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Peru achieved remarkable economic growth and poverty reduction over the two decades before the COVID-19 pandemic, but structural impediments to development persist and could slow down climate action. With a per capita gross domestic product (GDP) of $6,692 in 2021 (dropping from a historical high of $7,023 in 2019 after the COVID-19 pandemic),¹ Peru’s economy is one of the largest in Latin America and the Caribbean and was one of its fastest-growing in the pre-pandemic era. Its comparative advantage in commodities, coupled with solid macroeconomic management and well-targeted programs fostered inclusive economic growth, and poverty fell from 59 percent in 2004 to 20 percent in 2019. Although inequality fell substantially, persistently large spatial disparities and low productivity remain as structural impediments to growth and poverty reduction (SCD 2017). Between 2020 and 2021 during the COVID-19 crisis, accumulated growth was less than one percent, and the momentum to pursue important reforms for the country stalled. Despite a rebound of gross domestic product (GDP) in 2021 to pre-pandemic level, the poverty rate remains above pre-pandemic levels, at 25.9 percent, and labor market recovery has been uneven. Continued political uncertainty and the low effectiveness of the state have harmed the performance of the Peruvian economy, factors that are also barriers to climate action.

Peru’s reliance on freshwater from glaciers and on agriculture and fisheries makes it particularly vulnerable to climate change. Peru is more exposed and vulnerable to natural hazards than most of its structural peers.² The country already suffers earthquakes, landslides, droughts, and floods, which together cause average annual asset losses of 2 percent of GDP and welfare losses equivalent to 5.2 percent of GDP.³ It is the world’s third largest fish producer (the largest exporter of anchovy fishmeal),⁴ and has become a leading exporter of fruits and vegetables, and these sectors are particularly vulnerable to climate change impacts.⁵ Since 1970, Peru has lost about 43 percent of its surface glacial area. This is a major concern, given that one-third of its population lives in the Lima metropolitan area, which relies heavily on water from glacial melt.

Land use change and forestry (LULUCF) are responsible for most of Peru’s greenhouse gases (GHG) emissions, while the electricity sector is a low emitter thanks to hydropower. In 2016, emissions were distributed between LULUCF (53 percent); energy—including transport (28 percent); agriculture and livestock (13 percent); waste (3 percent); and industrial processes (3 percent).⁶ Between 2001 and 2019, Peru lost more than 4 million hectares of tree cover, representing 4 percent

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¹ World Bank and Organisation for Economic Co-operation and Development (OECD) national accounts data.
² Selected economies include some that share a similar level of hazard exposure and/or are structural peers (Ecuador, Colombia, South Africa), aspirational peers (Chile, Malaysia, Romania) and other typical comparators, such as Latin American, Caribbean, or upper-middle income countries (UMICs).
⁴ Fish products account for 25–30% of total exports.
⁵ Agricultural exports increased in value from $758 million in 2000 to more than $5.78 billion in 2016, growing at an average annual rate of 12.5%. During the same period, exports of nontraditional products—including grapes, asparagus, avocado, and other fruits—grew at an even faster rate. Coffee remains the most economically important agricultural export, increasing in real terms from $223 million in 2000 to $756 million in 2016, despite its share in total agricultural exports dropping from 28.5 to 13% over the same period (World Bank 2017).
⁶ The distribution of emissions by sector and total changes when considering global inventories. According to CAIT Climate Data Explorer, Peru accounts for 0.39% of global emissions (including LULUCF) and the main sources of emissions are LULUCF (48 percent), energy (29 percent), and agriculture (11 percent).
of its forest cover, mostly driven by agriculture. The growth in GHG emissions from energy is mostly driven by transport, since electricity is relatively clean. In 2021, hydropower generation accounted for 56.7 percent of total electricity generated, followed by natural gas, with 37.6 percent and 5.5 percent of other renewable energy sources.

This Country Climate and Development Report (CCDR) explores opportunities and trade-offs for aligning Peru’s development path with its recent commitments on climate change. First, we look at how the country’s structural, social, and economic impediments—high spatial inequality, informality, social exclusion, large infrastructure access gap, and low diversification and productivity—increase its vulnerability to climate change, and how addressing these key challenges can facilitate climate change adaptation and mitigation. Then, we consider how Peru can benefit from decarbonization policies, thanks to its mining, forestry and agriculture, and renewable energy resources. Finally, we explore how its government can prioritize and finance investments for climate change adaptation and mitigation and encourage the private sector to take action.

Efficient climate change adaptation requires addressing Peru’s key structural challenges

Climate risk and natural hazards threaten Peru’s development path. Water supply from glacier melts is likely to reduce significantly as early as 2030, and the increased frequency of droughts, floods, frost, and cold waves will heavily impact the agriculture sector—especially in rain-fed systems, which represent 64 percent of Peru’s cultivated land (World Bank 2017). This could lead to losses equivalent to 1.4–3.1 percent of sectoral GDP for 2010–40 and 3.8–14.2 percent of sectoral GDP for 2010–70 (ECLAC 2014). In the fishing sector, the impact of climate change is concentrated in a decline in anchovies, which will affect the production of fishmeal, one of the economy’s most important commodities. Although there is high uncertainty about the macroeconomic consequences of climate change, modeling estimates of partial impacts of climate change on GDP—through more intense and frequent flood events, heat impact on general productivity, and reduced average yields in agriculture and fisheries7—show that Peru could face cumulative losses close to $15 billion8 by 2050.

Poor and vulnerable populations are already more affected by natural hazards than richer ones; and without adaptation, climate change will slow poverty reduction. Poor people are more exposed to higher temperatures and fluvial floods in urban areas. Low access to safe water, sanitation, other basic services, and financial services, alongside a high degree of informality, increase the vulnerability of the poor to climate change impacts. A global World Bank study finds that by 2030, the income of the poorest 40 percent could be reduced by 5 percent, with another 0.6 percent pushed into extreme poverty (World Bank 2020). These impacts will mostly be channeled through the health sector, with increased prevalence of vector- and water-borne diseases and heat stress. In addition, without adaptation, yield decreases could lead to a loss in agriculture earnings, an increase in food prices, or both. New analysis for this report finds that the worst combination of impacts for Peru would

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7 These impacts, taken from CEPAL (2014), only model the impact of average climate change on average yields and therefore miss the potentially bigger impacts of cumulated individual shocks. There is high uncertainty associated with the macroeconomic impacts of climate change.

8 Net present value with a 6 percent discount rate between 2022 and 2050.
be increased food prices for consumers in Lima and the Costa region, which are exposed to global prices, combined with a loss in agriculture earnings for farmers in the Sierra and Selva regions, which are disconnected from global markets. A 2–5 percent food price increase, alongside a 2–5 percent decrease in agricultural earnings in these regions could increase extreme poverty by nearly one percentage point, or more than 300,000 individuals, by 2030.

**Identifying priorities to increase resilience and adaptation capacity forms a central piece in this CCDR.** To identify priorities for adaptation, it builds on the conceptual framework proposed by Hallegatte, Rentschler and Rozenberg (2020), organized around six pillars that reflect universal principles for effective climate change adaptation. Under each pillar lie several actions with indicators that are tailored toward Peru’s priorities for adaptation — agriculture, health, transport, and water, as identified in Peru’s National Climate Change Adaptation Strategy and Action Plan (de Vries Robbé 2022).

**Priority 1: Improving the resilience of infrastructure and public services while closing the infrastructure gap**

Improving access to resilient infrastructure and transport connectivity would decrease people’s vulnerability, reduce infrastructure disruption costs, and accelerate growth in agriculture and forestry. Peru has one of Latin America and the Caribbean’s most unequal distributions of infrastructure. In 2016, its national transportation infrastructure gap exceeded $49 billion (MEF 2019). Poor connectivity largely amplifies the cost of hazard disruptions, with entire communities disconnected from markets when the roads are damaged. More resilient transport infrastructure towards the Selva and Sierra regions, and less connected parts of the Costa region, combined with critical last-mile infrastructure (including irrigation) could help connect small-scale, low-productivity farmers with medium-to-large-scale, highly competitive, vertically integrated firms on the coast and allow for expanding the aquaculture sector (IFC 2022). But such investments in the Selva region must also be planned and blended with other policies in a way that avoids negative impacts on deforestation and biodiversity (Damania et al. 2019).

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Adapting service delivery in the health sector to evolving health needs would increase the country's capacity to respond to sudden surges in demand for care. Peru's health system is overwhelmed and outdated as the burden of disease has transitioned to chronic and non-communicable diseases while infectious and maternal-infant conditions remain prevalent. Climate change will further increase the burden of disease and direct damage to infrastructure will affect service delivery. Although Peru has a health sector emergency response plan and a national health adaptation plan, these are outdated and do not cover all relevant hazards. Priorities include improving health risk communication, increasing the share of doctors and nurses to the World Health Organization (WHO)-advised ratio, and improving the spatial distribution of health services that are concentrated in Lima and along the coast.

Priority 2: Facilitating the adaptation of people and firms
If expanded and improved to better respond to shocks, Peru's progressive social protection could be leveraged for adaptation. Peru's social protection programs have advanced delivery systems and solid financing arrangements. Making them adaptive would require several steps: increasing coverage in urban areas where it is limited; institutionalizing flexibility arrangements to quickly expand when needed; improving the interoperability of data and information between social protection and DRM systems—through the National Household Registry, Registro Nacional de Hogares (RNH) and the national DRM system, Sistema Nacional de Gestión del Riesgo de Desastres (SINEGERD) databases—and increasing the coverage and capillarity of digital payments.

Better job opportunities would facilitate adaptation for the poor and most vulnerable. Labor informality is a key determinant of poverty and vulnerability to shocks. In 2019, 73 percent of employed people had an informal job. Poverty rates among informal workers are more than four times higher than for their formal counterparts, and with no government support, their vulnerability to shocks is higher. Informality plays a key role in deforestation and fish stock depletion, further increasing vulnerability to climate shocks. According to Loayza and Wada (2010), 75 percent of the gap in labor informality levels between Peru and Chile is due to factors linked to poor governance, and the other 25 percent to low productivity. To reduce informality, government could reforms labor and tax regulations that hamper formalization—for example, by promoting greater flexibility for job separation, facilitating temporary hiring, such as seasonal agricultural workers, and unifying the tax regime for small and medium-sized enterprises (SMEs), facilitating their transition to the general regime.

Priority 3: Improving government coordination and capacity
Improving vertical coordination and building capacity across all government levels are priorities for increasing resilience. Although Peru has assigned institutional responsibilities for DRM and climate change, weak coordination and enforcement mechanisms, along with significant capacity gaps at regional and local levels, remain major barriers to mainstreaming DRM and climate change policies. Regional governments are responsible for implementing climate change policies, but coordination and steering mechanisms for aligning their efforts with national objectives are limited, and few have the needed implementation capacity. One objective of the recently updated National Disaster Risk
Management Policy (Government of Peru 2021) is to improve the implementation of DRM across the country, which will be one of the main DRM and adaptation challenges over the next years.

**Peru could benefit from aligning structural reforms with decarbonization objectives**

Climate change has been part of Peru’s development agenda since the early 1990s and the country has increased the ambition of its nationally determined contribution (NDC)—for both mitigation and adaptation—over time. Peru was the first Latin American country to ratify the Paris Agreement in July 2016, and its NDC includes an absolute ceiling on GHG emissions at 209 million tonnes of carbon dioxide equivalent (MtCO₂e) (unconditional goal) or 179 MtCO₂e (conditional goal) by 2030. President Castillo has announced the country’s commitment to reach carbon neutrality by 2050 and declared a national climate emergency; but achieving this ambitious target will require enforcing existing regulations and strengthening institutional capacity and coordination.

Peru’s comparative advantage lies with emissions-intensive goods and services, though status quo regulations abroad pose limited risk. Its main export sectors—agriculture and mining—will likely eventually need to decarbonize to compete in global markets. Current bans on products that are not deforestation-free (like the EU ban) would only impact 1 percent of Peru’s exports and affect few products, mainly coffee and cocoa, and could harm farmers. The transition risks posed by the European Union’s Carbon Border Adjustment Mechanism are also low, though if expanded to include metals, it could impact 6 percent of Peru’s exports.

**FIGURE S.1. Emissions in Peru: from 2015 to a net zero scenario**

This CCDR proposes an illustrative net zero scenario for Peru, aligned with development objectives and yielding net benefits for the country. The analyses done for this CCDR, combined with (IDB and MINAM 2021), lay out a strategy to achieve net zero carbon dioxide (CO₂) emissions by 2050, yielding net economic benefits (figure S.1). Decarbonizing the transport sector would yield

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12 The need to support the implementation of international commitments prompted the adoption of the National Strategy on Climate Change, followed by the Framework Law on Climate Change in 2018. The law defined the principles and approaches of the national climate policy and established institutional arrangements for its enforcement.
$165 billion in net benefits and reduce emissions by 76 MtCO₂e compared to the business-as-usual scenario in 2050. Decarbonizing the agriculture, forestry and land use (AFOLU) sector would yield $42 billion in net benefits and turn the sector into a net carbon sink, capturing 38 MtCO₂e in 2050 (compared to emitting 145 MtCO₂e in 2020). Decarbonizing transport and electricity generation would also positively impact competitiveness in the mining sector.

This report identifies a series of land use interventions that could transform the forestry sector into a carbon sink, and near triple its contribution to GDP. Investing $6 billion dollars between 2023 and 2050 in forest landscape interventions could create close to 85,000 jobs a year over the same period, multiply the sector’s contribution to the economy seven fold, and raise its contribution to GDP from 1.9 percent in 2023 to 5.5 percent in 2050 in real terms. By also helping to reduce deforestation from 200,000 hectares in 2020 to about 15,000 hectares in 2050 and increasing reforestation, such an investment could transform the sector from the largest emitter (115 MtCO₂e in 2020) to a carbon sink, capturing 38 MtCO₂e in 2050.

Renewable energy could diversify the electricity mix, improve the performance and resilience of the power system, and create jobs. Although Peru’s electricity mix is dominated by hydropower (58 percent) and natural gas (37 percent), the country also has world-class solar and good wind potential. Its government has committed to achieving 15 percent nonconventional renewable energy generation by 2030 and a recent study finds that Peru’s national interconnected electrical system, the Sistema Eléctrico Interconectado Nacional (SEIN), could incorporate 6,800 megawatts of installed photovoltaic and wind capacity by 2030. This would provide resilience and clean energy during times of water scarcity or if changes in hydrological patterns affect conventional hydroelectric generation. Such investments would also bring foreign direct investment into areas outside of Lima, creating new green jobs and skills. This CCDR proposes a phased increase of renewables, reaching 90 percent of the energy mix in 2050. This pathway includes an increase in energy efficiency (transmission, distribution, buildings) and investments in smart grids and battery storage to facilitate the electrification of important sectors, especially transport. Under this pathway, decarbonizing the energy sector would require an additional $33 billion in capital investment, but yield $38 billion in benefits.

There are opportunities for the mining sector to decarbonize and build trust with local communities. Peru is home to several of the world’s largest mines, and is the second largest producer of copper, silver, and zinc. The global value of metal production is likely to rise more than fourfold between 2021 and 2040, driven by rising demand for low-carbon energy and transport, and rivaling the global value of crude oil production. The copper market could see a deficit of 1.5 million to 9.9 million megatonnes by 2035, depending on the supply scenario (S&P Global Market Intelligence 2022). To take advantage of this opportunity and become a cornerstone of Peru’s green growth, the mining sector can act on:

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13 Additional jobs in forest landscape include wood-based processing subsectors, natural tourism, and agroforestry in deforested land (e.g., coffee and cacao).

14 Technical Assistance for the analysis of the Impact of Increasing the Share of Non-Conventional Renewable Generation in the Peruvian Interconnected Electricity System to 2030. Consultancy performed for MINEM (Ministry of Energy and Mines) in close coordination with COES (Economic Operation Committee of the National Interconnected System) and financed by the World Bank.

• Energy dependency, powering mines with renewable energy and decarbonizing transport. Following the example of Quellaveco mine, mining companies in Peru are reaching agreements to power entire operations with renewable energy. They are also working on reducing emissions from freight transport, their largest source of emissions.

• Water dependency, reducing its water footprint by reusing water.

• Social license to operate, designing new projects to ensure that all communities benefit from the revenues generated, as many large-scale projects remain undeveloped due to community conflicts. A recent analysis finds that departments that receive higher royalties from mining fare the worst on multidimensional exclusion measures (Ballon and Cuesta 2022).

A decarbonization strategy for the transport sector would require multiple transformations and significant coordination of urban, passenger, and freight transport. By 2030, this CCDR proposes six recommendations to increase emissions reductions compared to the government’s plan and lay the ground for a full decarbonization of the transport sector. For the freight sector, it proposes three policies: reducing truck travel distance, improving cargo fuel efficiency, and shifting to cleaner modes of freight transport. The four proposals in the urban context—expanding bus rapid transit operations, promoting nonmotorized transport in six cities, implementing traffic management solutions, and promoting cycle logistics for urban freight and parcel delivery—would develop efficient and reliable urban mobility systems to guarantee sustainable cities, emphasizing their role in providing primary access to job and educational opportunities.

After 2030, reaching net zero emissions in the transport sector will only be possible through aggressive vehicle electrification, public transport investments and by developing new habits. The decarbonization scenario considers a modal shift away from private cars towards public transportation, walking and cycling while also digitizing services and promoting teleworking to reduce passenger demand by 30 percent by 2050. Investing in infrastructure, densifying cities along transport corridors, and improving logistics would further reduce passenger demand by 15 percent and freight demand by 20 percent. An accelerated penetration of electrification in the medium term through competitive prices for low-emissions vehicles—private, public, passenger, and freight transport—would allow Peru to achieve zero emissions by 2050. But this process would require strong coordination between public authorities and private actors due to the estimated $64 billion investment required. It would also require strong coordination of land use planning for better transit-oriented development. These investments—related to modernizing the transport fleet, freight, and passenger transport infrastructure, and electric technologies—would yield $170 billion in direct benefits through reduced operating costs and increased efficiency, and co-benefits of $29 billion in terms of positive health impacts, fewer accidents, and increased productivity.

Cities can contribute to and benefit from decarbonization through land use planning, waste management, and energy-efficient buildings. To be sustainable, cities need to enforce clear land use plans to prevent development in high-risk areas, create incentives to selectively densify areas along transit corridors, and invest in and support mixed-used mass transit systems to reduce private vehicle use and prevent sprawl. Significant gains can be made, in terms of avoided infrastructure investments, by coordinating mass and nonmotorized transport infrastructure to incentivize city densification in low-risk areas (Rozenberg and Fay 2019). The waste sector can also contribute to decarbonization
by reducing the volume of solid waste through separation and recycling and increasing the treatment of wastewater and industrial effluents. Although waste represents less than 2 percent of total emissions, the sector has the highest net benefits per tonne of carbon dioxide equivalent (tCO2e) avoided, arising from waste valorization, water recovery, and health benefits. Scaling up regulations on energy-efficient and resilient buildings can also reduce emissions at low cost. Despite making limited progress in advancing the implementation of energy efficiency measures, there is a large potential to increase energy efficiency in Peru by promoting more resilient and energy-efficient buildings, including social housing. Public policies are already in place to incentivize green practices in construction—for example, the Bono Mivivienda Verde scheme—and there have been some positive local experiences; but there is a need to scale up both certification and financial and nonfinancial incentives to boost green buildings.

**Comprehensive policy action, alongside substantial private and public investment, is needed to enable Peru’s structural transformation to a greener and more resilient economy**

To rise to the climate change challenge, Peru would need to fundamentally transform its economy. Beyond sectoral interventions, it can put in place economywide incentives that increase the cost of inaction and lower the cost of action and thus encourage the private sector to take action. To ensure the resilience of the government budget, deeper public finance reform can be envisaged.

**Increased investment alongside improved public spending efficiency**

A low-carbon, resilient pathway for Peru would require substantial public and private investments by 2030, while maintaining strong macrofiscal foundations. Priority actions to reduce GHG emissions and adapt to climate change include combining land use and transport planning, improving water and transport asset management and maintenance, reforming the power sector, ensuring land tenure security to reduce deforestation, developing and implementing green and resilient building regulations, and improving early warning systems for water resource management (table S.1). We estimate that more than half (57 percent) could be undertaken by the private sector, for example, in vehicle electrification. The rest would need to be carried out by the public sector, which would play a predominant role in areas such as water storage investments. Pushing the analysis to 2050 brings more uncertainty, but one estimate places total investment and spending needs at $45 billion\(^{17}\) for 2023–30 and $93 billion for 2023–50. This would require a $3.3 billion increase in public spending (investments and current spending) annually, but benefits would be high (table S.1). Peru’s annual spending on climate change has been under $300 million for the past decade (MEF 2022), while public investment has averaged $10.6 billion per year for the past five years (of which $5.4 billion for infrastructure).\(^{18}\)

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\(^{16}\) For example, in Lima’s San Borja district, the municipality has incentivized green building construction by providing height bonuses that allow the construction of up to two additional levels in green buildings.

\(^{17}\) NPV, 6% rate.

\(^{18}\) National Fiscal Accounts, Ministry of Economy and Finance.
The economic benefits of funding emissions reductions and adaptation investments can compensate for the costs of meeting these needs. The main adaptation investment costs are in the water sector; and the main mitigation costs are in energy and transport (table S.1). The incremental cost of some investments would result in lower accumulation of physical capital, which would have a negative impact on GDP (figure S.2, light blue line). It can also leave fewer resources for other productive investments unrelated to climate change. But the estimated benefits outweigh the costs, turning the net impact positive (figure S.2, dark blue and orange lines). The water sector will see most of the benefits of adaptation investments, driven by an increase in productivity in agriculture, mining and industry, as well as avoided droughts and flooding damage. Decarbonization investment benefits—which are mostly from reduced operational expenditure—are mainly in the transport sector, due to savings on fuel. There will also be a significant boost in forestry output, driven by the increase in wood extraction, secondary transformation, and higher productivity of coffee and cocoa due to agroforestry systems. As a result, GDP could increase by 2 percent by 2030 and by up to 10 percent by 2050 compared to the baseline.

**FIGURE S.2.** Impact of adaptation and mitigation investments on GDP

Note: The investments costs and benefits modeled all come from table S1. The scenarios assume all additional investments are debt financed.

19 The model can endogenize investment needs/costs, but benefits are mostly exogenously provided by sector teams, who collected investment needs and GDP benefits (plus co-benefits, not included here). Box 4.3 in the main report provides methodological guidance and details on how investment needs/costs and benefits were collected and modeled.
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<td>49.4</td>
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Source: World Bank staff estimates based on sector analyses presented in chapter 3.

Notes: Costs are Net Present Values, discount rate 6%; ++ = large positive impact; + = small positive impact; a = reduced operational expenditure; b = forestry value added of production; c = water efficiency management, reduced droughts and flooding damage (conservative estimates); d = reduction in accidents, increased productivity, improved health and congestion; e = health benefits.

Peru will need to design a financing strategy for climate-related investments. Some of the investments proposed in Table S.1. are "conventional" investments that have climate benefits (for example, water supply and sanitation, public transportation) and could be funded and financed
through conventional instruments. These investments could be prioritized by the government over other conventional investments, thereby keeping total public investment spending unchanged. Others, on the other hand, are purely related to climate issues (for example, charging infrastructure for electric vehicles, or additional water storage). These investments could be implemented in addition to the current public investment envelope, and in the absence of additional domestic revenue mobilization, this will require increasing public debt. Debt-financing climate investments could stimulate GDP growth through the demand effect, as other growth-enhancing public investments would not be neglected, but it could also come at the cost of an increase in public debt-to-GDP ratio. A more realistic scenario would involve prioritizing urgent public adaptation and decarbonization investment needs that bring large development benefits (funding these investments from the budget or through domestic or foreign borrowing) while increasing concessional finance for climate-specific investments with high upfront costs and lower benefits, and incentivizing the private sector to invest in sectors with high cost recovery.

**Improving spending efficiency would help maximize social benefits from climate-related public investments.** Institutional efficiency is low in Peru, characterized by a low execution rate of public investment together with delays along the public investment management chain. This challenges the country’s efforts to make climate-relevant public investments, particularly at the local level. In recent years, the average execution rate of public investment budget has stayed relatively low, at about 65 percent. Investment projects experience many delays during preparation and execution. This is due to several factors, including a lack of prioritization, the atomization of small projects, low-quality terms of reference, technical files that require multiple revisions and clearances, and weak project management capacities in some ministries and local governments. Both national and local governments provide limited information on the status of projects under implementation, limiting the possibility of monitoring their completion and assessing the effects of delays on overall costs. Peru has recently carried out various reforms to improve its public investment system, creating an enabling environment for a more agile project investment cycle and climate-sensitive investment pipeline. But given the need to increase spending for climate action, more is needed to improve efficiency of spending and prioritize projects.

**Designing a comprehensive fiscal response to climate change**

Despite decades of impressive economic growth, tax revenues in Peru remain relatively low compared to the regional average, and its tax system is not aligned with a green growth strategy. Environmental tax revenues in Peru were barely 0.5 percent of GDP in 2020, well below the OECD average (1.35 percent), and lower than its regional peers (the Latin American and Caribbean average is 1 percent). Most of these revenues were derived from excises on fuel and gasoline, followed by motor vehicle and transport services. Several of Peru’s environmental and energy subsidies and

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20 Public investment in Peru is close to 5% of GDP, compared to an average of around 3.6% for seven big Latin American countries and 3% for OECD. But there is still room to improve prioritization and efficiency at the local level.

21 An ongoing World Bank study finds large delays between approving investment projects and preparing technical specifications (735 days on average), preparing and approving technical dossiers (229 days), bidding and procurement (299 days), and project execution (536 days), with large differences between government levels and sectors.

22 The 2018 Public Investment Management Assessment finds that Peru has a 37 percent efficiency gap in public investment management, which is well above the world (27 percent) and Latin American and emerging country (26 percent) average.

23 In 2020, Peru’s total fiscal revenue equaled just 17.8 percent of GDP, below the Latin American and Caribbean average (25.8 percent), and well below the OECD average (39.1 percent).

incentives could also qualify as environmentally harmful. Although some are designed to reduce levels of inequality and poverty, most generate an irrecoverable loss of efficiency, sometimes greater than the gains derived from taxes. Reforming environmentally harmful subsidies could also create fiscal space and encourage more sustainable consumption and production patterns. But political economy considerations and transparency are crucial for successful reform.

A carbon tax could help raise fiscal revenues and redirect economic activity toward a lower-emitting path. When applied upstream—on the carbon content of fuels—carbon taxes have important fiscal co-benefits related to covering the informal sector: they can be applied on a few points (where fossil fuels are extracted or before they are transformed), where they are not easily evaded. Thus, not only are carbon taxes highly environmentally effective in settings of high informality; they also help reduce the formal-informal tax wedge. And their ease of administration when applied upstream can help reduce costs. They also generate stable and predictable public revenue streams, which can be used to finance other sustainable development priorities. The CPAT model, described in (Dennig, Dorband and Schulz-Antipa 2022), finds that a $50 tax per tCO₂e, increasing to $93 by 2030, would have an initial small negative impact on GDP in the short term and bring GDP only about 1 percent below baseline by 2030. But it would also raise significant revenue (1.7 percent of GDP by 2030), which the government could use to ensure compensation and progress on development goals, and substantially reduce emissions, contributing 22 percent of the reductions needed to get to net zero by 2050. As such, it could complement the investments listed in table S.1.

A carbon tax can negatively impact consumers and producers, although with the right transfers in place, it can benefit the poorest and have a positive impact on employment. In Peru, a carbon tax would be progressive since, as a share of consumption, the two poorest income deciles would be less affected than the richest. However, since the carbon tax increases the price of fuels (with the high carbon tax, by 2030 the prices of gasoline, diesel, and LPG would increase by 15–26 percent), a carbon tax would increase poverty in the absence of compensatory transfers. But channeling 50 percent of the fiscal revenue collected into public investment and 50 percent into cash transfers would make the poorest 40 percent better off under the carbon price scenario. A carbon tax would also have a net-positive short-term effect on labor demand (2–4 years after reform).

Peru can develop a system for managing the fiscal and debt impacts of natural hazards. Although the country has clear institutional arrangements for public financial management during emergencies, it has yet to comprehensively assess the physical risks to its fiscal sustainability and public finances.

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25 Some of these subsidies include the Fund for Social Inclusion for Energy, Fondo de Inclusión Social Energético (FISE) program to promote access to liquefied petroleum gas (LPG), a government-sponsored initiative aimed at reducing solid fuel use by increasing low-income households’ access to clean cooking fuel; VAT and excise tax exemption for oil and natural gas to three departments in the Selva region; consumption tax (ISC) refund on diesel oils to encourage the formalization of interprovincial public passenger and freight transport services; and VAT recovery regimes for mining and hydrocarbon companies in exploration stage to promote investment in those industries.

26 Since carbon content is proportional to fuel quantities, fuel sales and emissions factors are sufficient to estimate carbon tax rates for fuels.

27 Emissions Trading Systems are generally applied downstream, where emissions are released into the atmosphere, limiting applicability to firms and/or installations in the formal sector.

28 Where the point of regulation applies to a few importers, refiners and/or distributors.

29 For example, an upstream carbon tax does not require the creation of an monitoring, reporting and verification system (which can involve important use of public funds). The number of regulated entities upstream is also generally much smaller, which helps reduce administrative costs.
One option is to extend its national disaster risk financing strategy\textsuperscript{30} to include more instruments to better insure public assets and include natural disasters and climate change impacts in its fiscal planning and debt management.

**Facilitating private sector action by creating a conducive regulatory environment and providing the right financing and insurance tools**

For agriculture and forestry, improving land tenure security and real-time monitoring of deforestation is key. Lack of land tenure rights for smallholders reduces their commercial opportunities and makes access to financial resources difficult, thereby incentivizing further deforestation. Land tenure security is crucial to strengthen incentives to make productivity-enhancing investments with long-term payoffs on climate and growth in agriculture and forestry. The government could provide the stability and legal security to foster private investment and develop monitoring and law-enforcement capabilities to protect Peru’s natural capital and the rights of all actors, including Indigenous communities. Providing a satellite-based system for real-time detection of deforestation is crucial for targeting law enforcement activities in the Selva region.

Regulatory power sector reforms would support private sector investments in solar and wind energy, helping the country reach its target of 15 percent renewable energy by 2030. Achieving the 2030 target and mobilizing the private sector will require regulatory change at different levels: in the wholesale market, transmission sector, and distribution and retail markets. The most urgent include changes to the electricity auction law to introduce hourly, daily, or seasonal blocks, allow contracting energy and capacity separately, and remove the requirement for energy supply to be linked to firm capacity.\textsuperscript{31} Likewise, further investments in the transmission system will be needed to address congestion in the network to ensure the electricity generated by the new renewable capacity in the south is delivered to other parts of the country.

Peru can increase requirements for the financial sector to assess and disclose climate-related risk and harness opportunities to develop a green financing ecosystem. Its bank-dominated financial sector is significantly exposed to climate change risks, with approximately 20 percent of its credit portfolios concentrated in transition-sensitive sectors, such as heavy industry and transport. To identify, monitor, and address these risks, the financial sector authorities could require banks, insurers, and large investors to systematically quantify physical and transition risks, perform stress tests to assess their portfolios’ resilience to climate change, and include identified risks in their business processes and disclosures. Peru’s initial efforts to develop a green financing roadmap, the *Hoja de Ruta de las Finanzas Verdes* (HRFV)\textsuperscript{32} also hold promise for channeling financial resources to help implement climate mitigation and adaptation measures. The recently approved sustainable bond framework will help the country implement its NDC by mobilizing capital for climate action.

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\textsuperscript{30} This 2016 strategy was developed by the World Bank in collaboration with the Ministry of Economics and Finance and others. [https://www.mef.gob.pe/contenidos/pol_econ/documentos/PeruFinProtectionFL_low.pdf](https://www.mef.gob.pe/contenidos/pol_econ/documentos/PeruFinProtectionFL_low.pdf).

\textsuperscript{31} To promote intermittent renewable energy in the Peruvian power market, the government is looking into introducing modifications to the auctions law to: (i) ensure that energy and capacity can be contracted separately and that firm capacity is recognized for variable renewable energy beyond of peak hours (17.00–00.00); and (ii) change from peak and off-peak blocks to hourly blocks that are better aligned with daily solar and wind power generation, as Colombia and Chile have done. These changes in the electricity supply auctions for regulated customers would enable renewable energy (other than hydro) to participate in technology-neutral auctions. The increase in renewable intermittency will require regulation related with ancillary services to ensure the system is flexible and the power grid well balanced.

and supporting interministerial coordination, green projects, and expenditure tagging. Developing and implementing the roadmap further will require sustained prioritization and close coordination between stakeholders to develop a green taxonomy and green portfolio options and implement the new framework. Working with the private sector will help the government identify blended finance instruments to mobilize capital for sustainable projects.

**Improving access to quality financial services and insurance for small firms and households would help farmers, fisherfolks and households adapt to climate change.** In the agriculture and forestry sectors, poor smallholders, peasants and Indigenous communities need appropriately sized and mature financing instruments, as their needs are different from large agribusinesses or companies developing sustainably managed concessions and commercial forest plantations. Greater availability of digital financial services for households—and increasing their uptake—can help support resilience to climate shocks and channel emergency payments to households impacted by climate-related disasters. Insurance penetration is low in Peru, among both households and firms. Of the 18 insurance companies active in the country, only five offer catastrophic insurance. To address this, the government could promote access to climate-smart insurance instruments for the agriculture sector that are cost-effective, affordable, free from moral hazard, and financially sustainable.

**Supporting productivity growth, innovation, and structural change**

In agriculture, private investment can play a crucial role in increasing productivity and adapting value chains to the growing imperatives of climate change led by market-side consumer trends and supply-side social pressure. The production structure in the Costa region poses serious environmental concerns, particularly regarding water use, land use, and soil pollution. Meanwhile, good environmental management is a growing source of competitiveness in global food exports. On the other hand, smallholder farmers with low productivity rely on extensification strategies to increase production, encroaching into marginal areas in the Sierra region and leading to accelerated deforestation in the Selva region. Improving land use planning and agriculture innovation systems, promoting intensification, and integrating smallholders and communal organizations from the Sierra and Selva regions into agriculture value chains in the Costa region could reverse these trends. For example, exporters on the coast can source goods and produce from farmers in the Sierra and Selva regions, using geospatial technologies and integrated land use planning to identify smallholders with strong potential to participate in export value chains and improving their access to adequate infrastructure and services. As well as capitalizing on successful experiences in market-driven productive alliances in the Costa region, such integration could accelerate access to technology, know-how, market intelligence, and climate-smart practices (CPSD 2022), bring crops to a conducive microclimate that is more environmentally sustainable, and increase inclusive growth and regional convergence.

**Facilitating structural economic change will help seize the opportunities of climate change and manage economic sectors that are in decline.** Peru is not very well diversified for its income level. Its export growth is driven by minerals, while other sectors—such as textiles, electronics, and machinery—have not taken off. To facilitate structural transformation, Peru can identify, and develop a strategy to maximize and distribute the benefits of, high-productivity sectors that might benefit

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33 [https://atlas.cid.harvard.edu/countries/173](https://atlas.cid.harvard.edu/countries/173)
from the physical and transition impacts of climate change. To hedge against climate risk, it can also develop a strategy to help sectors, such as agriculture and fisheries, that are likely to be negatively affected by climate change. Although it is aware of the risks climate change poses to Peru’s different economic sectors, the Ministry of Finance has yet to formalize a strategy to reduce vulnerabilities. To help reduce frictional costs and burdens on workers, facilitate the green jobs transition and sectoral reallocations, and address skill mismatches and shortages, the government could consider policy measures such as reskilling and upskilling alongside structural reform.

**Conclusion**

Peru has many opportunities to develop and implement comprehensive climate policies that also increase productivity and reduce poverty. It can achieve low-carbon and resilient development if it implements the right reforms and funds critical investments for water security and decarbonization (table S.2). While public investments must cover critical investments, the right regulations, information systems, social services and fiscal incentives can also ensure households and the private sector play a large role. The resulting productivity and efficiency gains could increase GDP by 2 percent by 2030 and potentially much more by 2050 and create many jobs. While the overall impacts of climate reforms and investments are positive on growth and job creation, policies need to be carefully designed to be politically acceptable. Fiscal reforms to reduce emissions can be designed to ensure increased support to the poorest and reduction of inequality. Technical support to the agriculture sector can target smallholder farmers and ensure informal subsistence farmers can be either integrated in more formal value chains or to the forestry sector. Social protection can be scaled up to support the poorest households after climate shocks and to support job transitions away from the most vulnerable or emitting sectors. Finally, the mining sector can be transformed to ensure that local populations benefit from revenues and participate in decision-making processes.
### Table S.2. Priority reforms to complement the investments identified in Table S1.

<table>
<thead>
<tr>
<th>Broad priorities</th>
<th>Benefits for adaptation</th>
<th>Benefits for mitigation</th>
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</thead>
<tbody>
<tr>
<td><strong>Planning and regulations</strong></td>
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<tr>
<td>1. Finalize and implement the Green Finance Roadmap, including components on</td>
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<td>disclosures related to climate change; implement Peru’s Sustainable Bond</td>
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<tr>
<td>Framework; and develop a green taxonomy</td>
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<td>2. Further incorporate climate risks into financial sector regulatory and</td>
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<td>supervisory frameworks</td>
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<td>3. Promote green products production and trade</td>
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<td>4. Improve access to export markets by smallholders (in the Sierra) by linking</td>
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<tr>
<td>them to large exporting firms in the Costa region and improving the efficiency</td>
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<td>of the agriculture innovation system to promote the development of climate-smart</td>
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<td>technologies and practices</td>
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<td>5. Improve land tenure security and real time deforestation monitoring through</td>
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<td>increased law enforcement</td>
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<td>6. Reform power sector regulations by implementing a long-term energy planning</td>
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<td>process that involves co-optimization of electricity and gas sectors; reforming</td>
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<tr>
<td>the electricity auctions law to enable nonconventional renewable energy to enter</td>
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<td>the market and compete; improve transmission planning and reduce delays in</td>
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<td>transmission infrastructure; develop long-term capacity expansion that</td>
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<tr>
<td>incorporates renewables, the potential for distributed energy sources, and</td>
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<tr>
<td>energy efficiency</td>
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<td>7. Deliver technical assistance to farmers, and enhance systems for monitoring</td>
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<tr>
<td>and mitigating vector and disease spread</td>
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<tr>
<td><strong>People-centric policies</strong></td>
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<td>8. Implement the Cuenta DNI initiative to facilitate the digital delivery of</td>
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<tr>
<td>government-to-person emergency payments in the event of natural disasters</td>
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<tr>
<td>9. Re- and upskill workers in the natural gas, mining and agriculture sectors</td>
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<td>10. Adapt service delivery in the health sector to evolving health needs and</td>
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<tr>
<td>increase capacity to respond to sudden surges in demand for care</td>
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<tr>
<td><strong>Macrofiscal reforms and price incentives</strong></td>
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<tr>
<td>11. Adopt feebate systems or taxation with output-based rebates for reducing</td>
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<td>emissions from forestry</td>
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<td>12. Adopt carbon pricing and remove environmentally harmful subsidies,</td>
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<td>accompanied by support to vulnerable groups</td>
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<td>13. Improve the execution rate of public spending and reduce delays along the</td>
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<tr>
<td>public investment management chain</td>
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<td>14. Unify the tax regime for SME, facilitating transition to the general regime,</td>
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<td>to reduce informality</td>
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<tr>
<td><strong>Public investments</strong></td>
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<td>15. Water supply and sanitation; multipurpose water storage; support for</td>
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<td>irrigation; drainage systems</td>
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<td>16. Public transport (nonmotorized transport in Lima and intermediate cities,</td>
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<td>expanding bus rapid transit system, last-mile freight system based on bikes for</td>
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<td>Lima)</td>
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<td>17. Invest in the electricity transmission system to ensure delivery of</td>
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<td>electricity generated by the new renewable capacity in the south to other parts</td>
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<td>of the country</td>
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</table>

*Note: ++ = large positive impact; + = small positive impact*
References


