

SUBMISSION OF CHILE
INPUTS WITH RESPECT TO WORKPLAN ACTIVITY 11
FOR CONSIDERATION BY THE KCI AT ITS SB57 MEETING

Santiago, September 2022

The workplan of the forum on the impact of the implementation of response measures (forum) and its Katowice Committee of Expert on the Impacts of the Implementation of Response Measures (KCI) was adopted at COP 25, in Madrid Spain in December 2019 (Decisions 4/CP.25, 4/CMP.15, 4.CMA.2).

The Government of Chile welcomes the call for inputs by the KCI mandated as modalities for implementing the **workplan activity 11**: “Facilitate, exchange and share experience and best practices in the assessment of the environmental, social and economic co-benefits of climate change policies and actions informed by the best available science, including the use of existing tools and methodologies”.

Chile would like to share three (3) different experiences in the assessment of the environmental, social and economic co-benefits of its climate change policies.

- (1) Assessment of social, environmental, and economic co-benefits of the Long-Term Climate Strategy to achieve carbon neutrality by 2050 in Chile [**EXP.1**]
- (2) Assessment of macroeconomic impacts of achieving carbon neutrality by 2050 in Chile [**EXP.2**]
- (3) Assessment of the co-benefits of the Coal Plant Closure Plan in Chile [**EXP.3**]

As requested, the submitted inputs are organized as responses to the guiding questions provided by the Secretariat in the document MTP/KCI/Inputs from 14 July 2022.

EXP.1

ASSESSMENT OF SOCIAL, ENVIRONMENTAL, AND ECONOMIC CO-BENEFITS OF THE LONG-TERM CLIMATE STRATEGY TO ACHIEVE CARBON NEUTRALITY BY 2050 IN CHILE

1. Which climate change policy(ies) and actions, informed by the best available science, were assessed for environmental, social and economic co-benefits and what were the co-benefits identified from your assessment?

In response to this question, please:

- i. Define the climate change policies and actions, including scope (e.g. local, sectoral, national, international), category (e.g. mitigation, adaptation) and type (e.g. market-based instrument, regulatory instrument, voluntary programme, mitigation strategy, individual action)*

To respond to the first guided question provided by the Secretariat, the climate policy assessed here is a **mitigation strategy** whose scope is **national**.

At COP26, Chile presented its **Long-Term Climate Strategy** (LTCS) in order to consolidate the vision to face climate change and comply with the provisions of Article 4(19) of the Paris Agreement, which states that the parties should formulate their long-term low greenhouse gas emission development strategies taking into account the temperature objective established in said agreement and taking into consideration their common but differentiated responsibilities and their respective capacities, in light of the different national circumstances.

The Long-Term Climate Strategy is the instrument that defines the general long-term guidelines that the country will follow in a transversal and integrated manner, considering a 30-year horizon, to face the challenges presented by climate change; move towards a development low in greenhouse gas emissions, until reaching and maintaining the neutrality of emissions; reduce vulnerability and increase resilience to the adverse effects of climate change; and, to comply with the international commitments assumed by the Government of Chile in the matter.

Among its most relevant contents are the determinations of a national greenhouse gas emissions budget for the year 2030 and 2050, of the sectoral mitigation goals (emission budgets for each of the sectors) and of the indicators and goals of adaptation, which must be fulfilled within a period of 10 years. Additionally, it contains guidelines on adaptation to climate change, as well as risk assessment, considering the vulnerability of each specific sector.

- ii. Describe what the environmental, social and economic co-benefits of the policies and actions are according to the assessment*

In pages 201 to 207 of the Long-Term Climate Strategy¹ presented to UNFCCC, there is a section describing the **co-benefits of achieving carbon neutrality by 2050**.

According to the assessment made, implementing the package of mitigation measures committed by Chile to achieve carbon neutrality by 2050 is not only profitable and cost effective from the point of view of (a) direct net benefits in GHG reduction, it is also necessary to consider (a) the benefit of reducing damage due to the effect of climate change, namely social costs, as well as (b) the health benefits of reducing local pollutants associated with reducing greenhouse gas emissions.

- (a) The implementation of the mitigation measures defined with the objective to achieve carbon neutrality by 2050, implies in net present value significant investment costs (CAPEX) of the order of USD 50,000 million; while the costs associated with operation and maintenance (OPEX) are in savings due to lower energy consumption in the carbon scenario neutrality, of the order of

¹ Long-Term Climate Strategy (LTCS) presented by Chile at COP26 of the UNFCCC: [Link to the LTCS](#)

USD80,000 million, thus achieving a net benefit of the order of USD30,000 million by 2050. Therefore, from the point of view of cost-effectiveness, the measures are profitable. The cost calculations were carried out by the Ministry of Energy, the Ministry of Finance and the Ministry of the Environment in the context of the definition of the carbon goal neutrality by 2050 and the update of the NDC, with a discount rate of 6%.

- (b) The direct valuation of GHG reductions according to the social price of carbon (MIDESO, 2017)², reaches USD 9,048 million value, considering a social price of carbon of 0.823 UF/ton CO₂ (estimated in 32 USD/ton CO₂)³.
- (c) The social benefits from reducing emissions of local pollutants at the national level reach USD 29,482 million. The results show the relevance of the cases of premature deaths avoided, which are equivalent to USD 28,078 million and represent 95% of the total benefits. On the other hand, hospital admissions represent 1% and lost productivity 3.5% of total benefits.

iii. *Specify how the best available science informed the assessment*

(b) Social price of carbon:

The marginal abatement cost analysis for Chile is derived from the best information available to date, which consists of the results of the MAPS Chile project⁴.

(c) Health co-benefits from reducing local pollutants:

The evaluation of environmental co-benefits from the reduction of local pollutants associated with the Long-Term Climate Strategy is based on the projection of local pollutant emissions for the period 2020-2050, developed by the Center for Climate and Resilience Research (CR2) of the Faculty of Physical and Mathematical Sciences of the University of Chile, through the study "Mitigation of black carbon in the update of the National Determined Contribution of Chile" (Gallardo, L. et al, 2020); in the costs of the mitigation measures estimated by the Ministry of Energy; and in the regulatory impact assessment methodology used by the Department of Environmental Economics (DEA) of the Ministry of the Environment for the development of "General Analysis of Economic and Social Impact (AGIES) for air quality management instruments" (MMA, 2013).

See more information on how the best available science informed the assessment in the second question below.

² Estimation of the social price of CO₂, Ministry of Social Development, 2017: [Link to the study](#)

³ The "Unidad de Fomento" (UF) is an inflation-indexed unit of account, calculated and published by the Central Bank of Chile.

⁴ The MAPS (Mitigation Action Plans and Scenarios) initiative is a South African initiative led by the Center for Energy Research at the University of Cape Town, in collaboration with the South South North Centre, and with funding from the Children's Investment Fund Foundation (CIFF): [Link to MAPS Chile](#).

2. How such assessment was conducted? Were there any standards used? What are challenges and opportunities, and lessons learnt from these assessments?

In response to this question, please elaborate on:

- i. *The assessment approach (e.g. qualitative and/or quantitative)*

(b) Social price of carbon:

In the case of Chile, the shadow carbon price is based on the range of emissions that the country is willing to reduce, which is reflected in the technical-political commitment to reduce greenhouse gas (GHG) emissions acquired under the Paris Agreement. In this way, the shadow price allows reflecting the current multilateral and national political environment, together with the current technological context, instead of the social cost that determines only the limited understanding of the damage caused by climate change. The versatility of the shadow price makes it possible to make public investment decisions compatible with Chile's goals and commitments to the UNFCCC. The social price of carbon was used to value the direct benefit associated with the reduction of GHG, expressed in CO₂eq.

(c) Health co-benefits from reducing local pollutants:

The evaluation of co-benefits associated with carbon neutrality by 2050 allows identifying, quantifying and valuing the positive effects on the health of the population due to the reduction of local pollutants, underlying the set of mitigation measures that are proposed as mitigation measures by the year 2050. In this way, the avoided cost associated with mortality and morbidity indicators resulting from population exposure to certain levels of contaminant concentration is established as a direct benefit.

- ii. *The tools and methods used for the assessment (e.g. surveys, models)*

(b) Social price of carbon:

In accordance with the review of concepts and methodologies for quantifying social costs and shadow prices, we followed the United Kingdom model and estimated a carbon shadow price based on Chile's willingness to reduce, and therefore pay for, greenhouse gases emissions according to its mitigation goal under the Paris Agreement, called "nationally determined contribution.

In this way, we estimated the shadow price based on the analysis of the marginal costs of carbon dioxide abatement that make it possible to meet Chile's mitigation goals under the Paris Agreement. The marginal abatement cost analysis for Chile is derived from the best information available to date, which consists of the results of the MAPS Chile project.

More information on the tools and methods available in the two following reports:

- Estimation of the social price of CO₂, Ministry of Social Development, 2017: [Link to study](#)
- Integrating the climate change into the National System for Investments, Poch Ambiental S.A. and the UK Embassy, 2016: [Link to study](#)

(c) Health co-benefits from reducing local pollutants:

The evaluation methodology follows the line of work developed by the Department of Environmental Economics of the Ministry of the Environment for the determination of socioeconomic impacts associated with environmental public policy instruments that are used in the studies of "General Analysis of Economic and Social Impact (AGIES)". This consists of the elaboration of a cost-benefit approach analysis, widely used and recommended in the literature for the evaluation of social projects, which in the case of

the AGIES, is applied by comparing the health benefits of the exposed population due to the reduction of pollutants with the estimated cost of the set of measures established to achieve the objective of the instrument.

In this sense, the carbon neutrality scenario by 2050 generates a series of socio-environmental co-benefits resulting from the joint reduction of GHG and trace pollutants, such as particulate matters and precursors of short-lived climate forcing. The estimation of these benefits uses as baseline scenarios and carbon neutrality those considered in the projection of local pollutants prepared by the Center of Climate and Resilience Research (CR2) in 2020.

The analysis also incorporates information on investment costs (CAPEX) and operation and maintenance costs (OPEX) for the implementation of the set of measures estimated by the Ministry of Energy, thus completing the necessary components to develop the cost-benefit analysis (MMA, 2013)

The results of this analysis allow obtaining a benefit-cost relationship for the set of measures evaluated, however, it is not possible to identify the effect of each measure on the total benefits, since even when the costs are defined by measure, the projections of local pollutant emissions were estimated at the scenario level with annual total values by pollutant and economic sector, but without disaggregating measure by measure; that is, it is not possible to connect reductions in emissions of local pollutants with specific measures.

More information on the tools and methods available in the following report:

- Evaluation of environmental co-benefits for the reduction of local pollutants associated with the Long-Term Climate Strategy, Ministry of Environment, 2021 ([Link to report](#))⁵

iii. The factors considered in selecting the assessment approach and data collection

(b) Social price of carbon:

Considering the difficulties of estimating a social cost of carbon, due to the fact that the world trajectory of emissions does not depend on a single country, therefore projecting the world trajectory includes many assumptions, added to the imperfections of the carbon market, we opted to use the carbon shadow price approach.

(c) Health co-benefits from reducing local pollutants:

The Department of Environmental Economics (DEA) of the Ministry of the Environment already had a wide 10-year experience in assessing the impacts of emissions of local pollutants and the benefits of reducing impacts on public health. Undertake co-benefit assessment of carbon neutrality was just a matter of adapting the models.

iv. The challenges and opportunities in, and lessons learned from, each step in the process

(b) Social price of carbon:

The study that allowed estimating the social price of carbon was carried out based on Chile's NDC presented in the Paris Agreement COP21, in 2015. Since then, Chile has committed to greater ambition and mitigation measures have been adjusted accordingly. That is the reason why the current shadow

⁵ This report was developed with the technical support of the IADB in the context of the elaboration of the Long-Term Climate Strategy; and it can be considered as a technical annex of the Chapter 7 of the Strategy.

price does not adjust to reality, it is underestimated. The estimate will be updated upwards, given that the abatement curves have been modified.

(c) Health co-benefits from reducing local pollutants:

The main **opportunity** lies in having generated a model that allows continuous evaluation.

This assessment of co-benefits was made for the whole mitigation strategy, that consists in a package of measures. The main **challenge** now is to assess the co-benefits of each measure, at sectoral level and at local level. Although the reduction of GHG emissions generates positive impacts at the global level, the reduction of collateral pollution generates externalities that are expressed at the local level. This is how territoriality becomes relevant.

3. What actions were/are/will be taken based on the co-benefit assessment and what specific measures taken to maximise the co-benefits if any?

In response to this question, please specify:

- i. *How the results of the assessment have informed the policymaking process*
- ii. *How the results of the assessment have incentivized further action to maximize the co-benefits*

The results of the assessment have fed and validated the decision-making process that led to the long-term mitigation strategy. Having information on its socio-environmental and economic impacts allowed to visualize its direct implications on the population and the territory.

They also served to reinforce the climate action message in an official long-term policy document. It is worth noting that this long-term strategy has been the basis for the new legislation launched a few months ago: the Climate Change Framework Law. This assessment also served for the legislative discussion.

Despite being quantitative results, their value was qualitative.

This exercise generated the baseline from where to start.

As priorly said, this assessment of co-benefits was made for the whole mitigation strategy. The challenge now is to assess the co-benefits of each measure, at sectoral level and at local level. It is expected that priorities may change or adjust when one adds an additional cost variable to the analysis, such as the estimation of environmental and social co-benefits. It is also likely that one same measure can be more significant in one specific territory than at national level.

Currently, the different sectoral ministries are preparing the sectoral mitigation plans. In the same way, local governments are developing local mitigation plans. Each of these plans must be aligned with the national strategy. Thanks to the cost-efficiency and the co-benefits evaluation tools described above, the Ministry of the Environment will have a tool to generate an effective technical counterpart, able to provide relevant inputs for the design of each plan.

EXP.2

MACROECONOMIC EFFECTS OF IMPLEMENTING CARBON NEUTRALITY IN CHILE BY 2050

1. Which climate change policy(ies) and actions, informed by the best available science, were assessed for environmental, social and economic co-benefits and what were the co-benefits identified from your assessment?

In response to this question, please:

- i. Define the climate change policies and actions, including scope (e.g. local, sectoral, national, international), category (e.g. mitigation, adaptation) and type (e.g. market-based instrument, regulatory instrument, voluntary programme, mitigation strategy, individual action)*

The assessment study called *Green Growth Opportunities for the Decarbonization Goal for Chile: Report on the Macroeconomic Effects of Implementing Climate Change Mitigation Policies in Chile*, conducted by the World Bank and the Ministry of Finance with data from the Ministry of Energy and published in 2020, presents the results of model simulations showing the macroeconomic effects of the implementation of key climate change mitigation policies in Chile, aimed to reduce CO₂eq emissions in accordance with Chilean latest NDC and a target of zero net CO₂eq emissions by 2050 ([link to report](#)).

The purpose of this work is to model the impact of the CO₂eq mitigation intervention package on the economy, particularly for aggregate macroeconomic indicators. Furthermore, it is important to understand how the interventions affect the different economic sectors, especially in the context of ambitious and novel decarbonization goals.

- Scope: national (Chile)
- Category: mitigation
- Type: package of mitigation measures, mainly within the energy wide sector seeking to displace the use of fossil fuels (power, transport, industry, mining, buildings).

- ii. Describe what the environmental, social and economic co-benefits of the policies and actions are according to the assessment*

By using a multi-sector macroeconomic general equilibrium model, the study shows that the implementation of the proposed policy package could have an overall positive impact on the economy both in the short and long run, as measured by the effect on economic indicators such as GDP and ensures decoupling of growth from fossil fuel use.

Based on simulations, the study infers that implementing the intervention package could have a positive impact on economic activity in Chile. The level of Gross Domestic Product (GDP) is expected to gradually increase relative to the baseline scenario. Towards the end of the simulation period, the level of GDP can be higher by as much as 4,4%, or equivalently US\$31 billion. On average, the intervention package will contribute an additional 0.13 p.p. to the average yearly growth rate, which is shown in Fig. 4.28. The positive impact on economic activity is a direct result of the positive net present value of the intervention packages. The required level of CAPEX crowds out investment in other sectors of the economy. However, the improvement in efficiency and savings of fuel use outweigh the former effect. Main contribution to GDP is expected from increased private consumption and investment, with an estimated 2.4 and 1.7 percent respectively.

- iii. Specify how the best available science informed the assessment*

2. How such assessment was conducted? Were there any standards used? What are challenges and opportunities, and lessons learnt from these assessments?

In response to this question, please elaborate on:

- i. The assessment approach (e.g. qualitative and/or quantitative)*
- ii. The tools and methods used for the assessment (e.g. surveys, models)*
- iii. The factors considered in selecting the assessment approach and data collection*
- iv. The challenges and opportunities in, and lessons learned from, each step in the process*

The model used is a purely economic model which takes into account CO₂eq emissions. One of the main advantages and value added is the soft link with sector models which were used to generate data on the total capital and operational expenditures related to sector interventions. This feature differentiates this exercise from other integrated models, taking advantage of the exogenous information on investment and operational decisions year by year, analyzed by the dynamic general equilibrium approach.

The objective here is to estimate the impact of the mitigation measures on the Chilean economy. The model does not incorporate a climate damage function, so we do not account for physical climate change negative impacts in both the baseline and the mitigation scenarios. Thus, this work shows how the mitigation package affects the main macroeconomic variables in terms of their deviation from the business-as-usual path.

For the assessment of the policy package the dynamic stochastic general equilibrium model MEMO (macroeconomic mitigations options model) was used. The model combines two strands of research – input-output and general equilibrium modeling. The model consists of the household sector, which maximizes utility from consumption and leisure, the firm sector which maximizes profits, the government sector which collects various taxes and finances public consumption, and a foreign sector responsible for trade with the rest of the world. The main features of the model include division of the firm into sectors calibrated to an input-output matrix, searching and matching on the labor market to model the transition of workers between sectors, and endogenous adaptation of technology related to energy use. The sector structure of the model is calibrated using the Chilean 2015 industry by industry input-output matrix from the OECD statistics database. In the model, the following sectors and products can be distinguished: Agriculture and Forestry; Mining of Coal; Mining of Crude Oil; Mining of Gas; Mining of Copper and Other; Manufacturing Industry, Manufacturing of Refined Petroleum Products; Fossil Fuel Electricity; Renewable Electricity; Distribution of Gas; Construction; Transport; Market Services; Public Services. The technical details such as exact equations, calibration and solution methods of the MEMO model can be found in the research report by Antosiewicz and Kowal (2016). The exact specification of the model used in this study slightly differs from the model described in the aforementioned research report, as it was tailored to the needs of the assessment.

3. What actions were/are/will be taken based on the co-benefit assessment and what specific measures taken to maximise the co-benefits if any?

In response to this question, please specify:

- i. How the results of the assessment have informed the policymaking process*
- ii. How the results of the assessment have incentivized further action to maximize the co-benefits*

The study evaluated the macroeconomic impact of implementing a mitigation package aligned with the achievement of the recent updated Chilean NDC and committed zero net CO₂eq emissions by 2050. Since positive economic and financial implications could arise from the implementation of the proposed mitigation package, the unsolicited participation of the private sector could be expected and enhanced. Remaining questions and discussions from the study relate to limitations for the uptake of mitigation measures sooner than long term scenarios.

Lack of enabling conditions and current restrictions to public-private sector engagement could prevent a smooth and spontaneous transition, including the risk of various market and government failures. Future analysis is needed on how to ensure financing of proposed mitigation measures, how to reduce political economy constrains and investment risks, and the evaluation of instruments needed for the implementation of the climate targets and related work plan.