERGIA worked in close collaboration with the Ministery of Eduation, the Chilean Association of Solar Energy, the private sector, and training schools for the development of job skills profiles and improvement of technical skills curricula. The project also had a positive effect among the youth and the women, who participated in training programs to become SWH and PV system installators. Thus, the program had a **strong gender and youth employment focus** along the various segments of the value chain which would leverage an opportunity for gender empowerment and maximization of income.

On the institutional side: the project had an important impact on the strengthening of government and industry institutional capacities. Not only for the MINENERGIA, but also for the Ministry of Housing, the Ministry of Environment, the Ministry of Education, the Superintendency of Electricity and Fuel, industry associations and the private sector (incl. engineering, manufacturing and consulting firms). The GoC enhanced its technical capabilities in: i) the fiscalization of solar project installations to ensure consumer rights and safety, ii) the design and implementation of laws, norms, regulations and policies to regulate and encourage the development of solar technolgies, iii) the creation of tax incentives and other government mechanisms to favor market entrance of renewable energies, and development of new industry value chains, and iv) the understanting of energy prices and tax implications of SWH system installations, to increase the availability of public information and price transparency on the technical applications of solar technologies.

Overall, the project resulted in a substantial increase of public awareness about the solar power potential in electricity generation and energy saving, streamlining solar energy not only as an energy source but also as a new industry and market that can lead to create new jobs, and develop solar technology.

On the Environmental and Social Safegards side: implementation of the project components across different solar technologies (SWH, PV and CSP) required the application of diversed Environmental and Social (ESG) Standards in order to avoid any harm to the environment or to any particular stakeholders. Application of ESG safeguards was particularly important for the design and execution of Components 2 and 3, development of demonstration projects using solar technologies and design of incentives and financial mechanisms. Consideration of the safeguards was demonstrated in the following cases: first, in the case of CSP, the project had a positive effect in the banking industry, because multilateral financing of Cerro Dominador was only approved once all ESG safeguards were duely performed. For this project, multilaterals demanded the developmet of environmental impact assesments (EIAs), in particular the environmental impact on birds[18]. The study was developed in line with KFW environmental safegards and project financing was later approved. And second, in the case of the design of the SWH Tax Franchise, the Government performed a thorough identification, classification and quantification of the actors to be impacted for the development of a SWH market[19]. Overall, the evaluation considers that the parties performed the adequate environmental and social due diligence processes during the project design, planning and execution stages, and that these were aligned to IDB's Environmental and Social Safegards.

[18] Interview carried out by the evaluator to Ruth Rain, from CORFO (rrain@corfo.cl), on Sep 2, 08:30AM
[19] Evaluación de Impacto y Resultados de la Ley N° 20.365 de Sistemas Solares Térmicos, pg 27

D. Results Framework & Indicator Matrix

Project Objective	The general objective of this project is to support the Government of Chile (GoC) and the Ministry of Energy (MINENERGIA) to develop a solar industry, for solar water heating (SWH) and power generation in Chile (Photovoltaic (PV) panels and Concentrated Solar Power (CSP)). The specific objectives are to: (i) promote technology transfer, institutional strengthening and capacity building in solar technologies; (ii) develop pilot projects using solar technologies (SWH and power generation) and (iii) support the design of incentives, financial mechanisms and a public awareness campaign to promote solar projects with SWH and power generation technologies.

Impact Indicators	Base Level (2010)	Target Level (2018)
Increase on SWH installation	0	1.506 MWh_{th}/yr[20]
Solar PV installation increased nationwide	0	543 MWh/yr[21]

Outcome Indicators	Base Level (2010)	Target Level (2018)
A CSP Plant installed (MW) (CSP)	0	5 MWh
PV-DG installed (MWh/year)	0	0,300 MW
Electricity generated with solar technologies (MWh/year) (informe de capacidad instalada en Chile. No lo hace el proyecto.)	0	13,655 MWh

[20] 0.5% of total to be achieved in 10 years.
[21] 1% of total to be achieved in 10 years

Certified Solar Water Heating Systems are installed	0	Informe de estudio de estado de SWH instalados con la FT 20.365
Energy generated with Solar thermal energy (informe de capacidad instalada en Chile. No lo hace el proyecto.)	0	Cambiar los informe
Financial mechanisms & Incentives for solar technologies designed	0	Incentives defined/improved for each technology
GHG emissions reductions achieved due to Solar projects ($tCO_{2/year}$)	0	6,840

Output Indicators	2011 (BL)	2014	2015	2016	2017	2018
Component 1.Promote transfer of technology and capacity building in solar technology.						
Economic and technical assessment for CSP, SWH and PV potential, including site assessments carried out.	0	1 study developed				
Definition of a PV-CSP energy pipeline project development	0		1 Pipeline Defined			
Support for a pre-investment study for the deployment of at least 5 MW of CSP or PV plant	0	1 Draft Report	1 final report developed	-		-

Output Indicators	2011 (BL)	2014	2015	2016	2017	2018
Definition of standards and monitoring protocols for solar panels	0		Draft for discussion available			Final protocols developed
Component 2: Development of demonstration projects using solar technologies.						
Design and installation of demonstrative projects PV	0 PV	0 kW PV	50 kW PV	150 KW		300 KW
Monitoring, and evaluation of installed pilot projects carried out	0%	0%	25%	60%		100%
Component 3: Design and implementation of financial mechanisms, incentives and public awareness campaign						
Incentives mechanism for the implementation of solar applications proposed and international experience assessed and share it with local partners	0 Study developed	0 Study developed	0 Study developed	1 Study developed		
Assessment of regulation for the integration of DG projects with solar technology carried out	0 Study developed	0 Study developed	0 Study developed	1 Study developed		

Output Indicators	2011 (BL)	2014	2015	2016	2017	2018
Design and implementation of a public awareness and education campaign.	0	0	0	1Campaign designed 1Workshop for presenting findings carried out		1 Campaign implemented 1Workshop for presenting findings carried out

E. Achievement of Outcomes and Outputs

This BID-GEF project played a catalytic role in promoting and supporting the transfer of technologies and know-how that are both climate-friendly and innovative. In addition, GEF financing was key to remove barriers that were hindering the development, growth and commercialization of such innovative but not yet fully commercialized technologies.

In the wake of the new NCRE technologies present in Chile, and after analyzing the new conditions for the development of solar energy in Chile and its level of advance in the market, in 2015 the Government of Chile (GoCH) requested a contract modification aiming to prioritize the solar technologies for self-consumption, such as photovoltaic (PV) and Collectors Solar Thermal (CST). As a result, the IDB and the GoCH subscribed an amendment agreement on March 17th, 2015. Under the discussions of such new agreement, the Ministry of Energy highlighted the importance to increase the availability of public information and price transparency on the technical applications of solar technologies. Thus, the project aimed to support the Government´s agenda in four strategic lines for the encouraging of PV systems: regulatory, enforcement, stimulation of demand, and reduction of supply asymmetries. The following modifications took place in light of the approved agreement:

- For the Concentration Solar (CSP) technology: to attend the specific demands related to the monitoring of the CSP plant being implemented by ABENGOA, along with expert advice and exchange of experiences.
- For the Collectors Solar Thermal (CST) technology: to focus on the monitoring and implementation of the new version of the Law "Franchise Tax for SWH.
- For the Solar Photovoltaic (PV) energy demonstration projects: to support the Government´s Energy Agenda for the implementation of the Public Solar Rooftops program. To determine the technical feasibility and prepare the installation specifications in public buildings and prioritize areas where the program focuses with GIZ funds and technical support of our project.
- For the design of financial mechanisms: to support the design and implementation of a financing line for MSMEs, oriented to finance PV systems with similar conditions than those of large integrated projects grant subsidies to reduce credits, in terms of interest rate and/or concessional terms to micro and small companies for the implementation of projects that include solar technology).

- **Achievement of Project Outcomes**

Project Strategy	Outcome Indicators	End of Project Target	Final Evaluation	Achievement Rating	Results Achieved and Justification
Impact Indicators: I. Increase on SWH installation to 1.506 MWhth/yr. II. Solar PV installation increased nationwide to 543 MWh/yr.	Outcome Indicator 1: A CSP Plant installed (MW) (CSP)	5 MWh	**Achieved**	**Highly Satisfactory**	Although no CSP plant was directly financed, project contributed to the tender and award of the Cerro Dominador project consisting of a 110 MW plant with 17.5 hrs of storage facility, currently owned by EIG Global Energy Partners (formerly Abengoa Solar Chile S.A. and Abengoa Solar S.A.). The Cerro Dominador complex also has a 100 MW photovoltaic plant that has been in operation since February 2018. The Cerro Dominador is the first CSP plant in South America (100 MW with 17.5 hrs. Of backup), which is consistent with the outcome indicator and therefore considered achieved.
	Outcome indicator 2: PV-DG installed (MWh/year)	300 kW	**Achieved**		300 kW achieved with the following installations: • (2015) Teletón Calama, SFV 40 kWp • (2015) Teletón Santiago, SFV 70 kWp. • (2016) Teletón Copiapó, SFV 40 kWp. • (2016) Teletón Iquique, SFV 25 kWp • (2017) Teletón Arica, SFV 25 kWp. • (2017) Teletón Talca, SFV 20 kWp.

					• (2018) Escuela Gabriela Mistral Tocopilla, SFV 20 kWp. • (2018) Complejo Educacional Pedro Prado, SFV 60 kWp.
	Outcome indicator 3: Electricity generated with solar technologies (MWh/year)	13,655 MWh	**Achieved**		949,000 MWh (September 2021, from large dispatch solar centrals)
	Outcome Indicator 4: Certified Solar Water Heating Systems are installed	Informe de estudio de estado de SWH instalados con la FT 20.365	**Achieved**		The MINEN provided capacity building on implementation of the Law 20.897, that provides tax incentives to engineering companies for the installation of SWH projects in new social housing. The project achieved 90,000m2 of SWH installed, equivalent to 1,858,500 MWh (Lifetime energy production).
	Outcome Indicator 5: Energy generated with Solar thermal energy	75 MWh	**Achieved**		Achieved by indirect projects generated upon implementation of the tax incentives. Between 2010 and 2019, the project added a thermal energy generation capacity of 70.334.058 kWh/year (with a total of 416.947.694 kWh supplied by the SWH for the years of the Tax Franchise), displacing other energy sources such as

					natural gas, liquid gas, electricity and biomas totaling 588.210.433 kWh/year.
	Outcome Indicator 6: Financial mechanisms & Incentives for solar technologies designed	Incentives defined/improved for each technology	**Achieved**		According to the modification made to the original agreement on March 17, 2015, approved by decree 313 of 03/17/2015, section 2.03 of the Sole Annex is eliminated from literal (ii) that indicated "the capacity will be improved. Manufacturing of solar water heating, in terms of design and assembly, among others aspects, in order to improve the quality of local solar heating products from Water;" and is replaced by: "(ii) local capacities will be strengthened, in terms of design and assembly, between ther aspects, in order to improve the quality of solar heating systems of Water"
	Outcome Indicator 7: GHG emissions reductions achieved due to Solar projects (tCO2/year)	6.840	**Achieved**		An estimated reduction of 5,712[22] tCO2 emissions achieved since the beginning of the Solar Public Roofs Program (2015-2018), while approximately 135,000[23] tCO2 were avoided from 2010-2019 as a result of SWH projects installed within the framework of the tax franchise.

[22] https://energia.gob.cl/sites/default/files/documentos/sistema_mrv_final.pdf
[23] Evaluación de Impacto y Resultados de la Ley N° 20.365 de Sistemas Solares Térmicos, Centro de Energía Facultad de Iencias Físicas y Matemáticas Universidad de Chile, pg. 18

- **Status of Project Outputs (Execution)**

Project Strategy	Expected Outcomes	Indicator	End of Project Target	Final Evaluation Assessment	Achievement Rating	Comments
Component 1. Promote transfer of technology and capacity building in solar technology.	Business model for CSP, SWH and PV defined	Output Indicator 1: Economic and technical assessment for CSP, SWH and PV potential, including site assessments carried out.	1 study developed (2012)	**Achieved**	**Satisfactory**	Completed in Document Study: ATACAMATEC
	Definition of a model for implementing pilot projects with CSP and PV for DG	Output Indicator 2A: Definition of a PV-CSP energy pipeline project development	1 Pipeline Defined (2013)	**Achieved**		The ATACAMATEC study prepared a portfolio of projects and carried out the pre-feasibility of the following projects: 1. heat generation processes: Codelco Potrerillos; 2. Desalination with CSP technology; 3. Solar electricity generation for water pumping: Minera Lomas Bayas; 4. process heat generation: SQM-Coya Sur.
		Output Indicator 2B: Identification and evaluation of optimal locations for CSP Projects	1 Pipeline Defined (2013)	**Achieved**		Completed in Document Study: ATACAMATEC

		Output Indicator 3: Support for a pre-investment study for the deployment of at least 5 MW of CSP or PV plant	1 final report developed (2013)	**Achieved**		Completed in Document Study: ATACAMATEC
	Local companies are able to manufacture, design, implement, monitor and certify PV and SWH projects	Output Indicator 4: Definition of standards and monitoring protocols for solar panels	Final protocols developed	**Achieved**		The Ministry through the SEC has already defined the terms for the two SWH and PV technologies.
	Local capacities on CSP transferred.	Output Indicator 5: Training activities for public and private stakeholders on CSP/PV.	This Indicator was not in the RM, but in the Project Doc. CEO Endorsement.	**Achieved**		• Course learning photovoltaics-Agriculture. Applied to irrigation. • Net billing-Photovoltaic (PV) Communication Campaign • Avant Premier Al Gore • ER Symposium • Solaria • Production Audiovisual Record PTSP • Production by opening SFV Hospital Barros Luco. • Solar photovoltaic stand production • Production Audiovisual Record Program Reconstruction CST • 2019 Seminar for the dissemination of Law 20,571 on Distributed Generation.

Component 1. Promote transfer of technology and capacity building in solar technology.

Component 1 aimed mainly at strenthening the capacities of the local solar industry, thereby supporting the development of the whole industry value chain. This component implied efforts increasing the capacities of local companies to import or produce technology-based components and their ancillary elements, and that of consulting firms to design and install solar systems.

A. Expected Outcomes of Component 1

Although there were changes introduced to the project implementation strategy, favoring the promotion of PV over SHW systems, the evaluation considers that these were in line with the expected outcomes of component 1. There were four component outputs. The two first component outcomes ***a) Business model for CSP, SWH and PV defined***, and ***b) Definition of a model for implementing pilot projects with CSP and PV for DG*** were completed under the study "ATACAMATEC"; and the other two ***d)***, Strengthening of the local capacities in terms of design and assembly to improve the quality of SWH systems, and ***e) Local capacities on CSP transferred***, were implemented with capacity building activities (documented on "Seminars on Law 20.571, Gestión Creativa Group"), and the monitoring and evaluation of installed projects that were part of the contracted study "Analysis of the SWH systems installed with Tax Franchise for the period 2010-2013".

Given the priorization of technologies proposed by the Government and approved by the Bank, this component mainly supported:

a) Development of the technical study "ATACAMATEC", co-financed by the Bank with the non-reimbursable technical cooperation CH-T1122. This technical cooperation, was also part of the Bank strategy to support the Government of Chile and the Ministry of Energy in the implementation of its Energy Angenda.

b) Development of the "Analysis of the SWH systems installed with Tax Francise for the period 2010-2013", whose methodology and results will be used on their current implementations. Law 20.897 for SWH.

c) Training activities for public and private stakeholders on the regulatory framework involved on Law 20.571 for PV projects in Distributed Generation (DG), and the capacities acquired under the Public Solar Rooftops Program.

The main results of this component were:

- Increased local capacities in all the value chain linked to the installation of SWH systems, including by the Government (certifying, approving and monitoring technical quality of installations), by the private sector (increasing their manufacturing, comercialization, engineering and consulting capacities), by the training schools (obtaining top notch international technical knowledge and technology transfer through capacity building efforts and labs).
- Increased institutional government capacities in the design and adaptation of policy and regulation mechanisms to encourage the promotion of solar technologies. Implementation of the Tax Franchise proofed to be succesful in the promotion of SWH systems, so much so that a second Tax Franchise was implemented in 2015-2020 once resources from the first one were exhausted. The Government gained technical capacities in both, solar technologies and regulation.

B. Completion of Project Outputs of Component 1

i. Output Indicator 1: Economic and technical assessment for CSP, SWH and PV potential, including site assessments carried out.

The following studies are highlighted due to their contributions to the development of the sector:

The ATACAMATEC Study, whose main objective was to support and promote the conditions that allowed the deployment of large-scale solar photovoltaic (PV) technologies, concentrated solar power (CSP) for the production of electricity and thermal energy for hybridization (integration of solar fields in thermal plants and solar thermal processes for its applications in the mining industry in Chile, by:

- Analysing the gap in the current regulatory framework and the proposed mitigation strategies to define actions to support and promote the deployment of solar technologies.

- Studying and proposing specific new and appropriate financial mechanisms to enable the deployment of solar technologies to the energy market and funding for implementation and future penetration of the three different solar technologies PV, CSP and SWH.

- Evaluating the characteristics of projects and identifying the need for support and promote the development of solar energy solutions as the primary source for the production of final electric energy, final thermic energy and hybrid energy solutions.

New Applications and Estimates of the Solar Resource in Chile, whose main objectives included:

- Develop a methodology to calculate the photovoltaic potential in roofs considering the new technological trends and current regulatory framework in an integrated way to the renewable energy modeling system.
- Develop a methodology for the evaluation of residential heating projects with solar input.
- Design and development of 4 online tools. The first tool was intended for the financial pre-evaluation of photovoltaic projects within the framework of the Casa Solar program. The second corresponded to a tool for the evaluation of photovoltaic projects with bifacial technology. The third was a tool for the simplified evaluation of home scale photovoltaic projects. The fourth was a tool for the evaluation of community-type self-consumption projects.

Technical Advice to design a strategy for the development and penetration of sustainable thermal technologies in Chile, whose main objective was to draw a long term and sustainable strategy for the sector incorporating renewable energy sources and energy efficiency measurements. The study covered the following three components:

- Preparation of a baseline and diagnosis of the sector.
- Identification of a long-term vision of the themes of heat and cold.
- Construction of possible future scenarios that the sector will face in Chile and the world.

Diagnosis and Impact Of Photovoltaic Systems on Agricultural Production Associated with Energy with Emphasis on The Application of The Distributed Generation Law, whose main objective was to identify the best practices in the development of energy communities with the main normative and economic aspects and conditions similar to the Chilean case. The study evaluated possible scenarios for the development an energy community model in accordance with the provisions of the Distributed Generation Law that allows users to install systems with a capacity of up to 300 kW, and supports the development of community systems. The study concluded that the most suitable figures for this model of energy community turned out to be cooperatives and organizations of water users, the latter mainly due to the degree of organization they achieve.

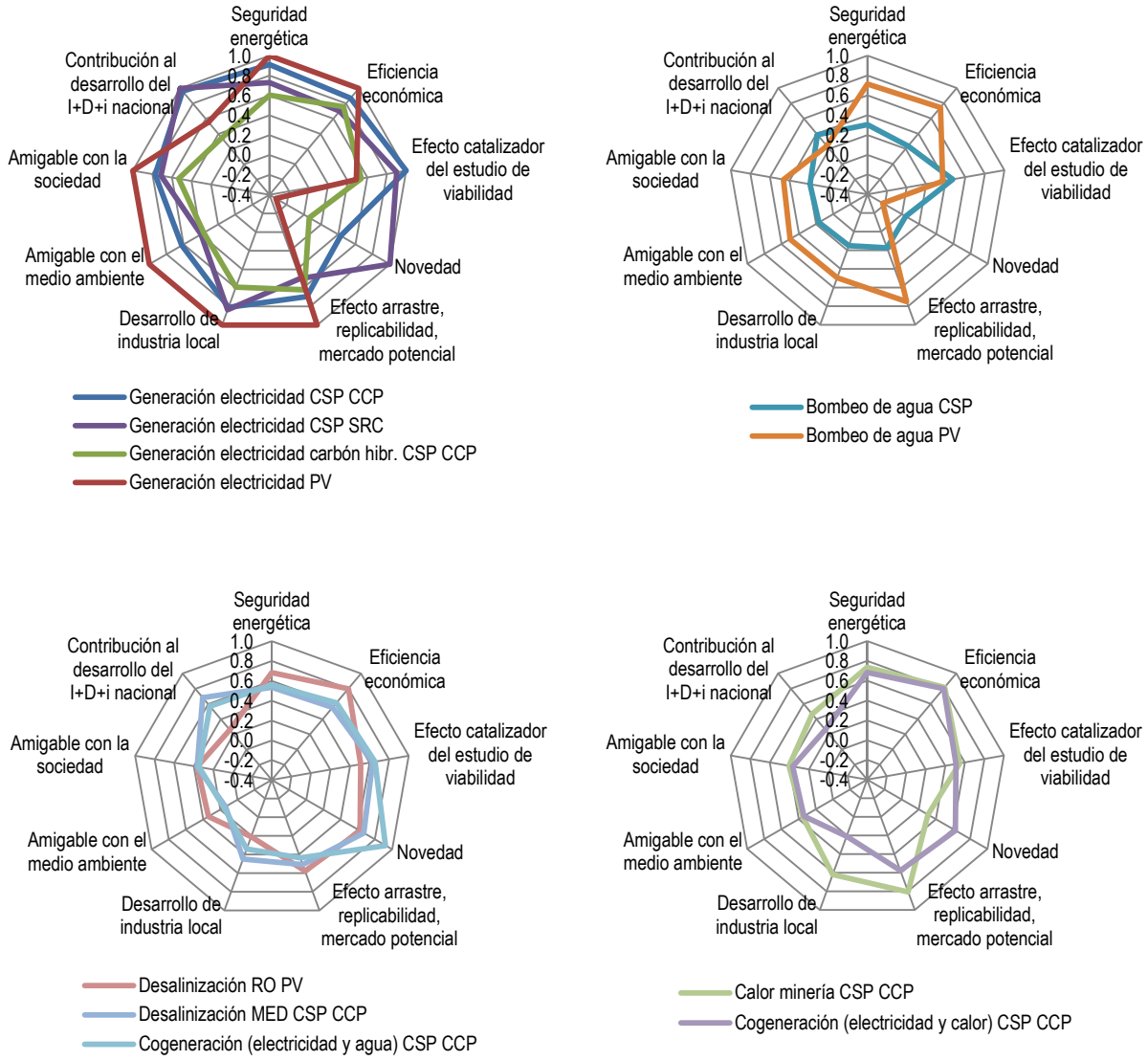
ii. Output Indicator 2: Definition of a PV-CSP energy pipeline project development and Identification and evaluation of optimal locations for CSP Projects.

The following are the PV energy pipeline projects along with the optimal development locations, according to the ATACAMATEC Study. The study used the Quality Function Deployment (QFD) methodology for the selection of large-scale solar projects to be developed in **Northern Chile**.

Table 3. Type of Solar Projects Identified

Goal	Technology	Description
Electricity Generation	CSP CCP	50 MW typical plant with 7.5 h of storage
	CSP SRC	50 MW typical plant with 10 h of storage
	FV	25 MW typical plant and fixed structure
	Hybridization	150 MW coal plant hybridized with CSP CCP
Water Pumping	CSP CCP	Pumping, flow equal to 0.5 m 3 / s and pumping head equal to 1,000 m
	FV	
Desalination	MED CSP CCP	Desalination of 0.5 m 3 / s
	RO PV	
Heating for Mining	CSP CCP	30 MWt generation
Cogeneration (Electricity and Heating)	CSP CCP	Generation 30 MWt and 8.5 MW e
Cogeneration (Electricity and Water)	CSP CCP	Generation of 0.5 m 3 / s of water and electricity

Graph 4. Comparison of Projects According to Quality Criteria

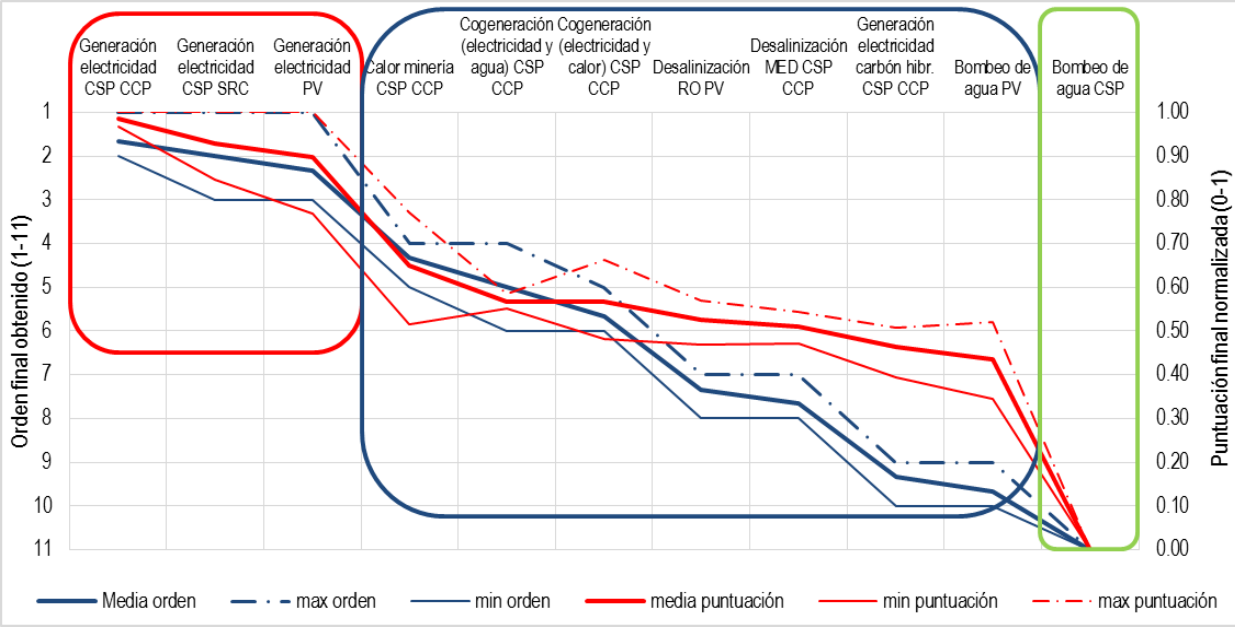


Source: ATACAMATEC Study

iii. Output Indicator 3: Support for a pre-investment study for the deployment of at least 5 MW of CSP or PV plant

The ATACAMATEC Study performed a selection and validation of instruments, according to the expected economic impact of each one of the three technologies, PV, CSP and SWH. The following table summarizes the results obtained.

Graph 5. Project Priorization



Source: ATACAMATEC Study

Based on the results obtained in the ATACAMATEC Study, the GoC decided to perform pre-feasibility studies in the central group of project technologies, given their derived benefits.

iv. Output Indicator 4: Definition of standards and monitoring protocols for solar panels.

Although a "Definition of standards and monitoring protocols for solar panels" report was not developed, MINENERGIA decided that an "**Analysis of the SWH systems installed with Tax Francise for the period 2010-2013**" was more beneficial for local companies to manufacture, design, implement, monitor and certify SWH projects. The methodology and its results were used in the implementation of SWH systems, under Law 20.897.

The company "Vivendio" was hired to developed the study "Assessment of the Current Functioning and Conservation Status of the Installed SWH Systems Through the Tax Franchise Established by Law 20.365 and of the Subsidies for the Protection of Social Housing Family Estate Program", whose main objective was to evaluate *in situ* the facilities installed since 2011 in five regions (Antofagasta, Valparaíso, Metropolitana, Bío-Bío y Los Lagos) in order to get feedback on the policies implemented, identify common problems and opportunities for improvement, and draw valuable conclusions that would alow to propose amendments to the current legal and technical reglamentation to ensure the quality of the next SWH projects to be installed and to defend certain long term policies.

Nonetheless, there were efforts made toward the promotion of PV tehcnology. The following activities performed were also in line with the development of this output:

On June 4, 2014, Supreme Decree No. 71 was promulgated to approve the Regulation of Law 20,571 (promulgated on February 20, 2012) that Regulates the Payment of Electricity Rates for residential generators. In the same way, technical instructions and resolutions issued by the Superintendency of Electricity and Fuel related to requirements for the design and execution of solar installations, among others, were also created. the Renewable Energy Unit was created in the Superintendency of Electricity and Fuels in order to establish a complete monitoring of the implementation of the law.

On November 17, 2018, The Distributed Generation Law (Law No. 21,118) was enacted, modifying aspects of the Distributed Generation Law, mainly increasing the maximum installed capacity per customer from 100 kW to 300 kW, in addition to allowing community systems.

As a result, from february 2015 to december 2019, there were 6,224 PV installations were declared with the SEC with a total installed capacity of 48,239 kW.

v. Output Indicator 5: Training activities for public and private stakeholders on CSP/PV

The Ministry of Energy performed a number of programs to upgrade the skills and capacity building for solar companies and businesses in order to improve their abilities to install, connect, operate and maintain PV panels. The program also included a course on how to apply the new Law for Net Metering and how to issue application for interaction with the grid.

According to the Procurement Plan shared by MINENERGIA, budget resources were used in the following activities:

- **Workshops**
  - Seminar for Law 20,571 on Distributed Generation.
  - Seminar for the dissemination of Law 20,571 on Distributed Generation.
  - Workshop for the dissemination of Law 20,365 of CST.
  - Training workshop for the inspection of solar thermal systems for professionals from the SERVIU of Arica y Parinacota, Tarapacá and Antofagasta.
  - Training workshop for inspection of solar thermal systems for professionals from the SERVIU of Copiapó.

- **Capacity Building/Training Activities:**
  - Course learning photovoltaics-Agriculture. Applied to irrigation.
  - Net billing-Photovoltaic (PV) Communication Campaign
  - Avant Premier Al Gore
  - ER Symposium
  - Solaria

- Production Audiovisual Record PTSP
- Production by opening SFV Hospital Barros Luco.
- Solar photovoltaic stand production
- Production Audiovisual Record Program Reconstruction CST

The general objective of the pilot project was to "Design and develop a Training Program in PV to implement it in high schools of technical and professional secondary education with a specialty in electricity selected for this purpose." The program aimed to increase the number of electrical technicians in Chile specialized in the implementation and maintenance of PV systems installed under the scheme of Law 20,571 on Distributed Generation, which was promulgated in 2012 by the Ministry of Energy. As a first effort and pilot experience, this initiative was implemented in **20 municipal high schools with the specialty of electricity, located in regions with high solar radiation (Arica and Parinacota to Biobío).**

Figure 3. Pilot Installation and Training Framework

Source: Informe Final, Programa de Capacitación en Energía Solar Fotovoltaica para Liceos De Educación Media Técnico Profesional, Corporación de Desarrollo Tecnológico de la Cámara Chilena de la Construcción

From 2015 to 2020, a series of training activities aimed at incresing the technical knowledge of electrical installers and the general public throughout the whole national territory, with the objective of disseminating the Distributed Generation Law (Law No. 20,571 (and then its modification Law N° 21,118)). The program increased the solar technology local capacities by:

- Updating the theoretical and practical skills of teachers of the electricity specialty of professional technical secondary schools (LEMTP) with a specialty in electricity, on the topics associated with photovoltaic solar technology, its regulatory aspects and the use of laboratory equipment, didactic material, methodological strategies and adaptations.

- Defining proposals for technical specifications of the didactic equipment necessary for the implementation of photovoltaic solar energy laboratories, which allowed the practice of the learning activities defined in the proposed curricular adaptation for the LEMPT.

- Developing the methodological strategy for the implementation of the training program that allowed teachers to incorporate expected learning, educational resources, activities and associated didactic material for the practical teaching of solar photovoltaic systems, so that students acquired knowledge associated with the installation and maintenance of photovoltaic solar energy systems.
- Training, supporting and technically advising the selected LEMTP teachers specializing in electricity, so that they could implement a curricular adaptation of the electricity study programs in their establishments, and thus incorporate the theme of photovoltaic solar technology by selecting the feasible modules and the specialty learning objectives.

- **Component 2.**

Project Strategy	Expected Outcomes	Indicator	End of Project Target	Final Evaluation Assessment	Achievement Rating	Comments
Component 2: Development of demonstration projects using solar technologies.	At least 300 kW of PV in DG installed At least 6,2 MW of CSP installed 100 m2 of certified SWH installed GHG reductions achieved	Output Indicator 1: Upgrade equipment for manufacturing installed (A SWH firm has upgraded its manufacturing lines).	At least 1 firm upgraded with international standards	Achieved	**Satisfactory**	Output was rephrased on Modificatory Agreement: "local capacities will be strengthened, in terms of design and assembly, among other aspects, in order to improve the quality of solar heating systems of Water". Since local capacities on SWH systems was improved, the output is considered achieved.
		Output Indicator 2: Design and installation of demonstrative projects. (Pilot projects specifically tailored for PV are designed and implemented)	80 m2 SWH 150 KW PV	Achieved		The project added a thermal energy generation capacity of 70.334.058 kWh/year (with a total of 416.947.694 kWh for the years of the Tax Franchise). 300 kW achieved with the following installations: • (2015) Teletón Calama, SFV 40 kWp • (2015) Teletón Santiago, SFV 70 kWp. • (2016) Teletón Copiapó, SFV 40 kWp. • (2016) Teletón Iquique, SFV 25 kWp • (2017) Teletón Arica, SFV 25 kWp. • (2017) Teletón Talca, SFV 20 kWp. • (2018) Escuela Gabriela Mistral Tocopilla, SFV 20 kWp. • (2018) Complejo Educacional Pedro Prado, SFV 60 kWp

	Design and installation of a CSP Plant	Output Indicator 3: A CSP pilot project designed and procured.		Achieved		IDB and MINENERGÍA agreed to prioritize PV technologies over the other technologies (CSP and SWH).
		Output Indicator 4: Design and tender of a CSP Plant		Achieved		The CSP Cerro Dominador project was completed on 2021, which brought experience in procurement and contracting of CSP technology, and a collection of market prices[24].
	Final results and lessons learned identified	Output Indicator 5: Monitoring,and evaluation of installed pilot projects carried out	100% finalized	Achieved		During 2016, the study "Evaluation of the state of operation and conservation of the Solar Thermal Systems installed through the Tax Franchise established by Law 20,365 and of the subsidies of the family patrimony protection program for social housing", was carried out to evaluate the degree of success of the intruments.

[24] https://cerrodominador.com/2021/06/09/cerro-dominador-inaugura-su-planta-de-concentracion-solar-de-potencia-la-cual-proveera-100-energia-renovable-24-7/

Component 2: Development of demonstration projects using solar technologies.

Component 2 aimed to support both the tendering process and the mobilization of financial resources to transfer technology for the implementation of a CSP plant, along with the design and installation of PV demonstrative projects. The Public Solar Rooftops Program (PTSP) was partially funded with this component. The objectives of the PTSP Program were to introduce photovoltaic plants on public property and to boost the maturity of the national PV market.

A. Expected Outcomes of Component 2:

The main objective of the development of the Public Solar Rooftops Program (PTSP) was to contribute to the maturation of the photovoltaic market (PV) through the installation of photovoltaic systems in public buildings connected to the distribution network, under the scheme of the Distributed Generation Law (Law 21,118). Under the program, eight (8) Photovoltaic Systems[25] projects were implemented with project funds totaling an installed capacity of 300 kWp.

In addition, one of the most relevant objectives of the PTSP program was to generate free public access information on costs and conditions of photovoltaic projects in the Chilean context to increase competition and lower prices. Thus, an important outcome achieved with this program was the collection and resulting market price reductions from seventeen public tenders made under the program.

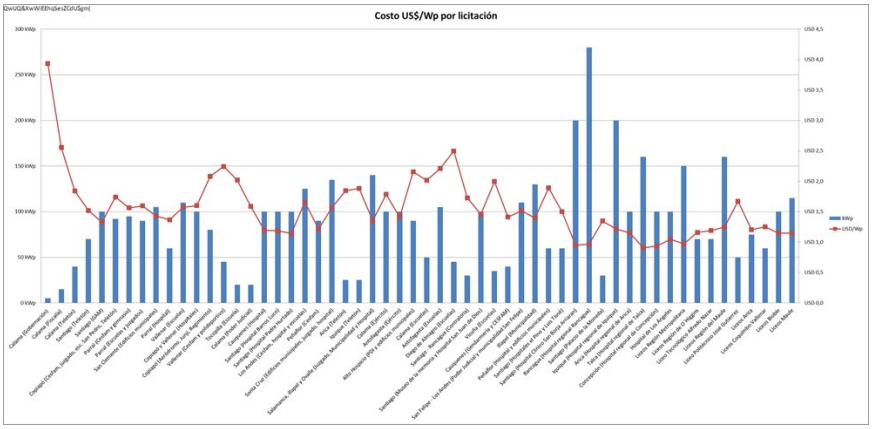
Some of the conclusions achieved were: the cost of PV plants awarded for 5 kWp to 100 kWp, varies in a range of 3.93 to 1.14 USD/Wp, respectively. So a clear effect of economies of scale is observed, since increasing the size of the PV plant and adding cost transparency, the cost decreases, whereby the 100 kWp PV plants have lower costs.

This benefit was particularly seen in the PTSP program (Teletón Santiago), whereby the cost of installing the PV systems went down gradually as a result of the public bidding put together by the Government. These are the cost per watt points obtained:

- First Tender (5 KWp): US$3.93/Wattp
- Second Tender (15KWp): US$2.55/Wattp
- Third Tender (40KWp): US$1.84/Wattp
- Fourth Tender (10KWp): US$1.5/Wattp

[25] https://techossolares.minenergia.cl/?page_id=6

Figure 4. Comparison of Net Auction Prices is USD/Wp for PV Plants from 5 to 100 kWp



Source: Evolution of the Price Award of Public Solar Roofs Program Tenders. 2018

B. Completion of Project Outputs of Component 2

i. Output Indicator 1: Upgrade equipment for manufacturing installed (A SWH firm has upgraded its manufacturing lines).

The Output Indicator was modified on Modificatory Agreement: "local capacities will be strengthened, in terms of design and assembly, among other aspects, in order to improve the quality of solar heating systems of Water". No specific activity was performed under this particular indicator however, since local capacities on SWH systems were strengthened, the goal of the output is considered achieved.

ii. Output Indicator 2: Design and installation of demonstrative projects. (Pilot projects specifically tailored for PV are designed and implemented)

The Output Indicator was achieved through the installation of 300 kW of PV panels in eight public buildings as part of the Public Solar Rooftops Program (PTSP). The main objective of the Public Solar Rooftops Program (PTSP) was to contribute to the maturation of the photovoltaic market (PV) through the installation of photovoltaic systems in public buildings connected to the distribution network, under the scheme of the Distributed Generation Law (Law 21,118). The program included an investment of USD 13 million in the construction of 300 kW photovoltaic systems on public buildings, on a public bid basis, open both to Chilean and foreign companies. In total the program installed 136 projects, 5,33 MWp, $5.983.484.554 CLP.

The investment program aimed to stimulate the market for small photovoltaic systems, to disseminate information about the possibility of installing photovoltaic systems for self-supply, as well as to optimize the existing standards and procedures.

GEF funds supported the Solar Rooftops Program by installing 300 kW of PV panels in the following eight public buildings:

- (2015) Teletón Calama, SFV 40 kWp
- (2015) Teletón Santiago, SFV 70 kWp.
- (2016) Teletón Copiapó, SFV 40 kWp.
- (2016) Telerón Iquique, SFV 25 kWp
- (2017) Teletón Arica, SFV 25 kWp.
- (2017) Teletón Talca, SFV 20 kWp.
- (2018) Escuela Gabriela Mistral Tocopilla, SFV 20 kWp.
- (2018) Complejo Educacional Pedro Prado, SFV 60 kWp

Table 4. Phographic Records, Teletón Santiago

Proyecto: Techos Solares Públicos (PTSP)
Location: Teletón Santiago
Size: 30KW (Phase I) / 40KW (Phase II)
Installed Capacity: 1MW - double net metering
Links:

- http://www.minenergia.cl/techossolares/?page_id=9
- https://youtu.be/CBpLwgkQ71w

iii. Output Indicator 3: A CSP pilot project designed and procured

iv. Output Indicator 4: Design and tender of a CSP Plant.

The ATACAMATEC Study provided the means to design, prepare and successfully tender the first CSP Plan in Chile with the following elements:

- Review and analysis of the bidding criteria defined in the terms of reference of prepared by MINENERGIA
- Review and analysis of the implementation plan for the tender including defined evaluation criteria for the proposals
- Suggestions and technical, economic and financial recommendations to be included in the basis of public tender
- Advice on the evaluation of bids received in the tender CSP: quality of the input variables, patterns of production and guaranteed values
- The GoC awarded ABEGOA, in 2014, the construction, operation and maintenance of a solar power tower plant to supply electricity to the SING located in the Atacama desert, in the town of Maria Elena, the area with the highest solar radiation in Chile.

In 2016, Abengoa and EIG Global Energy Partners ("EIG"), signed an Investment and Contribution Agreement to finance the construction of some projects, to be transferred to a newly formed company, named APW-1. APW-1 acquired a portfolio of selected Abengoa's projects under construction, including renewable and conventional power generation and power transmission assets in different geographies including Mexico, Brazil and Chile (including Atacama I & II (STE and PV) in Chile).[26] EIG, however, assumed full ownership and control of the project in October 2016.

The 100MW CSP Plant "Cerro Dominador" consists of 392,000 solar panels mounted on single-axis trackers on a 300ha-site. The PV plant commenced operation with 62MW of its installed capacity connected to the Chilean grid in August 2017.The plant achieved its full capacity in December 2017.

Although the project encountered this situation which challenged the completion of the CSP plant, the GEF resources were instrumental for the MINENERGIA to acquire international knowledge and institutional capacity, lacking previously in Chile, to design and implement a bidding process for CSP technologies. In this regard, the Final Evaluation considers that the outcome indicator to "Design and installation of a CSP Plant", along with its output indicators "design and procure a CSP pilot project", and "Design and tender of a CSP Plant", were achieved satisfactory.

[26]Abengoa announces final agreement with EIG for investment in Abengoa Projects Warehouse 1. http://www.abengoa.com/web/en/noticias_y_publicaciones/noticias/historico/2015/03_marzo/abg_20150326.html

Table 5. Phographic Records: Technical Inspection to the Abengoa Project (December 2015)

Source: MINENERGIA

v. Output Indicator 5: Monitoring,and evaluation of installed pilot projects carried out.

MINENERGIA contracted the two folowing studies to evaluate the results of the government programs to develop the market of solar technologies in Chile. The two studies were:

- Impact Evaluation and Results of Law No. 20,365 on Solar Thermal Systems in order to collect the experience and analyze the implementation of solar thermal systems performed under such tax credit (from 2009-2013). Such study includes the monitoring and evaluation of of installed pilot projects carried out under the Law.
- Evaluación de resultados del Programa Techos Solares Públicos (PTSP) del Ministerio de Energía.

- **Component 3.**

Project Strategy	Expected Outcomes	Indicator	End of Projecct Target	Final EvaluationAssessment	Achievement Rating	Comments
Component 3: Design of incentives, financial mechanisms and public awareness campaign	Replication effect of the Project is Achieved.	Output Indicator 1: Incentives mechanism for the implementation of solar applications proposed and international experience assessed and share it with local partners	1 Study developed	Achieved	Highly Satisfactory	Completed in Document Study: ATACAMATEC
		Output Indicator 2: Assessment of regulation for the integration of DG projects with solar technology carried out	1 Study developed	Achieved		MINEN implemented law 20.571 for DG with the support of project funds.
		Output Indicator 3: Design and implementation of a public awareness and education campaign.	1 Campaign designed 1 Workshop for presenting findings carried out	Achieved		Implementation of law 20.571 performed with project funds also included capacity building and awareness activities.

Component 3: *Design of incentives, financial mechanisms and public awareness campaign*

Component 3 aimed for the design of a financial mechanisms to promote solar-based technologies and thus ensuring its long-term sustainability. This component consisted of: (i) the identification and assessment of financial and other incentive mechanisms including credit schemes and tax incentives to promote solar technologies based on international experience (CSP, PV and SWH); (ii) the assessment of international experiences on rules and technical regulation for CSP and PV-DG, and (iii) the design and implementation of a public awareness and education campaigns to promote and replicate solar technology projects including information dissemination within the private and public sector.

A. Expected Outcomes of Component 3:

The main expected outcome was to generate a replication effect on the implementation of solar-based technologies. This evaluation considers that the expected outcome was achieved mainly in the case of SWH systems thanks to the implementation of Law N° 20.365, which created a tax franchise to promote the installation of new SWH systems generating the conditions for a new market associated to this technology to develop[27]; to some degree also achieved in the case of PV systems with the implementation of both, the Public Solar Roofs Program, and of Law 20.571 Net Billing (Regulation of Distributed Generation), which increased market demand for the installation of PV systems[28], and to a lesser degree achieved in the case of CSP, that although the tax incentive planned under this component wasn't awarded to the EPC contractor, other government actions advanced in relation to this component, such as the tendering process and the development of technical skills profiles and competences, did promote the development and replication of this technology in Chile.

[27] Evaluación de Impacto y Resultados de la Ley N° 20.365 de Sistemas Solares Térmicos
[28] Evaluación de Resultados del Programa Techos Solares Públicos (PTSP) del Ministerio de Energía, pg 61.

B. Completion of Project Outputs of Component 3

i. Output Indicators 1: Incentives mechanism for the implementation of solar applications proposed and international experience assessed and share it with local partners.

The following are the main incentive mechanisms advanced by the GoC for the development of solar technologies in Chile, related to this GEF program:

- Law 20,365 for the installation of solar thermal collectors in new homes, 2010-2013, and the "Hogar Mejor" constitute the source of incentives for the installation of SWH systems in existing social housing.

Law 20,365 created a tax exemption targeted construction companies willing to use SWH systems in new housing developments, allowing them to discount the cost of solar collectors from their taxes on a sliding scale indexed to the value of each home. The law granted tax deductions equivalent to the cost, or a share of the cost, of the installation of new solar thermal systems providing at least 30% of the hot water consumed in a given building per annum. This measure sought to promote the use of solar technology and extended its benefits to houses and buildings across the country by offering up to 100% of the installed cost of SWH system for new houses eligible by the tax exemption.

- Development of the SWH Price Index

The general objective of this initiative was to contribute to the development of solar market in Chile by providing information on the cost of Single-family and multi-dwelling SWH installed, through surveys of solar companies. Price indices were made with different configurations of the technologies in different regions that have served as a reference for the development of other program. The Index verifies if the range of money was consistent with the range of consumption of a system. The index checked the difference between prices and profit. The index serves as a reference to the margin of resources left to adjust the regulation. A total of 12 Chilean companies agreed to participate in the study by sending cost information for six SWH systems.

- The Distributed Generation Law (Law 21,118), superseading Law 20,571, raising the nominal capacity of self-generation Non Conventional Renewable Energy (NCRE) plants of regulated clients from 100kW to 300kW.

Law 20,571 of Distributed Energy Generation in Chile came into force once its regulation or its rules of procedure was published in 2014. The Law had a slow start, but it has been continuously ascending. During the first years, the regulation had a modification to simplify procedures, clarify the situation of new buildings and housing complexes and to avoid entry barriers to the market.

Law 21,118 superseded the Law 20.571, raising the nominal capacity of self-generation Non Conventional Renewable Energy (NCRE) plants of regulated clients from 100kW to 300kW. It also allows users to transfer any surplus they have to another property of their own in the same utility area. Also, the discounts on the electricity bill now apply to all charges, not just the consumed energy tariff. Now communities and joint properties (buildings, rural communities) can benefit from this scheme. Nowadays electronic procedures for the processing of permits are implemented, reducing the timing connection (Cámara de Diputados de Chile 2018a)[29]. As of September of 2021, there are 6,224 PV installations registered with the SEC with a total installed capacity of 48,239 kW.

- Study "Diagnosis and impact of Photovoltaic Systems in agricultural production associated with energy with emphasis on the application of the Distributed Generation Law" whose objective was to have a diagnosis of irrigation projects, installed with subsidies, with electricity supply through Photovoltaic systems subsidized by the CNR, evaluating connection opportunities through Law 20,571.

This study considered the analysis of primary and secondary information on subsidized projects under Law No. 18,450 to promote irrigation in the Coquimbo and Biobío regions. It entailed a review of international cases corresponding to energy communities, identifying the main regulatory and economic aspects and conditions similar to the Chilean case. After reviewing the experience in the United States, Germany and England, the study advanced in the definition of an energy community model in accordance with the provisions of the Distributed Generation Law that to allow users to install systems with a capacity of up to 300 kW, and support the development of community systems. The study performed on-site inspections carried out at 73 facilities in the regions of Coquimbo (22) and Biobío (51), during the months of September and October 2018, are released.

- Study demand SFV in MSMEs

The study aimed to evaluate the photovoltaic potential in urban areas. The results obtained were presented for a study area located in the Maipú commune (~ 6.5km 2 equivalent to ~ 230 blocks),

[29] Is the Distributed Generation Law Effective? The Case of the Chilean Residential Solar Energy, by Daniela CAIMANQUE FREDEZ, July, 2018 Budapest

summarized at the farm scale and combined with Population and Housing census data at the block level. A repository with raw data on the highly detailed three-dimensional representation of the land surface of much of the urban area of the Metropolitan Region was part of the results.

- A line of credit for small businesses projects with NCRE and Energy Efficiency and a credit for micro businesses from Banco Estado.

ii. Output Indicator 2: Assessment of regulation for the integration of DG projects with solar technology carried out

The GoC has designed and implemented a number of key tax exemption incentives, with project funds, to encourage the development of a solar technology market, including: implementation of the laws 20,571 and 21,118), Law 20.365 regulatory framework for the installation of solar water thermal systems, and Law 20.897 tax credit for the installation of solar thermal systems in single-family housing units.

Law 20,571 "Regulation of Distributed Generation" enabled homeowners and businesses that install a PV system up to 100 kW for self-consumption to sell the system's excess output to the national grid at a fixed tariff. The net-billing scheme will pay producers an energy tariff that is equal than the market rate. The aim of the law is to provide electricity customers with the right to generate and consume their own electricity and to feed the exceeding electricity into the grid. A main condition for the successful market entry for solar companies is to understand which new technical requirements and regulations need to be taken into account. Therefore, the law could not become effective before October 2014 due to the lack of implementing regulations and technical standards, which have been overcome to date. Law 21,118 superseded the Law 20.571, raising the nominal capacity of self-generation Non Conventional Renewable Energy (NCRE) plants of regulated clients from 100kW to 300kW. It also allows users to transfer any surplus they have to another property of their own in the same utility area. Also, the discounts on the electricity bill now apply to all charges, not just the consumed energy tariff. Now communities and joint properties (buildings, rural communities) can benefit from this scheme. (For more information on the Distributed Generation Law (Laws 20,571 and 21,118) go to:
https://generaciondistribuida.minenergia.cl/
https://www.youtube.com/watch?v=wO0yCI6fibY .

Law 20.897, which amends and extends Law 20.365 for the support of solar thermal systems in single-family housing units, establishes a tax support scheme for solar thermal installations in single-family housing units, granting between UF 26.5 and UF 33 during the first year based on the overall value of the unit. Project funds allowed the preparation of training and dissemination seminars in Chile, and a comprehensive technical study to collect the experience and analyze the

implementation of CST systems performed under such tax credit (from 2010-2013), and to derive its methodology and results for further applications. This technical study was completed and it was informed to us that the lessons learned study of such analysis will be ready in December of 2021[30].

The ATACAMATEC Study analyses the current incentives mechanism for the implementation of NCRE and proposes the best fiscal measurements, in terms of qualitative and quantitative value. This table summarizes the findings:

Table 6. Changes to the Fiscal Framework (The Most Efficient and Effective Measures)

Measurement[31]	Price Impact		Ration Efficiency		Application Friendlyness	Installation Friendlyness	Risk Reduction	Barriers of Entry Redution
	CSP	FV	CSP	FV				
CE - Type 0%	1,6 %	2,7 %	2,5	2,5	High	High	Media	High
IU – Accelerated Depreciation	1,7 %	1,7 %	5,6	5,7	Media	High	Media	Media
PC – Extension 100% (5 years)	1,1 %	1,1 %	6,1	6,1	High	High	High	High
Combined Measurements	4,2 %	5,5 %	3,7	3,3	High	High	Media	High
					Media	High	Media	Media
					High	High	High	High

[30] "Evaluation of the Operating and Conservation Status of the SWH Systems Installed through the Tax Credit Established by Act 20,365 and subsidies Protection Program for Social Housing Family Heritage" by Vivendio and the MINENERGIA, may 27th, 2016.
[31] IU: "Impuesto a las Utilidades", PC: "Impuesto de Patente comercial", IA: "Impuesto Adicional", CE "Impuesto al Comercio exterior".

iii. Output Indicator 3: Design and implementation of a public awareness and education campaign.

MINENERGIA completed a number of public awareness and education campaigns to disseminate the new Government incentives and Laws in relation to the development of solar-based technologies. The following is a list of activities performed with GEF funds:

- **Awareness campaings**
  - Production of photovoltaic solar system memory museum
  - Production Stand Generation Distributed OC1311-CM17
  - Solar photovoltaic stand production expovivienda
  - FV seal
  - PV Irrigation Video
  - Certification of Skills in SFV. USACH
  - Production of the photovoltaic solar system Palacio de la Moneda
  - Logistic production of transfers of teachers to technical high schools
  - Solar agreement production
  - Solar World Congress

Also, the consulting company "Gestión Creativa Goup" was contracted for the design and development of a series of seminars on the Law Seminar 20.571. The purpose of seminars was to inform the normative aspects the law, including the procedures, the technical framework and requirements for the commissioning of photovoltaic systems. A total of 816 assistants participated in the seminars.

The seminars were conducted in different rounds between 2015 and 2020. In addtion to having a dedicated online platform for registry and daily updates, disemination of the seminars was performed throughout the following media outlets:

- Digital Invitations
- Online , Save The Date
- Press Notices
- Banner on the websites of the Ministry of Energy and inviting SEC

V. Sustainability of Outcomes

The present section assesses the sustainability of outcomes in the long-run and provide a rating of likelyhood. Because sustainability of outcomes is correlated to the risks and benefits of the project, this assessment includes an analysis of the key risks identified during project design, their materialization during project execution and their likelihood of occurrence in the long run thus affecting sustainability of outcomes.

Table 7. Management of Risks and Sustainability

	Risks	**Mitigation Measures**	Was the Risk Materialized During Execution? Y/N	Likelihood to affect Sustainability
1	Lack of political commitment for development and implementation of solar projects.	The last administration had enacted several laws that promote NCRE, particular solar technology. All activities have been prioritized with the new authorities.	No	Low
2	Lack of national industry expertise to manufacture the components of the solar applications.	Chile has a strong tradition is metal works and manufacturing in general, therefore given the correct incentives through this project, this risk can mitigated.	No	Low
3	Lack of local expertise to design, construct, operate and maintain solar systems throughout its lifetime.	Chile has highly trained technical and professional human resources capable of designing. constructing, operating and maintaining technology in general. Therefore providing the correct incentives and training through this project, this risk can be mitigated.	No	Low
4	Lack of interest from private sector to develop PV, CSP or SWH projects.	This risk can be mitigated given the financial incentives already in operation and the enacted laws, together with the awareness campaign provided by this project.	No	Low

	Risks	Mitigation Measures	Was the Risk Materialized During Execution? Y/N	Likelihood to affect Sustainability
5	Local financial market not willing to lend to NCRE using solar applications.	This risk is addressed via the dissemination of CORFO's credit line for RE, EE and clean investments.	No	Low
6	Lack of raw materials to build solar applications.	Chile, as one the important mining countries in the world, has important sources of mineral and raw material required for solar power, such as copper, lithium, silicon among others. Is an opportunity if it is useful correctly	No	Low

The evaluation considers that GEF resources were instrumental for the mitigation of the key potential risks identified during project design, because they provided the resources to develop a body of technicians to construct, install, operate and maintain PV, SWH and CSP installations and components, and to design financing mechanisms that triggered the development and continuetion of a solar industry, all in the context of very committed institutions to transition the country's growth towards a green economy.

Overall, the evaluation considers that it is **likely (L)** that project outcomes will be sustainable over the long-run, along with the project long-term benefits including the development of a solar market industry, energy savings and carbon emission reductions.

VI. Assessment of Monitoring and Evaluation Systems

The M&E system was coordinated by the Project Execution Unit (PEU) in the MINENERGÍA with additional guidance from the PPEE. The PEU monitored the progress of achieving outputs and outcomes based on the Results Framework. The evaluation considers that Monitoring and Evaluation Systems installed during project design and implementation had a **Highly Satisfactory (HS)** performance.

Monitoring activities and project achievements employed various means of verification. Information related to process indicators (e.g. the consolidation of solar firms capacities in designing and implementing solar projects, the progress in the certification capacities of local entities, or the progress in the establishment of financial mechanisms for PVs) were collected mainly through evaluations and interviews with solar firms, technical public entities (IDIEM, INN) financial institutions and institutional actors and stakeholders, as well as through the review of meeting reports, minutes and agreements from the sub-sector round tables.

Solar technology implementation and emission reduction indicators (e.g. GHG- emission reductions from pilot projects) were assessed through reports on direct measurements and indirect measurements. The Government developed a "System for Monitoring, Reporting and Verification (MRV) for Renewable Energy Projects Implemented in Chile" to quantify the reduction of GHG emissions generated by energy projects implemented in the country, and thus measure the impact of the mitigation.

VII. Assessment of Implementation and Execution

The evaluation considers that the implementation and execution quality was highly satisfactory mainly because all project activities, outputs and outcomes were achieved despite a number of challenges presented during execution, mentioned earlier in the report. Success in the execution can be attributed to two main reasons, first, the long-term vision and commitment shown by the GoC with regards to the development of a renewable energy industry, and second the strengh of the GoC's institional capabilities in terms of collaboration and cooperation. Proof of that was that GEF resources benefitted the institutional capacities in solar technologies across a number of government agencies and industry associations, including, the MINENERGIA, the Superintendency of Electricity and Fuel, the Ministry of Housing, the Ministry of Environment, the Ministry of Education, industry associations (ACESOL) and the private sector (incl. engineering, manufacturing and consulting firms). Collaboration efforts allowed the GoC to enhance its technical capabilities in: i) the fiscalization of solar project installations to ensure consumer rights and safety, ii) the design and implementation of laws, norms, regulations and policies to regulate and encourage the development of solar technolgies, iii) the creation of tax incentives and other government mechanisms to favor market entrance of renewable energies, and development of new industry value chains, and iv) the understanting of energy prices and tax implications of SWH system installations, to increase the availability of public information and price transparency on the technical applications of solar technologies.

Table 8. Quality of Implementation and Execution

Institution	Roles and Responsibilities Implementation/Execution	Quality of Implementation/ Execution
IDB	**Role:** Implementation and Monitoring **Responsibilities:** • INE/ENE technical design and facilitation • CSC/CCH technical supervision	HS
Ministry of energy	**Role:** Execution **Responsibilities:** • Technical, financial and administrative matters • Technical matters that include: o SWH (Tax Franchise, programs, training, price index)	HS

	○ Photovoltaic (Net-billing Law, trainings) ○ Teacher training, PV laboratories	
Superintendency of Electricity and Fuel (SEC)	**Role:** Execution **Responsibilities:** • Co-execute technical matters that include: ○ SWH (Tax Franchise, programs, training) ○ Photovoltaic (Net-billing Law, trainings)	HS

- Highly Satisfactory (HS): There were no short comings and quality of implementation / execution exceeded expectations.
- Satisfactory (S): There were no or minor short comings and quality of implementation / execution meets expectations.
- Moderately Satisfactory (MS): There were some short comings and quality of implementation / execution more or less meets expectations.
- Moderately Unsatisfactory (MU): There were significant shortcomings and quality of implementation / execution somewhat lower than expected.

VIII. Conclusions

This final evaluation concludes that GEF financing played a catalytic role in promoting the development of a solar industry in Chile, consonant to a long-term vision started by the Government in the late eighties to transform the electricity sector and introduce renewable energies as a way to decouple the country's economic growth from fossil fuel electricity generation. As a result, today, renewable electricity from solar and wind power represents nearly 26% of the country's energy supply, and the volume of renewables is expected to increase every year.

Since then, Chile's energy sector has not only grown in capacity and demand, but has also gone through a number of reforms, beginning with its privatization in the 80's which separated the sector into three (3) distinguished businesses: generation, transmission and distribution. Today over 432 generating companies, 116 transmission companies and over 21 distribution companies are connected to the SEN, many of which are part of large corporate conglomerates.

GEF resources were used to support government actions that have been critical in this transformation, namely, the Public Solar Rooftop Program, implemenation of the Distributed Generation Law (Laws 20,571 and 21,118), implementation of the Law 20,365 on Tax Exemption for Solar Thermal Systems, and the development of capacity building programs for building of institutional capacities and transfering technology know-how for the introduction of innovative technologies, such as SWH, CSP and PV in DG and the development of the solar industry in Chile. In addition, GEF financing has also been key to remove barriers that were hindering the development, growth and commercialization of such technologies.

The program objectives: (i) to promote technology transfer, institutional strengthening and capacity building in solar technologies; (ii) to develop pilot projects using solar technologies (SWH and power generation) and (iii) to support the design of incentives, financial mechanisms and a public awareness campaign to promote solar projects with SWH and power generation technologies were fully achieved, while development of the three technologies, SWH, PV and CSP was achieved in different degrees.

In the case of SWH systems, which was considered as a very incipient market at project start, experienced a widespread of installations as a result of the implementation of Law N° 20.365, which created a tax franchise to promote the installation of new SWH. While at the beginning of this project there were about 30 companies able to provide installation services, today there are over 82 companies providing installation services and a whole new value chain of companies that revolves around the import, certification, installation

and maintenance of SWH systems. In addition to that, government data reports about 9,466 new jobs (as of 2019) associated to the installation of SWH systems. In terms of energy, the thermal energy supplied by SWH reaches 70GWh per year with the total of installed systems, while 416GWh have been supplied during the entire period of application of the tax exemption. Estimates also report an average saving of $ 151,962 per year per family beneficiary.

In terms of the development of the CSP technology, the evaluation concludes that although the tax incentive planned under this component wasn't utilized, other government actions made in relation to this component, such as the tendering process and the development of technical skills profiles and competences, did promote the development and replication of this technology in Chile. The process of developing a CSP Plant was jump started with efforts that were supported by the GEF funds, culminating in the development and construction of Cerro Dominador, the first CSP in Latin America. These efforts contributed to send the correct market signals that Chile was prepared to develop the CSP technology, in terms of its regulatory framework, financing platforms, associated market services, and technical job skills to sustain this technology in the long run. Partly, thanks to that, the renewable energy auction held by the Chilean National Energy Commission (CNE) recently, delivered a bid of $0.0399/kWh for a concentrated solar power (CSP) project, which is the lowest offer ever reported for an energy auction at a global level to date[32]. Overall, there is expectation that Chile will continue to adopt this technology and to improve the regulatory conditions needed for more plants to be developed.

The market of PV systems was also greatly benefited with the implemenation of the Public Solar Rooftop Program and deployment of the Law 20,571 of Distributed Generation for PV Systems. While the first provided a pipeline of demonstrative projects, the second one created a set of technical regulations and price compensation mechanisms that allowed self-consumers to sell energy to the grid. Moreover, the GoC elaborated "The energy path 2018-2022", which stated that one of the measurements was to increase the current capacity from small-scale distributed generation four times by 2022, compared to 2018 installations (Ministry of Energy of Chile 2018). Nonetheless, this goal was achieved in 2021 and has been already surpassed, and as of August 2021 Chile reached a PV installed capacity of 97,273 kW with 9,571 PV installations. GEF project resources, in tandem with the installation of PV systems under the Public Solar Rooftop Program, were used to prepare the technical capacities of around 2,000 trainees to install PV systems.

[32] https://www.evwind.es/2021/09/03/world-record-low-bid-of-3999-mwh-for-concentrated-solar-power-in-chiles-auction/82232

In terms of co-benefits, the project benefited 150,247 homes with SWH from 2010 to 2020, from which 74,279 dwellings benefited throught the Government Tax Frachnise, 70,360 social dwellings benefited through the 3PF “Hogar Mejor” program, and 5,608 dwellings benefited through the reconstruction program. In terms of emission reductions, an estimated reduction of 5,712 tCO2 emissions were achieved since the beginning of the Solar Public Roofs Program (2015-2018), while approximately 135,000 tCO2 were avoided from 2010-2019 as a result of SWH projects installed within the framework of the tax franchise. While the government’s institutional capacities in developing the market of Solar PV in DG and SWH systems were also enhanced. Moreover, the project also encouraged inter-institutional synergies, as the MINENERGIA worked in close collaboration with the Ministery of Eduation, the Chilean Association of Solar Energy, the private sector, and training schools for the development of job skills profiles and improvement of technical skills curricula.

IX. Lessons Learnt

- The Chilean case has demonstrated that the development of an active renewable energy sector requires a long-term vision, with clear institutional goals that transcend the political and government cycles and contribute to the creation of a stable and predictable environment to attract market participants. Manufacturers, distributors and retailers all require a transparent, long-term view of the market's future in order to invest in it.
- Policies and measures are needed to establish a conducive environment for the development of a domestic solar-based technology market. Such measures include the introduction of qualification requirements and standards, as well as education, training and certifications to ensure the quality of the products manufactured, imported and installed.
- Education, training and retraining policies are needed to meet the occupational and skills requirements of a solar industry. The availability of such skilled workers as plumbers, electricians, technicians, retailers and others is critical. Prospects for local employment are boosted by training programs and certification schemes for those occupations. Moreover, involving both men and women in a strong gender and youth focus in the employment opportunities along the various segments of the value chain would leverage an opportunity for gender empowerment and maximize income.
- A broad mix of policies and measures are needed to ensure the competitiveness of domestic firms. These include efforts towards industrial upgrading and supplier development; the creation of associations and networks among importers, producers and sellers; and the development of import markets. Quality improvement measures introduced in the case of SWH systems, such as technical standards, product labels for systems and special certificates for installation contractors, were critical in the development of a new market value chain.
- There are several barriers that hinder the full deployment of SWH systems, including low levels of awareness by households about modern hot water generating systems based on renewables. Homeowners tend to choose a known option. As a result, the deployment of SWH must be supported by a mix of policies in many countries. These include direct policies such as targets, public programs, obligations and mandates, and financial incentives such as tax franchises and low-interest loans to lighten the burden of the high initial cost (relative to cheaper alternatives such as gas boilers). In addition, enabling policies such as technical standards and certificates and training and retraining measures help create an enabling environment for the development of the SWH technology. Financial incentives are also still required to increase the cost competitiveness of SWH compared to other solutions. Financial incentives include a range of grants, low-interest loans and tax incentives.

- There is great potential to create a value-chain along the following phases of the process: manufacturing, wholesale distribution, sales and installation, and maintenance and operation of SWH systems. As with deployment, socio-economic value creation relies on the policies in place to develop the industry. Designing policies to maximize local benefits from the deployment of SWH requires a deep understanding of the requirements for labor, skills, materials, installations and equipment.

Annex 1. Persons Interviewed

- Andrés Véliz Araya, Ministerio de Energía Profesional MEN, SST (Franquicia Tributaria, programas, capacitaciones, índice de precios)
- Carlos Cerda SEC, Super Intendencia de Electricidad y Combustible Jefe de Unidad Solar Térmica, SST (Franquicia Tributaria, programas, capacitaciones) ccerda@sec.cl
- Manuel Binimelis Cárdenas, Liceo Domingo Ortiz de Rozas Docente, SFV (capacitación docentes, laboratorios FV) manuel.binimelis@gmail.com
- Ruth Rain CORFO, CSP, rrain@corfo.cl
- Christiaan Gischler BID, Jefe de Proyecto BID, christiaang@iadb.org
- María Soledad Barrios, Ministerio de Energía, Jefa Unidad Educación y Difusión, SFV (capacitación docentes, laboratorios FV), mbarrios@minenergia.cl

Annex 2. List of Documents Reviewed

Project Implementation Reports:

- Bi-annual Progress Implementation Reports.
- Informe Visita Tecnica Abengoa, Ministerio de Energia, Diciembre 2015.
- Project Implementation Reviews.
- Budget Execution Files.
- Project Logical Framework.
- Request For CEO Endorsement/Approval
- Plan of Operations.
- Audited Financial Statements and Auditors Opinion.

Consulting Reports:

- Apoyo a proyectos solares a gran escala en el norte de Chile, Informe Componente 2. Mecanismos legales, regulatorios e incentivos financieros, ATACAMATEC, Febrero 2013.
- Evaluación Del Estado De Funcionamiento Y Conservación De Los Sst Instalados A Través De La Franquicia Tributaria Que Estableció La Ley 20.365 Y De Los Subsidios Del Programa De Protección Al Patrimonio Familiar Para Viviendas Sociales, VIVENDIO, 27 de mayo del 2016.
- Formulación y Estructuración de un Instrumento Financiero para el Mercado de Servicios Energéticos en Chile, GERENS, Abril de 2012
- Estudio de Mercado Fotovoltaico Orientado a Estimar la Demanda en Micro, Pequeñas y Medianas Empresas, Subsecretaría de Energía, abril de 2016
- Visita técnica a Teletón de Copiapó. Evaluación de condiciones de instalación de un sistema solar fotovoltaico en techo, EFFERGY S.A., 17/04/2015
- Informe Final Modelo Tarifas de Distribución, Subsecretaría de Energía, julio de 2015
- Identification, Assessment Of Financial And Other Incentive Mechanisms Including Credit Schemes And Tax Incentives To Promote Solar Technologies Based On International Experience (CSP, PV And SWH);
- Assessment Of International Experiences On Rules And Technical Regulation For CSP And PV-DG;
- Design And Implementation Of A Public Awareness And Education Campaign To Promote And Replicate Solar Technology Projects Including Information Dissemination Within The Private And Public Sector.

Annex 3. Co-Financing Table

Cofinancing	Name of Co-Financer	Type of Cofinancing	Amount Confirmed at CEO endorsement (US$)	Amount Confirmed at Modificatory Agreement (US$)	Actual Amount Contributed at Final Evaluation Review (US $)	Actual % of Expected Amount
Parallel Financing						
IDB	IDB	Non-Reimbursable Coop.	650,000	650,000	650,000	100%
CORFO	Nat´l Gov´t	Credit Line	600,000	-	-	-
UN	ECLAC	Grant	200,000	-	-	-
Government of Chile	Nat´l Gov´t	Subsidies and Incentives	30,300,000	31,100,000	34,378,028.70	111%
End-Users	Private Sector	Cash/in-kind	14,150,000	14,150,000	-	-
Other Sources	Other	Other	-	-	-	-
TOTAL Parallel Financing			**45,900,000**	**45,900,000**	**35,028,029**	**76%**
GEF Funds			2,727,273	2,727,273	2,244,891.96	82%
Total project			48,627,273	48,627,273	37,272,920.66	77%
Total project without end-users			34,477,273	34,477,273	37,272,920.66	108%

Annex 4. Emissions Reductions Calculation

Assumptions SWH	
Average solar collector productivity in Santiago for small collector (conservative case): 826 kwh/m2/yr Solar collector area to be deployed: 90000 m2 **Annual thermal energy generated: 74,340 MWh/yr** 1,858,500 **Displaced energy calculation** Boiler efficiency Natural Gas 85% GLP 85% Market share of gas: Commercial, Public and Residential Gas natural 1% GLP 99% **Assumption 100% GLP** **Displaced Energy (GLP) 87459 MWh/yr** Emissions Factor GLP 0.225 tCO2e/MWh **CO2 saved 19718 tCO2e/yr**	The average solar collector productivity in Santiago, Chile is 826 kWh per square meter (m2) per year. The project achieved 90,000m2 of SWH installed, equivalent to 1,858,500 MWh (Lifetime energy production). This Report, pg. 34. **SWH will generate 74,340 MWh/yr.** SWH displaces the consumption of Gas Licuado del Petróleo (Liquified Petroleum Gas LPG), which has an emissions factor of 0.225 tCO2e/MWh.

Assumptions PV	
Installed Capacity: 300 kW Capacity factor: 20% Hours in a year: 8760 hrs. Operating hours: 1752 hrs. Energy generated-saved: 525.6 MWh/yr 10512 MWh/20 years Emissions Factor SIC-SING matrix: 0.383 tCO2/MWh **CO2 saved: 202 tCO2e/yr**	**The project added 300 kW of PV installed capacity, operating 1,752 hrs with a 20% capacity factor a year.** PV Energy generated is 525.5 MWh/yr. SIC-SING matrix emissions factor is 0.383 tCO2MWh.

Assumptions CSP			
Installed Capacity	110000	kw	**The project added 110,000 kW of CSP installed capacity, operating 8,584.8 hrs with a 98% capacity factor a year.**
Capacity factor	98%		
Hours in a year	8760	hrs.	
Operating hours	8584.8	hrs.	
Energy generated-saved	944328.00	MWh/yr	CSP Energy generated is 944,328 MWh/yr.
	18,886,560		
Emissions Factor			SIC-SING matrix emissions factor is 0.383 tCO2MWh.
SIC-SING matrix	0.383	tCO2/MWh	
CO2 saved	**362055**	**tCO2e/yr**	

Direct Emissions Reductions			
A) Annual Electricity Saved / Generated (MWh)			**The Project lifetime Direct Emissions Reductions of 7,664154 tons of CO2, result from the reductions of the three technologies:**
	74,340.00	SWH	SWH: 74,340 MWh of Annual Electricity Generated, multiplied by the emissions factor of GLP displaced energy 0.225 of, multipled by 25 years (lifetime average).
	525.60	PV	PV: 525.60 MWh of Annual Electricity Generated, multiplied by the emissions factor 0.383, multipled by 20 years (lifetime average).
	944,328.00	CSP	CSP: 944,328 MWh of Annual Electricity Generated, multiplied by the emissions factor 0.383, multipled by 20 years (lifetime average).
	1,019,193.60		
B) Emissions Factor (t CO2 / MWh)			
	0.225	SWH	
	0.383	PV	
	0.383	CSP	
C) Average Useful Investment Lifetime			
	25	SWH	
	20	PV	
	20	CSP	
Results: Direct Emissions Reductions (A*B*C)			
	7,664,154.81	tons CO2 e	
	7,664.15	KT CO2 e	
	7.664	MT CO2 e	

Indirect Emissions Reductions

SWH

Emissions Factor		
GLP	0,225	tCO2e/MWh
CO2 saved	**19718**	**tCO2e/yr**
Real potential indirectly attributed to GEF		
SWH installed m2	90.000	m2
Annual thermal energy generated	**74.340**	**MWh/yr**
Displaced Energy (GLP)	**87.459**	**MWh/yr**
CO2e saved	**19.718**	**tCO2e/yr**
CO2e saved over 25 years	**492.962**	**tCO2e**

PV

Emissions Factor		
SIC-SING matrix	0.383	tCO2/MWh
CO2 saved	**202**	**tCO2e/yr**
Real potential indirectly attributed to GEF		
PV installed	0.3	MW
Annual energy generated	**526**	**MWh/yr**
CO2e saved	**202**	**tCO2e/yr**
CO2e saved over 20 years	**4,030**	**tCO2e**

CSP

Emissions Factor		
SIC-SING matrix	0.383	tCO2/MWh
CO2 saved	**362055**	**tCO2e/yr**
Real potential indirectly attributed to GEF		
CSP installed	110	MW
Annual energy generated	**944,328**	**MWh/yr**
CO2e saved	**362,055**	**tCO2e/yr**
CO2e saved over 20 years	**7,241,107**	**tCO2e**

Indirect Emissions Reductions are a range going from 6,190,479.25 tCO2e to 15,328,310 tCO2, where:

6,190,479.25 tCO2e is Total Project Indirect (Top-Down) Emissions Reductions resulting from the CO2 savings of the three technologies time 80% (Casualty Factor):

- SHW: 492,962 tCO2e over 25 years
- PV: 4,030 tCO2 over 20 years
- CSP: 7,241,107 tCO2 over 20 years

AND

15,328,310 tCO2 which comes from Total Direct Emissions Reductions multipled by a replication factor of 2 (7,664,154.81 x 2).

Annex 5. Signed Code of Conduct

Evaluators/Consultants:

1. Must present information that is complete and fair in its assessment of strengths and weaknesses so that decisions or actions taken are well founded.
2. Must disclose the full set of evaluation findings along with information on their limitations and have this accessible to all affected by the evaluation with expressed legal rights to receive results.
3. Should protect the anonymity and confidentiality of individual informants. They should provide maximum notice, minimize demands on time, and respect people's right not to engage. Evaluators must respect people's right to provide information in confidence, and must ensure that sensitive information cannot be traced to its source.

Evaluators are not expected to evaluate individuals, and must balance an evaluation of management functions with this general principle.

4. Sometimes uncover evidence of wrongdoing while conducting evaluations. Such cases must be reported discreetly to the appropriate investigative body. Evaluators should consult with other relevant oversight entities when there is any doubt about if and how issues should be reported.
5. Should be sensitive to beliefs, manners and customs and act with integrity and honesty in their relations with all stakeholders. In line with the UN Universal Declaration of Human Rights, evaluators must be sensitive to and address issues of discrimination and gender equality. They should avoid offending the dignity and self-respect of those persons with whom they come in contact in the course of the evaluation. Knowing that evaluation might negatively affect the interests of some stakeholders, evaluators should conduct the evaluation and communicate its purpose and results in a way that clearly respects the stakeholders' dignity and self-worth.
6. Are responsible for their performance and their product(s). They are responsible for the clear, accurate and fair written and/or oral presentation of study limitations, findings and recommendations.
7. Should reflect sound accounting procedures and be prudent in using the resources of the evaluation.

MTR Consultant Agreement Form

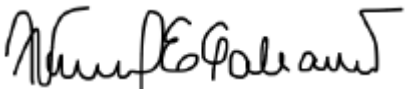
Agreement to abide by the Code of Conduct for Evaluation in the UN System:

Name of Consultant: _____Victoria Galeano

Name of Consultancy Organization (where relevant):

I confirm that I have received and understood and will abide by the United Nations Code of Conduct for Evaluation.

Signed at __Washington D.C. _____ (Place) on _October 29, 2021

Signature: _  _____