Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

NAMA CHILE
Self-Supply Renewable Energy

Ministerio de Energía
Gobierno de Chile

Final Report of the Technical Component of the NAMA Support Project "Self-Supply Renewable Energy" in Chile

NAMA Facility

On behalf of
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Department for Business, Energy & Industrial Strategy

European Commission

Table of Contents

List of abbreviations

Abbreviation	Definition
ACESOL	*Agencia Chilena de Energía Solar* – Chilean Agency for Solar Energy
AGRYD	*Asociación Gremial de Riego y Drenaje* - Irrigation and Drainage Association
ASCC	*Agencia de Sustentabilidad y Cambio Climático* - Sustainability and Climate Change Agency
ASE	*Agencia de Sostenibilidad Energética* - Energy Sustainability Agency of Chile
BEIS	UK Department for Business, Energy & Industrial Strategy
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BUR	Biennial Update Report
CAMCHAL / AHK	German-Chilean Chamber of Commerce and Industry
CETT	*Centro de Extensionismo Tecnológico de Turismo* – Center for Technological Extension in Tourism
CIFES	*Centro Nacional para la Innovación y Fomento de las Energías Sustentables* National Center for Innovation and Promotion of Sustainable Energies
CNR	*Comisión Nacional de Riego* – National Irrigation Commission
CO_2	Carbon dioxide
CONAF	*Corporación Nacional Forestal* – National Forestry Corporation
CORFO	*Corporación de Fomento de la Producción* – Chilean Economic Development Agency
CPL	*Consejo Nacional de Producción Limpia* - National Council for Clean Production
CSP	Concentrated Solar Power
DO	Delivery Organisation
ELE	Evaluation Learning Exercise
ESCO	Energy Service Company
FC	Financial Component
FEDETUR	*Federación de empresas de turismo de Chile* – Federation of Tourism Companies of Chile
FI	Financial Intermediary
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
IADB (BID)	Inter-American Development Bank (*Banco Interamericano de Desarrollo*)
IKI	International Climate Initiative
IKLU	*Initiative für Klima- und Umweltschutz* - Initiative for Climate and Environmental Protection
INDAP	*Instituto de Desarrollo Agropecuario* - Institute of Agricultural Development
KFW	*Kreditanstalt für Wiederaufbau* - German Development Bank
MMA	*Ministerio de Medioambiente* - Ministry of the Environment
MoE	Chilean Ministry of Energy
MRV	Monitoring Reporting and Verification
MW	Megawatt
MWh	Megawatt hour
NCRE	*Energías Renovables No Convencionales* – Non-Conventional Renewable Energy (RE excluding large-scale hydropower)
NDC	Nationally Determined Contribution
NAMA	Nationally Appropriate Mitigation Action
NSP	NAMA Support Project
ODA	Official Development Assistance
PMGD	*Pequeño Medio de Generación Distribuida* – Small Distributed Generator (< 9MW)
PMR	Partnership for Market Readiness
PV	Photovoltaic
PYME	*Pequeña y Mediana Empresa* – Small and Medium Enterprises (SME)
RE	Renewable Energy
SEC	*Superintendencia de electricidad y combustibles* - Superintendency of Energy and Fuels
SERCOTEC	*Servicio de Cooperación Técnica* – Technical Cooperation Service
SERNATUR	*Servicio Nacional de Turismo* – National Tourism Service
SME(s)	Small and Medium Enterprise(s)
SSRE	Self-Supply Renewable Energy
TC	Technical Component
UNIDO	United Nations Industrial Development Organization
UNFCCC	United Nations Framework Convention on Climate Change

Preface

This is the Final Report of the Technical Component (TC) of the NAMA Support Project (NSP) "Self-Supply Renewable Energy" (SSRE) in Chile. The TC was implemented by *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH in coordination with the Chilean Ministry for Energy (MoE) between August 2017 and December 2020. The NSP is funded by the NAMA Facility, a joint initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the UK Department for Business, Energy and Industrial Strategy (BEIS) and the European Commission.

This final report was submitted by GIZ with prior consultations with the Ministry of Energy (MoE) in March 2021. Some evaluative parts of this report make reference to the "Evaluation and Learning Exercise" (ELE), which was carried out on behalf of the Technical Support Unit (TSU) by Ambero Consulting GmbH and Oxford Policy Management (OPM) in October 2020.

1 Project overview

Chile, with an average per capita carbon dioxide emission of 4.6 tCO_2/pc, slightly exceeds the world average of 4.4 tCO_2/pc and is well below the OECD country average of about 8.9tCO_2/pc[1]. In 2013, when this NSP was prepared, the country´s total GHG emissions had increased by 109% since 1990 – rising to 129% in 2018. Despite being responsible for only a small fraction of global emissions, contributing a total of 0.24% of the world total (as of 2016)[2], Chile has actively participated in various international climate agreements[3] and has positioned itself as a regional frontrunner in climate policy. Chile presided over COP25 and was the first country in Latin America to submit its updated Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in April 2020 (see annex 5-6).

In 2012, Chile was the first country in the world to register a NAMA (*Nationally Appropriate Mitigation Action*) with the UNFCCC.[4] Currently, it has six sectoral NAMAs registered with the UNFCCC, which are being implemented at different levels of maturity (see annex 5-4).
The energy sector is the main national GHG source in Chile. In 2018, it accounted for 77% of total national emission, an 159% increase since 1990 and 1% since 2016. The main cause of the trend is the sustained increase in the country's energy consumption, including the consumption of coal and natural gas for electricity generation and the consumption of liquid fuels for land transport, mostly diesel and gasoline (see annex 5-5).

Consequently, the potential for mitigation actions, particularly by incorporating renewable energies (RE) into the system, is significant. Chile is an unsubsidized energy market, and the development of Self-Supply RE (SSRE) competes directly with utility-scale projects. In addition, the financial viability of small and medium scale projects is highly exposed to market price variability. Indeed, at the start of this NSP, only a limited number of renewable energy projects for self-supply had been developed, indicating the presence of barriers to the development of the SSRE-market.

Given this context, in 2014, the Ministry of Energy of Chile submitted a preliminary proposal for the NSP "Self-Supply Renewable Energy" (SSRE) during the first call of the NAMA Facility.
The NSP proposal was prepared in collaboration with:

- The Renewable Energy Centre (*Centro de Energías Renovables* – CER), which was part of CORFO (Economic Development Agency of the Ministry of the Economy). CORFO later became a direct stakeholder in the Financial Component (FC) after CER merged into *Centro Nacional para la Innovación y Fomento de las Energías Sustentables* (CIFES - National Center for Innovation and Promotion of Sustainable Energies).

[1] Chile's Fourth Biennial Update Report: https://unfccc.int/sites/default/files/resource/Chile_4th%20BUR_2020.pdf, page 120.
[2] Chile's Fourth Biennial Update Report,, page 120.
[3] Chile's environmental treaties, agreements and regulations: https://obtienearchivo.bcn.cl/obtienearchivo?id=repositorio/10221/26957/1/Tratados_medioambiente_Chile_1980_2018.pdf
[4] Chile's Third Biennial Update Report: https://unfccc.int/sites/default/files/resource/5769410_Chile-BUR3-1-Chile_3BUR_English.pdf, page 20.

- The Ministry of the Environment.
- The Chilean International Cooperation Agency (AGCI).
- *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH and *Kreditanstalt für Wiederaufbau* (KfW) were indicated as NAMA Delivery Organizations (DOs), GIZ for the Technical Component (TC) and KfW for the FC of this NAMA Support Project, respectively.

The overall mitigation potential of GHG emission reductions for this NSP was estimated at up to 1.5 Mt CO_2eq. Out of 47 projects submitted during the first call in 2014, the NAMA Facility Board selected the Chilean NSP SSRE as one of 4 projects approved for funding. The NSP in Chile was designed to promote the incorporation of SSRE systems in small and medium sized enterprises by both addressing relevant barriers and creating suitable financial and technical conditions for the development of this emerging industry by means of a Technical Component and a Financial Component (for more details, please see annex 5-7). Table 1 offers a summary.

Table 1-1: Summary of the component of the NSP in Chile

Technical Component	Financial Component
Partner Structure	
Implemented by GIZ and the Chilean Ministry of Energy	To be implemented by KfW, the Chilean Ministry of Energy and CORFO
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH 	KFW CORFO 
Technical Component	**Financial Component**
Objectives	
Improvement in technical conditions and capacities for project development	Creation of efficient and suitable access to financial instruments that promote investment and financing in the sector
Sub-component 1	
Awareness-raising and sensitization	Financial aid for feasibility studies
Sub-component 2	
Training and capacity building	Investment grants
Sub-component 3	
Help Desk; Analysis of potential projects	Technical consulting and development in the financial sector
Sub-component 4	
Monitoring, Reporting and Verification system (MRV)	Guarantee fund to enable easy credit-access
Technical Component	**Financial Component**
Budget of the Technical Component	**Budget of the Financial Component**
3,000,000 EUR* *An overview table as per the main budget lines of the TC is provided in Annex 5-3.	14,031,800 EUR
Overall NSP SSRE budget	
17,031,800 EUR	

Source: GIZ, own elaboration.

The **NSP aims at removing** the following **identified systemic barriers** by building capacities for private and public stakeholders in order to strengthen the development of the SSRE market in Chile:

(i) Financial and economic barriers that prevent SSRE end-users from accessing preferential financing conditions to pay for SSRE feasibility studies and subsequent project implementation.

(ii) Human capacity barriers, namely that (a) there is an overall lack of SSRE project implementers (i.e., installers and/or companies that can deal with the operation and maintenance of SSRE technologies), and (b) those that do exist are concentrated around major cities only.

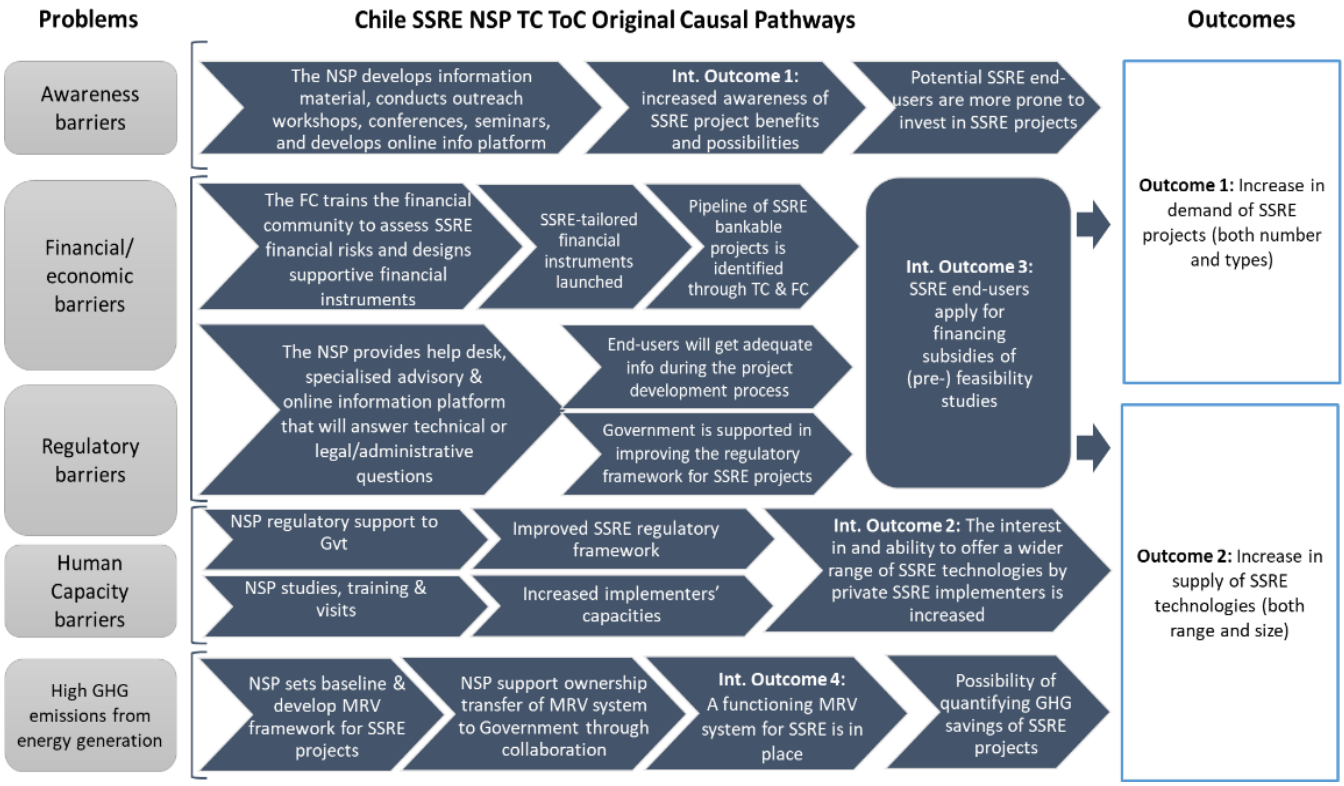
(iii) Awareness barriers that mean both end-users and implementers are not fully aware of all the options and benefits of different SSRE technologies.

During the implementation stage, the TC expanded its scope by addressing a relevant barrier which was initially considered in the project proposal as being outside of the scope of the implementation of this NSP:

(iv) Policy and regulatory barriers that pose substantial limits on the technical and economic viability of SSRE projects.

The following paragraphs discuss the causal relations between each barrier to the overarching goals of the project, through its intermediate outcomes, from the point of view of the TC and as shown in figure 1-1:

Figure 1-2: Causal Pathways of the Theory of Change of the Chile SSRE NSP



Source: ELE-Report

Causal pathway supporting Intermediate Outcome 1: If the NSP increases outreach on the economic and technological feasibility of SSRE projects among relevant private and public decision makers (Output 1-TC), then the general awareness of the market for SSRE projects benefits and possibilities will be raised (Intermediate Outcome 1), SSRE end-users will be more prone to invest in SSRE projects and there will be an increase in demand for SSRE initiatives (Outcome 1).

Causal pathway supporting Intermediate Outcome 2: If the NSP builds capacities of relevant stakeholders through professional training, studies, and visits (Output 2-TC) and, at the same time, supports the Government in improving the regulatory framework related to SSRE, then the number of private companies that implement SSRE projects will increase (Intermediate Outcome 2), they will be assisted by the NSP in performing basic and advanced steps in SSRE project development, and ultimately there will be an increase in the supply of SSRE technologies (Outcome 2).

Causal pathway supporting Intermediate Outcome 3: If the NSP supports a pipeline of feasible SSRE projects through appraisals and new business cases (Output 3-TC) and, at the same time, aids the Government in improving the regulatory framework related to SSRE, and the Financial Component supports the launch of SSRE-tailored financial instruments (Outputs-FC), then SSRE stakeholders will apply for financing subsidies for SSRE projects (Intermediate Outcome 3) and there will be an increase in both the demand for SSRE projects (Outcome 1) and the supply of SSRE technologies (Outcome 2).

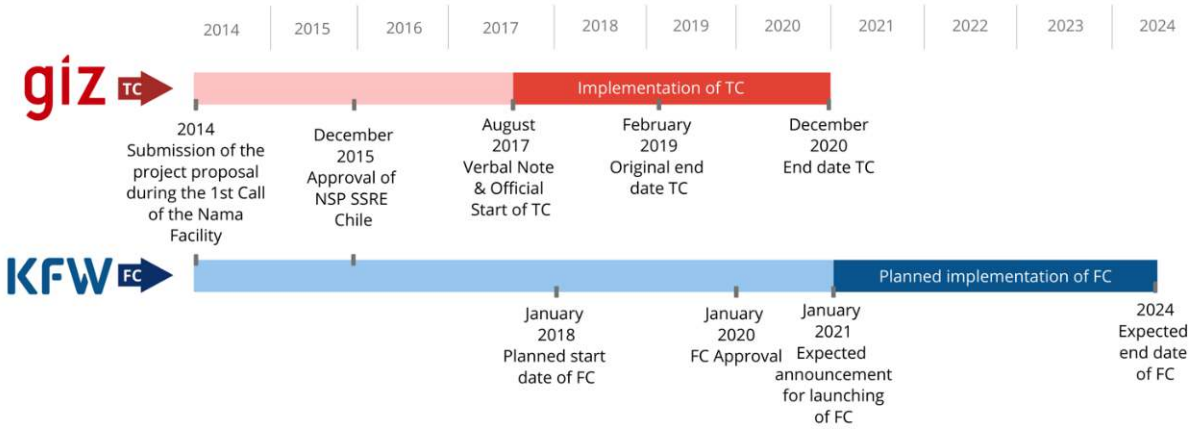
Causal pathway supporting Intermediate Outcome 4: If the NSP supports the development of a robust and flexible MRV system for SSRE projects (Output 4-TC), supports the ownership transfer of the MRV system to the Government and the testing of the MRV system on real SSRE projects (Intermediate Outcome 4), then the GHG mitigation and sustainable development co-benefits of the SSRE projects can be measured and observed, and this demonstration of the benefits will strengthen the SSRE market.

The **Theory of Change** of this NSP explicitly emphasizes the importance of the synergy between both components (FC and TC) to address the main barriers through action. The NAMA support project (NSP) "Self-Supply Renewable Energy" (SSRE) was formally approved by the NAMA Facility in December 2015. For various reasons, both components have seen various delays, as depicted in the timeframe of the project, see Figure 1-2 below. As per original planning, the TC was to start in the first half of 2016 and would be implemented six months ahead of the FC to forge ahead with the necessary technical preparation, with both components to be implemented in synergy thereafter. However, the first delay was related to the exchange of verbal notes between the governments of Chile and Germany, an international law agreement between the two countries. This meant that neither NSP component could officially begin until the verbal notes were signed in the second half of 2017.

The TC started its official activities in August 2017 and was concluded in December 2020, after having received two no-cost extensions from February 2019 to June 2020, and subsequently to December 2020. After several delays, the FC was finally approved for implementation for the beginning of 2020. Whereas Separate Agreements have been concluded between the MoE and KfW as well as CORFO and KfW in the last quarter of 2020, as of February 2021 formal launching dates for the subcomponents of the FC had not been announced. The FC is likely to run until the end of 2024. This means that – contrary to the original design of the NSP – there has been no implementation overlap between the two NSP components.

Photos: Capacity Building on the use of PV in the agricultural sector in the Los Lagos region (photo credit: GIZ).

Figure 1-2: Project Timeframe



Source: GIZ, own elaboration.

NAMA Support Projects are generally designed to catalyse transformational change through the cohesive actions of the Technical and the Financial Components. Due to the complete disconnection between the TC and FC, the Chilean NSP SSRE could not build on the synergistic interactions of the components to address the barriers identified for the evolution of the SSRE market. The achievements of the TC will be addressed in detail in the following section.

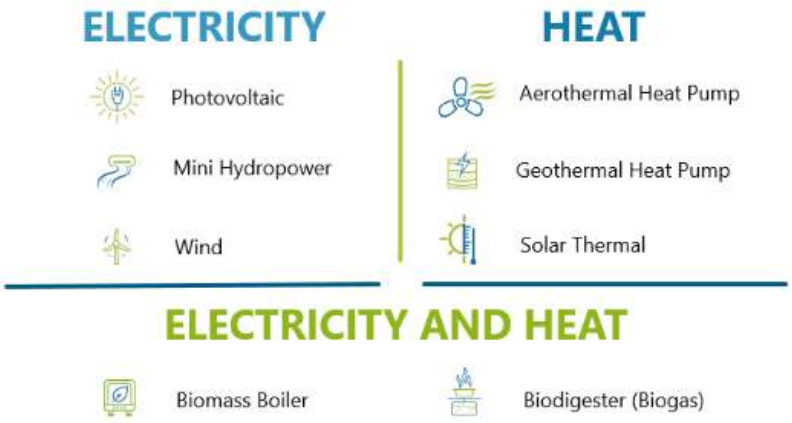
2 Project progress and achievement

2.1 General information

The TC started in 2017 with a baseline study which aimed at analyzing the Chilean SSRE market in detail, defining the target sectors and potential beneficiaries of this NSP. The attributes considered were the potential for reducing GHG, alignment with the specific sector and technology goals, the sector's contribution to national GDP, the productive chain of each sector and the number of SMEs. To this end, the food processing industry, the tourism sector, cereal agriculture and fruit growing were identified as priority sectors to the NSP due to their SSRE potential and initially favored sectors such as mining and retail were deprioritized.

The baseline study further helped to survey both the applicability of the various SSRE technologies for the distinct needs of SMEs and their market readiness in Chile:

Figure 2-1: Technologies Covered by the NSP



Source: GIZ, own elaboration.

Based on the baseline study, a roadmap was drawn up for how to proceed with the promotion of the distinct SSRE technologies depending on their relevance for and applicability in the identified sectors and

regions of Chile, which are visualized in the image on the cover page of this report and further detailed below in section 2.1.1.

The main achievements of the TC are shown below in line with its four sub-components.

2.1.1 Outreach and Awareness

The **outreach and awareness raising** activities of the TC contribute towards implementation of SSRE projects by highlighting the benefits and the application of SSRE. This subcomponent followed two distinct approaches: participation in promotional events and the creation of information material.

Promotional events: the TC has used study tours, good-practice site-visits, conferences, workshops etc., to offer content to 985 persons. Some of these events included:

Table 2-1: Examples of Outreach and Awareness events

Type and name of event	Sector	Target group	Date	Number of participants
Seminar for the Chilean Tourism Association "Fedetur" on SSRE	Tourism	Tourism sector entrepreneurs	July 2018	53
Seminar: "Energy Efficiency and Renewable Energies in Agriculture"	Agriculture	Farmers in Coquimbo Region	May 2019	100
International Fair on Renewable Energy Technologies	General SSRE	Entrepreneurs in the Magallanes Region	May 2019	80
Results presentation of the Heat Pumps Market Study	Heat Pumps	General public	January 2020	75

Source: GIZ, own elaboration.

For the purpose of building synergy, the TC coordinated its events with public institutions, such as the Ministry of Energy and its regional chapters *Seremis*, ASE, local municipalities, several business associations such as Acesol, CETT and Fedetur, AGRYD (Irrigation and Drainage Association), Chileoliva, Chilenut etc., as well as the other donor-funded projects in Chile:

Table 2-2: TC Support for other Initiatives

Project	Institution
"Biogas Development in the Dairy Industry"	GEF/UNIDO/Ministry of Energy of Chile
"Promotion and Development of Local Solar Technologies in Chile"	GEF/Inter-American Development Bank/Ministry of Energy of Chile
"Smart Energy Concepts"	BMU/IKI/AHK Chile/ASE (Energy Sustainability Agency of Chile)
"Program for the Direct Uses of Geothermal Energy"	Climate Investment Funds/Inter-American Development Bank/World Bank/Ministry of Energy of Chile
"Partnership for Market Readiness – Chile"	World Bank/Ministry of Energy of Chile

Source: GIZ, own elaboration.

The outreach and awareness events focused on the identified target sectors such as tourism, processed food industry, dairy, meat, agriculture, and fruit farming, more general events targeted at SMEs to bolster attention for SSRE.

With regard to promotional material, the TC has developed a wide array of materials to explore the market potential and promote the use of PV, biomass, biogas, heat pumps and mini hydro technologies in the form of best practice examples, guides, market studies, price indexes and other publications. Some of the highlights included:

Price Indexes:

- From 2017 to 2020, the TC NSP has conducted a price index for photovoltaic (PV) installations on a yearly basis, continuing and further enhancing the methodology initially developed by the IKI Solar

Project which was implemented on behalf of the BMU between 2012 and 2017[5]. The published reports helped create awareness for this technology and increase market transparency. The detailed price index has been integrated into tools such as *Explorador Solar* of the Ministry of Energy, which offers end users help to estimate potential energy generation using PV based on their specific location. The PV price index can help users obtain a realistic estimate of the investment costs and payback period for PV installations, providing a specific and tangible added value for potential end-users who want to consider a PV installation.

Following this positive example with PV, the TC prepared price indexes for heat pumps and biomass boilers. The price index for biomass boilers and heaters aimed to help modernize the heating matrix of central and southern Chile. The study produced three separate price indexes through supplier surveys: one for boilers that use pellets and wood chips; another for pellet heaters; and one for wood pellets in various regions of Chile. The heat pump study addressed the prices for purchasing, installing, and maintaining 25 different types of equipment, which helps potential consumers to decide on the best available technological solutions for residential and industrial hot water and air powered thermal applications.

Market Studies:

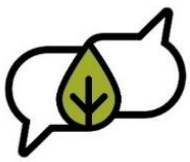
- The TC has conducted several explorative market studies to better assess existing and future market potential in Chile. The market studies for both heat pumps and biomass boilers and heaters were the first of their kind for the Chilean market. Both studies have resulted in market analysis with a value chain, a price index for various sub-categories of the respective technologies and a list of providers.
- A publication on battery energy storage systems for PV installations in Chile identified a set of norms, requirements, and standards to draw up recommendations for Chile's regulations and contributed to the development of this technology in adopting renewable energy for self-consumption in companies and households and evaluating other kinds of uses, such as irrigation, agriculture, and microgrids.

User Guides:

- Practical hands-on user guides were developed for PV installations and heat pumps to offer potential users an introduction showing the benefits, applications, and instructions for each technology.
- Infographics: TC has developed infographics that provide users an overview of the benefits of SSRE as well as publicly financed energy efficiency and renewable energy programs in a simplified and visually appealing way. The Ministry of Energy as well as Regional Ministerial Secretariats and other public institutions will use this infographic to promote EE and RE in various target sectors.

A complete catalogue of publications developed by the TC sorted by technology (in Spanish) can be accessed on the website of the project www.4echile.cl/nama.[6]

2.1.2 Technical Help Desk



Technical Help Desk: Support for potential investors or project developers on questions related to technologies, project development, and regulatory and legal matters. The objective of the Help Desk is to generate a pipeline of potential projects that could apply for funding from the FC.

The TC had established a Help Desk through which it offered potential end users free-of-charge technical assistance with the pre-evaluation of SSRE projects. The Help Desk offered two main services:

- **Technical Profiles** for SSRE projects, which included a basic project evaluation with preliminary technical information and profitability of a project, such as costs and return on investment.

[5] Solar Energy for power and heat generatión: https://www.giz.de/en/worldwide/23041.html

[6] Selection of Studies and Publications Prepared by the Technical Component of the NSP: https://4echile-datastore.s3.eu-central-1.amazonaws.com/wp-content/uploads/2020/11/12184101/NAMA-Support-Project-Chile-publicaciones-ES.pdf

- **Prefeasibility analyses** with more detailed and more complete information on the project (more accurate results than a profile).

With the confirmation of the launch of the FC in 2020, the TC decided to evaluate all technical project assessments that had been conducted both by the TC and by the Ministry of Energy in the previous years. This analysis aimed to both evaluate the implementation status of the pre-evaluated projects and update the relevant contact and technical information, while also providing a baseline for projects which had not been implemented and could potentially apply for subcomponents one and two of the FC.

The merging of the databases of the TC, the Ministry of Energy and ASCC (Sustainability and Climate Change Agency) and Camchal allowed an in-depth analysis of 229 technical profiles and pre-feasibility studies for SSRE projects which were conducted between June 2016 and November 2019 for 153 different companies. The follow-up on these projects was conducted via email and phone and resulted in a vast database with detailed information on the projects.

Out of all consultancy projects considered in this report, 146 pertained to profiles and 81 to pre-feasibility studies[7].

An important outcome of this follow-up was the finding that of the 229 project pre-evaluations, only 4 have actually been implemented. Of the 153 companies that were contacted, 17 could not been reached, 62 companies stated that they halted the implementation of SSRE projects due to other priorities and 58 companies expressed interest in implementing the project but cited the lack of financial resources as a major obstacle.

Although the TC had helped end users to better assess the technical requirements and economic benefits and costs of their potential SSRE projects and identified a relevant number of bankable projects, only 4 of those reached implementation with their own available funding and the rest did not come to fruition in the absence of financial mechanisms, which were supposed to be offered by the FC. This analysis confirmed the importance of the simultaneous implementation of the TC and the FC. In the case of this NSP, synergies between the components could not be realized, leading to a loss of effectiveness.


Photos: PV technicians in La Higuera – the TC conducted a capacity building activity on PV O&M for 49 professionals (photo credit: GIZ).

In the course of the project, the MoE requested the technical support of the NSP for the development of regulatory aspects, which was a considerable change to the initial scope of the TC, given the reduction of the probable impact of the project due to the lack of the FC. In sum, the TC contributed to the following regulatory and legislative specifications, which have relevant impact on the development of SSRE in Chile:

[7] Ratio between profiles and prefeasibility study by institution: ASCC (0/60); DES: (107/0); TC of this NSP: (39/16); CAMCHAL: (0/5).

Table 2-3: Contribution of the TC toward new Regulations and Norms

Regulatory / Normative Amendments	Study conducted by the TC	Contribution of the TC
Connection and Operation Technical Standard for PMGD (Abbreviated declaration for projects smaller than 1.5 MW)	"Alternative Design Solutions for PMGD" - Elice 2018	A study revealed tasks that were abbreviated in the connection procedure for PMGD installations smaller than 1.5 MW.
Law 21,118 "Netbilling" (Change of the Net Billing Law which regulated an increase from 100 to 300 kW of installed power)	"Study for the inclusion of technical improvements on the regulation of self-supply PV systems over 100 kW " – AC3E, 2019	A study was carried out in which the technical impacts of the increase from 100 to 300 kW were analyzed, as well as the incorporation of storage systems, grounding and the use of inverters to limit injections.
Law 19,657, on Geothermal Energy Concessions (Exclude from the concession system geothermal activities that use the heat of the earth between zero and 400 meters depth).	"Market Study and Price Index for Heat Pumps " – Aiguasol, 2019	The heat pumps market study was used in the Senate to explain the costs of geothermal heat pump projects. This illustrated the scale of these projects and the difficulties of going through geothermal energy concessions.
Technical Instructions ITG 01/2020 (PV installations isolated from the distribution grid) and ITG 06/2020 (Design and execution of energy storage (BESS) on electric installations)	"Study for the incorporation of Storage Systems (BESS) for self-supply PV Installations"" – AC3E 2020	A study on the incorporation of storage systems produced 109 technical recommendations for the development of ITG 01/2020.

Source: GIZ, own elaboration.

2.1.3 Training and Capacity Building

Training and Capacity Building: Workshops and training sessions providing insight into topics such as feasibility analysis, project development, operation and maintenance, for public and private sector stakeholders.

The Capacity Building sub-component focused on providing theoretical and practical knowledge on the application of SSRE technologies. A total of 446 stakeholders participated in 17 training activities, two international technological study tours and site visits. Topics ranged from safety in biogas installations and mini hydro power plant design, to operations and maintenance of PV-installations and storage systems:

Table 2-4: Capacity Building Activities

Capacity Building Activity	Technology	Date	Number of Participants
Biogas electric generation course	Biogas	August 2016	4
Design of Mini Hydro Installations	Mini Hydro	March 2017	22
PV for On-Grid Self-Supply	PV	August 2017	9
Specialized technical training course on biogas for professionals	Biogas	September 2017	20
Safety in Biogas Installations	Biogas	November 2017	87
PV Operations & Maintenance	PV	Janueary 2018	49
Design and Installation of Heat Pumps	Heat Pumps	May 2018	11
Train the Trainer activity for the use of PV simulation racks	PV	September 2018	40
Gestiona Energía – courses for SMEs on the benefits of SSRE	SSRE in general	July-October 2019	182
Battery Energy Storage Systems in PV Installations	Storage	May 2020	22

Source: GIZ, own elaboration.

Initially, the capacity building measures focused on stakeholders from the private sector, but they were then extended to also include representatives of the public sector, for which an amendment was granted by the TSU. This was to reflect the importance of public institutions such as the Superintendency of Electricity and Fuels (SEC), the National Irrigation Commission (CNR) and the Agricultural Development Institute (INDAP) which promote SSRE; an amendment was made to the original proposal that included public officials as a target group in capacity building activities.

The TC further supported the capacity building measures of the *Gestiona Energía* initiative of the MoE, which were initially focused on energy efficiency measures and were expanded to include the application

of SSRE. This led to the creation of the Energy Efficiency Potential Estimation Tool as well as an online training course for SMEs and public institutions on how to implement SSRE projects. The MoE estimates that over 500 representatives of SMEs will use these online based training activities each year, beyond the duration of the TC.

Furthermore, the TC supported a government program called "Training program in photovoltaic solar energy for high schools of technical and professional secondary education with a specialty in electricity." This was a pilot initiative developed by the MoE, with technical support from the Ministry of Education, SEC, and the Energy Sustainability Agency. Its objective was to increase the number of mid-level electrical technicians specialized in the implementation and maintenance of photovoltaic systems installed under the Distributed Generation Law. In July 2018, a training activity was carried out in a b-learning format, aimed at teachers. In this pilot scheme, 40 teachers met and learned to use the equipment that will be applied in future photovoltaic laboratories. The TC financed the photovoltaic laboratory equipment which is essential for this practical hands-on training. A revision in 2020 concluded that during the 2019 academic year, the 20 selected high schools had a total of 1,292 students (12.62% female and 87.38% male) enrolled in their electricity specialty courses, in which this equipment financed by the TC was used. Similar numbers are expected for coming years, which ensures the benefits of this initiative extend beyond the duration of the TC. This initiative was not considered in the count towards the indicators of this NSP but has received positive feedback on the enhancement of practical training activities from the technical high schools.

2.1.4 Monitoring Reporting and Verification (MRV) System

Monitoring, reporting and verification (MRV) System: Development of a GHG inventory in the small and medium-scale energy sector and design of an MRV system for the SSRE NAMA Support Project.

The development of the methodology and the MRV tool was the responsibility of GIZ in close collaboration with the Sustainable Energy, Environment and Climate Change divisions, both of which are MoE bodies, as well as the Climate Change Office at the Ministry of the Environment.

Two distinct MRV systems were developed by the TC to quantify the reduction of GHG emissions achieved by renewable energy projects – one MRV system covers small-scale renewable projects for self-supply energy, while the other system covers large-scale projects connected to transmission lines:

- The first MRV system addresses **renewable energy installations intended for self-supply** and quantifies the GHG emissions that will be avoided during the useful life of the technology in question (i.e., a minimum of 20 years). The calculations are generally based on the installed capacity, the replaced energy source and the location; other parameters vary depending on each technology. The renewable energy technologies included in this approach were photovoltaic solar, solar thermal, wind power, mini-hydro-electric, geothermal heat pumps, biogas and biomass, including cogeneration.
- Due to the positive results of the first MRV system, a second MRV system was developed to account for the growing uptake of renewable energy in the country's energy mix, namely large-scale **renewable energy projects connected to the transmission grid** based on solar photovoltaic, concentrated solar power (CSP), wind power and hydroelectric power.

These MRV systems has been prepared in accordance with international standards to perform the calculations, using the Project Accounting Protocol of the World Resources Institute (WRI) to estimate GHG reductions, and the equations given in Volume 2, Chapter 2 of the 2006 Guidelines of the Intergovernmental Panel on Climate Change (IPCC), on Stationary Combustion. At the same time, the system has been adapted to the Chilean context, since it uses capacity factors for different locations in the country, which have been calculated by the Sustainable Energy Division of the MoE through its Renewable Energy Explorers (www.exploradores.minenergia.cl/).

The MRV system has been applied to measure the reduction brought about through over 3,400 renewable energy projects implemented between 2012 and 2017 that have been financed by seven public institution programs (most of which were aimed at the residential sector). Therefore, small-scale projects can now be accounted for in a uniform way, which makes it possible to measure their contributions towards Chile's efforts to mitigate GHG emissions.

Table 2-1: Emissions mitigated in the year 2018 by RE projects assessed with the MRV System

Types of renewable energy projects	No. of projects	Installed Capacity (MW)	GHG reductions in 2018 [tCO_{2eq}]	Equivalence in vehicles no longer on the road	Equivalence in hectares of native forest planted
Focused on self-supply	3,293	13.22	9,401	5,250	0.59
Connected to the transmission network	142	9,905	12,459,948	7,000,000	778.75
Total	**3,435**	**9,918.22**	**12,469,349**	**7,005,250**	**779.34**

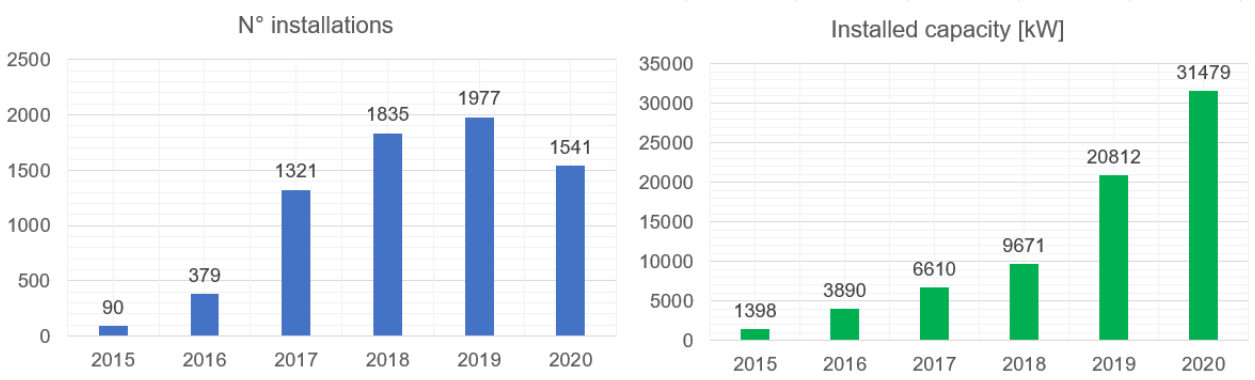
Source: Technical Note for the MRV System[8]

The results generated by the MRV system quantify the relevance of the contribution that renewable energy projects have on emission mitigation. The MRV system has been mentioned in the past Chilean Biennial Update Reports (BUR) and is one of the stand-out achievements of the TC. The BMU-financed project Decarbonization of the Chilean Energy Sector which is being implemented in Chile by GIZ with the MoE has announced plans to include the potential contributions of green hydrogen (H2) into the MRV system.

2.2 Changes in the NSP's environment

Since the initial proposal submission for this NSP in 2014, market conditions and implemented policies have changed considerably in favor of SSRE technologies in Chile. The potential for transformational change is positive overall, as RE projects have expanded from 90 in 2015 to 7,143 at the end of 2020. The installed capacity stemming from RE has increased from 1.4 MW in 2015 to over 73 MW at the end of 2020:

Figure 2-2: RE projects registered under the Net Billing Law



Source: December 2020 SEC report [9]

This NSP SSRE was conceived based on a scenario of a practically nonexistent SSRE market based on the assumptions of the Net Billing Law (Ley 20.571, de *Generación Distribuida*), which was approved in 2012 and came in effect in October 2014 – two months before the proposal of this NSP was submitted. Under the Net Billing Law, the number of installations and the installed capacity of RE projects connected to the grid grew significantly. The modifications to the Net Billing Law (Law 21,118) in November 2018 have further raised the maximum installed capacity allowed for the injection of surplus electricity (that is, not for self-

[8] Monitoring, Reporting and Verification (MRV) System for Renewable Energy Projects Implemented in Chile, Technical Note (2019): https://energia.gob.cl/sites/default/files/sistema_mrv_eng.pdf
[9] SEC report December 2020: https://www.sec.cl/sitio-web/wp-content/uploads/2021/01/Informe-SEC-Diciembre-2020.pdf

consumption) into the distribution grid for a pre-determined payment from 100 kW to 300 kW. Overall, under the Net Billing Law, RE projects with over 73 MW capacity have been installed in Chile.

The very dynamic development of the SSRE sector in Chile can further be seen in the levels of awareness of the benefits of SSRE projects among potential end-user stakeholders. At the baseline of the TC, awareness levels were measured at 20% by an expert panel, and the target for the end of the NSP was set at 50% (outcome indicator 3.2.1.). However, a poll conducted by the TC in 2019 found that 87% of the surveyed target group indicated a "high level" or "very high level" of awareness for SSRE. The apparent uptake in 2019 can be attributed to Chile's prominent role in the COP25 which gave extensive media coverage to topics such as climate change and renewable energy technologies.

In the project proposal, low electricity prices had been identified as a potentially "high risk" for the development of technologically and economically feasible SSRE projects. This risk played out stronger than anticipated, when in 2016 a historic drop in electricity prices on the spot market occurred in the auction bidding for regulated customers. In 2017, another historic price drop in spot market trading was recorded. Thus, it is to be assumed that the price drop will be passed on to the end-consumers as well starting in 2021. In support of this trend, the number of companies participating in the open electricity market quadrupled in 2019 compared to 2016, which can be interpreted as an indicator that low energy prices depress the incentives for companies to generate their own energy for self-supply.
The SSRE market has developed much more dynamically than expected when the NSP was designed. Hence, there is ample evidence for the potential for transformational change of the SSRE sector. The initial barriers identified in the proposal for this NSP included financial, technical, human capacity, awareness, and regulatory obstacles, and the Theory of Change (ToC) is still valid. Although the TC of this NSP has (over)achieved its indicators, the missing overlap between the FC and the TC has left financial barriers unaddressed. Therefore, NSP's overarching goals could not have been met and will depend on the further implementation of the FC without the support of the TC.

During the implementation period of the TC, there was a change of governments. As a result of the presidential election in December 2017, Sebastián Piñera was sworn in as President on March 11th, 2018 and is expected to remain in office until 2022. Nonetheless, the Chilean government remained committed to the expansion of RE in the energy mix and to a sustainable energy transition. Some of the milestones included:

Table 2-6: Chile's Policies on Climate and Energy

The short-medium term energy policy **Energy Agenda 2014-18** was approved in early 2014, and the long-term energy policy **Energy Policy 2050** followed in 2015. The latter establishes that at least 70% of national electricity generation will be generated by means of renewable technologies.
The **Chilean Sustainability and Climate Change Agency** was created in 2017.
The **PANCC - National Climate Change Action Plan 2017 - 2022** was launched as part of the Chilean Nationally Determined Contributions (NDC), in which the SSRE NSP is explicitly listed as a contributing project[10].
In 2018, a new governmental guideline, known as ***Ruta Energética 2018 - 2022*** **(Energy Roadmap)** was released. Its 4th core strand addresses "Low Emission Energy" and has a direct and substantial relevance to the NSP, as it postulates a 400% increase in SSRE projects under 300 kW by 2022.
In June 2019 Chile released its **decarbonization plan**, which specifies a gradual **phasing out of coal-fired power plants** to achieve total decarbonization of the electricity mix by the year 2040. Accordingly, coal-fired power plants with a total capacity of 1,047 MW are scheduled to be shut down by 2024 and replaced by RE and natural gas. During COP25, Chile doubled down and accelerated its commitments, revealing a goal of reaching overall zero net carbon emissions by 2040, instead of 2050.

[10] Plan de Acción Nacional de Cambio Climático 2017-2022: https://mma.gob.cl/wp-content/uploads/2017/07/plan_nacional_climatico_2017_2.pdf

Chile is committed to fulfilling its climate commitments and to visibly establishing itself as a **Renewable Energy Champion** on the international stage. Chile presided over the COP25, even though it withdrew from hosting the event in Chile due to social unrest.
Chile became **the first country in Latin America to submit a revised NDC** on 9th April 2020, confirming the goal of carbon neutrality by 2050 and more ambitious (unconditional) targets than the first version.
In January 2020, the **Climate Change Framework Bill** was submitted to Congress; it reinforces the institutional framework of climate change in a transversal manner at the national and local levels, establishing the instruments for climate change management and the goal of carbon neutrality by 2050.
The updated NDCs establish that 21% of overall emission reductions by 2050 will be achieved by means of green hydrogen. In November 2020, the Chilean Ministry of Energy presented **The National Hydrogen Strategy**[11] in which Chile commits to producing the cheapest green hydrogen world-wide by 2030, becoming one of top 3 exporters of green hydrogen by 2040 and bringing 5 GW of electrolysis capacity under development by 2025.

Source: GIZ, own elaboration.

Chile has graduated from the Official Development Assistance (ODA) status in 2017, with significant implications on the country´s ability to receive funds for international cooperation: in 2015, total ODA to Chile was reduced by 63% compared with 2014 and represented only 1.6% of total ODA to South America, when in 2014 it represented 5.3%.[12]

In addition to the decline in ODA volumes since 2015, several partners deactivated some of the existing cooperation mechanisms and Chile could no longer apply for call for projects aimed at ODA-countries. In the short term this is estimated to have limited Chile´s access to projects on renewable energies for USD 30 million.[13]
The Overseas Development Institute (ODI) described the following effect on Chile after its graduation from official development assistance (ODA): *[…] the country still has a strong demand for technical aid, expertise, and knowledge-sharing to address structural vulnerabilities. Interviewees from the Chilean government – the Ministry of Foreign Affairs and line agencies - called for continued technical assistance, knowledge-sharing, and expertise. They stressed that the government still faces structural vulnerabilities and would benefit from the experience that development partners have several built-in areas to address these challenges.*[14]

With the graduation of Chile from the ODA, the NAMA Facility confirmed the commencement of the NSP in 2017; however, it rejected the amendment request to extend the TC with additional funds in 2019 and 2020 despite the evident disconnection from the FC.

Against this overall trend, in 2019, the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) of Germany launched a program, Decarbonization of the Chilean Energy Sector, under its International Climate Initiative (IKI) framework. The German Federal Ministry for Economic Affairs and Energy (BMWi) has instated a bilateral Energy Partnership (*Energiepartnerschaft*) with Chile, which is a platform for a high-level intergovernmental dialogue on energy issues, see: www.energypartnership.cl.

It is important to mention that the TC of this NSP SSRE was embedded in the Renewable Energy and Energy Efficiency (4E) program, which is a portfolio of projects implemented in Chile by GIZ on behalf of several German Federal Ministries. This resulted in synergies for the NSP and allowed further promotion of SSRE in the context of the energy transition in Chile, see: https://www.4echile.cl/program-for-renewable-energies-and-energy-efficiency/.

[11] National Green Hydrogen Strategy: https://energia.gob.cl/sites/default/files/national_green_hydrogen_strategy_-_chile.pdf
[12] First Analysis of the Impact of the Graduation of Chile, PNUD 2017 (English Version, From Page 159 of the Document) https://www.agci.cl/images/centro_documentacion/Primer_Analisis_Impacto_de_la_Graduacion_Chile.pdf, Page 108.
[13] First Analysis of the Impact of the Graduation of Chile, PNUD 2017 (English Version, From Page 159 of the Document) https://www.agci.cl/images/centro_documentacion/Primer_Analisis_Impacto_de_la_Graduacion_Chile.pdf, Page 109.
[14] Overseas Development Institute: Report - Moving away from aid, The experience of Chile, December 2019: https://www.odi.org/sites/odi.org.uk/files/resource-documents/191126_chile_study_final.pdf, p. 34f.

Photos: Workers monitor the PV control panel at a nut processing plant in the Choapa Valley during a site visit organized by the TC (photo credit: GIZ).

2.3 Achievements of the Technical Component

The obvious **deviations from the original planning** centre on the implementation period of the NSP and the complete disconnect between the TC and the FC. The ELE analysis confirmed consensus among the stakeholders, that whenever the Technical Component did not have to substantially rely on the Financial Component to achieve its intermediate outcomes, the NSP causal pathways have held up well, which is the case for intermediate outcomes 1 (awareness raising), 2 (capacity building) and 4 (MRV system). Therefore, the Technical Component has taken the NSP as far with its ToC as it could. However, "*it is not possible to maintain a clear separation between the Technical and Financial Components when evaluating the likelihood of the NSP to contribute to its intended final outcomes and longer-term impact.*" This is particularly the case for intermediate outcome 3 (help desk), which as a result negatively impacts outcome 1 (awareness raising) and 2 (capacity building).

Indeed, as the project is designed, the synergistic contribution of the two components is essential to the strengthening of the SSRE market and the consequent role played by SSRE projects in the decarbonization of the national energy sector (NSP Impact in the ToC). For the overall success of the NSP, the success of the Financial Component will therefore be crucial.
In the following section, the achievements of the TC are displayed in accordance with the core indicators:

Table 2-7: Core M Indicators NSP SSRE Chile

Indicator		2016	2017	2018	2019	2020
M1: Reduction of GHG emissions (tCO_{2eq}) (without projection)	Goal	0	0	2,637	13,727	39,380
	Status	0	0	0	0	0
M2: Number of people directly benefiting from NAMA Support Projects	Goal	40	100	200	300	300
	Status	30	282	420	748	985
M3: Degree to which the supported activities are likely to catalyze impacts beyond the NAMA Support Project (potential for scaling-up, replication and transformation)						
M3A1: 50 % of FIs that participated in the NSP FC activities have established a financing instrument for SSRE	Goal	0	0	0	0	50
	Status	0	0	0	0	0
M3A2: Likelihood for transformational change for M3A1	Goal	1	1	2	3	4
	Status	1	1	1	1	1
M3B1: 50 SSRE projects developed without FC subsidies under this NSP.	Goal	0	0	10	20	50
	Status	27	220	350	453	661
M3B2: Likelihood for transformational change for M3B1	Goal	1	1	2	3	4
	Status	2	3	3	2	2
M4: Volume of public finance (domestic and/or governmental) mobilized for low carbon investment and development (MM EUR)	This indicator has been amended as per request of the KfW and will be reported on during the implementation of the FC.					
M5: Volume of private finance mobilized for low-carbon investment and development (MM USD)	Goal	0	0	5	20	45
	Status	0	0	0	0	0

Source: GIZ, own elaboration.

M1: Reduction of GHG emissions (tCO_{2eq}) (without projection)
According to the M&E Framework of the NAMA Facility, only the GHG emission reductions stemming (directly or indirectly) from the NSP implementation can be considered. As indicator M1 depends directly on the FC, which has not become operational by the time this report was handed in, no progress can be reported within this indicator.

M2: Number of people directly benefiting from NAMA Support Projects
Indicator M2 refers to the number of people directly benefiting from the NSP, with a target of 300, which was surpassed threefold with 985. The TC actively participated in almost 40 events in all 16 regions of Chile. To reach the target audience, the project collaborated with business associations and public institutions.

M3: Degree to which the supported activities are likely to catalyze impacts beyond the NAMA Support Project (potential for scaling-up, replication and transformation)

M3A1: 50 % of FIs that participated in the NSP FC activities have established a financing instrument for SSRE.
Indicator M3A1 depends directly on the FC. The FC was approved by donors in 2020 but did not become operational by the time the TC phased out. Therefore, no progress can be reported within this indicator.

M3B1: 50 SSRE projects developed without FC subsidies of this NSP.
As stated before, the SSRE market in Chile has developed exponentially in the past few years. Based on the data published by SEC, the TC estimates that 661 SSRE installations have been registered in the industrial, agricultural and commercial sectors relevant to the target group of this NSP. Furthermore, in 2020 alone, 1,541 installations have been declared to the SEC, accounting for over 31.4 MW of installed power. These new installations relate to all types of SSRE projects developed within the frame of the Distributed Generation Law, including the residential sector.

M4: Volume of public finance mobilized for low carbon (MM EUR)
This indicator has been amended as per request of the KfW and will be reported on during the implementation of the FC.
M5: Volume of private finance mobilized for low-carbon investment and development (MM USD)
Indicator M5 depends directly on the FC. The FC was approved by donors in 2020 but did not become operational by the time the TC phased out. Therefore, no progress can be reported within this indicator.
The indicators and outcomes directly dependent on the TC have been surpassed well ahead of schedule, as summarized in the following table:

Table 2-8: Overview of the Core Indicators

Indicator		2016	2017	2018	2019	2020	Achievement status at the end of TC
A1: Information events for SSRE awareness for 300 private and/or public decisionmakers in 3 industrial sectors and 3 regions are implemented. (Of the total of participants at least 50 % come from the final target group = private companies and/or potential investors in SSRE.)	Goal	40	100	200	300	300	100%
	Status	30	282	420	748	985	328.33%
A2: Information material on SSRE potential and/or best practice is published among potential SSRE end users. (At least 2 studies analyzing SSRE potential in 2 industrial sectors, at least 2 short information videos and at least 8 fact-sheets.)	Goal	0	2	3	4	4	100%
	Status	1	5	12	14	22	550%
B1: 100 additional entrepreneurs completed successfully professional training courses on SSRE project analysis, management and development.	Goal	20	60	100	100	100	100%
	Status	4	142	242	424	446	446%

B2: 40 people participated in good-practice site-visits and/or international exchange programmes.	Goal	0	10	25	40	40	100%
	Status	0	60	69	69	69	172.5%
C1: 200 inquiries on project development support received professional advice.	Goal	30	70	130	200	200	100%
	Status	20	78	218	229	229	114.5%
C2: A virtual project development information platform is established. (The platform received at least 6,000 clicks.)	Goal	0	0	1	1	1	100%
	Status	0	0	1	1	1	100%
D1: A functioning MRV system including SSRE is designed and implemented at the Ministry of Energy.	Goal	0	0	1	1	1	100%
	Status	0	0	1	2	2	200%
D2: A regular process for project management optimization is established.	Goal	0	1	1	1	1	100%
	Status	0	0	1	1	1	100%

Source: GIZ, own elaboration.

Despite the success of the TC in achieving and exceeding the indicators that depended solely on the TC itself, the gap between the TC and the FC clearly impacted the designed transformational process of the NSP as a whole and weakened the effectiveness of both components individually. At the time when the TC phases out, no additional SSRE installed capacity can be attributed directly to the NSP due to the absence of the financial support mechanisms of the FC.

Regarding the contribution of the TC as a stand-alone tool, which it was not designed to be, the ELE-report made the following assessments:

Intermediate Outcome 1: *"The ELE found that the Technical Component has worked extensively to raise awareness of the different SSRE options and benefits, and that awareness levels in key national stakeholders have increased as direct contribution of the Technical Component. Interviewed stakeholders consistently reported high levels of appreciation from users of both awareness events and material."*

Intermediate Outcome 2: "*The Technical Component was prolific in developing support tools and technical studies as well as delivering training, good practice site visits and international study tours to Europe. In general, the ELE interviews consistently confirmed the tools, assistance and capacity building provided were helpful and that the resulting knowledge gained is being used by SSRE project implementers. The ELE also evidenced good flexibility of the NSP in identifying the need for policy and regulatory framework support and following through by requesting an amendment to the project scope to allocate specific activities to it.*"

Intermediate Outcome 3: *"Through technical assistance, the NSP directly contributed to improve the national SSRE policy and regulatory framework, helped SSRE end-users better assess the key technical requirements and economic costs and benefits of their SSRE opportunities. It also identified a list of potential projects for the Financial Component. Nevertheless, Intermediate Outcome 3 has not been achieved, substantially because of the absence of the Financial Component. In hindsight, not having looked for a "plan B" to substitute the Financial Component can be seen as a missed opportunity for the NSP."*

To this end, the TC had clear instructions from the TSU to focus its support exclusively on the FC. The launch of the FC was expected on various occasions in past years but was then delayed repeatedly. Therefore, the TC repeatedly had to revise its support activities as well.

Intermediate Outcome 4: *"The MoE has been very satisfied with quality and robustness of the SSRE MRV system; in fact, it requested support to develop and test a second MRV system for large-scale RE, which can be considered an additional outcome of the project. In terms of supporting the MRV system's functioning, the Technical Component appears to have put in place an appropriate framework for the MoE to own and*

operate the RE MRV systems. In addition, by applying the MRV systems on RE projects in Chile, the NSP contributed to improving the transparency of the RE sector, another positive and unexpected outcome."

All in all, the ELE-report confirms that based on the impacts of the TC alone, "a clear causal link between the achievement of the NSP outcome of "strengthening the SSRE market in Chile" and its overarching impact in the ToC can be validated". However, the overall effect of the NSP on the desired transformational change will have to be evaluated at the end of the implementation of the FC.

3 Lessons learned

Throughout its implementation, the TC had to continuously adapt to a rapidly changing environment with considerable deviations from the assumptions made in the project proposal. On the one hand, the SSRE market developed much more dynamically than could initially be assumed. On the other hand, the start of the FC was expected and then postponed on numerous occasions, which immediately impacted the implementation and effectiveness of the TC.

The fact that the ELE report deems the TC a success on its own despite the deviations from the project proposal can be considered important lessons towards "upward learning" as well as "outward learning":

Flexibility: The ELE report confirmed that the TC had "evidenced good flexibility" in operating within a changing and unpredictable environment. Some of the key changes included:

- The extension of the TC to policy and regulatory framework support which had not been considered in the initial NSP proposal.
- Inclusion of representatives of public institutions in the capacity building measures, which were initially aimed at SMEs only.
- Innovative approach to market trends to further promote new technological solutions suitable for the Chilean market.

This flexibility was made possible not least by the willingness of the NAMA Facility to consider and grant the TC's requests for changes. The close exchange between GIZ as the NAMA Delivery Organization and the Technical Support Unit, which took place in semi-annual progress reports, regular telephone consultations and occasional meetings, deserves positive mention. Needs that arose during project implementation could be communicated and promptly amended.

Partner Structure: The close relationship between GIZ as the NAMA Delivery Organization and the MoE as the Implementing Partner made it possible for the TC to actively support the Chilean Government's National Energy Policy endeavors towards decarbonization of the energy mix. The following elements helped foster this positive collaboration:

- By the design of NSPs, Implementing Partners act with the explicit mandate of the national government towards achieving a clearly defined Nationally Appropriate Mitigations Action (NAMA) which fosters strong ownership and an active role in the implementation of the NSP (see also: "ownership" below).
- The MoE and GIZ held regular strategic planning sessions to establish the general action plans for the TC.
- Progress was monitored in weekly meetings between the counterparts.
- Regular executive coordination meetings took place between several heads of unit at the MoE and the leads of GIZ projects implemented in Chile with a focus on energy and climate. This helped align the various approaches towards decarbonization of the Chilean energy sector.
- The staff of GIZ was assigned a room at the MoE, which fostered a close co-working and (informal) exchange.
- In 2020, a Directive Committee composed of representatives from the MoE, CORFO, KfW and GIZ was created. Its main objective was to prepare the launch of the FC and to provide a strategic view over both components to ensure successful implementation and coordination of the NSP.

Ownership: As stated above, the MoE has shown strong ownership of the NSP and seems to be ready to provide continuation of key products developed by the TC:

- The MRV-tool for RE is a stand-out result of the TC and was developed in close collaboration between GIZ, the Division of Sustainable Energy and Division of Environment and Climate Change, both at the MoE, as well as the Climate Change Office at the Ministry of the Environment. The MoE has assumed ownership of the MRV systems and processed data on thousands of SSRE installations to estimate their contribution towards mitigation action and will use the MRV system henceforth for the reporting of its NDCs.
- The TC has developed price indexes for three distinct technologies: photovoltaics, heat pumps and biomass boilers. Price indexes offer effective means of creating market transparency, raising awareness among potential users and thus promoting (new) technologies. The MoE has used the PV price index as a base for the "*Explorador Solar*", which allows customers to calculate the cost benefits of PV systems. The price indexes for the other two technologies were incorporated into the "*Calculadora térmica"*[15]*,* which provides comparative analysis for various technologies for thermal applications in the residential sector.
- The MoE has incorporated the methodologies of the Price Indexes for the three technologies into its Information Management Unit (*Unidad de Gestión de Información*) and is committed to implementing them in the future in order to provide continuity of market transparency and price comparability.
- Both the MRV system and the price indexes will be applied in the evaluation of projects that apply for the subcomponents of the FC: the former for consideration of the CO_2 emission reduction of project proposals and the latter for the comparability of their cost efficiency and profitability.

Synergies: One of the main factors which allowed the TC to maintain a solid understanding of the needs and developments of the SSRE sector was its tightly knit network with relevant public and private key players. These relationships with public entities, business associations and private sector organizations helped the TC to better understand market needs and therefore develop relevant products (see "Capacity Building" and "Awareness Raising"). The alignment of its activities helped the TC to extend its reach and to anchor the products developed beyond its implementation time (see below "Longevity").

The most relevant synergy resulted from the inclusion of the TC into the portfolio of "4e", the energy and climate programs implemented by GIZ on behalf of the German Government, see: www.4echile.cl. Through this joint coordination, SSRE could be embedded into the broader strategic context of the energy transition in Chile. The integration of staff and methodologies between projects implemented by GIZ further allows the continuation and further development of knowledge that would otherwise likely be lost.

Longevity of the generated results: Before its expiration, the TC made a special effort to preserve relevant results beyond its duration:

- Relevant materials which had been developed in previous years to promote SSRE technologies were reviewed and revised in content and design with the aim of prolonging the relevance of these publications so that potential users might benefit from these resources once the FC becomes available.
- A catalogue was prepared in which all the relevant updated publications were sorted per technology. This catalogue was published on the website (see below) and distributed among the stakeholders of the NSP.[16]
- The TC has updated its website www.4echile.cl/nama which now contains all the updated materials in an online library, in which materials can be searched, viewed and downloaded. The website is embedded in the general website of the portfolio of energy programs implemented by GIZ in Chile.

[15] Exploradores de energía térmica: www.exploradorenergia.cl, Herramienta de calefacción: http://calefaccion.minenergia.cl/inicio

[16] Selección de Estudios y Publicaciones Preparados por la Componente Técnica de la NSP: https://4echile-datastore.s3.eu-central-1.amazonaws.com/wp-content/uploads/2020/11/12184101/NAMA-Support-Project-Chile-publicaciones-ES.pdf

This assures that SSRE will remain visible to the target audience interested in the energy transition in Chile.

- All relevant publications were further published in the "*Energía Abierta*" (Open Energy) platform of the *Comisión Nacional de Energía* (CNE, National Energy Commission, http://energiaabierta.cl/).

Knowledge Management: Some of the knowledge management strategies applied have already been mentioned in the sections on "ownership", "synergies" and "longevity" above. Additionally:

- The TC submitted semi-annual reports to the TSU, in which its progress and challenges were documented, and expenditures were accounted for.
- In 2020, GIZ actively participated in the external Project Evaluation and Learning Exercise (ELE) for the NAMA Facility, implemented by AMBERO Consulting Gesellschaft GmbH and Oxford Policy Management, in which lessons learned for the TC were established and handed over to the FC.[17]
- Based on the very positive experiences with the price indexes, a general guide for the development of price indexes for three technologies was prepared and published. This guide aimed at facilitating their duplication in the future and was presented to several units within the MoE and to various specialized associations to motivate and enable them to hopefully implement these price indexes in the future.
- In 2019 this NSP participated in a workshop organized by the Technical Support Unit (TSU) in Bonn. Interchange with the other NSPs was highly beneficial in many ways. Given the similarities of the objectives and target groups between this NSP in Chile and the NSP in Mexico, "Energy Efficiency in SMEs as a Contribution to a Low Carbon Economy", the TC has shared some of its experiences and methodologies. In 2020, GIZ colleagues from Mexico published their first PV price index and mentioned the PV price index of the Chilean NSP as one of the primary methodological resources.[18]

The TC of this NSP has enhanced the TSU's awareness of the need for a more systematic support mechanism for knowledge sharing and management among NSPs. As seen by the examples above, there is great potential for upward learning between NSPs across countries and sectors.

4 Outlook

In its updated NDCs from April 2020, Chile confirmed its commitment to achieving the goal of climate neutrality by 2050. Chile intends to reach its peak of absolute GHG emissions by 2025 and retire 50% of its coal-fired power plants by the same year. As the electricity grid will become overall "greener", the relevance of the SSRE sector will play a diminishing role in achieving Chile's decarbonization goals of its energy mix in the next 10-15 years – both for electricity generation and thermal applications. With the phasing out of the TC in December 2020, the successful future implementation of the FC will be crucial to achieving the intended outcomes of the NSP and contributing to transformational change of the sector.

Chile has strong potential in the energy sector to combine economic growth with job creation. This could include the construction of crucial energy infrastructure (solar parks, wind farms, transmission lines, substations) and their maintenance. Also, measures towards upgrading energy-efficient housing and heating as well as reforestation measures on a large scale could enhance green growth. Chile has an abundance of renewable energy sources - with larger investments, the creation of new industries would be feasible, such as production and transportation of green hydrogen, desalination plants and production sites for bifacial solar panels or batteries.

[17] It is to be noted that although the MoE was included as an interviewee, it was not consulted for the review of the findings of the ELE. Both GIZ and KfW have brought forward concerns to the TSU that the scope of the ELE report went beyond what had been communicated to them initially.

[18] Monitor de información comercial e índice de precios de Generación Solar Distribuida en México: https://energypedia.info/images/c/c2/Monitor_info_comercial_GSD.pdf, p. 8.

With regards to small scale renewable energy for SSRE, in 2020 the Chilean government has introduced a number of initiatives to foster a green recovery: "*Ponle energía a tu PyME*" and "*Casa Solar*", both implemented by *Agencia de Sostenibilidad Energética* (ASE) on behalf of the Ministry of Energy as well as the "*Crédito Verde*" by CORFO.

The FC has been confirmed to remain active until 2024 but has yet to become operational as of February 2021. The financial landscape of SSRE incentives in Chile has evolved substantially since the beginning of the NSP and includes the aforementioned initiatives, as well as various instruments such as guarantee funds, green certificates, revenues from offsets and models such as ESCOs and green mortgages. Therefore, the design and interplay of the four sub-components of the FC will be of crucial relevance to impact the SSRE sector in Chile.

The ELE provides an extensive list of suggestions for the FC going forward, drawn up by various stakeholders in this NSP. While the repetition of these suggestions goes beyond the scope of this report, it can be summarized that the strategy of the FC still "*appears to be adequate to address the barriers to access finance for SSRE*". From the point of view of the TC it is of special interest to note that the "continuation of technical backstopping" was listed as the first success factor for the FC to operate successfully. This once again confirms the validity of the initial ToC of this NSP.

Annex

Annex 5-1: Overview table for all project indicators and outputs

Annex 5-1.1: Core M Indicators NSP SSRE Chile

Indicator		2016	2017	2018	2019	2020
M1: Reduction of GHG emissions (tCO_2eq) (without projection)	Goal	0	0	2,637	13,727	39,380
	Status	0	0	0	0	0
M2: Number of people directly benefiting from NAMA Support Projects	Goal	40	100	200	300	300
	Status	30	282	420	748	985
M3: Degree to which the supported activities are likely to catalyze impacts beyond the NAMA Support Project (potential for scaling-up, replication and transformation)						
M3A1: 50 % of FIs that participated in the NSP FC activities have established a financing instrument for SSRE	Goal	0	0	0	0	50
	Status	0	0	0	0	0
M3A2: Likelihood for transformational change for M3A1	Goal	1	1	2	3	4
	Status	1	1	1	1	1
M3B1: 50 SSRE projects developed without FC subsidies under this NSP.	Goal	0	0	10	20	50
	Status	27	220	350	453	661
M3B2: Likelihood for transformational change for M3B1	Goal	1	1	2	3	4
	Status	2	3	3	2	2
M4: Volume of public finance (domestic and/or governmental) mobilized for low carbon investment and development (MM EUR)	This indicator has been amended as per request of the KfW and will be reported on during the implementation of the FC.					
M5: Volume of private finance mobilized for low-carbon investment and development (MM USD)	Goal	0	0	5	20	45
	Status	0	0	0	0	0

Source: GIZ, own elaboration.

Annex 5-1.2: Overview of the Core Indicators

Indicator		2016	2017	2018	2019	2020	Achievement status at the end of TC
A1: Information events for SSRE awareness for 300 private and/or public decisionmakers in 3 industrial sectors and 3 regions are implemented. (Of the total of participants at least 50 % come from the final target group = private companies and/or potential investors in SSRE.)	Goal	40	100	200	300	300	100%
	Status	30	282	420	748	985	328.33%
A2: Information material on SSRE potential and/or best practice is published among potential SSRE end users. (At least 2 studies analyzing SSRE potential in 2 industrial sectors, at least 2 short information videos and at least 8 fact-sheets.)	Goal	0	2	3	4	4	100%
	Status	1	5	12	14	22	550%
B1: 100 additional entrepreneurs completed successfully professional training courses on SSRE project analysis, management and development.	Goal	20	60	100	100	100	100%
	Status	4	142	242	424	446	446%
B2: 40 people participated in good-practice site-visits and/or international exchange programmes.	Goal	0	10	25	40	40	100%
	Status	0	60	69	69	69	172.5%
C1: 200 inquiries on project development support received professional advice.	Goal	30	70	130	200	200	100%
	Status	20	78	218	229	229	114.5%
	Goal	0	0	1	1	1	100%

C2: A virtual project development information platform is established. (The platform received at least 6,000 clicks.)	Status	0	0	1	1	1	100%
D1: A functioning MRV system including SSRE is designed and implemented at the Ministry of Energy.	Goal	0	0	1	1	1	100%
	Status	0	0	1	2	2	200%
D2: A regular process for project management optimization is established.	Goal	0	1	1	1	1	100%
	Status	0	0	1	1	1	100%

Source: GIZ, own elaboration.

Annex 5-2: Logframe of the TC (see separate excel sheet)

Annex 5-3: Budget / expenditures of the TC

1. Personal, time sheets and consultancies	2,277,570€
2. Travel costs	90,522€
3. Acquisitions	91,957€
4. Financing (grants)	0€
5. Human capacity development	31,954€
6. Other direct costs	100,221€
7. Overheads and taxes	407,776€
Total	**3,000,000€**

Source: GIZ, own elaboration.

Annex 5-4: Comparison of Progress between 2014 and 2020 of Chile's NAMAs

Name of NAMA	Sector(and emissions)	Period	BUR 2014[19]		BUR 2020[20]	
			Progress status	Estimated GHG reduction	Progress status	Estimated GHG reduction
Self-supply renewable energies in Chile (SSREs) - Operated by MINENERGIA (Ministry of Energy)	Energy (CO_2)	2015-2022	Implementation phase	2 $MtCO_2eq$	Implementation phase	1.5 $MtCO_2eq$
Energy recovery from industrial waste program (former National Program for Industrial and Commercial Catalyzation and Organic Waste Management in Chile) - Operated by MMA (Ministry of Environment)	Energy, Waste (CO_2, CH_4)	To be defined	Seeking support for implementation	12 $MtCO_2eq$	No progress	Not estimated
Design and Implementation of Strategy on Climate Change and Plant Resources - Operated by CONAF (National Forestry Corporation)	LULUCF (CO_2)	2013-2025	Seeking support for implementation	42 $MtCO_2eq$	Implementation phase	Not estimated
Clean Production Agreements (APL) in Chile - Operated by CPL (National Council for Clean Production)	Cross-sector	2012-2020	Implementation phase	18.4 $MtCO_2eq$	Implementation phase	18.4 $MtCO_2eq$

[19] Chile's First Biennial Update Report of Chile:
https://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/chlbur1eng.pdf
[20] Chile's Fourth Biennial Update Report:
https://unfccc.int/sites/default/files/resource/Chile_4th%20BUR_2020.pdf

Green Zone for Transport in Santiago - Operated by Municipality of Santiago	Transport and Infrastructure (CO_2)	2014-2022	Design stage	1.43 $MtCO_2eq$	Implementation phase and development of MRV system	1,43 $MtCO_2eq$
Carbon sequestration through sustainable land management - Operated by INIA (Institute of Agricultural Research) and SAG (Agriculture and Livestock Service)	Agriculture, Forestry/AFOLU (CO_2)	To be defined	Design stage	65-80 $MtCO_2eq$	Design phase, seeking for support for implementation	65-80 $MtCO_2eq$

Source: GIZ, own elaboration.

Annex 5-5: GHG emissions by sector for different year, $KtCO_2eq$

Sector	1990	2000	2010	2013	2016	2017	2018	2018 variation with respect to 1990 [%]
1. Energy	33,631.4	51,746.4	66,607.7	79,901.3	86,191.0	86,896.1	86,954.3	+158.6%
2. IPPU	2,224.2	4,803.6	4,279.6	5,084.5	5,977.1	6,079.8	6,611.3	+197.2%
3. Agriculture	11,834.8	13,708.9	12,921.1	12,597.4	11,881.3	11,724.0	11,789.4	-0.4%
4. LULUCF	-60,152.6	-73,364.3	-76,966.4	-77,561.5	-74,697.9	-11,710.3	-63,991.9	-6.4%
5. Waste	1,519.0	2,742.6	4,133.6	5,095.1	6,106.0	6,515.7	6,957.6	+358.0%
Balance	-10,943.1	-362.9	10,975.6	25,116.9	35,458.2	99,505.3	48,320.7	-
Total	49,209.5	73,001.4	87,942.1	102,678.4	110,156.0	111,215.6	112,312.6	+125.2%

Source: Chile's Fourth Biennial Update Report, page 17[21]

Annex 5-6: Chile's national mitigation commitment

National mitigation commitment		NDC 2015[22]	NDC 2020[23]
Emissions	Absolute emissions	Absolute maximum annual emission levels of about 123 $MtCO_2eq$ by 2030.	Absolute maximum annual emissions level of 95 $MtCO_2eq$ by 2030.
	Reduction commitment	Chile is committed to reducing its CO_2 emissions per GDP unit by 30% below their 2007 levels by 2030, considering a future economic growth which allows implementation of suitable measures to reach this commitment.	Chile commits to a GHG emission budget not exceeding 1,100 $MtCO_2eq$ between 2020 and 2030, with a GHG emissions maximum (peak) by 2025.
	Reduction commitments subject to international monetary contributions	The country is committed to reducing its CO_2 emissions per GDP unit by 2030 until it reaches a 35% to 45% reduction with respect to the 2007 levels, considering, in turn, a future economic growth which allows implementation of suitable measures to achieve this commitment.	This is an unconditional target, i.e., it is not subject to qualifying external conditions (grants).
	Annual absolute emission levels by 2030	123 $MtCO_2eq$	95 $MtCO_2eq$
Short-lived climate pollutants	Black Carbon	No reduction target	Reduce total black carbon emissions by at least 25% by 2030, with respect to 2016 levels. This commitment will be implemented primarily through national policies focused on air quality. In addition, it will be monitored through permanent and periodic work to improve information available in the black carbon inventory.

[21] Chile's Fourth Biennial Update Report: https://unfccc.int/sites/default/files/resource/Chile_4th%20BUR_2020.pdf, page 17.
[22] Intended Nationally Determined Contribution of Chile (NDC 2015): https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Chile/1/INDC%20Chile%20english%20version.pdf
[23] Chile's Nationally Determined Contribution (NDC 2020): https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Chile%20First/Chile%27s_NDC_2020_english.pdf

Source: GIZ, own elaboration.

Annex 0-7: Objectives and Subcomponents of the TC and the FC as per detailed project proposal[24]

Technical Component	Financial Component
Partner Structure	
Implemented by GIZ and the Chilean Ministry of Energy.	To be implemented by KfW, the Chilean Ministry of Energy and CORFO.
Objectives	
Improvement in technical conditions and capacities for project development.	Creation of efficient and suitable access to financial instruments that promote investment and financing in this sector.
Sub-component 1	
Awareness raising The NSP will help to raise awareness on options for utilising SSRE in diverse industrial sectors of Chile. General seminars, technology road shows and site visits sponsored by the NSP will bring potential investors in contact with the technologies, customized applications and current users.	**Development of a bankable project pipeline** to accomplish this, the FC will use (amongst others) the project preparation database from TC. In Chile, there is a lack of bankable projects since project promoters are not willing to bear the high up-front cost of feasibility studies given the uncertainty of funds available for implementing projects or because existing studies do not fulfil the commercial bank's requirements for taking financing decisions. The FC will provide co-financing to undertake necessary pre-investment studies which address quality and information requirements of potential financiers. These study grants will be provided in the early stage of the program in order to contribute to build up a high-quality and diversified project pipeline. Hereby the FC will partially build upon the TC database of high-potential SSRE projects and partially on the market development in the field of SSRE technologies.
Sub-component 2	
Capacity Building Through workshops and training activities, stakeholders from the private and public sectors (excluding the financial sector, which is covered by the PC) will be trained in areas, such as: Introduction to RE technologies, SSRE Feasibility Analysis, Project Development & Management, Operation & Service, and MRV. The NSP will also encourage exchange of knowledge by means of funding and carrying out a program with national and international experts to share best practices and experiences.	**Investment Subsidies/Grants** At the investment stage, the FC will provide financial incentives for project developers by covering part of the investment costs and therefore incentivizing developers' investment decisions. The final necessity of the investment grants will be assessed in detail by the Ministry of Energy when the funds are available. This will be done considering the evolution and maturity of the self-supply energy market with a special focus on its capability to allocate funds in projects that show additionality. If there is evidence of any redundancy of these instruments, funds will be redirected to the Guarantee Fund (on the basis of No Objections from KfW and the TSU). However, there are no indices in the market today to expect rapid development that could make the above-mentioned sub-components unnecessary.
Sub-component 3	
Help-Desk for Technical support (Project Preparation) A technical help desk and a virtual platform will provide on-demand technical and administrative support to project developers regarding technologies, project development and regulatory and legal matters. Furthermore, high-potential SSRE projects will be identified and included in a database as probable cases to receive support from the FC. The Ministry of Energy, CORFO, GIZ and KfW will define minimum criteria for eligibility of SSRE projects with higher potential, which will be defined at the beginning of the TO implementation. These criteria could change during the NSP implementation due to market evolution. The projects in operation will help to decrease the perceived risks by providing lessons learned and experiences, and also by demonstrating their technological and economic feasibility.	**Training and Advisory Services for FIs** This instrument aims at strengthening relevant competences of FIs interested in financing SSRE projects. Training and advisory activities will focus on the following aspects: (i) assessment of bankable SSRE business models in the local market; (ii) development of standardized financing proposals for eligible projects; (iii) training of staff for efficient screening and assessment of project proposals; (iv) screening and filtering of pre-investment studies and promotion of suitable identified projects to local FIs. As outlined in the specific FC-component part, this sub-component will finally be assessed in detail by the Ministry of Energy and CORFO when the funds are available.
Sub-component 4	
Monitoring, Reporting & Verification (MRV) System. Development of a tool to quantify GHG emissions mitigated through NCRE projects.	**Guarantee Fund** An EUR 11 million guarantee fund for partial credit guarantees will be established in order to leverage a larger pool of capital

[24] NAMA Support Project Proposal, 2.5 Project concept and methodological approach (Page 16), 2017.

	from FIs for project financing. This scheme aims to facilitate financing from local commercial banks through sharing or bearing the potential losses of SSRE projects.

Source: GIZ, own elaboration.