A Green Costa Rican COVID-19 Recovery

Aligning Costa Rica's Decarbonization Investments with Economic Recovery

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About This Research Report

This study was commissioned by the United Nations Development Programme, Costa Rica, as a follow-on analysis to the 2020 RAND Corporation study on the net benefits and costs of Costa Rica's National Decarbonization Plan (Groves et al., 2020). In this report, we seek to understand in what ways the implementation of Costa Rica's National Decarbonization Plan, which would lead to an unprecedented economic transformation, could align with emergent needs for a just and robust recovery from the coronavirus disease 2019 (COVID-19) pandemic. The intended audience of this report includes policymakers in Costa Rica and other Latin American countries and individuals working toward decarbonization worldwide.

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Summary

The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected Costa Rica—upending Costa Ricans' way of life and hampering economic prosperity. Together with the necessary governmental response, COVID-19 has had a significant impact on prevailing economic conditions, particularly for vulnerable individuals and households. From 2019 to 2020, the pandemic led to a sharp increase in unemployment, from about 12 percent to more than 24 percent, and economic output declined by about 5 percent—a loss of $3 billion (INEC, undated-a). Low-wage and female workers experienced greater job losses than male and high- wage workers did; women lost about 18 percent of all their jobs compared with a 10-percent job loss for men (INEC, undated-b). Furthermore, households in poverty increased from 20 percent in 2018 to more than 26 percent in 2020, and rates of extreme poverty increased from 5.7 percent to 7.0 percent (INEC, 2020a).

Prior to the onset of the pandemic, Costa Rica had been taking a leading role in addressing the global climate crisis through investments in adaptation and decarbonization. Costa Rica's National Adaptation Policy, completed in 2018, lays out a broad strategy for reducing future climate change impacts. Costa Rica's National Decarbonization Plan (NDP), released in 2019 and available online, set the goal of becoming carbon neutral by 2050, which means that Costa Rica's local greenhouse gas emissions would be equivalent to the local sequestration provided by forests and other carbon sinks. The NDP describes a set of investments and policies across ten lines of action, covering all main economic and infrastructure sectors of Costa Rica's economy. A 2020 study estimated that the required upfront investments to decarbonize Costa Rica's economy through 2025 would be about $5 billion and provide more than $40 billion in net benefits through 2050 under baseline assumptions (Groves et al., 2020). Newer estimates of total investments needed for four of the ten lines of action, including those that would likely be incurred in the absence of the NDP's implementation, are considerably larger (South Pole Carbon Asset Management, 2019, 2021).

As Costa Rica recovers from COVID-19, the government has stated its strong intentions to ensure that the NDP is aligned with a just and rapid economic recovery. This study adapts a model of the Costa Rican economy to evaluate three possible recovery trajectories and estimate the potential effects of three decarbonization investment scenarios on employment, including employment distribution between women and men and job skill categorizations, and economic activity, as described by value added by economic sector. By comparing modeled economic activity and employment across the scenarios, we estimate the potential benefits of decarbonization spending on COVID-19 economic recovery. Lastly, we explore how decarbonization investments could contribute to the achievement of the United Nations sustainable development goals (SDGs).

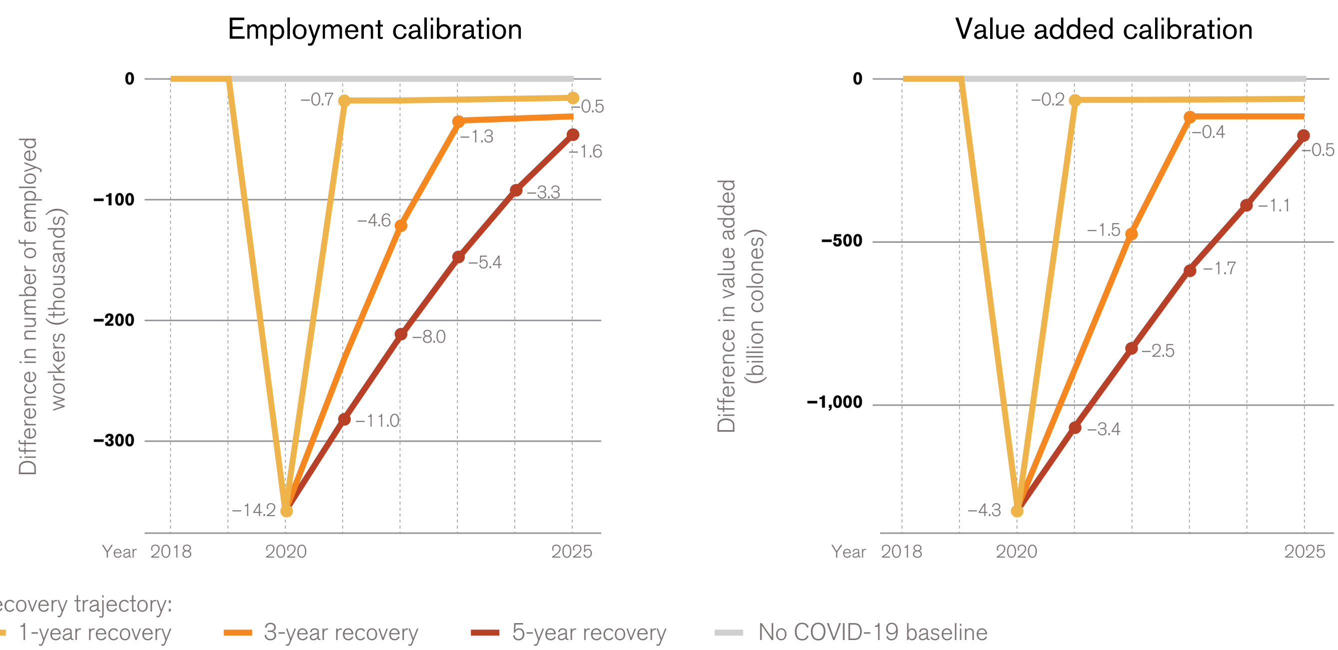
In this report, we review the timeline for COVID-19 socioeconomic impacts and governmental responses in 2020. We then use a general equilibrium model of the Costa Rican economy—Plataforma de Modelación Económico-Ambiental Integrada (Integrated Economic-Environmental Modeling [IEEM]; Banerjee and Cicowiez, 2020a, 2020b; Banerjee et al., 2019)—to model how the Costa Rican economy has been affected by the COVID-19 pandemic, how it might recover from the COVID-19 pandemic shock, and how decarbonization investment could hasten economic recovery.[1] IEEM is a future-looking, dynamic, and computable general equilibrium framework that enables the analysis of how public policy and investment affect such indicators as value added, income and employment, wealth, and natural capital (Banerjee et al., 2016).

[1] IEEM WAS PROVIDED TO THE STUDY TEAM BY THE CENTRAL BANK OF COSTA RICA, THROUGH A PARTNERSHIP WITH ONIL BANERJEE OF THE INTER-AMERICAN DEVELOPMENT BANK.

Key Findings

We simulate three COVID-19 recovery trajectories, and these simulations suggest that **employment and value added may not fully recover to the levels that would have prevailed without COVID-19; the slower the recovery, the larger the suppression of employment and value added will be in 2025.** Figure S.1 shows model simulations of the drop in employment (left) and drop in value added (right) in 2020 due to COVID-19 and the recovery through 2025 under three sets of recovery trajectories. Employment and value added declines due to COVID-19 lessen over time, inversely proportional to the assumed recovery time. However, in none of the three recovery trajectories does employment or value added fully recover, and the longer the recovery time, the larger the employment and value added reduction. Specifically, our modeling suggests that employment could be more than 1.5 percent lower and value added up to 0.5 percent lower in 2025 than they would have been without COVID-19.

Figure S.1. Modeled Change in Jobs and Value Added Under Three COVID-19 Recovery Trajectories Relative to the No COVID-19 Baseline

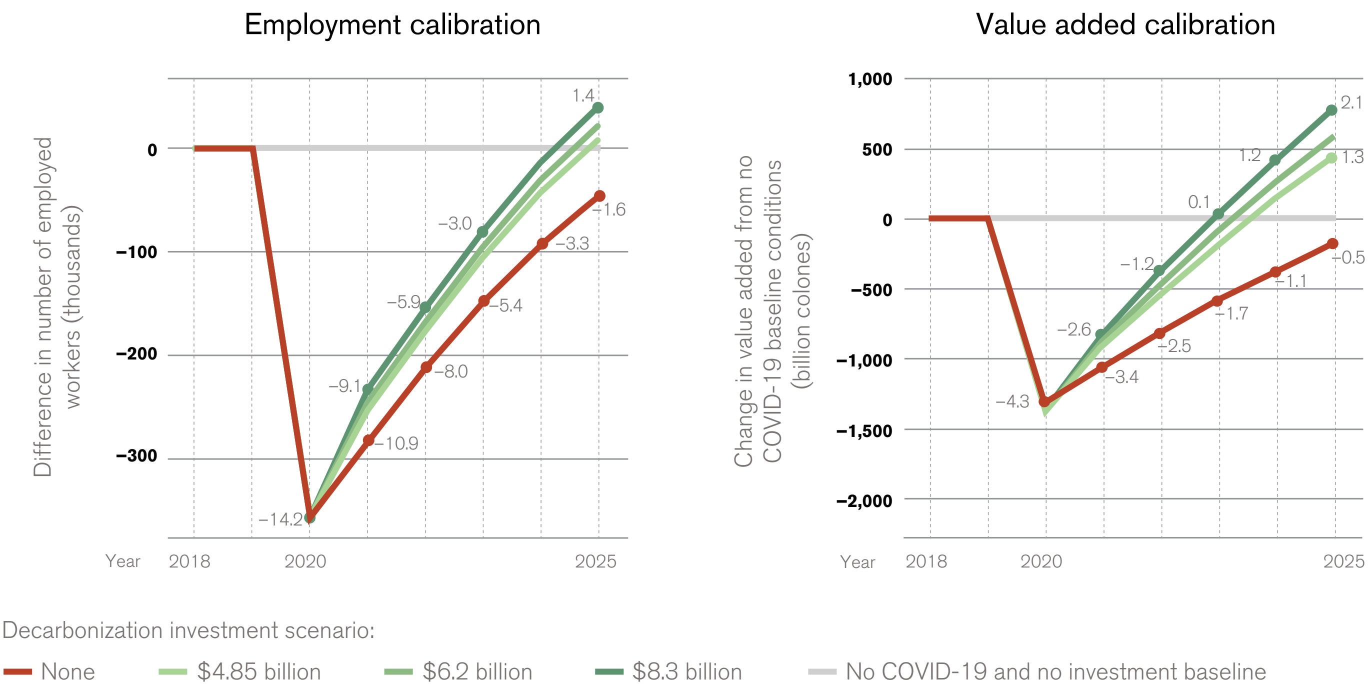


NOTE: THE NUMBERS IN EACH CHART INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE NO COVID-19 BASELINE CASE. THE RESULTS FOR EMPLOYED WORKERS ARE BASED ON A CALIBRATION OPTIMIZED FOR EMPLOYMENT; RESULTS FOR VALUE ADDED ARE BASED ON A CALIBRATION OPTIMIZED FOR VALUE ADDED.

Decarbonization-related capital investments may significantly facilitate economic recovery and lead to higher employment and value added by 2025. We estimate that the effects of five years of decarbonization investments, beginning in 2021 and consistent with Costa Rica's NDP, would markedly improve employment and increase economic activity. The modeling shows that the job losses from COVID-19 are more quickly reduced from a 14.2-percent loss in 2020 to a net gain in jobs by 2025 for all three levels of decarbonization spending (Figure S.2). Decarbonization investments similarly increase the recovery of economic output from a decline in value added of 4.3 percent to a level of 1.3 to 2.1 percent higher than it otherwise would have been without COVID-19.

If the COVID-19 recovery were to proceed more quickly—consistent with our three-year recovery trajectory—the NDP would still yield significant benefits. Employment could be 1.8 percent higher by 2025 than if there had been no pandemic (compared with 1.4 percent higher for a five-year recovery), and value added could be slightly higher as well—2.3 percent higher, compared with 2.1 percent higher for the five-year recovery.

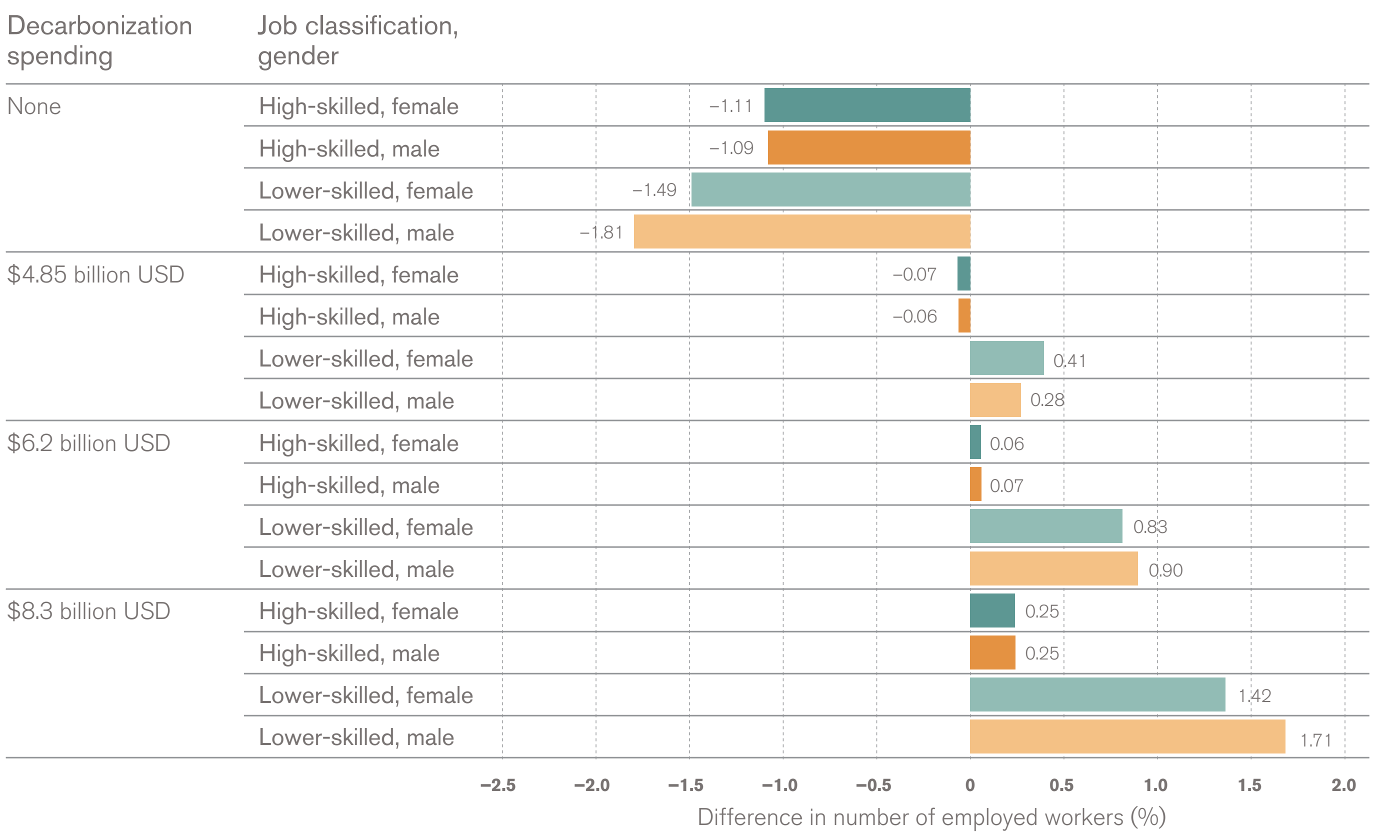
Figure S.2. Modeled Change in Jobs and Value Added for Three Decarbonization Investment Scenarios Relative to the No COVID-19 Baseline



NOTE: THE GRAY LINE IN EACH CHART REPRESENTS THE NO COVID-19 BASELINE. THE RED LINE SHOWS THE IMPACT OF NOT INVESTING IN DECARBONIZATION OVER THE FIVE-YEAR RECOVERY TRAJECTORY; THE NUMBERS IN EACH CHART INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE BASELINE. THE RESULTS FOR EMPLOYED WORKERS ARE BASED ON A CALIBRATION OPTIMIZED FOR EMPLOYMENT; RESULTS FOR VALUE ADDED ARE BASED ON A CALIBRATION OPTIMIZED FOR VALUE ADDED.

COVID-19 led to larger proportional job losses for women and low-wage earners. Investments in decarbonization could reverse this inequity. The depth and uneven distribution of the social and economic effects of COVID-19 and related lockdown and social distancing measures in Costa Rica intensified previously existing inequalities: Proportionally more jobs were lost by low- and mid-skilled earners and by women. Our modeling shows that these discrepancies would likely persist after recovery. Investments in decarbonization, however, may reduce these employment inequities between women and men. Figure S.3 shows the percentage difference in employment by high-skilled workers versus low- and mid-skilled workers by gender in 2025 compared with the baseline (no COVID-19) for the three decarbonization spending scenarios through 2025. Without decarbonization (top rows), there would be about 1 percent fewer high- skilled jobs. There would be even fewer jobs for low- and mid-skilled workers, with the largest losses by low- skilled male workers (−1.8 percent), which is consistent with the larger share of low- and mid-skilled jobs that are held by men. For the three decarbonization spending scenarios, there are broad employment increases for women and men and in lower-skilled jobs, and the number of high-skilled jobs increases over the no COVID-19 baseline for the higher two spending scenarios. However, the category of employment with the greatest projected increases in 2025 over the no COVID-19 baseline is that of low- and mid-skilled female workers for the $4.85 billion decarbonization spending scenario. This reflects increases in employment in sectors with relatively higher proportions of female workers, such as commerce, home employees, and hotels and restaurants. The higher spending scenarios show continued employment gains by lower-skilled female workers, and even greater gains by lower-skilled male workers.

Figure S.3. Difference in Jobs in 2025 by Skill Classification and Gender Compared with the No COVID-19 Baseline for Three Decarbonization Spending Scenarios

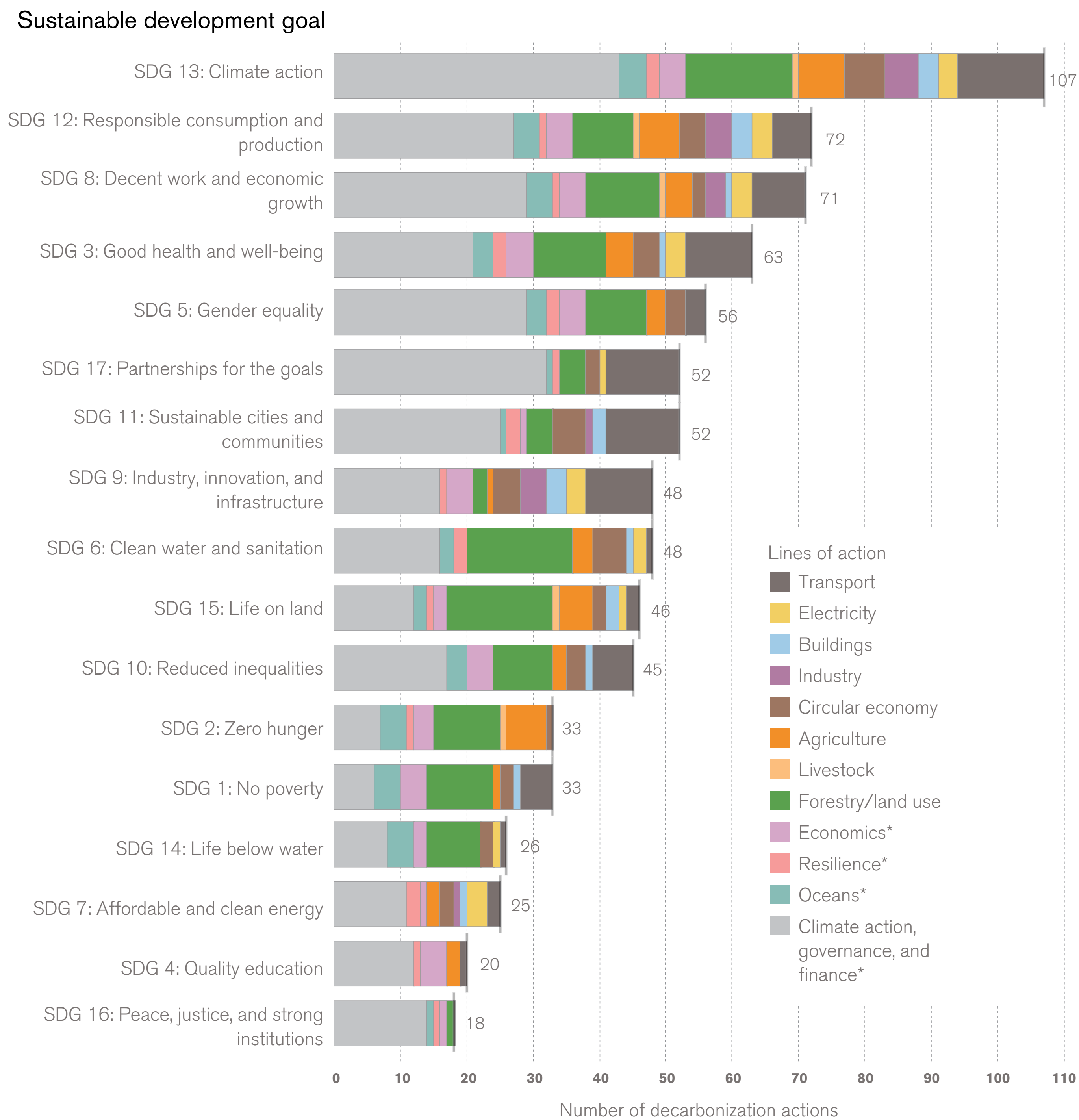


NOTE: IEEM ESTIMATES THE NUMBER OF JOBS IN TERMS OF HIGH AND LOW PRODUCTIVITY. WE MAPPED HIGH-PRODUCTIVITY JOBS TO HIGH-WAGE AND HIGH-SKILLED JOBS. WE MAPPED LOW-PRODUCTIVITY JOBS TO LOW-WAGE AND LOW- AND MID-SKILLED JOBS, WHICH WE REFER TO AS "LOWER-SKILLED" JOBS IN THIS FIGURE. GREEN BARS REPRESENT WOMEN; ORANGE BARS REPRESENT MEN. RESULTS ARE BASED ON A FIVE-YEAR RECOVERY TRAJECTORY AND CALIBRATION OPTIMIZED FOR EMPLOYMENT. USD = U.S. DOLLARS.

Quantitative modeling in this study and in the Benefits and Costs of Decarbonization study (Groves et al., 2020) suggests tangible positive effects of decarbonization investments on ten of the 17 SDGs. Growth in employment and economic activity are only two measures that characterize a just economic recovery and development trajectory. To complement the economic modeling, we also evaluated how the NDP would affect progress toward meeting the SDGs. The economic modeling described in this study shows that decarbonization spending would support gains in the economic-related SDGs: SDG 8 (decent work and economic growth) and SDG 5 (gender equality). The Benefits and Costs of Decarbonization study, which was one of the main inputs to inform the Nationally Determined Contribution (NDC) update (Government of Costa Rica, Ministry of Environment and Energy, 2020), estimated large benefits from improved air quality and reduced accidents due to improved public transportation network actions, which would support improvements in cities and communities (SDG 11) and infrastructure (SDG 9), including transportation-related pollution reductions of more than $1.5 billion (through 2050) and transportation networks. Electrification of transport, buildings, and industry would lead to nearly 100-percent use of renewable electricity and at lower costs, thus achieving SDG 7 (affordable and clean energy). Decarbonization actions in industry would reduce the carbon intensity of cement and other industrial activities by more than 40 percent, contributing to SDG 13 (climate action). The circular economy–related decarbonization actions would connect nearly all households to clean water and sewage systems, leading to significant progress toward SDG 6 (clean water and sanitation). Other circular economy–related decarbonization actions would make modest progress toward SDG 12 (responsible consumption and production) through increases in recycling and composting of more than 50 percent by 2050. The efforts in forestry, in particular the halting of primary forest removal, are highly consistent with SDG 15 (life on land).

Implementation of the 107 investments described in Costa Rica's 2020 NDC could advance all SDGs. We qualitatively cross-referenced the 107 individual actions described in Costa Rica's 2020 NDC, which is explicitly aligned with the NDP and represents the most recent vision of how Costa Rica intends to achieve it, to each of the 17 SDGs and indicated which actions would be consistent with each of the SDGs (Figure S.4). By design, all 107 actions are consistent with SDG 13 (climate action). The next three SDGs supported by the most decarbonization actions are SDG 12 (responsible consumption and production), SDG 8 (decent work and economic growth), and SDG 3 (good health and well-being). This reflects the significant investment in the circular economy sector and the economic and health benefits associated with improving mobility through public transport and reducing hospitalizations from accidents, air pollution, and water pollution.

Figure S.4. Tally of Nationally Determined Contribution Actions That Are Consistent with the United Nations Sustainable Development Goals



NOTE: * INDICATES NDC ACTIONS THAT ARE NOT ASSIGNED TO CARBON-EMITTING LINES OF ACTION.

In summary, our modeling and analysis show that upfront decarbonization investments of the scale required to implement the NDP could accelerate employment and economic recovery from COVID-19, and these investments would lead to higher employment and value added by 2025 than would have occurred otherwise without COVID-19 and decarbonization spending. We also find that employment improvements for women are stronger with decarbonization investment, but this alone does not eliminate existing gender disparities in employment. Furthermore, the implementation of the NDP through 2050 could contribute to the achievement of the SDGs.

Recommendations

We provide the following recommendations to maximize the potential impacts for decarbonization investments to accelerate COVID-19 recovery and contribute to reductions in economic inequities in Costa Rica:

- **Employment outcomes across sectors should be carefully monitored to understand how the NDP investments are modifying the labor market.** This employment monitoring could feed into a program that ensures that job creation from decarbonization meets specific recovery objectives in all sectors. Policies that reduce the barriers to employing foreign labor in the agricultural sector could help as well.

- **Costa Rica should consider developing and implementing additional policies to facilitate the hiring and training of vulnerable groups (lower-skilled workers, racial/ethnic minority groups, and women) when meeting the employment requirement of decarbonization.** The analysis shows that new decarbonization investment alone will not provide the needed opportunities to vulnerable groups. Furthermore, the types of jobs required for a green transition are very often different from current employment opportunities, and workers will require training to transition to these new jobs.

- **Costa Rica should continue to develop an analytical framework for identifying, measuring, and managing transformational change across the economy.** This framework can help Costa Rica adapt to socioeconomic, political, technological, and many other conditions. This framework can build on strong capabilities in the Costa Rican university system and ministries.

- **Funders of new research should continue to require that research not only integrates environmental and economic dimensions of decarbonization but also addresses the socioeconomic effects of and opportunities from decarbonization.**

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Chapter one

Introduction

COVID-19 in Costa Rica

On January 30, 2020, the Director of the World Health Organization declared that the coronavirus disease 2019 (COVID-19) outbreak was a global public health emergency, and the Costa Rican National Emergency Commission acted soon after. It activated emergency protocols and coordinated actions across various institutions, such as the Ministry of Health, the water and sanitation authorities, the Ministry of Public Safety, and the Ministry of Labor. By February 26, 2020, Costa Rica's centralized virology lab had been successfully trained and equipped for COVID-19 testing, although generalized testing remained limited.

The first positive case of COVID-19 was confirmed on March 6, 2020. Over the next month, 467 more cases were confirmed, and two people died. Between June and September, cases and deaths steadily increased as the government rolled back restrictive measures initially put in place to contain the spread of COVID-19. By October 6, 2020, deaths had exceeded 1,000 and the total number of cumulative cases was more than 82,000. Cases and deaths held steady through February 2021, at which point they began declining. At the time of finalizing this report (September 2021), however, cases and deaths had risen once again to their highest levels of the pandemic (Figure 1.1).

Figure 1.1. Daily New COVID-19 Cases and Related Deaths

SOURCE: AUTHOR ANALYSIS OF DATA FROM RITCHIE ET AL., 2020.

Compared with the United States, Costa Rica initially maintained a lower disease transmission and much lower mortality rates. As of January 19, 2021, 3.6 percent of Costa Ricans had been infected with COVID-19, and 480 of every million people had died—a mortality rate of 0.5 per 100,000 people. In the United States, 7.3 percent of the population had contracted COVID-19, and the mortality rate was 1.2 deaths per 100,000 for the same period (Ritchie et al., 2020). Compared with other countries in Central America, Costa Rica had the second-highest case and mortality rates. However, some experts believe that the low estimates for such countries as Nicaragua, Guatemala, and El Salvador may be indicative of underreporting due to a lack of public health and medical infrastructure in these countries, as well as a lack of government transparency (Pearson, Prado, and Colburn, 2020).

Although the first batch of COVID-19 vaccines arrived in Costa Rica on December 23, 2020, supplies initially were extremely limited and increased only gradually in the following months. By March 2021, only 4 percent of the population had received one or more vaccine doses. Vaccinations rates have since increased, but as of September 2021, less than 40 percent of Costa Ricans had been fully vaccinated. As a result, cases and deaths are likely to persist well into 2022.

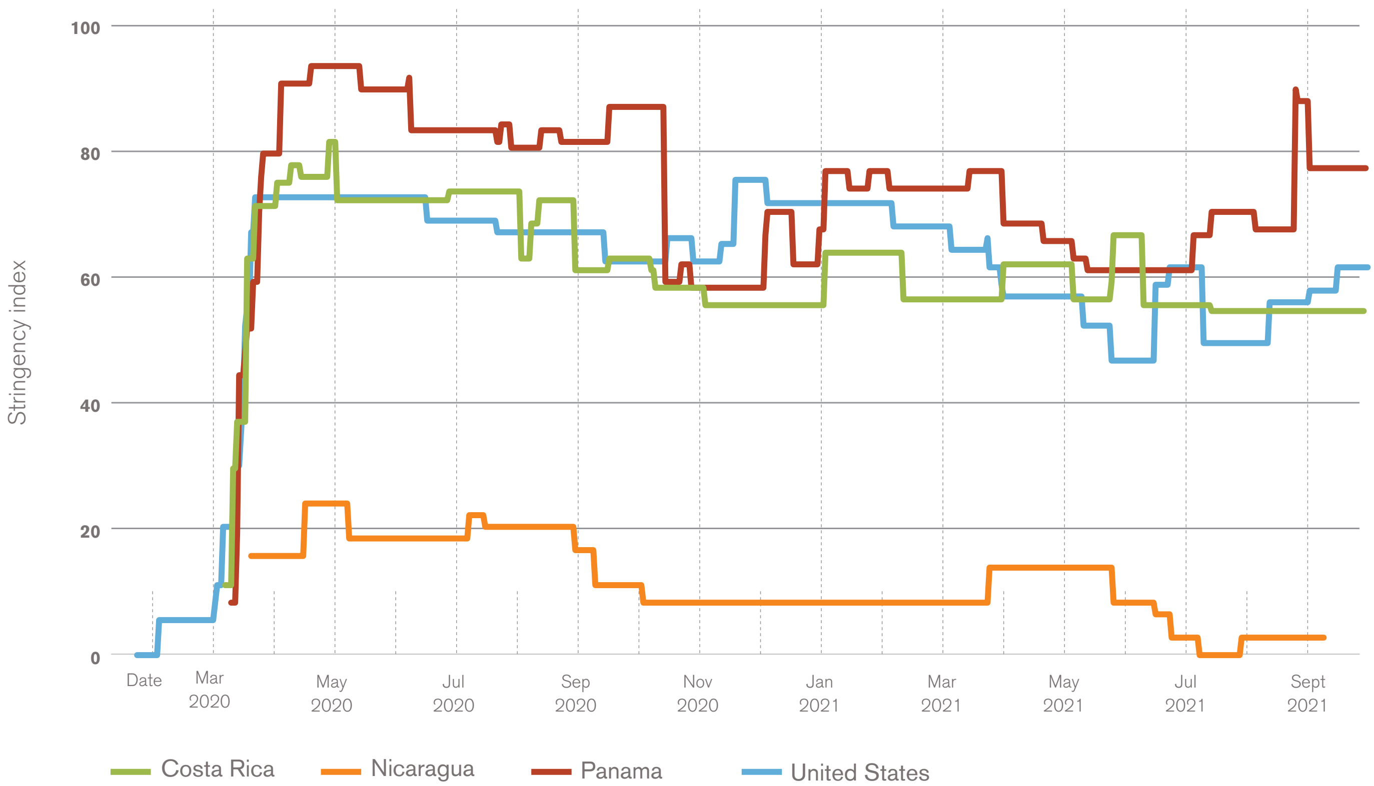
Governmental Response to the Pandemic

At the onset of the pandemic, the Costa Rican government imposed numerous measures to reduce mobility and slow the spread of COVID-19, such as

- **Workplace closings:** On March 9, 2020, public sector workers were asked to work from home, and remote work was strongly encouraged for the private sector.
- **Canceled public events:** On March 10, 2020, permitting for large public events was withdrawn and all events were canceled.
- **School closings:** On March 12, 2020, all universities, as well as schools without drinking water supply, closed.
- **Signing of executive decree (Costa Rican Ministry of Health, 2020):** On March 16, 2020, this executive action laid out a roadmap for further response.
- **Restrictions on internal movement** (Government of Costa Rica, undated): On March 24, 2020, the first "vehicular restriction" was instituted, and vehicles could operate only between 5:00 a.m. and 10:00 p.m. on weekdays and between 5:00 a.m. and 8:00 p.m. on weekends. The vehicular restrictions fluctuated thereafter. Vehicular restrictions were also enacted for different cantons of the country depending on the alert level (yellow alert or orange alert). On October 17, 2020, a unified policy wasenacted for the country with no more differentiation for alert level; vehicles were allowed to circulate only between 5:00 a.m. and 10:00 p.m. on weekdays and until 9:00 p.m. on weekends.
- **International travel controls:** On March 18, 2020, entry to the country by any individual who was not a Costa Rican resident was halted. By November 1, 2020, international travel restrictions were removed to boost the tourism sector (Costa Rican Ministry of Health, undated).
- **Restrictions on nonessential businesses:** Beginning in March 2020, temporary closures of nonessential businesses were put in place.
- **Restrictions on gatherings:** On April 1, 2020, there was a temporary closure of all venues categorized under health permitting as places for public gathering.
- **Closing of public transport:** On April 3, 2020, public transportation routes were suspended during Easter to encourage people to stay home over the holiday.

The government of Costa Rica's response to reduce transmission of COVID-19 was similar to responses taken in neighboring Panama and in the United States, and it was considerably more stringent than Nicaragua's. In each country, stringency was highest during the early period of the pandemic—April to June 2020— and then it gradually declined to a steady state through the deployment of vaccinations (Figure 1.2).

FIGURE 1.2 Stringency Index of COVID-19 Response in Costa Rica, Panama, Nicaragua, and the United States



SOURCE: AUTHOR ANALYSIS OF DATA FROM RITCHIE ET AL., 2020.
NOTE: THE STRINGENCY INDEX CONSISTS OF NINE METRICS: SCHOOL CLOSURES, WORKPLACE CLOSURES, CANCELATION OF PUBLIC EVENTS, RESTRICTIONS ON PUBLIC GATHERINGS, CLOSURES OF PUBLIC TRANSPORT, STAY-AT-HOME REQUIREMENTS, PUBLIC INFORMATION CAMPAIGNS, RESTRICTIONS ON INTERNAL MOVEMENTS, AND INTERNATIONAL TRAVEL CONTROLS (HALE ET AL., 2021).

Economic Effects of COVID-19

The economic effects of COVID-19 and governmental response have been significant. Prior to the pandemic, unemployment in the country remained steady, around 10 percent between 2011 and 2018, and increased to a bit more than 12 percent from 2018 to 2019. The pandemic, however, led to a sharp increase in unemployment; the number of unemployed workers increased by more than 240,000 people between February and June 2020, and the unemployment rate peaked at more than 24 percent. On an annual basis, the unemployment rate increased from 12.5 percent in 2019 to 24.4 percent in 2020 (Figure 1.3).

Figure 1.3. Monthly Change in Unemployed Workers and Unemployment Rate from 2010 to 2020

SOURCE: AUTHOR ANALYSIS OF DATA FROM INSTITUTO NACIONAL DE ESTADÍSTICA Y CENSOS (INEC) (INEC, UNDATED-A).

NOTE: VALUES IDENTIFIED CORRESPOND TO EMPLOYMENT STATISTICS RIGHT BEFORE COVID-19 RESTRICTIONS WERE ENACTED AND PEAK EMPLOYMENT EFFECTS.

COVID-19 effects on employment were not equal between women and men or across skill or wage classifications. Between the 2nd quarter of 2019 and the 2nd quarter of 2020, 52 percent of the 286,000 jobs lost had been held by women. This represented an 18-percent decline in employment by women, whereas loss of jobs held by men declined only by 10 percent (Table 1.1). Job losses by skill and wage also show that the jobs lost by women were lower skilled and lower wage than those lost by men. As a result, unemployment of women increased from 15 percent in 2019 to more than 30 percent in 2020, compared with the 20 percent unemployment rate for men in 2020 (State of the Nation Program, 2020). This discrepancy is largely due to job losses concentrating in lower-skilled and lower-wage sectors that employ mostly women, such as home employees (with 90 percent of female workers) and hotels and restaurants (with 61 percent of female workers).

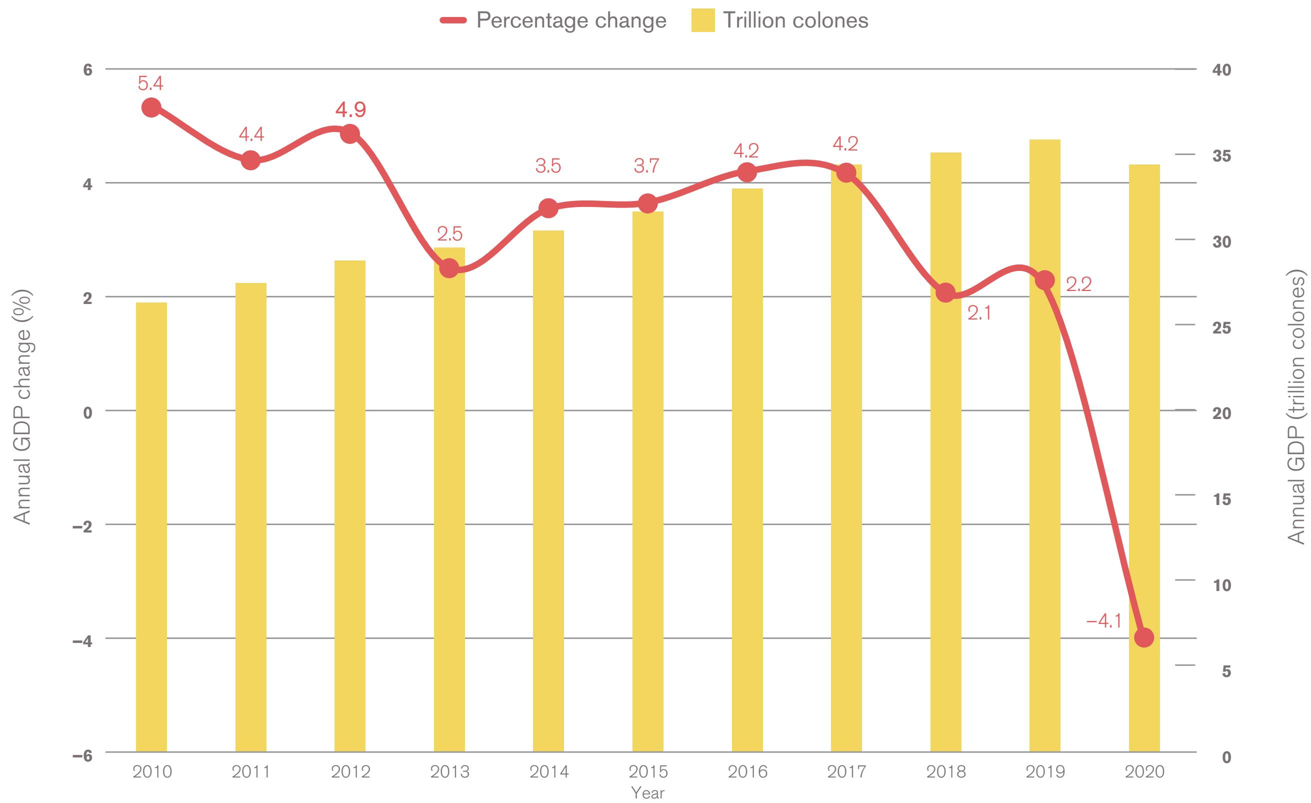
Table 1.1. Job Losses by Gender and by Skill and Wage Category from 2019 to 2020

Gender	Skill and Wage Category	Number of Jobs 2019	2020	Change from 2019–2020	Percentage Lost of Total Job Loss (%)	of 2019 Job Loss (%)
Female	Low-skilled	182,208	155,534	-26,673	9.3	14.6
	Mid-skilled	436,023	341,200	-94,823	33.1	21.7
	High-skilled	220,574	193,251	-27,323	9.6	12.4
	Skill not specified	3,417	2,725	-692	0.2	20.3
	Low-wage	738,073	608,305	-129,768	45.4	17.6
	High-wage	104,148	84,405	-19,743	6.9	19.0
	Total women	**842,222**	**692,710**	**-149,512**	**52.3**	**17.8**
Male	Low-skilled	333,845	309,020	-24,825	8.7	7.4
	Mid-skilled	736,523	666,829	-69,694	24.4	9.5
	High-skilled	262,567	219,978	-42,589	14.9	16.2
	Not specified	6,662	7,207	546	-0.2	-8.2
	Low-wage	1,119,201	1,003,194	-116,007	40.6	10.4
	High-wage	220,396	199,840	-20,556	7.2	9.3
	Total men	**1,339,597**	**1,203,034**	**-136,563**	**47.7**	**10.2**
Total		**2,181,818**	**1,895,744**	**-286,074**	**100.0**	**-13.1**

SOURCE: AUTHOR ANALYSIS OF DATA FROM COSTA RICA'S "CONTINUOUS SURVEY OF EMPLOYMENT" (INEC, UNDATED-B).
NOTE: SUMS OF JOBS BY SKILL AND WAGE CATEGORY EACH SUM TO TOTAL BY GENDER.

COVID-19 and the governmental response led to a significant contraction in economic activity. Prior to the pandemic, gross domestic product (GDP) grew within the range of 2.1 percent and 5 percent per year (between 2010 and 2019). GDP for 2020, however, declined by 4.1 percent, a loss of 1.76 trillion Costa Rican colones (about $3 billion U.S. dollars [USD]), according to the International Monetary Fund (IMF, undated; see Figure 1.4). In the early months of the pandemic, a report by the Ministry of Economics, Industry, and Commerce found that more than half of surveyed small and mid-size business owners reported having lost more than 75 percent of their sales income (Pomareda, 2020). Losses in income in the commercial sector were estimated to be $1.8 billion between March and June (Montero Soto, 2020). By November 2020, the Chamber of Commerce had registered about 5,000 businesses closing in the country due to the pandemic and the subsequent restrictions put in place to mitigate the spread of COVID-19 (Pomareda, 2020).

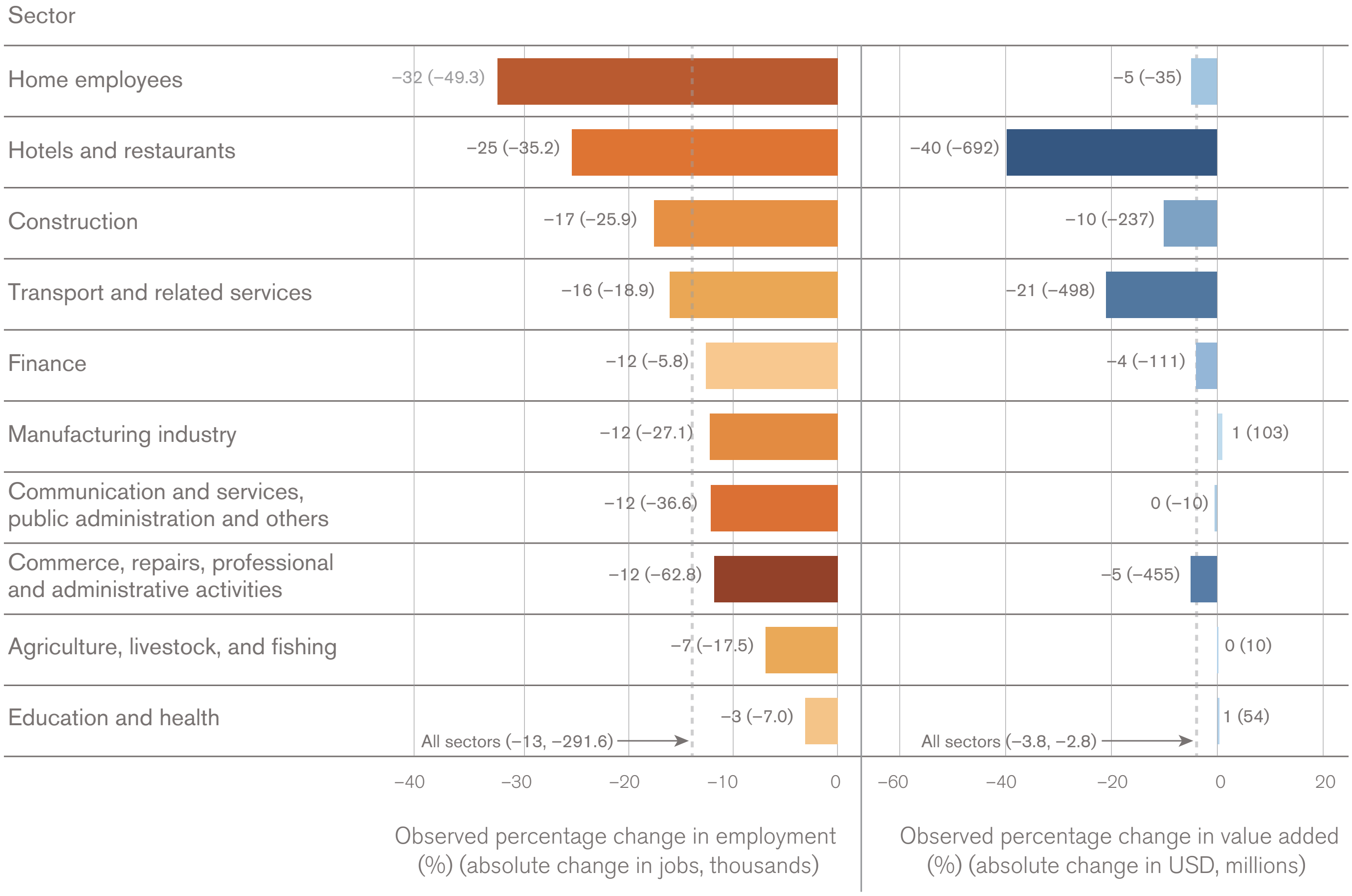
Figure 1.4. Annual Change in GDP from 2010 to 2020



SOURCE: AUTHOR ANALYSIS OF PRELIMINARY FIGURES FROM THE COSTA RICAN CENTRAL BANK (BANCO CENTRAL DE COSTA RICA [BCCR], 2021A).
NOTE: PERCENTAGE CHANGE IN ANNUAL GDP IS SHOWN BY THE LINE PLOTTED OVER THE ANNUAL GDP VALUES.

Unemployment and economic activity did not change uniformly across the Costa Rican economy. The hardest-hit workers were those working in private residences or household employees (32-percent decrease in employment), followed by those working in hotels and restaurants (25-percent decrease in employment) (see Figure 1.5). The construction and the transport and related services sectors each experienced more than 15-percent losses in jobs. The largest number of jobs lost, in absolute terms, occurred in commerce, repairs, professional, and administrative activities—almost 63,000 jobs. Change in economic value added from 2019 to 2020 was also quite different across sectors, according to BCCR. Economic decline was greatest on a percentage basis in the hotel and restaurant sector (−40 percent), followed by transport and related services (−21 percent) and construction (–10 percent). Little or no change in value added was recorded in several sectors, such as (1) manufacturing industry and (2) communication and services, public administration and others, despite significant job losses.

Figure 1.5. Change in Employment and Value Added from 2019 to 2020 by Sector



SOURCE: AUTHOR ANALYSIS OF DATA FROM INEC, UNDATED; BCCR, 2021A.
NOTE: DARKER SHADING CORRESPONDS TO LARGER ABSOLUTE CHANGE.

There are different explanations for the decoupling of employment and value added across sectors. Sectors associated with mid- to high-skilled workers, such as (1) education and health and (2) communication and services, public administration and others, were able to adopt teleworking technologies. This could have increased productivity by reducing the time that workers spent commuting. Additionally, teleworking technologies (e.g., cloud infrastructure, virtual meeting applications) could have enabled workers in these sectors to complete their work more efficiently. Workers also worked longer hours and at higher sustained levels of effort to compensate for fewer employed people.

Although there is evidence that COVID-19 lockdowns have increased the productivity of some portions of the workforce in some nations, the effects have been heterogenous and have varied significantly by profession and gender. For example, lockdowns have led to job losses in categories with high rates of female employment, such as housecleaning and hospitality. Alternatively, the rapid adoption of remote-working technologies has led to employment and revenue increases for software-related industries, which employ a higher percentage of men (Cui, Ding, and Zhu, 2020; Bao et al., 2020; Kramer and Kramer, 2020). Even though research on how COVID-19 has affected employment and economic activity sectors is not definitive, the available economic data used in this study suggest that declines in employment in some sectors of the economy were offset partially by increases in productivity: Labor that was not eliminated due to COVID-19 and its restrictions led to proportionally higher output. The employment and output results for some sectors, however, are less clear. Employment among home employees is a particularly difficult case to reconcile using the available data. For example, in this sector, employment declined by more than 30 percent, yet value added declined only modestly. The exact source of this discrepancy is not yet known but could be due in part to the financial support that laid-off home employees received from government programs that was reported as income and thus counted as value added for the sector, or because only people who had stopped working and were looking for work were counted as unemployed.

An Exacerbation of Historical Inequities

The pandemic has also highlighted and widened historical inequities and patterns of social exclusion that existed in Costa Rica (and elsewhere) prior to the onset of COVID-19. Before the pandemic, in 2019, the Costa Rican Gini coefficient—an index representing family income equality—was estimated to be 0.51 (INEC, 2021c),[2] which is similar to that of other Central American countries. Low-income households represented 43.5 percent of households in the country, but they received only 15.8 percent of total income generated. Prior reports of *Estado de la Nación* [State of the Nation] had warned of the country's low capacity to withstand shocks to the system due to deterioration in key indicators, a decelerating economy, poor job generation, and a concerning fiscal deficit (State of the Nation Program, 2020). As expected, the pandemic had a significant effect on income and disparities; households in poverty increased from 20.0 percent in 2018 to 26.2 percent in 2020. Rates of extreme poverty[3] increased from 5.7 percent to 7.0 percent in the same period. The Gini coefficient also increased slightly to 0.52 (INEC, 2020a).

Women also faced an increased burden of child care due to school closures and care for family members who had become sick from COVID-19, and there is also strong evidence that COVID-19 has led to increased levels of violence against women. According to the Ministry of Public Safety, between the first semester of 2019 and the first semester of 2020, the ministry saw an increase of 28 percent in domestic violence reports (Observatorio de la Violencia, undated). There have also been increased reports of xenophobic attitudes, discrimination, and violence against migrants, especially against people from Nicaragua due to public perception that migration is to blame for the spread of the pandemic (Fernández, 2020).

Education has also been strongly affected. The Minister of Education reported that in 2020 half of children enrolled in the public school system did not have access to internet services and thus were not able to participate in online learning. Furthermore, even for those children with connectivity, delays in establishing online learning and inefficiencies from hybrid learning environments reduced learning. On the other hand, children in higher-income families are more likely to attend private schools and have received better access to continued education through the course of the pandemic (Cerdas, 2021).

The Costa Rican government enacted more than 450 measures to mitigate the economic effects of COVID-19, including agreements, memorandums, decrees, laws, guidelines, and temporary tax and insurance payment relief to protect workers. For example, a recovery payment program, called Bono Proteger, was established in April 2020 to provide eligible citizens with 125,000 colones (approximately $200 USD) per month for three months. In the first 12 months of the program, approximately 1 million people (about half of the working population in 2019) had applied for or received assistance. More women than men applied, and about half of the program participants had completed only primary school education or less (State of the Nation Program, 2020). To assist small business owners, the government also temporarily reduced the original rate of social security taxes by 5 percent.

[2] THE GINI COEFFICIENT (G) IS A MEASURE OF THE INEQUALITY IN A DISTRIBUTION, GIVEN BY THE DIFFERENCE BETWEEN A HYPOTHETICAL STRAIGHT LINE THAT REPRESENTS PERFECT EQUALITY AND THE ACTUAL DISTRIBUTION OF WEALTH, WHICH IS OFTEN REFERRED TO AS THE LORENZ CURVE (Y=L(X)). IT IS CALCULATED AS FOLLOWS: G=1−2 ∫ L(X)DX, EVALUATED FROM 1 TO 0. THE MEASURE RANGES FROM 0 (PERFECT EQUAL- ITY) TO 1 (ALL INCOME IS CONCENTRATED IN ONE PERSON).

[3] EXTREME POVERTY RATES REFER TO THE PROPORTION OF HOUSEHOLDS WITH A PER CAPITA INCOME EQUAL TO OR LESS THAN $1.90 USD PER DAY.

Costa Rica's Performance on the United Nations Sustainable Development Goals

The United Nations sustainable development goals (SDGs), adopted in 2015, provide a structured framework to evaluate countrie's progress toward 17 high-level goals, based on 169 specific targets (Figure 1.6). The first scientific reporting on progress toward achieving the SDGs was released in 2019, and it concluded that despite some important progress, the world's countries were not on track to meet all goals by 2030 (Indepen dent Group of Scientists, 2019). Even more concerning but unsurprisingly, the COVID-19 pandemic has led to considerable regression in progress on SDGs across the world (Sachs et al., 2021). Although Costa Rica did not experience significant reversals in SDG progress due to COVID-19, it is not making the needed progress on all SDGs.

Figure 1.6. United Nations Sustainable Development Goals

SOURCE: SDG ICONS ARE USED IN ACCORDANCE WITH UNITED NATIONS GUIDELINES (UNITED NATIONS DEPARTMENT OF GLOBAL COMMUNICATIONS, 2020).

As of 2021, Costa Rica has achieved only SDG 7 (affordable and clean energy). This goal has been met due to very high access to electricity and clean fuels and technologies for cooking, as well as low CO2 emissions from the production of electricity. Challenges remain toward achieving all the other SDGs, as indicated in Table 1.2.

Table 1.2. Costa Rica's Achievement Toward the United Nations Sustainable Development Goals as of 2021

Sustainable Development Goal	Performance			
	SDG Achieved	Challenges Remain	Significant Remain Challenges	Major Remain Challenges
SDG 1: No poverty		✓		
SDG 2: Zero hunger				✓
SDG 3: Good health and well-being			✓	
SDG 4: Quality education		✓		
SDG 5: Gender equality		✓		
SDG 6: Clean water and sanitation		✓		
SDG 7: Affordable and clean energy	✓			
SDG 8: Decent work and economic growth			✓	
SDG 9: Industry, innovation and infrastructure			✓	
SDG 10: Reduced inequalities				✓
SDG 11: Sustainable cities and communities		✓		
SDG 12: Responsible consumption and production			✓	
SDG 13: Climate action		✓		
SDG 14: Life below water				✓
SDG 15: Life on land				✓
SDG 16: Peace, justice and strong institutions				✓
SDG 17: Partnerships for the goals		✓		

SOURCE: SACHS ET AL., 2021.

Notably, many challenges exist in achieving the three SDGs that are most related to poverty and economic well-being: SDG 1 (no poverty), SDG 2 (zero hunger), and SDG 8 (decent work and economic growth). Challenges also remain for the two equality-related SDGs: SDG 5 (gender equality) and SDG 10 (reduced inequalities). As shown in this report, COVID-19 has impacted employment and economic output, which are closely related to these SDGs. Additionally, the analysis presented in the next section also strongly suggests that the first five years of decarbonization investment could help make progress toward SDG 8 (decent work and economic growth), which in turn could lead to reduced poverty and hunger (SDGs 1 and 2).

Recovery Through Decarbonization Investment

Despite the near-term economic measures, the economic consequences of COVID-19, as measured by employment and economic activity, are likely to be long-lasting without mitigation. Green government investment and policies, when properly directed, can increase employment and economic development (Ianchovichina et al., 2012). These green industrial policies are sector-specific interventions that seek to change the economic production structure while supporting the development of critical new technologies and generating environmental benefits, even in the absence of carbon pricing (Hallegatte, Fay, and Vogt-Schilb, 2013). This approach is particularly important for Latin America and the Caribbean region, which registered a loss of 7.4 percent of its GDP as a result of COVID-19 and is currently struggling to keep pace with economic recovery, even though most countries have implemented policies to counteract the negative impacts of the pandemic (Watkins, Breton, and Edwards, 2021: Cavallo, Powell, and Serebrisky, 2020). For example, recent evidence suggests that, if correctly implemented, green industrial policies in the region could generate 15 million more jobs compared with a business-as-usual (BAU) scenario (Vogt-Schilb, 2021).

Government investment has been key for innovation and sociotechnological transformations beyond the traditional role of responding to market failures. Investments can help create new markets and achieve growth and specific industrial objectives (Mazzucato, 2016). Economic policies, in which the state invests in and implements industrial policies across the value chain, have in some cases (such as in China) contributed to large industrial transformations (Mazzucato, 2013), including in information technologies (Block and Keller, 2011), biotechnology (Lazonick and Tulum, 2011) and renewable energy (Mazzucato and Semieniuk, 2018). It is worth noting that these policies by themselves do not spur economic growth and innovation; in the absence of inclusive political and economic institutions, or a strong state, these policies can also lead to inefficiencies and corruption (Acemoglu and Robison, 2012, 2019). There are numerous benefits to public infrastructure investment, including increased private sector productivity, a higher rate of return than some forms of private capital, broader distribution of gains among the population, and production of public goods, such as clean air and water (Bivens, 2012). The benefits of public investment have the potential to be particularly large in Latin America, where a large gap between needed and existing infrastructure exists. However, without concurrent action to increase the efficiency of infrastructure and the regulation of the services provided, the benefits could be unrealized (Cavallo, Powell, and Serebrisky, 2020). Additionally, government investments can help mobilize private capital and signal to investors which key industrial and technological sectors could experience future growth (Aghion et al., 2015).

Costa Rica's National Decarbonization Plan (NDP), released in 2019, sets the goal of becoming carbon neutral by 2050, which means that Costa Rica's local greenhouse gas (GHG) emissions would be equivalent to the local sequestration provided by forests and other carbon sinks (Government of Costa Rica, 2019). The NDP proposes a set of investments and policies organized around ten lines of action that represent the main economic and infrastructure sectors of Costa Rica's economy. Table 1.3 summarizes these investments, and Table C.1 (in Appendix C) lists each specific NDP action.

Table 1.3. Representative Decarbonization Actions in Costa Rica's National Decarbonization Plan

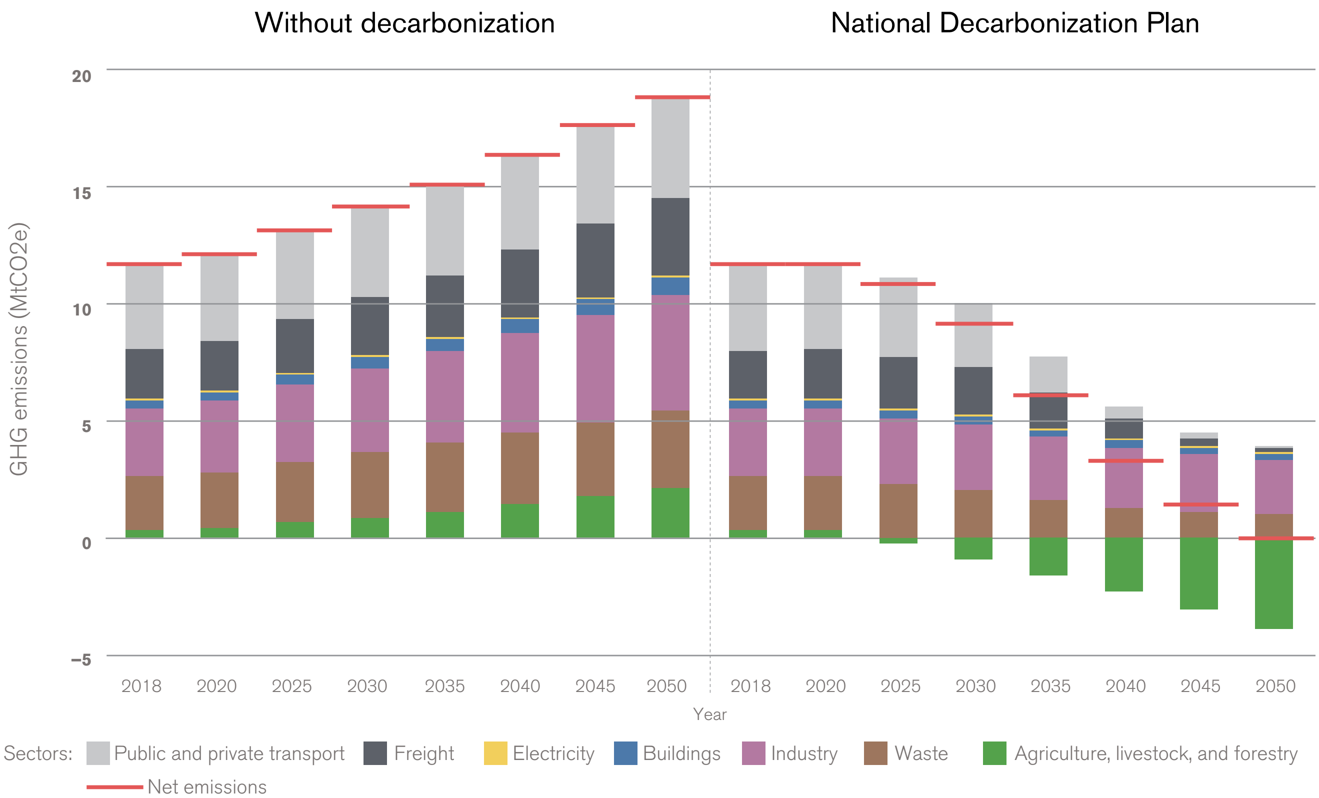
Public, private, and freight transportation	▪ Electrification of public and private fleet ▪ Conversion of freight transport away from diesel ▪ Increased reliance on public transportation and ride sharing over private vehicles ▪ Deployment of electric train for passagers in the Greater Metropolitan Area ▪ Stabilized motorcycle fleet by 2025, and plan to decarbonize ▪ Infrastructure for electricity charging and hydrogen refueling ▪ Electric for freight and passengers
Electricity system	▪ Reach and maintain 100% renewable electricity generation ▪ Upgrade transmission and distribution systems to support electrification of the economy
Buildings	▪ Electrification and increased eenrgy efficiency ▪ Adoption of low emissions building technologies and practices
Industry	▪ Process improvements to reduce energy use ▪ Electrification of processes ▪ Process improvements to reduce emissions ▪ Increased efficiency of use and reduction in emissions from industrial products
Waste management	▪ Increased recycling and composting ▪ Complete sanitation and sewer system coverage
Agriculture	▪ Reduce emissions through improved agricultural practices
Livestock	▪ Reduce emissions through improved rangeland and manure management
Forestry	▪ Maintain and increase forests ▪ Restore and protect coastal and rural areas

SOURCE: GROVES ET AL., 2020, TABLE S.1.

Figure 1.7 shows projected emissions without decarbonization and with the implementation of the NDP under the baseline assumptions; note that gross emissions from all major sectors would decline in this projection. [4]

[4] SINCE THE COMPLETION OF THE BENEFITS AND COSTS OF DECARBONIZATION STUDY, A MORE REFINED MODEL OF THE WATER AND LAND USE SECTORS HAS BEEN DEVELOPED. THIS MODEL, CALLED CLEWCR, EXTENDS THE TRANSPORTATION AND ELECTRICITY SECTOR MODEL USED IN THE PRIOR STUDY TO INCLUDE THE CIRCULAR ECONOMY AND THE AGRICULTURE, LIVESTOCK, AND FORESTRY SECTORS. IT PRODUCES SECTOR EMISSIONS ESTIMATES UNDER THE BAU AND NDP ASSUMPTIONS THAT ARE DIFFERENT FROM THOSE GENERATED IN THE COSTA RICA BENEFITS AND COSTS OF DECARBONIZATION STUDY (GROVES ET AL., 2020).

Figure 1.7. Costa Rican Greenhouse Gas Emissions Without Decarbonization and with Implementation of the National Decarbonization Plan



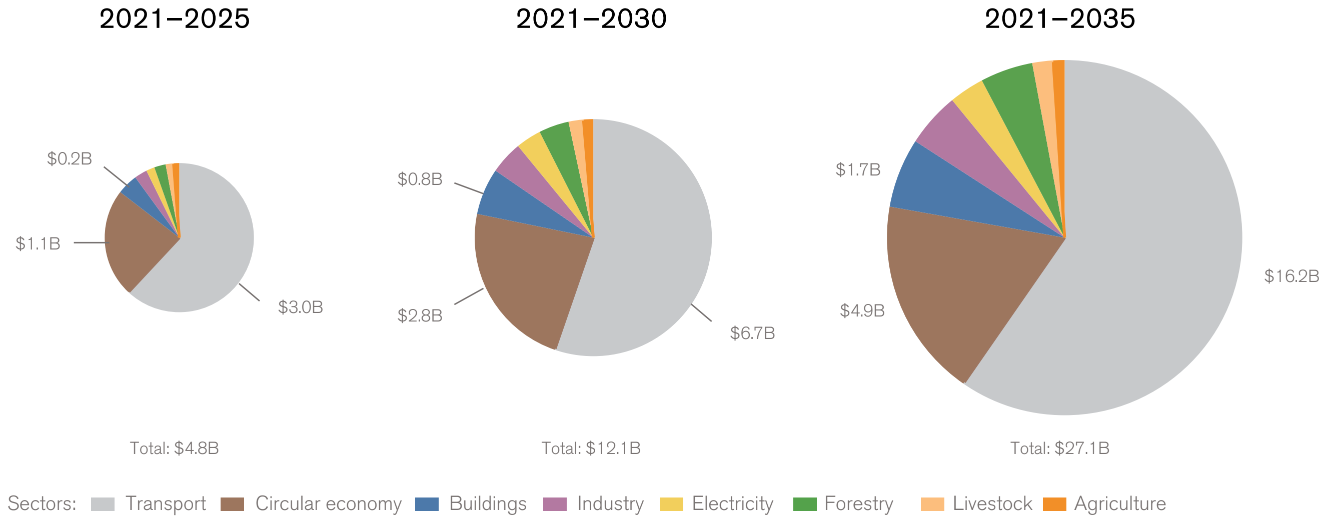
SOURCE: AUTHOR ANALYSIS OF DATA FROM GROVES ET AL., 2020.
NOTE: GHG EMISSIONS FROM THE ELECTRICITY SECTOR ARE NEGLIGIBLE BECAUSE COSTA RICA ALREADY PRODUCES MORE THAN 90 PERCENT OF ITS ELECTRICITY USING HYDROPOWER. NEGATIVE GHG EMISSIONS ARE POSSIBLE DUE TO THE HIGHER CAPTURE CAPACITY OF COSTA RICA'S FOREST COVER UNDER THE NDP. MTCO2E = METRIC TONS OF CARBON DIOXIDE EQUIVALENT.

The Benefits and Costs of Decarbonization study evaluated the NDP under a wide variety of plausible futures and determined that the long-term economic benefit to the Costa Rican economy could be significant—about $40 billion (Groves et al., 2020). These economic benefits are largely concentrated in the transport and forestry sectors, yet the specific benefits are relevant to many of the SDGs.

Reducing emissions across all sectors will require significant up-front investment. Although these investments were shown to have long-term economic benefits, they could also facilitate economic recovery from COVID-19. Groves et al., 2020, estimated additional capital expenditures to support decarbonization actions from 2021 to 2025 to be about $5 billion, mostly concentrated in the transport and circular economy lines of action (see Table B.2 in Appendix B for more detail). Looking out ten and 15 years, however, significant investment would need to be made in buildings and other lines of action, as well as in transport and circular economy (Figure 1.8).

More recent estimates of the total investment required to both support ongoing economic development and decarbonization in the transport sector (South Pole Carbon Asset Management [hereafter South Pole], 2019) and the agriculture, livestock, and forestry sectors (South Pole, 2021) have since been developed for the Investment Plan for Costa Rica's NDP (South Pole, 2019). These estimates include investments that would likely be incurred in the absence of the NDP's implementation and are considerably larger. We evaluate decarbonization spending scenarios based on all three sources.

Figure 1.8. Estimated Capital Costs for the National Decarbonization Plan by Lines of Action for the First Five, Ten, and 15 Years from the Benefits and Costs of Decarbonization Study



SOURCE: AUTHOR ANALYSIS OF DATA FROM GROVES ET AL., 2020.
NOTE: B = BILLION. VALUES OF ESTIMATED CAPITAL COSTS ARE SHOWN FOR BUILDINGS, CIRCULAR ECONOMY, AND TRANSPORT LINES OF ACTION.

Organization of This Report

This study aims to evaluate how investment in decarbonization, through the implementation of the NDP, could improve employment and economic growth in the near term as Costa Rica recovers from COVID-19. We first configure a model of the Costa Rican economy to evaluate the effects of COVID-19 on employment and economic activity between 2019 and 2020, and we then simulate a few scenarios of recovery in the coming years (Chapter Two). In Chapter Three, we present the modeling results of the COVID-19 effects and recovery as a baseline for evaluating the benefits of decarbonization investments. We then show how these COVID-19 economic recovery trajectories could be improved through investments in decarbonization (Chapter Four). In Chapter Five, we describe how decarbonization could help Costa Rica make progress on SDGs—a key tenet in Costa Rica's decarbonization vision, as described in its updated Nationally Determined Contribution (NDC; Government of Costa Rica, Ministry of Environment and Energy, 2020), which builds on the NDP. We conclude with recommendations for how decarbonization investments could be best targeted to provide additional near-term economic benefits, how these investments should be deployed and coordinated to generate long-lasting positive benefits across the different sectors of the economy, and how these investments could be prioritized to meet different SDGs over time, considering the progress the country has made on each one of them (Chapter Six).

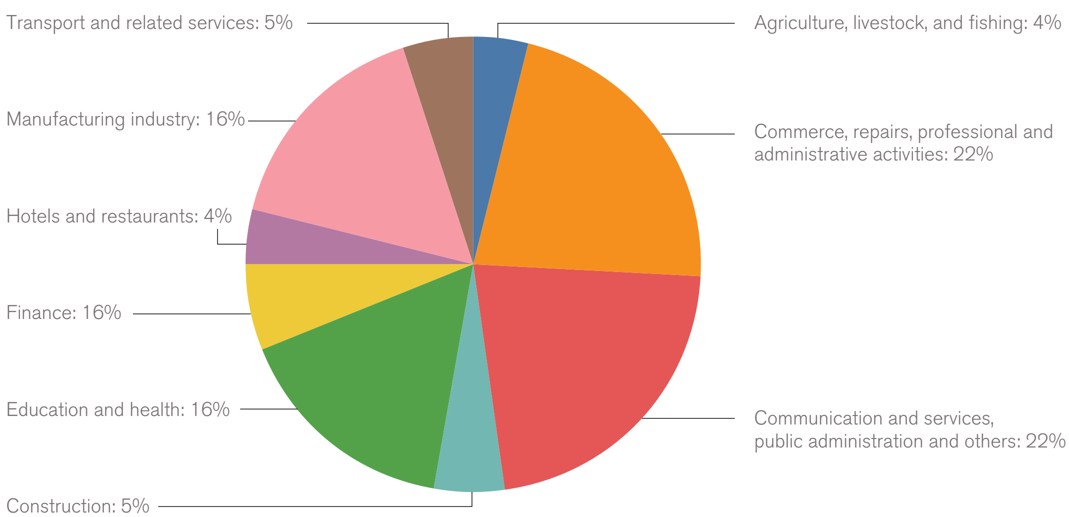
Chapter two

Modeling the Effect of COVID-19 and Decarbonization Investment on Costa Rica's Economy

Costa Rica's Economy: More Than Just Tourism

Costa Rica's economy is ranked 13th out of 40 in Latin America and the Caribbean, with a GDP of $63.9 billion in 2019 (World Bank, undated). Its economy is well known for its tourism, drawing visitors to its rain- forests, volcanos, beaches, and rich biodiversity. Costa Rica is ranked tenth in Latin America with respect to the state of its natural ecosystems (Yale Center for Environmental Law & Policy, 2020). The country boasts 30 national parks, and approximately 25 percent of the country is designated as protected through the Sistema Nacional de Áreas de Conservación (National System for Conservation Areas [SINAC], undated). According to BCCR (BCCR, undated), the direct contributions to GDP from tourism represent between approximately 4 percent and 6 percent of the total. When accounting for transportation, medical services, and recreational activities, the extended contribution of tourism to GDP is more than 8 percent. Figure 2.1 shows the share of value added by each of the economy's sectors, as quantified by the INEC. Note that these data do not provide a specific estimate for tourism. However, the sector classified as hotels and restaurants is closely linked to tourism.

FIGURE 2.1. Value Added by Sector as a Percentage of GDP, 2019



SOURCE: BCCR, UNDATED.
NOTE: BCCR DOES NOT SEPARATE ECONOMIC ACTIVITY FROM HOME EMPLOYEES; THAT ACTIVITY IS INCLUDED IN THE COMMERCE, REPAIRS, PROFESSIONAL AND ADMINISTRATIVE ACTIVITIES SECTOR.

Other important sectors include manufacturing industry, construction, and agriculture. Traditionally, Costa Rica has been a large exporter of agricultural products, including bananas, pineapples, coffee, palm oil, and cassava. However, over the past few decades, Costa Rica has diversified exports, and now the highest export revenue comes from medical products manufactured in its country. In 2019, export revenue was approximately $12 billion, and 70 percent of that came from 30 products, of which about one-third were medical products, such as needles, catheters, transfusion kits, medications, prosthetics, and electrodiagnosis devices (Costa Rican Trade Promotion Agency, 2021).

According to INEC, in 2019, Costa Rica sold almost $5 billion of goods to the United States. Reciprocally, the United States sold Costa Rica $7.8 billion of its $17.5 billion of imported goods (INEC, 2021a). Petroleum oil and diesel accounted for about $1.4 billion of imports, followed by textiles and clothing, medications, and automobiles at around $500 million each. Most employment comes from commercial (retail trade) and service provision sectors. At the end of 2019, there were 2.1 million people employed, of which 15 percent were public sector employees (INEC, undated-b).

Modeling Costa Rica's Economy

We used a general equilibrium model of the Costa Rican economy—Plataforma de Modelación Económico- Ambiental Integrada (Integrated Economic- Environmental Modeling [IEEM]; Banerjee and Cicowiez, 2020a, 2020b; Banerjee et al., 2019)—to simulate how the Costa Rican economy was affected by the COVID-19 pandemic, how it might recover from the COVID-19 pandemic shock, and how decarbonization investment could hasten its recovery. IEEM is a future-looking, dynamic, and computable general equilibrium framework that enables the analysis of how public policy and investment affect such indicators as value added, income and employment, wealth, and natural capital (Banerjee et al., 2016).

IEEM was configured to be consistent with the underlying economic structure of the Costa Rican economy and has been used to explore the effects that different environmental policies, such as ecosystem service payments, can have on productivity, wages, and consumption across different sectors of the Costa Rican economy (Banerjee and Cicowiez, 2020b). Foreign trade is modeled in IEEM assuming that prices for imports and exports are based on specified world prices. IEEM then estimates economic activity (e.g., jobs, productivity, value added) for all sectors of the economy, such as transportation demand, industrial production, agricultural production, and livestock production.

IEEM is calibrated using a social accounting matrix (SAM) for Costa Rica (Banerjee and Cicowiez, 2020b). The SAM provides an aggregated description of the key characteristics of the economic sectors registered in a country's national accounts by representing transactions between economic agents in an economy (Mainar Causapé, Ferrari, and McDonald, 2018). Table 2.1 shows a few representative rows from the Costa Rican SAM. The first three numerical columns indicate the relative share of capital, labor, and natural resource expenditures for each indicated sector. For example, the SAM shows that some sectors, such as electricity and gas and communications, are capital-intensive sectors, while other sectors, such as commerce, home employees, and coffee cultivation, are labor intensive. The fourth and fifth columns show the percentage of imports and exports with respect to total expenditures and sales. In this case, we see that banana and coffee production are highly targeted to foreign markets. In contrast, economic sectors such as electricity and gas and mining are highly targeted to the local Costa Rican market. This distinction is relevant because it determines how much an economic sector can expand in response to higher capital investments; export-oriented economic sectors have higher expansion opportunities than do economic sectors oriented mainly to the Costa Rican market.

Table 2.1 Select Rows of the Costa Rican Social Accounting Matrix

Sector	Share of Capital Expenditures Across Sector (%)	Share of Labor Expenditures Across Sector (%)	Share of Natural Resources Expenditure (%)	Percentage of Imports with Respect to Total Expenditures (%)	Percentage of Exports with Respect to Total Receipts (% Sales)
Banana	25	49	26	0.1	92.5
Coffee cultivation	10	87	3	0.3	0.0
Coffee production	76	24	0	3.3	57.4
Commerce	39	61	0	0.0	0.0
Communications	67	33	0	4.0	0.6
Construction	45	55	0	0.6	0.0
Electricity and gas	69	31	0	1.3	0.6
Food	61	39	0	13.2	19.5
Forestry (silviculture)	46	50	3	1.1	21.3
Home employees	0	100	0	0.0	0.0
Hotels and restaurants	56	44	0	10.1	0.1
Machinery and equipment	63	37	0	43.6	36.5
Mining	62	16	22	9.6	1.3
Rice	44	23	33	18.8	0.2
Services	64	36	0	4.5	6.0
Vehicles	37	63	0	55.5	0.6

NOTE: BOLD ITEMS ARE DISCUSSED FURTHER IN THIS REPORT.

Another important characteristic of the Costa Rican economy that is represented by the SAM is the interrelations that exist among the different economic sectors. For example, higher levels of production of coffee increase economic activity in this sector but also lead to high levels of activity in sectors that supply resources for coffee production (e.g., labor, water, energy). At the same time, changes in capital intensity or labor intensity in one sector may affect the levels of production of other economic sectors. As another example, a shock in capital in one sector due to outside investment could have employment effects in that sector and in the rest of the economy (see Appendix A for further discussion on this subject).

We use IEEM to estimate the productivity of the Costa Rican economy for each sector using the value added metric[5]. We use direct estimates of employment by sector to characterize the labor market. Because IEEM does not distinguish between female or male employment, we assume that the share of jobs held by women and men in each sector is constant over time. This approach provides a first approximation to how women and men may lose or gain jobs, based on employment change by sector. A more refined analysis would incorporate additional information about how the relative share of jobs for women and men within a sector might change during COVID-19 recovery. Similarly, we estimate employment changes across low- wage and high-wage jobs by assuming that the wage characteristics of each sector remain the same over time. Appendix A describes how the wages of each sector are classified.

COVID-19 Economic Impacts and Recovery

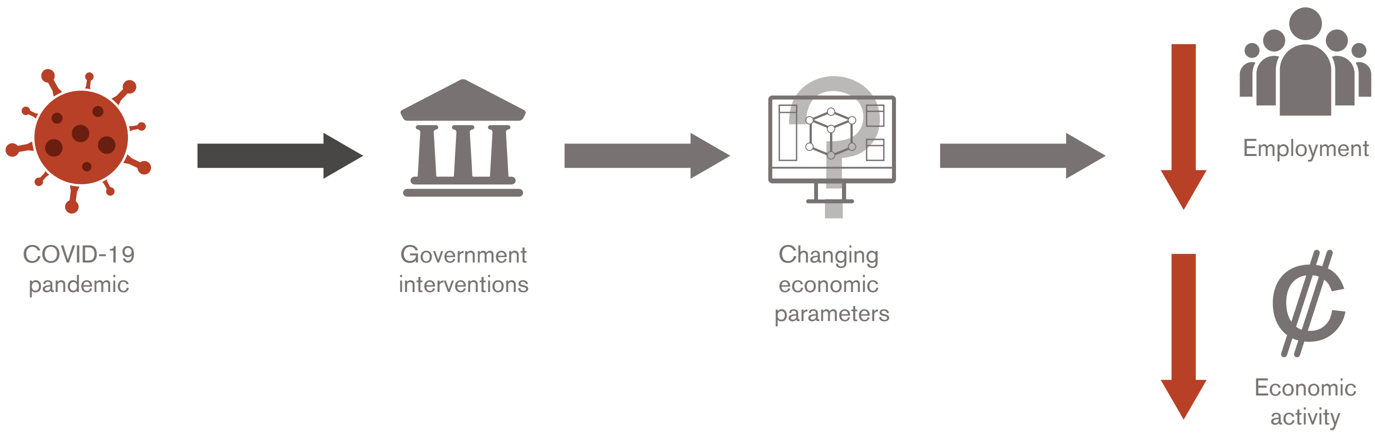
COVID-19 and public health responses have affected economies worldwide in many ways. Social distancing interventions and mobility restrictions, for example, have suppressed demand for many goods and services, such as domestic workers, restaurants, and tourism. Similarly, restrictions on how businesses can operate have reduced the productivity of labor and capital and the need for workers (Vardavas et al., 2020).

We configured IEEM first to represent the employment and economic output declines experienced in 2020 due to the pandemic. There are various mechanisms by

[5] VALUE ADDED PROVIDES A PROXY FOR THE LEVEL OF ECONOMIC ACTIVITY WITHIN AN ECONOMIC SECTOR BECAUSE IT CONSIDERS THE DEMAND FOR LABOR AND CAPITAL IN PRODUCTION. HOWEVER, IT DOES NOT CONSIDER THE DEMAND FOR IQTERMEDIARY INPUTS IN PRODUCTION.

which the economic shocks associated with the COVID-19 response can be represented in a general equilibrium model (e.g., labor productivity shocks, excess capacity, and exogenous shocks to sectorial demand).[6] However, the data and research have not yet identified which mechanisms are the most important in Costa Rica; thus, we explored the interplay of these shocks, as well as different levels of intensity for each. Figure 2.2 illustrates a simple conceptual model of how we modeled COVID-19 effects through the adjustment of IEEM parameters.

Figure 2.2. Framework for Modeling COVID-19 Effects on the Costa Rican Economy



We explored the sensitivity of employment and economic output in response to the following parameters:[7]

- **Labor productivity:** Labor productivity determines how much production a single worker provides on behalf of a business. COVID-19 and governmental responses have reduced the productivity of labor through additional social distancing requirements and closures of some businesses. Productivity declines lead to reduced total wages paid to workers (which affects consumption), as well as reduced economic output in affected sectors. In IEEM, labor productivity rates are adjusted downward for sectors affected by the governmental response.

- **Elasticity of real capital return with respect to excess capacity (capital) rate:** The elasticity of real capital return with respect to excess capacity (capital) rate determines the marginal effect that changes in unused capital have on capital rents, which affect household income, consumption, and ultimately unemployment across the economy. The effects that COVID-19 restrictions have on wages are modulated by adjusting this elasticity parameter; increasing this elasticity leads to a larger effect of COVID-19 on household incomes.

- **Elasticity of wages on unemployment:** The elasticity of wages on unemployment determines the marginal effect that changes in unemployment have on wages across the economy. The higher the elasticity, the higher the effect that unemployment has on wage declines, which put a greater share of workers below the reserve wage. This parameter is used to capture the effect that COVID-19 restrictions had on the total number of jobs lost in the economy. Through the adjustment of this parameter, it is possible to differentiate the impact of COVID-19 on high-skilled and lower-skilled (mid- and low-skilled) workers.

[6] *ALTERNATIVE APPROACHES TO MODELING COVID-19 SHOCKS ARE AS FOLLOWS: (1) DEMAND AND (2) OUTPUT RESTRICTIONS FOR SECTORS AFFECTED BY CONTAINMENT POLICIES. THESE ALTERNATIVE MODELING APPROACHES WERE OUTSIDE THE SCOPE OF THIS STUDY, BUT WE HIGHLY RECOMMEND THAT THESE APPROACHES ARE EXPLORED IN SUBSEQUENT ANALYSES WHEN MORE INFORMATION ABOUT THE COVID-19 IMPACTS ON THE COSTA RICAN ECONOMY BECOMES AVAILABLE. BOTH MODELING APPROACHES AFFECT EMPLOYMENT AND OUTPUT BUT MAY DIFFER WITH RESPECT TO HOW THE COVID-19 SHOCK IMPACTED THE USE OF CAPITAL IN THE DIFFERENT ECONOMIC SECTORS.*

[7] *IN OUR CALIBRATION, WE ASSUME THAT THESE PARAMETERS ARE EXOGENOUSLY DETERMINED EVEN THOUGH THESE PARAMETERS ARE DETERMINED BY ECONOMIC CONDITIONS AND POLICIES. SUCH CONSIDERATION FALLS OUTSIDE THE SCOPE OF THIS STUDY.*

- **Demand for goods and services:** The SAM indicates the inputs demanded by each sector from the others to supply goods and services. For example, the demand for tourism is determined primarily by forces outside of Costa Rica, and therefore, tourism is primarily exogenously determined. Similarly, the demand for domestic services is also modeled independently from other economic sectors of the Costa Rican economy. Thus, for these two sectors—tourism and domestic services—we adjusted the demand to reflect the effects that COVID-19 restrictions had on these sectors.

Table 2.2 summarizes the four IEEM parameters that are used to model COVID-19 effects on the Costa Rican economy.

Table 2.2. Modeling the Effects of COVID-19 and Governmental Interventions in IEEM

IEEM Parameter	Economic Effect
↓ Labor productivity	↓ Total wages paid to workers ↓ Economic output ↓ Household income
↑ Elasticity of real capital return with respect to excess capacity (capital) rate	
↑ Elasticity of wages on unemployment	↓ Employment and ↑ unemployment
↓ Demand for goods and services	↓ Employment and ↓ economic output

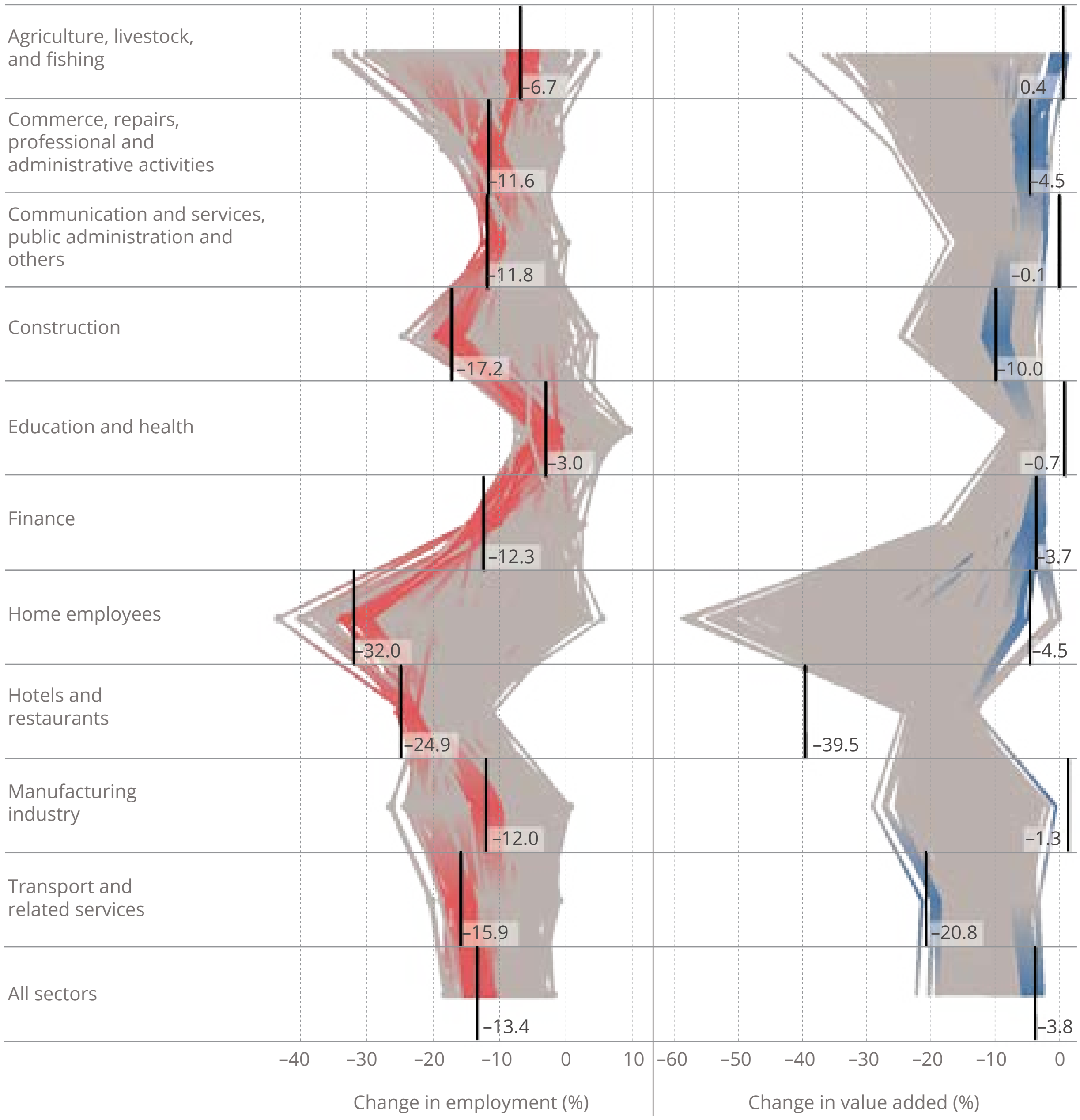
NOTE: ARROWS INDICATE THE CARDINALITY OF THE MODELED EFFECT AND THE RESULTING ECONOMIC IMPACT.
DOWNWARD-POINTING ARROWS INDICATE NEGATIVE MARGINAL CHANGES, AND UPWARD-POINTING ARROWS INDICATE POSITIVE MARGINAL CHANGES.

We simulated economic behavior from 2019 to 2020 across many combinations of parameters to find a set that minimizes the differences in IEEM-estimated sector-based changes in employment and value added to observed changes.[8] Figure 2.3 shows the sector changes in employment (left) and value added (right) from 400 IEEM simulations (colored lines) compared with the observations (black labeled lines). The red and blue simulation results correspond to the results that are close to the observations.[9] IEEM simulates the observed change for most sectors, with the noticeable exception of value added in the hotel and restaurant sector. Also, the parameters that lead a modeled change in one sector and variable to match observations do not always lead to well-matched changes in other sectors. Furthermore, parameter settings that lead to good employment estimates significantly overestimate changes in value added for all but a couple of sectors, and vice versa. These results suggest that the adjusted variables—labor productivity, elasticity of excess capital capacity on wages, elasticity of wages on unemployment, and exogenous demand for tourism and domestic services—do not provide sufficient flexibility (or degrees of freedom) to completely reflect the observed changes in employment and value added across all sectors simultaneously. This is not unexpected, because existing prepandemic economic models have been configured and calibrated to account for more-common economic conditions. Further research and model development will allow IEEM and similar models to reflect COVID-19 effects more closely. Despite these limitations, the IEEM results can usefully estimate recovery conditions by focusing on independent calibrations for employment and value added and the benefits of decarbonization investment on the economy as a whole, by using a single calibration that balances performance across employment and value added results.

[8] THIS APPROACH IS SIMILAR TO THE ONE TAKEN BY GO ET AL., 2016.

[9] CLOSENESS IS DEFINED AS THE DIFFERENCE BETWEEN THE ECONOMIC INDICATOR CHANGES (E.G., EMPLOYMENT AND VALUE ADDED) REGISTERED IN CENSUS ECONOMIC DATA AND IN THE RESULTS OF OUR NUMERICAL SIMULATIONS. THE CLOSER THIS DIFFERENCE IS TO ZERO, THE HIGHER THE CLOSENESS BETWEEN THE SIMULATION AND THE ECONOMIC CENSUS DATA. ESTIMATED CHANGES IN THESE ECONOMIC INDICATORS USING THE ECONOMIC CENSUS DATA ARE CALCULATED BY COMPARING CENSUS DATA BETWEEN 2019 AND 2020. ESTIMATED CHANGES IN THESE ECONOMIC INDICATORS USING THE NUMERICAL RESULTS OF THE SIMULATION ARE CALCULATED BY COMPARING THE OUTCOMES OF THE BASELINE (NO-SHOCK [I.E., NO COVID-19]) SIMULATION AND THE EXOGENOUS SHOCK SIMULATION (COVID-19) FOR THE YEAR 2020.

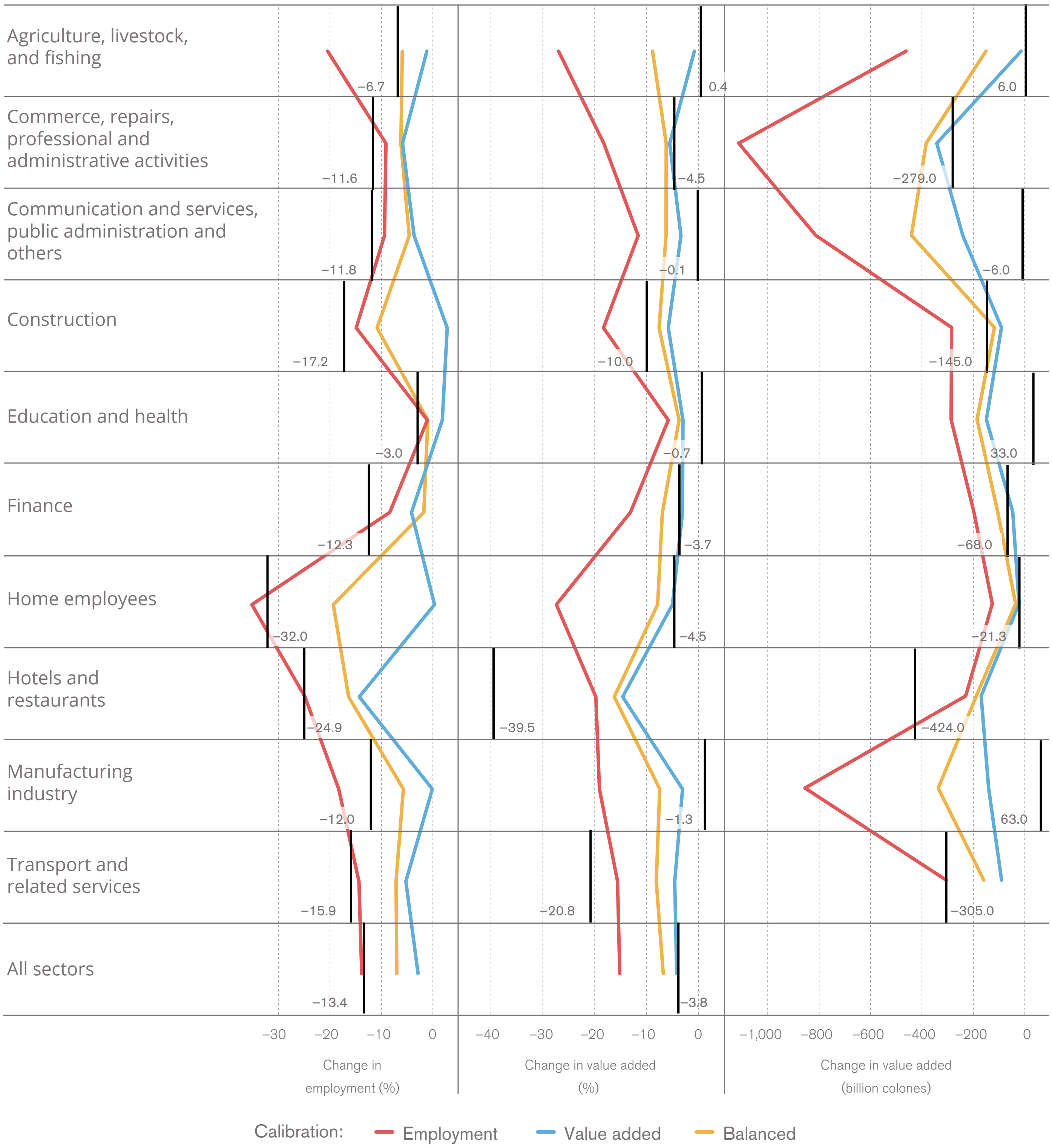
Figure 2.3. Predicted Change in Employment and Value Added Due to COVID-19 for 400 IEEM Simulations



NOTE: THE LINES ARE SHADED RED OR BLUE FOR THE PORTIONS OF THE RESULTS THAT ARE WITHIN 2.5 PERCENTAGE POINTS OF THE OBSERVED VALUE.

We defined three calibrations—one for employment, one for value added, and one that balances between the two economic indicators. For employment, we identified a set of parameters that produced close esti- mates for eight of the ten sectors while overestimating job losses in the agriculture, livestock, and fishing and the manufacturing industry sectors. For value added, we similarly identified a solution that roughly matched eight of the ten sectors while underestimating changes in value added in the hotels and restaurants and the transport and related services sectors. We defined a balanced calibration that missed more targets for both employment and value added; however, it was consistent across the sectors and thus more appropriate to use when evaluating sector effects (Figure 2.4). Table A.2 (in Appendix A) shows the range of productivity shock parameters for each IEEM subsector and the values for the three calibration cases.

Figure 2.4. Predicted Change in Employment and Value Added Due to COVID-19 for 400 IEEM Simulations



We estimated three trajectories of economic recovery from COVID-19 by relaxing the COVID-19 shocks imposed in 2020 over three different time horizons—one year, three years, and five years. Specifically, each model parameter that is changed to simulate COVID-19 effects in 2020 is adjusted back to its original setting over a one-, three-, or five-year time horizon.

Decarbonization Investments on Economic Recovery

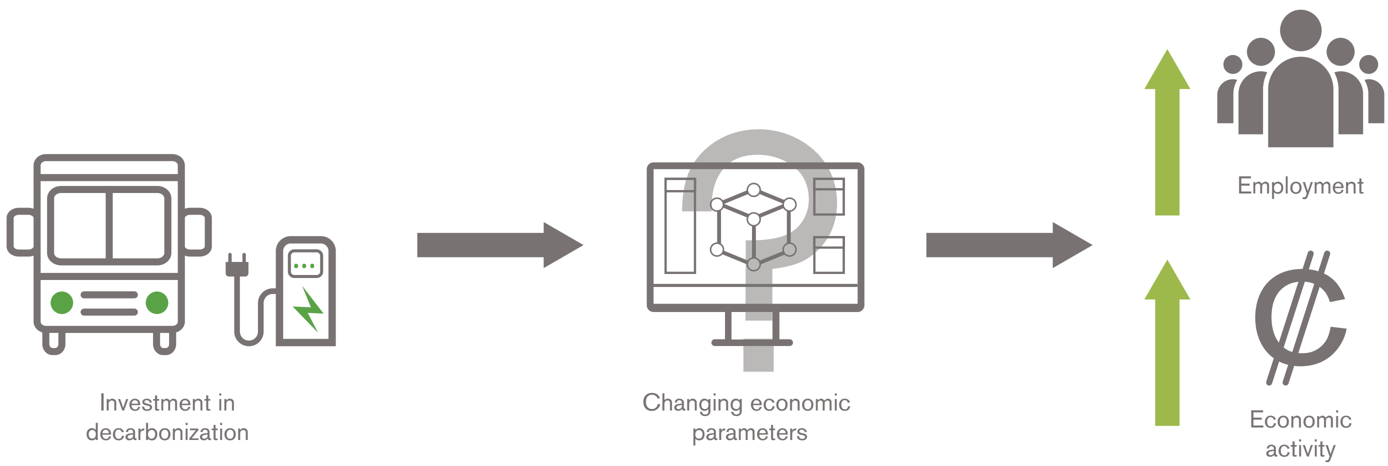
The scale of the investments required to support the NDP are large, relative to Costa Rica's GDP, and it will be necessary to mobilize both government and private investments. Although a financing plan is not yet completed, it is expected that the NDP will be implemented through the combination of targeted governmental investments with regulatory changes that incentivize private investment in the different lines of action of the NDP—for example, tax incentives and mandates that induce firms and customers to adopt decarbonization practices and other policy instruments that satisfy the restrictions imposed by ongoing IMF negotiations and the prevailing political climate.

To simplify our analysis, we assume that the financing of the NDP will not result in a higher share of public investments, higher taxes, or higher government debt.[10] Thus, we modeled the economic effects of decarbonization investments in IEEM by assuming that decarbonization investments will be privately financed through foreign capital markets. This simplifying assumption allows this study to focus primarily on understanding how decarbonization investments could change the interrelations of the different sectors of the Costa Rican economy. This modeling approach could be expanded to consider endogenous mechanisms of structural change resulting from these investments, such as market creation and higher productivity gains through endogenous productivity improvements in sectors associated with the NDP. Additionally, the benefits of decarbonization could be modeled by dynamically changing coefficients in the SAM used in the model. For example, the SAM could be adjusted to make the transportation sectors less reliant on the import of fossil fuels and more reliant on domestic electricity over time. Lastly, environmental externalities, such as air pollution and reduced congestion resulting from decarbonization actions, could be introduced as positive productivity shocks in the labor force.

Given the volume of investments required to implement the NDP, it is expected that these investments will be made by the private sector and the public sector, with the support and collaboration of multilateral organizations, such as multilateral development banks or the Green Climate Fund. However, further research is needed to understand in more detail how these investments can be incentivized through the deployment of public investments or through fiscal and regulatory reforms. Figure 2.5 shows our conceptual framework for estimating the effects of decarbonization investment on employment and economic activity.

[10] *INFLATIONARY IMPACTS OF THESE INVESTMENTS ARE NOT ESTIMATED IN THE MODELING FRAMEWORK USED IN THIS STUDY.*

Figure 2.5. Framework for Modeling Decarbonization Investments on the Costa Rican Economy



In our analysis, decarbonization investments are allocated to different economic activities across Costa Rican's economy, per an investment/capital shock matrix that maps capital investments to each sector in the IEEM (see Appendix A). Higher private investment in these activities induces higher levels of capital stocks, which in turn increase productivity and value added. Additionally, because economic sectors are interconnected, investments in one sector can also induce changes in economic activity and employment in other sectors. For example, higher levels of production in the construction sector increase the demand of inputs produced by other sectors,[11] such as manufacturing and professional services, and have a multiplier effect on the economy

At the time of this study, the only complete estimate of costs for the NDP was presented in the Benefits and Costs of Decarbonization study (Groves et al., 2020). That study estimates costs for fully implementing all transportation and electricity line of action investments without the NDP in place (the BAU case) and with the NDP in place. The difference in costs between these two estimates represents the investment needed to implement the transportation- and electricity-specific measures in the NDP. Investment estimates for the other lines of action were based only on the incremental activities between BAU and the implementation of the NDP, using decarbonization cost factors drawn from the literature.

Concurrent with this study, another effort was underway for the National Investment Plan (hereafter Investment Plan) to estimate costs more formally for each of the ten lines of action from the NDP, which provided estimates for the transport line of action (South Pole, 2019) and the agriculture, livestock, and forestry lines of action (South Pole, 2021).

The South Pole studies estimate total investment costs for the NDP, including those that would have been otherwise incurred in BAU conditions; they do not specify the incremental costs associated with implementing the NDP. For the transport line of action, the estimate of total investment costs from Groves et al., 2020, and South Pole, 2019, are similar, because they both are based on detailed evaluations of the required transportation infrastructure to meet future needs. For the land use lines of action (agriculture, livestock, and forestry), direct cost comparisons are not possible because Groves et al., 2020, estimates only additional NDP costs, whereas South Pole, 2021, estimates only total investments, inclusive of BAU costs. However, the newer, and more detailed, bottom-up estimates from South Pole are likely to be a more reliable representation of the NDP costs. Given that BAU investments in the land use lines of action are likely to be much lower than those for the NDP, the South Pole total investment estimates suggest that higher decarbonization investments are required for the NDP in the land use lines of action. Estimates for

11 OUR MODELING FRAMEWORK DOES NOT DISTINGUISH BETWEEN DIFFERENT LEVELS OF CARBON INTENSITY WITHIN SECTORS (E.G., CEMENT-BASED CONSTRUCTION AND SUSTAINABLE MATERIALS-BASED CONSTRUCTION)

the remaining lines of action—electricity, buildings, industry, and circular economy—were still being prepared while we completed this report.

Using available information, we developed three decarbonization investment scenarios to evaluate the effects of decarbonization investments on each broad sector of the Costa Rican economy. Each scenario assumes that investments begin in 2021. If investments begin later than 2021, the benefits would shift in time but still have a similar effect.

The first investment scenario is based solely on the decarbonization cost estimates from Groves et al., 2020, totaling $4.85 billion between 2021 and 2025 (Table 2.3). The second and third scenarios replace transportation, livestock, agriculture, and forestry cost estimates with the newer estimates of investment needs in these lines of action developed for the Investment Plan (South Pole, 2019, 2021). These scenarios assume that the additional transport costs for the NDP are proportionally the same as those from Groves et al., 2020, or 18.65 percent. For the land use sectors, we assume that 50 percent and 100 percent of the total investment costs are attributable to the NDP for the second and third scenarios, respectively. The total investment costs from 2021 to 2025 for the second and third scenarios are $6.2 billion and $8.3 billion, respectively.

TABLE 2.3 Estimates of Decarbonization Investment Costs, 2021—2025 (billion U.S. dollars)

	Decarbonization Investment Scenario		
NDP Line of Action	$4.85 Billion	$6.2 Billion	$8.3 Billion
Transport	2.96[a]	2.42[b]	2.42[b]
Electricity	0.09[a]	0.09[a]	0.09[a]
Buildings	0.21[a]	0.21[a]	0.21[a]
Industry	0.13[a]	0.13[a]	0.13[a]
Circular economy	1.20[a]	1.20[a]	1.20[a]
Livestock	0.06[a]	0.78[c]	1.56[d]
Agriculture	0.08[a]	0.42[c]	0.84[d]
Forestry	0.12[a]	0.92[c]	1.84[d]
Total	**4.85**	**6.17**	**8.29**

a COST DERIVED DIRECTLY FROM GROVES ET AL., 2020.

b TRANSPORT NDP NET COST BASED ON SOUTH POLE, 2019, ESTIMATES OF TOTAL NDP COSTS AND THE RATIO OF NDP NET COSTS TO TOTAL NDP COSTS FROM GROVES ET AL., 2020, OR 18.65 PERCENT.

c NET COSTS FOR LIVESTOCK, AGRICULTURE, AND FORESTRY LINES OF ACTION ARE BASED ON SOUTH POLE, 2021, ESTIMATES OF TOTAL NDP COSTS, WITH AN ESTIMATION THAT 50 PERCENT OF COSTS ARE ADDITIONAL DECARBONIZATION COSTS.

d NET COSTS FOR LIVESTOCK, AGRICULTURE, AND FORESTRY LINES OF ACTION ARE BASED ON SOUTH POLE, 2021, ESTIMATES OF TOTAL NDP COSTS, WITH AN ESTIMATION THAT 100 PERCENT OF COSTS ARE ADDITIONAL DECARBONIZATION COSTS.

Chapter three

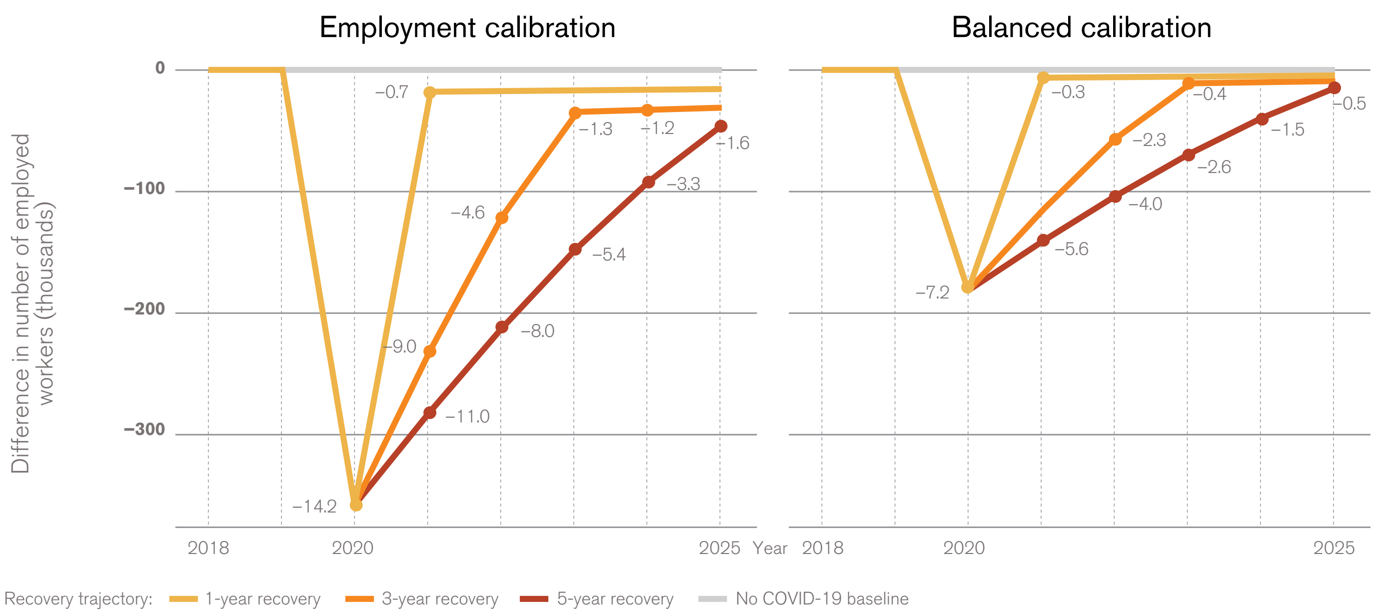
Possible COVID-19 Recovery Trajectories

In this chapter we explore how the Costa Rican economy could recover from COVID-19 through 2025 for three different recovery time horizons—in one, three, and five years. These recovery trajectories are com- pared with a no COVID-19 baseline case. We present modeling results of employment and value added, with a focus on employment changes to low- and high-wage workers and to female and male workers, as well as how COVID-19 affects employment and value added across sectors.

COVID-19 Effects on Employment

COVID-19 led to a significant drop in employment in 2020, and it is expected to take several years for recovery. Figure 3.1 shows IEEM estimates of the change in jobs relative to the no COVID-19 baseline case for three scenarios of COVID-19 recovery. We present the results in terms of absolute jobs and percentage of jobs lost. The left panel shows the results for the employment calibration case, which most closely matches the observed employment change from 2019 to 2020 (14.2 percent). The right panel shows the results for the balanced calibration case, which simulates lower employment losses. In both cases, the differences in employment between no COVID-19 and with COVID-19 conditions lessen over time inversely proportional to the assumed recovery time. For both calibrations and each of the three recovery time assumptions, employment does not reach by 2025 the levels that it would have reached had the COVID-19 pandemic not happened; the longer the recovery, the larger the employment reduction is. These results serve as the baseline for the analysis of decarbonization investment shown in Chapter Four.

Figure 3.1. Modeled Change in Jobs Under Three COVID-19 Recovery Trajectories Relative to the No COVID-19 Baseline

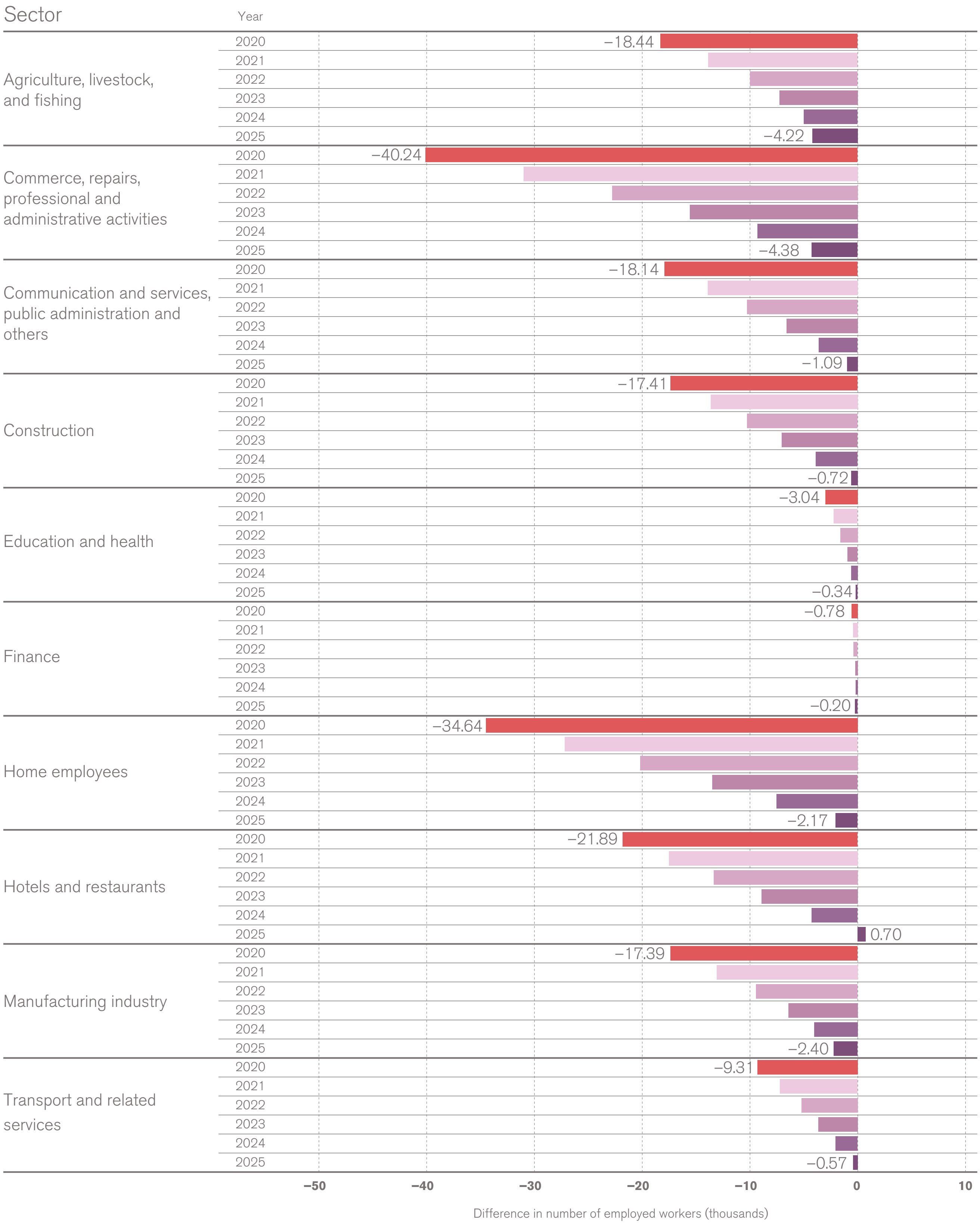


NOTE: THE RESULTS ON THE LEFT ARE BASED ON A CALIBRATION OPTIMIZED FOR EMPLOYMENT; RESULTS ON THE RIGHT ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED. THE VALUE LABELS INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE NO COVID-19 BASELINE CASE.

We next explore how employment across economic sectors could recover from the shock of COVID-19 using the balanced calibration, which underestimates the total job loss but better reflects relative sectoral job loss. Figure 3.2 shows the modeled change in employment by sector from 2020 to 2025 for the five-year recovery time assumption and employment calibration. Each bar corresponds to one year. For the sectors in which COVID-19 leads to employment loss, the employment decline becomes smaller over time. Note that by 2025, the difference in employment is mostly gone for some sectors. For others, residual declines persist— agriculture, livestock, and fishing (−4,220 jobs); commerce, repairs, professional and administrative services (−4,380 jobs); home employees (−2,170 jobs); and manufacturing industry (−2,400 jobs).[12]

[12] *IEEM is a dynamic recursive model in which several parameters, such as the general tax rate, savings, and investments, are endogenously calibrated to balance the national accounts of the economy being simulated. Thus, because no steady state in the economy has been determined, once an economic shock occurs, the economy does not necessarily return to the preshock levels.*

Figure 3.2. Modeled Difference in Number of Jobs Due to COVID-19 Under a Five-Year COVID-19 Recovery Trajectory (2020–2025)



NOTE: EMPLOYMENT RESULTS FOR 2020 AND 2025 ARE LABELED. RESULTS ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED.

Using IEEM as a representation of what occurred from 2019 to 2020 and what could happen through 2025, we simulated how jobs held by men versus women and high-wage versus low-wage workers were lost and could recover (Table 3.1). For this analysis, we assume the same share of female and male workers by sector as observed in 2019. We categorize jobs by skill; high productivity sectors are classified as high-skilled sectors and low productivity sectors are classified as low- and mid-skilled sectors, based on the classification of IEEM sectors shown in Table A.1 (in Appendix A).

Comparing the simulated employment results by gender and skill (Table 3.1), using the employment calibration, with the observed data in Table 1.1 (in Chapter One), we see similar patterns in job losses by gender and wage classification. IEEM estimates that 295,500 jobs were lost from 2019 to 2020 (or 12.0 percent) compared with the observed job loss of 286,074 or 13.1 percent.[13] IEEM estimates that women lost 12.9 percent of their jobs compared with the observed loss of 17.8 percent. This underestimate in female job losses by IEEM could be because we assumed that, within a specific sector, job losses by gender were proportional to the share of jobs held by women and men and that these proportions remained unchanged before and after COVID-19. In reality, there are forces related to COVID-19 that affect women proportionately more than they do men. For example, women are more likely to leave the workforce to care for sick family members or to support children who are no longer going to school due to school closures.

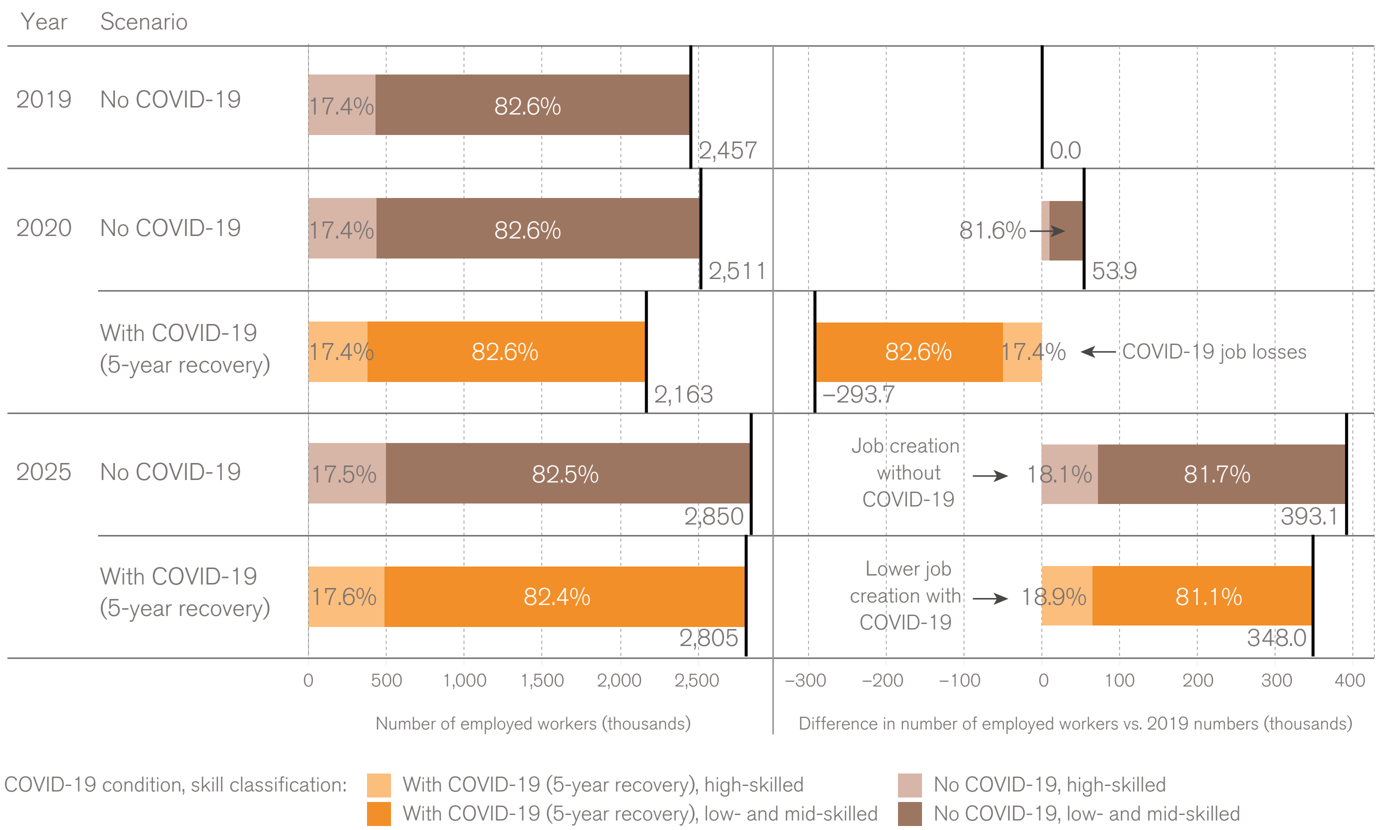
Table 3.1. Simulated Share of Employment in 2019 and 2020 Without COVID-19 and the Simulated Difference in Employment Between COVID-19 Conditions and the No COVID-19 Baseline by Gender and Skill Classification

Gender	Skill Classification	Difference in 2020 Jobs Compared with 2019 Jobs (Absolute and Percentage)	Difference in Jobs in 2025 Compared with the No COVID-19 Baseline (Absolute and Percentage)		
			1-Year Recovery	3-Year Recovery	5-Year Recovery
Female	Low and mid	-104,400 (-13.1%)	-4,700 (-0.5%)	-9,200 (-1.0%)	-13.800 (-1.5%)
	High	-16,000 (-11.9%)	-600 (-0.4%)	-1,200 (-0.7%)	-1,700 (-1.1%)
	All	-120,000 (-12.9%)			
Male	Low and mid	-140,000 (-11.3%)	-8,600 (-0.6%)	-17,100 (-1.2%)	-25,800 (-1.8%)
	High	-35,000 (-11.9%)	-1,300 (-0.4%)	-2,500 (-0.7%)	-3,700 (-1.1%)
	All	-175,000 (-11.4%)			
Total		-295,500 (-12.0%)	-15,500 (-0.5%)	-30,600 (1.1%)	-46,000 (-1.6%)

13 NOTE THAT IEEM BASE CALIBRATION YEAR IS BASED ON THE LAST YEAR FOR WHICH THE SAM EXIST (I.E., 2016), AND JOBS ARE SIMULATED TO GROW FROM 2017 TO 2019 AT A RATE FASTER THAN WHAT OCCURRED. THEREFORE, THE 12 PERCENT OF JOB LOSS MODELED BY THE IEEM REPRESENTS MORE JOBS THAN 12 PERCENT OF JOBS IN CENSUS DATA.

To better visualize the changes in employment by skill classification and gender, we show total employed workers over time and the change from 2019, broken out by skill classification (Figure 3.3) and by gender (Figure 3.4). Based on the modeling of employment prior to the COVID-19 pandemic, about 83 percent of jobs were lower-skilled (i.e., low- and mid-skilled), and a similar proportion of lost jobs between 2019 and 2020 were also lower-skilled (Figure 3.3). Without COVID-19, IEEM estimates that by 2025 jobs would have increased, with a slightly higher proportion of high-wage jobs (18.1 percent versus 17.4 percent). With COVID-19, however, job creation is less and low- and mid-skilled jobs increase at a slightly lower proportion to their share in 2019.

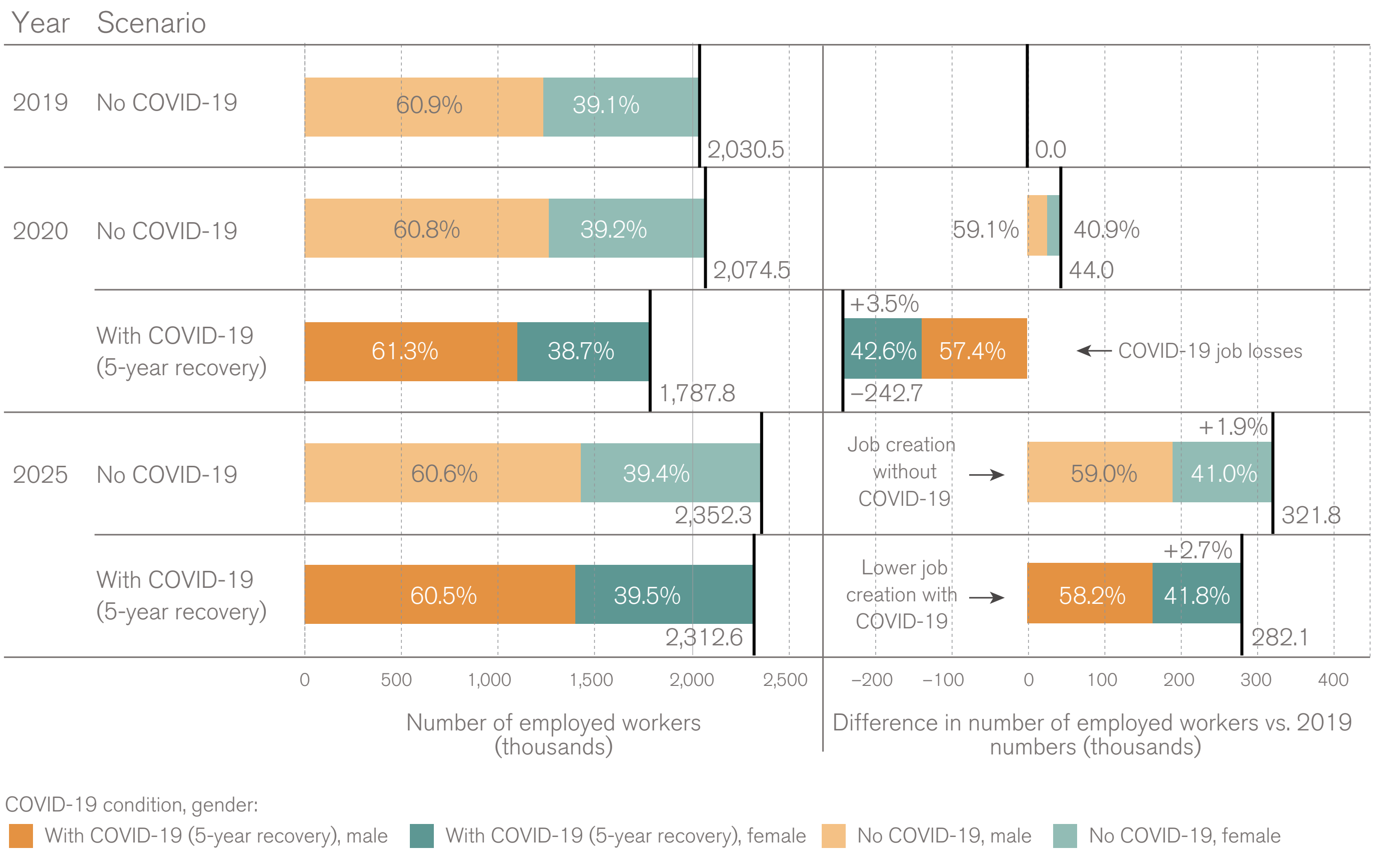
FIGURE 3.3 Total Jobs, by Skill Classification, and Change in Jobs, by Skill Classification, 2019–2020 and 2025, With and Without COVID-19



NOTE: RESULTS ARE BASED ON A FIVE-YEAR RECOVERY TRAJECTORY AND THE EMPLOYMENT CALIBRATION. THE LEFT-HAND PERCENTAGE IN EACH PAIR SHOWS THE SHARE OF HIGH-SKILLED JOBS COMPARED WITH THE SHARE OF LOW- AND MID-SKILLED JOBS.

When looking at employment by gender, however, we see larger discrepancies with respect to the percentage of workforce participation in 2019 and changes in employment due to COVID-19 (Figure 3.4). In 2019, 39.1 percent of low- and mid-skilled employees were women (as estimated by IEEM). However, 42.6 percent of jobs lost between 2019 and 2020 due to COVID-19 were held by women—a 3.5 percent higher percentage of jobs held by women. The job recovery through 2025 simulated by IEEM only partially reverses this gender disparity: Only 2.7 percent more of the jobs gained would be held by women. As a result, the IEEM simulations suggest that a portion of the higher burden of employment loss faced by women will persist after recovery. In Chapter Four, we explore how investments in decarbonization could reduce these employment inequities.

Figure 3.4. Lower-Skilled Jobs by Gender and Change in Lower-Skilled Jobs by Gender from 2019 to 2020 and 2025 With and Without COVID-19

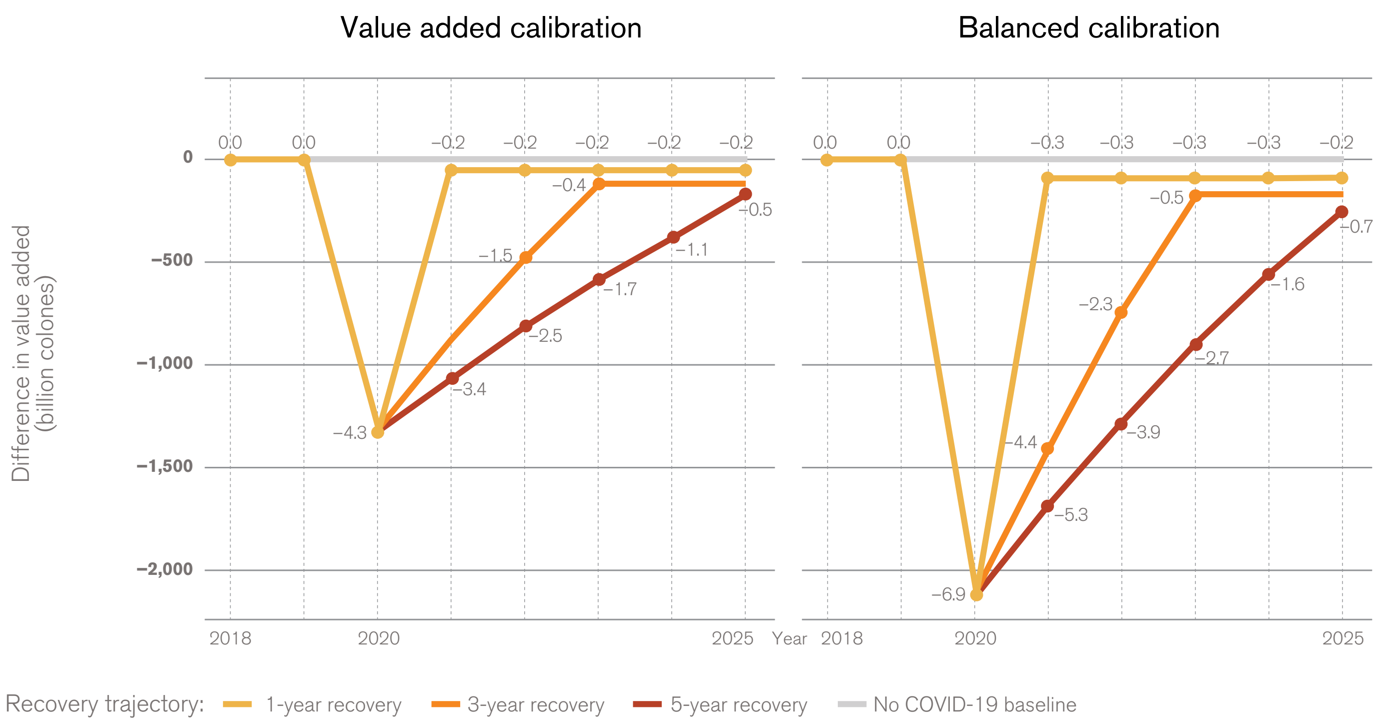


NOTE: RESULTS ARE BASED ON A FIVE-YEAR RECOVERY TRAJECTORY AND THE EMPLOYMENT CALIBRATION. PERCENTAGES SHOW THE SHARE OF MALE AND FEMALE JOBS. THE +3.5%, +1.9%, AND +2.7% LABELS CORRESPOND TO PERCENTAGE DIFFERENCES BETWEEN THE SHARE OF ALL JOBS BY GENDER AND THE SHARE OF JOBS LOST OR CREATED BY GENDER.

COVID-19 Effects on Economic Activity

Our economic modeling replicates reasonably well the COVID-19 shock on Costa Rican economic activity, as measured by value added (i.e., a decline of 4.3 percent in 2020 versus the Central Bank's estimated contraction of 4.1 percent [BCCR, 2021b]). Using IEEM to estimate future economic conditions, we find that the Costa Rican economy would nearly, but not completely, recover to prepandemic conditions by 2025 (Figure 3.5). Under the value added calibration, total value added recovers to within 0.5 percent of what it would have been without COVID-19 under all three recovery assumptions. Note that even if the difference in value added by 2025 is small, the compound effect on the economy of losses each year can be significant. Thus, the shorter the recovery time, the lower the overall effects on the economy will be. The balanced calibration, which estimates larger economic activity declines in 2020, suggests that full recovery does not occur under any of the three assumed trajectories by 2025.

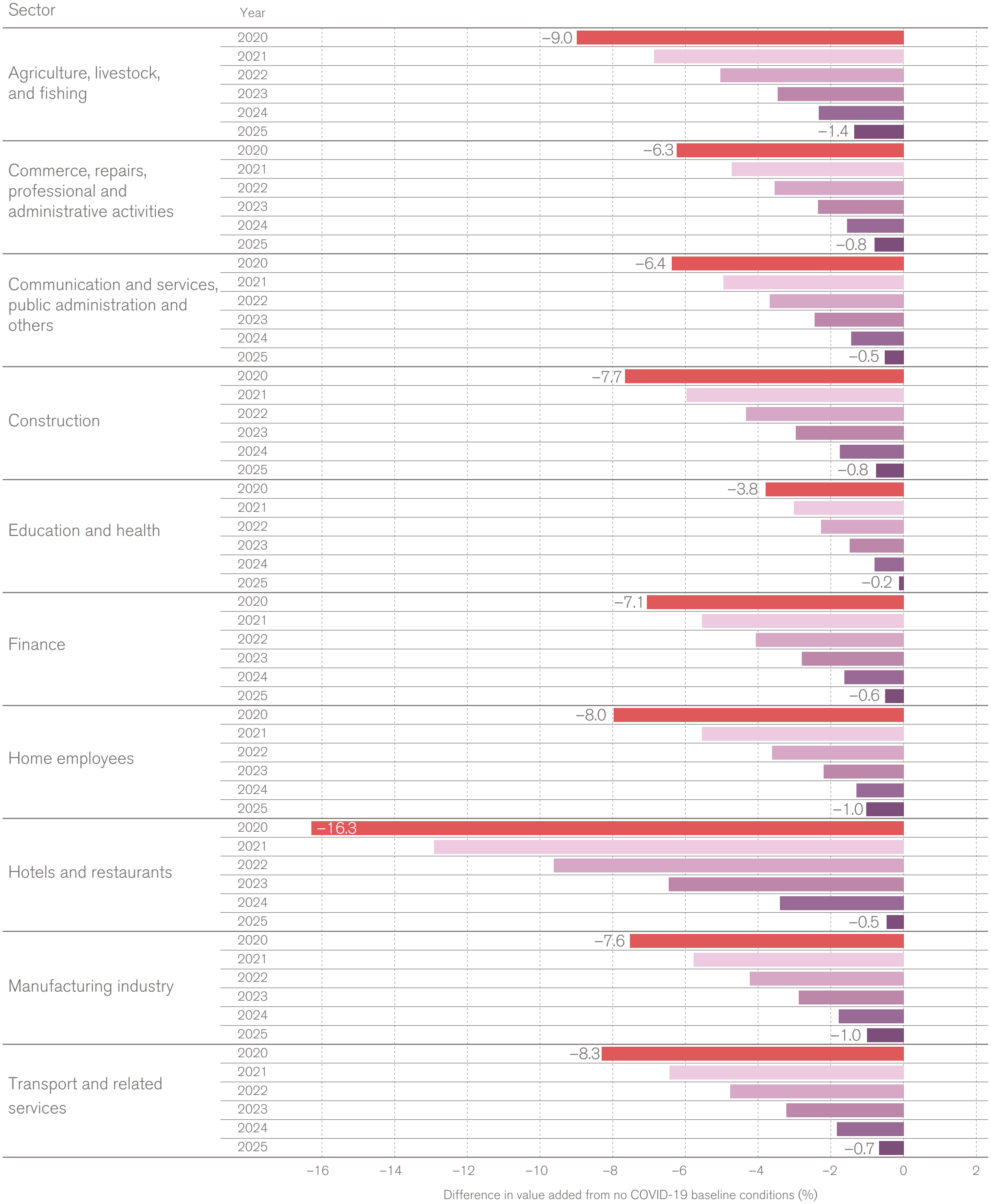
Figure 3.5. Modeled Change in Economic Activity Under Three COVID-19 Recovery Trajectories Relative to the No COVID-19 Baseline



NOTE: THE RESULTS ON THE LEFT ARE BASED ON A CALIBRATION OPTIMIZED FOR VALUE ADDED; RESULTS ON THE RIGHT ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED. THE VALUE LABELS INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE NO COVID-19 BASELINE CASE.

Although COVID-19 led to an about 4-percent decline in value added, the change in value added by sector varies substantially. Figure 3.6 shows the percentage change in value added by sector for the three recovery scenarios. Consistent with observations, IEEM models the biggest effect of COVID-19 on value added in the hotels and restaurants sector (−16.3 percent). IEEM also models large declines in all other sectors. Economic activity recovers from 2021 to 2025 and reaches within 1 percent of what it would have been in 2025 without COVID-19 for all but one sector—agriculture, livestock, and fishing (−1.4 percent in 2025).

Figure 3.6. Modeled Percentage Change in Value Added by Sector Relative to No COVID-19 Conditions for the Five-Year COVID-19 Recovery Trajectory (2020–2025)



NOTE: VALUE ADDED RESULTS FOR 2020 AND 2025 ARE LABELED. RESULTS ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED.

We summarize the key findings of the analysis of COVID-19 economic effects and recovery as follows:

- The significant declines in employment due to the COVID-19 pandemic that have been observed in 2020 and replicated by our models will largely recover; however, there will be slightly fewer total jobs in 2025 than there would have been without COVID-19. The modeling suggests that this effect will be the largest for both the commerce, repairs, professional and administrative activities and the agriculture, livestock, and fishing sectors, followed by the manufacturing industry and home employees sectors.

- Proportionally more jobs were lost by women and low-wage workers due to COVID-19, and only a partial reversal of this disparity is modeled to occur as Costa Rica recovers from COVID-19.

- Declines in economic activity, measured by value added, are modeled to mostly recover by 2025, regardless of the recovery time frame.

- In 2025, value added would be 0.5 percent lower under a five-year recovery trajectory than it otherwise would have been without COVID-19.

Chapter four

Jump-Starting COVID-19 Recovery Through Decarbonization Investment

The depth and uneven distribution of the social and economic effects of COVID-19 and related response measures in Costa Rica have intensified previously existing inequities. Economic inequality is likely to be perpetuated if steps are not taken to replace lost jobs and lost value added and to ensure that this replacement favors the communities and populations that have been affected most directly by COVID-19. pandemic These communities and groups are often the most vulnerable to climate change as well (Soergel et al., 2021), and therefore, a recovery from COVID-19 that creates more job opportunities and results in higher productivity among currently disadvantaged groups can also greatly reduce their vulnerability to future impacts of climate change and public health emergencies.[14] The steps taken as Costa Rica emerges from the pandemic will determine the length and effectiveness of its economic and social recovery and will likely change its economic structure. These steps will also determine whether Costa Rica can capitalize on its early adopter advantage and substantial leadership position in decarbonization and the promotion of human rights and social well-being—thus reinventing itself for a postpandemic 21st century. If successful, the policies and investments that Costa Rica deploys after the COVID-19 pandemic could spark profound sectoral transformations that increase Costa Rica's climate change resilience and strengthen its capacity for low GHG emission development over the long term. This chapter estimates how decarbonization investments can accelerate COVID-19 recovery, change the structure of the Costa Rican economy, and reduce existing inequalities.

Decarbonization Investments Can Accelerate Economic Recovery

Using IEEM, we model three levels of decarbonization investments from 2021 to 2025 corresponding to the Benefits and Costs of Decarbonization study and Investment Plan estimates described in Chapter Two. The total levels of investment evaluated are $4.85 billon, $6.2 billion, and $8.3 billion.

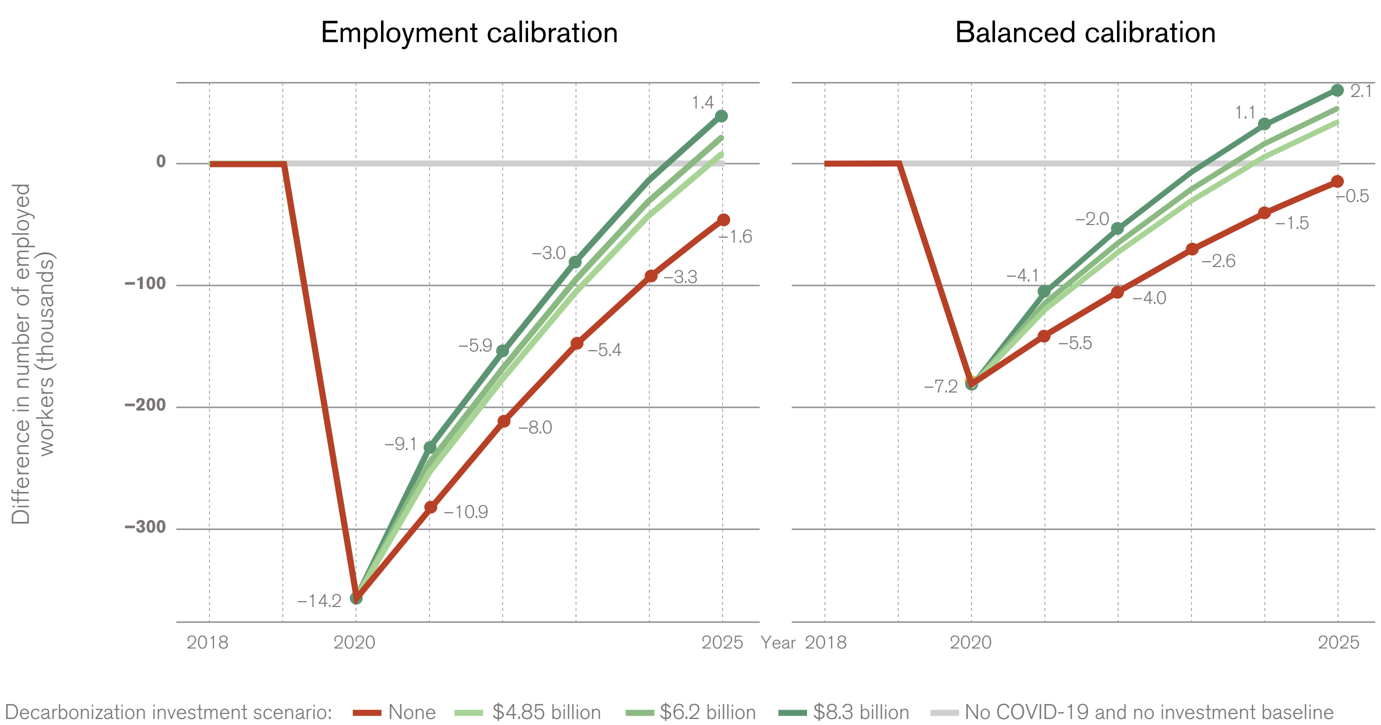
For each investment level, we estimate how decarbonization investments could be distributed across the Costa Rican economy for each of the lines of action considered in the NDP. Table B.4 in Appendix B speci fies how line of action–specified investments are allocated to the sectors represented in the IEEM.[15] Figure 4.1 shows that under each of the three decarbonization investment scenarios, employment recovery acceler-ates and that by 2025 employment is higher than it would have been without

[14] HIGHER PRODUCTIVITY IS POSITIVELY CORRELATED WITH HIGHER WAGES IN THE JOB MARKET, AND HIGHER WAGES INCREASE THE PROBABILITY OF WORKERS SAVING THE FINANCIAL RESOURCES NEEDED TO DEAL WITH UNEXPECTED SHOCKS.

[15] NOTE THAT THE ALLOCATION OF INVESTMENT USED IN THIS STUDY IS ONLY ONE OF MANY POTENTIAL WAYS IN WHICH THESE INVESTMENTS COULD BE ALLOCATED. FURTHER RESEARCH IS NEEDED TO STUDY HOW DIFFERENT ALLOCATION SCHEMES COULD CONTRIBUTE TO MEETING DIFFERENT ECONOMIC AND INDUSTRIAL OBJECTIVES AND TO UNDERSTAND SPECIFIC ECONOMIC POLICY TRADE-OFFS OF NDP INVESTMENTS. WE ALSO ASSUME THAT THESE INVESTMENTS WILL BE SUCCESSFUL AND WILL INCREASE CAPITAL STOCKS. HOWEVER, INSTITUTIONAL FACTORS AND KNOWLEDGE ENDOWMENTS COULD REDUCE THE EFFECTIVENESS OF THESE INVESTMENTS.

COVID-19 and decarbonization investments. For the employment calibration, the job loss compared with the no COVID-19 baseline case is improved by 2022 from −8 percent without decarbonization investment to up to −5.9 percent for the highest investment scenario. By 2025, five years of investment completely negates the employment effect of COVID-19, and the higher investment estimate ($8.3 billion) increases employment by 1.4 percent. The results for the balanced calibration are similar but reflect a lower without-investment unemployment estimate and correspondingly greater improvement by 2025.

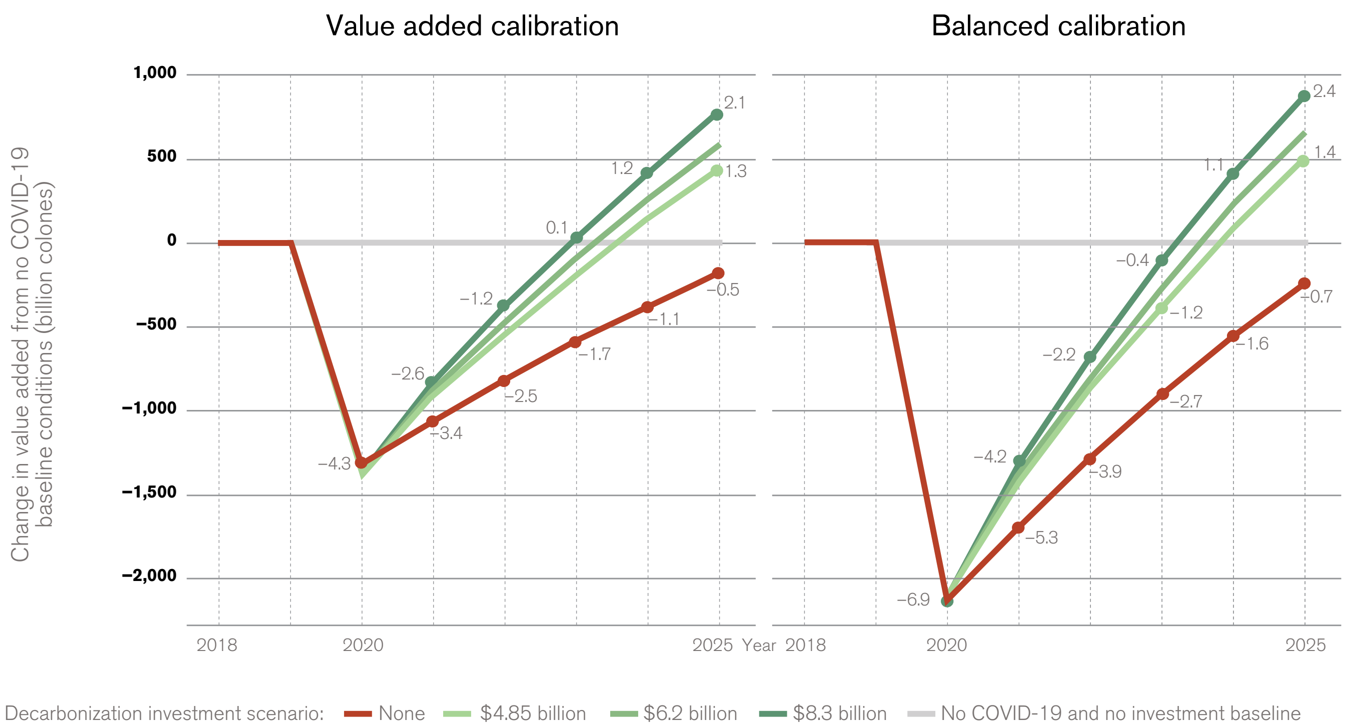
Figure 4.1. Modeled Change in Jobs Under Three Decarbonization Investment Scenarios for a Five-Year COVID-19 Recovery Trajectory, Relative to the No COVID-19 Baseline



NOTE: THE RESULTS ON THE LEFT ARE BASED ON A CALIBRATION OPTIMIZED FOR EMPLOYMENT; RESULTS ON THE RIGHT ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED. THE VALUE LABELS INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE NO COVID-19, NO INVESTMENT BASELINE.

In addition to reducing employment declines due to COVID-19, decarbonization investment could reduce the decline in value added due to COVID-19 (Figure 4.2). The effect is significant in the first few years and increases through 2025. For the value added calibration, this leads to a 2.1 percent higher value added in 2025 than in the no COVID-19 baseline (or 2.6 percent or 945 billion colones more than the no investment case). For the balanced calibration, which is more sensitive to economic shocks, the economic gains from decarbonization investment are even stronger.

Figure 4.2. Modeled Change in Value Added Under Three Decarbonization Investment Scenarios for a Five-Year COVID-19 Recovery Trajectory, Relative to the No COVID-19 Baseline



NOTE: THE RESULTS ON THE LEFT ARE BASED ON A CALIBRATION OPTIMIZED FOR VALUE ADDED; RESULTS ON THE RIGHT ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED. THE VALUE LABELS INDICATE THE PERCENTAGE CHANGE RELATIVE TO THE NO COVID-19, NO INVESTMENT BASELINE.

These results show that decarbonization investments could accelerate the recovery from COVID-19 in Costa Rica. For instance, in the worst-case scenario (i.e., five-year recovery trajectory), decarbonization investments could accelerate COVID-19 recovery by about two years for both employment and value added. Additionally, these results also indicate that these investments could induce higher job creation and higher economic growth even after recovery is realized. Thus, our analysis suggests that these two outcomes— quicker recovery and higher economic growth—are totally compatible with a lower emissions trajectory for the country.

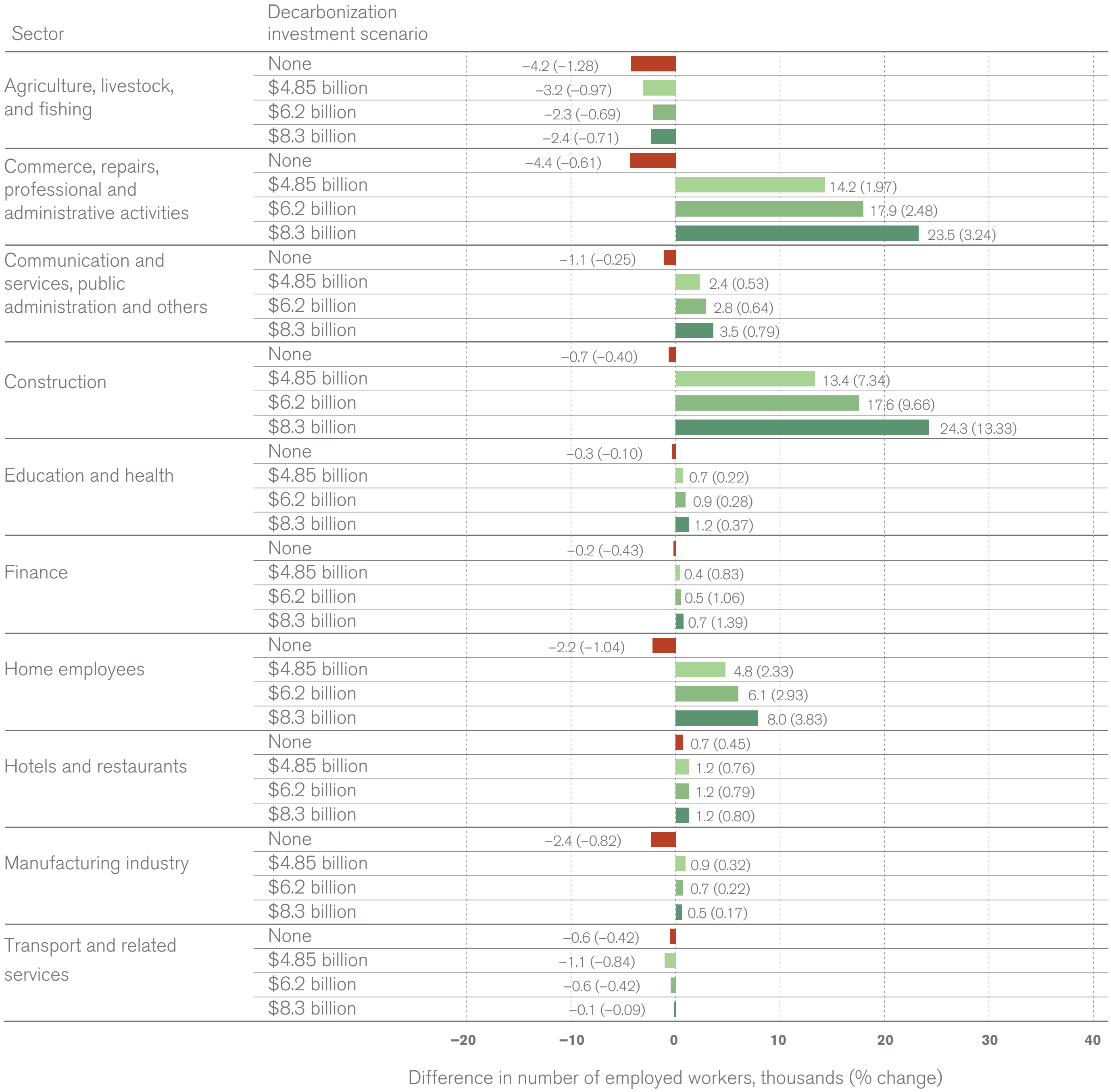
If the COVID-19 recovery were to proceed more quickly—consistent with our three-year recovery timeline—the NDP would still yield significant benefits. Employment could be 1.8 percent higher by 2025 than if there had been no pandemic (compared with 1.4 percent higher for a five-year recovery), and value added could be slightly higher as well—2.3 percent higher than the 2.1-percent increase under the five-year recovery trajectory.

Effects of Decarbonization Investments Will Vary Across Sectors and Socioeconomic Groups

Employment

Decarbonization investment could augment recovery from COVID-19 and eliminate the residual effect on employment in the aggregate by 2025—our modeling shows that total employment could be 1.4 percent higher than the no COVID-19 baseline with the highest level of decarbonization spending ($8.3 billion) under the employment calibration. However, the effects would not likely be uniform across all sectors of the Costa Rican economy, because these investments will change its underlying structure. Figure 4.3 shows how employment could differ from the conditions in 2025 that could have prevailed had COVID-19 not occurred, as modeled by IEEM, using the balanced calibration, which better represents intersectoral employment effects.

FIGURE 4.3 Modeled Difference in Jobs by Sector in 2025 Under a Five-Year COVID-19 Recovery Trajectory, Relative to the No COVID-19 Baseline for Three Decarbonization Investment Scenarios



NOTE: RESULTS ON THE RIGHT ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED. FOR THIS CALIBRATION, TOTAL DIFFERENCE IN JOBS IN 2025 WITHOUT DECARBONIZATION SPENDING IS −15,400 JOBS (OR −0.54 PERCENT). TOTAL DIFFERENCE WITH $4.85 BILLION AND $8.3 BILLION INVESTMENT SPENDING IS +33,700 JOBS (+1.18 PERCENT) AND +60,400 JOBS (+2.12 PERCENT), RESPECTIVELY.

For all sectors, except for hotels and restaurants, IEEM estimates that employment levels would be lower in 2025 than they would have been in 2025 without COVID-19 or decarbonization investment (red bars). The biggest employment losses in terms of absolute jobs would be experienced in commerce, repairs, profes- sional and administrative activities (−4,400 jobs, −0.71 percent). The biggest employment losses in terms of percentage would be experienced in the agriculture, livestock, and fishing sector (−4,200 jobs, −1.28 percent).

Higher employment than otherwise would have occurred without decarbonization spending is seen in all but one sector and funding scenario.[16] The most significant effect is seen in the construction sector, which could experience between 7.3 percent and 13.3 percent higher employment compared with a 0.4-percent decline without decarbonization investment. This sector benefits both from direct investment in the housing and waste sectors and from indirect investments required to improve the infrastructure needed to decarboize other sectors—for example, new public transportation corridors, rail lines, and vehicle electrification infrastructure upgrades. Commerce, repairs, professional and administrative services would also see large gains in employment as investments across all sectors would lead to greater activity in this sector as well. The home employees sector would also see employment gains greater than those under the no COVID-19 baseline conditions. This sector gains less directly from decarbonization investment and instead increases in response to wage and income rises that would accompany the additional economic investment and job creation in sectors directly financed for decarbonization.

Gender Differences

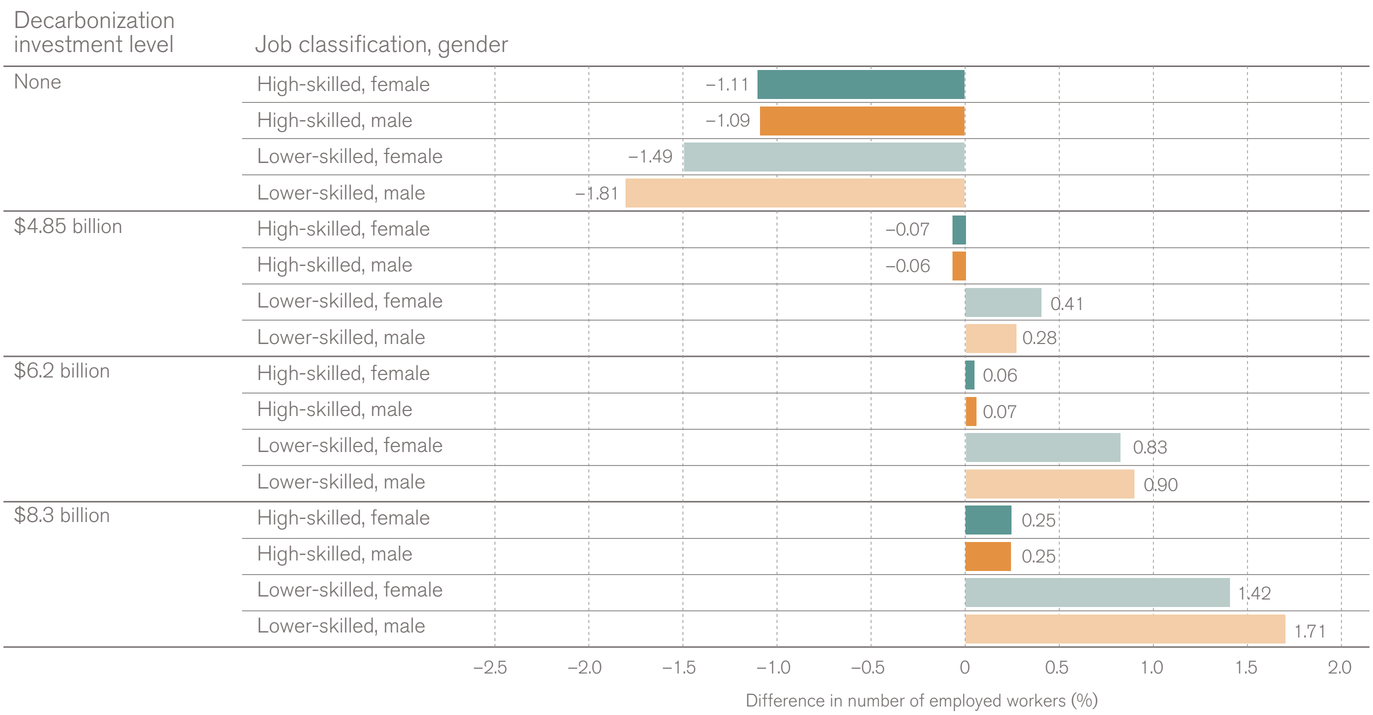
The employment effect of decarbonization investments can also be viewed through the perspective of equity between high-skilled and low- and mid-skilled workers and between women and men. To evaluate how job creation through decarbonization spending might affect these different types of employees, we assume that the share of jobs held by women in each sector in 2019 remains the same in future years. Similarly, we assume that the classification of jobs by skill remains the same across sectors.

Figure 4.4 shows IEEM estimates of the percentage difference in employment by skill classification (high-skilled versus low- and mid-skilled) and gender in 2025 compared with the no COVID-19 baseline scenario.[17] Without decarbonization spending (top four rows), there would be about 1 percent fewer high-skilled jobs and up to 1.8 percent fewer low- and mid-skilled jobs. There would be even fewer jobs for low- and mid-skilled workers, with the largest losses by low- and mid-skilled male workers, which is consistent with the larger share of low- and mid-skilled jobs that are held by men (see Table 3.1 in Chapter Three). For the three decarbonization spending scenarios, there are broad employment increases for women and men and in lower-skilled jobs, and high-skilled jobs increase over the no COVID-19 baseline for the higher two spending scenarios. However, the category of employment with the greatest projected increase in 2025 over the no COVID-19 baseline is that of low- and mid-skilled female workers for the $4.85 billion decarbonization spending scenario. This reflects increases in employment in those sectors with relatively higher proportions of female workers, such as commerce, home employees, and hotels and restaurants. The higher spending scenarios show continued employment gains by lower-skilled female workers and even greater gains by lower-skilled male workers.

[16] THE TRANSPORT AND RELATED SERVICES SECTOR SHOWS SLIGHTLY FEWER JOBS IN 2025 IN THE LOWEST INVESTMENT SPENDING SCENARIO ($4.85 BILLION) AS COMPARED WITH THE NO INVESTMENT CASE; HOWEVER, THE NUMBER OF JOBS IN 2025 INCREASES IN THE TWO OTHER INVESTMENT SCENARIOS.

[17] WE CLASSIFY JOBS ESTIMATED BY IEEM USING THE ECONOMIC SECTORS' PRODUCTIVITY. HIGH-WAGE AND HIGH-SKILLED JOBS ARE ASSOCIATED WITH HIGH-PRODUCTIVITY SECTORS, WHILE LOW-WAGE AND LOW-AND MID-SKILLED JOBS ARE ASSOCIATED WITH LOW-PRODUCTIVITY SECTORS. AS SHOWN IN TABLE 1.1 IN CHAPTER ONE, CLASSIFICATION OF JOBS BY SKILL AND WAGE LEVELS ARE SIMILAR.

Figure 4.4. Difference in Jobs by Skill Classification and Gender in 2025 Relative to the No COVID-19 Baseline

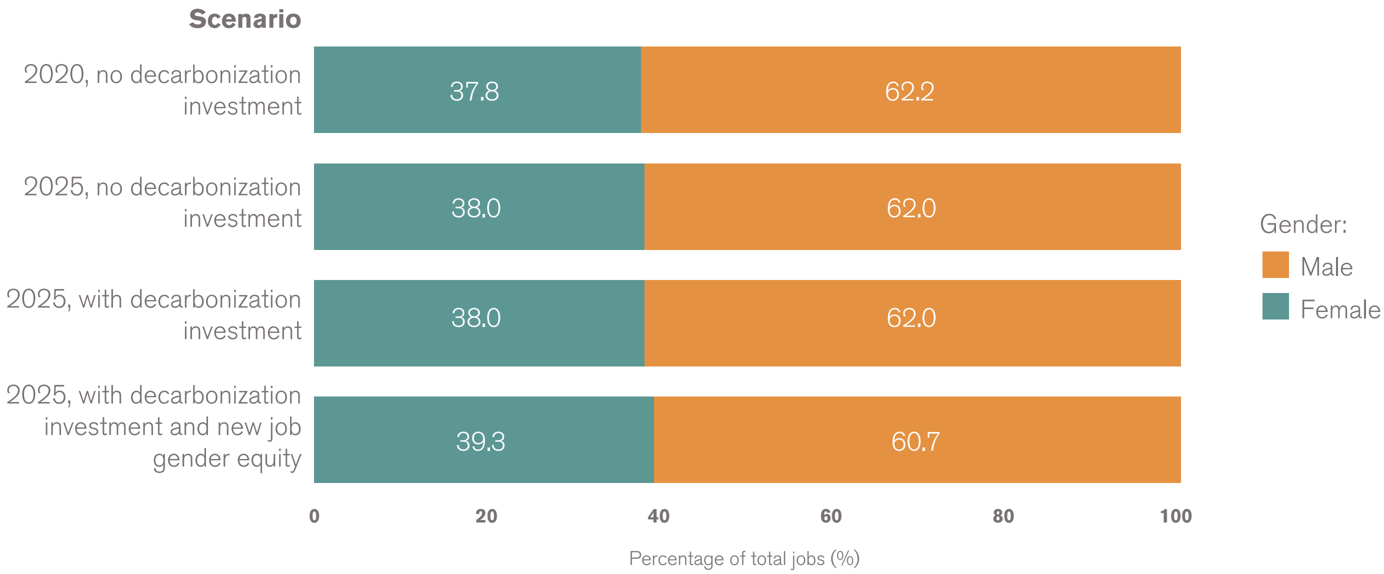


NOTE: IEEM ESTIMATES THE NUMBERS OF JOBS IN TERMS OF HIGH AND LOW PRODUCTIVITY. WE MAPPED HIGH-PRODUCTIVITY JOBS TO HIGH-WAGE AND HIGH-SKILLED JOBS. WE MAPPED LOW PRODUCTIVITY TO LOW-WAGE AND LOW- AND MID-SKILLED JOBS, WHICH WE REFER TO AS "LOWER-SKILLED" JOBS IN THIS FIGURE. RESULTS ARE BASED ON A FIVE-YEAR RECOVERY TRAJECTORY AND CALIBRATION OPTIMIZED FOR EMPLOYMENT.

This modest increase in low- and mid-skilled female jobs relative to other employment categories, however, does not significantly change the percentage of jobs held by women in Costa Rica. According to IEEM,women held only around 38 percent of all jobs in 2020 after accounting for the effects of COVID-19, and they would hold about the same percentage of all jobs in 2025, both without and with decarbonization investments (top three rows of Figure 4.5). As a thought experiment, we assumed that all new jobs from 2020 to 2025 would be filled by women and men in equal proportions. Under these conditions, the share of jobs that would be held by women in 2025 with decarbonization investment would increase to a bit more than 39 percent—a very modest improvement. In fact, even if all new jobs from 2020 were filled by women, an unrealistic and unfair scenario, the share of employment between women and men would still fall short of 50/50; it would be only 45/55.

The analysis suggests that the disproportionate effect that COVID-19 had on female employment could be directly addressed through a significant investment in decarbonization; however, achieving employment parity by gender will take much longer than five years and will require a variety of other policy instruments to be deployed. The specific commitments around ensuring a just transition and incorporating the gender perspective into Costa Rica's NDC, including issues related to gender inequality in the labor market, policy-making, and data collection, are examples of how the decarbonization process can, if intentionally managed, address multiple development challenges at the same time.

FIGURE 4.5 Difference in Low-Wage Jobs, by Wage and Gender, in 2025, Relative to the No COVID-19 Baseline



Value Added

Our economic modeling shown above estimates that value added could be more than 2 percentage points higher by 2025 with decarbonization spending (see Figure 4.2). The sector-specific results for value added are similar to the employment results, as seen in Figure 4.6. The biggest effect of decarbonization spending on economic activity would be in the construction sector, with increases greater than the no COVID-19 baseline case of between 8.1 and 13.7 percent, corresponding to an absolute increase in value added of between 146 and 249 billion colones. Large increases in value added are also seen in the commerce sector, ranging from 2.1 to 3.5 percentage points higher than value added reached without decarbonization investment. As with employment, decarbonization spending eliminates the residual effects of COVID-19 in all other sectors as well, excluding agriculture, in which modest employment effects of less than a 0.5-percent reduction remain.

Decarbonization spending is modeled to have a smaller positive effect on the agricultural sector, particularly in the $4.85 billion spending scenario, where the level of spending in the agricultural sector is small, relative to spending in other sectors. In this case, the larger, simultaneous levels of investment in other sectors may create disproportional comparative advantages in these sectors (e.g., manufacturing and transportation) and reduce employment and activity in agriculture as workers move to these other sectors. This effect is smaller under the $6.2 billion and $8.3 billion investment scenarios, when spending in the agricultural sector is much larger.

It is important to note that the results presented here are based on a calibration that does not perfectly estimate the observed employment effects of COVID-19 across all individual sectors. As a result, the modeled gains in jobs across sectors should be viewed as suggestive of the possible outcomes and not as predictions.

Figure 4.6. Modeled Percentage and Absolute Difference in Value Added by Sector in 2025 Under a Five-Year COVID-19 Recovery Trajectory Relative to the No COVID-19 Baseline for Three Decarbonization Investment Scenarios

NOTE: RESULTS ARE BASED ON A CALIBRATION THAT BALANCES MODEL PERFORMANCE ACROSS EMPLOYMENT AND VALUE ADDED.

We summarize the key findings of the effects of these decarbonization investment scenarios as follows:

- Decarbonization investments induce a faster COVID-19 recovery in terms of employment and value added by about two years.
- Decarbonization investments lead to improved recovery outcomes in all sectors, particularly for the $6.2 billion and $8.3 billion investment scenarios.
- Decarbonization investments from the NDP could trigger substantial changes in the structure of the Costa Rican economy, modifying the comparative advantages of its economic sectors and inducinga new labor equilibrium. Further research is needed to better assess the potential structural changes induced by these investments.
- As currently modeled, decarbonization investment only slightly reduces existing gender inequalities in Costa Rica's labor market because many of the jobs needed for decarbonization are from sectors with a larger share of male workers, and decarbonization investments alone would not adjust the gender mix within sectors.
- Decarbonization investments will affect not only the level of emissions of the Costa Rican economy but also its inherent structure and growth potential. Further analysis and considerations are required to coordinate these investments in a way that can meet specific national gender equity, industrial, and financial objectives.

Chapter five

Aligning Decarbonization with Broader Sustainable Development Goals

The Benefits and Costs of Decarbonization study (Groves et al., 2020) concluded that the implementation of Costa Rica's NDP would result in significant long-term economic benefits under a wide variety of plausible scenarios. Similarly, Costa Rica's most recent process to update its emissions commitment to the United Nations Framework Convention on Climate Change (Government of Costa Rica, Ministry of Environment and Energy, 2020) determined that Costa Rica will need to close the remaining development gaps across socioeconomic groups and regions of the country in order to transform its economy to be decarbonized, more climate resilient, and more socially just. And the economic modeling presented in the preceding chapters shows that investments in decarbonization would improve two important economic indicators—employment and value added—over the near term as Costa Rica recovers from the COVID-19 pandemic. However, these two measures are incomplete proxies for the socioeconomic conditions in a country, and the analysis is silent on whether the implementation of the NDP would benefit a broader set of sustainable development goals. This chapter takes an initial step toward understanding whether and how decarbonization—which will require a dramatic reconfiguring of economic and social activity—could help achieve these goals and thus help Costa Rica transition to a more socially just economy.

As a first step to considering how decarbonization could assist Costa Rica in making progress toward the SDGs, we conduct a qualitative mapping of select NDP actions, SDG indicators, and modeled outcomes from this and the Decarbonization Benefits and Costs study (Groves et al., 2020) to examine how decarbonization could contribute to the achievement of the SDGs in Costa Rica. First, we identify for each NDP line of action which action or set of actions could contribute to each SDG. Next, we identify the specific SDG targets that could be influenced by decarbonization, as summarized by Sachs et al., 2021,[18] and, in a few cases, the specific numbered targets defined by the SDG framework. Lastly, where there is a strong link between NDP benefits and SDGs, we describe how the modeled NDP benefits would contribute to or work against progress toward the SDGs. We summarize this analysis in Table 5.1 and in our subsequent discussion.

[18] SEE THE PERFORMANCE-BY-INDICATOR DASHBOARD THAT USES DATA FROM SACHS ET AL., 2021, FOR COSTA RICA'S PROGRESS ON 92 INDICATORS RELATED TO THE SDGS (SUSTAINABLE DEVELOPMENT REPORT, UNDATED).

TABLE 5.1 Mapping of National Decarbonization Plan or COVID-19 Recovery Outcomes to Sustainable Development Goals and Targets

NDP Decarbonization Line of Action	NDP or COVID-19 Recovery Outcome	Affected SDG	Related SDG Target per Sachs et al., 2021	Description of Potential Effects of the NDP on SDG Target
All	Increased employment	8 DECENT WORK AND ECONOMIC GROWTH	Unemployment rate (percentage of total labor force)	The analysis presented in Chapter Four shows that implementing the NDP will significantly increase economic activity in the 2021–2025 period, as measured by value added and employment. See Figures 4.1, 4.2, 4.3., and 4.6.
	Value added	8 DECENT WORK AND ECONOMIC GROWTH	Adjusted GDP growth (%)	
	Increased employment by women	5 GENDER EQUALITY	Ratio of female-to-male labor force participation rate (%)	NDP investment will improve employment for women through reversal of the unequal employment effects of COVID-19. With additional programs to ensure more proportional participation in employment by women, the NDP could help Costa Rica make progress toward gender equality.
	Investments to achieve net zero GHG emissions	13 CLIMATE ACTION	Mobilized amount of USD per year between 2020 and 2025 accountable toward the $100 billion commitment (13.a.1)[a]	This study evaluates a range of expenditures on decarbonization—between $4.85 billion and $8.3 billion. These levels of expenditure would more than account for Costa Rica's share of the SDG's $100 billion commitment.
Transport	Improvement of public transportation networks	11 SUSTAINABLE CITIES AND COMMUNITIES	Satisfaction with public transport (%); related to the proportion of the population that has convenient access to public transport, by sex, age and persons with disabilities (11.2.1)[a]	The NDP will heavily invest in reconfiguring mobility throughout Costa Rica, with a focus on improving public transport. By 2050, the NDP would shift 13% of private transport to public transportation (95% electrified) and another 10% to nonmotorized transport.
	Reduced transport emissions	11 SUSTAINABLE CITIES AND COMMUNITIES	Annual mean concentration of particulate matter of less than 2.5 microns in diameter (PM2.5)	Nearly complete electrification of the transport sector would remove a significant share of urban pollution. The discounted total health co-benefits from 2021–2050 due to reduced transportation pollution is valued at nearly $1.6 billion.
	Increased freight transport efficiency	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Logistic Performance Index: Quality of trade and transport-related infrastructure	The NDP's focus on mode shifting from private transport to public transport and transporting freight by trucks to rail will reduce freight congestion by more than 66%, yielding approximately $919 million in discounted total benefits.
	Reduced traffic accidents	3 GOOD HEALTH AND WELL-BEING	Traffic deaths (per 100,000 population)	The NDP's focus on mode shifting from private transport to public transport and transporting freight by trucks to rail will reduce traffic accidents. The discounted total value from 2021–2050 of accident reduction is about $7.28 billion.
	Electrification of transport	7 AFFORDABLE AND CLEAN ENERGY	Proportion of population with primary reliance on clean fuels and technology (%) (7.1.2)[a]	Nearly complete electrification of private and commercial transport will eliminate most of Costa Rica's use of nonrenewable fuels. The cost of transport energy provided by electricity is projected to be lower than the nonrenewable liquid fuels that will be replaced.
Electricity	Sustaining and expanding share of renewable electricity production	7 AFFORDABLE AND CLEAN ENERGY	CO2 emissions from fuel combustion for electricity and heating per total electricity output (MtCO2/TWh [tera-watt hour])	The modest investments to ensure that the nearly 100% renewable electricity grid remains so will ensure that electrification leads to increased use of clean fuels.

SOURCE: SDG ICONS ARE USED IN ACCORDANCE WITH UNITED NATIONS GUIDELINES (UNITED NATIONS DEPARTMENT OF GLOBAL COMMUNICATIONS, 2020), AND SDG TARGET DESCRIPTIONS ARE TAKEN FROM SACHS ET AL., 2021; NUMBERED SDG TARGETS DERIVE FROM UNITED NATIONS STATISTICS DIVISION, 2018.
[a] INDICATES A SPECIFIC, NUMBERED SDG TARGET OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT.

TABLE 5.1 Mapping of National Decarbonization Plan or COVID-19 Recovery Outcomes to Sustainable Development Goals and Targets

NDP Decarbonization Line of Action	NDP or COVID-19 Recovery Outcome	Affected SDG	Related SDG Target per Sachs et al., 2021	Description of Potential Effects of the NDP on SDG Target
Buildings	Electrification of residential and commercial buildings	7 AFFORDABLE AND CLEAN ENERGY	Population with access to clean fuels and technology for cooking (%)	Under the modeled NDP, 80% of residential and commercial energy demands will be electrified by 2050, and this will reduce Costa Rica's use of nonrenewable fuels.
		3 GOOD HEALTH AND WELL BEING	Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	Electrification of homes (80% by 2050) will nearly eliminate the use of fossil fuels for heating and cooling.
Industry	Industrial efficiency, electrification, and process emissions reduction	13 CLIMATE ACTION	CO^2 emissions from fossil fuel combustion and cement production	The modeled decarbonization actions more than triple industrial electrification and reduce per production industrial emissions (including cement production) by more than 40%.
Circular economy	Increase percentages of households connected to treated water supplies and wastewater systems	6 CLEAN WATER AND SANITATION	Population using at least basic drinking water and sanitation services (%)	The NDP would ensure that all households have access to clean water and that 80% of households are connected to sewage treatment systems. It would also ensure that more than 70% of wastewater is treated and eliminate open-pit defecation in rural areas.
		11 SUSTAINABLE CITIES AND COMMUNITIES	Access to improved water source, piped (% of urban population)	
		6 CLEAN WATER AND SANITATION	Anthropogenic wastewater that receives treatment (%)	
		6 CLEAN WATER AND SANITATION	Proportion of bodies of water with good ambient water quality (6.3.2)[a]	Increased solid waste collection and wastewater treatment and universal urban sewerage will reduce runoff into local and regional bodies of water.
	Increase quantities of trash collected and disposed of, including recycling and composting	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Municipal solid waste (kg/capita/day)	The NDP would reduce solid waste by increasing the rate of recycling (from 5% under BAU to more than 50% by 2050) and composting.
		11 SUSTAINABLE CITIES AND COMMUNITIES	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities (11.6.1)[a]	The NDP would increase trash collection and treatment by 20% and increase the share of recyclable materials recycled 11-fold.
Agriculture	Improved agricultural practices to reduce emissions	2 ZERO HUNGER	Sustainable Nitrogen Management Index; exports of hazardous pesticides (tons per million population); related to proportion of agricultural area under productive and sustainable agriculture (2.4.1)[a]	The NDP actions in the agricultural sector will improve productivity and sustainability of the sector while reducing emissions per hectare by 30%. This will increase food security in agricultural regions and strengthen resilience to food shortages and hunger.
Forestry	Reduction in removal of primary forests	15 LIFE ON LAND	Permanent deforestation (% of forest area, 5-year average); mean area that is protected in terrestrial sites that are important to biodiversity (%); Red List Index of species survival; mean area that is protected in freshwater sites that are important to biodiversity (%)	Reducing the removal of primary forests and planting new forests will lead to increases in forested areas and the preservation of mountain ecosystems and the many species that live in them. The NDP could increases forested area by 14%.
	Improved forest management	15 LIFE ON LAND	Progress toward sustainable forest management (15.2.1)[a]	Increasing the ability of Costa Rica's forests to sequester carbon will require implementation of improved forestry management techniques.

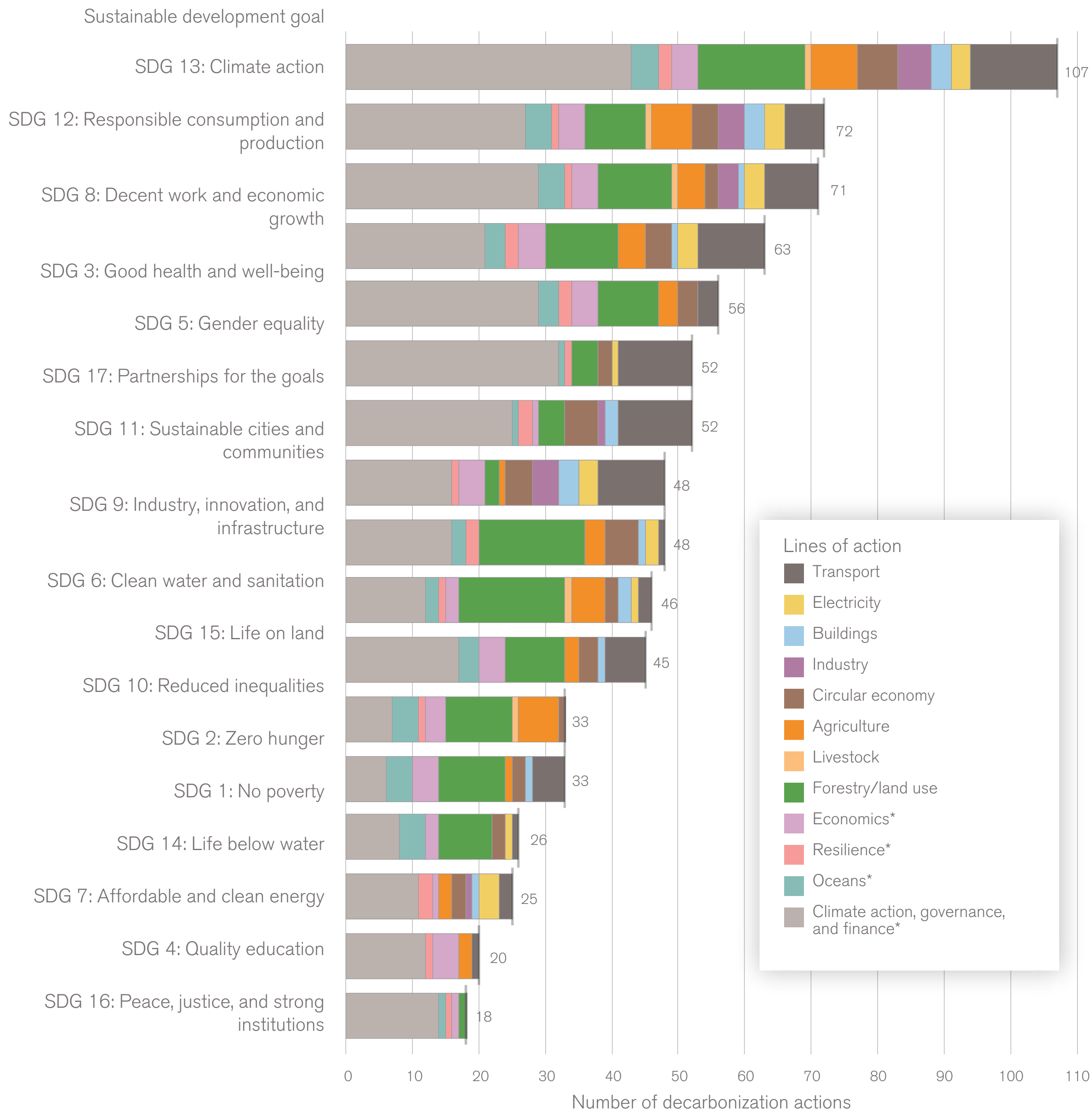
SOURCE: SDG ICONS ARE USED IN ACCORDANCE WITH UNITED NATIONS GUIDELINES (UNITED NATIONS DEPARTMENT OF GLOBAL COMMUNICATIONS, 2020), AND SDG TARGET DESCRIPTIONS ARE TAKEN FROM SACHS ET AL., 2021; NUMBERED SDG TARGETS DERIVE FROM UNITED NATIONS STATISTICS DIVISION, 2018.
[a] INDICATES A SPECIFIC, NUMBERED SDG TARGET OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT.

The NDP, as originally described, will directly support Costa Rica's progress with respect to 11 of the 17 SDGs (Table 5.1). Decarbonization spending will support gains in the economic-related SDGs—SDG 5 (gender equality) and SDG 8 (decent work and economic growth)—as demonstrated in Chapter Four. The implementation of the NDP represents an extremely aggressive set of climate actions and would advance the use of no-carbon, renewable energy (SDG 13). Many of the NDP actions, such as improvement to the country's public transportation networks, transport electrification, and shifts from truck-based freight to rail would support improvements in cities and communities (SDG 11) and infrastructure (SDG 9). Implementing the NDP would contribute toward strong progress on clean water and sanitation (SDG 6) and modest progress toward responsible consumption and production (SDG 12) through increases in recycling and composting. Lastly, the NDP's efforts in forestry are highly consistent with SDG 15 (life on land).

The NDP does not, however, directly address all SDGs. It does not include measures that would reduce educational gaps as reflected in SDG 4 (quality education) or address ocean resources as reflected by SDG 14 (life below water). Our analysis also is not able to evaluate whether or how the NDP might contribute to SDG 16 (peace, justice, and strong institutions) and SDG 17 (partnerships for the goals).

Costa Rica's 2020 NDC (Government of Costa Rica, Ministry of Environment, 2020) presents Costa Rica's most recent vision of how it intends to achieve decarbonization, and it includes additional actions targeted for all SDGs. To illustrate this, we cross-referenced the 107 individual actions described in the 2020 NDC to the specific SDGs and indicated which actions were consistent with each SDG. Figure 5.1 shows the total number of consistent actions for each SDG, color-coded by each sector's alignment with the lines of action from the NDC—which align with the ones in the NDP, with a few additional categories for actions that cut across lines.

Figure 5.1. Tally of Nationally Determined Contribution Actions That Are Consistent with the United Nations Sustainable Development Goals



NOTE: * INDICATES NDC ACTIONS THAT ARE NOT ASSIGNED TO CARBON-EMITTING LINES OF ACTION.

This analysis shows that the 2020 NDC does identify links to all 17 SDGs.[19] By design, all 107 decarbonization actions are consistent with SDG 13 (climate action). The next three SDGs supported by the most decarbonization actions are SDG 12 (responsible consumption and production), SDG 8 (decent work and economic growth), and SDG 3 (good health and well-being). This reflects the significant investment in the circular economy and the economic and health benefits associated with improving mobility through public transport and reducing hospitalizations from accidents, air pollution, and water pollution. Lastly, the 2020 NDC includes a thematic area with a set of commitments on action for climate empowerment and other sector-specific commitments related to SDG 4 (quality education) and another thematic area with a set of commitments on oceans, water resources, and blue biodiversity, which relate directly to SDG 14 (life below water). It was developed with an increased focus on a just transition and social and climate justice, and the thematic area and commitments on transparency and continuous improvement relate to SDG 16 (peace, justice, and strong institutions) and SDG 17 (partnerships for the goals).

Note that the decarbonization investment costs used in this study were developed based on decarbonization achievement and aggregations of individual actions. As a result, it was not possible to show the value of investment that might benefit each SDG. However, the new NDP action cost estimates—some of which have been completed recently (South Pole, 2019, 2021) and some of which are under development—could support this useful analysis.

The participatory nature of the NDC process, especially the inclusion of historically excluded groups in that process, was particularly important to the development of actions related to SDG 16 (peace, justice, and strong institutions) and SDG 17 (partnerships for the goals). This work was undertaken because the Costa Rican government clearly understands that just, resilient, and adaptive decarbonization must be a society- wide process to be successful. Costa Rica will need to ensure that progress toward all the SDGs accompanies the economic transformations required by both the NDP and the updated NDC. An increasingly skilled workforce will be needed to implement many of the transformations and to thrive in a low-carbon economy.

Mission-oriented innovation policy and investment have been shown to produce around ten times the stimulus of output growth than standard government spending does, excluding research and development. Furthermore, mission-oriented spending is effective at "crowding-in" the private sector and can lead to high additional direct private research and development investment (Deledi et al., 2019). Properly identifying "what type of growth the country wants" beyond economic performance becomes especially important in this context (Mazzucato, 2019) and requires robust, diverse, accessible, and culturally appropriate citizen engagement, particularly as that relates to Indigenous Peoples, Afrodescendants, and other local communities. In addition, with billions of dollars of spending required to implement the NDP, Costa Rica will need to ensure that graft and other forms of corruption are limited. The potential for special interests to opposespending directed toward economic transformations could be high.

[19] AN INTERACTIVE VISUALIZATION OF THESE LINKAGES IS AVAILABLE ON COSTA RICA'S NATIONAL SYSTEM OF CLIMATE CHANGE METRICS (SINAMECC) PLATFORM (SINAMECC, UNDATED).

Chapter six

Conclusion

The COVID-19 pandemic has had a profound impact on the Costa Rican economy, with significant losses in employment and reductions in economic activity. COVID-19 has affected low-wage earners and women disproportionately, raising concerns that existing inequalities in Costa Rican society have been further exacerbated. The modeling presented in this report suggests that, without targeted investments, employment levels may not recover to levels expected without COVID-19 by 2025—particularly for these vulnerable groups.

Costa Rica has recently committed to decarbonize its economy in accordance with the Paris Agreement (United Nations, 2015). Importantly, this commitment has been made with a recognition that the economic transition required to decarbonize presents an opportunity to improve both socioeconomic equity and justice in Costa Rica and that this transition will not be possible without achieving these improvements. The new necessity of COVID-19 recovery only elevates the urgency. By engaging with the climate crisis as a development model issue and not simply an environmental issue, Costa Rica can build on the technical decarbonization trajectories laid out in the NDP and provide a framework for just decarbonization centered on the most-vulnerable people, communities, and ecosystems.

Our analysis shows that the upfront decarbonization investments based on estimates of what would be required to implement the NDP would accelerate both employment and economic recovery from COVID-19, and these investments would lead to higher employment and value added by 2025 than would have been achieved without COVID-19 and decarbonization investments. We also find that employment improvements for women are stronger with decarbonization investment, but this alone does not eliminate existing gender disparities. Our initial assessment of decarbonization and the SDGs suggests that decarbonization investments could also drive progress toward many of the specific SDG targets.

Eliminating net GHG emissions will require significant amounts of new infrastructure, particularly to modernize and electrify the transportation system. As a result, the construction sector is positioned to gain the most in terms of employment and economic activity from decarbonization investments. How these decarbonization actions are implemented will have a substantial effect on development outcomes, resilience- building, accessibility, and equity. Although the intensity of the effects of the NDP will be diverse across the different economic sectors, the overall economy would expand due to economic improvements and investments in other sectors.

The size of the required investment for decarbonization is large, relative to the size of the Costa Rican economy. In the smallest investment scenario ($4.85 billion), spending in the NDP's livestock, agriculture, and forestry lines of action is significantly less than in the transportation and circular economy lines of action. Our analysis suggests that, in this case, employment and value added gains in the agriculture, livestock, and forestry sector would be correspondingly smaller. In the more balanced investment scenarios, benefits to the land use sectors are greater. These findings highlight the importance of considering how spending across different lines of action could influence different sectors. In this analysis, this consideration is reflected by the SAM within our model (IEEM). Given the size of spending increases called for by the NDP, other structural changes in the economy, not estimated by our model, may occur. Costa Rica may need to consider policies to carefully monitor labor effects and support necessary transitions.

This study represents a first look at the impact of COVID-19 on Costa Rica's economy and the potential for enhancing its recovery through decarbonization investment. There are several key areas in which additional research is needed to improve understanding for informed policymaking:

- Costs of decarbonization. Detailed estimates of the upfront costs of decarbonization have yet to be developed for all parts of the NDP. New action-by-action estimates for transportation, livestock, agriculture, and forestry provide an improved estimate of future investment needs to achieve decarbonization. Similar estimates for the electricity, building, industry, and circular economy lines of action, which are currently under development, will provide a fuller picture of investment needs. Additional analysis, however, will be required to better estimate and remove BAU investments from these new estimates.

- Economic modeling of sectoral transformation due to COVID-19 and decarbonization. The modeling presented in this report is based on an economic model that was designed to represent the behavior of the Costa Rican economy under "normal" conditions. We calibrated the model to represent the significant economic shocks of COVID-19, but more research is needed to do so more thoroughly.

- Mapping of specific decarbonization actions to upfront costs. The analytical model that we used does not resolve specific decarbonization investments. However, additional analyses of specific decarbonization investments could suggest which ones would have the largest effects on employment and economic activity. This further analysis could then guide the development of complementary policies that would maximize investment benefits to vulnerable groups. This more refined modeling could also help policy-makers evaluate more specifically the effects that decarbonization could have on the SDG indicators.

- Economic modeling of individual decarbonization investments. Further modeling and analysis could help policymakers better understand how mitigation and adaptation policies and investments impact jobs and productivity across the economy. Additional research could evaluate the network effects of investments across industries, economic sectors, and regions.

To conclude, we provide several recommendations to maximize the potential for decarbonization investments to accelerate COVID-19 recovery and contribute to reductions in socioeconomic inequities in Costa Rica. The analysis shows that new decarbonization investment alone will not provide the needed opportunities to vulnerable groups, and indeed, the types of jobs required for a green transition are very often different from current employment opportunities. For example, a 2017 analysis looking at the ranking of countries in their ability to generate and export green products—related to many decarbonization activities—ranked Costa Rica 65th out of 122 countries assessed (Mealy and Teytelboym, 2017). Costa Rica should consider developing and implementing additional policies to facilitate the hiring and training of vulnerable groups (lower-skilled workers, racial/ethnic minority groups, and women) when meeting the employment requirement of decarbonization.

Next, we suggest that employment outcomes across the sectors be carefully monitored as NDP investments are made. This employment monitoring could feed into a program that ensures that job creation from decarbonization meets specific recovery objectives in all sectors. For example, complementary educational and training programs that can increase the multiplier effect of capital investments in the sector or fiscal policies that could create or maintain high-value market niches in the agricultural sector could be effective. Other policies that reduce the barriers to employing foreign labor in the agricultural sector could help as well. We recommend that Costa Rica develops an analytical framework for identifying, measuring, and man- aging transformational change across the economy. Successful implementation of the NDP will require Costa Rica to adapt to socioeconomic, political, technological, and many other conditions. For example, how costs for different technologies evolve may provide different opportunity areas for decarbonization. Similarly, low availability of critical materials and technologies, such as batteries, could lead some aspects of the NDP to be highly suboptimal. This framework can build on strong capabilities in the Costa Rican university system and ministries, but it will also require robust, diverse, accessible, and culturally appropriate citizen engagement, particularly as that relates to Indigenous Peoples, Afrodescendants, and other local communities.

Funders of new research should continue to encourage research that not only integrates environmental and economic dimensions of decarbonization but also addresses the socioeconomic effects of and opportunities from decarbonization. This research will be critical to ensure a just economic transition, especially for the most vulnerable. Toward this end, the establishment of participatory mechanisms for designing decarbonization policies can help ensure that the credibility and legitimacy of decarbonization policies are maintained.

Appendix A

IEEM Details

IEEM Sectors and Aggregation

IEEM evaluates economic activity across 39 sectors. In order to compare IEEM-modeled employment to those reported by INEC, we developed a common aggregation, shown in Table A.1. This table also indicates which IEEM sectors we classified as low- and mid-skilled.

TABLE A.1 Sector Aggregation for Model and Observation Comparisons

Aggregate Sector	Included Census Sector	Included IEEM SAM Element
Agriculture, livestock, and fishing	Agricultura, ganadería y pesca	Rice[a] Other agriculture[a] Banana[a] Pineapple[a] Coffee[a] Silviculture[a] Fishing[a]
Commerce, repairs, professional and administrative activities	Comercio y reparación Actividades profesionales y administrativas de apoyo	Commerce[a] Professional services[a]
Communication and services, public administration and others	Otros Administración pública Comunicación y otros servicios No especificado	Other services Public administration[a]
Construction	Construcción	Construction[a]
Education and health	Enseñanza y salud	Education[a] Health[a]
Finance	Intermediación financiera y de seguros	Financial services[a]
Home employees	Hogares como empleadores	Domestic services[a]
Hotels and restaurants	Hoteles y restaurantes	Hotels and restaurants[a]
Manufacturing industry	Industria manufacturera	Mining Rice produce Food Coffee produce Drinks and tobacco[a] Textiles and leather[a] Oil refined Plastic and rubber[a] Chemicals Mineral products, not metallic Metallic products[a] Machinery and equipment Vehicles[a] Other manufactures[a] Electricity and gas Water[a] Bunker Diesel Gasoline Other oil[a]
Transport and storage	Transporte y almacenamiento	Rail transport[a] Land passenger transport[a] Transportation taxis[a] Sea and air freight transport[a] Other transport[a] Telecommunications Freight transport Sea and air passenger transport

[a] INDICATES AN IEEM ELEMENT THAT WE CLASSIFIED AS A LOW- OR MID-SKILLED SECTOR. WE CLASSIFIED ALL OTHERS AS HIGH-SKILLED SECTORS.

IEEM Calibration

Table A.2 shows the range of productivity shock parameters for each IEEM subsector and the values for the three calibration cases. Note that the parameter values for the elasticity of excess capital capacity on wage parameters have very small effects on the employment and value added outcomes.

TABLE A.2 Parameter Ranges for Calibration of IEEM

Sector	IEEM Variable	Minimum	Value Added Target	Balanced Target	Employment Target	Maximum
Agriculture, livestock, and fishing	ls_a-pinia (pineapple)	0.85	1.02	0.86	0.99	1.05
	ls_a-pesca (fish)	0.85	1.03	0.96	0.89	1.05
	ls_a-otragr (other agriculture)	0.85	1.01	0.99	0.93	1.05
	ls_a-for (silviculture)	0.85	0.95	0.97	0.94	1.05
	ls_a-cafeenfruta (coffee)	0.85	1.00	0.99	0.99	1.05
	ls_a-banano (banana)	0.85	0.88	0.88	0.95	1.05
	ls_a-arroz (rice)	0.85	0.98	1.01	1.02	1.05
Commerce, repairs, professional and administrative activities	ls_a-svcprf (professional services)	0.85	0.87	0.85	0.93	1.05
	ls_a-comercio (commerce)	0.85	0.95	0.92	1.03	1.05
Communication and services, public administration and others	ls_a-com (telecommunications)	0.85	0.91	1.00	0.98	1.05
	ls_a-otrsvc (other services)	0.85	1.01	1.03	1.03	1.05
	ls_a-admpub (public administration)	0.85	0.88	1.05	1.01	1.05
Construction	ls_a-cns (construction)	0.85	0.95	0.98	0.86	1.05
Education and health	ls_a-salud (healthcare)	0.85	0.90	0.85	0.92	1.05
	ls_a-edu (education)	0.85	0.98	0.99	0.97	1.05
Finance	ls_a-fin (finances)	0.85	0.95	1.01	0.99	1.05
Home employees	ls_a-domest (domestic services)	0.85	0.88	1.04	0.96	1.05
Hotels and restaurants	ls_a-hotelrest (hotels and restaurants)	0.85	0.86	0.87	1.00	1.05
Manufacturing industry	ls_a-vehiculos (vehicles)	0.85	1.01	1.01	0.93	1.05
	ls_a-texcuero (textiles and leather)	0.85	0.95	0.94	0.96	1.05
	ls_a-refpet (oil refined)	0.85	0.98	0.85	1.04	1.05
	ls_a-quimicos (chemicals)	0.85	0.91	0.88	0.87	1.05
	ls_a-prodminnomet (mineral products, not metal)	0.85	0.91	0.86	0.88	1.05
	ls_a-prodmet (metallic products)	0.85	0.87	1.04	0.91	1.05
	ls_a-prodcafe (coffee production)	0.85	1.05	0.98	0.87	1.05
	ls_a-otrmnf (other manufacturing)	0.85	0.93	1.00	0.92	1.05
	ls_a-min (mining)	0.85	0.93	1.02	0.86	1.05
	ls_a-maq (machinery and equipment)	0.85	1.04	1.00	0.99	1.05
	ls_a-elegas (electricity and gas)	0.85	0.94	0.92	0.96	1.05
	ls_a-cauchoplast (plastic and rubber)	0.85	1.01	0.95	0.86	1.05
	ls_a-bebtab (drinks and tobacco)	0.85	0.93	0.94	1.04	1.05
	ls_a-arrozelaborado (rice production)	0.85	1.04	0.88	1.04	1.05
	ls_a-alimentos (food)	0.85	0.92	1.03	0.90	1.05
	ls_a-agua (water)	0.85	1.01	0.91	0.90	1.05
Transport	ls_a-trnstierrapasajeros (land passenger transport)	0.85	0.89	0.95	0.96	1.05
	ls_a-trnsferrocarril (rail transport)	0.85	1.05	1.01	0.93	1.05
	ls_a-trnmarairecarga (sea and air freight transport)	0.85	1.02	0.95	0.95	1.05
	ls_a-taxis (taxis)	0.85	0.95	1.04	1.03	1.05
	ls_a-otrtrns (other transport)	0.85	0.95	1.02	0.90	1.05
Wages unemployment elasticities	High-skilled workers (Wages-eta_wf_f-lab-h)	−1.00	−0.09	−0.06	−0.05	−0.04
	Mid-skilled workers (Wages-eta_wf_f-lab-m)	−1.00	−0.07	−0.06	−0.05	−0.04
	Low-skilled workers (Wages-eta_wf_f-lab-l)	−1.00	−0.09	−0.05	−0.10	−0.04

Appendix B

Decarbonization Investment Costs

We considered three sources of cost estimates for the NDP: those included in the 2019 Benefits and Costs of Decarbonization study (Groves et al., 2020) and those from South Pole's studies (South Pole, 2019, 2021). Table B.1 indicates the lines of action for which each source provides estimates.

CR-IDPM Cost Estimates

The Benefits and Costs of Decarbonization study (Groves et al., 2020) developed simple models of the buildings, industry, circular economy, agriculture, livestock, and forestry lines of action. Costs used in this analysis are estimated using several different approaches detailed in Table B.2. In some cases, the academic literature provides cost estimates as a function of GHG emissions reductions by a specific sector activity. In other cases, we draw estimates from Costa Rican sources that are related more directly to the actions proposed in the NDP. These estimates are coarse and highly uncertain. Table B.2 summarizes the types of costs accounted for by sector in the CR-IDPM and indicates the cost drivers that are multiplied by cost factors to estimate costs.

In general, costs are not estimated based on specific investments or programs, but instead they are based on cost factors applied to sector-specific cost drivers. Exceptions include the sanitation improvements costs as defined by AyA, 2016.

TABLE B.1 Sources of Decarbonization Cost Estimates, by Line of Action

Line of Action	Benefits and Costs of Decarbonization Study (Groves et al., 2020)	South Pole (2019 and 2021)
Transport	✔ (OSeMOSYS)	✔
Electricity	✔ (OSeMOSYS)	
Buildings	✔ (CR-IDPM)	
Industry	✔ (CR-IDPM)	
Circular economy	✔ (CR-IDPM)	
Agriculture	✔ (CR-IDPM)	✔
Livestock	✔ (CR-IDPM)	✔
Forestry	✔ (CR-IDPM)	✔

NOTE: CR-IDPM = COSTA RICA INTEGRATED DECARBONIZATION PATHWAYS MODEL; OSEMOSYS = OPEN SOURCE ENERGY MODELING SYSTEM—COSTA RICA.

TABLE B.2 Costs Accounted for in the CR-IDPM, by Line of Action

Line of Action	Costs Accounted for in the CR-IDPM	Cost Driver
Buildings	Costs of improving efficiency and electrification of households	Number of households
	Costs of improving efficiency and electrification for commercial buildings	Commercial value added
Industry	Costs of reducing emissions from cement manufacturing	Production of cement
	Costs of improving efficiency and reducing emissions from industrial products (such as refrigerants)	Industrial value
	Costs of improving efficiency and electrification	Energy saved in the NDP projection (compared with the BAU projection)
Circular economy	Costs of collecting solid waste	Amount of waste generated
	Costs of disposing of waste in landfills	Amount of waste disposed of in landfills
	Costs of recycling and composting waste	Amount of waste recycled and composted
	Costs of adding new and/or rehabilitating existing urban sewage connections and rural secure sanitation	Number of households
	Costs of increasing wastewater treatment	Aggregate costs from sanitation plan distributed over time
	Costs of capturing methane at landfills	Tons of methane captured
Agriculture		
	Costs of non-coffee decarbonization	Amount of CO2e reduced
Livestock	Costs of reducing carbon emissions from livestock	Amount of CO2e reduced
Forestry	Opportunity cost of forgone timber	Amount of timber not harvested
	Opportunity cost of forgone grazing	Amount of land not converted to graze land
	Opportunity cost of forgone agricultural production	Amount of land not converted to agriculture
	Costs of increasing carbon sequestration by forests	Additional amount of CO2e sequestered

NOTE: CO2E = CARBON DIOXIDE EQUIVALENT.

SouthPoleTransportDecarbonization Cost Estimates

Table B.3 shows the specific transportation measures analyzed in South Pole, 2019.

TABLE B.3 Transportation Measures Analyzed in South Pole, 2019

Public Transport

- By 2022, operate eight public transport (PT) corridors.
- Operate at least one PT mode with an integrated e-payment system.
- Operate a tendered electric passenger train.
- Operate e-buses in at least two PT corridors.
- Include zero emission and e-bus targets in PT concession contracts.
- Design the roadmap of the national hydrogen cluster.
- Implement transit-oriented development practices in three municipalities.
- By 2022, have 16 cantones participate in the 2.0 Carbon Neutrality Programme.
- By 2035, have 30% of the PT fleet be electric.
- In 2050, have the PT system become the first mobility option.
- By 2050, have 85% of the PT fleet operating at zero emissions.
- By 2050, increase nonmotorized travel by 10%.

Light and Private Transport

- Publish National Electric Transport Plan and complementary laws.
- Acquire zero emissions–producing fleets at three new public institutions.
- By 2022, operate 69 fast-charging centers.
- Incorporate 5–10% of ethanol in both gasolines.
- Publish roadmap for biodiesel production and use.
- Design eco-labeling for vehicle efficiency.
- By 2035, have 30% of the private and institutional vehicle fleets be electric.
- By 2050, have 95% of the private and institutional vehicle fleets be electric.
- By 2025, stabilize the motorcycle fleet and move to zero-emissions units.
- By 2050, consolidate new models and schemes for shared mobility.
- By 2050, have a country-wide electric charging network.

Freight Transport

- By 2022, establish a pilot project for freight logistics under low-emissions parameters.
- Operate Tren Electrico Limonense de Carga.
- Develop a plan to improve efficiency and reduce emissions in the cargo sector.
- Develop a plan to improve the efficiency of the cargo transport sector (biofuels and liquified petroleum gas [LPG]).
- By 2030, operate 20% of the freight transport fleet on LPG.
- By 2035, put in place consolidated sustainable logistics models in major ports and urban areas.
- By 2050, have highly efficient freight transport with 20% reduced emissions compared with 2018 emissions.

Linking Decarbonization Investments to Sector Capital Stocks

Table B.4 shows how we linked the capital investments for the different NDP lines of action (columns) with private investment levels, as represented in IEEM across different economic activities (rows) in Costa Rica. The cell values denote the share of the total capital costs of the NDP (estimates of which are shown in Table 2.3 in Chapter Two) that is allocated to each indicated economic activity. For example, for the transport line of action, 67 percent of the total capital costs of the NDP is allocated evenly (16.7 percent) to land passenger transport, transportation taxis, other transport, vehicles, sea and air freight transport, and rail transport sectors. This distribution of capital investments across the economy is informed by expert judgement.

TABLE B.4 Estimated Investment Share of Decarbonization Investments Across Different Lines of Action and Economic Activities

	Line of Action							
Economic Activity	**Agriculture (%)**	**Buildings (%)**	**Electricity (%)**	**Forestry (%)**	**Industry (%)**	**Livestock (%)**	**Transport (%)**	**Waste (%)**
Bananas	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	0.0	0.0	7.7	0.0	0.0	3.8
Coffee produce	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Coffee	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commerce	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Construction	0.0	100.0	0.0	0.0	0.0	0.0	0.0	38.5
Domestic services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drinks and tobacco	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Education	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity and gas	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Financial services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fishing	14.3	0.0	0.0	0.0	0.0	33.3	0.0	0.0
Food	0.0	0.0	0.0	0.0	7.7	33.3	0.0	0.0
Health	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hotels and restaurants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Land passenger transport	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Machinery and equipment	0.0	0.0	0.0	0.0	7.7	0.0	0.0	3.8
Metallic products	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Mineral products not metallic	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Oil, refined	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other agriculture	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other manufactures	0.0	0.0	0.0	0.0	7.7	0.0	0.0	3.8
Other services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
Other transport	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Pineapples	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plastic and rubber	0.0	0.0	0.0	0.0	7.7	0.0	0.0	3.8
Professional services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public administration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail transport	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Rice	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rice produce	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sea and air freight transport	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Silviculture	14.3	0.0	0.0	100.0	0.0	33.3	0.0	0.0
Telecommunications	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textiles and leather	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Transportation taxis	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Vehicles	0.0	0.0	0.0	0.0	7.7	0.0	16.7	3.8
Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5

Appendix C

Relevance of Nationally Determined Contribution Decarbonization Actions to the United Nations Sustainable Development Goals

The relationships identified in Table C.1 were informed by an existing analysis of the 2015 Intended Nationally Determined Contribution (INDC) previously commissioned by the Climate Change Directorate with support from the German Agency for International Cooperation.[20] That effort used document review, augmented by interviews with subject-matter experts, to identify interactions between INDC actions and SDGs on a 7-point scale developed by Weitz et al., 2018. For the sake of simplicity and internal consistency, we evaluated the interactions between the 2020 NDC actions and the SDGs on a binary scale. We specified a relationship whenever the 2015 analysis noted a relationship on similar actions and, for actions that did not have a 2015 analog, when we could agree on a plausible relationship. If a link could not be identified through a 2015 analog or through a consensus on a plausible relationship, no relationship was specified.

Table C.1 lists each NDC action and the SDGs that we determined to be relevant for each. As a reminder, the SDGs are as follows:

- SDG 1: No poverty
- SDG 2: Zero hunger
- SDG 3: Good health and well-being
- SDG 4: Quality education
- SDG 5: Gender equality
- SDG 6: Clean water and sanitation
- SDG 7: Affordable and clean energy
- SDG 8: Decent work and economic growth
- SDG 9: Industry, innovation, and infrastructure
- SDG 10: Reduced inequalities
- SDG 11: Sustainable cities and communities
- SDG 12: Responsible consumption and production
- SDG 13: Climate action
- SDG 14: Life below water
- SDG 15: Life on land
- SDG 16: Peach, justice, and strong institutions
- SDG 17: Partnerships for the goals

[20] AN INTERACTIVE VISUALIZATION OF THE RESULTS OF THIS ANALYSIS IS AVAILABLE ONLINE (KUMU, UNDATED).

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	0 Fair settlement, social and climate justice	
0.1	By 2022, Costa Rica will have made its "National Cycle of Ambition" official, with which it officially establishes the bases of a continuous, iterative, and inclusive process that incorporates the various worldviews and knowledge and based on the best available science and that makes the efforts necessary to properly incorporate the groups most vulnerable to climate change, for monitoring and updating their Nationally Determined Contributions and their long-term strategy under the Paris Agreement. This Cycle will help update the goals of the different instruments, seeking the best strategy to maintain the trajectory of emissions toward the goal of decarbonization by 2050 and the emissions budget defined in this NDC for the period from 2021 to 2030, as well as the definition of emissions targets and budgets for future periods, maintaining the focus of climate and social justice and just transition and the considerations of the well-being of people and ecosystems.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15, SDG16, SDG17
0.2	By 2022, Costa Rica will have carried out an analysis of Costa Rican green and blue jobs, which analyzes the state of green jobs in the country, including the identification of green and blue jobs linked to the main existing value chains and potentials.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15
0.3	By 2022, Costa Rica will have established a just transition governance scheme led by the Ministry of Environment and Energy (MINAE), the Ministry of Human Development and Social Inclusion (MDHS), and the Ministry of Labor and Social Security (MTSS) to the sectors contemplated in the NDC. This scheme will include a working commission between the two ministries to achieve a common understanding of the just transition and to coordinate joint actions, as well as permanent and ad-hoc spaces for dialogue that allow promoting tripartite social dialogue between government and representatives of employers and of workers, as well as a broad social dialogue that integrates women and young people from an intersectional perspective, Indigenous Peoples, and Afrodescendant communities in a manner appropriate to the realities and worldviews of the different communities and territories.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG8, SDG9, SDG10, SDG12, SDG13
0.4	By 2024, Costa Rica will have developed a just transition strategy for the country, accompanied by a national policy on green jobs and the mechanisms to monitor and evaluate them, including the development and implementation of the necessary functions in the National System of Climate Change Metrics (SINAMECC) to estimate green employment, the evolution of the just transition, and the impact of climate action on employment and vulnerable groups, as well as to foresee and anticipate changes in occupational demand caused by it.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG8, SDG9, SDG10, SDG12, SDG13, SDG14, SDG15
	1 Mobility and transportation	
1.1	During the period of compliance with this NDC, the electric passenger train will come into operation in the greater metropolitan area, powered by renewable electric energy.	SDG1, SDG3, SDG8, SDG9, SDG10, SDG11, SDG13, SDG17
1.2	In 2021, public bus concessions will be renewed with criteria of decarbonization, adaptation, and resilience, including cross-sectorization, electronic payment, and multimodal integration of public and active means of transport.	SDG1, SDG3, SDG8, SDG9, SDG10, SDG11, SDG13, SDG17
1.3	During the period of compliance with this NDC, the Limonense Electric Freight Train (TELCA) will be in operation by the year 2022.	SDG8, SDG9, SDG12, SDG13
1.4	By 2030, at least 8% of the country's public transport fleet will be zero emissions.	SDG3, SDG9, SDG11, SDG13, SDG17
1.5	By 2030, the infrastructure will have been expanded and improved to increase non-motorized mobility trips (including pedestrian and bicycle mobility) by at least 5% compared with the current trajectory.	SDG1, SDG3, SDG5, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG17
1.6	By 2025, the country will have adopted standards to migrate toward a zero-emission motorcycle fleet and stabilize the growth of the motorcycle fleet.	SDG3, SDG11, SDG13, SDG17
1.7	By 2030, at least 8% of the fleet of light vehicles—private and institutional—will be electric.	SDG3, SDG11, SDG13, SDG17
1.8	In 2025, the establishment of sustainable logistics models will have begun in the country's main ports, urban areas, and logistics consolidation centers, in line with the Costa Rica 2050 National Strategic Plan.	SDG8, SDG9, SDG11, SDG12, SDG13, SDG17
1.9	By 2030, the country will have significantly reduced its digital and technological gap, with particular emphasis on socially and economically vulnerable populations, through a solidarity model, considering such aspects as Internet connectivity, equipment, and digital appropriation. This will be an enabler to close social and economic gaps through digital practices, such as telecommuting, e-commerce, and virtual tourism (which reduce the need for travel), increasing efficiency and national economic dynamism.	SDG1, SDG3, SDG4, SDG5, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG17

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	2 Development and land use planning	
2.1	By 2030, adaptation criteria will have been incorporated into different territorial planning instruments, including regional development plans, cantonal and coastal regulatory plans, master plans, and general management plans for protected wild areas and biological corridors, among others, with adherence to established norms and institutional competencies.	SDG3, SDG5, SDG6, SDG9, SDG10, SDG11, SDG13, SDG14, SDG15, SDG17
2.2	By 2030, transport-oriented development criteria will have been incorporated into different territorial planning instruments, including the National Urban Development Plan, regional development plans for land use planning, and cantonal and coastal regulatory plans; these are implemented in a way that articulates the modes of sustainable mobility with the model of compact cities.	SDG1, SDG3, SDG8, SDG9, SDG10, SDG11, SDG13, SDG15, SDG17
	3 Energy	
3.1	The aspirational goal of this contribution is to achieve and maintain 100% renewable electricity generation by 2030. The country will maintain the thermal capacity necessary to ensure the reliability of the system, seeking to eliminate it as soon as there are other technically and economically viable alternatives.	SDG3, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13
3.2	Costa Rica undertakes to develop, during the period of implementation of this contribution, an integrated intersectoral planning of the process of electrification of energy demand, which will incorporate the needs of the various sectors and the diversity of renewable energy sources available in the different regions of the country.	SDG3, SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
3.3	By 2030, Costa Rica will have developed and/or updated energy efficiency standards and regulations for end-use technologies (including, but not limited to, refrigeration and air conditioning equipment, boilers, heat pumps, vehicles, machinery, and other energy-intensive equipment) to ensure consistency with the country's decarbonization trajectory to be net zero emissions by 2050.	SDG7, SDG8, SDG9, SDG12, SDG13
3.4	By 2030, technology substitution and energy efficiency measures in the passenger, cargo, and industrial transport sectors will reduce black carbon emissions by 20% compared with 2018 emissions.	SDG3, SDG7, SDG11, SDG12, SDG13
3.5	By 2022, Costa Rica will have developed a strategy for the development and promotion of green hydrogen in the country.	SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
3.6	During the period of implementation of this contribution, Costa Rica will push for the moratorium on exploration and exploitation of hydrocarbons in the national territory to be raised to the rank of law.	SDG3, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13, SDG14, SDG15
	4 Infrastructure and construction	
4.1	The country will increase the use in buildings of wood, bamboo, and other local materials, including those of plantations of forests managed sustainably, until increasing a minimum of 10% in 2025 on the baseline of 2018. In this effort, it will favor the traditional crafts and knowledge of these materials through their generational transfer, recognition, and dialogue with related knowledge.	SDG1, SDG8, SDG9, SDG10, SDG12, SDG13, SDG15
4.2	By 2030, 100% of new buildings will be designed and built using low-emission and resilient systems and technologies under bioclimatic parameters.	SDG3, SDG9, SDG11, SDG12, SDG13, SDG15
4.3	During the period of implementation of this contribution, the country will incorporate criteria for adaptation to climate change in norms and guidelines for public investment, in order to ensure its robustness in the face of climate impacts.	SDG6, SDG7, SDG9, SDG11, SDG12, SDG13
4.4	By 2030, applications of guidelines will have been developed with adaptation criteria, institutional articulation efforts, and improvements in response capacity, among others, to guarantee the continuity of vital public services (health, education, water and sanitation, energy, transportation) to extreme hydrometeorological events.	SDG3, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG11, SDG13
	5 Industry, commerce and services	
5.1	In 2030, the thematic area of industry, trade, and services will have innovative production models from "cradle to grave" or with a circular economy approach in the main productive chains of agroindustry, services, construction, and creative and cultural economy, among others.	SDG1, SDG2, SDG6, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13, SDG14, SDG15, SDG17
5.2	During the period of implementation of this contribution, Costa Rica will create and will have begun the implementation of objectives and goals based on science and aligned with the Nationally Determined Contributions and the National Decarbonization Plan for the productive activities of the industry and commerce sectors—services that generate the greatest impact on GHG emissions.	SDG8, SDG9, SDG12, SDG13

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	5 Industry, commerce and services	
5.3	By 2030, the actions and concrete results in mitigation and adaptation to climate change of companies and the value chains of the products that have the most impact on GHG emissions will be reported, through the country's program for carbon neutrality and the national system of climate change metrics.	SDG12, SDG13
5.4	Costa Rica confirms the commitments established in the Kigali Amendment of the Montreal Protocol to progressively reduce hydrofluorocarbons (HFCs) and promote low-power global warming refrigerants.	SDG9, SDG13
5.5	By 2030, the necessary conditions will have been created to promote innovation, investment, e-cocompetitiveness, and resilience of the economy to the adverse effects produced by climate change.	SDG8, SDG9, SDG11, SDG12, SDG13
	6 Integrated waste management	
6.1	In 2025, at least ten municipalities implement the national composting plan.	SDG3, SDG6, SDG11, SDG12, SDG13, SDG17
6.2	By 2030, at least 50% sanitary sewer coverage will be achieved in areas with high population density, incorporating criteria of resilience to climate change.	SDG3, SDG5, SDG6, SDG9, SDG10, SDG11, SDG13
6.3	In the year 2030, at least 50% of the wastewater in the areas of high population density will receive treatment.	SDG3, SDG5, SDG6, SDG9, SDG10, SDG11, SDG13, SDG14, SDG15
6.4	In the first two years of the implementation period of this NDC, Costa Rica will launch its public policy instrument for the promotion of the circular economy.	SDG1, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12, SDG13
6.5	During the first two years of implementation of this NDC, Costa Rica will have published and started the implementation of its public policy instruments, such as the Action Plan for the Comprehensive Management of Solid Waste 2021–2026 and the National Composting Plan 2020–2050, articulating the efforts to reduce emissions, with a focus of transformation toward the circular economy and the bioeconomy.	SDG3, SDG11, SDG12, SDG13
	7 Agricultural	
7.1	In 2030, the value chains of coffee, livestock, sugar cane, rice, and bananas will apply production systems that are low in GHG emissions both at the farm level and at the processing stage level.	SDG2, SDG6, SDG7, SDG8, SDG12, SDG13, SDG15
7.2	In 2025, the country will promote a circular economy system for agricultural farms, integrally considering the biodigestion process and soil recarbonization through the use of technologies to increase soil organic carbon (SOC) levels, among others.	SDG2, SDG7, SDG12, SDG13, SDG15
7.3	In 2030, 70% of the livestock herd and 60% of the area dedicated to livestock will implement low-emission production systems.	SDG2, SDG8, SDG12, SDG13, SDG15
7.4	By 2026, a study will have been developed on impacts derived from climate change in agricultural and fishing production systems, including effects on agricultural health, and whose results are shared appropriately to the realities and worldviews of the different communities.	SDG2, SDG3, SDG4, SDG10, SDG13
7.5	By 2024, the agricultural sector will have its own sector plan for adaptation to climate change in implementation.	SDG2, SDG3, SDG5, SDG6, SDG8, SDG12, SDG13, SDG15
7.6	By 2030, there will be a reduction in the total area of pasture at an annual rate of 1% and an increase in the area of pasture with good management at a rate of 1 to 2% annually over the trend in the baseline.	SDG12, SDG13, SDG15
7.7	By 2030, adaptive and resilient practices will have been incorporated into agricultural production systems, through technical guidelines for resilience, certification, and training.	SDG2, SDG3, SDG5, SDG6, SDG8, SDG9, SDG12, SDG13, SDG15
7.8	By 2022 the "adapted dietary guidelines" will have been developed in two territories of the country with maps and information that promote the consumption of indigenous and traditional seasonal agricultural and food products, highlighting their nutritional value and their contribution to the protection of cultural heritage and reduction of emissions and food insecurity.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG8, SDG10, SDG12, SDG13

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	8 Forests and terrestrial biodiversity	
8.1	During the period of implementation of this contribution, Costa Rica undertakes to promote nature-based solutions as a central pillar of its climate action and to include them in its public policies related to climate change.	SDG3, SDG6, SDG11, SDG13, SDG14, SDG15, SDG16, SDG17
8.2	By the year 2030, Costa Rica will have managed actions, including the strengthening of the indigenous cultural conservation system, that allow it to maintain or increase the capacity to capture and/or reduce emissions from terrestrial ecosystems, such as forest ecosystems, agroforestry, and peat bogs, among others.	SDG6, SDG13, SDG15
8.3	By 2030, Costa Rica will have maintained and improved the Payment for Ecosystem Services program, including other services and ecosystems not covered so far, including as a priority soils, peatlands, and other ecosystems with high potential for carbon sequestration, identifying and increasing the funding sources.	SDG1, SDG2, SDG6, SDG8, SDG9, SDG13, SDG15, SDG17
8.4	In 2030, the country will increase and maintain its forest cover to 60%, while this type of cover does not compete with the agricultural sector.	SDG6, SDG8, SDG13, SDG15
8.5	In 2030, the country will maintain a zero deforestation rate in mature forest.	SDG6, SDG13, SDG15
8.6	By 2030, adaptation based on ecosystems within and outside the state's natural heritage will have been promoted through the conservation of biodiversity in biological corridors, private reserves, indigenous territories, agricultural farms, and the integral management of natural and cultural heritage, among others.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG9, SDG10, SDG11, SDG13, SDG15
8.7	By 2030, the application of complete silvipastoral and agroforestry systems will increase by 69,500 hectares.	SDG2, SDG3, SDG6, SDG8, SDG12, SDG13, SDG15
8.8	By 2030, 1,000,000 hectares of forest cover will have been intervened, including secondary growth forest, to avoid land degradation and favor biodiversity.	SDG3, SDG6, SDG13, SDG15
8.9	By 2030, Costa Rica executes the Territorial Forest Environmental Plan, together with the indigenous territories, as an instrument for implementing the measures established in the national REDD+ strategy, built through the consultation process carried out in accordance with the framework established for this purpose in national and international legislation.	SDG1, SDG5, SDG6, SDG8, SDG10, SDG11, SDG12, SDG13, SDG15, SDG17
	9 Ocean and water resources	
9.1	By 2022, 30% of the country's ocean territory will be under some official protection scheme.	SDG1, SDG2, SDG3, SDG5, SDG8, SDG12, SDG13, SDG14, SDG16, SDG17
9.2	By 2030, water security and sustainability will have been promoted in the face of climate change, as well as the adequate and integrated management of hydrographic basins, through the protection and monitoring of sources.	SDG2, SDG3, SDG5, SDG6, SDG7, SDG11, SDG12, SDG13, SDG15, SDG16, SDG17
9.3	As an overall ambition of its blue carbon goal, Costa Rica will continue to lead in the conservation, responsible use, and restoration of coastal wetlands by deepening scientific knowledge of the ecosystem services these habitats provide and will take steps to better protect and restore these spaces in the future.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15
9.4	During the period of implementation of this contribution, Costa Rica commits to improved protection and conservation of existing blue carbon ecosystems.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15
9.5	The country will protect and conserve 100% of the coastal wetlands included and reported in the National Inventory of Wetlands (in the period 2016–2018) by the year 2025 and will increase the area of estuarine wetlands registered by at least 10% by the year 2030, in order to protect and conserve these ecosystems.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15
9.6	Costa Rica will ensure that coastal wetland areas are effectively managed and monitored and will continue to develop mechanisms to continue sustainable community use of key mangrove areas for local livelihoods and sustainability.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	9 Ocean and water resources	
9.7	Costa Rica aspires to stop or reverse the net loss of coastal wetlands by 2030, by addressing the main drivers of deforestation and degradation that threaten the very existence, health, and vitality of coastal wetlands, according to the National Forest Inventory.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15
9.8	By 2025 and within the framework of the restoration of blue carbon ecosystems, Costa Rica is committed to restoring prioritized coastal wetland areas, as identified in the implementation plan of the National Landscape Restoration Strategy, with an additional percentage of area established by the strategy for 2030.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15
9.9	In the framework of restoring blue carbon ecosystems, Costa Rica is committed to ensuring that these prioritized coastal wetland areas are effectively managed and monitored, including through integration with existing management plans. Costa Rica will continue to develop mechanisms to enable sustainable community management of key mangrove areas for livelihoods and local livelihoods.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15
9.10	Costa Rica is committed to exploring innovative conservation financing mechanisms, including the potential expansion of terrestrial Payment for Ecosystem Services models, subject to improvements, to support the implementation of blue carbon targets.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15
9.11	Costa Rica will explore the potential of public-private investments to support the protection and restoration of mangroves.	SDG1, SDG2, SDG3, SDG5, SDG6, SDG8, SDG10, SDG12, SDG13, SDG14, SDG15, SDG17
9.12	Costa Rica undertakes to promote sustainable fishing activities, including mariculture schemes, value added from artisanal and traditional fishing, and marine spatial planning schemes to promote the development of a blue economy.	SDG1, SDG2, SDG8, SDG10, SDG12, SDG13, SDG14
	10 Action for climate empowerment	
10.1	In the first two years of the implementation period of this contribution, a national strategy for climate empowerment will be in operation with actions in education, training, social awareness, access to information, citizen participation, and international cooperation. This strategy will be created in an inclusive and participatory manner, including with the culture and education sectors, and will follow the best international practices for its creation, including those of the United Nations Framework Convention on Climate Change and the United Nations Organization for Education, Science and Culture (UNESCO). This strategy will have specific indicators and metrics, will propose financing proposals, and will centrally include young people, the Citizen Consultative Council on Climate Change, Indigenous Peoples, and Afrodescendant communities, whose worldviews, traditions, and knowledge are invaluable to inform a truly sustainable national development.	SDG4, SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG16, SDG17
10.2	During the period of implementation of this contribution, the country will review the education curricula in the first and second educational cycles to include or expand material on climate change, the just transition, and green employment, and will create alliances between key actors in the formal and non-formal education sector—including the Ministry of Public Education, civil society organizations, and community organizations that have the capacity to implement education programs aimed at citizens in general—and will create a process with public and private universities to include in their programs or strengthen content related to climate change and the training of competencies for green employment based on the professional requirements foreseen.	SDG1, SDG3, SDG4, SDG5, SDG8, SDG10, SDG12, SDG13, SDG16, SDG17
10.3	During the period of implementation of this contribution, the country will develop specific training programs for women, young people, people of African descent, Indigenous Peoples, and other groups historically excluded from the labor sector, in order to facilitate access to green jobs, including such areas as renewable energy, regenerative and precision agriculture, sustainable construction, and recovery of valuable assets, in which they are often underrepresented.	SDG1, SDG3, SDG4, SDG5, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG16
10.4	During the period of implementation of this contribution, the country will have implemented communication, participation, and empowerment actions of citizens to promote the integration of the perspectives of different groups, including young people, Indigenous Peoples, and Afrodescendant people in a manner appropriate to the realities and worldviews of the different communities.	SDG3, SDG4, SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG16, SDG17
10.5	By 2030, the capacities in mitigation and adaptation to climate change of decisionmakers at different levels of government, as well as community leaders and young people, have been strengthened in a manner appropriate to the realities and worldviews of the different communities.	SDG3, SDG5, SDG6, SDG7, SDG8, SDG10, SDG11, SDG13, SDG17

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	10 Action for climate empowerment	
10.6	By 2030, awareness-raising and capacity-building actions for decisionmakers will have been incorporated with an emphasis on the triple helix innovation model to promote economic and social development through the interaction of the business sector, the public sector, and the academy for the development of an inclusive, decarbonized, and resilient economy.	SDG4, SDG8, SDG9, SDG11, SDG12, SDG13, SDG17
10.7	By 2030, community management and participation in adaptation will have been promoted to reduce the vulnerability of communities to climate change.	SDG3, SDG5, SDG6, SDG7, SDG11, SDG13
10.8	During the period of implementation of this contribution, the country will take communication and citizen participation actions aligned with the National Strategy for Responsible Consumption and Production to reduce consumerism, specifically of individual consumption products with a high carbon footprint.	SDG5, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13
10.9	Starting in 2021, the country will develop spaces for dialogue and participation, both virtual and face-to-face, for groups particularly vulnerable to climate change, including the Afrodescendant community, organized groups of women, youth, the transsexual community, Indigenous Peoples, people with disabilities. and older people in a way that is appropriate and accessible to the realities, worldviews, and traditions of the different communities and populations.	SDG4, SDG5, SDG10, SDG13, SDG16, SDG17
10.10	As of 2022, the country has generated a Plan for the Integration of Youth in Climate Action.	SDG5, SDG10, SDG11, SDG12, SDG13, SDG16, SDG17
10.11	In 2024, the structures for the incorporation of youth and children into actions for climate empowerment will be strengthened, including the establishment of an Annual Forum for Youth on Climate Action as part of the climate action axis of the Public Policy of the Person Youth 2020–2024.	SDG5, SDG10, SDG11, SDG12, SDG13, SDG16, SDG17
	11 Transparency and continuous improvement	
11.1	By 2022 Costa Rica has implemented the monitoring system to monitor the progress of the NDC, the National Policy for Adaptation to Climate Change, the Communication on Adaptation, the National Adaptation Plan, and the National Decarbonization Plan, allowing access to data in an open way.	SDG3, SDG5, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
11.2	By 2022, Costa Rica will have established processes and institutional arrangements that allow it to have a permanent capacity for analysis, prospecting, and independent technical publication on climate action.	SDG3, SDG5, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
11.3	By 2030, the country will monitor the indicators required to guarantee gender equality and the empowerment of the Afrodescendant community, organized groups of women, youth, the transsexual community, Indigenous Peoples, people with disabilities, and older people on the climate agenda in the sectors of action.	SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG17
11.4	By 2030, the country will have differentiated data on the reality of the historically excluded and most vulnerable groups to the effects of climate change, including at least the Afrodescendant community, organized groups of women, youth, transsexual community, Indigenous Peoples, people with disabilities, and older adults.	SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG17
11.5	By 2030, platforms have been set up to facilitate access to climate information and services to all audiences using relevant and appropriate language and examples for the different realities and worldviews of the country.	SDG4, SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG17
11.6	As a cross-cutting support action, Costa Rica will account for the fluxes (emissions and removals) of GHGs from coastal wetlands through integration in the National Inventory of Greenhouse Gases and harmonization with other measurement, reporting and verification systems, such as REDD+, using the most robust IPCC [Intergovernmental Panel on Climate Change] GHG good practice guidelines at least in 2024, when it presents the first biennial transparency report, given the special circumstances for developing countries granted under Article 13 of the Paris Agreement.	SDG13, SDG16
11.7	By 2030, the country, with the support of the Scientific Council on Climate Change (4C), will have implemented policies to promote scientific research, systematic data collection, and current and prospective analysis of information on risks, impacts, losses, and damages due to hydrometeorological threats.	SDG4, SDG6, SDG9, SDG11, SDG13, SDG14, SDG15, SDG17
11.8	By 2030, the country will have an open climate data policy, from both the public and private sectors, that facilitates its generation, access, and use for decisionmaking in all sectors.	SDG4, SDG5, SDG6, SDG8, SDG9, SDG11, SDG12, SDG13, SDG14, SDG15, SDG16, SDG17
11.9	By 2030, the knowledge, monitoring, and response of sanitary surveillance services in public health will have been strengthened.	SDG2, SDG3, SDG5, SDG11, SDG13, SDG16 SDG2, SDG6, SDG13,

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	11 Transparency and continuous improvement	
11.10	By 2030, the National Forest Monitoring System will have been consolidated, including the platform of the National System for Monitoring Cover and Land Use and Ecosystems (SIMOCUTE) and its link with the National System of Climate Change Metrics (SINAMECC) and other national environmental reporting systems and their safeguards.	
	12 Finance	
12.1	By 2030 Costa Rica will have implemented at least one green tax reform instrument consistent with the necessary path for decarbonization.	SDG3, SDG8, SDG12, SDG13, SDG17
12.2	By 2025, the country will have developed the tools, instruments, regulations and incentives to accompany the financial sector in the analysis, disclosure and management of the risks and impacts of climate change in its sector.	SDG3, SDG8, SDG12, SDG13, SDG17
12.3	Mobilize the financial system, including the development banking system so that by 2030 there are financial products in the market to support decarbonization and resilience.	SDG3, SDG8, SDG12, SDG13, SDG17
12.4	Costa Rica is committed to strengthening financial instruments such as payment for ecosystem services, royalties and other carbon price instruments, as well as insurance and tariff and fiscal instruments, to finance adaptation and mitigation needs.	SDG3, SDG8, SDG12, SDG13, SDG17
12.5	Costa Rica undertakes to identify climate actions in the annual budget exercises, in order to have financial protection measures against the impacts of climate variability and change.	SDG3, SDG8, SDG13, SDG17
12.6	By 2022 Costa Rica will publish the first investment analysis of the National Decarbonization and the Adaptation Plan (yet to be presented), which will be updated every five years.	SDG3, SDG8, SDG13, SDG17
12.7	By 2024, sustainable, decarbonized, resilient infrastructure criteria have been incorporated that promote the creation of green jobs to prioritize public investment, in line with the 2050 National Strategic Plan.	SDG3, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13
12.8	During the execution period of this NDC, Costa Rica will have developed a financial support instrument with the national banking system to promote the energy transition.	SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
12.9	By 2024, the Costa Rican Compensation Mechanism (MCCR) will have been launched as a successor to the Domestic Carbon Market, with the aim of supporting and facilitating the mobilization of funds, mainly national, in pursuit of the decarbonization of the country through the generation of Costa Rican compensation units generated by projects, activity programs or activities incorporated into a program, which reduce or sequester greenhouse gas emissions in the national territory.	SDG5, SDG7, SDG8, SDG9, SDG12, SDG13, SDG17
	13 Climate change policies, strategies and plans	
13.1	In 2021, Costa Rica will publish the Costa Rica Territorial Economic Strategy: Toward an Inclusive and Decarbonized Economy 2020–2050 and the 2050 National Strategic Plan as long-term planning instruments aimed at achieving inclusive and decarbonized economic development.	SDG1, SDG2, SDG3, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG13, SDG14, SDG15, SDG16, SDG17
13.2	The country undertakes to take the necessary steps during the period of this NDC to seek ratification of the Regional Agreement on Access to Information, Public Participation and Access to Justice in Environmental Matters in Latin America and the Caribbean (Agreement Escazú) and the forms of implementation with national regulations.	SDG13, SDG16, SDG17
13.3	By 2030, the Payment for Environmental Services Program, and other carbon price instruments and fiscal and tariff instruments, will have developed new financing mechanisms for adaptation and mitigation to climate change in line with the national REDD+ strategy.	SDG1, SDG2, SDG5, SDG6, SDG8, SDG10, SDG11, SDG12, SDG13, SDG15
13.4	By 2022, the guidelines will have been established and the Inclusive Sustainable Development Fund will be put into operation with a seed capital of 1.2 million USD to promote the financial recognition of the productive spaces of rural women and their contribution to mitigation and adaptation to climate change.	SDG1, SDG2, SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG15

TABLE C.1 Relevant Sustainable Development Goals for Each Nationally Determined Contribution Decarbonization Action

	NDC Action	Relevant SDG
	13 Climate change policies, strategies and plans	
13.5	In 2021, the implementation of the National Bioeconomy Strategy of Costa Rica 2020–2030 will begin to cement a Costa Rica with sustainable production of high value added in all its regions and emerging biocities, based on the fair and equitable use of its biodiversity, the circular use of biomass, and the country's biotechnological progress as a knowledge society.	SDG1, SDG2, SDG4, SDG5, SDG6, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13, SDG14, SDG15, SDG17
13.6	In 2021 Costa Rica will have incorporated the Ministry of Labor and Social Security, the Ministry of Human Development and Inclusion, the Ministry of Public Education, and the Ministry of Culture and Youth to the Interministerial Technical Council on Climate Change, establishing specific cooperation agendas with each one.	SDG3, SDG4, SDG5, SDG8, SDG10, SDG11, SDG12, SDG13, SDG16, SDG17
13.7	By 2022, the Plan of Action of the National Policy for Adaptation to Climate Change (National Adaptation Plan) will have been formulated, approved, and started.	SDG3, SDG5, SDG6, SDG8, SDG9, SDG11, SDG12, SDG13, SDG14, SDG15, SDG17
13.8	As of 2022, the Disaster Risk Management Plan 2021–2025 is being implemented.	SDG3, SDG5, SDG9, SDG11, SDG13
13.9	By 2022, action plans for the six socioeconomic regions of the country will have been drawn up in a participatory manner with the regional development councils and their regional intersectoral committees and considering their priorities, where priority adaptation measures are identified for each region, as well as the institutional arrangements necessary for its implementation.	SDG3, SDG5, SDG6, SDG9, SDG11, SDG13, SDG14, SDG15, SDG16, SDG17
13.10	By 2030, adaptation criteria and guidelines have been incorporated into the sectoral, regional and local planning instruments for territorial, marine, and coastal planning, at different scales.	SDG3, SDG5, SDG6, SDG9, SDG11, SDG13, SDG14, SDG15
13.11	Costa Rica in 2022 will begin the implementation of its Gender Equality and Climate Change Action Plan under the framework of the National Policy for Effective Equality between Women and Men, the National Adaptation Plan and the National Decarbonization Plan, and the national REDD+ strategy, including training and capacity building regarding the differentiated impact of climate change by gender condition on women and sexually diverse populations, especially historically excluded populations from an intersectional perspective, institutions that work with climate change, and particularly for decisionmakers who work directly with the population.	SDG5, SDG8, SDG10, SDG11, SDG13
13.12	Costa Rica will continue its leadership position in the High Ambition Coalition for People and Nature as a strategic forum to promote synergies between climate action and the protection of biodiversity.	SDG13, SDG15, SDG17
13.13	Costa Rica will continue its leadership position with the San Jose Principles for High Ambition and Integrity in International Carbon Markets seeking to generate momentum to achieve a high ambition result for Article 6 of the Paris Agreement.	SDG13, SDG17

Abbreviations

BAU	business as usual
BCCR	Banco Central de Costa Rica
CO2e	carbon dioxide equivalent
COVID-19	coronavirus disease 2019
CR-IDPM	Costa Rica Integrated Decarbonization Pathways Model
GDP	gross domestic product
GHG	greenhouse gas
IEEM	Plataforma de Modelación Económico-Ambiental Integrada (Integrated Economic-Environmental Modeling)
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
INEC	Instituto Nacional de Estadística y Censos (National Institute of Statistics and Censuses)
MTCO2e	metric tons of carbon dioxide equivalent
NDC	Nationally Determined Contribution
NDP	Costa Rica's National Decarbonization Plan
OSeMOSYS	Open Source energy Modeling System—Costa Rica
SDG	United Nations sustainable development goal
SINAC	Sistema Nacional de Áreas de Conservación (National System of Conservation Areas)
SAM	social accounting matrix
USD	U.S. dollar

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The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected Costa Rica, especially its most vulnerable population groups. Prior to the onset of the pandemic, Costa Rica had been taking a leading role in addressing the global climate crisis through investments in adaptation and decarbonization. The pandemic, however, led to a sharp increase in unemployment; the number of unemployed workers increased by over 240,000 people between February and June 2020, and the unemployment rate peaked at over 24 percent, exacerbating prepandemic inequities.

In this follow-on analysis to their 2020 study on the benefits and costs of Costa Rica's National Decarbonization Plan (NDP), the authors evaluate how investment in decarbonization through the NDP could improve employment and economic growth in the near term as Costa Rica recovers from COVID-19. Using a computable general equilibrium model, the authors estimate that five years of decarbonization investments would offset the lingering impacts that COVID-19 would have on employment and economic activity.The authors also describe how decarbonization could help Costa Rica make progress in achieving the United Nations Sustainable Development Goals (SDGs)—a key tenet in Costa Rica's decarbonization vision.

The authors conclude with recommendations for how decarbonization investments could be best targeted to provide additional near-term economic benefits, how these investments should be deployed and coordinated to generate long-lasting positive benefits across the different sectors of the economy, and how these investments could be prioritized to meet different SDGs over time, considering the progress the country has made on each one of them.

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