CLIMATE POLICIES FOR A SUCCESSFUL GREEN TRANSITION[1]

A. Introduction

1. Chile has a comprehensive and ambitious climate strategy. Chile has been an early adopter of climate change policies for adaptation and mitigation, tracing back to the Kyoto Protocol of 1994. More recently, Chile has made important climate commitments, such as updating in 2020 its Nationally Determined Contribution (NDC) target to reduce carbon dioxide (CO_2) emissions by up to 45 percent by 2030 from 2016 levels and reach carbon neutrality before 2050. In November 2022, Chile further updated its NDC at the COP27, expanding its ecosystem protection by 2030 and committing to reverting the growing trend of methane emission by 2025.[2] As part of its climate strategy, Chile introduced a US$5 tax per ton of CO_2 in 2014, making it the first Latin American country to introduce green taxes on CO_2 emissions and local pollutants. Chile was also a pioneer in green financing, becoming the first country in the region to issue green bonds in 2019, and in the same year announcing the decommissioning of coal-fired power plants by 2040. Chile continued to enhance its climate strategy by approving the Framework Law on Climate Change in June 2022 and started work on a Green Taxonomy to help private investment in mitigation and adaptation projects.

2. A higher carbon price would be an effective tool to deliver on Chile's climate goals. To reach its 2030 NDC target, Chile will need to increase its carbon capturing or reduce emissions. A higher carbon price, which Chile already has experience with, would help to reduce emissions, green the energy sector, and accrue revenue for the fiscal sector. If the revenue from the higher carbon price is prudently recycled, it can be progressive, benefitting the poorest in society, and positively add to GDP growth in the long term.

3. Now is the time to act, although mitigation risks need to be managed. Acting now and gradually increasing the carbon price over several years would dampen any potential economic costs and transition risks. The increase in the carbon price should be balanced with the current elevated global prices of fuels. As fuel prices fall, Chile can use the opportunity to raise its carbon tax and excise duty on diesel, helping stabilize fuel prices. The economic cost of the rise in the price of nonfuel goods, an indirect effect of increasing the carbon price, which impacts the poorest in society, could be offset through higher spending on health, education, and infrastructure, as well as targeted transfers, financed from the higher carbon price revenue received.

4. Chile should also act now to benefit from the global green transition. The global green transition will likely entail rising demand and prices of lithium and copper and would positively benefit Chile as a leading exporter. Chile also has plans to become the lowest-cost green hydrogen

[1] Prepared By Christopher Evans (RES) and Karlygash Zhunussova (FAD)

[2] In November 2022, Chile also launched the Natural Capital Committee, a body integrated by the Ministry of the Environment, the Ministry of Finance, and the Ministry of the Economy, to advise and provide recommendations for the measurement of natural assets in Chile.

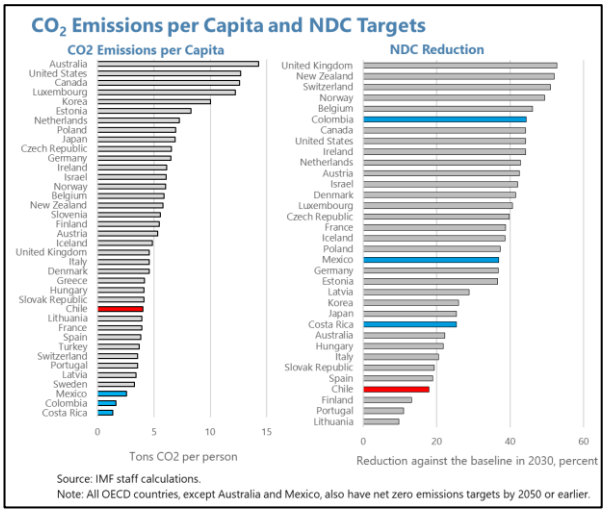
producer by 2030 and one of the largest exporters by 2040, which would help to diversify its exports.

5. This paper presents simulations based on the Climate Policy Assessment Tool (CPAT) developed by the IMF and the World Bank. CPAT is a spreadsheet model that projects, on a country-by-country basis for 175 countries, fossil fuel CO_2 emissions, as well as the emissions, fiscal, economic, energy price, public health and distributional implications of carbon pricing and other commonly used mitigation instruments (Black et al., 2021). This work focuses solely on the impact of carbon pricing on emissions and the macroeconomy. Alternative carbon mitigation tools, which could form the basis of a broader climate strategy, are outside the scope of this analysis.

6. The rest of the paper is organized as follows. Section 2 outlines Chile's current mitigation and adaptation landscape, comparing Chile's emissions to OECD countries. Section 3 details Chile's climate strategy. Section 4 analyses the economic benefits of increasing the carbon price. Section 5 explores Chile's opportunities from the global green transition and then Section 6 concludes.

B. Where Does Chile Stand

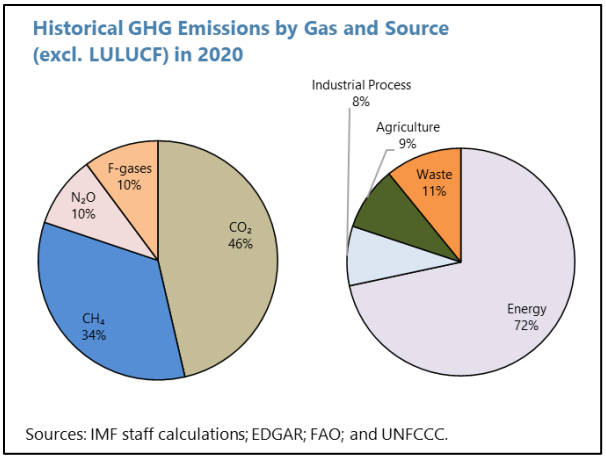
7. Chile is a relatively low emitter among OECD countries but has less ambitious NDC emission targets. GHG emission per capita is low for Chile. However, the country is still the largest Latin America emitter in the OECD. Chile has relatively low ambitious NDC targets by OECD standards, with targets below that of other countries in the region (Colombia and Mexico) despite its higher emissions.



CO_2 Emissions per Capita and NDC Targets

Source: IMF staff calculations.
Note: All OECD countries, except Australia and Mexico, also have net zero emissions targets by 2050 or earlier.

8. Chile's energy sector accounts for three-quarters of total emissions. Electricity generation and transport account for the two largest shares. Coal and diesel are the two fuels emitting the most (coal for electricity generation in power plants and diesel for transport). However, there are signs that electricity generation is becoming cleaner. In June 2021, EIG Global Energy Partners inaugurated *Cerro Dominador*, the first concentrated solar plant in Latin America, as part of Chile's national renewable energy program (NCRE). Another solar project (PV Almagro Sur) in Atacama,

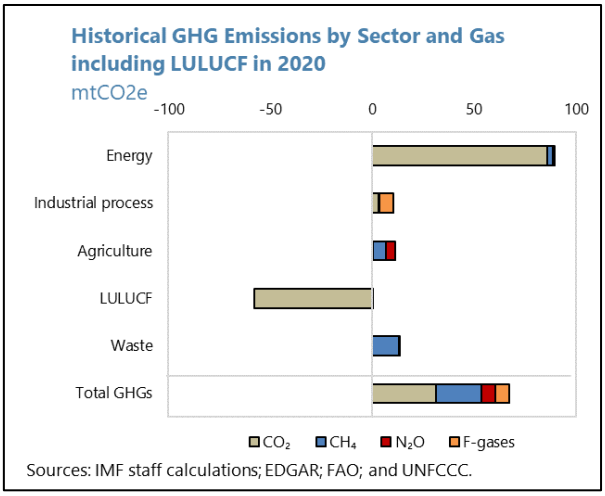


Historical GHG Emissions by Gas and Source (excl. LULUCF) in 2020

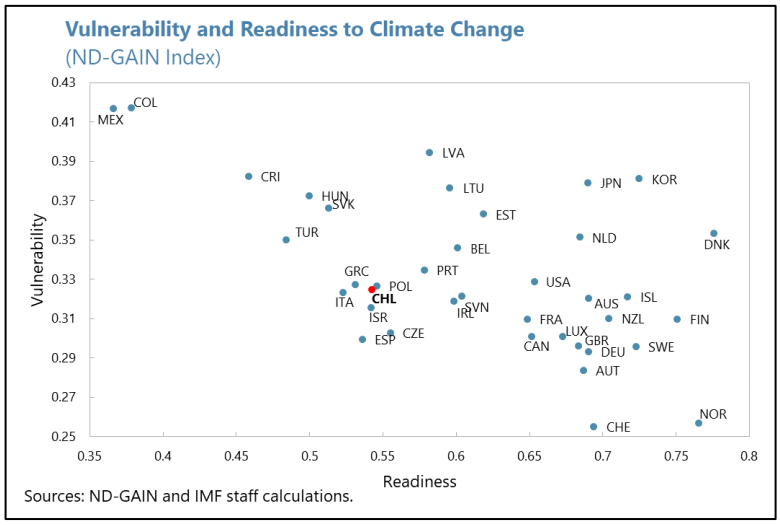
Sources: IMF staff calculations; EDGAR; FAO; and UNFCCC.

northern Chile, and a wind farm (Parque Eólico Caman) in Valdivia, southern Chile, are under construction. Moreover, Chile plans to phase-out electricity generation from coal by 2040.[3]

9. Land use, land-use change, and forestry (LULUCF) act as an essential carbon sink, dampening total emissions. Over the last 20 years, Chile's LULUCF absorbed, on average, around two-thirds of total emissions. According to Chile's National Greenhouse Gas Inventory, LULUCF is the only sector currently acting as a carbon sink (Ministry of the Environment, 2020), with LULUCF carbon capture primarily made up of native forests (Lara et al., 2019). Chile's industrial plantations, in contrast, act as a net carbon source due to the clear-cut harvesting that occurs for the production of short-lived goods, the burning of firewood, and occurrence of wildfires (Johnston and Radeloff, 2019, and Ministry of the Environment, 2020). In 2017, when the forest lands, crop lands, and grasslands were devastated by wildfires, the sector temporarily changed from a carbon sink to a net GHG emission source. Due to the uncertain nature of the long-term carbon capture capacity of native forests and risk of forest fires, Chile must diversify its carbon sequestration capacity without compromising the ecological functionality of biodiverse ecosystems (Hoyos-Santillan et al., 2021).



10. Among OECD countries, Chile ranks within the bottom third on readiness to climate change. According to the ND-GAIN index, which measures vulnerability (the exposure to climate change) and readiness (the ability to leverage investments and convert them into adaptation actions), Chile ranks within the bottom third for readiness. Although Chile is less vulnerable to climate change and more prepared than others in the region, it ranks below the OECD on average. Chile's exposure to more frequent and severe climate change events stems from its susceptibility to droughts, wildfires, floods, and sea level rise. Chile has previously suffered long-term droughts and is currently suffering a water crisis due to a drought that started in 2010.



[3] https://energia.gob.cl/sites/default/files/folleto_estrategia_desc_eng_30102020.pdf

C. Chile's Climate Strategy

11. Chile has been an early adopter of climate change policies for adaptation and mitigation. The institutional structure for climate change in Chile can be traced back to the ratification of the United Nations' Framework Convention on Climate Change in 1994, when Chile subscribed to the Kyoto Protocol. Shortly afterwards, in 1996, a Supreme Decree established The National Advisory Committee on the Global Climate, tasked with coordinating local efforts and foreign policy on climate change. In 2006, Chile began transforming the country's multisectoral model (in which environmental matters were coordinated by the National Environmental Commission (CONAMA)) into a centralized model under the Ministry of the Environment established in 2010. During this period, CONAMA introduced the National Climate Change action plan for 2008-2012 to fulfill Chile's National Climate Change Strategy. The strategy included three main focal areas: adaptation, mitigation, and the creation and promotion of national capacities. A new National Climate Change Action Plan 2017-2022 was introduced to tackle the goals set out in Chile's National Strategy of Climate Change and Vegetation Resources 2017-2022. Chile is also a member of The Coalition of Finance Ministers for Climate Action—a group of over 75 countries aimed at leading the global climate response.

12. The country has committed itself to carbon neutrality by 2050 and to shut down all coal-fired power plants at the latest by 2040. The Government of Chile, in its updated NDC of 2020 submitted under the Paris Agreement, pledged to achieve carbon neutral by 2050.[4] The target is aligned with the international efforts required to halt the global average temperature increase of between 1.5ºC and 2ºC (IPCCC, 2022). As part of this pledge, the government committed in 2019 to close all of Chile's coal-fired power plants by 2040, and more recently in July 2021, announced that 65 percent of all coal-fired power plants will be retired by 2025. The updated NDC of 2020 also sets an emission reduction target maintaining GHG emissions below 95 $MtCO_2e$ by 2030, defining 2025 as the deadline for peak emissions, and maintaining the GHG emissions budget below 1,100 $MtCO_2e$ for the period 2020-30. The updated NDC also incorporates components on oceans, forests, peat bogs and ecosystems, as well as a social pillar on a *just transition* and sustainable development goals, which consider criteria such as gender equity and equality, water safety, and nature-based solutions. In November 2022, Chile presented a further update to their NDC at the COP27, further committing to expand the current area of official protection of terrestrial and aquatic ecosystems by 2030 and revert the growing trend of methane emissions by 2025.

13. Chile continues to enhance its climate strategy, publishing the Framework Law on Climate Change in June 2022. The Climate Change Framework Law (Law 21.455) outlines Chile's climate change goals set out in its updated NDC of 2020, Long-Term Climate Strategy, Climate Change Financial Strategy, and the national, regional, and local climate policies to achieve them. This law partly reverses the centralized approach taken by the Ministry of Environment to assign climate change action to all governmental entities, creating a multi-sector response once again to the climate crisis. Moreover, the law defines a system that could establish GHG emission limits for

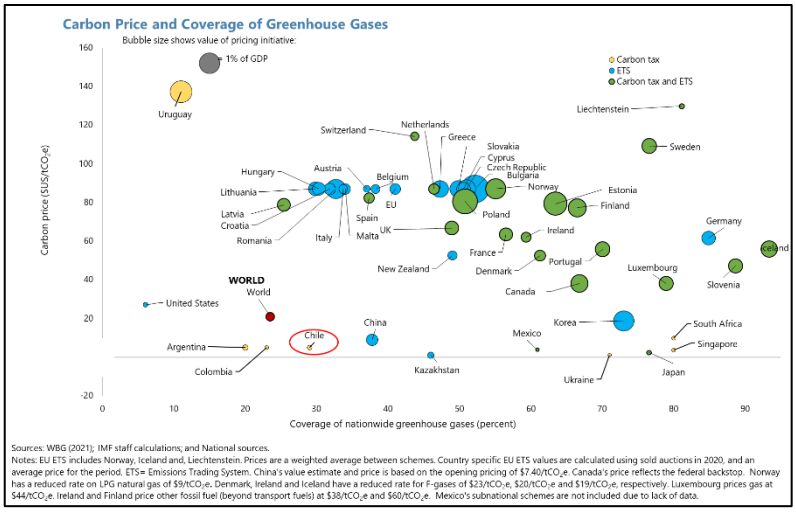
[4] Chile presented its updated NDC to the UNFCC in April 2020.

regulated entities, laying the foundation for the potential introduction of an emission trading scheme. Additionally, Chile has started work on a Green Taxonomy to further foster private investment in mitigation and adaptation projects.

14. Chile's climate strategy has been bolstered by its successful green financial issuances. Chile is a leader in the region issuing green and ESG bonds under its Green Bond Framework of 2019 and subsequently the Sustainable Bond Framework (2020) and SLB Framework (2022). Chile became the first country in the Americas to issue a green bond in 2019, issuing €861 million and US$1.4 billion to finance projects dedicated to infrastructure for electrified public transport (trains, buses); solar projects; energy efficiency; renewable energy; water management and green buildings. Chile has continued to successfully issue ESG bonds, which form around 30 percent of its stock. In 2022 Chile became the first country to issue a Sustainability Linked Bond (SLB), of US$2 billion, that matures in 2042. The funds raised from the SLB are tied to sustainability performance targets, such as achieving annual GHG emissions of 95 $MtCO_2e$ by 2030, one of Chile's NDC goals. Additional sustainability performance targets include the goal to achieve a maximum GHG budget of 1,100 $MtCO_2e$ between 2020 and 2030 and achieve 60 percent electricity generation derived from non-conventional renewable sources by 2032.

D. The Economic Benefits of a Gradual Increase in the Carbon Price

15. Chile is one of the few LAC countries that implemented a carbon tax, but the tax rate has remained low.[5] In 2014, Chile introduced a tax reform (Law 20.780) on carbon dioxide that implemented a US$5 carbon tax starting in 2017 that has remained at this level since then.[6] The tax levies atmospheric emissions of local pollutants (PM, NOX and SO_2) and the main global pollutant (CO_2) from all those establishments that own boilers and/or turbines that together add up to a thermal power greater than or equal to 50 MWt (thermal megawatts). Each global source pays US$5 per ton of CO_2 emitted, except for those whose primary source of energy is biomass. The tax has lower coverage (30 percent) and price than the majority of the equivalent policies in OECD countries. However, Chile's tax is on par with other countries in the region (Argentina and Colombia) that have introduced a carbon tax and is close to the world average (Parry et al., 2022).



[5] See Box 1 for a detailed description of Chile's green taxes.

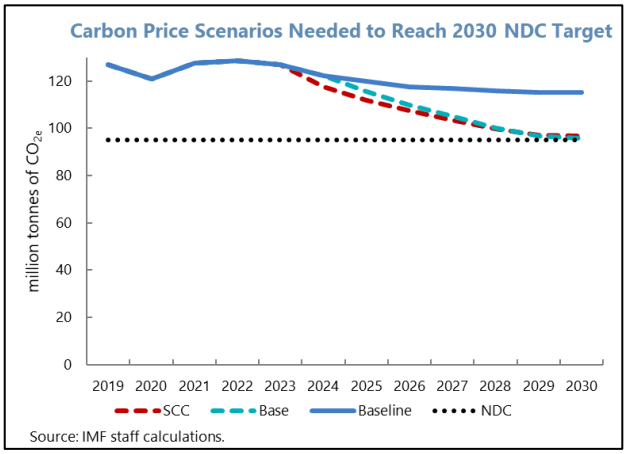
[6] At the same time, Chile introduced a green tax on the sales of new light-duty vehicles based on fuel efficiency and nitrogen oxides (NOx) emissions. See Box 1 for more details.

16. There is scope to graduallly increase the carbon tax, expanding the coverage and raising the price, yet transition risks need to be managed. A gradual rise in the carbon price should be balanced with the current higher-than-usual energy prices. To limit upward pressure on prices, an increase in carbon taxes should be measured. It is critical to act now by gradually increasing the carbon price and balancing this with the subsiding of geopolitical tensions that are currently putting upward pressure on oil and gas prices. Further, revenue generated from a higher tax could be recycled to dampen the short term costs and serve as a tool for income redistribution to low-income households.

Impact of Higher Carbon Price on Emissions

17. This section relies on CPAT to assess the impact of an increase in the carbon tax, combined with other policies, on emissions and the economy. CPAT is a spreadsheet model developed jointly by IMF and World Bank staff that projects, on a country-by-country basis for 175 countries, fossil fuel CO_2 emissions, as well as the emissions, fiscal, economic, energy price, public health and distributional implications of carbon pricing and other commonly used mitigation instruments (Black et al., 2021). The tool uses countries' economic data, combined with the use of fossil fuel and other fuels by the power, industrial, transport, and household sectors. Baseline or Business-As-Usual emissions are then projected using GDP forecasts, assumptions about the income elasticity of demand for electricity and other fuel products, the rate of technical progress, and future energy prices. The impact of a higher carbon tax and other mitigation policies on fuel use and emissions are determined by their effect on future energy prices, induced switching of fuels within the power generation sector, and various price elasticities for electricity and fuel use in other sectors.

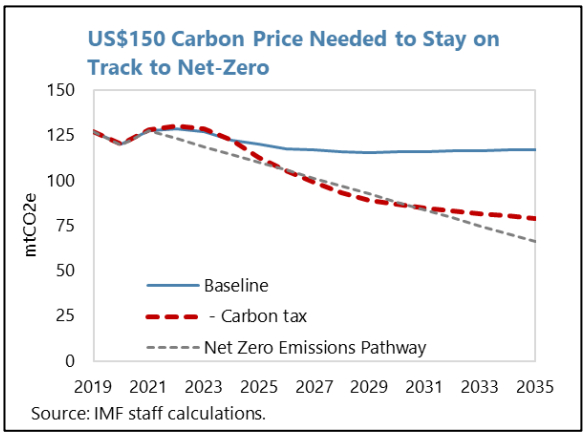
18. A gradual increase of the carbon price should be part of Chile's climate strategy. An increase in the carbon price is the most effective way to meet Chile's NDC emission reduction goal and put Chile on track to reach net-zero emissions by 2050. For instance, a gradual increase in the carbon tax from US$15 starting in 2024 to US$60 by 2030, while at the same time increasing the excise on diesel, will help Chile reach its NDC target (Base Scenario).[7] Alternatively, the 2030 NDC target could also be reached by an increase in the carbon tax alone under the Social Cost of

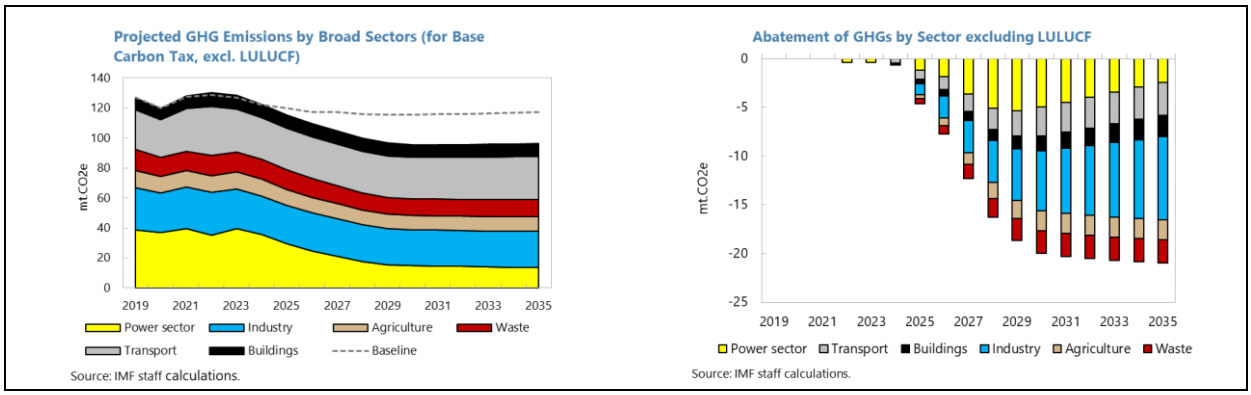


[7] The Base Scenario sets the carbon tax at US$15 per ton of CO_2 in 2024, increasing linearly to US$60 per ton of CO_2 in 2030. The carbon tax excludes gasoline and diesel, but the excise on diesel is increased to bring the effective carbon rate equal to that of gasoline (starting from US$0.05/liter in 2024 and increasing linearly to US$0.37/liter in 2030).

Carbon (SCC)[8] scenario, which requires a higher initial carbon price of US$35 in 2024, gradually increasing to US$75 by 2030.

19. Chile will need to raise its carbon tax to US$150 and broaden its scope to stay on track to net-zero by 2050. The carbon price will need to reach US$150 by 2030 if Chile is to stay on track to reach net-zero by 2050. Chile will also need to broaden the scope of the tax to all sectors and fuel types. To keep on this emission reduction path solely through the use of a carbon tax, Chile will need to continue to raise the price of carbon beyond 2030. Alternative emission reduction schemes and carbon capture, which are outside the scope of this analysis, could also be used to reach Chile's NDC and net-zero goals.[9]





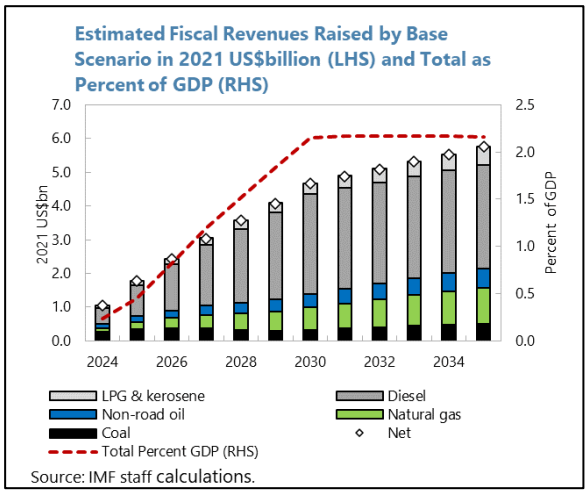
20. Increasing the carbon price and expanding coverage is expected to induce a fall in emissions across a broad range of sectors. If the carbon price is expanded and increased following the Base Scenario (a rise in the carbon tax to US$60 by 2030 and an increase in the excise on diesel) would foster a fall in emissions across the economy. The power sector, which previously was the most pollutant, would become one of the greenest sectors as renewables become the primary source of energy generation. Falling emissions in the transport and industry sectors would also be expected.

[8] The SCC scenario sets the economy-wide carbon tax at US$35 per ton of CO_2 in 2024 and increasing linearly to US$75 per ton of CO_2 in 2030.

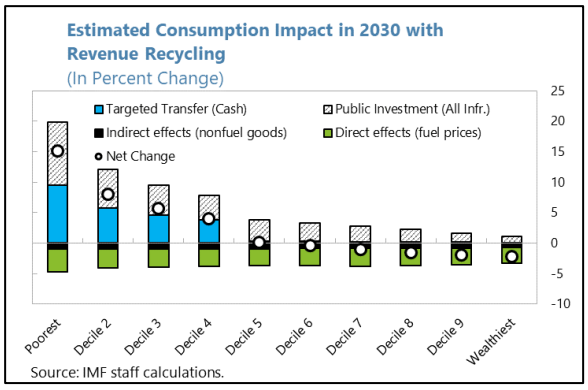
[9] Proposed carbon pricing scenarios would need to be re-calibrated if used in conjunction with other emission mitigation policies to determine the required carbon price needed to reach Chile's NDC and net-zero goals.

Revenue Mobilization and Recycling

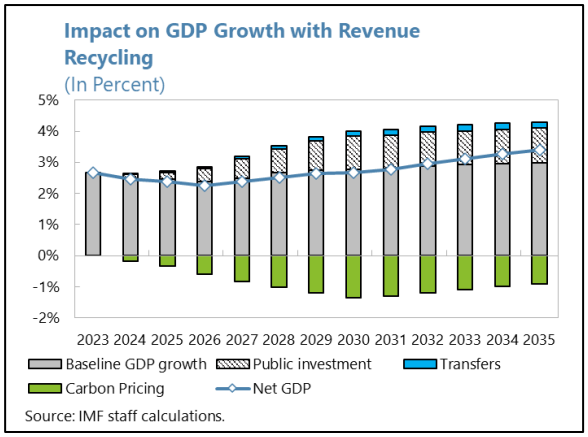
21. Carbon pricing can also be a significant source of revenue, which could amount to US$5 billion or 2 percent of GDP in revenue by 2030 in the Base Scenario. If the carbon tax is gradually increased to US$60, combined with an increase in the excise on diesel by 2030, it could be a significant source of revenue. The higher price on emissions would impact highly pollutant fuels, such as coal, lowering their usage and bringing in revenue. The largest source of revenue from the carbon tax and excise duty is expected through diesel, which is used to fuel most cars in the country. The second largest source of revenue is expected from natural gas.



22. Carbon pricing can be progressive, if revenue is recycled well, benefiting the bottom half of the income distribution. A higher carbon price typically impacts more the richer in society through higher fuel prices (direct effect of a carbon tax and excise duty). However, the poorer in society are also negatively impacted, as they suffer a rise in the price of nonfuel goods (indirect effect). On its own, a higher carbon price would lead to lower consumption across all income deciles. However, if the revenue is recycled into public investment and targeted transfers, it can become progressive and benefit the poorest. For example, if part of the revenue from the higher carbon price were rebated to the poorest half of society, then the policy would entail a net gain for them.



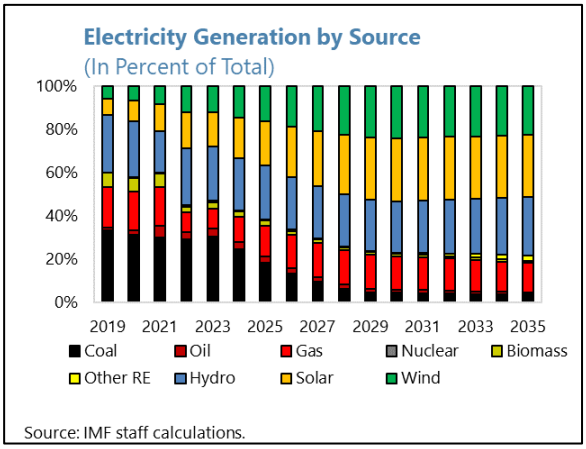
23. The revenue from a higher carbon price can be recycled to also soften the impact on GDP growth in the short term and boost potential growth for the future. The revenue from implementing a carbon tax and higher excise duty on diesel can be reused to improve growth prospects in the future. For instance, recycling the revenue to public investment projects, such as improvements in public transport and infrastructure investment, will help boost growth. If the revenue is prudently recycled, it can dampen



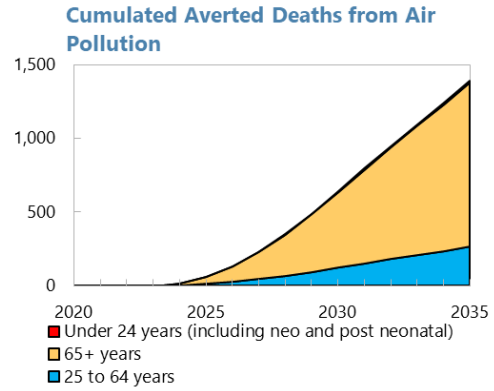
the negative impact on growth in the short term and help to increase growth after the economy has transitioned to a higher carbon price in the long term.

Broader Benefits of a Higher Carbon Price

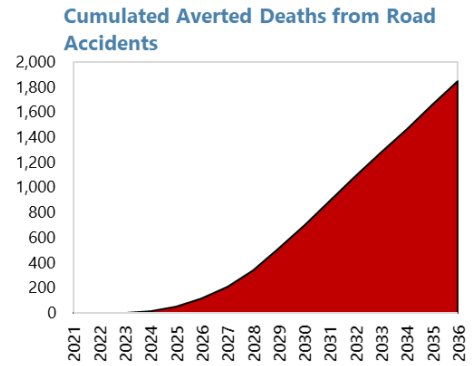
24. A higher carbon price will change Chile's energy matrix, encouraging greater use of renewables. Electricity generation from highly pollutant fuels (coal) is expected to fall, as the user cost of coal rises relatively more than less pollutant sources. The higher carbon price would help reduce the use of coal, and therefore is well aligned with the government's policy to close half of its coal-fired power plants by 2025 and remove all coal power plants by 2040. The share of electricity generation from renewable energy such as wind, solar, and hydro are expected to increase, as they are less affected by the carbon price and become relatively cheaper as the carbon price rises. If a higher carbon price is introduced, staff simulations show that by 2030 around three quarters of electricty generation in Chile will come from renewables.



Source: IMF staff calculations.



Source: IMF staff calculations.



Source: IMF staff calculations.

25. Improvements in air quality due to falling emissions are also expected to reduce mortality from air pollution. Alongside its economic benefits, a higher carbon price is expected to improve air quality and therefore reduce mortality due to air pollution. In the Base Scenario, more than 1000 deaths due to air pollution are expected to be avoided. A higher carbon price will also increase the price of conventional car use and incentivize public transport use, helping to reduce road accidents.

E. Opportunities from the Global Green Transition

26. Owing to an abundance of lithium and copper, Chile is well positioned to benefit from the global green transition. Under a net-zero global emissions scenario, the global price of lithium is expected to rise several hundred percent from 2020 levels, which combined with higher demand for copper, could increase Chile's export revenues from lithium by a factor of 50 and double copper export revenue (Boer et al., 2021).

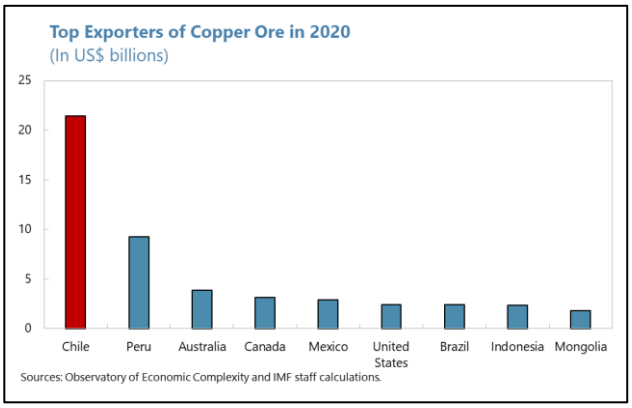
- Chile was 2nd in the world in lithium mining in 2021 and has large reserves. Although lithium markets vary by location, batteries are the main use (74 percent) globally and ceramics and glass the second most common use (14 percent). Lithium consumption for batteries has increased significantly in recent years because rechargeable lithium batteries are used extensively in the growing market for portable electronic devices, and increasingly used in electric tools, electric vehicles, and grid storage applications.

Lithium Production and Reserves in 2021
(Tons)

	Mine Production	Reserves
Australia	55,000	5,700,000
Chile	**26,000**	**9,200,000**
China	14,000	1,500,000
Argentina	6,200	2,200,000
Brazil	1,500	95,000
Zimbabwe	1,200	220,000
Portugal	900	60,000

Sources: U.S. Geological Survey and IMF staff calculations.

- Chile is the world's top copper exporter, which is a key metal for the green transition. Copper is used in many types of green energy (electric vehicles, wind farms, solar, and energy storage). It is estimated that in a net-zero global scenario, copper prices would increase more than 60 percent by 2040 from 2020 levels (Boer et al., 2021). The rise in price and demand for copper would provide significant windfalls to Chile.



27. Chile aims to become a leader in green hydrogen. In November 2020, Chile outlined is plan in the National Strategy for Green Hydrogen to become one of the lowest-cost green hydrogen producers by 2030 and one of the largest exporters by 2040. The Strategy highlights the need to activate the domestic industry, build infrastructure and supply chains, and then scale production and achieve stronger integration in international markets. To this end, in 2021, Chile's state development office (CORFO) pledged US$50 million in grants to six green hydrogen projects, with an additional three agreements signed in 2022. The hope is that Chile's exports of green hydrogen could rival its copper exports; however, the success of low-cost production will hinge on the expansion of its renewable energy sector.

F. Conclusion

28. A gradual increase in the carbon price would help Chile lower emissions, achieve its climate goals, and boost inclusive growth in the long term. Staff simulations based on CPAT suggest that a gradual increase in the carbon tax to at least US$60 by 2030, coupled with a higher excise for diesel, would be needed to reach NDC goals. The 2030 NDC target could also be reached by an increase in the carbon tax alone to US$75 by 2030, while a carbon tax of US$150 would allow Chile to stay on track to net-zero. These estimates would need to be re-calibrated if combined with complementary measures to curb CO_2 emissions. If the revenue from the higher carbon price is used prudently for productive infrastructure projects, health and education spending, and targeted transfers, it can be a progressive tax that benefits vulnerable households, while boosting growth in the future. Now is the time to act, so that the increase in the carbon price can be gradual and transition costs be minimized.

29. A higher carbon price will help green energy production, which will be vital for the National Strategy for Green Hydrogen. Chile aspires to become one of the lowest-cost green hydrogen producers by 2030 and one of the largest exporters by 2040. An increase in the carbon price, which increases the cost of pollutant fuels and helps to incentivize renewable energy production, could be a crucial component of this goal. Staff estimates that a US$60 carbon price, a higher excise on diesel, and the planned reduction of coal in electricity usage by over half by 2025, could result in around three quarters of electricity generation in Chile stemming from renewables by 2030. The greening of the energy sector is a vital component of Chile's National Strategy for Green Hydrogen so that it can become the lowest-cost green hydrogen producer and expand its green hydrogen exports. Further, through sizable lithium reserves, and already prominent copper exports, Chile has the opportunity to benefit from a global green transition. An institutional framework for lithium needs to be developed to accelerate growth in the sector to seize the current, and expected, rising global demand and price of lithium.

Box 1. Green Taxes

In 2014, Chile introduced a tax reform bill that included 3 green taxes, which were implemented in 2017. As of 1 January 2017, green (or Pigouvian) taxes came into force in the country. The main objectives are to support and complement efforts to reduce local air pollution and mitigate greenhouse gas emissions. The first tax was on CO_2 emissions from stationary sources with boilers and turbines (sum over 50MW). The second tax was on local contaminants also on stationary sources with boilers and turbines (PM, SO_2 and NO_x), and the third was a tax on the first sale of new cars taking into account the expected NO_x emissions over their lifetime.

The tax on the local pollutant is higher for regions with a larger social cost of pollution. While the tax on the global pollutant is fixed at US$5 per ton of CO_2, the local pollutant tax (T_{ij}) of pollutant i in municipality j is dependent of the air quality (CCA_j) and population (Pob_j) in the municipality and the social cost of the pollutant ($CSCpc_i$). A shown in the equation below, the tax on the local pollutant is calculated in terms of its marginal costs, such that the tax is higher for particulate matter pollution, which is linked to cardiovascular and respiratory diseases. The local pollutant tax also increases with the population of the municipality (Pob_j) as the social cost of emissions is higher.

$$T_{ij} = 0.1 * CCA_j * CSCpc_i * Pob_j$$

The tax has brought in around US$200 million each year from 2017-2020. The majority of this is from CO_2 emitted from the energy sector. From the first year of operation, a total of 94 affected establishments, including 303 sources (boilers and turbines), reported their emissions and the tax raised US$191 million. The CO_2 tax accounted for the largest share of the total (88%), while the local pollutant taxes accounted for the remaining 12% (PM (8%); NO_x (3%); and SO_2 (1%).The carbon tax has continued to bring in close to US$200 million each year.

The tax reform law of 2020 updated the scope of the green tax and allows offsets starting in 2023. With the approval of the tax reform law, Law N° 21.210, in early 2020, modifications were made to the green tax that aim to further generate incentives to reduce emissions. From 2023, the number of estabilishments that are subject to the tax are expected to increase, as the threshold for taxation changes to sources that are emitting 25,000 tons of CO_2/year or 100 tons of PM/year, regardless of size or characterisitcs of the technology. Further, the reform introduced the ability to implement projects that reduce pollutants to offset emissions against the green tax.

References

Black, S., Parry I., Roaf, J., and Zhunussova, K., 2021. "Not Yet on Track to Net Zero: The Urgent Need for Greater Ambition and Policy Action to Achieve Paris Temperature Goals." IMF Staff Climate Note 2021/005, International Monetary Fund, Washington, DC.

Boer, L., Pescatori, M.A. and Stuermer, M., 2021. "Energy Transition Metals." International Monetary Fund Working Paper No. 2021/243.

Hoyos-Santillan, J., Miranda, A., Lara, A., Sepulveda-Jauregui, A., Zamorano-Elgueta, C., Gómez-González, S., Vásquez-Lavín, F., Garreaud, R.D., and Rojas, M., 2021. "Diversifying Chile's climate action away from industrial plantations." Environmental Science & Policy, 124, pp.85-89.

Intergovernmental Panel on Climate Change (IPCC), 2022. *Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, and others. Geneva.

Johnston, C.M.T., and Radeloff, V.C., 2019. *Global mitigation potential of carbon stored in harvested wood products*. Proc. Natl. Acad. Sci. 116, 14526–14531.

Lara, A., Urrutia-Jalabert, R., Reyes, R., Gonzalez, M., Miranda, A., Altamirano, A., and Zamorano-Elgueta, C., 2019. *Bosques Nativos.*

Ministry of the Environment, 2020. *Chile's Fourth Biennial Update Report on Climate Change*. Santiago, Chile.

Parry, I.W., Black, S. and Zhunussova, K., 2022. "Carbon Taxes or Emissions Trading Systems?: Instrument Choice and Design." IMF Staff Climate Note, 2022/006, International Monetary Fund, Washington, DC.

U.S. Geological Survey, 2022. *Mineral Commodity Summaries, Lithium*. January.