

RENEWABLES
READINESS
ASSESSMENT

HONDURAS



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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Foreword

from the Secretary of
State in the Energy Office

Honduras' geographical location provides an ideal setting for producing electricity through renewable energy sources, such as hydro, solar, wind, biomass and geothermal.

Total installed capacity in Honduras is approximately 3 159 MW, distributed over 107 power plants. Fossil fuel-based generators provide some 1 104 MW (34.94%) of total capacity, while 2 055 MW (65.06%) comes from renewable sources.

While the country has a high share of electricity produced from renewables, we aim to achieve a 70% share in electricity generation from renewable sources by 2026, in line with the Government Plan to Refound Honduras.

Honduras is a signatory to the Paris Agreement and the United Nations Framework Convention on Climate Change that aim to reduce the greenhouse gas emissions that are responsible for global warming and climate change, and are primarily produced by fossil fuel combustion. Honduras has committed to reduce its greenhouse gas emissions by 16% by 2030 and - as a 100% fuel importer - to reduce the drain on its foreign currency caused by its oil bill.

The energy sector in Honduras is currently undertaking strategic steps towards comprehensive, inclusive, democratic and sustainable development. These include the approval of Legislative Decree No 46 of 2022 on the Special Law to Guarantee the Electric Energy Service as a Public Good of National Security and a Human Right of Economic and Social Nature, which empowers the executive authorities and the Board of Directors of the National Electric Energy Company to formulate and execute an action plan to rescue the state-owned company, promoting a vertically integrated business model.

The country also faces challenges due to its vulnerable and deteriorating electrical system, which has not received any significant investment in generation, transmission or distribution in the past decade.

Given the important contribution of renewable energy sources in the country, Honduras requires a robust and flexible electricity system. For this reason, as far as is technically possible, transmission lines have been built, substations have been repowered and others will be developed to allow the injection of this type of technology into the National Interconnected System.

It has also been noted that the incorporation of a larger amount of variable renewable energy, including solar and wind, should consider the stability of the system in order to avoid frequency problems, voltage drops, as well as a lack of firm capacity and reactive injection. Therefore, future project developments will consider storage systems and ensure a sufficient level of reserves.

Honduras is also considering geothermal power technology, which offers firm power with plant factors above 98%; albeit its geothermal potential is relatively low compared to other countries in the region at 200 MW owing to the lack of volcanic activity. We are also considering hydroelectric plants with reservoirs and pumping systems, as well as using the various types of biomass available in the country for electricity generation.

We express our special thanks to IRENA and all the actors who have actively participated in the elaboration of this *Renewables Readiness Assessment*, which will undoubtedly serve as a reference to achieve the deployment of renewable energy in Honduras.

We reaffirm the commitments of the Energy Secretariat - the governing body of the country's energy sector responsible for creating policies for the adequate exploitation of natural resources and the generation of renewable energy in harmony with the environment. We also seek to promote a just and effective transition towards sustainable clean energy management.

Erick Tejada Carbajal, PhD
Secretary of State in the Energy Office



Foreword

from the IRENA
Director-General

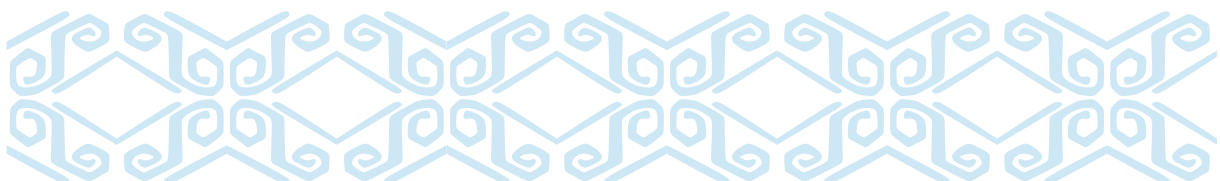
The Republic of Honduras, like other countries in the Central American and Latin American regions, faces a variety of challenges in delivering inclusive, fair and sustainable development. In overcoming these challenges, it is critical to focus on far-reaching measures that can enhance the resilience and diversification of the economy, ensure the viability of the energy sector, attract investment in clean energy projects and meet the country's climate change mitigation targets.

Honduras has shown its commitment to deploying more renewable energy, with ambitious plans for transforming the energy sector. These include efforts to develop long-term policies that ensure a sustainable, resilient, low-carbon energy supply that will account for 80% of electricity generation by 2038.

This Renewables Readiness Assessment (RRA), developed in co-operation with the Energy Secretariat (SEN), identifies the key actions required to expand renewable energy development. It outlines a series of recommendations for strengthening energy institutions and governance; enhancing energy policy and regulatory frameworks for the renewable energy sector; promoting sustainable development and energy efficiency; strengthening the electricity industry; increasing investments in renewable energy technologies and infrastructure; and strengthening institutional and human capacities.

IRENA is grateful to SEN and the country's other energy institutions for their vital inputs and engagement, as well as to numerous other government agencies and national stakeholders for their valuable contributions. We look forward to working with them all, as well as with regional institutions and development partners, to turn these recommendations into practical initiatives that promote renewables as a key element in sustainable, equitable socio-economic development.

Francesco La Camera
Director-General
International Renewable Energy Agency



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Abbreviations

AECID	Spanish Agency for International Development Co-operation
CABEI	Central American Bank for Economic Integration
CAF	Development Bank of Latin America and the Caribbean
CIF	Climate Investment Funds
CND	National Dispatch Center
CO₂	carbon dioxide
CREE	Electric Energy Regulatory Commission
DES	Decarbonising Energy Scenario
ECLAC	Economic Commission for Latin America and the Caribbean
ENEE	National Electric Energy Company
GCF	Green Climate Fund
GDP	gross domestic product
GIZ	German Agency for International Co-operation
GWh	gigawatt hour
HNL	Honduran lempira
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
kt	kilotonne
kV	kilovolt
kWh	kilowatt hour
LPG	liquefied petroleum gas
MER	Regional Electricity Market
MW	megawatt

MWh	megawatt hour
NDC	Nationally Determined Contribution
ODS	System Operator
OLADE	Latin American Energy Organization
PES	Planned Energy Scenario
PJ	petajoule
PPA	power purchase agreement
PV	photovoltaic
REmap	Renewable Energy Roadmap
RRA	Renewables Readiness Assessment
SDG	Sustainable Development Goal
SEN	Energy Secretariat
SICA	Central American Integration System
SieHonduras	Honduras Energy Information System
SIEPAC	Electricity Interconnection System for the Countries of Central America
SIN	National Interconnected System
STEM	science, technology, engineering and mathematics
TJ	terajoule
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USD	United States dollar

Executive summary

Honduras has outlined a national strategic framework in its Country Vision 2010-2038, which aims to foster inclusive economic growth through a focus on enhancing labour capabilities, bolstering infrastructure, improving access to finance and strengthening resilience to climate change. The energy sector is well integrated into the Country Vision framework through the Energy Roadmap 2050 and the National Plan 2010-2022. These documents include targets such as the achievement of an 80% share of renewable energy in the country's total electricity generation by 2038, up from the current 60%.

In accordance with the 2015 Paris Agreement on climate change, the Government of Honduras has established sector-specific commitments towards reducing greenhouse gas emissions in the energy, forestry, agriculture, waste and industrial processing sectors. The country's initial Nationally Determined Contribution (NDC), submitted to the United Nations Framework Convention on Climate Change, outlined a commitment to reduce carbon emissions 16% below 2000 levels by 2030.

National ambitions for sustainable development in Honduras face important infrastructure constraints. Significant investment is needed to enhance the quality of energy and water services, including improvements in coverage and connectivity. By the end of 2020, close to 90% of the population had access to electricity, but less than half of Hondurans were using modern energy sources for cooking purposes. Limited connectivity and service levels affect access to production areas, internal and external markets, tourism areas, and health and education services, resulting in inequitable development and low national and regional integration.

The country has high exposure to hurricanes and tropical storms. In 2020, the Economic Commission for Latin America and the Caribbean estimated that hurricanes Eta and Iota resulted in economic losses of USD 2 billion, affecting key economic sectors such as crops and livestock, which serve as critical sources of sustenance and food security for already marginalised households. In 2019, droughts, heavy rains and flooding affected agricultural businesses and impacted livestock production. Climate change forecasts for 2030 point to significant risks for Honduras, including a potential 9% decrease in gross domestic product, higher living costs, reduced food security and damage to critical infrastructure.

Honduras was among the countries most severely impacted by extreme weather events during the period 1998-2017, and it regularly experiences a broad range of climate-related impacts, which have adverse implications for various sectors. Hydropower production faces challenges due to changing climatic patterns, and the agricultural and fishing sectors experienced significant effects on productivity and yields; these two sectors, together with the forestry sector, employ 35% of the economically active population and represent 36% of total exports.

The Renewables Readiness Assessment (RRA) process for Honduras included the development of a background paper and a consultative process led by the Energy Secretariat (SEN), facilitated by the International Renewable Energy Agency (IRENA). This process generated a set of actions, where the main challenges for an accelerated uptake of renewable energy have been identified.

Challenges and key recommendations

The role of energy sector institutions and governance

The Energy Secretariat (SEN) faces difficulties in promoting policy coherence across public institutions, systematising dialogues with local communities and creating local capacities to empower under-served communities in developing renewable energy projects. The Electric Energy Regulatory Commission (CREE), in addition to overseeing the main activities of the sector, is responsible for establishing regulations and ensuring compliance. Other secretariats or ministries are in charge of additional activities within the energy sector (hydrocarbons, biofuels, geothermal energy, firewood, water) and are working with limited regulatory capacities and budgets.

The National Dispatch Center (CND) operates the electricity system and market, and is responsible for the operation and management of electricity dispatch. Because the CND is mandated to provide reliable electricity at the lowest cost, it has a reduced authority to pursue the decarbonisation and resilience of the electricity system; this limits the CND's ability to promote trust and transparency in the actions taken.

These and other institutions face difficulties co-ordinating their policies in areas where mandates are shared across secretariats and agencies, which is a particularly salient barrier for developing environmental, climate and energy policy. Public and private renewable energy projects that rely on local natural resources and land areas face complicated dialogues with local communities around energy expansion plans and agriculture industry development, among other issues.

In this context, it is important to more clearly define the responsibilities and regulatory functions of existing entities linked to the energy sector. Some of the challenges faced by national institutions include independent decision making, enhanced governance, capacity building and expanded abilities for policy implementation. Achieving a well-defined regulatory landscape through the creation of a comprehensible and actionable framework would attract relevant stakeholders that can help transform the market and identify opportunities for further development of the national energy sector.

Energy policy and regulatory framework for the renewable energy sector

National ambitions and intentions to accelerate renewable energy use are on the right track. Nevertheless, there is a need to better align policy ambitions with the likely outcomes of existing energy programmes. The country's energy policy is impacted by the Energy Roadmap 2050, and a disconnect exists between its goals and the budgets associated with the incorporation of renewables. Furthermore, the objectives and actions outlined in the NDC are detached from the necessary funding and human resources, as well as from the institutions responsible for achieving climate change targets.

Laws created to facilitate the promotion of low-carbon technologies and renewable energy remain under-enforced due to a lack of regulations and implementation mechanisms. Addressing the current conditions of power purchase agreements (PPAs) is paramount to bring certainty to the development of infrastructure in the short term.

It is important to identify the appropriate mechanism for the implementation of national public policy that targets climate goals and includes an energy transition based on renewable technologies. Comprehensive, long-term energy planning that is both resilient to political shifts and inclusive of local communities' validation will bring certainty to potential investors.

Sustainable development and energy efficiency

The government has prioritised several urgent actions in its development agenda, including poverty alleviation, education, health care, gender equality, and more robust infrastructures for water, electricity, sanitation and roads. Moderate execution of programmes and limited access to financing have prevented national institutions from keeping pace with the United Nations' Agenda 2030 and its 17 Sustainable Development Goals (SDGs). Many challenges remain in assessing investments and maintaining the envisioned funding that has a direct impact on programmes and budgets.

Government institutions can create a favourable environment for identifying solutions to accomplish the targets of both the country's NDC and the SDGs. The inclusion of renewable-based solutions in the process can facilitate the visualisation of pathways to developing critical energy infrastructure.

Other challenges to achieving national climate goals include addressing oil dependency, energy access, deforestation and the restoration of degraded ecosystems. People in rural areas face limitations on energy access and other basic needs interlinked with the SDGs, and appropriate regulations to prevent forest degradation and funding for reforestation are lacking. Distributed generation using variable renewable energy could help increase energy access and reduce fossil fuel use in isolated communities.

Actions taken to meet NDC targets should include analysing pathways to energy-related goals, such as defining energy standards and modernising carbon-based and inefficient technologies used in industry, private and public buildings, and households. The recently presented bill to promote rational and efficient use of energy will facilitate the government's efforts to establish regulations for the use of more efficient energy-consuming products.

Strengthening the electricity industry

Originating from a law approved in 2007, a new tariff scheme integrated into PPAs contracted with the National Electric Energy Company (ENEE), the state electricity provider, left the company in deep financial trouble. Recovering the cost of services is at the core of the energy sector's challenges, and inadequate cost-recovery mechanisms are a key driver of ENEE's financial under-performance. Further, energy policies that lack thorough assessments of their economic implications have worsened the company's financial situation.

Existing debt and expensive PPAs are the main drivers limiting ENEE's ability to finance new investments in generation, transmission and distribution infrastructure. Specifically, insufficient investment in transmission and distribution networks constrains the ability to develop renewable energy prospects; it also affects electricity losses, quality of service and the fulfilment of investment commitments in the Central American Electrical Interconnection System (SIEPAC).

Significant progress to address these issues could be achieved by separating and reducing the operational costs of ENEE, which would be among the first steps towards generating returns that would allow the company to improve its service. Restructuring the company's outstanding debt would also provide relief for future endeavours.



Investment in renewable energy technologies and infrastructure

As the production costs of renewable energy technologies continue to fall, and as demand increases steadily, the prospect of further uptake of renewables in Honduras is very much evident. The country has substantially increased its adoption of renewables in the electricity industry over the last two decades, with investors embracing the financing of a diverse set of technologies. However, government incentives are lacking to expand the use of renewables beyond the electricity sector.

Among the factors hindering progress towards widespread adoption of renewables are a lack of co-ordination among institutions as well as the absence of roadmaps and specific measures to advance the uptake of low-carbon technologies. The prospects of developing geothermal energy and a national green hydrogen industry have not been fully explored, and an updated assessment of solar and wind power resources could greatly benefit the accuracy of current energy models and development plans. Adding complementary data analytics could provide useful insights to attract new energy developers.

Local private banks understand the energy sector and have a track record of financing renewable energy projects. However, this needs to be coupled with a stronger understanding of the associated environmental and social risks, which could result in higher costs of capital. Development banks and the government can work together on finding pathways to expand financing for small- and medium-scale projects with a larger scope than the activities of the conventional electricity industry.

Institutional and human capacities

Honduras has a well-developed network of universities gathering knowledge on regulatory issues and policy making to tackle the most difficult challenges in energy and climate change. The modernisation and diversification of the country's energy sector demands more in-depth knowledge of modelling, data collection, design of business models and additional complexities connected to the fast-growing energy-related sectors.

By collaborating with academia in mapping existing and future capacity gaps in the energy sector, the government could address gaps through current academic programmes. Involvement of the finance sector would further the efforts towards identifying specific knowledge gaps among professionals.

The government can also support the implementation of training programmes run by private or public educational institutions, addressing relevant areas such as the energy transition, sustainable energy access and security, and energy technologies, among others.

Capacity building programmes can be extended to local communities focused on increasing access to financing renewables. These plans can include providing business development support and financial literacy training, with equal opportunities for women.



1 Introduction

1.1 The Renewables Readiness Assessment process in Honduras

The Renewables Readiness Assessment (RRA) is a country-led consultative process developed by the International Renewable Energy Agency (IRENA) to identify appropriate policy and regulatory choices to support the transition towards renewable energy in all energy sector applications.

IRENA developed the RRA as a tool for carrying out a comprehensive evaluation of the conditions for renewable energy deployment in a particular country. The RRA provides a venue for multi-stakeholder dialogue to identify challenges to renewable energy deployment and to define the necessary actions to further improve current conditions. It aims to identify the elements necessary for an effective policy framework to support the accelerated development of the renewable energy market.

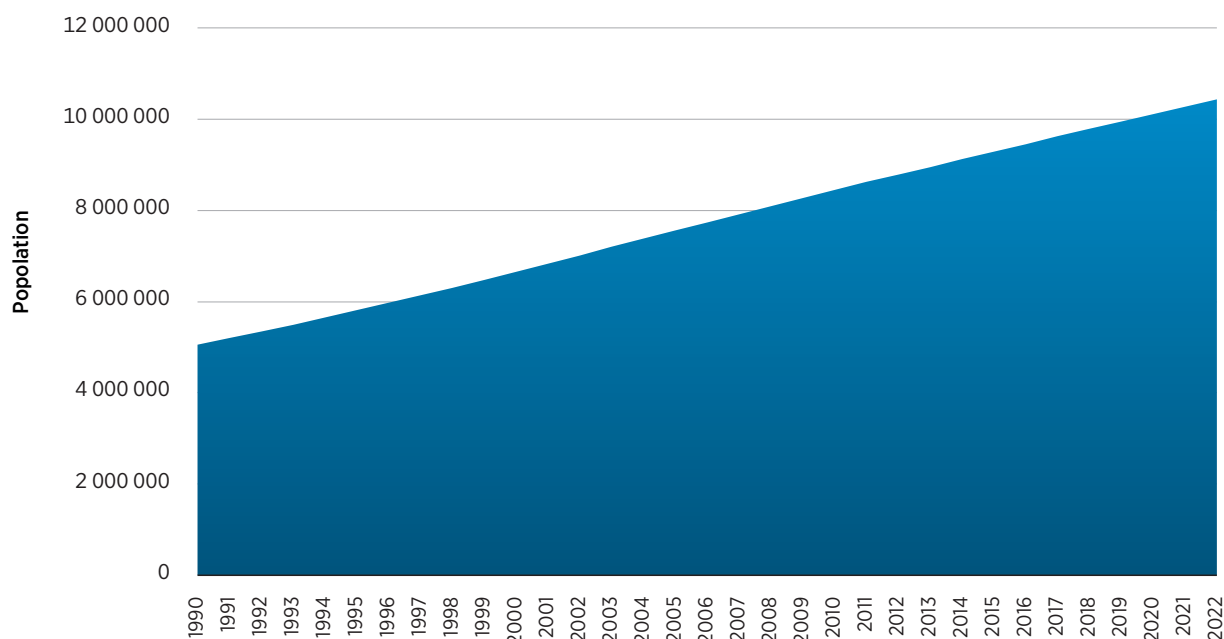
As a crucial stakeholder in the country and IRENA focal point, the Honduran Energy Secretariat (SEN) initiated the process to develop the RRA, which was led by the Directorate General for Renewable Energy and Energy Efficiency in collaboration with all departments of the Secretariat.

The RRA process included the development of a background paper, further identification of main participants in the sector and group and organise different institutional resources, as well as two meetings with stakeholders: an Expert Consultation workshop on 7-8 December 2022 and a Validation workshop on 8 March 2023, hosted by the government of Honduras in collaboration with IRENA. This process generated the set of recommendations provided in section Chapter 4 of this report.

1.2 Country profile

Located in the centre of the American continent, the Republic of Honduras is the second largest country in Central America. It borders the Caribbean Sea to the north and has a small connection with the Pacific Ocean to the south. Mountain ranges divide the country into three natural regions (north, centre and south) that concentrate the main water resources of the country. The longest rivers are the Coco and Patuca, extending 775 kilometres (km) and 500 km, respectively.

The population of Honduras doubled between 1991 and 2021 and reached an estimated 10.4 million people in 2022 (see Figure 1). Average annual population growth during the decade 2011-2021 was 1.7%, exceeding the average growth in Central America of 1.4% (United Nations, 2019). In 2022, an estimated 55.4% of the Honduran population lived in urban areas and 44.6% was rural (SieHonduras 2022). The most populated cities in the country are the capital city of Tegucigalpa (1 293 611 people), followed by San Pedro Sula (812 689) and Choloma (282 684).

Figure 1 Population of Honduras, 1993-2022

Source: World Bank (2022a).

In 2021, the Honduran Human Development Index (HDI) was below the regional average for Latin America and the Caribbean (0.76), at 0.62, and ranked 138th out of 198 countries worldwide (UNDP, 2022a). Prior to the economic shocks of 2020, half of the Honduran population lived below the poverty line, and 25.2% lived in extreme poverty (INE, 2021). In 2021, Honduras had the fourth-highest level of income inequality in Latin America and the Caribbean, with a Gini index of 0.483 (World Bank, 2023a).

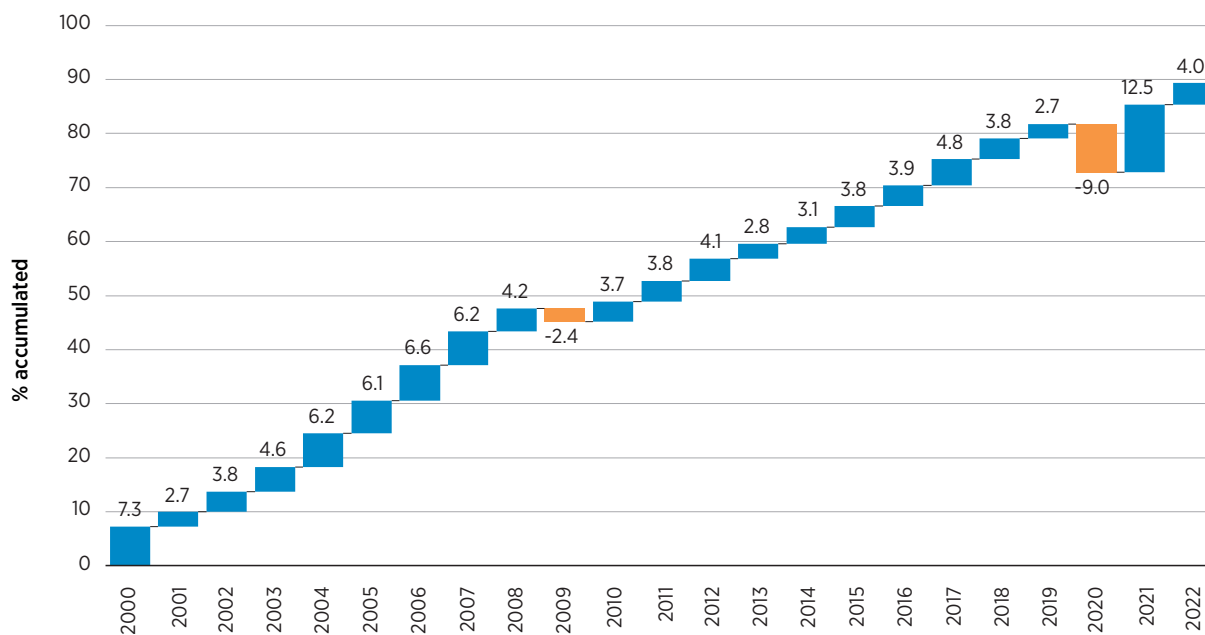
During the period 1999-2019, the Honduran gross domestic product (GDP) grew at an average annual rate of 3.86% (World Bank, 2022b). In 2019, Honduras ranked fourth in competitiveness among the Member States¹ of the Central American Integration System (SICA) due to its strong macroeconomic stability and improvements in life expectancy and debt dynamics (WEF, 2019). However, in 2020 the COVID-19 pandemic, combined with two destructive hurricanes (Eta and Iota), resulted in a 9% decline in GDP. After a period of economic recovery, the Honduran GDP grew 4% in 2022 (see Figure 2), with further growth of 3.1% projected for 2023. The largest contributor to the GDP in 2022 was financial intermediation (earnings from trusts, mortgage loans and credit cards),² at 23.4%, followed by manufacturing industries (19.5%); agriculture, livestock, forestry and fishing (12.2%); and trade, hotels and restaurants (11.5%) (Central Bank of Honduras, 2023).

The agricultural, forestry and fishing industries are vital to the Honduran economy, as it employs 35% of the economically active population and represent 36% of total exports. The country's economy focuses on exporting of FOB³ processing goods, which represented 49% of total exports in 2022 (Banco Central de Honduras, 2023).

¹ Belize, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

² According to the GDP classification of the Central Bank of Honduras. Financial Intermediation, Real Estate Services, Services to Companies, Hotels and Restaurants, Services to Households, and Government Services

³ Free On Board: the buyer takes responsibility for the goods as soon as they leave the seller's premises.

Figure 2 Annual growth in gross domestic product, 2000-2022

Source: World Bank (2022b).

National ambitions for sustainable development in Honduras face important infrastructure constraints. Significant investment is needed to enhance the quality of energy and water services, including coverage and connectivity. By the end of 2020, 87.2% of the population had access to electricity, according to the Electricity Access Index, but only 45% of Hondurans were using modern energy sources for cooking purposes (30% natural gas and 15% electricity) (SEN, 2020). In 2019, Honduras ranked 101st out of 140 countries on the Global Competitiveness Index 4.0, due mainly to limitations in infrastructure and connectivity (WEF, 2019). Connectivity restrictions and service levels affect access to production areas, internal and external markets, tourism areas, and health and education services, resulting in inequitable development and low national and regional integration.

The country has high exposure to hurricanes and tropical storms. In 2020, the Economic Commission for Latin America and the Caribbean (ECLAC) estimated that hurricanes Eta and Iota resulted in economic losses for Honduras of over USD 2 billion, affecting key economic sectors such as crops and livestock, which serve as critical sources of sustenance and food security for already marginalised households (ECLAC, 2021a). In 2019, droughts, heavy rains and flooding affected agricultural businesses and impacted livestock production. Climate change forecasts for 2030 point to significant risks for Honduras,⁴ including a potential 9% decrease in GDP, higher living costs, reduced food security and damage to critical infrastructure.

The Country Vision 2010-2038 outlines a pathway towards local sustainable development, democracy, citizenship and governance (Republic of Honduras, 2010). Among the plan's goals (goal 3.3) is to enhance the presence of renewable energy sources in the energy mix. In 2021, the government published an Energy Roadmap 2050 to guide energy sector planning and development in compliance with social and environmental safeguards (SEN, 2021a).

⁴ Climate change impacts the availability of water for human, agricultural, and industrial consumption, as well as for power generation, mainly in places that previously received a large amount of rainfall and that are now affected by climate variability.

2 Energy context

2.1 General strategic framework

The Country Vision 2010-2038 outlines the national strategic framework for Honduras, which aims to foster inclusive economic growth through a concerted focus on enhancing labour capabilities, bolstering infrastructure and access to finance, and strengthening resilience to climate change (Republic of Honduras, 2010). The energy sector is well integrated into the Country Vision framework through the Energy Roadmap 2050 and the National Plan 2010-2022.⁵ These documents set targets and key activities for developing long-term policies that ensure robust, eco-friendly, cost-effective and enduring energy provision (see Table 1). Among the targets is to achieve an 80% share of renewable energy in the country's total electricity generation by 2038, up from the current 60%.⁶

In accordance with the 2015 Paris Agreement on climate change, the Government of Honduras has established sector-specific commitments in the energy, forestry, agriculture, waste and industrial processing sectors. The country's initial Nationally Determined Contribution (NDC) towards reducing greenhouse gas emissions, submitted to the United Nations Framework Convention on Climate Change (UNFCCC), outlined a commitment to reduce carbon emissions 15% by 2030 (from 2000 levels); in the country's revised NDC, submitted in 2021, the level of ambition was increased to 16% (UNDP, 2021).

Table 1 Framework of government priority activities (energy-related)

Institutional framework
Co-ordinate strategic sectors to craft a national energy policy.
Improve energy affordability.
Reduce dependency on fossil fuel consumption.
Increase power generation capacity to supply growing demand for electricity.
Decarbonise the national power generation mix.
Strengthen electricity distribution networks.
Develop financial mechanisms to facilitate expansion of the electricity sector.
Manage energy-related conflicts with local communities.
Unlock biomass and biofuels potential for energy purposes.
Reduce firewood consumption in the residential sector.
Strengthen the rules and procedures of the energy regulator (CREE).
Address market distortions caused by energy subsidies.
Guarantee universal access to electricity by 2030.
Overcome barriers to electric mobility.

⁵ The roadmap framework includes 5 pillars focused on energy planning; 24 strategic objectives; 104 goals and 376 actions related to different energy stakeholders. See OLADE and Government of Honduras (2020).

⁶ Estimation based on SieHonduras, 2022.

Table 1 Framework of government priority activities (energy-related) (continued)

Policy and planning
Implement the power generation expansion plan, including the use of variable renewable energy.
Prepare energy planning, considering national commitments for regional integration.
Enhance the preparation of power purchase auctions.
Monitor the implementation of energy efficiency plans, including the National Loss Reduction Program.
Institutional management
Monitor the Steering Committee implementing the General Electric Power Industry Act and Roadmap 2050.
Monitor the performance of state-owned electricity company ENEE, preparing its financial statements in compliance with independent audits.
Contract private operators for distribution activities, and monitor performance reports.
Monitor strategic co-ordination of the National Energy Council (CONAEN) with the energy sector.
Monitor the performance of the system operator and the publication of expansion plans and energy assessments.
Legal framework
Adopt legal provisions established in the General Electric Power Industry Act (LGIE).
Implement regulations for LGIE enforcement activities.
Adopt regulatory provisions for power systems operation and the administration of the wholesale market.
Adopt regulatory provisions for firm capacity and energy purchase.
Adopt technical regulations on the distribution service, including service quality and contributions.
Ensure that the provision of electricity is a public good of importance for national security and an inherent human right.
Adopt technical regulations on energy transmission services, including the price structure for network use.
Regional integration
Adopt regulations to include power purchases from the regional electricity market in bidding processes.

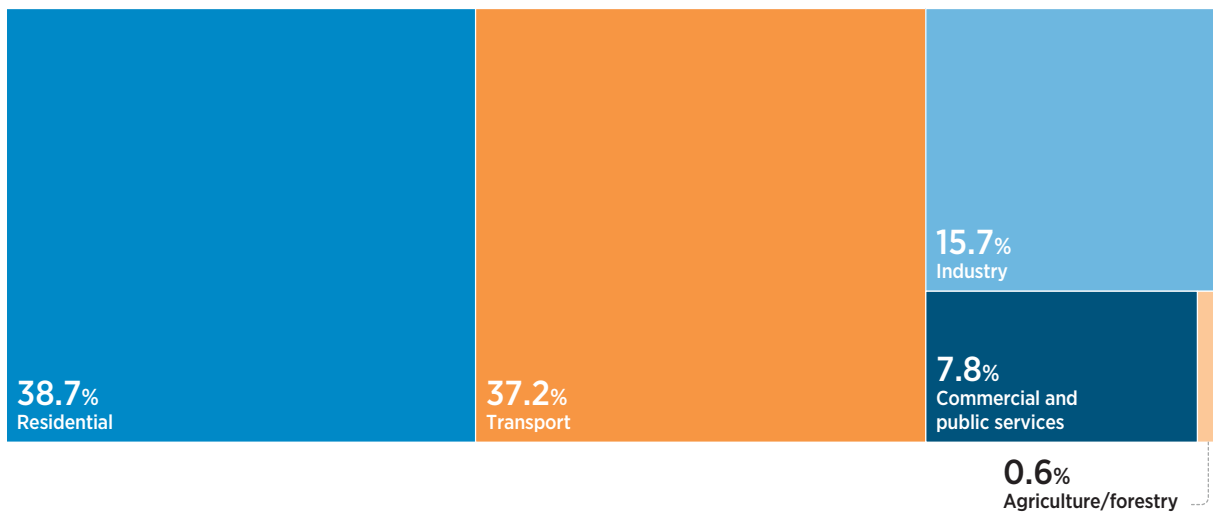
Based on: SEN (2021a).

2.2 Overview of the energy sector

Energy sector

Average long-term trends show an increase in the total final energy consumption in the country of 11.25% between 2010 and 2022. The residential and transport sectors together accounted for over three-quarters (75.9%) of the final energy consumption in 2022, followed by the industrial sector (15.7%) and the commercial and public services sector (7.8%) (see Figure 3).

Figure 3 Final energy consumption, 2021

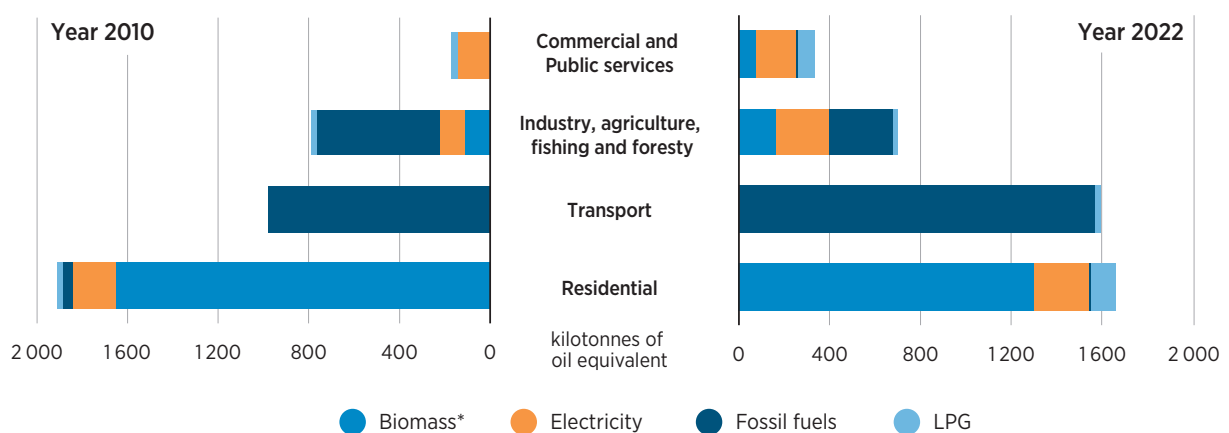


Based on: SieHonduras (2022).

Between 2010 and 2022, the transport sector experienced the highest growth in energy consumption (31%), followed by the commercial sector (21%) and more distantly the industrial sector (9%) (SEN, 2021b). Consistent growth in transport demand during this period resulted in a 5.25% annual increase in transport energy consumption (see Figure 4). The country’s motorcycle fleet grew 36.5% annually on average, followed by sport utility vehicles (SUVs) (28.3%), transport for tourism (18%) and heavy vehicles (12.6%) (INE, 2016; INE, 2020).

During the 2010-2022 period, annual electricity demand increased almost 4% per year, while biomass consumption fell 21% in the residential sector and grew 51% in the industry sector. Household demand for liquefied petroleum gas (LPG) increased 177%, displacing a portion of the firewood used for cooking purposes.

Figure 4 Final energy consumption by sector and source, 2010 and 2022



Based on: SieHonduras (2022).

Note: * includes charcoal; LPG = liquefied petroleum gas.

Energy and climate change

According to the 2019 Global Climate Risk Index, Honduras was among the countries most severely impacted by extreme weather events during the period 1998-2017 (Eckstein, Hutfils and Wings, 2021), with average annual losses totalling 2.1% of GDP.⁷ The country experiences a broad range of climate-related impacts, which have adverse implications for various sectors. Hydropower production faces challenges due to changing climatic patterns, and the agricultural and fishing sectors (particularly maize cultivation and shrimp production) have experienced significant effects on productivity and yields. Given Honduras' susceptibility to extreme weather events and its economic reliance on forestry, agriculture and fishing industries, the country remains highly vulnerable to climate change.

In this context, Honduras has established priority actions for promoting resilience in agricultural activities through sustainable management and the adoption of technologies that increase productivity and generate a sustained source of income for small farmers. Honduran energy and climate change policies are integrated in national strategies and executed through dedicated national committees and task forces. The country's Nationally Determined Contribution (NDC) outlines ambitious targets for 2030, including the reforestation of 1 million hectares, a 16% reduction in greenhouse gas emissions (excluding land use, land use change and forestry) and a substantial 39% reduction in firewood consumption.

The Country Vision 2010-2038 promotes the increased use of renewable energy for electricity generation to reduce carbon dioxide (CO₂) emissions. This nationwide strategy sets a clear target to decarbonise the energy mix by generating 80% of total electricity consumption from renewable sources by 2038. Table 2 summarises key indicators related to energy, transport and the environment.

Table 2 Key indicators related to energy, transport and the environment

ENERGY	
Share of electricity consumption from fossil fuels (2021)	33.7%
Electricity generation capacity (2022)	3 159.33 MW
Electricity production (2022)	9 769.26 GWh
Share of electricity production from renewable sources (2021)	60.09%
TRANSPORT	
Vehicle fleet growth (2016-2020)	40.6%
• Motorcycles	74.8%
• Sport utility vehicles (SUVs)	49.6%
• Buses and minibuses	11.8%

⁷ Between 1998 and 2017, Puerto Rico, Honduras and Myanmar were the countries most affected by extreme weather events worldwide (Eckstein, Hutfils and Wings, 2021).

Table 2 Key indicators related to energy, transport and the environment (continued)

POLLUTION	
Total greenhouse gas emissions (2022)	2 281.29 kt CO ₂ eq
• Carbon dioxide	21 598.37 kt CO ₂ eq
• Methane	19.37 kt
• Nitrogen dioxide	0.53 kt
Share of greenhouse gas emissions from land use, land use change and forestry (2015)	30%
Share of greenhouse gas emissions from agriculture (2015)	16%
Share of greenhouse gas emissions from waste (2015)	6%
Average particulate matter emissions (PM _{2.5}) (2019) (WHO safe level = 5 µm/m ³)	20.4 µm/m ³

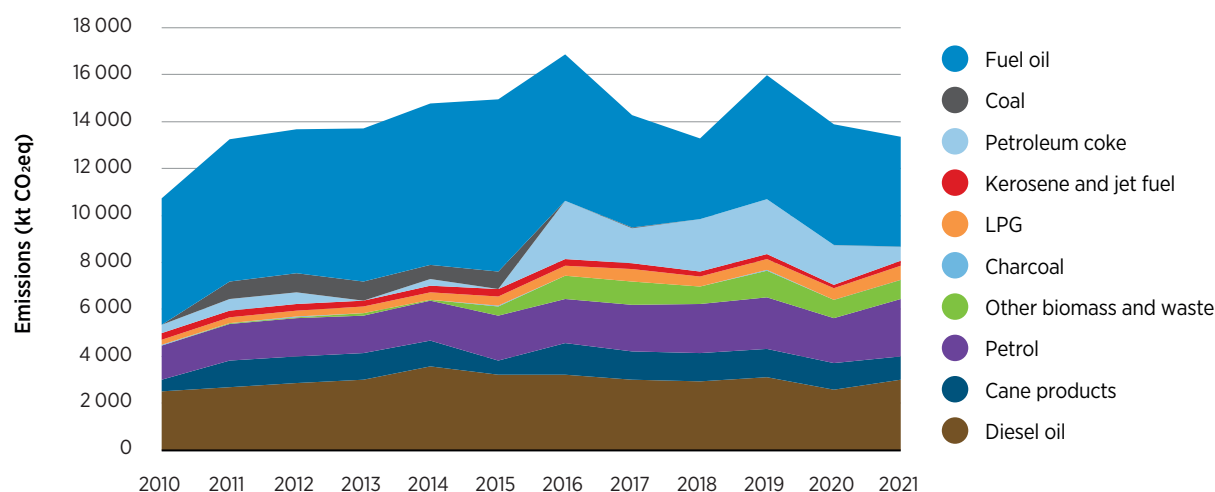
CLIMATE COMMITMENTS	
Greenhouse gas reduction by 2030, as targeted in NDC	16%
Restored forest area by 2030	1.3 million hectares
Renewable energy share in electricity generation mix by 2038	At least 80%

Source: INE (2020); SieHonduras (2022); IRENA, UNFCCC, World Bank and UNDP (2022).

Note: MW = megawatts; GWh = gigawatt hours; kWh = kilowatt hours; kt = kilotonnes; CO₂eq = carbon dioxide equivalent; µm/m³ = micrograms per cubic metre; WHO = World Health Organization.

Greenhouse gas emissions

Honduras' carbon emissions increased 3% annually on average between 2010 and 2021 (OLADE, n.d.). The energy sector contributed on average 51% of total CO₂-equivalent emissions, followed by agriculture (30%), industry (16%) and waste (3%). Figure 5 shows the country's energy-related CO₂-equivalent emissions by source for the period 2010-2021.

Figure 5 Energy-related CO₂-equivalent emissions, by source, 2010-2021

Based on: SieHonduras (2022).

Note: LPG = liquefied petroleum gas.

Energy supply

In 2021, the total energy supply was more than 237 368 terajoules (TJ), with firewood, diesel and petrol providing 60% of the energy supply⁸ and the remaining 40% coming from fuel oil, hydropower, geothermal and LPG (SEN, 2021b). In 2022, biomass dominated the primary energy production, accounting for 71.46% of the total. Biomass consumption (in the form of firewood and sugarcane bagasse) occurs mainly in households, representing 75.97% of the overall energy consumption in the residential sector. The use of firewood is a sensitive topic because it is one of the few affordable fuel options for households living below the poverty line.

The primary energy supply from renewable sources increased 26% between 2010 and 2022. In 2020, the renewable energy supply fell 3% due to severe droughts that affected hydropower generation. In 2022, biomass was the main renewable primary energy source, followed by hydropower and geothermal (see Table 3).

Table 3 Total energy supply in Honduras, 2010-2022

	2010	2012	2014	2016	2018	2020	2022
Primary energy (TJ)	89 557	112 180	57 517	122 424	113 409	111 245	112 883
Hydropower	11 082	10 025	9 407	8 081	11 360	9 720	13 968
Wind	0.00	1 217	1 433	2 097	3 341	2 545	2 467
Solar PV	5.9	6.5	7.2	3 190	3 581	3 765	3 654
Geothermal	0.00	0.00	0.00	0.00	10 688	11 045	12 131
Biomass	78 469	92 381	40 501	108 921	84 439	84 170	80 662
Coal	0.00	8 551	6 169	133.7	0.00	0.00	0.00
Secondary energy (TJ)	99 638	109 774	117 375	132 968	122 917	114 779	135 116
Oil products and LPG	99 606	109 505	116 237	131 898	121 608	113 755	134 432
Electricity	31.7	268.8	1 138	1 070	1 309	1 025	684.3
Total supply (TJ)	189 195	221 954	174 892	255 392	236 326	226 024	248 000

Based on: SieHonduras, National Energy Balances 2010-2022.

Note: LPG = liquefied petroleum gas; TJ = terajoule; PV = photovoltaic.

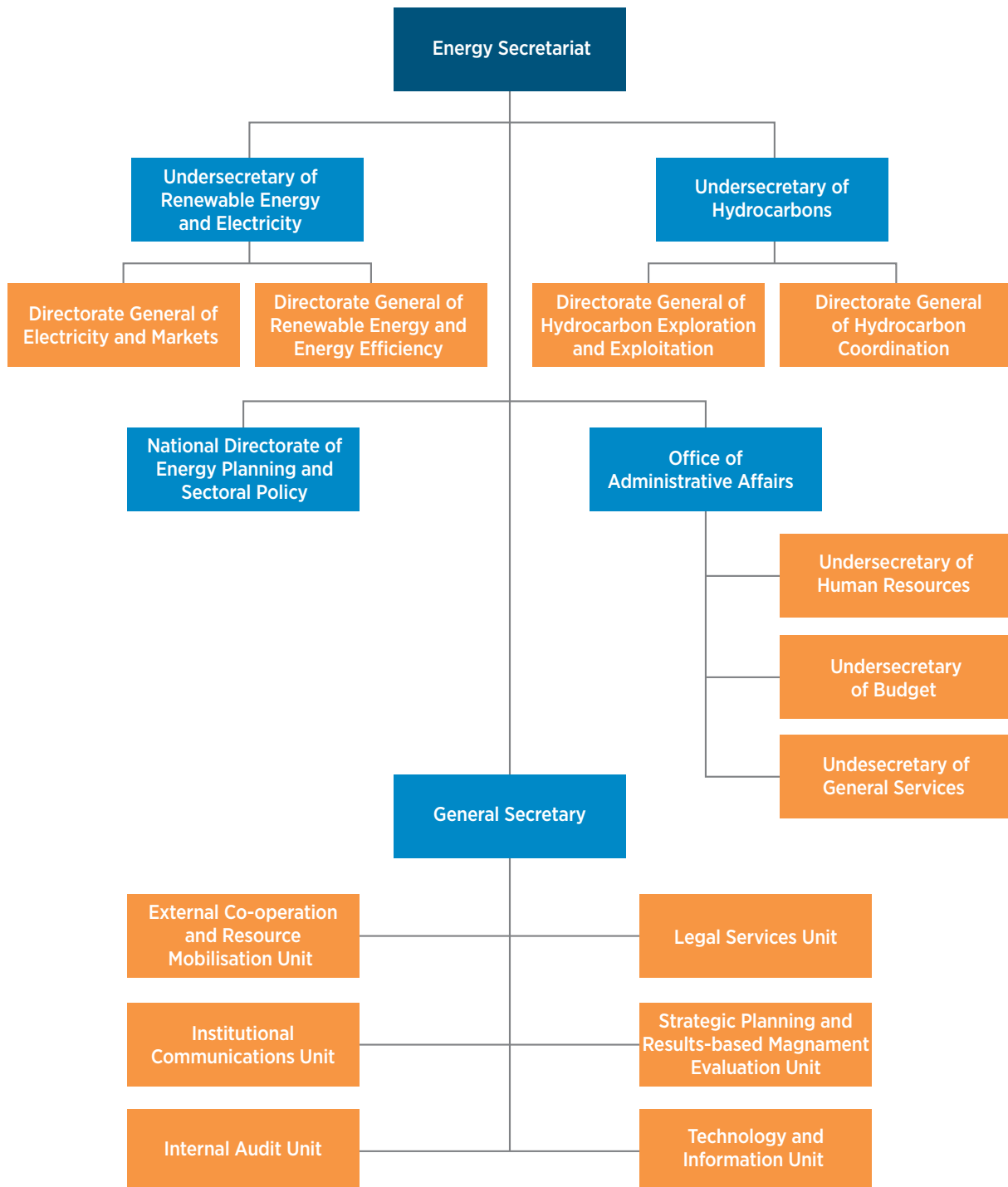
Institutional structure

The Energy Secretariat (Secretaría de Energía, or SEN) crafts energy policies and prepares national energy plans. SEN is also responsible for modelling energy scenarios and publishing annual energy balances. The Secretariat exercises its mandate in the areas of electricity, energy efficiency, renewable energy, hydrocarbons, energy planning, data analysis and electricity markets (SEN, 2023). The institutional structure of SEN is provided in Figure 6.

⁸ Honduras is a net importer of all fossil fuels consumed in the country.

The national regulator is the Electric Energy Regulatory Commission (Comisión Reguladora de Energía Eléctrica, or CREE), which was created in 2014 and gained budgetary and operational independence in 2020 (Decree 61-2020). CREE is responsible for designing, enforcing, and monitoring energy regulations, including the main activities within the electricity and hydrocarbons value chains.

Figure 6 Institutional structure of the Energy Secretariat (SEN)



Based on: SEN (2022).

Existing electricity infrastructure

Electricity access in Honduras has increased substantially, expanding from 66% of the population in 1995 to 87.19% in 2019 (World Bank, 2023a). However, challenges remain in bringing access to remote areas and in improving quality of service at an affordable cost. In rural areas, electrification rates are lower, with around 22.5% of households lacking access to electricity. Disparities in the deployment of power infrastructure result in numerous regions lacking electricity. Because of its outdated infrastructure, Honduras ranks among the top three countries in Latin America and the Caribbean on both the System Average Interruption Duration Index (with a SAIDI score of 32.5) and the System Average Interruption Frequency Index (with a SAIFI score of 23.4)⁹ (Calvo *et al.*, 2021).

The country's installed power capacity for commercial exchange is composed nearly equally of thermoelectric and hydroelectric power plants. As of December 2022, fossil fuel thermal power technologies (diesel, natural gas and coke) represented 35.5% of the total installed capacity, followed by hydropower (30.6%) and solar photovoltaic (PV) (17.2%). Publicly owned hydropower plants accounted for 19% of the total installed capacity. Variable renewable energy sources have gained prominence in the last decade, with wind and solar PV power growing from zero in 2011 to reach 25.1% of the total power capacity in 2022 (17.2% wind and 7.9% solar PV) (ENEE, 2011, 2012, 2022).

Honduras faces the highest electricity losses among Central American countries, with technical and commercial losses accounting for as much as 30% of the total production in 2019 (IDB, 2022a). This high level of losses is related mainly to operational inefficiencies and to the gap in investment needed to strengthen the transmission and distribution networks. The government is implementing a series of actions to improve the performance of electricity generation, transmission, distribution, and commercialisation, including periodic revisions of rates and electricity costs and a commitment to improve grid efficiency through a national loss reduction programme.

Power capacity and generation

In 2022, Honduras had a total installed electricity generation capacity of 3 159.33 megawatts (MW), including self-production and the off-grid sector (SieHonduras, 2022). The installed power capacity for commercial exchange totalled 2 970.3 MW, dominated mainly by thermal and hydropower plants, representing around 62.6% of the national power capacity (see Table 4) (ENEE, 2022).

The largest power plants, with a combined capacity of around 535 MW, are state owned and include the Francisco Morazán (300 MW), Patuca III (104 MW), Rio Lindo (80 MW), Cañaveral (29 MW) and Nípero (22.5 MW). The remaining 312 MW of hydropower capacity is privately controlled, with plant capacities ranging from 0.5 MW to 40 MW. Among variable renewable energy sources, solar PV has the largest installed capacity (510 MW), followed by wind power (235 MW). Other fast-growing renewables include biomass (221 MW) and geothermal (39 MW) (ENEE, 2011, 2012, 2022).

Thermal generation accounts for 949.9 MW of power capacity and is mostly privately owned (97%). The capacity share of these plants, which rely on fossil fuel energy sources (bunker fuels, diesel, gas, coal and coke), fell from 62% in 2011 to 31% in 2022.

⁹ By comparison, Chile's SAIDI score was 0.2 and Costa Rica's SAIFI score was 0.2. SAIDI measures the amount of time the average customer experiences a power outage or interruption, while SAIFI describes how often the average customer experiences an outage or interruption.

Table 4 Installed power capacity for commercial exchange, 2022

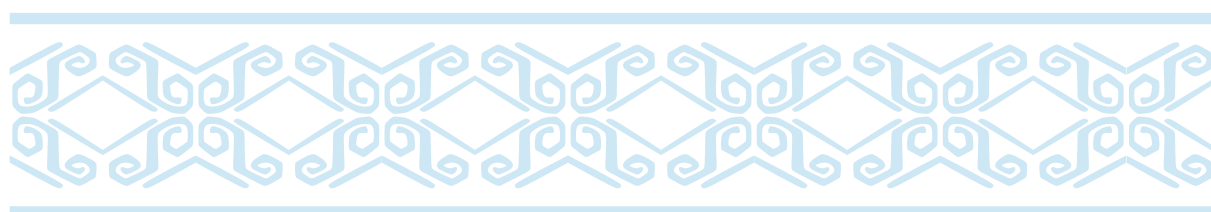
Technology	Capacity (MW)	% of Total
Hydropower	909.4	30.6
Thermal	949.9	32
Biomass	221.3	7.5
Wind	235	7.9
Solar PV	510.8	17.2
Geothermal	39	1.3
Coal	105	3.5
Total	2 970.3	100

Based on: ENEE (2023).

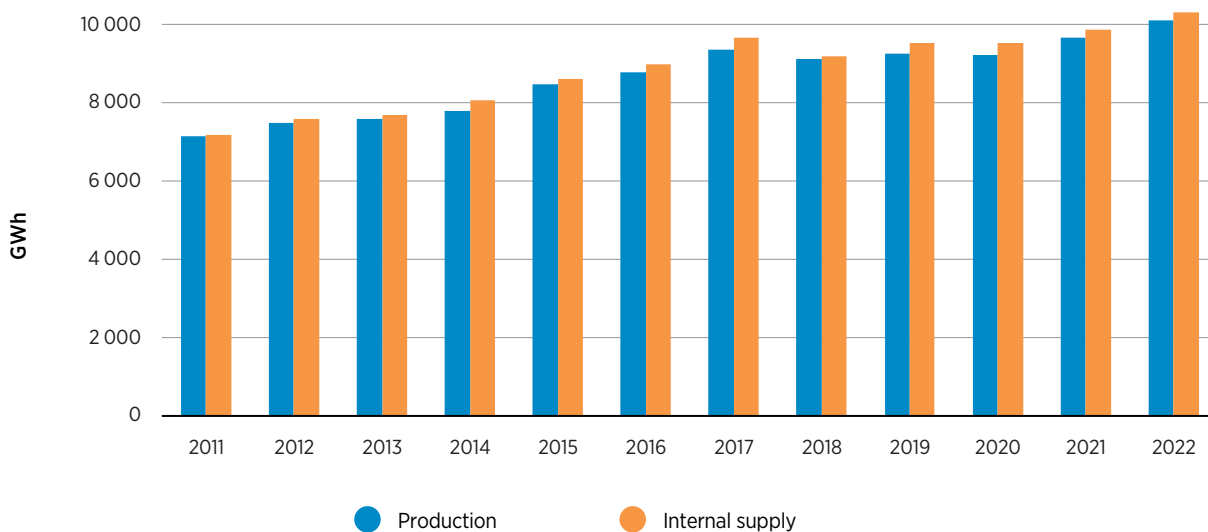
Note: MW = megawatts; PV = photovoltaic.

The National Electric Energy Company (ENEE) manages around 20.1% of the total installed electricity capacity for commercial exchange, comprising mostly hydropower plants as well as three fossil fuel plants used in emergency cases. The remaining capacity is managed by the private sector and includes 10.5% of the total installed hydropower capacity, 7.9% of wind farms, 17.2% of solar PV installations, as well as geothermal and biomass projects. The largest private electricity producers using fossil fuels are ENERSA and Lufussa, which together generated 25.2% (2 594.43 gigawatt hours, GWh) of the total dispatched electricity in 2022 for commercial exchange.

All of the electricity produced in Honduras is for domestic consumption. Between 2011 and 2022, the country's net electricity production (excluding self-production) grew 43.5%, increasing from 7 172 GWh to 10 294 GWh (ENEE, 2011, 2022). In 2022, renewable energy accounted for 60.1% of the total electricity output (37.3% hydropower, 9.1% solar, 6.6% wind, 4.3% biomass and 2.7% geothermal). Variable renewables represented 19% of the renewable energy contribution. Honduras imported 1.9% of its total electricity supply on average in 2022. Figure 7 illustrates the trends in electricity production and domestic supply over the past decade.¹⁰



¹⁰ The internal electricity supply refers to the available energy that includes the final consumption and the losses.

Figure 7 Electricity production and domestic supply, 2011-2022

Based on: ENEE (2011, 2022).

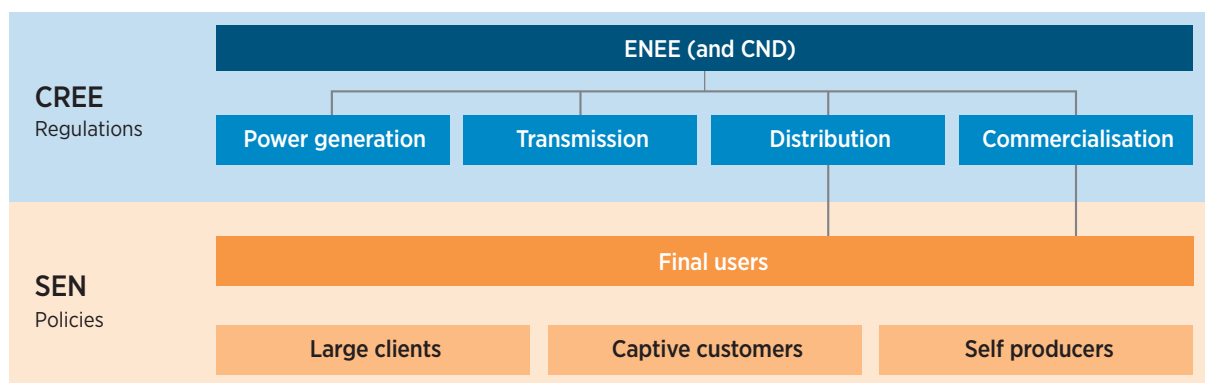
Note: Production accounts for national power generation only, while domestic supply includes imports.

Electricity sub-sector

Before 2014, the Honduran electricity sub-sector was vertically integrated under the state-owned power company ENEE. In 2014, the General Law of the Electric Industry (Decree 404-2013) modified this vertically integrated model, seeking economic efficiency through guidelines for decentralisation and restructuring of the electricity sub-sector (Republic of Honduras, 2014). After 2022, the new legislation Decree 46-2022 (“Special law to guarantee the service of electric energy as a public good of national security and a human right of an economic and social nature”) transformed ENEE into four business units – generation, transport, distribution and commercialisation – with the aim of improving the company’s operational and financial performance (Republic of Honduras, 2022).

ENEE currently controls subsidiary entities that specialise in producing, transporting, distributing and commercialising electricity (see Figure 8). The four business departments operate under competitive conditions and are encouraged to enter into contracts with private operators. The reforms also included the establishment of a system operator (Operador del Sistema, or ODS) responsible for the efficient management of power grids. The ODS assumes a crucial role in designing comprehensive expansion plans for electricity generation and transmission activities, defining rules and procedures for purchasing electricity in national markets, and managing payment systems in the wholesale market. When created, the ODS board and governance included public and private stakeholders. In May 2022, the ODS became an entity controlled by the public sector and changed its name to the National Dispatch Center (Centro Nacional de Despacho, or CND).

As the main energy regulator, CREE’s functions in the electricity sub-sector include defining and overseeing regulations affecting electricity generation, transmission, distribution and commercialisation. CREE also provides oversight and grants operating licences to companies engaged in the transmission and distribution of electricity and approves the expansion plans prepared by the CND. CREE collaborates closely with the CND in evaluating and implementing new procedures and regulations aimed at improving the operation of the systems.

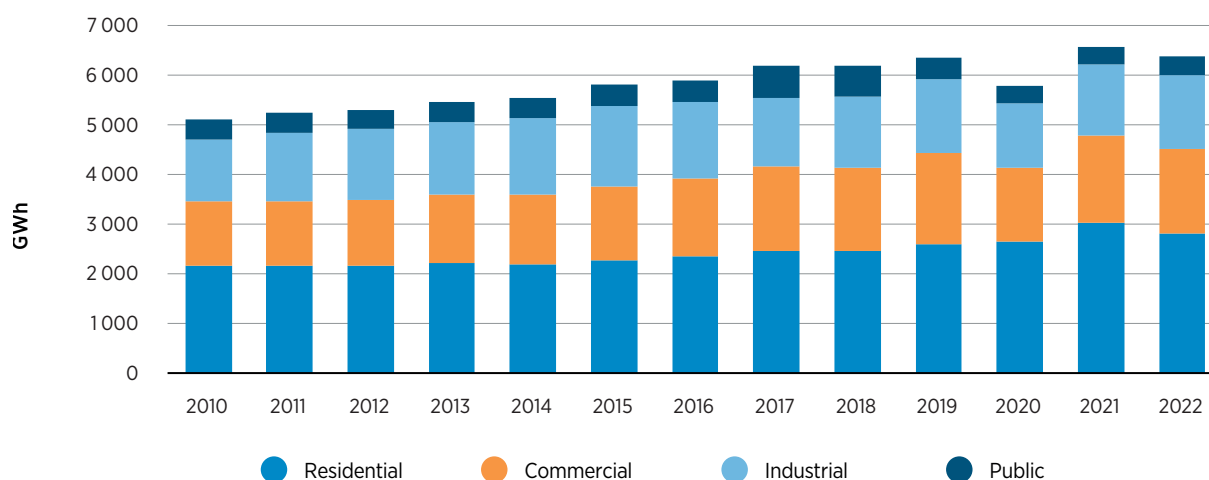
Figure 8 Structure of the electricity sub-sector

Note: CND = Centro Nacional de Despacho; CREE = Comisión Reguladora de Energía Eléctrica; ENEE = National Electric Energy Company; SEN = Energy Secretariat.

Power generators include public, private and hybrid companies. In 2022, around 105 power plants produced most of the national electricity demand. The Electric Transmission and Operation Company (EMETO) owns and operates the transmission system. The operation and maintenance of distribution networks are controlled by the Electricity Distribution and Marketing Company (EDCO) in close collaboration with Honduras Energy Enterprise (EEH).

Electricity consumption

In 2022, the country's per capita electricity consumption was around 0.79 megawatt hours (MWh) (SieHonduras 2022). Honduras' electricity consumption grew 55.43% during 2011-2022, with end users increasing their consumption from 5 235 GWh to 6 380 GWh (see Figure 9). The largest consumer was the residential sector (32.24%), followed by the commercial (30.63%) and industrial (23.82%) sectors (ENEE, 2022). Self-producers include individuals and companies participating in government programmes that promote solar projects, with a total off-grid installed capacity of between 50 W and 100 W, an on-grid capacity of 60 MW, as well as microgrids in remote communities.

Figure 9 Electricity consumption by end-use sector, 2011-2022

Based on: SieHonduras (2022); ENEE (2011, 2022).

Electricity consumption in the country varies by region. In 2022, the north-western region encompassing San Pedro Sula, with its high concentration of operating maquiladoras,¹¹ accounted for half of the total electricity consumption (3 207 GWh). The south-central region, which includes the capital city of Tegucigalpa, consumed 2 549 GWh (40%). The coastal-eastern region, comprising mainly under-served areas, had a comparatively lower share of electricity consumption, totalling 622.15 GWh (10%) of the overall demand (ENEE, 2022).

Energy subsidies

Energy subsidies are in place for both oil products and electricity. Most of the subsidies are not targeted at specific user groups and benefit the population at large. These subsidies represented 2.9% of the country's GDP in 2017, according to the International Monetary Fund (see Table 5) (IMF, 2021).

Table 5 Energy subsidies in Honduras, 2017

Nominal GDP USD billion (2017)	Oil product subsidies (% of GDP)	Electricity subsidies (% of GDP)	Oil products and electricity (% of GDP)
USD 22.98	1.8%	1.1%	2.9%

Source: IMF (2018).

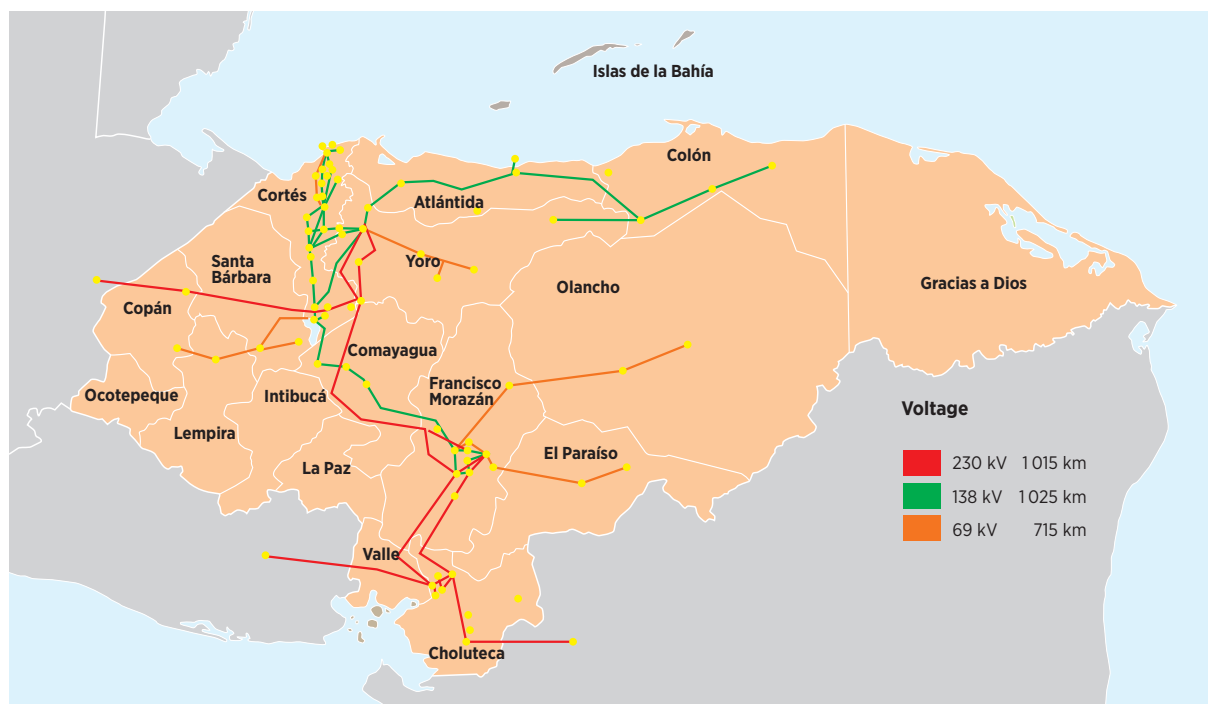
Electricity subsidies pose financial risks for ENEE. Reduced electricity tariffs worsen the already difficult financial situation of the state-run company, which faces high prices in its power purchase agreements (PPAs) with private generators, as well as high losses in dispatching electricity to end users. ENEE's debt increased from USD 1.8 billion (equivalent to 8% of GDP) in 2016 to USD 3.4 billion (around 15% of GDP) in 2020 (IMF, 2021). Despite some financial achievements, ENEE continues to contribute significantly to the ongoing public deficit, which stood at 0.7% as of December 2017, posing fiscal risks for the country.

Transmission and distribution networks

The country's south-to-north electricity interconnection is reliant on a single 230 kilovolt (kV) transmission line, linking SE Agua Caliente in the south to SE Progreso in the north (see Figure 10). The northern zone has lines that reach only up to 138 kV, which constrains dispatch options for northern power producers and potential energy developers. Honduras is connected to the rest of Central America by 230 kV transmission lines that are part of the Electricity Interconnection System for the Countries of Central America (SIEPAC), interconnecting the country with El Salvador, Guatemala and Nicaragua.

¹¹ A manufacturing plant engaged in the importation and assembly of duty-free components for the purpose of export.

Figure 10 Transmission infrastructure 2023



Source: CREE (2023).

Note: kV = kilovolt; km = kilometre

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

The under-development of electricity transmission, sub-transmission and distribution explains in part the high rates of electricity loss. In July 2022, Honduras reported the highest electricity losses in Central America, at around 31.83% of total production (Manitoba Hydro, 2022). Technical losses originate in installations used to build transmission networks, due to inadequate design, lack of maintenance, inadequate cable sections and overloaded transformers. Non-technical losses are related to illegal distribution connections and unpaid billings (World Bank, 2018).

Installed capacity of renewables

The country's biofuel production capacity relies on more than 50 000 km² of forest (covering 45% of the national territory). Biofuels include firewood, sugarcane bagasse and African palm production. Firewood demand remained relatively steady between 2010 and 2022 (see Figure 11), despite government efforts to displace its consumption by providing subsidies for LPG use in low-income households.

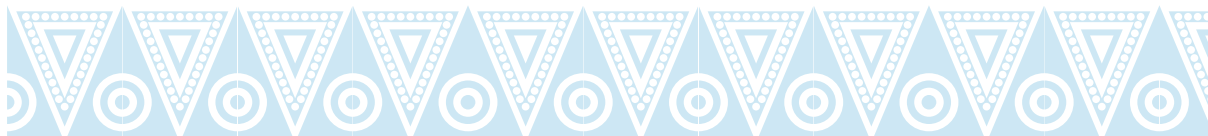
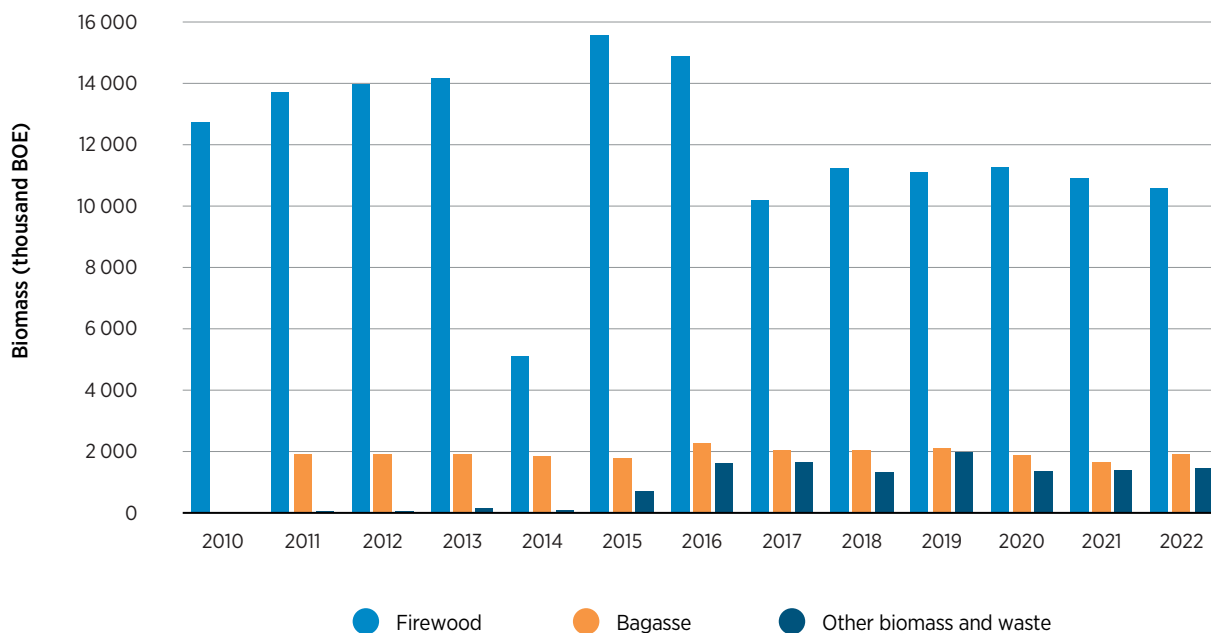


Figure 11 Biomass for energy use

Based on: SieHonduras (2022); SEN (2017, 2021b).

Note: BOE = barrels of oil equivalent.

The country's firewood production capacity faces sustainability challenges. Despite the overall vast capacity to meet firewood demand, the location of sustainable supplies is far from the cities and large settlements where most of the demand is concentrated. The rise in transport costs resulting from high fuel prices means that firewood exploitation occurs mainly in the forests surrounding highly populated areas, which already suffer from high deforestation rates. Firewood demand in the departments of Choluteca, Cortés, Francisco Morazán and Valle is assumed to surpass reforestation rates, while the departments of Copán, La Paz and Ocotepeque face moderate risks of forest degradation.

Bagasse, a product derived from the sugarcane milling process, serves a dual purpose of generating steam for thermal applications and producing electricity. National sugar production undergoes processing in six mills strategically positioned across the country, using an expansive land area of 45 000 hectares (Sanders, 2009). Around 25% of the cultivated sugar cane is dedicated to producing bagasse as an energy source. Sugar mills play an important role in increasing the biomass power capacity. Biomass power capacity from bagasse and biowaste (African palm oil, wood residue and king grass) grew from 91.4 MW (electrical) in 2010 to 221.3 MW (electrical) in 2021, while the total dispatched biomass electricity directed to international exchanges increased from 142 GWh in 2010 to 475 GWh in 2021 (ENEE, 2010, 2022).

In 2022, Honduras had 2 055 MW of installed renewable energy capacity, representing 65.1% of the total installed power generation capacity. In less than a decade, between the years 2012 and 2022, the share of renewables in the overall generation capacity increased from 48% to 65%, reflecting the efforts of different stakeholders to decarbonise the energy sector (SieHonduras 2022).

The country is home to around 95 power plants using renewable energy sources (see Table 6 for examples). The predominant technologies are hydropower, which contributes 30.6% of the total capacity (excluding self-production), and solar PV plants (17.2%).

Honduras has more than 50 hydropower plants. In 2021, hydropower accounted for 38% of the total electricity production (ENEE, 2022). ENEE owns the country's largest hydropower plants, with a combined installed capacity of 433 MW. This includes the 300 MW Francisco Morazán hydropower plant, which produced 12% of the country's total electricity consumption in the first quarter of 2022 (ENEE, 2022). The 104 MW Patuca III plant, the second largest in the country, came online at the end of 2020.

Solar energy in Honduras was not widely developed until 2012. In 2016, the country led the Central American solar PV market with an installed capacity of 433 MW, and in 2021 solar energy contributed 10% of the total electricity dispatched in the interconnected system. The government of Honduras estimates that solar panel installation costs have fallen by as much as 60% since 2020 and will further decrease as energy storage batteries are installed in the commercial and residential sectors (IDB, 2021).

Starting in 2019, the country began operating geothermal power plants. As of 2022, the total geothermal capacity was 39 MW, contributing 2.7% of the total electricity generation. The first geothermal plant, a public-private partnership in Plantares, added 39 MW of capacity to the interconnected system. Private companies were granted concessions for three fields, with the Pavana and Azacualpa fields going to Geopower S.A., and the Platanares fields going to Geoplatanares. Simultaneously, the Natural Resources Secretariat (SERNA) conducted a survey to assess geothermal manifestations and co-ordinated most of the activities for mapping potential geothermal development opportunities (SICA, 2018).

Table 6 Sample non-hydropower renewable energy projects

Energy source	Project	Responsible party	Maximum power installed
Solar PV	Nacaome and Valle Solar Power Plant	Soposa and Cohessa	146 MWp
Wind	Mesoamérica	ENEE	> 125 MW
Geothermal	Geoplatanares	ENEE	> 35 MW
Biomass	Cahsa Biomass Power Plant	Compañía Azucarera Hondureña, S.A.	> 30 MW

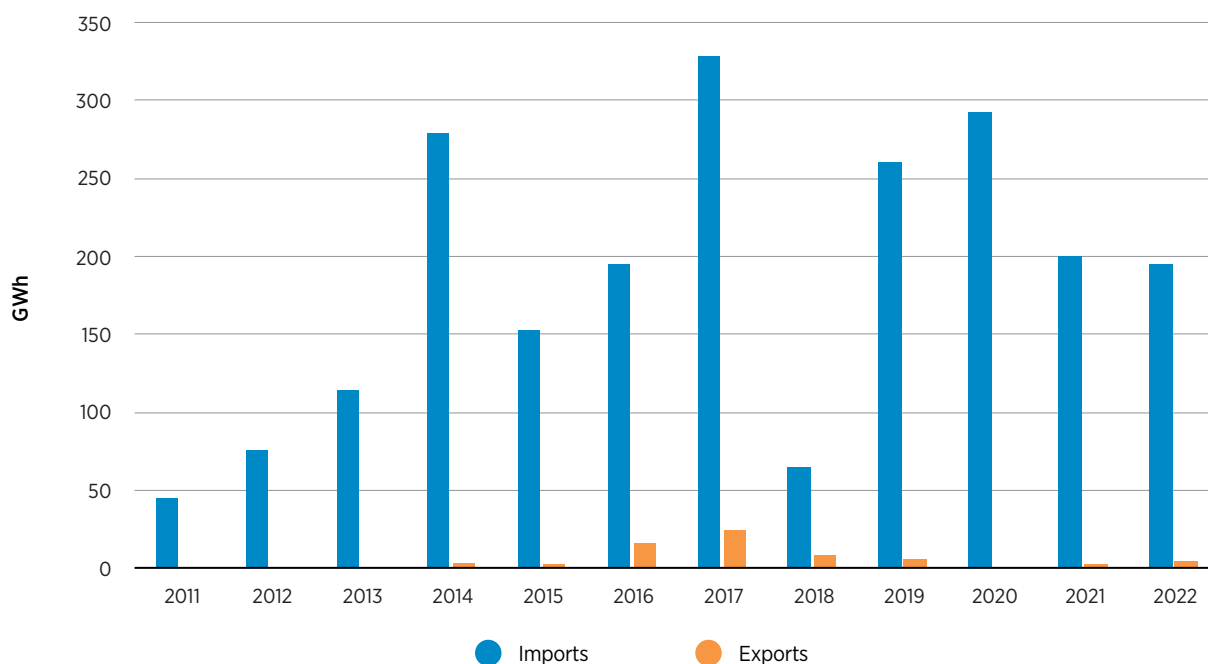
Based on: SieHonduras (2022).

Note: ENEE = National Electric Energy Company; MWp = megawatt peak; PV = photovoltaic.

International electricity trade

In 2020 and 2021, Honduras purchased the second largest amount of electricity in the Regional Electricity Market (MER) among Central American countries (ENEE, 2022). The country quadrupled its imports between 2011 and 2021, in both the contract and opportunity markets. In 2014, severe droughts that affected hydropower capacity led to one of the largest energy purchases to supply domestic electricity demand.

The commercialisation of Honduran electricity in the MER is constrained by the transmission system and generation capacity. Between 2011 and 2015, the country was a net electricity importer, and in 2016-2017 it exported 20 GWh per year on average, which fell to 2.5 GWh in 2021. Figure 12 shows the recent evolution of electricity trade in the country.

Figure 12 Electricity trade, 2011-2022

Based on: ENEE (2011, 2022); ODS (2021).

2.3 Energy rates

In 2021, electricity users in Honduras paid between USD 0.14 and USD 0.23 per kilowatt hour (kWh) (IDB, 2022b). After electricity subsidies, the national average rate during 2009-2021 was USD 0.15/kWh. Table 7 shows the national electricity rates in 2021 for different clients.

Table 7 Electricity rates by client, 2021

Client	Tariff (USD)
<i>Residential</i>	
Electricity consumption	
• 0-50 kWh	0.18
• > 50 kWh	
– First 50 kWh	0.18
– >50 kWh	0.23
<i>Low voltage</i>	0.23
<i>Medium voltage</i>	0.15
<i>High voltage</i>	0.14

Source: CREE (2021).

Electricity tariffs are intended to reflect the generation and transmission costs incurred by distributors. The official tariff calculation and adjustment methods are defined by CREE regulation 065-2020, which includes the base cost of energy generation. Levelised transmission costs are presented in hourly blocks. Although variations in fuel prices and exchange rates are not fully accounted for in tariff calculations, imbalances from subsidies aimed at residential households that consume less than 150 kWh per month are offset using cross-subsidies from the commercial and industrial sectors, supplemented by public funds.

2.4 Legal and regulatory framework

Hydrocarbons and biofuels sub-sector

The current structure of the hydrocarbons and biofuels sub-sector is based on a group of reforms and policies from the 1990s. Prior to these reforms, the state played a significant role in the energy sector, acting as regulator and controlling the prices of petroleum products.

The Law on Hydrocarbons (Decree 194-84) initially covered the hydrocarbons industry. The law established a legal framework governing the research, exploration and extraction of crude oil and related substances, as well as refining activities, transport, commercialisation and storage (Republic of Honduras, 1984). The law lacked direct incentives for the development of upstream and downstream activities, which eventually ceased in 1993, despite high oil prices. As a result, the Energy Secretariat, the governing body responsible for formulating policies in the energy sector, introduced new procedures in 2009 for the modernisation of the hydrocarbons sector, guided by the principles of competition and unrestricted market entry.

Honduras is the only country in Central America with a law and a regulation for both biofuel and ethanol production. The Law for the Production and Consumption of Biofuels (Decree 144-2007) declares biomass projects for energy production of public interest and creates a registry of biofuel producers. Its provisions also include fiscal incentives such as 12-year tax exemptions, and tax benefits on imported equipment (Republic of Honduras, 2007a).

Electricity sub-sector

In 1990, the National Energy Commission was created to regulate the electric power market. During the 1990s, the Honduran energy mix was heavily dependent on fossil fuel power generation (61%), with hydropower plants accounting for the remaining 39%. A financial crisis unfolded in 1993, precipitating an energy emergency that coincided with a profound drought, which greatly impacted the hydropower generation capacity. In response to this crisis, the government crafted new policies and regulations to promote energy investments.

As a consequence of sectoral reforms initiated in 1994, the enactment of Electricity Law No. 158 of 1994 laid the foundation for a competitive electricity market. This entailed the vertical unbundling of activities, enabling freedom of entry for all sector participants, open access to transmission and distribution networks, and freedom of choice for large users. The reform also led to the segregation of roles between policy making, regulation and electricity service provision; the implementation of cost-recovery tariffs and targeted subsidies; and the introduction of private sector involvement in electricity provision.

In 2007, Honduras passed Law No. 70 of 2007 aimed at fostering the generation of renewable energy. This law included provisions to introduce a 20-year income tax break and to waive import taxes on equipment, while mandating ENEE to enter into 20-year PPAs with renewable energy firms. Law No. 70 was later complemented by Decree No. 138 of 2013, which included the promotion of solar power plants and rooftop PV projects in the residential sector.

The General Electricity Industry Act (Law. No. 404 of 2013), enacted in 2014, includes provisions for the greater liberalisation of generation and commercialisation activities. It created a wholesale market and transformed ENEE into three specialised companies subordinated to the Central ENEE Business Group: 1) Generation, 2) Transmission and Operation and 3) Distribution. It also designated the ODS and CREE as the regulatory authorities for the electricity sector. Subsequently, Law N. 46 of 2022 transformed ENEE into four business units (generation, transport, distribution, and commercialisation).

In 2022, the National Congress authorised Law No. 46 of 2022 to ensure the provision of electricity as a fundamental aspect of national security and a fundamental human right. Among other provisions, this law enables the government to renegotiate PPA tariffs. In the event that the PPA renegotiations fail, the government will take over the generator's assets, paying compensation with government bonds. The law raised concerns about a potential and imminent renegotiation of PPAs; if the generator refuses to lower tariffs, the fallback scenario is to incorporate its assets into the public sector. Further discussions in enforcing this law include the variables for calculating the compensation in the case of the integration of assets into the public domain.

Transport sector

The main legislation in the transport sector is the Overland Transportation Law (Decree 136-2018), which was revised in 2018. This law provides guidelines for improving the safety and efficiency of overland transport.

In 2017, Honduras prepared the National Freight Logistics Plan, which characterises the trade relationship with the National Logistics System.¹² Currently, the Government of Honduras is formulating a Logistics Law that promotes sustainable planning practices, incorporating environmental and innovation dimensions into the components of the National Logistics System and the energy transition. The law's regulations will set standards for logistics infrastructure (currently there are none), with a focus on resilience to natural disasters. Once passed, the Logistics Law will complement the Overland Transportation Law.



¹² The National Logistics System is relevant at the Central American level, providing economic integration processes, specifically with the Secretariat for Central American Economic Integration (SIECA) and the Mesoamerica Project.

3 Renewable energy development

Renewable energy development in Honduras includes the use of hydro, solar, wind, geothermal and biomass resources. Variable renewable energy generation started in 2011 with small-scale wind projects and later increased with the addition of solar power plants that initiated operations in 2014.

3.1 Key drivers

The main drivers for renewable energy development in Honduras, as mentioned in the Energy Roadmap 2050, are reducing dependency on fossil fuels, enhancing energy access and efficiency, and promoting sustainable development. The government works in two major areas to further the development of renewable energy infrastructure: 1) providing supplementary electricity to meet the needs of industrial, commercial and residential customers connected to the power grid, and 2) ensuring the delivery of sustainable energy services in rural areas, with a focus on enhancing access to electricity and clean cooking energy sources. Table 8 summarises the expected outcomes of these drivers of renewables in Honduras.

Table 8 Drivers of renewable energy development and expected outcomes

Driver	Expected outcomes
Reducing fossil fuel dependency	Expanding the energy mix by incorporating locally available energy resources. Increasing imports of renewable energy from the MER. Increasing the share of renewable energy in final energy consumption. Overcoming barriers to the adoption of electric mobility.
Enhancing energy access and efficiency	Universal access to high-quality electricity. Increasing the energy efficiency of end uses. Strengthening transmission and distribution systems. Reducing energy losses in transmission and distribution systems. Encouraging private investment in the development of energy infrastructure.
Sustainable development	Reducing firewood consumption in the residential sector. Reducing greenhouse gas emissions as outlined in the country's NDC. Minimising the degradation of natural resources. Successfully managing social conflicts with local communities.

Based on: SEN (2021a).

3.2 Recent investments in renewable energy infrastructure

Honduras is taking great steps to harness its renewable energy resources, with a focus on enhancing power generation and the transmission and distribution infrastructure. For power generation, the country has introduced projects such as El Tornillito and Arenal Stage I and II, which represent a substantial addition to the system's capacity. The Indicative Generation Expansion Plan envisions a transition to a more sustainable energy mix, emphasising the integration of renewable sources such as wind, solar and geothermal. On the

transmission side, efforts to interconnect renewable energy generation to the main hubs of electricity demand focus mainly on strengthening existing networks, in particular to improve the south-to-north flow of electricity. The ultimate objective of planned generation and transmission projects is to enhance cross-border electricity imports and to optimise the quality of domestic supply.

- **Generation:** The largest and latest capacity additions to the system are the 200 MW El Tornillito project (under construction) and the 61.2 MW Arenal Stage I and II project (operational as of late 2022), with combined investments close to USD 600 million. The Indicative Generation Expansion Plan 2022-2031 contemplates the introduction of additional renewable energy capacity, with approved contracts and permits totalling 160 MW of wind, 240 MW of solar and 15 MW of geothermal. However, recent energy reforms instruct ENEE to renegotiate the PPAs and incentives of existing and planned projects, adding uncertainty about their development. Alternative scenarios mentioned in the Generation Expansion Plan include covering the unbuilt renewable energy capacity through greater participation from thermal power plants (natural gas, LPG, bunker and combined-cycle), ranging between 1442 MW and 1922 MW.
- **Transmission and distribution:** Investments in transmission capacity are focused mainly on strengthening the existing infrastructure for transporting electricity from south to north. Projects under construction include six reactive compensation banks to the north and two banks to the central zone to increase power imports from neighbouring countries. The San Pedro Sula Sur to San Buenaventura transmission line (48 km) is a new addition that includes 230/138 kV transformers in San Pedro Sula Sur and enables the injection of new electricity generation in the north-west. Other projects include the Progreso to San Pedro Sula Sur transmission lines; the Miraflores to Lainez line; the Arenales to Coyoles Central line, and repowering the Villanueva to San Pedro Sula Sur line. Forthcoming ENEE investments include the installation of 15 sub-stations in the distribution system to reduce electricity losses and improve the quality of supply.

The government recently prioritised ENEE's Strategic Expansion Plan, which commits new investments with the aim of avoiding further delays in strengthening the national transmission system. The Plan contemplates investments in transmission equivalent to 2.3% of the country's GDP. Planned investments for the period 2017-2021 include USD 243 million to address around 60% of the identified needs. Despite delays in developing this infrastructure, progress has been achieved in the development of new substations (El Centro and Calpules), expanding existing ones (Miraflores and Laínez) as well as the construction of new transmission lines, all linked to the mentioned financing allocation.

3.3 Renewables in the energy mix

Renewable energy projects under construction during 2022 were mostly plants with installed capacities of below 20 MW. Renewables represented 64.49% of the total installed power capacity that year, with hydropower generation contributing the largest renewable energy share (ENEE, 2022). Between 2011 and 2021, four large hydropower plants (35 MW to 100 MW) were added to the grid, and 26 small hydropower stations (below 13 MW) were linked to mini-grids or independent applications such as agro-processing.

Wind and solar power are also growing. Private firms introduced variable renewable energy production in 2011 with the opening of a 102 MW wind farm in the localities of Santa Ana and San Buenaventura. This paved the way for two additional wind projects of 50 MW that began operations in 2014 and 2017. In 2015, the solar industry started operations, adding 388 MW and surpassing the wind power installed capacity. The country's solar power capacity grew 30% between 2015 and 2022, to reach 510 MW, and includes 17 plants with capacities ranging between 5 MW and 50 MW. Geothermal power capacity was introduced in 2017 through the Plantares plant, a public-private partnership, adding 39 MW to the interconnected system (SICA, 2018).

Honduras has the largest production of palm oil used to make biofuels in Central America (USDA, 2008; Tauro *et al.*, 2021). The country’s palm oil sector includes co-operatives, community-driven companies, individual producers and the private sector.

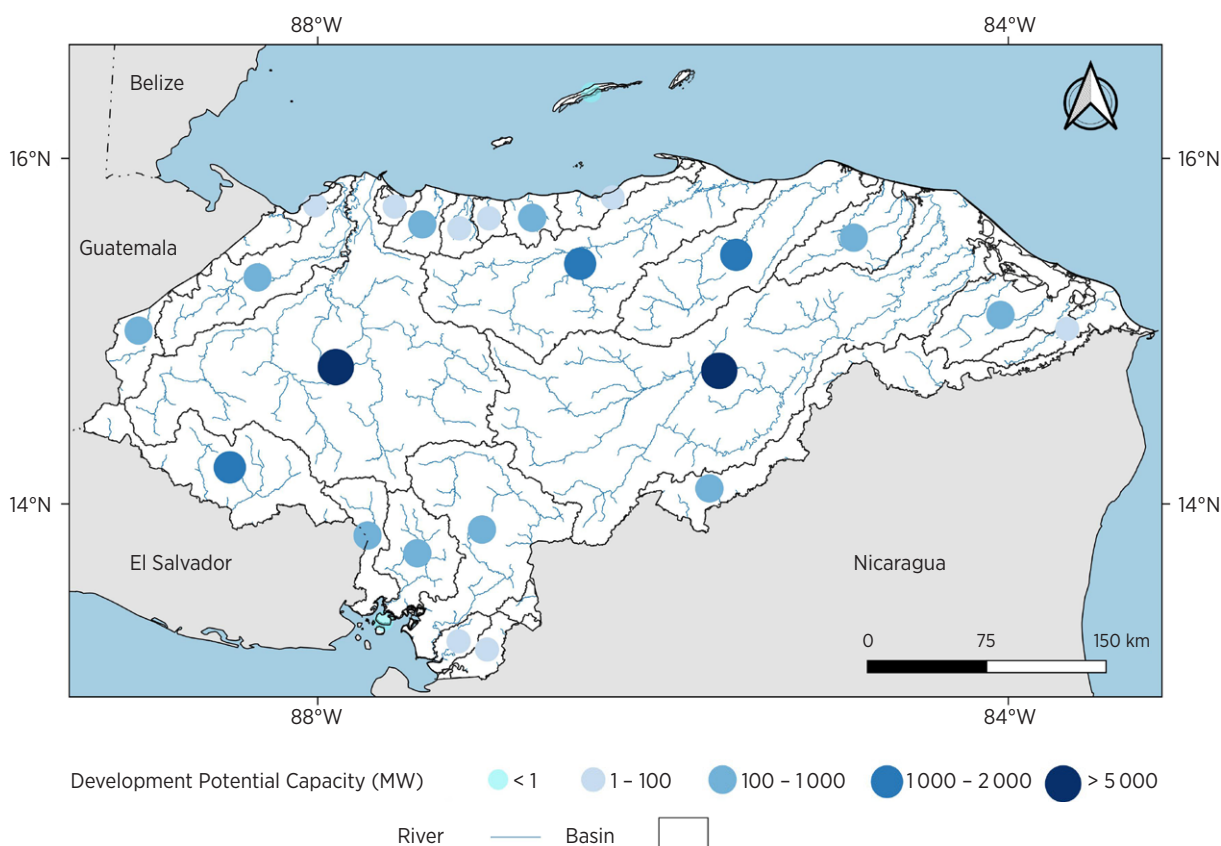
Fuelwood is the dominant thermal energy source, used mainly for cooking purposes. Honduras has also implemented several noteworthy biogas projects, such as the 1.3 MW EECOPALSA project that captures methane from oil palm oxidation.

3.4 Renewable energy potential

Hydropower

Honduras has exceptional hydrological resources. These resources are concentrated in two main drainage basins, encompassing numerous watersheds and rivers that flow towards the ocean (see Figure 13). On the Atlantic Ocean side, there are 13 watersheds, featuring prominent rivers such as the Aguan, Patuca and Ulua. Collectively, these “Atlantic slope” watersheds and rivers contribute a substantial 87% of the country’s surface water run-off. The “Pacific slope” of Honduras hosts the remaining 13% of water resources in five major watersheds. The most important rivers include the Choluteca River, which supplies water to Tegucigalpa, and the Lempa River.

Figure 13 Hydropower potential



Source: Hydropower potential from Hoes (2014); base map from UN Boundaries.

Note: MW = megawatt.

Disclaimer: This map is provided for illustration purposes only. Boundaries shown on this map do not imply any endorsement or acceptance by IRENA.

Between 2022 and 2031, the Honduran government has plans to build a combined 980.85 MW of new hydropower plants, comprising medium- and small-scale projects located in the Chamelecon, Patuca and Ulua rivers (Henriquez, 2021). During 2023, ENEE began reviewing the designs of the Los Llanitos hydroelectric plants, targeting the addition of 80 MW. Simultaneously, an evaluation of El Tablón dam was performed, which is expected to add 20 MW of installed capacity.

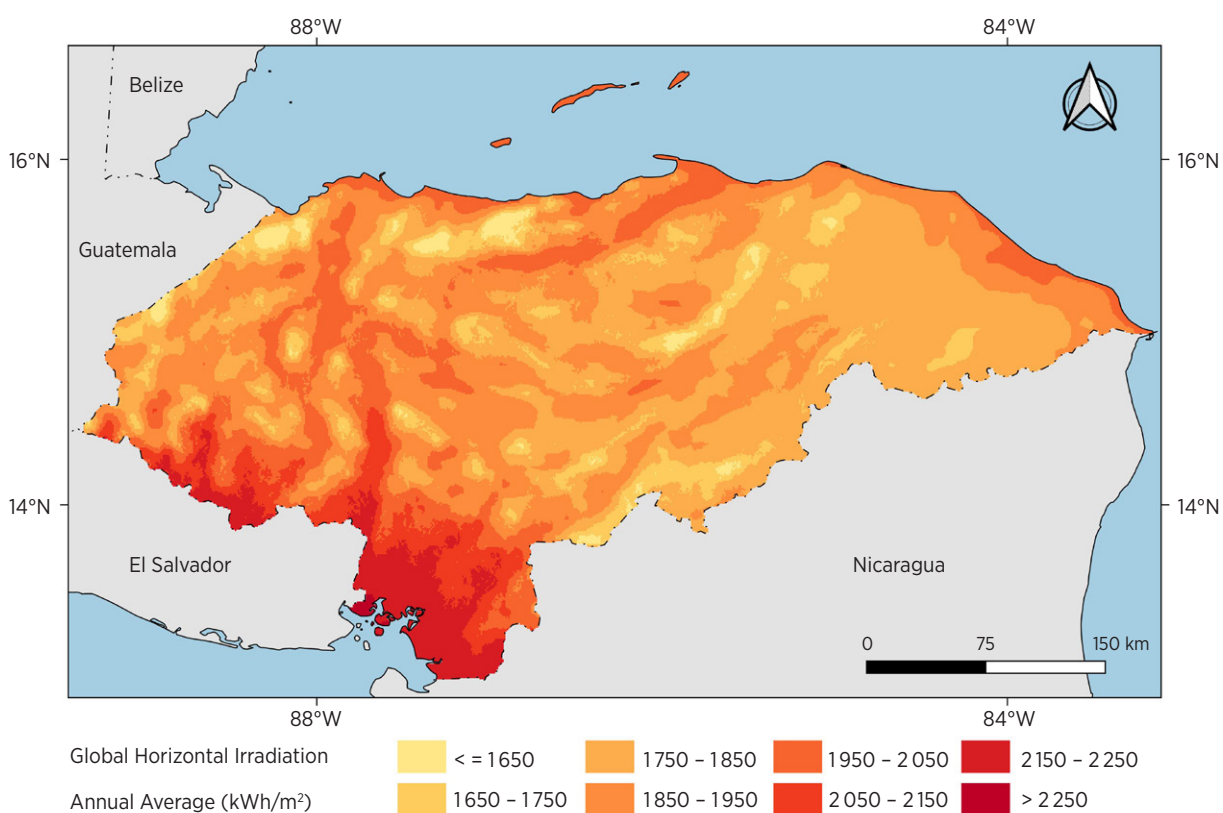
Solar

Interior regions of Honduras have high solar potential for electricity production (see Figure 14). The greatest solar potentials are in Choluteca and Valle. In 70% of the country's land area, the annual generation per unit of installed solar capacity is around 1650 kWh per kW peak, well above the global average of only 20% of the land area reaching this capacity (World Bank SolarGIS, 2019).

Currently, prefeasibility studies are under way for eight solar PV energy projects (Henriquez, 2021), which would add 125 MW peak of power generation. In addition, around 60 MW peak of distributed solar energy is in the stages of design, installation and development.

Studies indicate that the country's southern region has the greatest potential for solar deployment. However, there are challenges with ensuring a constant energy supply on the current transmission lines, as a high share of the existing solar plants in the area have faced curtailment.

Figure 14 Solar power potential



Source: World Bank SolarGIS (2019); base map from UN Boundaries. Maps are also available on the IRENA Global Atlas for Renewable Energy.

Note: kWh/m² = kilowatt hours per square metre.

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Box 1 IRENA's SolarCity Simulator

The SolarCity simulator is an innovative web application, developed as part of IRENA's Global Atlas for Renewable Energy Initiative, to accelerate the deployment of rooftop solar PV systems in urban areas. The simulator is designed to support member countries in assessing:

- Technical potential for each selected roof, which includes the suitable areas to install PV systems for each 1 square metre of the roof and the corresponding hourly and annual energy production. These parameters are calculated using a robust power generation model that considers the city's solar resource profile and city features (roof shape and angles) obtained from the 3-D building footprints over the selected area of interest.
- Financial potential for different case studies (homeowner, investor and government), which includes a range of economic indicators, such as payback period, Equity Internal Rate of Return (EIRR) and investment cash flow. These indicators are obtained from a simplified financial model that considers the local context of the country.
- Socio-environmental benefits, which include the annual carbon emissions avoided as well as reductions in fine particulate matter (PM_{2.5}), the equivalent number of tropical trees planted and the equivalent number of cars taken off the street when sourcing the electricity from rooftop solar PV systems, and the number of jobs created. These parameters are calculated using simple metrics based on the estimated annual electricity production.

Through this activity, IRENA can support Honduras by enhancing data collection for solar PV integration and assessing opportunities for renewable energy use. To this end, the simulator will contribute to the achievement of the country's NDC targets.

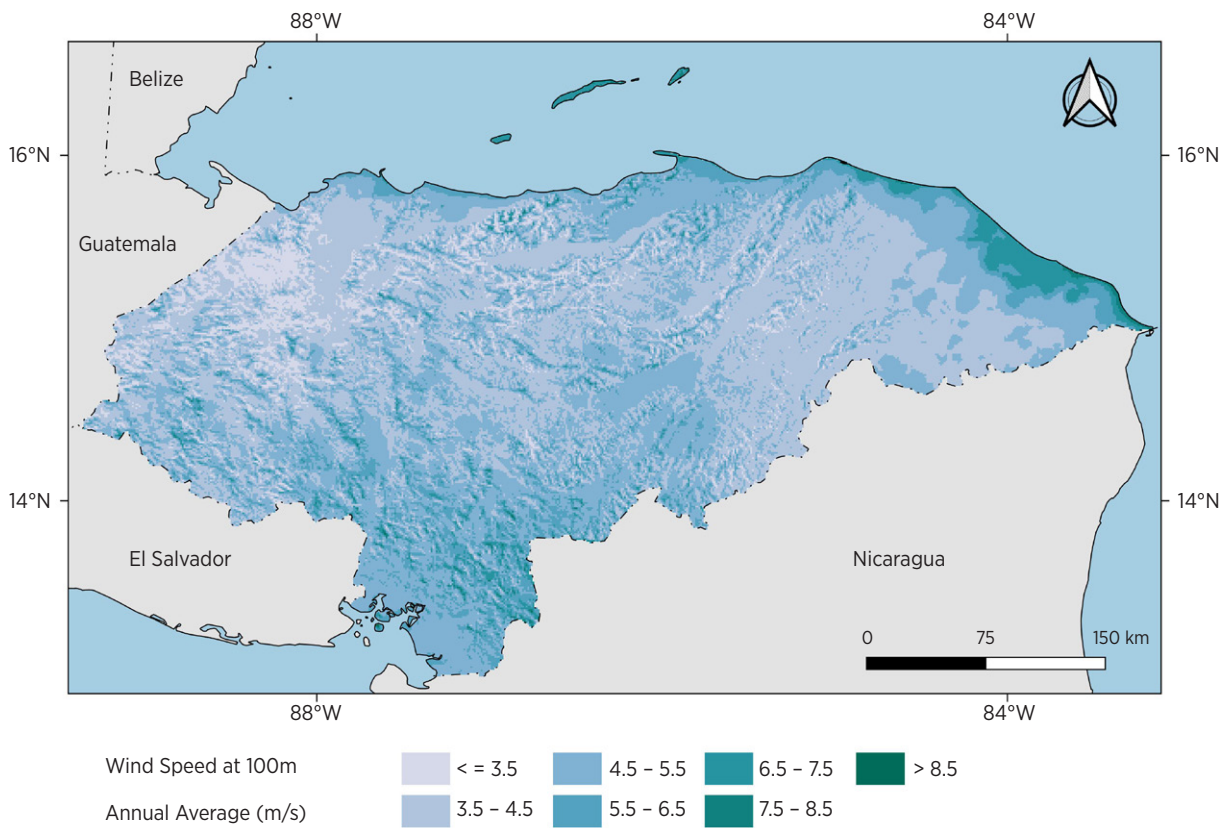
For more information, see the SolarCity Simulator at www.irena.org/Energy-Transition/Project-Facilitation/Renewable-potential-assessment/SolarCity-Simulator.

Wind

According to ENEE, Honduras has the potential to reach 1200 MW of installed wind power capacity in the long term. Wind power resources in 10% of the total territory have a power density between 260 W/m² and 420 W/m² at a height of 100 metres. This is lower than the global trend, where 20% of the world's total territory exhibits that capacity. The regions identified as the best locations for wind farms are located in the centre and south of the country and include Choluteca, La Mosquitia, Roatan and Utila, (see Figure 15).



Figure 15 Wind power potential



Source: DTU and IRENA (2015); base map from UN Boundaries. Maps are also available on the IRENA Global Atlas for Renewable Energy.

Note: m = metre; s = second.

Disclaimer: This map is provided for illustration purposes only. Boundaries shown on this map do not imply any endorsement or acceptance by IRENA.

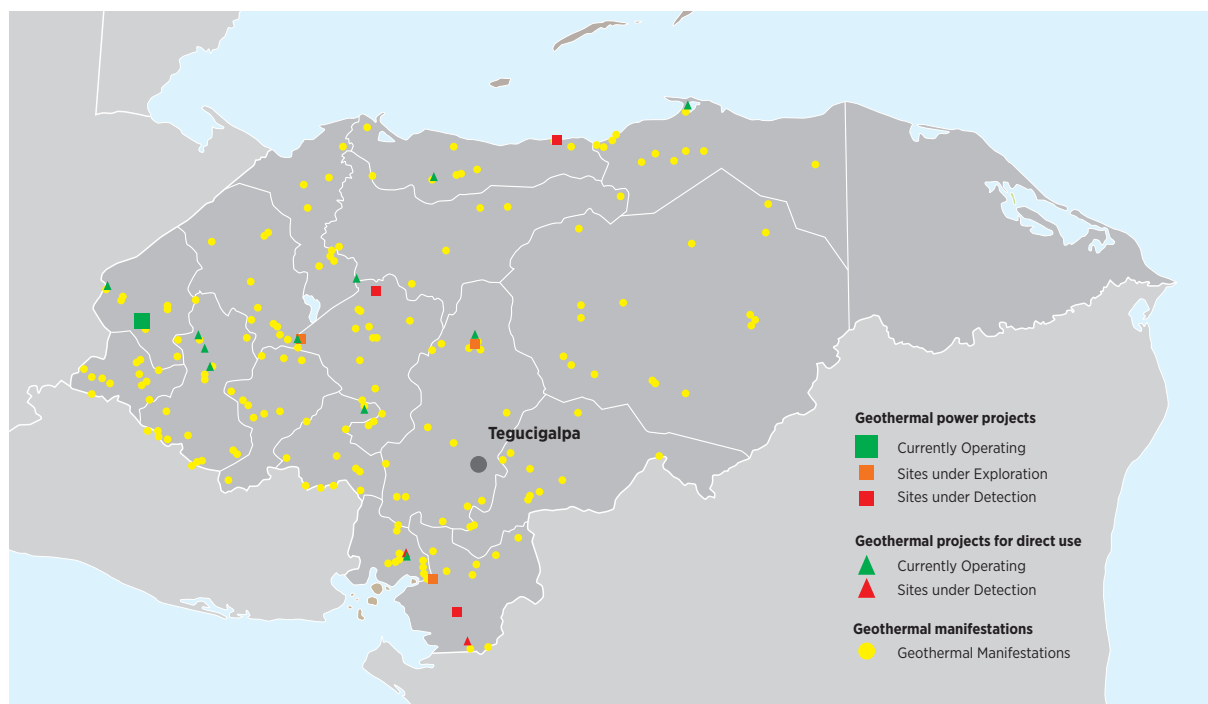
Geothermal

Positioned within the Pacific Ocean’s “Ring of Fire”, Central America boasts abundant geothermal resources. The estimated geothermal power generation capacity in the region ranges between 3 000 MW and 13 000 MW, yet only a fraction of this potential has been confirmed through drilling activities (World Bank, 2012).

In Honduras, there are no magma bodies at shallow depth acting as a heat source. Under these conditions, geothermal resources are usually linked to water infiltration through deep-reaching faults. Geothermal resources are found in 17 of the country’s 18 departments, with 6 of them suitable for the development of potential high-enthalpy (high-temperature) projects: Azacualpa, Pavana, Platanares, Puerto Cortes, Sambo Creek and San Ignacio (see Figure 16) (GIZ, 2017).



Figure 16 Geothermal power potential



Source: SICA (2021).

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

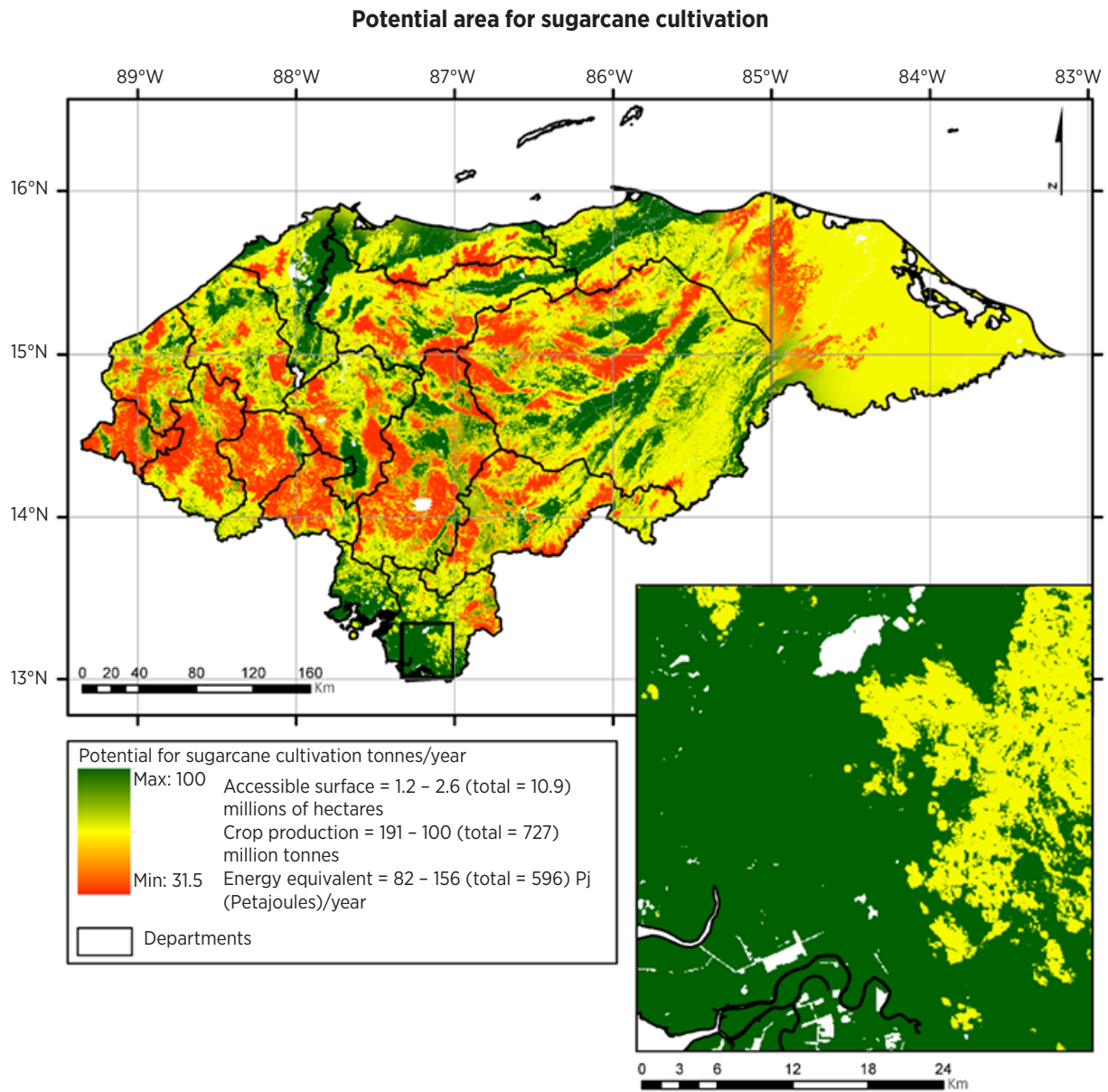
Bioenergy (biomass, bagasse, biofuels)

Honduras has large untapped biomass resources for energy purposes. The energy potential of using sugar cane and oil palm crops to produce biofuels is 756.5 petajoules (PJ) per year. Crop production could supply the total current demand for petrol and diesel in the transport sector, at 49 000 barrels of oil equivalent per day (0.3 PJ per day) (ECLAC 2021b). The greatest potential is in the departments of Atlántida, Colón, Cortés, Intibucá, Olancho, and Santa Bárbara, which have the largest annual wood production in the country (see Figure 17).

The annual development potential for biomass energy totals around 57 698 TJ from coniferous forest, 5 993 TJ from infested forest, 71 703 TJ from African palm, 2 808.91 TJ from sugar cane, and 91.04 TJ from coffee, in addition to annual biogas potentials of 55 724 TJ from cattle biogas and 1 202 885 from swine biogas (Henriquez, 2021).



Figure 17 Biofuels power potential

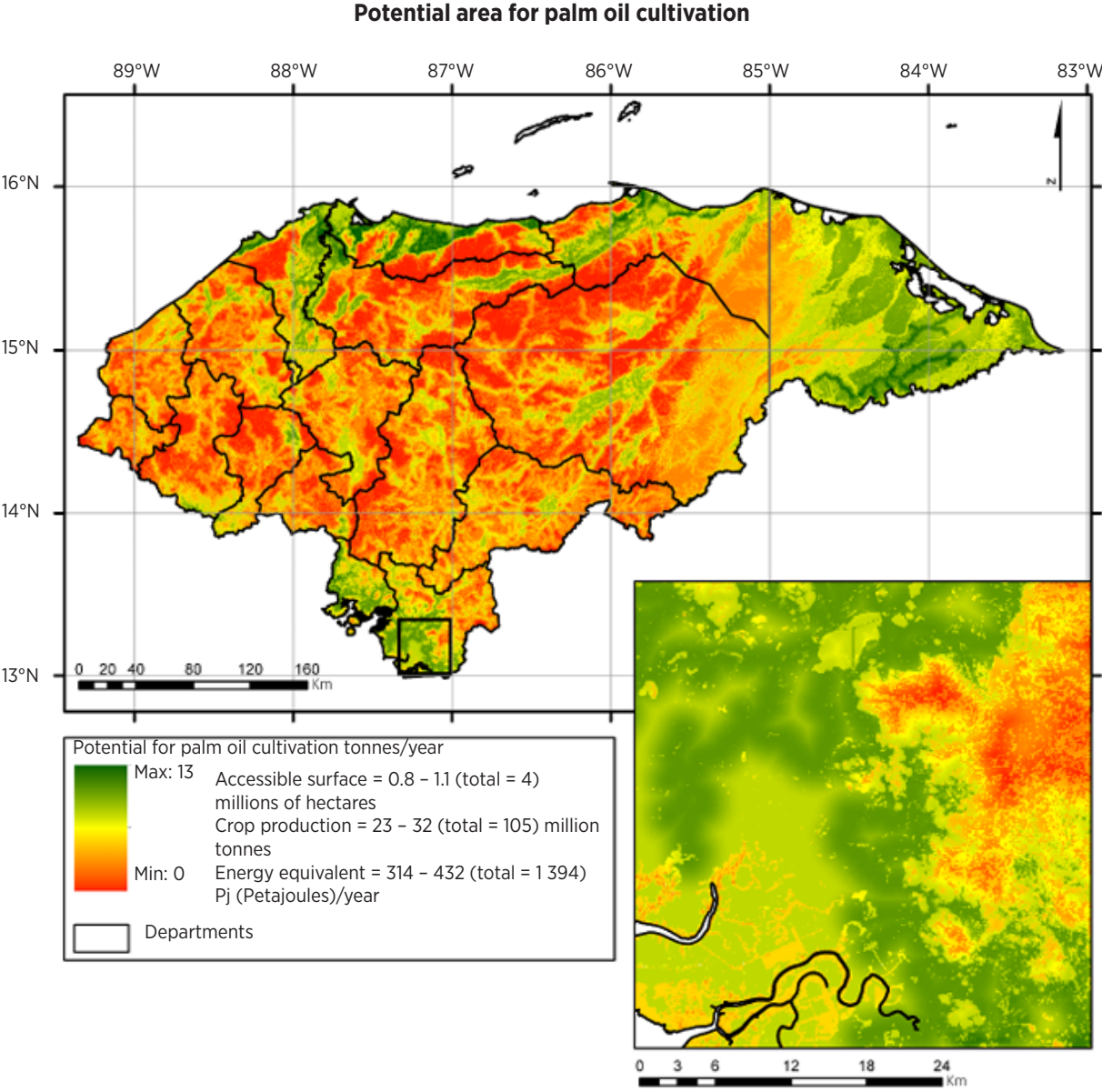


Source: Tauro et al. (2021).

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.



Figure 17 Biofuels power potential (continued)



Source: Tauro et al. (2021).

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Sugarcane bagasse

Sugarcane bagasse production is considered the most organised industry in Honduras, and also has the largest untapped energy potential in the country. In 2008, this sector produced a total of 3.81 GWh of electricity (Sanders, 2009).

Palm oil waste

Palm oil has the potential to add 61.46 MW (electrical) (Tauro *et al.*, 2021). Moreover, the palm oil decomposition process releases nearly 28 million cubic metres of methane annually, which can add 47 759 MWh of electricity (Agüero, 2009).

Biodiesel can also be produced in Honduras using oil palm and tilapia products (USDA, 2008). The national territory has 540 000 hectares suitable for oil palm cultivation, but only an estimated 200 000 hectares are necessary to supply the country's total diesel consumption in 2008 (IDB, 2009).

Biogas

The energy potential for biogas from cattle, swine and poultry activities is an estimated 72 MW (electrical) (Agüero, 2009). However, there is currently a lack of projects or a national database to estimate the biogas potential from animal sources.

3.5 Renewable energy economics

Investment in renewables

The Inter-American Development Bank (IDB), the International Finance Corporation (IFC) and the Climate Investment Funds (CIF) are the main entities financing public-related investments in renewable energy (including public-private partnerships) in Honduras. Between 2010 and 2020, these development institutions disbursed USD 556.3 million (67% IDB, 24% IFC and 9% CIF) in the country.

As shown in Table 9, the IFC investment was allocated mainly to hydropower and solar infrastructure. The IDB directed its support to strengthening transmission systems, modernising existing hydropower plants, promoting regional energy integration, increasing energy access and improving energy services. CIF funds improved the transmission infrastructure, co-financed off-grid wind and solar plants in remote areas, and supported the creation of renewable financing funds.



Table 9 Investments in renewable energy projects in Honduras, 2010-2020

Project	Year	Investment amount (million USD)
La Vegona Hydropower Plant (38.5 MW)	2010	30
Project on energy integration and additional renewable capacity in the western zone (goal: increasing 22.5 MW to 84 MW of installed capacity)	2013	22
Sustainable Rural Energisation (ERUS)	2013	1.02
Pacifico Solar Plant (80.8 MWp)	2014	46
Valle Solar Plant (70 MWp)	2015	31
Aura II Solar Plant (61 MW direct current / 50 MW alternating current)	2015	26
Cañaveral-Río Lindo Hydropower Complex Rehabilitation and Upgrading Project	2015	23
Solar plants for self-producers and energy efficiency	2015	1.40
Honduras Renewable Energy Finance Facility I and II	2015	21
Strengthening On-grid Renewable Energy and Honduras Renewable Energy Financing Facility I (H-REFF)	2015	15
Self-Producers Using Renewable Energy Guarantee Program	2015	1.46
Grid-Connected Renewable Energy Development Support (ADERC) Generation / H-REFF	2015	5.95
Patuca III Hydro Power Plant (104 MW)	2015	297
Support for the National Electricity Transmission Program	2018	155
Grid-Connected Renewable Energy Development Support (ADERC) Transmission Phase I	2018	7
Grid-Connected Renewable Energy Development Support (ADERC) Transmission Phase II	2018	5
Renovation of the Francisco Morazán Hydropower Plant to Facilitate the Integration of Renewable Energy	2020	18
DPSP III: Upgrade of the El Cajón Hydropower Plant to Facilitate the Integration of Renewable Energy	2020	16.4
CABEL: OPD in Support of the Implementation of the General Law of the Electricity Industry (LGIE)	2020	250

Notes: MWp = megawatt peak.

Planned infrastructure for renewable energy

The Indicative Generation Expansion Plan 2022-2031 evaluates five scenarios that project future additions of 1700 MW to 2600 MW of power generation capacity by 2030. Two of the five scenarios model a high participation of fossil fuels, and the remaining three scenarios assume a moderate increase in the participation of renewable energy (CREE, 2019). These latter scenarios consider the introduction of 262.5 MW of hydropower plants, 240 MW of solar, 160 MW of wind farms and 15 MW of geothermal. Table 10 summarises the projects under consideration.

Table 10 Renewable power capacity evaluation, 2022-2031

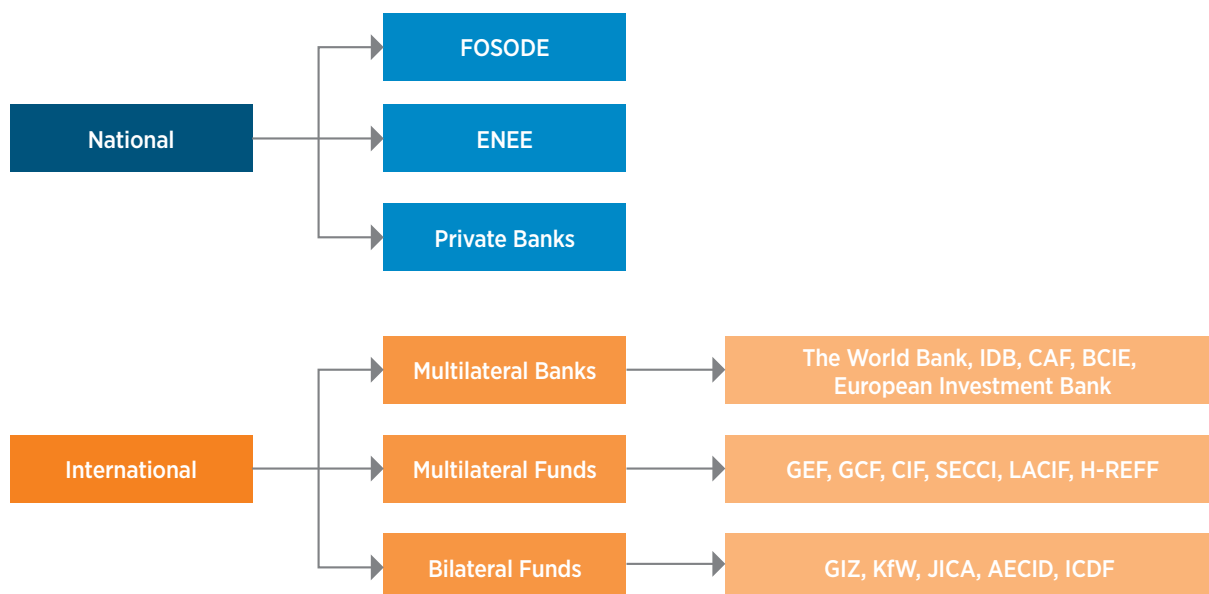
Project	Capacity (MW)	Investment (million USD)	Year
Wind farm – Toncontín	40	70	2024
Wind farm – Zamorano	80	140	2025
Wind farm – Santa Rosa	40	70	2026
Solar plant and energy storage – San Pedro Sula Sur	40	62	2024
Solar plant and energy storage – Coyoles	40	62	2024
Solar plant and energy storage – Naco	40	62	2024
Solar plant and energy storage – Ceiba	40	62	2024
Solar plant and energy storage – Comayagua I	40	62	2024
Solar plant and energy storage – Comayagua II	40	62	2025
Geothermal power plant	15	65	2027
Total	415	717	

Source: ODS (2022).

Available funding

Honduras finances its renewable energy and energy efficiency infrastructure using both public and private funds. Public investments come from a mix of public resources, concessional loans, guarantees and donations from national and international institutions. Donations constitute non-reimbursable funds from technical co-operation for small-scale investments, whereas concessional loans complement national or other funds to cover additional investment. Guarantees are usually used to improve the financial conditions of projects facing risks that the public or private sector cannot absorb. Figure 18 shows the main institutions financing renewable energy infrastructure in Honduras.

Figure 18 Renewable energy financing institutions



Note: FOSODE = Social Development Fund; ENEE = National Electric Energy Company; IDB = Inter-American Development Bank; CAF = Corporación Andina de Fomento; BCIE = Central American Bank for Economic Integration; GEF = Global Environmental Facility; GCF = Green Climate Fund; CIF = Climate Investment Funds; SECCI = Sustainable Energy and Climate Change Initiative; LACIF = Latin America and Caribbean Investment Facility; H-REFF = Honduras Renewable Energy Financing Facility; GIZ = Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH; KfW = KfW Development Bank; JICA = Japan International Cooperation Agency; AECID = Spanish Agency for International Development Co-operation; ICDF = International Cooperation and Development Fund of Taiwan.

National financing institutions

FOSODE

The General Law of the Electricity Industry specifies the creation of the Social Development Fund (FOSODE), administered by ENEE. This fund finances studies and electrification infrastructure using capital contributions from distribution companies equivalent to 1% of total electricity sales. As a complement to these contributions, the government injects HNL 15 million (roughly USD 600 000) annually to the fund.

ENEE

ENEE has an Energy Investment Program to develop and strengthen the power sector infrastructure. This programme comprises loans (80%), donations (10%) and the company's own resources (8%). Most of the investments are allocated to the construction, operation and maintenance of hydropower plants; energy integration (SIEPAC); rural electrification; and transmission systems. Loans and donations derive mainly from contracts and/or agreements with the Central American Bank for Economic Integration (CABEI), the IDB and Japan International Cooperation Agency (JICA) (Finance Secretariat, 2021).

Private banking

Honduras has a well-developed banking system that finances renewable energy infrastructure. Private banks such as Atlántida uses credit guarantees from CABEI to offer financing mechanisms for renewable infrastructure development (CABEI, 2012). The approval of loans for developing energy projects is a common

practice in the banking sector, which increases local financing capacity and dilutes risk. The experience in financing projects in the electricity sector has led Honduran bankers to integrate guarantees in loans to bring comprehensive components that include much more than the valuation of pledged fixed assets. The banking system shows a clear preference for projects backed by construction contracts (engineering, procurement and construction, or EPC, contracts) signed with long-standing construction companies, and for projects backed by formal PPAs.

International financial institutions

Multiple banks and multilateral funds are available in Honduras for developing renewable energy and energy efficiency. These entities have high credibility in fiduciary and risk management that allows creditors to access the funds at relatively low costs, transferring this benefit to investments. Multilateral funds are constituted as a financial intermediary that channels the resources of large investors towards the public and private sectors. Table 11 describes the applicable funds for the financing of investments in renewables and energy efficiency.

Table 11 Multilateral funds financing renewable energy and climate action in Honduras

Fund	Stated objective	Partners working in Honduras
Global Environment Facility (GEF)	Provides grants and blended finance for options to support initiatives pertaining to biodiversity, climate change, international waters, land degradation, sustainable forest management, food security and sustainable urban development in developing nations.	World Bank, IDB, CAF, UNDP, UNIDO, UNEP
Green Climate Fund (GCF)	Supports developing nations in their efforts to implement adaptation and mitigation measures aimed at addressing the challenges posed by climate change.	World Bank
Climate Investment Funds (CIF)	Facilitates the acceleration of climate action by empowering transformative changes in clean technologies, improved energy access, enhanced climate resilience and sustainable forest management practices within developing and middle-income countries.	World Bank, IDB
Sustainable Energy and Climate Change Initiative (SECCI)	Finances activities aiming at expanding investment in renewable energy and energy efficiency technologies, enhancing access to carbon finance, and integrating climate change adaptation measures across various sectors in Latin America and the Caribbean.	IDB
Latin America and Caribbean Investment Facility (LACIF)	Helps Latin American countries finance projects aimed at attaining the Sustainable Development Goals, such as energy, environment, water, transport and support to small and medium-sized enterprises.	AECID, KfW, CABI, CAF, IDB
Honduras Renewable Energy Financing Facility (H-REFF)	Provides financing to projects that utilise solar, wind, biomass, biogas and energy-efficient technologies across Honduras, Guatemala, El Salvador and Nicaragua.	GEF, IDB

Based on: GEF Agencies, www.thegef.org/partners/gef-agencies, CIF Funding, www.cif.org/cif-funding, IDB SECCI Funds, www.iadb.org/en/climate-change/secci-funds, LACIF, www.eulaif.eu/es/home and H-REFF, <https://deetkenimpact.com/sustainable-energy/#funds>.

International entities have made available long-term financing for renewable energy infrastructure and its application in industrial initiatives in Honduras. Multilateral development institutions, including the IDB, CABEL, and the World Bank, play significant roles in the development and project financing landscape of Honduras. Affiliated organisations such as the Inter-American Investment Corporation (IIC) and the International Finance Corporation (IFC) contribute to these efforts as well. Moreover, the US International Development Finance Corporation (DFC) actively engages in the Honduran market, making investments across various sectors such as energy, health care, critical infrastructure and technology.

Development banks provide loans, technical assistance and guarantees for the repayment of loans. These banks have several financial instruments with attractive conditions to finance energy projects that may be difficult to develop under private credit market conditions, and act as catalysts of third-party resources, such as the multilateral funds mentioned in Table 11 (Arbache and dos Santos, 2020). Other multilateral and bilateral institutions assisting Honduras in the development of renewable energy include the Development Bank of Latin America (CAF), the European Investment Bank (EIB), the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ), Germany's KfW Development Bank, JICA, the Spanish Agency for International Development Cooperation (AECID) and the International Cooperation and Development Fund (ICDF) of Taiwan.

The existing financing platforms for the development of renewable energy face relevant debt constraints. In 2015, Honduras reached debt levels that prompted the approval of the Fiscal Responsibility Law (LRF) of 2016 to set a deficit ceiling for the non-financial public sector of no more than 5.6% of GDP. In 2021, the first quarter public debt reached USD 14 655 million, and it was financed by 55.7% (USD 8 163 million) of external debt (IDB, CABEL, the World Bank and commercial banks). The law aims to limit the balance of the total public debt of the non-financial public sector as a share of GDP from exceeding 55%, leaving USD 581.7 million as a ceiling for contracting new external financing for 2021, and USD 350 million for each year of the 2022-2024 period. After the impacts of the COVID-19 health crisis and hurricanes Eta and Iota, in 2021 the government gave greater priority to new public debt investments to sanitation (57% COVID-19 pandemic and 26% water and sanitation) and reconstruction of critical infrastructure (17% modernisation of the state) (UNDP, 2022b).

Multilateral support

One year after Hurricane Mitch (1998), international institutions working in Honduras created the G-16 Group to co-ordinate multilateral and bilateral co-operation. The G-16 comprises delegates from 15 countries, 3 development banks, and 4 multilateral organisations, functioning across four distinct tiers: heads of mission, heads of co-operation, technical-sectoral roundtables and a secretariat. Each level of the group engages in political, economic and technical dialogues with the government, civil society, the private sector and academia. Currently, the G-16 is focused mainly on critical national concerns, including COVID-19 pandemic management, economic revitalisation, the state of the electricity sector, proposed reforms for its enhancement, job creation, poverty reduction initiatives, climate change adaptation and the development of resilient cities.

Currently, the IDB has an active portfolio in Honduras of USD 1421 million, directed mainly to social investments, energy, the environment and natural disasters. The IDB is implementing three energy-related investments seeking to improve the existing hydropower infrastructure, strengthen transmission systems and increase energy access in rural areas (IDB, 2023). The World Bank manages 13 investment projects totalling USD 984 million targeting the enhancement of rural competitiveness, social protection, health, water and sanitation, food security and disaster risk management (World Bank, 2023a), while its investment agency, the IFC, finances investments in sustainability and has four active loans directed to power plants using renewable energy (IFC, 2023).

The CIF implements the Renewable Energy Expansion Program (SREP), the Pilot Program for Climate Resilience (PPCR) and the Forest Investment Program (FIP). The SREP investment plan includes USD 45 million to improve the transmission infrastructure connecting renewable energy, increase deployment of wind and solar energy in isolated locations, promote low-carbon cookstoves, and support policy and regulatory reforms (CIF, 2021). ICDF Taiwan has eight projects supporting the development of the health system and the agricultural and forestry sectors.

CABEI manages investments of USD 1632 million, allocated towards operations related to social development, energy and environment. In the energy sector, CABEI helps to reduce losses in the electricity system through a USD 250 million policy loan that comprises measures such as the implementation of the National Plan to Reduce Electricity Losses, focused allocation of subsidies to electricity tariffs, initiatives to expand electricity access, promotion of electric mobility, modernisation of El Cajón Hydroelectric Power Plant, expansion of transmission infrastructure, and the implementation of adaptation and mitigation measures in accordance with the Paris Agreement (CABEI, 2023).

GIZ's co-operation is oriented, among others, to rural development and sustainable infrastructure through technical assistance promoting renewable energy and energy efficiency (GIZ, 2022). The AECID has supported the regional integration of Honduras since 2001, directing its co-operation towards activities that contribute to social welfare and economic growth, institutional strengthening and democratic governance, resource sustainability, and reducing environmental vulnerability, among others (AECID, 2021). Lastly, The Government of Japan through JICA provides technical assistance and loans in sustainable development and focuses its efforts on reducing poverty, improving the industrial structure, and strengthening the capacity to prevent and respond to natural disasters that periodically affect Honduras (Embassy of Japan, 2021).

Investment conditions

Honduras is poised for strong economic growth and development. Foreign direct investment (FDI) inflows into the country have maintained an average of 5.6% of GDP over the last two decades, surpassing the regional average of 3.2% (IFC, 2022). Honduras' abundant natural resource reserves and a progressively favourable business environment have successfully attracted increasing levels of private investment. These factors have also contributed to the country's attainment of the second highest trade-to-GDP ratio in Latin America and the Caribbean, prior to the onset of the COVID-19 crisis.

Despite notable advancements by the government in fostering economic openness, the development of the private sector continues to face limitations due to a frail regulatory framework and business environment. The private sector has difficulties accessing the financing necessary for infrastructure projects. Honduran enterprises identify intricate tax policies and burdensome tax administration as the primary obstacles to conducting business, followed closely by security concerns related to crime and violence. Limited access to financial mechanisms, especially for micro, small, and medium-sized enterprises, poses additional challenges. Inadequate infrastructure, particularly pertaining to road networks and public utilities, further hampers business operations. An insufficiently skilled labour force and weak rule of law, coupled with policy uncertainties and governance-related concerns, also contribute to the prevailing constraints in the country.

3.6 Opportunities for renewable energy development

Honduras has promising advantages to further develop its renewable energy resources. The country possesses a variety of exploitable natural resources (water, sun, wind and geothermal). It also has a legal framework for modernisation that can attract new investments in renewable energy projects, fulfilling national and international social and environmental safeguards and reaching competitive prices that are akin to projects in the region. Since 2011, the country has gathered key lessons on incentives and social and environmental issues related to the deployment of renewable energy projects, working with the private sector, which is guiding current energy reforms and will help to design new policies in the years to come.

Honduras has enabling policies and useful experiences supporting the development of renewable energy in the electricity industry and its adoption in the productive sectors. National commitments to achieve the UN Sustainable Development Goals (SDGs) pledge an expansion of the renewable energy share in total electricity generation to 68.4% by 2026, while the National Plan and Country Vision foresee increasing the participation of renewables in the energy mix to 80% in 2038.

These ambitions require greater technological diversification and have the potential to reduce electricity generation costs. This will enable the adoption of energy-efficient systems and technologies, such as smart mini-grids, distributed generation and electric vehicles.

Comprehensive projects such as multi-purpose water reservoirs offer benefits to local communities and farmers (through flooding prevention and water supply) and add installed capacity in the electricity sector. These initiatives are geared towards enhancing resilience against climate change.

Meanwhile, the use of renewable energy to power charging stations for electric vehicles may reduce the country's reliance on fossil fuels. Coupled with distributed generation in local communities, this approach provides an alternative to meet the objectives of the National Rural and Social Electrification Program. This, in turn, can decrease poverty, elevate the quality of life in rural areas, and better integrate communities.

3.7 Professional and institutional capabilities

Honduras has a network of universities supporting regulatory institutions and policy makers to tackle the most difficult challenges in energy and climate change. Local energy degrees train students with advanced expertise in renewable energy and environmental matters, empowering them to take effective action in leadership roles within governments, businesses and civil society. Meanwhile, post-graduate programmes encompass a range of specialised disciplines such as energy management, planning, energy technology, and energy automation, as well as electrical and electronic engineering at the master's and doctoral levels.

Universities knowledgeable on renewable energy include the Autonomous University of Honduras – UNAH (Electrical, Forestry, Agro-industrial Engineering); Polytechnic University of Honduras (Electronic Engineering); Central American Technological University of Honduras-UNITEC (Energy Engineering, Master in Renewable Energy Management); Polytechnic University of Engineering (Renewable Energy Engineering); Central American Technological University-UNITEC (Energy Engineering); and the National University of Forestry Sciences (Forestry Engineering, Master's in Renewable Energy Management).

Zamorano Renewable Energy Center leads activities on energy efficiency and renewable energy technologies and provides knowledge to integrate and optimise energy systems. The Center works in three main areas: biofuels, alternative energy technologies and policy making. Part of its activities include test and research pilot projects on the use of biogas from agricultural residues for electricity production, biodiesel production,

energy markets, development of solar technologies, improved energy performance of wood-fuel stoves, and the enhancement of skills and capabilities in using renewable energy in the agricultural and forestry sector (UNEP-REGATTA, 2023).

Lastly, the Special Unit for Renewable Energy Projects (UEPER) within ENEE has the knowledge and capacity to implement large projects and provide technical assistance. UEPER works in co-ordination with other ENEE divisions and energy-related organisations, collaborating to formulate programmes and initiatives that enhance energy access and support the implementation of renewable energy solutions for households, businesses and institutions. Its core responsibilities include planning, design, supervision, construction, operations, and ensuring compliance with social and legal procedures (ENEE, n.d.).

Support on capacity building from international co-operation is based on agreements to provide technical training to professionals from ENEE and SEN.¹³ For example, the Latin American Energy Organization (OLADE) has been offering Virtual Energy Training Courses (CAPEV) focused on energy planning and energy balances since 2008, while in 2018 CABEI financed an academic programme at the National University of Forestry Sciences (UNACIFOR) to strengthen local research capacity and technology transfer.



¹³ Current agreements include those with OLADE, CABEI, IDB and IRENA.

4 Challenges and recommendations

The Honduran government has set ambitious goals to address urgent needs around poverty reduction and fair economic development. In the energy sector, the targets indicated in Decree 46-2022, the “Special Law to guarantee the service of electric energy as a public good of national security and a human right of economic and social nature”, are consistent with the government’s current ambitions. These targets demand that public and private energy institutions increase their efforts to promote inclusive development that is respectful of human rights and consistent with the goals of reducing poverty, achieving universal access to energy, empowering local communities, creating well-paying, dignified, caring and fair jobs, advancing environmental and social justice, and improving the health and security of communities across Honduras.

As part of its support for these national efforts, IRENA framed its analyses and recommendations based on current government priorities. For this purpose, a series of interviews were conducted with key stakeholders in the national energy and climate-related sectors, which have helped to gain a better understanding of the challenges affecting institutions, regulations, communities, investors and the country in general. In addition, opportunities were identified to provide decision makers and government leaders with the specific information and actions required to translate these challenges into necessary actions, policies, regulations, budgets and management decisions to meet government expectations and, most important, the expectations of the Honduran population.

This section summarises the main recommendations to help accelerate the deployment of renewable energy in Honduras. These suggestions are derived from the obstacles identified through the Renewables Readiness Assessment (RRA) procedure.

4.1 The role of energy sector institutions and governance

The Electric Energy Regulatory Commission (CREE) plays an increasingly important role in delivering economic and social objectives in the electricity sector. In addition to overseeing the main activities of the sector, CREE is responsible for establishing regulations and ensuring compliance with them. Meanwhile, other activities within the energy sector, such as those related to hydrocarbons, biofuels, geothermal energy, firewood, and water, are overseen by secretariats or ministries working with limited regulatory capacities in terms of human resources and budget.

In the last five years, the Energy Secretariat (SEN) has gained capacity in crafting energy policies, preparing national energy plans and modelling energy scenarios in the areas of electricity, energy efficiency, renewable energy and hydrocarbon regulation. Nevertheless, SEN faces difficulties promoting policy coherence across public institutions and enhancing political and administrative mechanisms and tools for the government to harmonise action towards sustainable development, systematise dialogs with local communities and create local capacities to empower under-served communities for the development of renewable energy projects.

Regarding the operation of the electricity system and market, the National Dispatch Center (CND) has responsibilities in the operation and management of electricity dispatch. As established by Law 46-2022, the CND is a public capital entity managed by ENEE, and it is still adjusting its structure and procedures. Given the limitations in infrastructure and tools to manage the variability and uncertainty of wind and solar energy, as well as transmission line congestion, the CND makes complex decisions to preserve system stability, which under certain conditions result in economic and operation inefficiencies in the dispatch operations, and also environmental impacts. Because the CND's mandate focuses on providing reliable electricity at the lowest cost, the system co-ordinator requires guidance and direction for assigning responsibility as well as the authority to pursue the decarbonisation and long-term climate resilience of the electricity system, thereby preventing the promotion of trust and transparency in the actions taken.

There is a broad consensus in the Honduran government about the essential role of the state in guiding the adoption of renewable energy and ensuring energy access as a human right and proper responses to emergencies. The Natural Resources and Environment Secretariat (SERNA), together with SEN, recently validated the country's climate change commitments outlined in the NDCs. They also ensured the alignment of Energy Compacts with long-term development strategies such as electricity access, electro-mobility, green hydrogen, low-temperature solar technologies (such as heat collectors for water heating, among other technologies promoting the expansion of renewables beyond the scope of the electricity industry). Nevertheless, the evolving infrastructure institutions face difficulties co-ordinating their policies in areas where mandates are shared across secretariats and agencies, which is a particularly salient barrier for developing environmental, climate and energy policy.

SEN centralises the development, proposal process and evaluation of public policies related to energy. However, the Secretariat has limited capacity to oversee cross-cutting programmes that can advance the adoption of renewables outside the electricity industry. Recent energy legislation has defined the provision of electricity services as a human right (Decree 46-2022), which requires a robust implementation capacity and acute co-ordination with other government secretaries to bring energy to the 1.5 million Hondurans who currently lack access to electricity (SEN, 2020) and for whom renewable energy can play a key role in meeting access needs. Government secretariats and agencies working in under-served communities implement programmes for climate-resilient housing and public infrastructure, health and education that can benefit from a closer co-ordination with SEN to design and implement broader development strategies to tackle the interlinked aspects of poverty.

The government has set as a priority the promotion of inclusive economic development by leading dialogues on energy planning with local communities, in particular with indigenous peoples in areas with a high potential for renewable energy. Despite the increased public consciousness around the historical injustices faced by the indigenous and Afro-descended Honduran population, along with government efforts to reconcile with this past, there are perceptions in some economic sectors and communities that indigenous people create a climate of conflict when different perspectives about land and resources arise. Local communities, however, are facing an imperfect system that has a modest capacity to enforce environmental and social safeguards and that is partial to sectors that have a different set of priorities, thus leading to conflict and division. As a result, public and private renewable energy projects and other infrastructure developments exploiting natural resources and using local land are either repelled or face complicated dialogues with local communities around energy expansion plans and agriculture industry development, among other issues.

Action 1. Define responsibilities and regulatory functions to existing energy entities for renewable energy applications beyond the electricity sector that currently lack regulations and regulatory entities.

The primary objective of this action is to bolster the prospects for significant and reliable investments in renewable energy. By clearly defining new institutional responsibilities and regulatory roles, especially concerning biofuels, biomass, geothermal energy, waste-to-energy, and green hydrogen, the country can create a robust, comprehensible and actionable framework. This refined regulatory landscape is intended not only to attract reputable investors, developers, and utilities, but also to drive a transformative shift in the market. For example, multiple countries in the region are developing green hydrogen strategies and roadmaps, which will allow them to identify the potential, opportunities and challenges in developing a green hydrogen industry. Many of the identified challenges can be overcome through technological innovation, while others can be solved by regulation and business model development (IDB, 2023).

Case studies worth exploring:

- **Green hydrogen in Chile.** The Ministry of Energy of Chile is developing the Green Hydrogen Action Plan 2023-2030. This inclusive approach involves community engagement, industry representatives, academic institutions and public institutions.
- **Geothermal regulation in El Salvador.** El Salvador has invested significantly in geothermal energy, which accounts for around 25% of the country's electricity generation. The regulatory framework has been pivotal in guiding safe and efficient development.
- **Biomass regulation in Argentina.** Argentina's National Bioenergy Program, launched in 2016, focused on promoting biomass and biogas energy production.

Guidelines for implementation:

- Before introducing new regulatory functions, conduct a thorough assessment to determine the existing strengths and weaknesses of energy-related entities.
- Encourage collaborative actions among regulators across sectors such as energy, climate action, water and transport. This can be facilitated through joint workshops and task force teams to share knowledge and best practices.
- Periodically evaluate institutional performance and adapt regulations as necessary to respond to technological advancements and market changes.
- Training programmes should be developed in conjunction with academic institutions to ensure that regulatory staff understand stakeholder, legal and market issues.

Action 2. Increase the independence of decision makers and institutions responsible for the power system operation and the electricity dispatch administration in the national electricity market.

If the CND and energy institutions controlling and managing the power systems lack complete autonomy in their decision-making process, planning choices will be subject to short-term agendas rather than incorporating long-term commitments that can benefit both the public and private sectors. The need for institutional resilience is especially acute in Honduras' energy sector. Since public administration is a hierarchical system, the resilience of ENEE influences the resilience of the CND. Renewable resources that generate variability and intermittency, among other factors, are creating operational challenges for the system administrator, which, in principle, should undertake neutral and autonomous decision-making processes.

Unlike traditional generation, it is not possible to forecast renewable energy output with great accuracy, and most renewables are not responsive to dispatch instructions but to climate conditions. In the past, the electricity generation mix comprised conventional technologies that operated based on demand signals, with this being the main source of variation in production, where the level of generation would increase or decrease to balance the system. Nowadays, the high participation of some renewable generation sources adds variability that also needs to be balanced with fast-response technologies for smoothing supply drops and electricity curtailment when an unplanned overproduction of electricity occurs. Renewable energy contracts generally pay for as much energy as the resources can produce even when the system does not need it or faces important additional costs and losses from congested transmission lines.

Additional actions could include strengthening the regulator to ensure that the CND's decisions are disconnected from any public asset ownership and that decisions are made in the best interests of all users while increasing transparency and promoting competition. There are several examples of public sector system operators in countries across Europe that the government may want to consider when formulating a strategy to reduce and eventually eliminate the CND's affiliations or financial involvement in the electricity market.

Action 3. Expand the Energy Secretariat's policy implementation capacity.

Accelerating renewable energy projects characterised by uncertainty and complex dialogues with local communities requires concerted, adaptive and transparently managed approaches. The Secretariat can improve its policy implementation capacity by defining a strategy to overcome at least the following five clusters of challenges:

1. **Local specificity and governance.** This involves the interlinkages drawn from the governance and social matters that are intertwined with local issues, encompassing aspects such as local strategies, knowledge systems, social frameworks and partnerships.
2. **Complexity and multiplicity of factors.** Issues in this cluster are cross-cutting. These findings exemplify the intricate nature of the numerous challenges connected with the energy policy implementation, such as the interlinkages of poverty, local opposition to renewable energy projects, the complexity of the processes affecting renewable energy implementation and unbalanced linkages between economic and environmental goals.
3. **Technological challenges.** These challenges revolve mainly around technological factors related to meeting the consistently increasing energy demand by leveraging advanced yet established and sustainable energy technologies, along with enhancing grid infrastructure.
4. **Environmental and social concerns.** This cluster of challenges is dominated by the interest in preserving the environmental and social surroundings, as well as the uncertainty associated with the development of renewable projects. It also addresses the promotion of a virtuous and positive relationship between entrepreneurship and sustainable development.
5. **Economic opportunities and competitiveness.** These issues are mainly associated with economic aspects, such as economic opportunities for under-served areas, subsidies, local renewable energy markets and niches. SEN can seek support from multilateral institutions and Climate Investment Funds (CIF) frameworks through a structured approach such as the following:
 - **Research and analysis:** Begin by conducting a comprehensive assessment of the requirements and opportunities in under-served areas, the potential of local renewable energy markets and relevant niches. This will provide evidence for decision making and attract potential developers.

- **Engagement strategy:** Identify the key multilateral institutions and specific working groups within the CIF framework that align with SEN's objectives. Crafting a targeted engagement strategy will increase the possibility of successful collaboration.
- **Technical assistance proposals:** Develop detailed technical assistance proposals highlighting the areas of support needed. Clearly articulate how such assistance will foster economic opportunities, reshape subsidies and accelerate the deployment of renewable energy.
- **Highlight indigenous integration:** Emphasise the importance of integrating indigenous peoples in these initiatives. By showcasing the potential social, economic and environmental benefits of this integration, SEN can underscore the value and urgency of their request.
- **Partnership models:** Propose models of partnerships with academia, think tanks and experimental facilities. Define clear roles, responsibilities and expected outcomes from each partnership to demonstrate readiness to potential supporters.
- **Showcase innovations:** Detail the infrastructure and process innovations that are envisioned, ensuring that they align with the broader objectives of multilateral institutions and CIF frameworks. Demonstrate how these innovations can lead to tangible benefits, both in terms of renewable energy deployment and in valorising results for national economic development.
- **Regular reporting:** Ensure a system of regular updates and reporting on progress, challenges and successes. This transparency will help foster further support in the future.

Action 4. Build the institutional capacity to run a national programme directed towards public and private developers specialising in renewable energy and energy efficiency.

This programme should mirror the ambitious investment targets and actions for under-served communities set by Decree 46-2022 and realistically weight the budget and labour capacity necessary for quick results, addressing urgent issues, such as providing electricity access to 1.5 million people, while empowering local communities in the development of small-scale projects. SEN and SERNA have expertise and professionals trained in low-carbon technologies, but they are constrained in what they can implement in terms of rural electrification and direct renewable energy use in transport, industrial, commercial and residential decarbonisation.

A national programme would work closely with agencies, the public and private sectors, and partner organisations to co-ordinate inter-agency working groups; promote research on renewable energy technologies, business models and financing mechanisms; and develop energy projects that can accelerate the deployment of investments in energy access and decarbonisation initiatives while promoting technological innovation and public-private partnerships. A specialised programme that provides advanced energy services to enterprises could have a major responsibility for training the workforce, strengthening the government's capacity for increasing renewables in the energy mix, increasing co-operation among stakeholders, building knowledge of innovative business models and certifications, managing future investment programmes and providing technical support on projects empowering local communities.

Case studies worth exploring:

- **Solar Women of Totogalpa, Nicaragua:** This co-operative focuses on the construction, use and improvement of solar technologies, along with international technology exchange around them. In the case of Totogalpa, a group of women received training in India on solar panel installation and maintenance. Upon return, they electrified their communities, providing sustainable energy solutions and reducing dependency on harmful kerosene (UNFCCC, 2023).

- **Brazil's pico hydropower projects:** Back in 2000, most of the hydroelectric systems were artisan-built and -designed to support specific rural electrification projects with installed capacity from 300 W to 2 000 W and tailored to the steady-flow rivers of Central Brazil that have maximal differences in water level of less than a metre. With the National Electrification Project ("Light for All"), the Brazilian government supports pico-hydro systems with the objective of enabling communities to generate electricity sustainably, and offers an affordable and renewable solution, promoting local employment and knowledge transfer. As the technology matured and stabilised, innovative concepts and methods emerged, concentrating on enhancing production scale. Simultaneously, fresh strategies were developed to increase the technology's accessibility and to mainstream its use.

Guidelines for implementation:

- Establish a national programme for renewable energy developers, aligned with Decree 46-2022, prioritising urgent energy access needs.
- Strengthen collaboration among SEN, SERNA, agencies and the private sector to expedite research and renewable energy project deployment, aligning with NDC commitments, the SDG targets and national decarbonisation goals.
- Establish a dedicated department within the programme to enhance workforce skills in renewable energy, advance business strategies for programme effectiveness and provide technical guidance for community-focused renewable projects.
- Leverage insights from proven case studies such as the Solar Women of Totogalpa and Brazil's pico hydropower projects to guide programme implementation.

Action 5. Create governance pathways, such as deliberation and consultation mechanisms, to systematise community participation in the renewable energy planning process.

A social agenda for enhancing energy governance can include regulations to implement deliberation programmes and consultation mechanisms for removing barriers or discriminatory attitudes and behaviours, thereby ensuring the active engagement of individuals in social, economic, political and civic domains. Communication among stakeholders has been shown to reduce hostility and dehumanisation across groups (Cameron, 2019), while deliberation processes can prevent polarisation; they are one of the essential means of gaining recognition from local communities.

The government can prepare a framework for strengthening planning, regulatory and negotiation skills in energy institutions to ensure that there are clear rules and regulations promoting civil deliberation and inclusive and participatory dialogues with indigenous peoples and communities located in rural areas. This also involves mapping key stakeholders to engage in a collective sense of commitment to the development of renewable energy and to instilling a culture of deliberation. Deliberation with indigenous peoples is especially important for enabling public reasoning or socialisation in an inclusive way, thus ensuring that ideas can be put forward by all groups, irrespective of political, economic or other status. The framework might include actions to balance expectations for faster, continuous adaptation, with a call for more inclusive policy making and transparency in all the stages of the decision-making process.

Action 6. Ensure and enhance compliance with social and environmental regulations.

The government can use the IFC performance standards as a benchmark for mapping urgent regulatory gaps when strengthening environmental and social rules for the development of energy projects, including mandatory requirements for permits and certifications issued by local governments. The creation or strengthening of a regulatory framework that ensures compliance with environmental and social regulations can be underpinned by the lessons learnt from multilateral institutions and incorporate principles of transparency on decision making, regulatory formulation or adjustment of existing ones using disaggregated data that allow a better understanding of the seasonal variations of natural resources.

Additionally, legal provisions can be included to define ways for the participation of key stakeholders in decisions related to infrastructure projects that affect local natural resources, indigenous peoples, labour, land acquisition and resettlement, biodiversity and community heritage. Environmental and social regulations cut across sectors and involve many ministries, agencies and departments. Therefore, effective governance requires that institutions be given mandates that are straightforward and transparent in detailing jurisdiction, goals, and authority, and that are co-ordinated with other institutions.

Case studies worth exploring:

- **From policy to practice in Paraguay – experiences and challenges in the application of operational policies related to indigenous peoples:** There are 19 indigenous groups in Paraguay, divided into 493 communities and 218 villages. A total of 117 150 indigenous people are distributed across 13 departments in the country. In Paraguay, a consultation and development process was successfully implemented that involved indigenous communities actively participating in culturally appropriate ways. The sociocultural perspective, which prioritised community participation and incorporated a gender approach, resulted in more effective organisational and management outcomes. Collaboration among institutions and across disciplines was crucial for addressing the needs identified in the territory and ensuring the success of any strategies that were implemented.
- **Biodiversity conservation in Peru:** Germany's KfW Development Bank, in collaboration with the Peruvian government, initiated a programme for the conservation of biodiversity in the Andean region of Peru. This programme not only protected the unique ecosystems but also ensured that infrastructure projects, such as roads and dams, were developed with sustainability and minimal ecological disruption in mind.
- **Low-carbon coffee Nationally Appropriate Mitigation Action (NAMA) in Costa Rica:** The programme reinforces Costa Rica's commitment to social and environmental standards. By championing low-carbon coffee production techniques, it prioritises sustainable agriculture, safeguarding soil health and minimising water and chemical use. Moreover, it strengthens community capacities through training, ensuring both environmentally conscious farming and the promotion of fair working conditions, elevating social responsibility in the coffee value chain.

Guidelines for implementation:

- Adopt international benchmarks such as the IFC's Performance Standards on Environmental and Social Sustainability to identify regulatory gaps in environmental and social norms for energy developments. Ensure alignment with these global standards and emphasise transparency and use disaggregated data for understanding natural resources.
- Streamline permit processes establishing standardised procedures for mandatory permits and certifications. Local governments should oversee processes to ensure alignment with local needs.

- Encourage stakeholder participation by creating a legal framework that ensures key stakeholder involvement in infrastructure decisions. Address concerns like labour, land rights, biodiversity and cultural heritage.
- Co-ordinated institutional governance: Clearly co-ordinate mandates across ministries, agencies and departments. A central co-ordinating unit can be established to oversee alignment, complemented by inter-agency communication platforms for streamlined decision making. A unified regulatory framework, recognised by all involved institutions, ensures a harmonised interpretation of rules. Joint training sessions can further standardise approaches, while feedback mechanisms and stakeholder consultations refine processes and align strategies with on-the-ground realities. Lastly, periodic reviews of this governance model ensure its ongoing effectiveness, adaptability and relevance in addressing evolving social and environmental challenges.
- Extract insights from case studies, such as those from Paraguay, Peru, and Costa Rica, and integrate their successful practices into the national regulatory context.
- Prioritise institutional capacity enhancement, collaborating with seasoned global entities for training while emphasising the importance of public awareness and establishing a system for feedback and regular regulation assessment.

Action 7. Create co-ordination groups for effective oversight of new institutional responsibilities.

In order to achieve a cohesive and sustainable implementation of inclusive policies, it is imperative for the government, following the guidelines of the Strategic Planning Secretariat, to establish co-ordination groups to oversee new institutional responsibilities. By co-ordinating efforts at various levels of government, vertical co-ordination can prevent institutional overlap and identify opportunities for cost-effective deployment of renewable energy and low-carbon technologies. Empowering local governments to spearhead energy projects that enhance quality of life for citizens while also supporting economic growth is a key benefit of this approach.

National groups such as the Asociación de Municipios de Honduras (AMHON) can provide validation for renewable energy plans, while SEN, in co-ordination with SERNA, can develop new guidelines for regulations and monitor interinstitutional co-ordination. To ensure consistency of policy, public institutions can be required by law to co-ordinate their renewable energy plans and policies with local governments and indigenous communities. In addition, inter-institutional co-ordination on energy efficiency can be reactivated or strengthened by focus groups tasked with developing guidelines for the reduction of energy waste and promoting climate resilience. These groups can leverage research, public funding and stakeholder engagement to achieve an equitable, productive and sustainable energy system across various sectors including buildings, transport, water, agriculture and food production.

Energy policy and regulatory framework for the renewable energy sector

The NDC and national energy guidelines specified in Decree 46-2022 share actions and policy priorities in three major areas in which renewable energy infrastructure plays a crucial role: 1) promoting inclusive social and environmental justice in energy sector development, 2) guaranteeing access to electricity as a human right and 3) developing renewable energy projects that involve the multi-purpose use of infrastructures such as flood control, irrigation and power generation. However, the plan outlined in the Energy Roadmap 2050 is

an input for the country's energy policy, and has its objectives disconnected from clear budgets associated with initiatives aiming to increase the integration of renewable energy sources in the energy mix.

Furthermore, the budgets mentioned in the energy policy have not been fully implemented to date. Similarly, the objectives and actions of the NDCs are detached from financing funds, human resources and the institutions responsible for achieving climate change targets. The Energy Roadmap 2050 and the NDC overlook key aspects of renewable energy applications, such as the development of multi-purpose infrastructure and initiatives to increase energy access, such as mini power generation, energy crops, and mini-grids developed and managed by local communities.

The energy planning process includes the use of modern modelling tools to construct forward-looking policies that serve as guiding principles for the future trajectory of both local and national energy systems. Nevertheless, the energy plan lacks the political agreements that will ensure resilience to political changes in the country's administration. Also, the current scope of the planning excludes issues such as the significance of electrification across end-use sectors and the imperative to adopt technologies that enhance flexibility in the power sector (for distributed generation), and the assessment of stability and weaknesses in power grids when increasing variable renewable energy sources.

National ambitions and intentions to accelerate renewable energy use seem to be pointing in the right direction. But the government should undertake an in-depth review of the consistency of policy ambitions with the likely outcomes of existing energy programmes. For example, Honduras requires a long-term investment plan that identifies a financing mechanism to comply with the provisions of Decree 46-2022 indicating that private sector investments cannot exceed public sector investments. Furthermore, indigenous peoples and local communities are expected to play a role in the rights to land use for energy development, but neither the energy policy nor the regulatory framework indicates clear actions on communication or pathways to encouraging social participation.

The 2007 Law for the Promotion of Electricity Generation with Renewable Resources (Decree 70-2007) and subsequent reforms paved the way for promoting low-carbon technologies and renewable energy (Republic of Honduras, 2007b). This law signalled the country's interest in creating conditions favourable for attracting investments and a willingness to integrate renewable energy within institutional development strategies and specialised teams. However, some laws are under-enforced due to a lack of regulations and implementation mechanisms, such as strengthening the existing process of tariff definitions for energy producers that operate in areas that go beyond the conventional electricity industry (e.g. distributed generation), provisions promoting renewable energy with larger influence than only the electricity industry, and compensation schemes affecting prosumers (power producers in the residential sector), mini-grids and distributed generators.

Further, recent changes to legal incentives and PPA conditions (Decree 46-2022) addressed the onerous capacity and expense of energy in comparison to other countries in Latin America; nevertheless, these amendments face resistance from current energy stakeholders and brought uncertainty about the construction of planned energy infrastructure in the short term. These modifications are perceived as immediate risks that can lead to increased financing expenses and diminished investment returns. On the other hand, obsolete cross-cutting regulations increase the complexity and overall burden of the regulatory framework. For example, water concessions on some kinds of residual waters lack definitions and provisions regulating the volume of consumption for energy purposes.

Action 1. Strengthen national public policy implementation mechanisms targeting climate goals and renewable energy transition.

Existing policies can employ mechanisms such as investment vehicles and regulatory frameworks tailored for the power sector, ensuring alignment with Decree 46-2022 provisions indicating that the private sector investments cannot exceed public sector investments. Addressing barriers and incorporating both public and private financing programmes can enhance conditions to attract investments, fast-tracking projects outlined in the Indicative Generation Expansion Plan while empowering local communities. Furthermore, adopting new innovative climate leverage mechanisms, along with the development of a renewable energy integration model, can help align the current efforts with the NDCs. This approach not only complies with national climate commitments, but also positions the country as an attractive destination for investment in climate-related projects.

Case studies worth exploring:

- **Costa Rica's policy on carbon neutrality by 2050.** Costa Rica aims to achieve total carbon neutrality through a combination of reforestation efforts and a transition to renewable energy. The Decarbonization Plan (2019) lays out Costa Rica's strategy to modernise its transport, energy, industry and waste sectors. Key elements include expanding the electric rail system in urban areas and promoting electric vehicle adoption. The country already derives nearly 100% of its electricity from renewable sources, mostly hydropower.
- **Successful transition to renewables in Uruguay.** From 2006 and 2020, Uruguay increased its share of renewables in the energy mix from nearly 1% to around 64%. The following policies and actions accelerated Uruguay's adoption of renewable energy during this period.
 - Energy Policy 2005-2030: Established ambitious goals to increase renewable sources in the national energy mix.
 - Decree 77/2006: Set fiscal and tariff incentives for renewable energy generation.
 - Law No. 18.585 (2009): Promoted distributed generation by enabling users to produce energy and sell excess to the grid. Also facilitated a trust fund.
 - Long-term contracts with private investors: The state company UTE secured contracts to purchase energy from wind and solar projects, ensuring demand and stability for investors.
 - Sustainable rural electrification programme: Extended renewable electricity access in rural areas and fostered collaboration for exporting and importing energy.

As an example, Honduras could explore green bond issuance as an option to raise finance for climate change solutions. Despite the low level of green bond issuance in the region, there is potential for growth in the future. Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico and Peru have issued green bonds through different institutions (public and private) and using different mechanisms. In recent years, Latin America and the Caribbean has witnessed a rapid growth in climate policies and related initiatives, especially in regard to green finance.

Guidelines for implementation:

- Policy assessment: Conduct a detailed review of current policies, ascertaining deficiencies, and obstacles. Ensure alignment with the provisions of Decree 46-2022.
- Prepare investment protocols: Balance private and public investments in line with Decree 46-2022. The government can introduce financing mechanisms to expedite projects in the Indicative Generation Expansion Plan.

- Regulatory reforms: Adapt regulations for power sector infrastructure to overcome existing gaps. Implement innovative climate leverage mechanisms and design a renewable energy integration model, learning from the experiences of Costa Rica and Uruguay.
- Community integration: Consider local community training and participation in renewable energy projects.

Action 2. Prepare long-term energy planning that is resilient to political shifts and incorporates the validation of local communities.

In addition to the conventional process for preparing energy plans over the last 20 years, the government is encouraged to achieve multi-party deals and local community buy-in for a long-term energy planning that integrates 1) mapping land use and resource exploitation locations, 2) preparing greenhouse gas emission trajectories and associated monitoring plans, 3) identifying infrastructures and associated investment requirements critical to delivering on climate change commitments, 4) identifying key investments for the adoption of new environmental and social regulations, and 5) approving new standards for clean fuels and for quality of electricity services.

Effective long-term plans should have clear targets for technologies and their particular demands, such as variable power generation from renewable energy, public charging stations for electric vehicles, green hydrogen, and power-to-X, and should include sufficient investments in transmission, distribution and storage. Including bipartisan agreement and local community validation on a flowchart can also facilitate the identification of priority actions, projected timelines, estimated investments and expected private co-financing aligned with the Decree 46-2022 directives indicating that private sector financing must not exceed public sector investments. For the validation process, Honduras can harness international experience around unlocking the economic potential of indigenous peoples and reaching agreements on the construction of critical infrastructure.

Action 3. Harness regulatory reforms to promote inclusive growth and fair energy transition.

Energy and environmental entities can follow a regulatory agenda that consists of periodically submitting lists of necessary and obsolete rules. The regulatory agenda should also include a government-wide compilation of upcoming and ongoing regulations, including a brief description of each rulemaking effort and a timetable for action. Urgent new regulations might cover rural electrification, energy tariffs for mini-grids and distributed generation, energy conservation and decarbonisation standards, and carbon reduction goals for the transport, industrial and commercial sectors, energy market transparency, energy storage, power-to-X in high- and low-voltage networks, hydrogen, geothermal energy, and electric mobility, among other topics. The government can establish a regulation workstream to ensure that indigenous peoples and local communities do not face inequality or discrimination regarding investments directed to renewable energy and energy access.

Countries such as Australia, the Plurinational State of Bolivia, Canada, Chile, New Zealand, and Peru, as well as the IFC and climate investment funds (such as the Green Climate Fund and the Clean Technology Fund), have crafted innovative standards and regulations worth exploring for targeting the indigenous and local populations that remain excluded from training, education and employment opportunities. SEN can also consider asking for the support of multilateral institutions to enhance and increase the adoption of the principles of the International Labour Organization's (ILO) Convention No. 169 when adjusting national regulations.

ILO No. 169 is an important step towards reversing exclusion and discrimination and ensuring that human rights are respected and socio-economic gaps are closed. Using ILO guidelines can help establish mechanisms for consultation and participation covering the following principles: 1) the concept of “indigenous peoples”, 2) the right to be invited to consultation processes, 3) the entitlement to decide individual development priorities, 4) the entitlement to accept receiving additional education, 5) ensuring collaborative engagement and co-operation across borders, 6) creating and supporting institutions representing indigenous communities, 7) respecting cultural customs and customary legal systems, and 8) encouraging participation and contribution of indigenous peoples in the ILO’s monitoring processes.

Sustainable development and energy efficiency

Honduras’ SDGs have performed well in achieving 2 of the 17 development objectives (Sachs *et al.*, 2022). The country outperforms others in initiatives for implementing prompt measures in addressing climate change and its repercussions, as well as in promoting responsible consumption and production. The government has prioritised several urgent actions in its development agenda. These actions include eradicating extreme poverty, providing access to education and health care for all, ensuring gender equality, and strengthening infrastructure to increase access to water, electricity, and sanitation services, as well as road infrastructure. Since the country agreed to Agenda 2030, the responsible institutions have not been moving fast enough to meet the SDGs, due mainly to low implementation of programmes and limited access to financing. Programmes and projects have planning weaknesses in assessing investments in the initial stages, leading to delays in execution and budget modifications that increase project costs and duplicate procurement and contracting processes.

The work for achieving SDGs 7 and 15 is focused on reducing greenhouse gas emissions by 16% and restoring forests (UNDP, 2021). The country has a strategic plan to manage and save fuels, as well as the electricity decree (10-2012), which is centred on saving energy in fast-growing sectors, but the plan lacks the binding commitments and the evaluation mechanisms necessary for assessing its actual impact. Major challenges to achieving national climate goals include addressing oil dependency, energy access, forest deforestation and the restoration of degraded ecosystems. People in rural areas face limitations on energy access and other basic needs interlinked with the SDGs. National forests provide most of the residential energy consumed, in the form of firewood, and despite the government’s efforts to displace its consumption, the demand for this energy source remained unchanged between 2010 and 2021 (SEN, n.d.). Honduras lacks appropriate regulations to prevent forest degradation, funding for reforestation commitments, and human resources for encouraging stakeholder participation and enforcing sustainability regulations.

In 2006, the country promoted energy efficiency initiatives and regulations through the Interinstitutional Group for a Rational and Efficient use of Energy (GIURE). The GIURE co-ordinated the preparation of guidelines on energy efficiency across sectors. It also led activities for creating public awareness of the rational use of energy and provided technical assistance in the design of energy programmes, financing mechanisms and energy standards. After institutional reforms in 2009, the GIURE ended its activities in all institutions. In 2012, through Decree 010-2012, the Strategic Plan for the Management and Conservation of Fuels and Electric Energy was presented. Then, in 2014, through Decree 34-2014, Measures for Energy Conservation in State Institutions were introduced. These legal acts were part of specific government initiatives to efficiently manage the use of electric energy and fuels, although these efforts have not met the expected goals set in the Roadmap 2050.

In February 2023, SEN presented a bill to the Energy Commission of the National Congress to promote the Rational and Efficient Use of Energy. The objective of this proposal is to implement a comprehensive set of actions targeting a wide range of products and equipment with the aim of reducing energy consumption

in Honduras. The bill empowers the government to establish and enforce regulations pertaining to the performance of energy-consuming products imported into Honduras or produced within the country and transported across regional boundaries. Additionally, the initiative seeks to grant the government the authority to impose labelling requirements on these products, enabling consumers to compare the energy efficiency of different models within the same product category.

Action 1. Prepare an energy transition strategy to achieve net-zero emissions.

It is recommended to harness the lessons learnt from inter-institutional thematic groups focused on energy and climate change, as well as the findings from existing analyses of the integration of renewable and net-zero technologies into end-use and power sectors, to elaborate a strategy for 2030 and 2050. Key inputs for building energy scenarios might include IRENA's REmap analyses, to initiate the definition of Honduras' potential to scale up renewables in the energy mix using four energy scenarios covering the period 2018-2050 and assessing end-use sectors (see Box 2). Existing or past inter-institutional groups focused on the energy and climate change sector can bring value from the experience acquired and serve as a reference platform for the government to include new definitions of responsibilities regarding the main institutions involved, technologies, and means for financing renewable energy. Furthermore, actions taken to meet NDC targets should include the investigation of pathways to energy-related goals, such as defining energy standards and modernising carbon-based and inefficient technologies used in industry, private and public buildings and households. Distributed generation using variable renewable energy can also reduce the use of fossil fuels in isolated communities.

Action 2. Create legal, economic and social conditions to ensure the sustainable stewardship and exploitation of forests for energy purposes.

The government should define strategies to strengthen the legal, technical, economic, social and environmental aspects of forest management and the use of forest products. Assigning these responsibilities to a public institution can maintain and improve the health, diversity and productivity of Honduras' forests and grasslands to meet the country's NDC commitments and the needs of current and future generations. Public institutions can provide various degrees of support including reducing hazards, managing vegetation, restoring ecosystems and promoting energy-valuable species to improve competitiveness and the production of goods and services.

Incorporating these actions into a single national plan may facilitate co-ordination but will require considering the multiple functions that forests serve, which in some cases are interdependent – for example, energy crops, preservation of biodiversity, safeguarding of soil and water resources, and fulfilment of cultural and spiritual roles. Therefore, a multi-dimensional and multi-purpose approach might include 1) improving the available information (potential, supply, demand, etc.), 2) restoring ecosystems and reducing hazards, 3) developing low-impact crops and biomass markets for energy purposes, 4) promoting energy efficiency, 5) minimising the adverse effects of household wood consumption, and 6) reducing greenhouse gases or increasing greenhouse gas sinks. Additional actions might include sustainable forest management certifications and programmes to enforce regulations.

Box 2 Central America's Renewable Energy Roadmap: Advancing a regional shift in energy

IRENA's Renewable Energy Roadmap (REmap) programme assesses the renewable energy potential of countries, regions, and the world, with the aim of providing insights, strategies and pathways for the energy transition.

The outcomes of REmap for Central America are based on the context of each country, including its energy resources, regulatory environment and socio-economic status. The methodology of this energy assessment includes the analysis of four energy scenarios covering the period 2018-2050, based on data from end-use sector analysis, results from the modelling of individual and regional power systems, and a flexibility assessment of the power system. The REmap study is accompanied by an analysis of the investment, costs and emissions of technologies associated with the end-use and power sectors.

The four energy scenarios considered in the REmap study are:

- **Base Energy Scenario (BES).** This scenario is similar to a business-as-usual scenario. It shows possible outcomes by keeping existing policies without changes in the short, medium and long term.
- **Planned Energy Scenario (PES).** The PES reflects the outcomes under current plans and expected objectives of each country. This includes the Nationally Determined Contributions (NDCs) submitted under the Paris Agreement.
- **Transforming Energy Scenario (TES).** The TES scenario presents a determined pathway to meet the climate targets. It contemplates a wide deployment of renewable energy, the inclusion of new technologies and the rise of energy efficiency.
- **Decarbonising Energy Scenario (DES).** DES is the most ambitious scenario under this analysis. It envisions further emission reduction alternatives for the energy system of each country.

Results drawn from the analysis show that the needed transformation of energy systems in Central American countries requires individual efforts but also co-ordinated efforts through integrated regional planning, which is central to emission reduction efforts and the energy transition. The decarbonisation strategy focuses on the increasing penetration of renewables and the electrification of the transport fleet, and can reduce fossil fuel consumption in the power sector 90% and in the end-use sector 65% by 2050 under the DES compared to the PES. This can be supported by using the total renewable energy potential in the regional power system, estimated to be around 180 GW, and by considering the corresponding expansion and reinforcement of regional and national transmission and distribution grids.

In Honduras, the power sector installed capacity is expected to reach 9 629 MW by 2050, under the DES. This includes 4 586 MW of solar PV, 2 039 MW of hydropower, 1 055 MW of bioenergy, 925 MW of wind and 112 MW of geothermal, with the remaining capacity based on fossil fuels. The annual average investment under the DES is expected to be USD 360 million for the period 2021-2030 and USD 347 million for the period 2030-2050.

In 2019, the transport sector remained the main contributor to regional emissions, followed by the power sector and the industry sector (Climate Watch, 2023). In Honduras, the DES shows that emissions can be reduced around 50% by 2050 in comparison to the PES in the same year, as long as the targets established under this scenario are fulfilled. Electric vehicles will represent 58% of the road transport vehicle's fleet by 2050 under the DES.

Additionally, the definition and update of regional energy efficiency standards for energy-intensive equipment could contribute to bringing down the energy intensity in the region and in all its countries. Furthermore, the direct use of renewables in the end-use sectors, such as bioenergy for modern uses, solar thermal, geothermal, biofuels and green hydrogen, shows great potential to contribute to the decarbonisation of all of these sectors.

For more information, see IRENA's Renewable Energy Roadmap for Central America, www.irena.org/Publications/2022/Mar/Renewable-Energy-Roadmap-for-Central-America.

Action 3. Fast track critical energy infrastructure for development.

Accelerating the identification and creation of solutions for the most pressing NDC and SDG commitments requires an enabling environment at all levels of government and a re-invigorated institutional partnership for sustainable development. Decentralised solutions can be promoted for locations that the grid has not yet reached or is unlikely to reach in the near future. Including renewable energy solutions in new infrastructure can help people visualise faster paths for delivering critical infrastructure, mobilising resources, identifying complementary technologies, building capacity and creating multi-stakeholder partnerships, as discussed previously.

Decentralised energy projects can exist at different levels: 1) the village level where the focus is on providing energy and electricity (mini- and micro-grids) to meet rural needs, such as the lessons learnt on micro-grids that are part of the Universal Access Policy (PAU) in Honduras, and 2) at the industrial level, where the industry's energy and electricity demand is the main focus and any excess energy produced in the sector is supplied to the grid. It is relevant to strengthen and update energy production favourability maps and to create programmatic lines that support the development of pilot projects for geothermal and low-temperature solar thermal energy in industrial uses. Among the projects worth exploring are hybrid technologies (such as solar hybrid systems with storage or biomass for power generation, and power-to-X), and the multi-purpose infrastructures, such as dams and waste-to-energy projects, as well as electricity mini-grids and electrical storage infrastructure to increase the share of renewable energy and charging infrastructure for electric transport.

Action 4. Issue regulations on energy efficiency.

Approving a new law on energy efficiency with targets related to rational energy use across sectors and the adoption of energy performance standards can promote the elaboration of new climate agreements within the main productive sectors in the country and incentives for adopting high-efficiency end-use appliances in public and private infrastructure and processes. Regulations affecting sectoral development plans might include initiatives to promote energy efficiency in buildings (for example, through energy performance regulations for office spaces), transport, households, industry, and the public sector, such as labelling programmes and minimum energy performance standards. Collaboration with municipalities and infrastructure-related secretariats might facilitate agreements on the inclusion of energy efficiency and sustainability requirements in public tenders for the acquisition of goods and services.

Action 5. Design innovative, gender-inclusive programmes for energy access.

The government should consider launching development programmes addressing multi-dimensional needs as a strategy for enhancing programme effectiveness addressing gender issues. For example, a programme on access to energy for productive use in rural development could include components related to roads and to public infrastructure for health, water, agriculture, food processing and education while also empowering women and under-served populations. Recent business models and programmes for rural electrification in Latin America have emphasised the importance of the links between sustainable development and poverty alleviation, access to and quality of services, and inclusive economic growth. Of particular significance is the role that women frequently assume as crucial catalysts for pioneering and inclusive approaches.

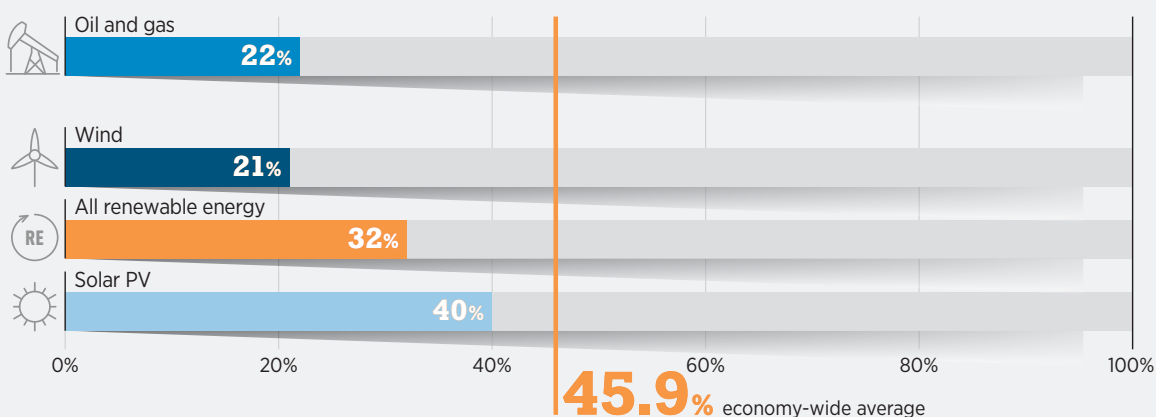
Globally, women hold just 22% of jobs in conventional energy production and distribution, and 32% in the renewable energy workforce (IRENA, 2019). IRENA analyses of the global solar PV industry have found that the share of women working full time is 40% (IRENA, 2022a). However, the share of women's

Box 3 Socio-economics of renewable energy

Renewable energy plays a crucial role in promoting economic well-being and fostering social equity and inclusion. The renewable energy sector has witnessed remarkable growth over the past decade, creating employment opportunities and increasing the number of jobs from 7.1 million in 2012 to 12.7 million globally in 2021 (IRENA and ILO, 2022). According to IRENA's macroeconomic model, in a scenario aligned with Paris Agreement commitments, the industry could generate over 38 million jobs by 2030, with a significant portion in Latin America (IRENA, 2022b). To support this growth, governments play a pivotal role by implementing policies that incentivise renewable energy investments, research and development, and job creation. It is essential to mainstream gender in all renewable energy policies and programmes to ensure women's active participation in the workforce.

However, women continue to be under-represented in the energy sector, particularly in the traditional oil and gas industry, where their share is the lowest compared to overall renewable energy (22% and 32% respectively). Within the renewable energy sector, IRENA data reveal that women's representation is comparatively higher in the solar PV field, with almost double the average share compared to the wind energy sector (40% and 21% respectively) (see Figure 19).

Figure 19 Women's participation (share) in selected energy sectors, 2021



Source: IRENA (2022a).

IRENA's "A Gender Perspective" series of reports highlight that women are primarily present in administrative positions, while being vastly outnumbered in other roles, particularly managerial and technical STEM jobs. Including women in the energy workforce is not only a matter of fairness but also a strategic approach for economic growth. Closing gender employment gaps could lead to an average increase of nearly 20% in long-run GDP per capita across countries (World Bank, 2023b). Boosting female labour force participation, particularly in decision-making positions within the energy sector, is vital for shaping positive social and economic development outcomes.

Efforts like the Rompiendo Barreras initiative (Delegation of the European Union in Honduras, 2022), a collaboration between the European Union and Christian Aid, are dedicated to empowering women in rural areas. One of the key objectives is to create job opportunities for women in the sustainable energy sector through various means, including the microfinancing of women-led entrepreneurship initiatives. For instance, Belen Solar is a successful project that employs women to provide solar energy for lighting to rural communities, thereby improving livelihoods and supporting families. These initiatives not only tackle the hurdles presented by climate change but also foster gender equality and empower women economically, helping to foster a more sustainable and inclusive society.

Women possess knowledge, innovative solutions, diverse perspectives and leadership skills that are crucial for advancing decarbonisation efforts in Honduras. Therefore, it is imperative to apply a gender lens to all renewable energy policies and programmes to ensure that women are at the forefront of the energy transition.

representation in the solar PV sector falls slightly behind the global average of female participation in the broader economy, estimated at 45.9% according to the ILO's 2020 data (ILOSTAT, 2022). The government can prepare guidelines and standards, setting measurable targets and adopting policies and programmes to address obstacles related to persistent gender stereotypes, gender imbalances in STEM (science, technology, engineering and mathematics) fields, and inertia embedded in institutions and networks in both the private and public sectors. Box 3 provides examples of current efforts and gender-inclusive programmes relevant to renewable energy's role in promoting economic well-being.

Strengthening the electricity industry

Recovering the cost of services is at the core of the energy sector's challenges. Inadequate cost-recovery mechanisms are a key driver of ENEE's financial under-performance. Further, energy policies lacking thorough assessments of their economic implications have worsened the company's financial situation. In 2007, Honduras approved Decree 070-2007, which supported the development of renewables under an expensive tariff scheme integrated into PPAs agreed on with ENEE, while electricity tariffs for end users remained unchanged and electricity losses continued to increase. As a result, installed solar PV and wind power capacity soared between 2010 and 2022 while ENEE's costs increased.

Decree 46-2022 ratified the importance of separating ENEE's costs per activity in the power sector. Even though this action builds towards improving the company's performance, ENEE still depends on government bailouts to sustain its finances. The existing debt,¹⁴ expensive PPAs, large electricity losses, and weaknesses in collection limit the company's ability to finance new investments in generation, transmission and distribution infrastructure. Specifically, low levels of investments in transmission and distribution networks constrain the alternatives for the development of renewable energy prospects and affect electricity losses, quality of service and the fulfilment of investment commitments in the Central American Electrical Interconnection System (SIEPAC).

The country has made efforts in electrification in the last two decades that have resulted in increasing energy access to more than 80% of the total population, emphasising the need to concentrate efforts on reaching remote areas that experience the greatest limitations to access. However, the government faces challenges to bringing access to remote areas and improving the quality of services at affordable costs. Electrification rates are the lowest in rural areas with scattered populations over large areas, and power shortages are common nationwide, putting the country among the top three in Latin America and the Caribbean for the longest and most frequent power interruptions (IDB, 2023).

Action 1. Unbundle and reduce ENEE operational costs across energy activities.

Separating the national company's costs should be an integral part of corporate governance to ensure the ability to generate lucrative return on investment and to efficiently deliver electricity services. Actions should include 1) mapping and carrying out fast-track measures to make separation costs effective as soon as possible, 2) enhancing existing programmes on loss reduction by taking actions on discharge management, dispatch optimisation, accurate metering and billing, and energy efficiency, 3) promoting competition among electricity generators, and 4) developing annual execution and monitoring plans outlining responsibilities and timelines for the separation of ENEE's costs.

¹⁴ The state company's debt increased from USD 1.8 billion (8% of GDP) in 2016 to USD 3.4 billion in 2020 (about 15% of GDP).

Action 2. Reinforce actions to increase proficiency in managing ENEE's operations and revenue collection.

Commercial viability, addressing the company's ability to invoice its customers for electricity consumed and subsequently collect that revenue, is vital for the provision of adequate and reliable services. But it requires the capacity to generate an adequate income that covers operational costs and debt obligations, while also allowing for expansion and upholding service quality standards. The government should consider adding new components into tariffication schemes to pass through cost fluctuations from transmission lines, generation location and demand volume (per hour, day and season). The government should also contemplate revising retail and industrial consumer tariffs to reflect service costs more accurately, adjusting subsidies, reviewing distributor tariffs to ensure that they reflect costs, and revising high-voltage transmission tariffs to reflect geographical cost variations.

Action 3. Strengthen ENEE's readiness for financial viability.

The government should consider restructuring ENEE's debt across energy activities to alleviate the company's economic stress. To facilitate a faster and more sustained recovery of the company, the government could ponder promoting a comprehensive debt restructuring agreement. This agreement might incorporate financial pacts and commitments to implement measures aimed at enhancing ENEE's financial performance. These could include cost recovery plans, increase in payment collection, refining methodologies for setting and adjusting tariffs, as well as boosting operational performance and making investments in physical infrastructures. Core actions might include 1) distributing existing debt across independent administrative areas, 2) assessing options to restructure acquired debt and identify new financing mechanisms, and 3) introducing goals for financial performance.

Action 4. Fast-track renegotiation of electricity contracts with the private sector.

The breakthroughs on agreements must come quickly to dissipate concerns regarding tariffs, incentives and compensations in the case of the incorporation of assets to the public sector and allow the energy sector to move forward with its development. A protracted process will further deteriorate ENEE's financial situation and continue to build scepticism around the feasibility of developing renewable energy projects in the country.

Investment in renewable energy technologies and infrastructure

The country has substantially increased its adoption of renewable energy in the electricity industry over the last two decades, with investors funding its ecosystem at large, supporting biomass, hydropower, solar, wind and geothermal power capacity. The production costs of wind and solar energy have fallen greatly over the past decade, accompanied by a surge in demand as energy providers embark on the transition away from fossil fuels. Nevertheless, the absence of government incentives to expand renewable energy use beyond the electricity sector is attributed to the exceeded capacity of the responsible institutions.

Scattered sectoral attributions among institutions have created co-ordination problems in creating the conditions for the widespread adoption of renewable energy. Current ambitions lack roadmaps and specific measures to advance the adoption of low-carbon technologies, including but not limited to green hydrogen, solar PV systems for water irrigation, electric mobility solutions, energy storage systems and biomass use across various energy applications. Furthermore, Honduras has renewable energy resources, such as geothermal and green hydrogen prospectus developments, that have not yet been fully assessed,

and outdated information on solar and wind power affects the accuracy of current energy models and development plans. Lastly, the information on hydropower is not up to date, and in the case of solar and wind energy, although the existing data are a good first effort, there is potential to improve data accuracy and increase its scope using modern tools to enhance measurements, affecting the accuracy of energy models and current development plans.

The country has broad experience and mechanisms for financing private development. Local private banks have financed large renewable energy projects and gained knowledge about financing the energy sector. Currently, the national banking sector lacks strong knowledge on environmental and social risks related to energy projects, which could result in increased costs of capital.

Public sector investments lean mainly on loans from development banks. Multiple development banks and multilateral funds are available in Honduras to support the renewable energy and energy efficiency. These entities have high fiduciary and risk-management credibility, which allow creditors to gain access to funds at relatively low cost, transferring this benefit to investments. The Fiscal Responsibility Law set a ceiling of USD 350 million per year on non-financial public investments for the period 2022-2024. Nonetheless, the country has reached lending limits, constraining its capacity to borrow funds for large renewable energy projects.

Action 1. Empower community-based organisations to develop renewable energy projects that promote inclusive economic activities, create good-quality work opportunities and increase energy access.

Community-based organisations have intimate grassroots relationships with their communities and can be staffed and managed by local people. As highly influential experts on local advocacy, these organisations can also become a trusted network for delivering clean energy solutions when coupled with adequate technical and implementation capabilities that consider best practices from other countries for securing the long-term business sustainability of community energy systems. For guaranteeing the long-term sustainability of community entrepreneurs and companies, the government should combine these advantages with appropriate technical and implementation capacities, considering best practices from other countries.

Development programmes that support community organisations could include low-cost loans and individual business consultations, which would guide entrepreneurs from the conception of the idea to its execution in the launch of energy companies. These companies could build supply chains and generate employment, further strengthening local development in the communities. Moreover, it is important to consider mitigating the financing risks of the community-based organisation projects to unlock the participation of financial institutions.

One option is to provide incentives for non-banking financial entities, such as pension funds and insurance companies. These institutions offer distinct advantages compared to commercial banks as they focus on aligning their assets and liabilities and possess long-term resources ranging from 10-40 years. By engaging insurance companies and pension funds, it becomes possible to secure financing for renewable energy, including large projects such as large hydropower plants. Lastly, the government must consider that financial institutions need to crowd in private investment to build community-based organisations projects. This means that, for those situations in which there is no interest from investors to fund certain projects, the Honduran government would assume the role of the final investor for community-based organisation projects.

Action 2. Strengthen climate and renewable energy financing mechanisms.

Development banks and the government can work together on finding pathways to expand financing for small- and medium-scale projects with a larger scope than the activities of the conventional electricity industry. New climate debt mechanisms are worth exploring to advance partial debt-relief operations that would be conditionally dependent on debtors' commitments to climate-related investment. Carbon pricing instruments can also promote investment in renewables by increasing access to international funds.

For example, creating the conditions for implementing Article 6 of the Paris Agreement by using carbon market mechanisms, such as "cap and trade" (emission reduction trading between countries that facilitates financing of projects), would allow Honduras to voluntarily co-operate with other countries to achieve the emission reduction targets set out in the NDCs and leverage investments aligned with national climate commitments. Honduras' readiness for the development of carbon market instruments requires it to have greenhouse gas baselines, systems for measurement, reporting, and verification (MRV), and offset standards.

The government might consider seeking the support of multilateral institutions for developing carbon markets, connecting the country's climate policies to specific components of carbon markets, and identifying target sectors; where appropriate, it could explore and select climate financing instruments for testing. Other financing instruments worth exploring include those using sovereign guarantees to structure dedicated mechanisms for targeted sectors. For example, the Climate Investment Funds can support actions to increase the availability of financial resources for the implementation of renewable energy and energy efficiency initiatives.

Action 3. Improve data on renewable energy.

Updating the existing resource maps on solar, wind, hydro and geothermal using homogenous methodologies and in-field data could enhance the accuracy of energy models, assessments of economies of scale and energy planning. Adding complementary data analytics regarding cross-sectoral interactions, costs related to transmission-line bottlenecks, distribution networks connecting potential demand, and identification of productive uses of energy and climate risks could provide useful insights to attract new energy developers.

Action 4. Promote active governance, identifying and addressing construction risks for planned renewable energy projects.

The government should increase its capacity to identify systemic and structural problems and guide organisations in all industries to be more ethical and climate resilient. Encouraging the adoption of these practices could have a greater impact than what risk assessments or administrative compliance monitoring could achieve. The government can prepare a cross-cutting strategy for the management of infrastructure risks and compliance, considering links with the SDGs and mandates across ministries and different government levels (national, sub-national and local).

Action 5. Prepare roadmaps for developing multi-purpose renewable energy infrastructure.

Co-ordination between government and industry can yield innovation on projects serving more than one purpose, such as developing pumped-storage hydropower plants that include solar and wind power, and building industrial hubs near renewable energy resources to promote investment in energy crops, waste to energy, power-to-X, electric mobility, geothermal energy, and green infrastructure in cities and tourism. Multi-purpose schemes are inherently more complex, and planning weaknesses may result in lengthy processes and operational conflicts that contribute to under-performance on financials and targets.

Therefore, the government can support the assessment of sustainable business models for public projects or public-private partnerships, and identify key elements for financial viability and risk management and mitigation. At the strategy level, the government should promote multi-stakeholder roundtables including the main institutions and civil society, and map pathways for financing. For example, internationally, multi-purpose water-energy infrastructures are typically funded in part with public money, with possible international donor support. Multi-purpose projects can be more likely to receive international support when aligned with the SDGs.

Action 6. Create finance instruments to enable citizens to save energy by adopting energy efficiency technologies and practices.

As mentioned in the 2050 Energy Roadmap, the government could start implementing energy efficiency programmes and regulations on energy labelling and minimum energy performance standards in co-operation with development banks. This would promote the commercialisation of efficient technologies and create awareness around energy saving at various end-user levels by conducting campaigns to encourage people to reduce energy consumption and replace inefficient appliances. The government can use the lessons from the Strategic Plan to Manage and Save Fuels and Electricity to identify complementary analyses, policies and incentives for the adoption of renewable energy and energy efficiency across sectors. Increasing awareness regarding the efficient use of energy can also foster collaborative endeavours among institutions to identify economies of scale in the public sector.

Institutional and human capacities

Honduras has a well-developed network of universities gathering knowledge on regulatory issues and policy making to tackle the most difficult challenges in energy and climate change. The modernisation and diversification of the country's energy sector demands specific knowledge of energy modelling, data collection, design of business models and financing mechanisms, technology and maintenance certifications, installation of non-traditional energy systems, and processes to develop infrastructure in fast-growing energy-related sectors.

Honduras has understood the linkages in the energy sector between the environment, economic growth and social cohesion. Thus, when developing infrastructure, the government should seek to increase and ensure compliance with environmental and social regulations (including those related to guaranteeing fundamental civil rights and reducing gender disparities), while developers should maintain a positive dialogue with local communities, including indigenous peoples. Regardless of whether the government strengthens environmental and social regulations, the current weaknesses of implementation and enforcement limit the potential impact of measures that address national environmental and social challenges. Implementing secretariats are often under-funded and short-staffed in comparison to ministries responsible for economic or natural resource development.

Action 1. Map current and future capacity gaps in the energy sector.

The government should be aware of the disparities between its energy transition goals and its ability to achieve its vision and commitments. Key areas worth assessing include policy-making processes, public and private leadership, financial management, public and private employees, cross-functional co-operation with non-energy institutions such as transport for electric mobility, fundraising (including climate action financing for NDC commitments) and programme effectiveness. Mapping needs out, in collaboration with academia, may help the government align technical, regulatory, and policy gaps with existing academic programmes.

The involvement of the finance sector is crucial to uncover specific knowledge gaps among professionals. It is observed that insurance practitioners, owing to a lack of specialised knowledge, may attribute elevated risks to certain assets, subsequently amplifying capital costs for renewable energy project developers. Analogously, financial specialists might inadequately structure the financing of projects, thereby influencing the overarching financing risks and costs associated with renewable energy projects. The government should also analyse strengths, opportunities and capacity gaps in community-based organisations to build, operate and maintain renewable energy projects. In sectoral institutions like SEN, it is crucial to address difficulties where employees are technically literate on renewable energy but the Secretariat lacks the same economic strength or structure to fully leverage these capacities.

Action 2. Support the involvement of academic institutions in capacity development initiatives, upskilling and reskilling for sustainable development.

Energy programmes should encompass not only strategies for the development, provision and use of clean energy but also the assignment of development priority on the basis of local assessments of the social and economic impacts of increases in the price of fossil fuels, the deterioration of forest resources, the maintenance of conventional fossil fuel transport, and the implications of poverty in decision-making processes related to the trade-offs between fuel and food, health care, education and other fundamental needs. The government can support the implementation of training programmes run by private or public sector educational providers and education platforms for capacity building and reskilling by supporting institutional, policy and individual development by connecting at least three areas: 1) energy, energy transition, and social, cultural and environmental management; 2) sustainable energy access and security; and 3) energy technologies (such as electric mobility), applications and policies.

Action 3. Create development and management capacities in local communities.

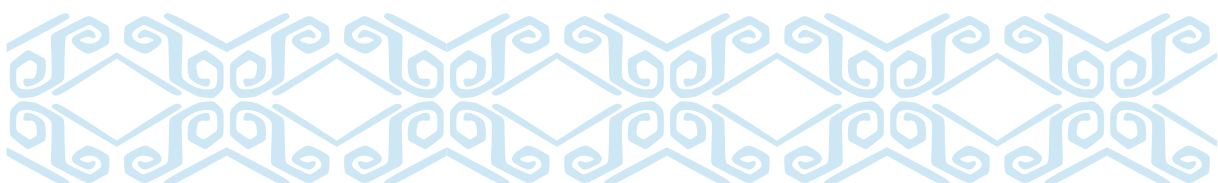
The government could execute community-led development initiatives guided by the principles of responsiveness to demand, participation, local empowerment, transparency, increased accountability, and bolstered local capabilities, using both long- and short-term capacity building. Energy programmes can include tailor-made courses to address real-life projects for practitioners to learn about 1) specific energy technologies (solar, wind, geothermal, biomass, waste-to-energy, etc.), 2) sustainable energy and its implications for development, 3) economic aspects of energy, 4) analysis of investments in the energy sector, 5) effective management and optimisation of energy efficiency, 6) energy and gender considerations, 7) evaluation of renewable energy resources, 8) energy and its relationship with climate change, 9) rural electrification, 10) electric mobility and 11) industry decarbonisation. These programmes must ensure equal opportunities for women in technical STEM-related positions. The government can consider creating innovation laboratories to deliver knowledge and support the design of business models that include shared ownership.

Action 4. Create capacity for rural financing of clean and sustainable energy solutions with low carbon emissions.

The government should implement comprehensive capacity building plans focused on increasing access to financing renewables. These plans can include providing business development support and financial literacy training, with equal opportunities for women. Capacity building programmes for private banks and financial institutions such as BANHPROVI Honduras can improve conditions and attract new investors in renewable energy and low-carbon technologies such as electric mobility. The experience of Mexico designing and implementing programmes for rural financing through NAFIN is worth reviewing. Specifically, BANHPROVI can use NAFIN's experience mapping its potential beneficiaries and designing tailored programmes to: 1) include a strategic focus and business orientation towards the adoption of renewable energy in rural and agriculture financing; 2) make policies, products and business processes suitable for investments in renewable energy; and 3) strengthen knowledge of rural, agriculture, and cottage and small-industry financing.

Action 5. Address urgent capacity gaps in energy and environmental institutions.

The government should strengthen capacities to enforce environmental and social safeguards to ensure just treatment of local communities when building and operating renewable energy projects. Synergies with public entities not related to the energy sector (including municipalities and regional governments) and with multilateral and bilateral institutions might improve overall energy governance. The assessment of local legislation in comparison with international standards might also reveal opportunities to enhance regulatory frameworks affecting communities at large and the development of renewable energy projects. Energy institutions also require the building of new capacity on: 1) long-term planning, including assessments to help policy makers understand the intricate economic, political and environmental interdependencies and uncertainties associated with energy systems; 2) modelling of transmission lines under changing scenarios of renewable energy, and identification of weaknesses in transmission networks affecting system stability and flexibility; and 3) the design and implementation of carbon pricing mechanisms (such as cap and trade), and monitoring, reporting, and verification (MRV) systems.



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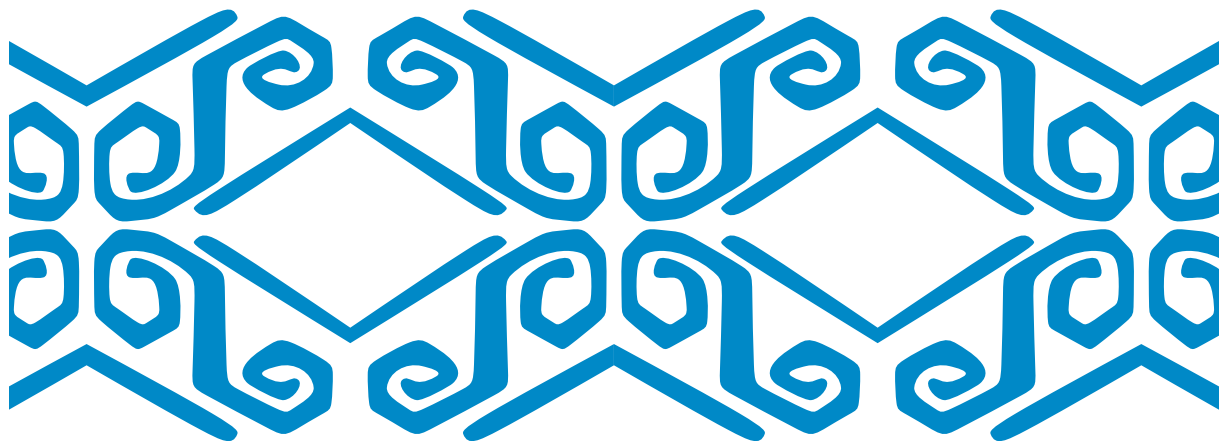
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