RENEWABLE READINESS ASSESSMENT

EL SALVADOR

IRENA
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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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Renewables Readiness Assessment

EL SALVADOR

Foreword

from the President of the Executive Hydroelectric Commission of the Lempa River

For 75 years, the Executive Hydroelectric Commission of the Lempa River (CEL) has positioned itself as a benchmark in power generation in El Salvador, creating important hydropower and geothermal energy projects that for several years have contributed to the economy of the country as well as to improve the quality of life of millions of Salvadorans. Since its creation, CEL has directed its efforts in the country's development through the energy output of four hydropower plants, with coverage across a broad area of national territory. Historically, these power plants enabled the electrification of the country, giving rise to national industrialisation and, in turn, the steady growth we see today.

Over time, CEL has created programmes that contribute to environmental conservation, improving landscapes, caring for ecosystems, and developing social initiatives to enhance the capacities of the most vulnerable, reflecting principles that must always be considered when exploring and developing new sustainable energy projects. CEL has diversified its business to include renewables, including geothermal projects undertaken through its subsidiary company LaGeo, which has set international standards, training professionals from Latin American countries who seek to explore and promote this so-called "white gold".

Under the government of President Nayib Bukele, CEL and its companies have taken on another key role, initiating projects to reduce the price of electricity for the Salvadoran people and boost the economy, even in the midst of the COVID-19 pandemic. This is why CEL is working to explore, create and promote renewable power generation through geothermal, solar photovoltaic, wind and hydropower projects. One ongoing flagship project focuses on constructing the new '3 de febrero' hydropower plant. This efficient, transparently managed dam project, when completed, will further boost the Salvadoran energy mix while also bringing other benefits, such as job creation and enhanced tourism development.

The efforts of CEL and others in initiating the energy transition have also benefited from the support of the International Renewable Energy Agency (IRENA), with which we have been working for some years in a co-ordinated and synergistic way. This co-operation will allow us to continue strengthening our endeavours to scale up renewable energy. The Renewables Readiness Assessment (RRA) for El Salvador provides a key milestone that aims to promote new initiatives and instruments, particularly to improve the efficiency of public policies and regulations on energy. Even in the midst of a pandemic, this assessment can help to create suitable conditions for the widespread, sustainable deployment of renewables in El Salvador.

Consequently, the recommendations are in line with the government's energy policy, which proposes increasing public investment in projects to develop and use new renewable energy sources, as well as reviewing and reconfiguring the country's energy mix. On behalf of our President and the Government of El Salvador, I wish to express the greatest appreciation for IRENA's valuable and constant support, as well as for the honour conferred on the Republic of El Salvador in holding the Vice Presidency of the IRENA Assembly in 2020.

Daniel Alejandro Álvarez Campos
President, CEL
Republic of El Salvador

Foreword

from the Executive Secretary of the National Energy Council

The main renewable resources used in El Salvador for electricity generation are geothermal and hydropower. While variable renewable power is growing considerably, there is much more potential for these resources, either for electricity or direct uses. This report, prepared with the support of the International Renewable Energy Agency (IRENA) identifies the conditions to expand the use of renewables nationally.

Input from multiple stakeholders in the Salvadorian energy sector has been key in identifying priorities for action in key sectors like agriculture, industry, tourism and health, aimed at utilising solar, geothermal and biomass resources, driving decentralised economic development, and ensuring environmental and social benefits in the short, medium and long term.

El Salvador adheres to environmental commitments under international agreements. Its national policy aims to further deepen the energy transition, with a view to ensuring a sustainable energy supply, strengthen our economy, bring widespread benefits to the Salvadoran population while increasing our resilience to climate change.

The National Energy Council continues to work on updating institutional and regulatory frameworks to promote optimal resource use and the efficient implementation of appropriate technologies. We reiterate our gratitude to IRENA, as well as to all the stakeholders involved in the development of this assessment. We reaffirm our commitment to develop enabling initiatives for renewables in all sectors and position El Salvador as a reference case in the use of renewable energy.

José Salvador Handal Candray
Executive Secretary, National Energy Council
Republic of El Salvador

Foreword

from the IRENA Director-General

The Republic of El Salvador, like other countries in Central America, the Latin American region and around the world, faces unprecedented health and socio-economic challenges amid the COVID-19 pandemic. Beyond short-term recovery measures, the national response has started to focus on longer-term measures, such as ensuring energy security, aligning new investments with climate commitments and building a resilient economy. The decarbonisation of El Salvador's energy sector can pave the way for broad-based, sustainable socio-economic development in years to come. For now, the growing demand for energy continues to be met mainly through oil imports. However, indigenously sourced renewables are assuming a larger role.

The new National Energy Policy 2020-2050 aims to diversify El Salvador's energy mix and take advantage of the country's significant renewable energy resource potential. At the same time, the policy highlights the need to reduce dependence on fossil fuels and mitigate the impact of climate change. This means adopting energy storage, efficiency measures, digitalisation and other innovative technologies, as well as promoting renewables beyond the power sector.

This Renewables Readiness Assessment (RRA), prepared through a broad-based consultative process in close co-operation with the Executive Hydroelectric Commission of the Lempa River (CEL) and the National Energy Council (CNE), examines El Salvador's energy sector holistically. The report identifies key actions to expand renewable energy development in the short and medium term. Discussions with stakeholder have also heightened knowledge exchange and fostered international co-operation to promote clean, indigenous renewable energy technologies.

The report examines planning and operations, the existing regulatory framework and the financing mechanisms that could come into play to achieve the country's long-term renewable energy ambitions. The assessment underlines the role of the Central American power market and ongoing regional energy integration, in line with IRENA's Clean Energy Corridor of Central America (CECCA) initiative.

Since 2011, nearly 40 countries, spanning the Latin America and the Caribbean, Africa, the Middle East, Asia and the Pacific have undertaken RRAs, exchanging knowledge and fostering international co-operation to accelerate the deployment of renewables. Each process has been country-led, with IRENA providing technical expertise and highlighting regional and global insights, along with facilitating national stakeholder consultations.

IRENA wishes to thank CEL, CNE and all Salvadorian energy institutions for their vital input and engagement. We also appreciate the valuable contributions of numerous other government agencies and national stakeholders. We look forward to working with all of them, as well as with regional institutions and development partners, to turn these recommendations into practical on-the-ground initiatives that promote renewables as a key element in sustainable, equitable socio-economic development.

I sincerely hope this report and its recommendations will strengthen El Salvador's pursuit of renewables and enhanced climate action. IRENA stands ready to assist in the country's transition to a sustainable energy future.

Francesco La Camera
Director-General, IRENA

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Abbreviations

AEP	Annual Energy Production *(AEP)*
ANDA	National Administration of Aqueducts and Sewers *(Administración Nacional de Acueductos y Alcantarillados)*
BANDESAL	El Salvador Development Bank *(Banco de Desarrollo de El Salvador)*
CABEI	Central American Bank for Economic Integration
CD-MER	Council of the Regional Electricity Market *(Consejo Director del MER)*
CDM	Clean Development Mechanism
CECCA	Clean Energy Corridor of Central America
CECSA	Cucumacayán Electricity Company *(Compañía Eléctrica Cucumacayán)*
CEL	Executive Hydroelectric Commission of the Lempa River *(Comisión Ejecutiva Hidroeléctrica del Río Lempa)*
CER	Certified Emission Reductions
CIP	Climate Investment Platform
CLP	Long-Term Contract *(Contratos de Largo Plazo)*
CNE	National Energy Council *(Consejo Nacional de Energía)*
CPI	Consumer Price Index
CRIE	Regional Commission for Electrical Interconnection *(Comisión Regional de Interconexión Eléctrica)*
DC	Consumer Advocacy *(Defensoría del Consumidor)*
DRHM	Regulatory Directorate of Hydrocarbons and Mines *(Dirección Reguladora de Hidrocarburos y Minas)*
EDP	Pacific Energy *(Energía del Pacifico)*
EOR	Regional Operating Entity *(Ente Operador Regional)*
EPR	Enterprise Owner of the Central American Electrical Interconnection System *(Empresa Propietaria de la Red)*
ETESAL	Transmission Company of El Salvador *(Empresa Transmisora de El Salvador)*
EU	European Union
FISDL	Social Investment Fund for Local Development *(Fondo de Inversión Social para el Desarrollo Local)*
FINET	National Investment Fund for Electricity and Telephony *(Fondo de Inversión en Electricidad y Telefonía)*
FMO	Development Finance Company *(Netherlands)*
GCF	Green Climate Fund
GDF	Geothermal Development Facility for Latin America
GDP	Gross Domestic Product
GJ	Gigajoule
GW	Gigawatt
GWh	Gigawatt hour
IDB	Inter-American Development Bank
INE	Energy Investments *(Inversiones Energéticas)*
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
KfW	German Development Bank
KWh/kWp/yr	Kilowatt hours per kilowatt peak per year
KWh	Kilowatt hour
kV	Kilovolt
LAIF	Latin America Investment Facility
LCOE	Levelised cost of electricity
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LaGeo	Salvadorean Geothermal *(Geotérmica Salvadoreña)*
MARN	Ministry of the Environment and Natural Resources *(Ministerio de Medio Ambiente y Recursos Naturales)*

MER	Regional Electricity Market *(Mercado Eléctrico Regional)*
MH	Ministry of Finance *(Ministerio de Hacienda)*
MICULTURA	Ministry of Culture *(Ministerio de Cultura)*
MINEC	Ministry of Economy *(Ministerio de Economía)*
MINSAL	Ministry of Health *(Ministerio de Salud)*
MJ	Megajoule
MOP	Ministry of Public Works and Transport *(Ministerio de Obras Públicas y de Transporte)*
MRS	The spot market *(Mercado Regulador del Sistema)*
m/s	metres per second
MW	Megawatt
MWh	Megawatt hour
MWp	Megawatt peak
NDC	Nationally determined contribution
O&M	Operation and maintenance
OLADE	Latin American Energy Organisation *(Organización Latinoamericana de Energía)*
PPA	Power purchase agreement
PPP	Purchasing Power Parity
PV	Photovoltaic
RRA	Renewables Readiness Assessment
RTL	Regional transmission line
SC	The Superintendence of Competition *(Superintendencia de Competencia)*
SDGs	Sustainable Development Goals
SE4All	Sustainable Energy for All
SIEPAC	Central American Electrical Interconnection System *(Sistema de Interconexión Eléctrica de los Países de América Central)*
SIGET	General Electricity and Telecommunications Superintendence *(Superintendencia General de Electricidad y Telecomunicaciones)*
SME	Small and médium sized enterprises
tC/ha/yr	Tonnes of carbon per hectare per year
TJ	Terajoules
UNDP	United Nations Development Programme
UT	Transactions Unit *(Unidad de Transacciones)*
VAT	Value added tax
VMDU	Department of Housing and Urban Development *(Viceministerio de Vivienda y Desarrollo Urbano)*
VRE	Variable renewable energy
W/m²	Watts per square metre

Executive summary

El Salvador depends heavily on fossil fuels to meet its energy needs for industry, transport and, to a certain extent, power generation. Increasingly, the country also imports electricity from neighbouring countries to meet domestic demand. Renewable energy use – already seen in hydropower and geothermal projects – could therefore be scaled up further and faster in the Central American country.

Encouragingly, the past decade has seen national energy policy recognise the benefits of developing solar, wind and bioenergy, as a wide range of renewable energy technologies can help to diversify the energy mix, expand electricity access and strengthen regional energy integration.

El Salvador's economy, based mainly on services, industry and agriculture, grew by an estimated 2.4% in 2019, within a moderate average annual growth rate of its gross domestic product (GDP) per capita of 3.9% over the last 20 years. Regardless of persistent challenges, El Salvador has made substantial social and economic progress over the last two decades, with national policies increasingly mirroring with the United Nations 2030 Agenda for Sustainable Development.

With no domestic oil, gas or coal supply, the country depends entirely on imported fossil fuels, which accounted for 69% of its total energy supply in 2019. Yet the energy sector continues to be recognised as a strong contributor to economic and social development. The country has prioritised the development of renewables to mitigate import dependency and thus improve energy security. Renewables are also expected to stimulate local commerce and industry, help reduce electricity tariffs and improve people's welfare.

The General Electricity Law of 1996, which liberalised the power sector, also allowed for more private sector participation in renewable energy development, alongside the government's more active promotion of renewable energy sources.

The National Energy Policy 2010-2024 then became a key tool for the implementation of renewable energy, especially in the power sector. Indeed, no new fossil-fuel based power generators have been added since 2013. By 2019, renewables, including hydropower, biomass, solar photovoltaic (PV) and geothermal power, had reached 64.3% of the country's total installed capacity of 2.2 gigawatts (GW). Since 2015, solar PV capacity alone has grown nearly tenfold, reaching 273 megawatts (MW) in 2019.

Additionally, El Salvador is connected to the Central American Electrical Interconnection System (SIEPAC – Sistema de Interconexión Eléctrica de los Países de América Central), making the country an active participant in the Regional Electricity Market (MER – Mercado Eléctrico Regional). Electricity imports, mainly from Guatemala, accounted for around 21% of the country's electricity supply in 2019.

The National Energy Council (CNE – Consejo Nacional de Energía) is currently developing its long term National Energy Policy 2020-2050. This aims to reduce the electricity tariff through added renewable power generation, facilitating the removal of electricity subsidies towards the end of the policy period. This new strategy goes beyond the power sector, too, stipulating targets for clean energy technologies in end-use sectors and energy efficiency, as well as promoting pilot projects for direct use of renewables in the industrial and agri-food sectors.

The country's Renewables Readiness Assessment (RRA) process has highlighted key actions for the short and medium-term that could create more conducive conditions for renewable energy deployment. The country-led assessment, facilitated by the International Renewable Energy Agency (IRENA), aims to help unlock El Salvador's renewable energy potential. The identified actions are grouped in five areas, where the main challenges have been identified.

Challenges and key recommendations

1. Enhance long-term planning and policy for the renewable energy sector

Competitive tendering processes and various fiscal incentives for renewable electricity have helped to create good business conditions for renewables in El Salvador, resulting in significant uptake of renewable energy technologies.

Yet rapid renewable energy development has highlighted insufficient co-ordination in terms of long-term energy plans. El Salvador could devise a more comprehensive national energy plan, encompassing all energy technologies, suppliers and consumers through an integrated analysis of current market conditions. The plan should also consider the integration of renewable energy technologies for end uses in buildings, heat and transport, while establishing clear targets that contribute to the ongoing scale-up of renewables.

El Salvador benefited greatly from regional energy integration and plays an active role in the MER. The country should therefore incorporate the Regional Energy Strategy 2030 in its national long-term planning efforts. This is in line with the country's overall development strategy and assures the participation of both public and private sectors.

2. Create enabling conditions for geothermal energy development

Despite having a long tradition of geothermal energy use, El Salvador's geothermal development has stagnated in recent years, with a limited number of new projects for geothermal power generation, or heating applications.

El Salvador's geothermal potential could be also utilised for direct-use applications, but the existing regulatory framework only covers power applications. Classifications need to be established for geothermal resources by temperature, including varying potential for direct uses. A more in-depth review of the regulatory framework could also help to overcome challenges with the existing remuneration scheme, as well as the licensing procedure currently in place for geothermal projects.

Likewise, geothermal project developers struggle to access financing options, underlining the need to further enhance the capabilities of local financial institutions and project owners to help create a better understanding of funding geothermal projects and its associated risks.

3. Establish clear institutional frameworks and co-ordination

Currently, responsibilities among institutions in the country's energy sector remain decentralised, which is affecting the performance of the sector and is clearly reflected in the absence of longer term co-ordination of different participants' action plans. El Salvador may consider several options to improve this condition, including the creation of an entity that centralises sector development and directives.

Additionally, the development of the national transmission system and of new generation facilities are undertaken separately. Potential new renewable-based power generation, therefore, is not consistently included in transmission expansion plans. Such plans, moreover, tend to overlook the short construction times needed for solar and wind (variable renewable energy) facilities.

Measures are needed to ensure closer collaboration between the entities responsible for developing such plans. For instance, the identification of renewable energy zones in the most suitable areas for project development could serve to inform both transmission and generation planners, facilitating a co-ordinated planning effort.

4. Assess the implementation of distributed power generation

The implementation of the net metering scheme in 2017 has resulted in a successful promotion of rooftop solar PV generation. Yet, there is still no clear understanding of the effects that the growing self-generation practice has on the reliability of the power system and the overall energy market.

To improve this, all existing use of self-generation must first be registered. This should consider both self-use and the potential injection of energy into the grid from existing projects. This exercise could provide a better

assessment of the existing regulatory framework, while considering the stability of the grid and the existing distribution market, as well as empowering end users for relatively flexible energy management.

5. Foster project development and financing for renewables

There have been significant achievements and progress in regulation for the development of renewable energy in El Salvador. Renewable project developers still face challenges, however, with administrative procedures and permits. These are not centralised and cause delays in project development. Regulation in this area must ensure transparent processes and well-defined timetables for obtaining permits. A unified national office (or "single-window agency") should be established to handle all applicable licenses and permits for renewable energy projects, reducing project delays and development costs.

El Salvador's long-term uptake of renewable energy technologies will also hinge on assessing the availability, along with the potential for improvement and expansion, of existing financing instruments. Existing mechanisms and conditions for financing and risk mitigation by private institutions, similarly, must be clear to ensure that project developers can make use of these instruments. Additionally, local private institutions will need to be familiarised with the renewable energy market to attract more interest from them in project finance.

The implementation of these steps, in close collaboration with all national and regional stakeholders from the private and public sector, should help El Salvador attract investments that contribute towards a climate resilient, low-emission development pathway.

Sonsonate Solar Plant, Acajutla, El Salvador

Image credit: Shutterstock

1. Introduction

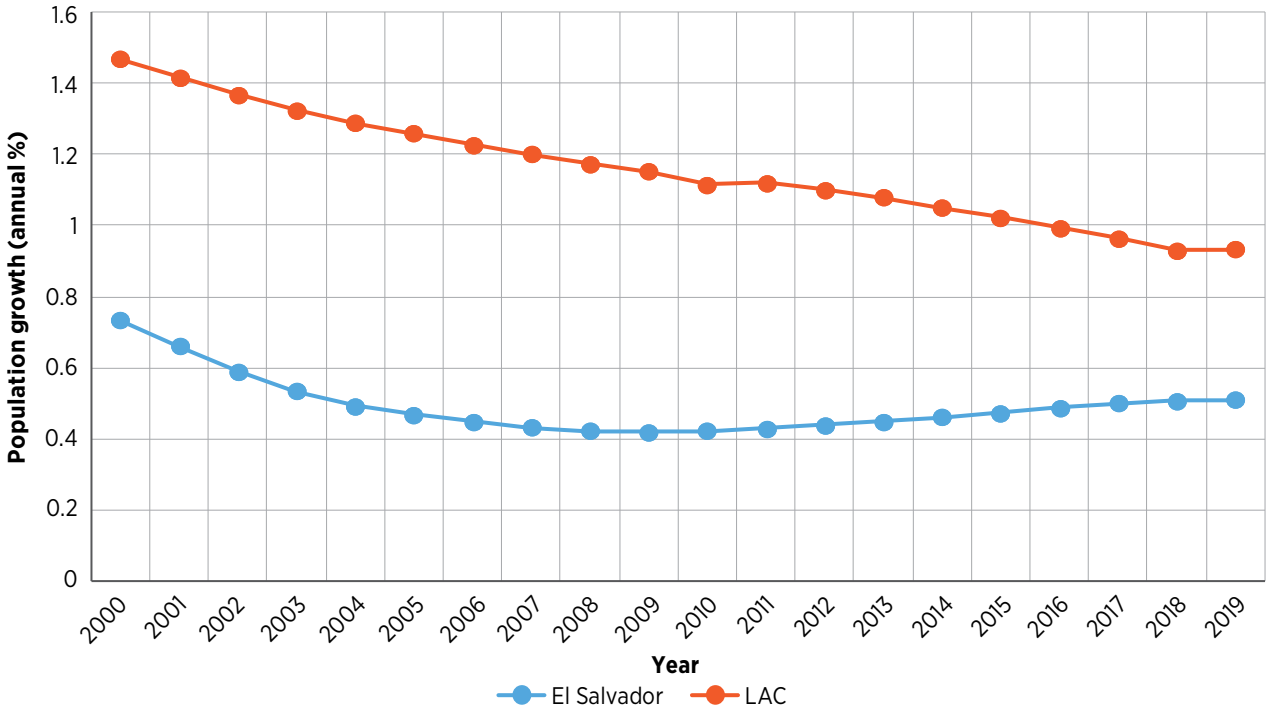
Country background

With a land area covering only 21 040 square kilometres (km^2), El Salvador is Central America's smallest country. Bordering Guatemala to the west, Honduras to the east, and the Pacific Ocean to the south, in 2018, El Salvador had an estimated population of just over 6.4 million. This gave it a high population density, at 309.4 inhabitants per km^2 (UN, 2018).

Overall, annual population growth in the country was low between 2000 and 2019, when compared to the regional average in Latin America and the Caribbean, with the rate falling between 2000 and 2010. Since 2010, however, the growth rate has been slowly rising (see Figure 1).

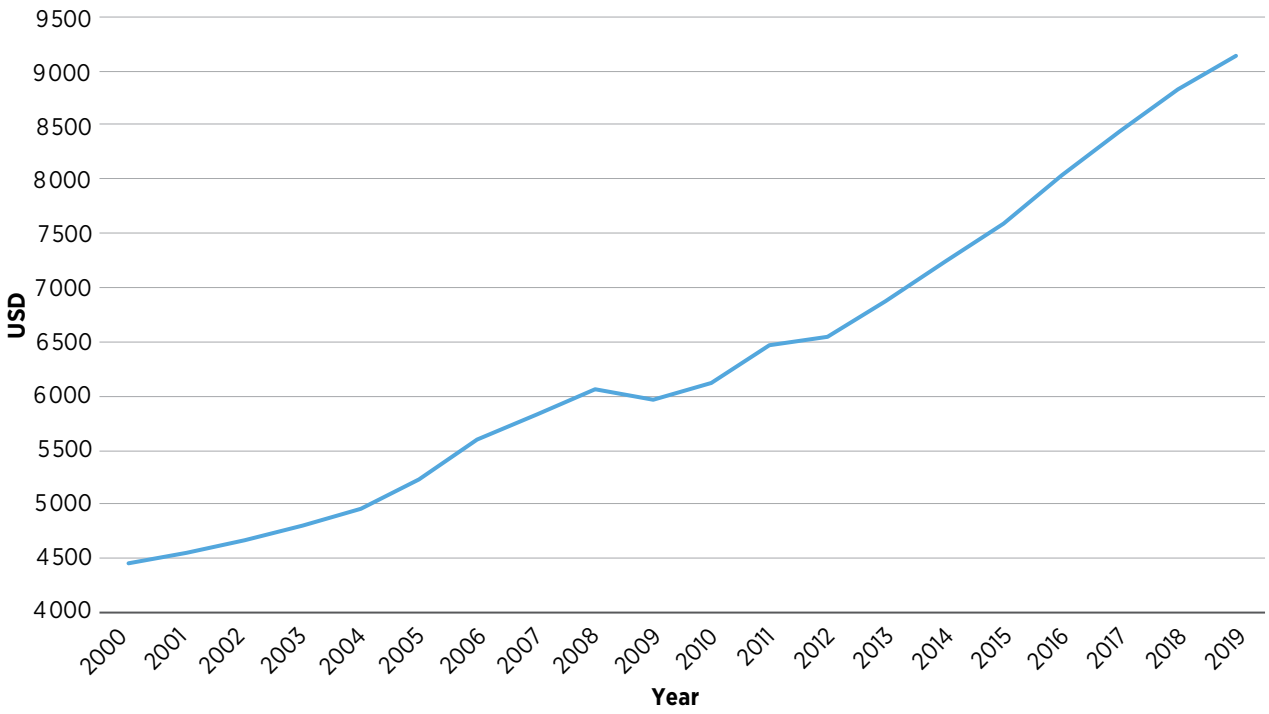
In fiscal year (FY) 2019, El Salvador's gross domestic product (GDP) per capita at purchasing power parity (PPP) was around USD 9 140. As shown in Figure 2, this number has been rising in recent years, with an average annual growth rate of 3.9% from FY 2001 to FY 2019. This was, however, one of the lowest rates of growth in Central America (World Bank, 2020b). Higher private consumption and a peak in gross investment boosted annual average growth to 4.3% in FY 2006, while GDP shrank 2.1% in FY 2009, following the global financial crisis.

Figure 1. **Annual population growth (%) (FY 2000 and 2019)**



Based on: World Bank (2020a)

Figure 2. **GDP per capita, PPP (current international USD) (FY 2000 and FY 2019)**



Based on: World Bank (2020c)

Table 1. **Economic indicators**

	2014	2015	2016	2017	2018	2019
GDP growth (annual %)	1.71	2.40	2.51	2.31	2.54	2.40
Agriculture, forestry, and fishing, value added (% of GDP)	5.87	5.53	5.63	5.04	4.88	5.10
Industry (including construction), value added (% of GDP)	26.01	25.29	24.80	25.16	25.35	25.60
Manufacturing, value added (% of GDP)	16.08	16.39	16.23	16.27	16.18	15.80
Services, value added (% of GDP)	59.42	60.01	60.46	60.67	60.34	59.50

Source: World Bank (2020d)

In FY 2018 and FY 2019, the Salvadoran economy saw annual GDP growth of 2.5% and 2.3% respectively. The largest contribution to the country's GDP traditionally comes from the services sector, followed by industry, manufacture and agriculture. An overview of the key economic indicators from 2014 to 2019 can be found in Table 1.

The economy has also benefited from an improvement in real wages, stronger flows of worker remittances and an increase in private consumption, including personal loans (UN ECLAC, 2017). This was reflected in the national poverty rate, which declined from 38.8% in 2000 to 29.2% in 2017 (DIGESTYC, 2018). The still relatively high poverty rate is the result of both the country's low overall economic growth and trends in migration to urban areas.

The national deficit stood at approximately 2% of GDP in 2017, down from 3.6% in 2015 (UN ECLAC, 2017). This decrease follows a reduced national oil bill, given that El Salvador imports all its oil products and is thus highly dependent on international oil prices.

The Central Reserve Bank of El Salvador does not have complete monetary autonomy. This is due to the adoption of the United States dollar as the formal unit of currency, a policy in force since 2001, as well as the free mobility of capital. As a result, the supply and demand for US dollars between locally-based financial intermediaries is the main determinant of interest rates, in the short term. These intermediaries reported stable liquidity conditions in 2016. (UN ECLAC, 2017).

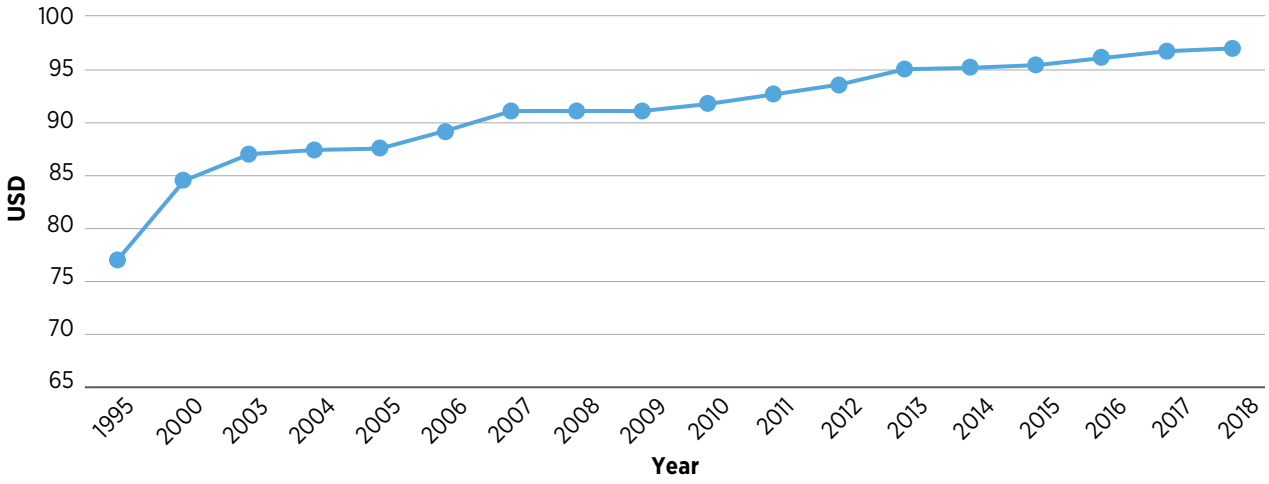
Over the last two decades, El Salvador has made substantial progress in its social and political development. The country has expanded access to its public services, which has directly contributed to improved living conditions, including enhanced energy services. Despite this progress, however, the country's long-term sustainable development continues to face challenges, including threats from adverse natural events, environmental degradation and climate change (World Bank, 2020b).

El Salvador is pursuing the UN 2030 Agenda for Sustainable Development by including it as part of its national development strategy. The co-ordination of actions related to the Sustainable Development Goals (SDGs) is led by the Presidency, with the support of the Ministry of Foreign Affairs (SDGs Knowledge Platform – UN, n.d.).

Regarding SDG7 – ensuring access to affordable, reliable, sustainable and modern energy for all – El Salvador has made impressive progress. Figure 3 presents the country's access to electricity rates, with these reaching around 97% in 2018, compared to 95.4% in 2015.

Other SDG7 indicators reflect the country's effort to achieve sustainable development across the energy sector. By 2016, 88% of the population had access to clean cooking, while the same year, energy efficiency had improved to 4 megajoules (MJ) per USD of GDP (UNStats, n.d.).

Figure 3. **Proportion of population with access to electricity**



Based on: UN ECLAC (2020)

Renewables Readiness Assessment (RRA) in El Salvador

The International Renewable Energy Agency (IRENA) has developed its Renewables Readiness Assessment (RRA) as a tool for carrying out a comprehensive evaluation of the conditions for renewable energy deployment in a given country.

The RRA is a country-led, consultative process, providing a venue for multi-stakeholder dialogue in identifying challenges in renewable energy deployment. The assessment then tries to come up with solutions to existing barriers.

The RRA presents short and medium-term recommendations to governments to help guide the formation of new policies and regulations, or to reform existing ones. The aim is to create a more enabling environment for the deployment of renewable energy. The RRA also consolidates existing efforts and mobilises resources for priority action.

For the Republic of El Salvador, the RRA process has been led by the Executive Hydroelectric Commission of the Lempa River (CEL – Comisión Ejecutiva Hidroeléctrica del Río Lempa), in co-ordination with the National Energy Council (CNE – Consejo Nacional de Energía) and with technical support from IRENA. The process involved extensive consultations with a large group of public and private energy stakeholders, including the ministries, the regulator, generation companies, transmission and distribution utilities, project developers, energy market operators, financial institutions, development partners, regional organisations, civil society and academia, among others.

The consultative process was launched during a meeting of experts held in the country's capital, San Salvador, in December 2018. This was based on a background paper, which described the challenges and opportunities for renewables development. The outcomes of these discussions facilitated the identification of various challenges hindering the deployment of renewable energy in the country, as well as possible solutions to these impediments.

The challenges identified were grouped and assessed in a series of short and medium-term draft recommendations. These were then presented at a follow-up validation workshop held in October 2019 and jointly organised by CEL and IRENA, with CNE's support. The main outcome of the discussion at this meeting was the validation of the challenges identified, along with the proposed recommendations, with these to be compiled in the final RRA report. This process also benefitted from bilateral interviews with key stakeholders.

The co-ordinated approach employed in producing this RRA, which saw consultation with governmental institutions, bilateral and multilateral co-operation agencies, financial institutions, the private sector, regional organisations, civil society and academia, helps set priorities for implementing the actions recommended.

Renewables and COVID-19 recovery

The COVID-19 outbreak has led the countries around the world to an unprecedented economic, health and social crisis. The International Monetary Fund (IMF) estimates a resultant contraction of the economies in Central America of around 3.5 percent average during 2020. These new regional conditions are undermining the economic growth of El Salvador, however the new National Energy Policy 2020-2050 and the ongoing efforts towards the revision of the NDCs by the country, are creating an opportunity to centrally position the Salvadorian energy sector at the core of the post-COVID recovery, focusing its efforts to achieve a green recovery. Renewable energy serves as an opportunity to increase energy security, attract investment to the country and developing into a long-term source of jobs for its inhabitants. Additionally, investing in domestic renewable energy infrastructure offers the potential to boost health capacity and build climate resilience. It can also greatly strengthen El Salvador's post-COVID recovery efforts.

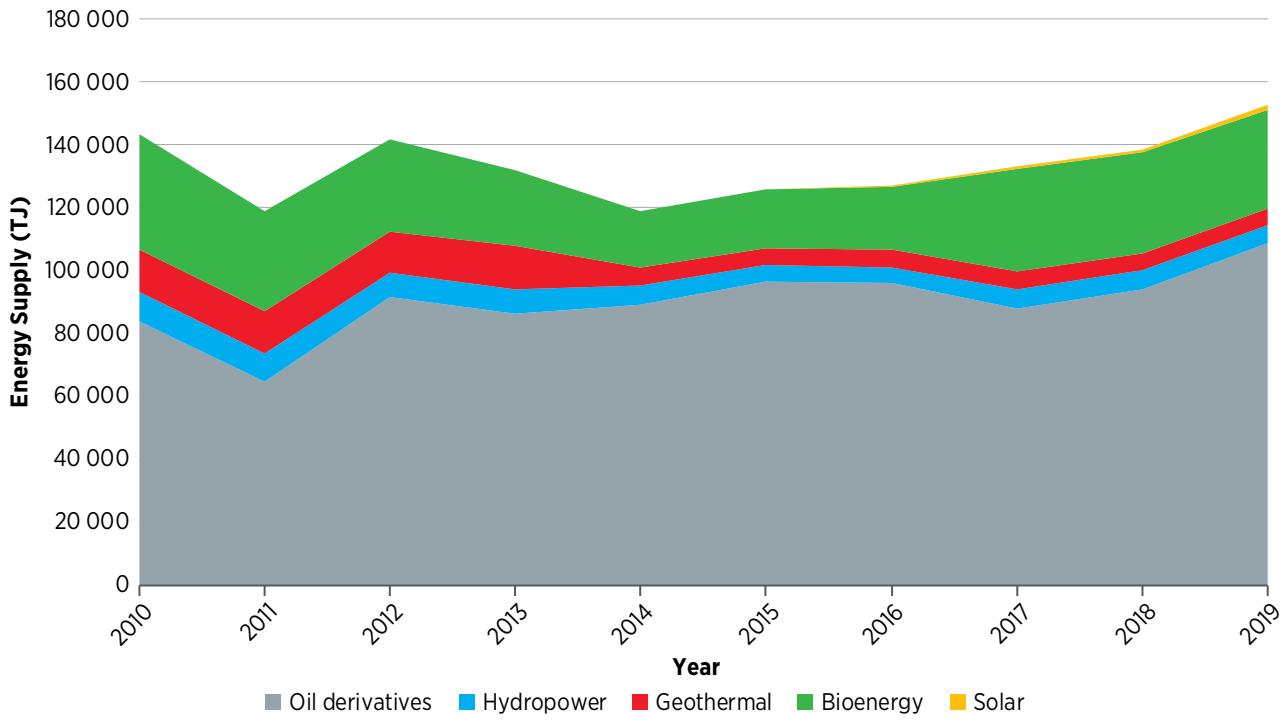
2. Energy context

Energy sector overview

The bulk of El Salvador's primary energy comes from fossil fuels. As shown in Figure 4, the total energy supply sources since 2010 have mainly been oil derivatives, such as gasoline, diesel, liquid petroleum gas (LPG), kerosene and bunker fuel (CNE, 2020). The total fossil supply accounted for a total 108 721 terajoules (TJ) in 2019, or 69% of the total energy supply.

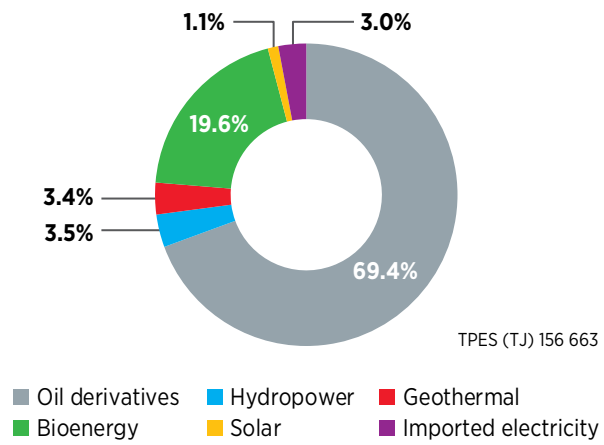
Diesel has a high level of consumption, mainly in the transport and industrial sectors. Gasoline is used exclusively for the transport sector, while fuel oil or bunker fuel is used for the generation of electricity. Natural gas does not have a relevant role in the country's energy mix, yet. In 2021, however, a liquefied natural gas (LNG) power plant is expected to be commissioned, giving this resource a more prominent role in the energy sector (see Section 3).

Figure 4. **Total energy supply by source**



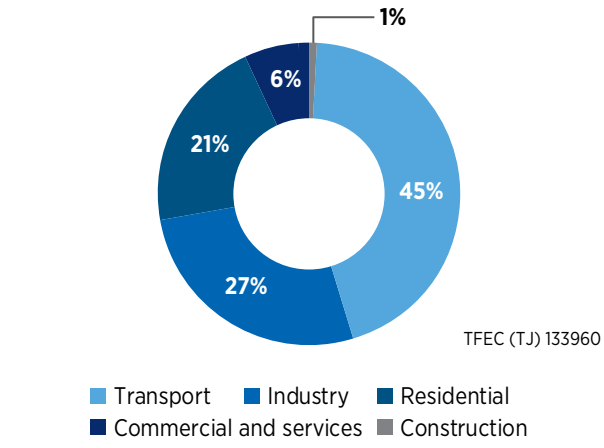
Based on: CNE (2020)

Figure 5. **Total energy supply, 2019 [%]**



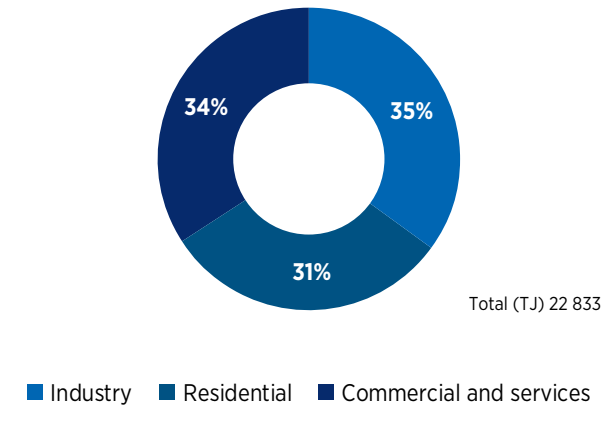
Based on: CNE (2020)

Figure 6. **Final energy consumption by sector, 2019**



Based on: CNE (2020)

Figure 7. **Electricity consumption by economic sector, 2019 (%)**



Based on: CNE (2020)

In 2019, total energy supply in El Salvador reached around 156 600 TJ (see Figure 5). That year, the renewable energy source with the largest share as part of the primary energy supply was bioenergy (19.6%), followed by hydropower (3.5%), geothermal energy (3.4%), and solar energy (1.1%) (CNE, 2020).

On the energy consumption side, the transport sector accounts for the largest share, followed by the industrial and residential sectors (Figure 6). Final energy consumption in the transport sector increased from 43 126 TJ in 2010 to 60 710 TJ in 2019, with the sector's overall share growing from 42% to 45% over the same period. Between 2010 and 2019, the residential and commercial sectors' shares fell, reaching 21% and 6% respectively, in 2019 (CNE, 2020).

In terms of electricity consumption, in 2019, the total was 22 833 TJ. As shown in Figure 7, the industrial sector is the largest consumer (35%), followed by the commercial, service and public sectors (34%) and the residential sector (31%).

City Hall of Santa Ana. Santa Ana, El Salvador.
Image credit: Shutterstock

Power sector

Electricity supply and demand

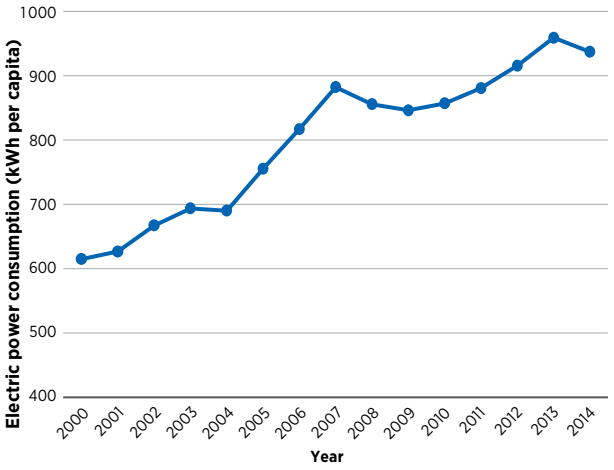
With 2018 seeing the achievement of an electricity access rate of 97%, El Salvador is close to universal access across the country (UN ECLAC, 2020). The remaining population without access to electricity is located in rural areas that are widely scattered.

From 2000 to 2014, electricity consumption per capita grew from about 615 to 937 kilowatt hours (kWh), following the same trend as the per capita GDP (Figure 8).

As shown in Figure 9, in 2019, total installed capacity in El Salvador reached 2.2 gigawatts (GW) (including off-grid generation). In the last five years, the average annual growth rate of total installed capacity has been around 6%. Since 2013, however, there have been no new additions of conventional thermal capacity (which in El Salvador has traditionally corresponded to fuel oil and bunker fuel). Yet, this type of power generation still has the largest share among all energy sources.

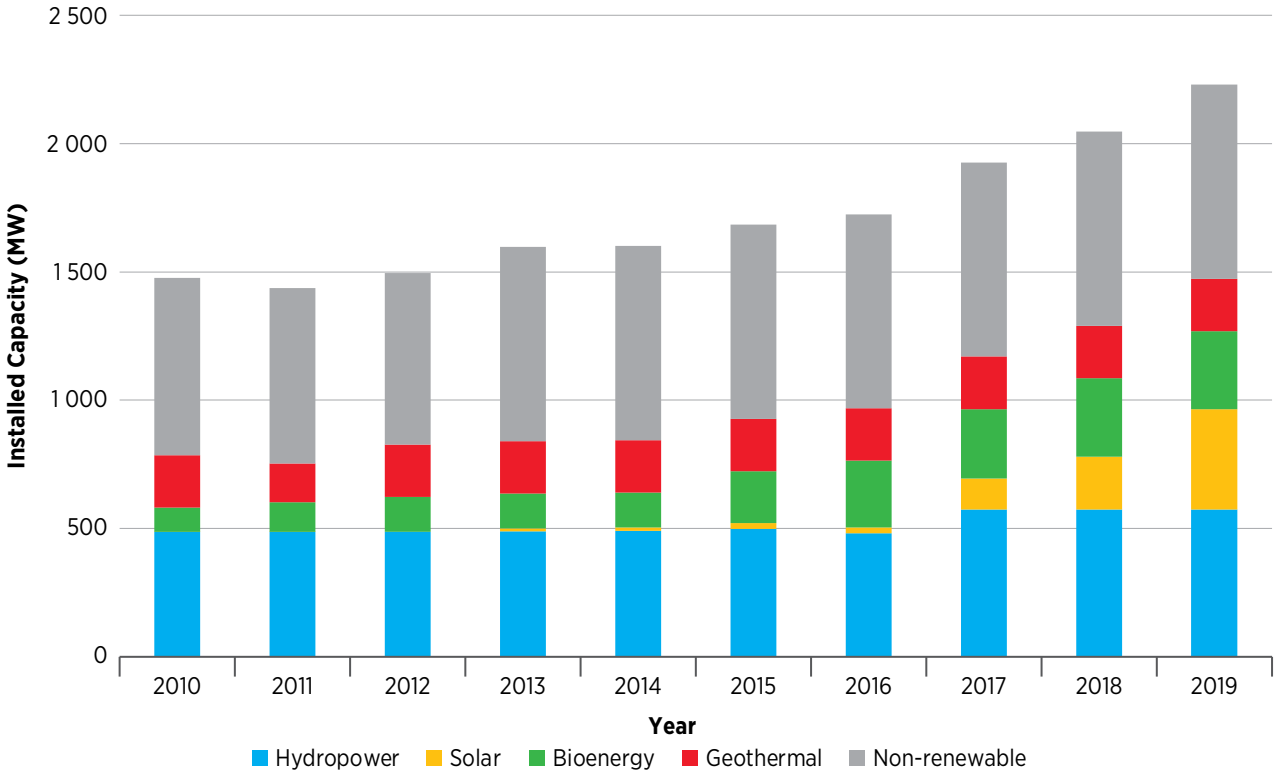
In 2019, conventional thermal capacity stood at 35.7%, followed by hydropower (26.9%), biomass (14.9%), solar photovoltaic (PV) (12.9%) and geothermal (9.6%). Since 2015, solar PV capacity has grown nearly tenfold, reaching 273 MW in 2019 (including off-grid generation). Moreover, solar PV and wind energy capacity is expected to grow in the coming years, as multiple projects are in the pipeline.

Figure 8. **Electricity consumption per capita**



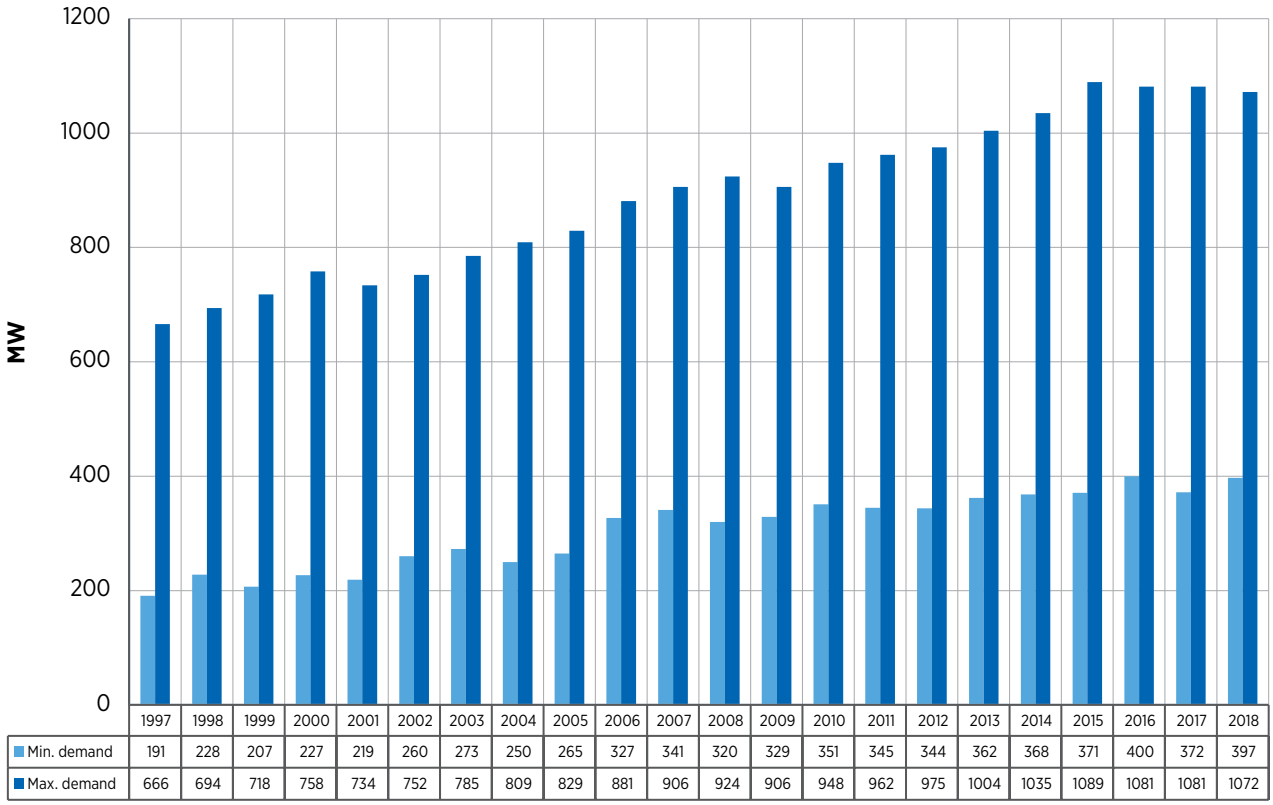
Based on: World Bank (2020e)

Figure 9. **Total installed power capacity by source, 2019**



Based on: IRENA (2020a)

Figure 10. **Development of electricity demand (minimum and maximum demand by year)**



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Min. demand	191	228	207	227	219	260	273	250	265	327	341	320	329	351	345	344	362	368	371	400	372	397
Max. demand	666	694	718	758	734	752	785	809	829	881	906	924	906	948	962	975	1004	1035	1089	1081	1081	1072

Source: SIGET (2019)

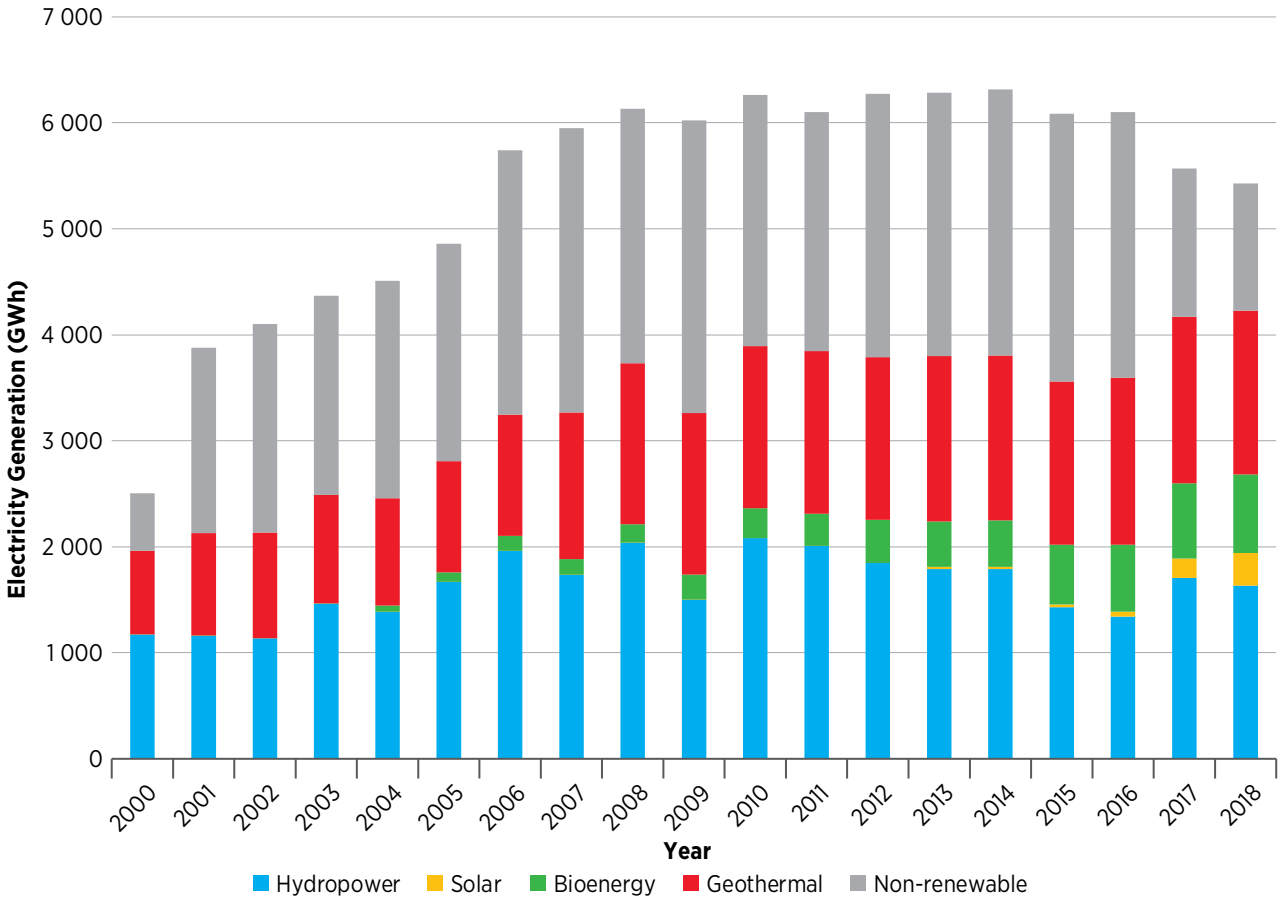
As of 2018, El Salvador's power system consisted of 25 power plants located around the country (Appendix 2). These are interconnected with the electricity transmission system and operate in the wholesale market. This generating fleet is composed of four hydropower plants operated by CEL (552.7 MW); two geothermal plants operated by LaGeo (204.4 MW), ten thermal power plants (757.1 MW), where one is state owned and operated by Energy Investments (INE – Inversiones Energéticas); five biomass power plants (293.6 MW)[1] and one solar PV plant (60 MW). In total, 45.9% of the total power generation capacity in El Salvador is state owned. A more detailed description can be found in Appendix 3.

Figure 10 shows the evolution of final electricity demand from 1997 to 2018. In order to cover the average annual growth rate in demand, which is between 2% and 3%, installed power capacity has increased. The difference between the installed capacity shown in Figure 9 and peak demand in Figure 10, is given by the nominal installed capacity and the reliability of generation. Thermal power plants are at present used as a back-up for variable renewable energy (VRE) generation. Thermal electricity production in El Salvador is, however, sometimes costlier than importing electricity within the regional market, as will be presented in the section below.

The evolution of electricity generation in El Salvador between 2000 and 2018 is shown in Figure 11. Since the 1990s, the Salvadoran electricity sector has relied most heavily on thermal power generation, followed by hydropower and geothermal energy. Geothermal generation reached over 1500 gigawatt hours (GWh) in 2008 and has since stagnated. Solar PV generation reached 309 GWh in 2018, while bioenergy generation exceeded 700 GWh. That same year, the share of non-renewable energy generation reached one of its lowest values in the last decade, at 1200 GWh (IRENA, 2020a).

1 The five biomass power plants are not available all year long (SIGET, 2019). They are mostly available during the May to October harvesting period.

Figure 11. **Gross electricity generation by type of resource**



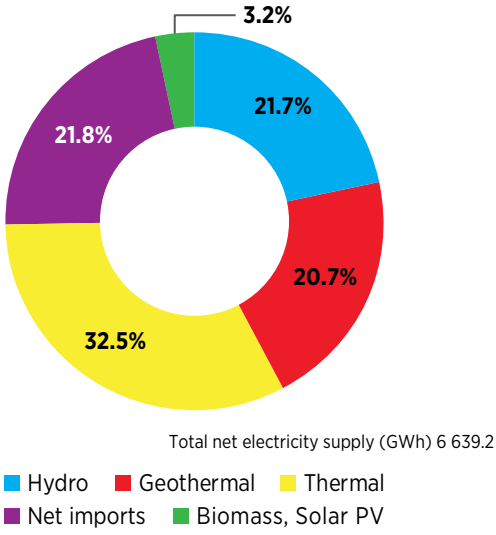
Source: IRENA (2020a)

In recent years, there has been a decrease in domestic electricity generation, mainly due to growing electricity imports, most of which come from Guatemala. Figure 11 reflects a clear reduction in domestic generation since 2014, with total net electricity generation standing at 5 426 GWh in 2018.

Figure 12 shows net electricity supply (including imports) by generation resource in 2019, with this accounting for a total of 6 639.2 GWh. Fossil fuels held the greatest share, at 32.5%, followed by net imports, at 21.8%, hydropower, at 21.7%, geothermal at 20.7%, and other renewable energy sources (biomass, solar PV, etc) at 3.3%.

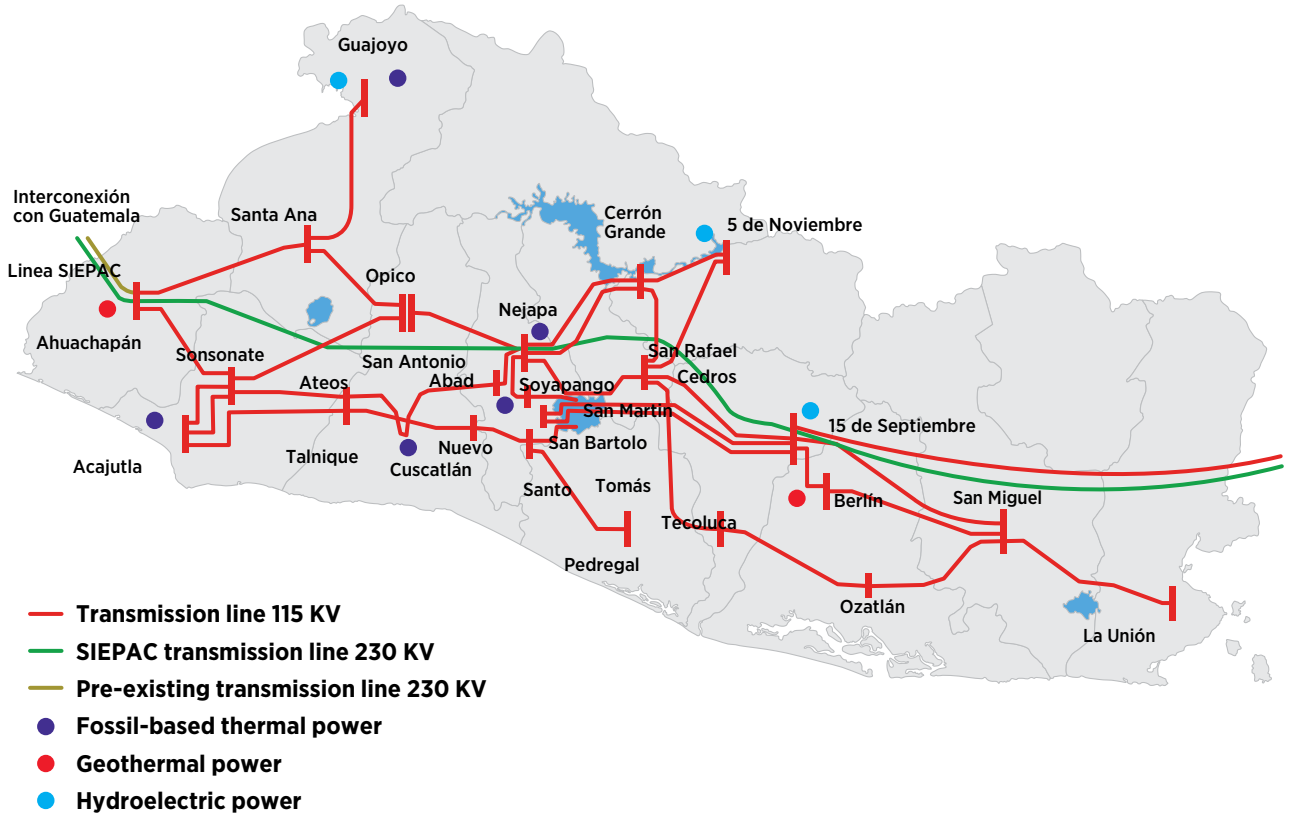
There is a high degree of interaction between the Regional Electricity Market (MER – *Mercado Eléctrico Regional*) and the national electricity market, as shown by the considerable share taken by net imports. In addition, at 20.7%, geothermal energy's share in net electricity supply is one of the highest in the world.

Figure 12. **Net electricity supply by resource, 2018 (%)**



Source: UT (2019)

Figure 13. **Generation and transmission system, 2018**



Source: SIGET (2019)

Transmission system

The Salvadoran electricity transmission system relies on 230 kilovolt (kV) central lines that also serve the interconnection with Guatemala and Honduras, as part of the Central American Electrical Interconnection System (SIEPAC – *Sistema de Interconexión Eléctrica de los Países de América Central*). This system's regional transmission line (RTL) has a transfer capacity at all borders in the region of 300 MW in one circuit.

The central lines are complemented by 1 372 km long transmission lines, consisting of 40 lines at 115 kV (1072 km) and four interconnection lines at 230 kV (299 km). The UT manages the country's electricity market and is responsible for the operation of the transmission system (SIGET, 2019).

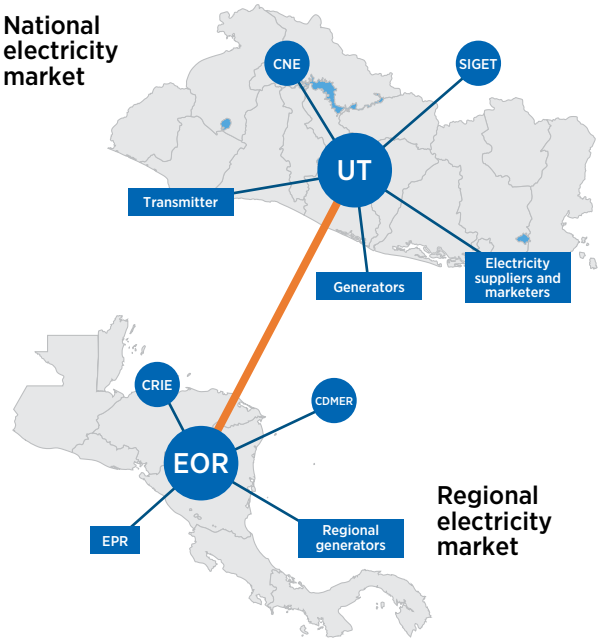
Wholesale power market

The electricity market in El Salvador comprises both public and private sector actors (Figure 14). In addition to the CNE, which is in charge of developing the national energy policy, the General Electricity and Telecommunications Superintendence (SIGET – *Superintendencia General de Electricidad y Telecomunicaciones*) is responsible for regulating the power sector.

The Salvadorian power market also includes generation and distribution companies; a transmission system owner – the Transmission Company of El Salvador (ETESAL – *Empresa Transmisora de El Salvador*); a market and system operator in charge of power exchanges (the UT); electricity suppliers and traders. All these actors are subject to electricity regulation at the national and MER levels.

The key actors in the MER are: the Regional Commission for Electrical Interconnection (CRIE – *Comisión Regional de Interconexión Eléctrica*), which is the regional regulator; the Regional Operating Entity (EOR – *Ente Operador Regional*), which is the system operator and market administrator; the Enterprise Owner of the Regional Electric Grid (EPR – *Empresa Propietaria de la Red*); the Council of the Regional Electricity Market (CD-MER – *Consejo Director del MER*), which is the body in charge of regional policies; the regional generating companies; and other market participants.

Figure 14. **Wholesale electricity market structure**



Source: CNE-PROESA (2016)

Disclaimer: Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA

The Transmission System and Wholesale Electricity Market Operation based on Production Cost Regulation (ROBCP – *Reglamento de Operación del Sistema de Transmisión y del Mercado Mayorista basado en Costos de Producción*) is the regulatory regime for the El Salvador market. Establishing clear rules, ROBCP aims to provide investors with guaranteed profits and end-users with affordable rates, while also rewarding efficiency. Variable production costs are the basis for each generator's generation dispatch, meaning that the market operator also has responsibility for conducting a mandatory cost audit for each generator, in order to verify their costs. (CNE-PROESA, 2016).

The electricity market comprises of two main business areas: the Long-Term Contract market (CLP – *Contratos de Largo Plazo*), and the spot market (MRS – *Mercado Regulador del Sistema*). The CLP was established in 2011 and is where long-term contracts are subscribed to by the distribution companies, via a competitive bidding process. This takes place under the supervision of the regulatory entity, SIGET. The MRS, meanwhile, operates on a production-cost basis and allows commercialisation of energy at variable prices, with these depending on the sector specifics. Factors here may include national demand, unavailability rates, and maximum powers for each plant, among others (CNE-PROESA, 2016).

Electricity generation costs and tariffs

Every three months, SIGET reviews the energy charge within the electricity tariff and may revise rates for each distribution company (SIGET, 2017a). Electricity prices in power purchase agreements (PPA) that have already been established through the competitive procurement process form the basis for any revision, as they reflect the current wholesale market power generation costs.

The end-user tariff considers the trading, transmission, distribution and energy charge, which are reviewed every five years, with the last revision in 2017. Within reviews, these tariffs can be adjusted annually according to changes in the Consumer Price Index (CPI) for the month of September.

The three electricity tariff categories are segmented according to maximum demand. First, there are small-scale users – those with demand under 10 kW – while second, there are medium-scale users, which have demand ranging from 10 kW to 50 kW. Finally, large-scale users are considered to be those with demand exceeding 50 kW. For small-scale residential users that have consumed between 1 kWh and 105 kWh in the six months prior to the calculation period, a continuous subsidy is provided by the government and paid through the National Investment Fund for Electricity and Telephony (FINET – Fondo de Inversión en Electricidad y Telefonía) (Legislative Assembly Executive Decree No. 38, 2018 – Asamblea Legislativa de la República de El Salvador, Decree Executivo No. 38, 2018).

Energy sector institutions and governance

El Salvador's institutional landscape in the energy sector is evolving, after going through a series of restructuring processes, focusing mainly on the power sector.

Key institutions

The CNE was created by a 2007 legislative decree and established as the energy sector's governing authority. It is responsible for developing national energy strategy and policy in order to further promote the development of renewable energy, the rational use of energy, the integration of regional energy markets, and the creation of enabling regulatory frameworks.

Before the creation of the CNE, the Ministry of Economy (MINEC – *Ministerio de Economía*) was in charge of the sector and operated through two directorates for its management and co-ordination. These were: the directorate for electricity and the regulatory directorate for hydrocarbons and mines. The latter still exists as part of MINEC, but as the regulatory entity for the oil and gas sector only (MINEC, n.d.).

The main functions of the CNE highlighted in the legislative decree are (IDB, 2013):

- planning and design of the national energy policy
- promotion of regulatory frameworks for the creation of investment and competitive conditions in the energy sector
- promotion of an adequate use of energy
- promotion of the development and deployment of renewable energy resources
- promotion of the integration of regional energy markets.

The CNE has a board of directors made up of representatives from its five member institutions: MINEC, which acts as president of the board; the Minister of Finance (MH – *Ministerio de Hacienda*); the Minister of the Environment and Natural Resources (MARN – *Ministerio de Medio Ambiente y Recursos Naturales*); the Minister of Public Works and Transport (MOP – *Ministerio de Obras Públicas y de Transporte*); the Deputy Minister of Transportation; and the President of Consumer Advocacy (DC – *Defensoría del Consumidor*).

The board of directors has responsibility for: monitoring the implementation of policy and strategies contained in national energy plans; promoting the approval of laws and regulations of the energy sector at a national level; preparing the national energy balance; developing and implementing subsidies for the energy system and monitoring the good use of the energy resources, as well as energy access across the Salvadorian population (IDB, 2013).

Additionally, the CNE has a consultative council, which includes: representatives of private sector trade associations (industrial and commercial); representatives of professional associations linked to energy; representatives of academic and research institutions; representatives of organisations linked to consumer protection; representatives of organisations linked to protection of the environment; and representatives of electrical industry unions.

As previously mentioned, the regulatory authority in the hydrocarbon sector is MINEC, operating through the Regulatory Directorate of Hydrocarbons and Mines. Infrastructure and handling of transportation of hydrocarbons are also overseen by MINEC. The participation of private companies in the marketing and importing of oil by-products is allowed. The regulator fixes liquified petroleum gas (LPG) prices and establishes a reference price for all petroleum derivative products. The Superintendence of Competition (SC) oversees monitoring of the markets in order to promote and protect competition, increase economic efficiency and consumer welfare.

Recently, the government of El Salvador created several executive bodies, or cabinets, for institutional co-ordination and strategic planning in key policy areas (Legislative Assembly Executive Decree No. 14, 2019 – Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 14, 2019).

Amongst these, the Energy Cabinet was created to undertake the strategic planning of investments in the generation, transmission and distribution of electricity, as well as to conduct a review of the country's energy mix. This is to be done in order to achieve affordable, cheaper energy from renewable resources for the population. The Energy Cabinet is composed by the Presidential Commissioner for Operations and Government Cabinet, MINEC, CNE, CEL, SIGET and the DC.

Structure of the power sector

Until the 1990s, El Salvador maintained a vertically integrated structure in its power sector, with CEL as the country's only state-owned generator. With Legislative Decree No. 137, dated October 18, 1948, CEL was established as an independent, public electric utility in charge of developing, conserving, managing and using the energy resources of the country (SIGET, 2017a).

Before the approval of the General Electricity Law and in preparation for reform, Legislative Decree No. 808, dated September 1996, established SIGET as the regulatory institution for the electricity and telecommunications sector. As the regulator, SIGET has the task of applying and enforcing the country's legal framework concerning both the electricity and telecommunications sectors. SIGET also guarantees both user and operator rights, while acting to develop a competitive market and more investment by establishing a robust legal framework. Final consumer tariffs are regulated by SIGET, while FINET is in charge of administration and the allocation of subsidies to low-income users, as well as the expansion of electricity coverage and rural electrification.

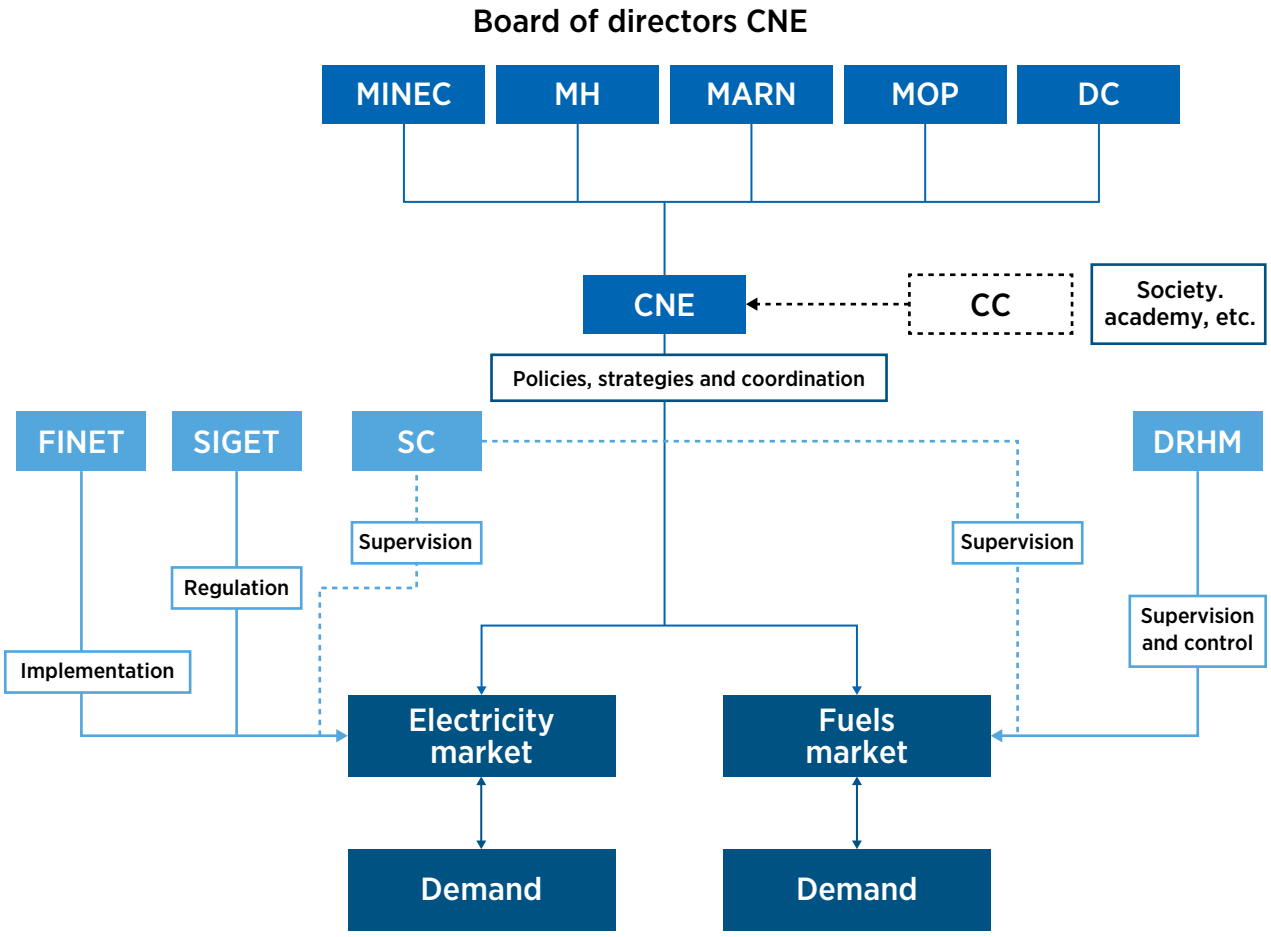
Following the enactment of the General Electricity Law and Legislative Decree 843, dated 10 October,1996, El Salvador began liberalising its electricity market and unbundling the vertically integrated CEL. The law opened up both generation and distribution to private sector participation, and by 2018, there were 25 private sector electricity generation plants operating in the wholesale market (UN ECLAC, 2020).

The law also maintained CEL's presence in the generation sector and, over time, CEL subsidiary generation companies were created. These include LaGeo in the geothermal sector, the Cucumacayán Electricity Company (CECSA – Compañía Eléctrica Cucumacayán) in the hydropower sector and Energy Investments (INE – Inversiones Energéticas) in the thermal sector.

Ownership and maintenance of the transmission system was turned over to the company ETESAL, while UT, a private corporation, was assigned to operate the transmission system and national electricity market.

A simplified scheme of the institution framework of the energy sector in El Salvador can be found in Figure 15, while a more detailed overview of the energy sector's institutions can be found in Appendix 1.

Figure 15. **Institutional structure of energy sector**



Based on: CNE (2012)

Energy policies and regulatory framework

El Salvador's National Energy Policy 2020-2050 was still being developed by CNE at the time of this report's release, with a publishing date of later in 2020. At time of writing, the existing national energy policy was thus still the one published by the Council in 2010 (CNE, 2010). This had the purpose of serving as a strategic guide for the development of the national energy sector during the 2010-2024 period.

The 2010-2024 policy includes:

- renewable energy resource promotion and energy mix diversification
- protection of final users with a strengthening of the sector's institutional frameworks
- the deployment of technologies that save energy and development of a culture of energy efficiency
- increasing access to power across the nation and the use of preferential rates
- the development of innovation and technology
- further energy integration of El Salvador at regional level

The primary entity for implementing this energy policy is the CEL and its subsidiary companies. These assume a strategic role in energy research, project execution and renewable energy generation, as well as maintaining a high degree of co-ordination with the CNE in the development of El Salvador's energy sector.

The government has also developed various actions for the development of renewable energy in the country and for the fostering of private sector participation.

These include the development of fiscal incentives for renewable energy project development proposed by MINEC and approved by the Salvadoran Legislative Assembly (Legislative Assembly Executive Decree No. 462, 2007 – *Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 462*, 2007). The CNE has been developing standards for renewable energy PPAs (CNE-PROESA, 2016), net-metering, and priority dispatch in the wholesale market for non-conventional renewable energy generators (wind, solar and biomass plants), among others.

The General Electricity Law

In addition to serving as the basis for the liberalisation of El Salvador's energy sector, the General Electricity Law establishes that auctions are the preferred mechanism for procuring new power capacity and allocating concessions for projects using geothermal and hydropower.

For geothermal and hydropower projects under 5 MW, there is a more streamlined concession process involving directly awarded tenders that are regulated by SIGET.

SIGET issues an agreement for an approved project, which can be granted in concessions of geothermal and hydro resources for power generation purposes. The project developers must also present the agreement for processing by the Legislative Assembly, which has to grant concessions for the use of the corresponding natural resources.

Rules for electricity trading activities

The retail electricity market is governed by a regulatory framework that promotes the commercialisation of electricity. The regulations allow for a wide diversity of electricity suppliers. This allows for more competitive options at the retail level, so that end-users are able to choose their electric power supplier. This regulation stipulates that an electricity market participant, or marketer, can:

- sign contracts for the supply of electric power, transmission, and distribution
- purchase and sell electric power in low voltage networks
- purchase and sell electric power in the wholesale market.

Regarding the first of these points, the prices and conditions of the supply contracts may be the same, or they may differ from those contained in the tariffs approved by SIGET for distributors that operate as marketers in the areas where their networks are located (SIGET, 2017b).

This regulation also allows for the connection of small power plants directly to the distribution system, enabling transactions between generators and distributors, distributors and marketers, and distributors and end users.

Legal Stability Law for Investment

In order to attract and promote investment, El Salvador enacted the Legal Stability Law for Investments in 2014. This provides a framework for guaranteeing legal assurance to the investor, through the implementation of legal stability contracts (Legislative Assembly Executive Decree No. 905, 2015 – *Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 905*, 2015). This law can be applied to national or foreign investors that are developing new projects, or expanding existing projects, within strategic sectors of El Salvador, including the energy sector.

Investors covered under this law are ensured stability of taxation and capital repatriation conditions, among other benefits. Under the law, developers must commit to undertake development work in the territory of the municipality where their project is located. This work must be worth at least 3% of the total contracted investment. There is also a time limit of two years from the start of the project's operation for disbursing the development work funds.

Despite the benefits of the law, however, several developers have experienced delays in project implementation due to its execution. Nonetheless, in 2019, MINEC signed the first legal stability contract for investments, between the government of El Salvador and the company Ventus S.A de C.V, which is developing the Ventus Wind Farm in Metapán, in the province of Santa Ana.

Fiscal Incentives Act to promote renewable energy

This Act for the promotion of renewable energy describes the benefits intended for investment in the construction or expansion of renewable energy power plants. The technologies covered by the Act include biomass, geothermal energy, hydropower, solar PV and wind.

According to the law, investments in new projects shall enjoy the following benefits and tax incentives (Legislative Assembly Executive Decree No. 462, 2007 – *Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 462*, 2007):

- For the first ten years of the project's lifetime, imported power generation equipment is duty free.
- For the first five years of the project's life time, if the project is larger than 10 MW, and for ten years, if it is less than 10 MW, the project is exempt from income tax.
- Any sales made under Certified Emission Reductions (CERs, made under the Clean Development Mechanism), or via similar carbon offsetting markets, gain a complete exemption from tax.
- Value Added Tax (VAT) is waived if it is otherwise liable as part of efforts made for investment or pre-investment in power plant construction.

Distributed generation regulation

In 2013, with Agreement No. 120-E-2013, SIGET approved a new norm, known as Open Procurement Processes for Long-term Contracts Supported by Renewable Distributed Generation. This enables the development of renewable distributed generation auctions of up to 20 MW. Under this, the procurement process is led by a distribution company, willing to purchase power from a self-generator for the distribution grid.

In 2017, through Agreement No. 367-E-2017, SIGET approved the Norm for End User Producers of Electrical Energy with Renewable Energy Sources. This established the procedures, requirements and responsibilities applicable to the connection, operation, control and commercialisation of surplus energy from distributed renewable generation units. In addition, this regulation also governs relations between the generator of electricity for self-consumption and the distribution company that is to receive the injections of surplus power.

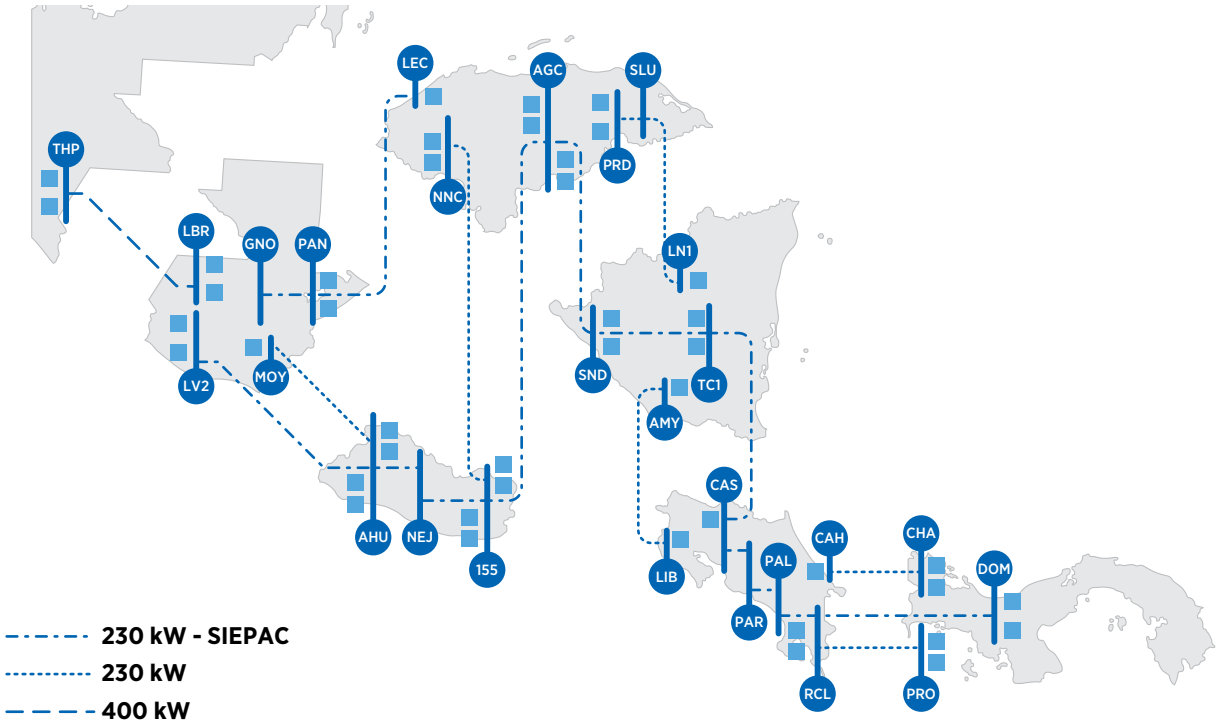
This procedure for selling electricity to the grid is usually referred to as "net metering". With this scheme, end users (generally residential and commercial customers) which generate their own electricity can feed excess generation back into the grid. This end user producer is then compensated in terms of energy (i.e., credit in kWh), and the credit can be applied to offset consumption of electricity within the current billing period (e.g., one month).

International power trade

Today's regional transmission line – known as SIEPAC (Figure 16) – links six different countries and evolved from a series of bilateral arrangements between regional countries. In those early stages, energy transfers were limited to amounts varying between 5 MW and 50 MW and took place according to specific arrangements.

Such transfers enjoyed considerable political support amongst Central American countries, which led to the 1996 Marco Treaty of the Electricity Market of Central America, which came into force in 1999. This was the foundation stone for MER, which uses the infrastructure established by SIEPAC. At time of writing, in addition to El Salvador, MER's members are Costa Rica, Guatemala, Honduras, Nicaragua and Panama.

Figure 16. **Regional electricity system (SIEPAC line)**



Source: EOR (2017)

Disclaimer: Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA

The Marco Treaty

The SIEPAC interconnection established by the Marco Treaty of the Electricity Market of Central America is owned by the EPR, which the Treaty also established, along with the regional regulator, the CRIE, and a regional market operator, the EOR (Reinstein et al., 2011).[2]

CRIE is based in Guatemala and began work in 2000, led by its board of commissioners and executive secretary. The board contains a representative from each member-state, with this representative usually also a member of their country's national regulatory board.

Regional electricity transactions

MER member-state agencies conduct transactions with each other in three ways: spot transactions, firm, or non-firm contracts. (Reinstein et al., 2011). The EOR then produces a monthly regional economic transactions record, setting out all the transactions undertaken in summary form. For agencies which have debts, the monthly record also gives a timeline for them to make credit transfers to the regional liquidating bank. As a condition to participate in the MER, agents must supply a payment guarantee to this financial institution. In order to make sure that there is always enough daily collateral to support the transactions made, a deduction equal to the amount of credit is made by the EOR from the value of this payment guarantee.

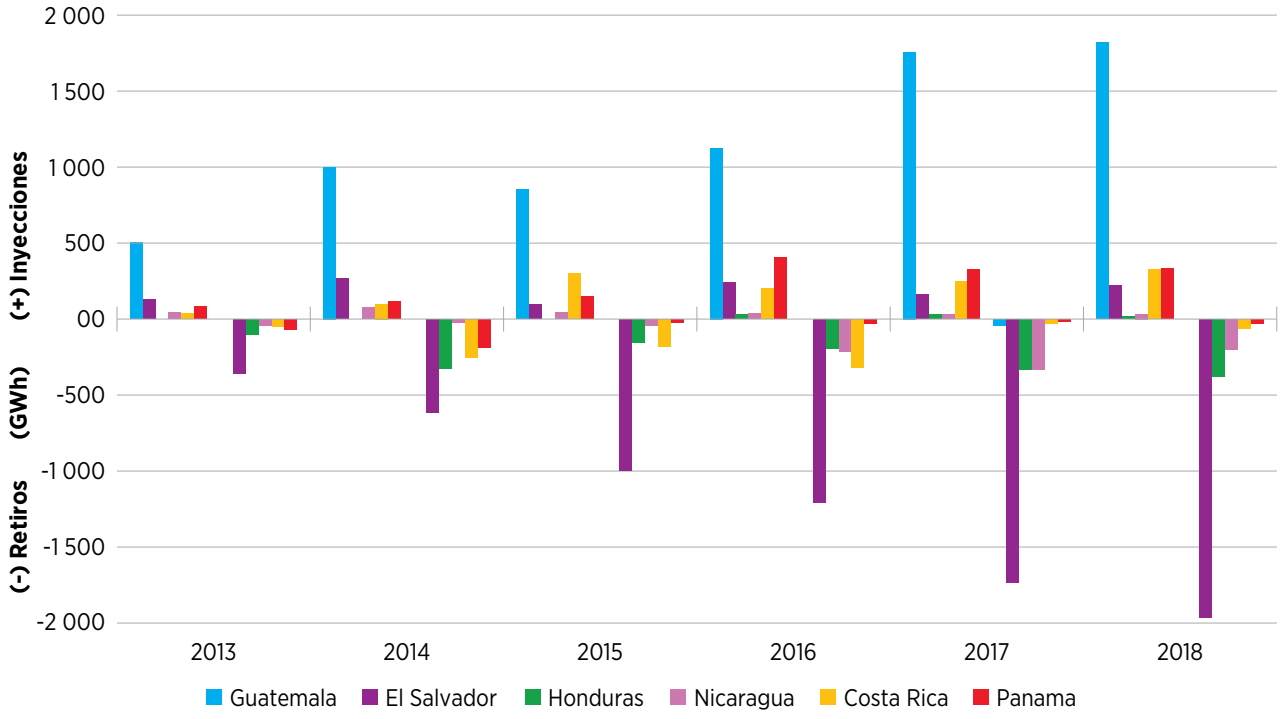
Given the increasing volume of electricity imports from the region, El Salvador's national electricity market has become highly dynamic. As of 2017, the country had 47 authorised agents for transactions in MER: eight generators, seven distributors, 31 marketers and one large user (CRIE, 2018). The majority of El Salvador's import transactions come from Guatemala, which accounted for over 67% of electricity injections into the SIEPAC in 2018.

2 Transmission rights (DTs – Derechos de transmission), is a system of trading the rights to using transmission lines.

3 The transmission entity (EOR in this case) will issue rights to use the regional line (SIEPAC) and make it available to buyers and sellers of electricity in the region. The regional energy buyer/seller will then buy these transmission rights in order to use the line to transmit/transport the energy across the region for their needs.

4 The regional transmission line is often constrained, and transmission entities are required to plan ahead of time to manage the system. The transmission rights system allows them to plan and offer a transparent pricing system for the users.

Figure 17. **Imports and exports in the regional market, per country**



Source: CRIE (2019)

El Salvador complies with regional interconnection requirements and provisions in transmission expansion planning at the national level. This is thanks to the growing number of transactions within both the regional market and the integrated national electricity system within SIEPAC.

Since El Salvador has the opportunity to use the SIEPAC infrastructure to meet national electricity demand, opportunities exist that can create a more robust national transmission system. One such opportunity is the construction of additional 230 kV lines between the Port of Acajutla, El Pedregal and the 15 de Septiembre substations, which, when complemented by the 230 kV line to be built by Pacific Energy (EDP – *Energía del Pacifico*) between Acajutla and Ahuachapán (see Figure 13), would form a ring loop and therefore create a more robust network (CRIE, 2018).

On the other hand, the construction of a transmission line between Acajutla and Ahuachapán is also tied to the construction of a natural gas power plant in the Sonsonate region.

Such considerations are included in ETESAL's transmission network expansion plan. This type of network would also facilitate the dispatch of electricity that is expected to be generated by new power plants (including renewable energy generating facilities), which would be strategically located for interconnection with the transmission grid.

In November 2018, CRIE published RESOLUTION-CRIE-95-2018, which establishes the minimum technical requirements for connecting and operating solar PV and wind plants in the regional power system.

This resolution will be applicable to new requests for integrating these renewable technologies into the regional grid. (CRIE, 2018) The resolution and the minimum technical requirements have been transferred by the Executive Secretary of the CRIE to national regulatory bodies in the region, to evaluate the possibility of including them in their national regulations, in the short term. Consultation and training activities are therefore also envisaged by the national regulators of the participating member states, as well as solar PV and wind project developers.

The resolution further stipulates that system operators and market operators adopt the necessary measures to co ordinate the operation of the distributed generation of wind and solar PV power plants connected at low or medium voltage levels, or storage of energy at the distribution level (CRIE, 2018).

Box 1. **The Clean Energy Corridor of Central America**

IRENA launched the Clean Energy Corridor of Central America (CECCA) initiative in 2015. This was in order to support the accelerated deployment of renewables at the regional level. It was also undertaken within the context of the SIEPAC line that interconnects Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, and to promote cross-border trade of renewable energy power in the region.

CECCA is built around the key pillars of implementation: power system operations and regulatory frameworks for increasing VRE shares; country and regional power system planning with renewables; zoning and renewable resource assessment; and capacity building and information dissemination.

The implementation of CECCA started within its pilot country, Panama, in 2016. There, an assessment was made of PPAs for solar and wind energy, as part of the regulatory component of the initiative. Likewise, IRENA has conducted a series of capacity building activities for Central American national and regional grid operators, targeting the integration of VRE into their electricity systems, in line with CECCA's technical component.

Additionally, IRENA has recently started the regional Renewable Roadmap (REmap) and flexibility assessment of the power systems of all the CECCA countries – an effort that forms part of the country and regional power system planning pillar of the initiative. It is envisaged that this pillar will be expanded by implementing a series of workshops. These will be on long-term energy planning, the promotion and identification of best planning practices, and experience sharing among the countries of Central America when planning with renewable energy sources.

Regional partners have supported CECCA in its development, with the initiative becoming a milestone and reference point for the Central American region. It has also now been included as part of other regional efforts, as it forms the basis for the Central American Economic Commission for Latin America and the Caribbean (ECLAC)-Central American Integration System (SICA) energy strategy 2030.

3. Renewable energy developments

Drivers of renewable energy deployment

The Republic of El Salvador is making a concerted effort to boost economic growth and the welfare of its inhabitants. In this regard, the government considers the energy sector a strong contributor to economic and social development (CNE, 2010). Recent IRENA work, for example, estimates that more than 2 million jobs have been created by the renewable energy sector in Latin America and the Caribbean by 2017. Potentially, this could reach more than 3 million jobs by 2030, given a scenario in which the rise in global temperatures is kept to well below 2°C and closer to 1.5°C, during this century (IRENA, 2020b).

On a global level, renewable energy has experienced a rapid decline in cost in recent years. Between 2010 and 2019, the global weighted average levelised cost of electricity (LCOE) from solar PV fell 82%, to USD 68.40 per megawatt hour (MWh), while the cost of electricity from onshore wind declined 45%, to USD 52.8/MWh (IRENA, 2020b). El Salvador's power generation costs, however, have been strongly influenced by the price volatility of oil and gas, due to fossil fuel dependency in the country's energy sector. The cost of this energy has put pressure on the state budget and has a negative impact on its final users (see Box 2).

In addition, El Salvador is vulnerable to climate change, with temperatures forecast to rise between 1.4°C and 2°C by 2050. During this period, sea levels may rise by some 18 centimetres (cm), while 'extreme weather events', such as tropical storms, floods and droughts, are also expected to increase in frequency and intensity (USAID, 2017). All these conditions will affect different aspects of the country, including energy infrastructure and power generation. Hydropower generation along the Lempa River Basin, for example, could decline by between 33% and 53% by the end of the century (USAID, 2017).

Addressing these challenges has become the main driver for the promotion of renewable energy in El Salvador. With the introduction of the National Energy Policy 2010-2024, the country prioritised the diversification of the energy mix, as a starting point for improving the energy supply. This was also seen as a tool for increasing access to electricity across the population.

With the adoption of the Paris agreement, El Salvador has also prioritised the mitigation of greenhouse gas emissions from the energy sector. This is to be achieved by increasing the penetration of clean energy sources, together with improving energy efficiency along the whole energy chain.

With good progress made on energy access rates and renewable energy penetration in the power sector, the new, National Energy Policy 2020-2050 is now under development. This draws up a long-term energy strategy for the country, highlighting the importance of mitigating the dependency on fossil-fuels and climate change effects, with the promotion and use of renewable energy beyond the power sector.

The new energy policy supports the development of direct use applications from renewable energy sources, such as geothermal and solar thermal, facilitating the penetration of clean technologies in the industrial and agricultural sector. This is the result of the successful implementation in recent years of renewable energy pilot projects, involving local and vulnerable communities. These have provided clear benefits by boosting local economies, promoting the development of the agri-food sector, and by the inclusion of women in commercial activities.

Additionally, El Salvador envisages the use of innovative technologies such as electric vehicles, blockchain and digitalisation. This is with the aim of creating a modern energy sector, as a priority on the path to achieving the country's sustainable development objectives and attracting foreign investment to boost the economy.

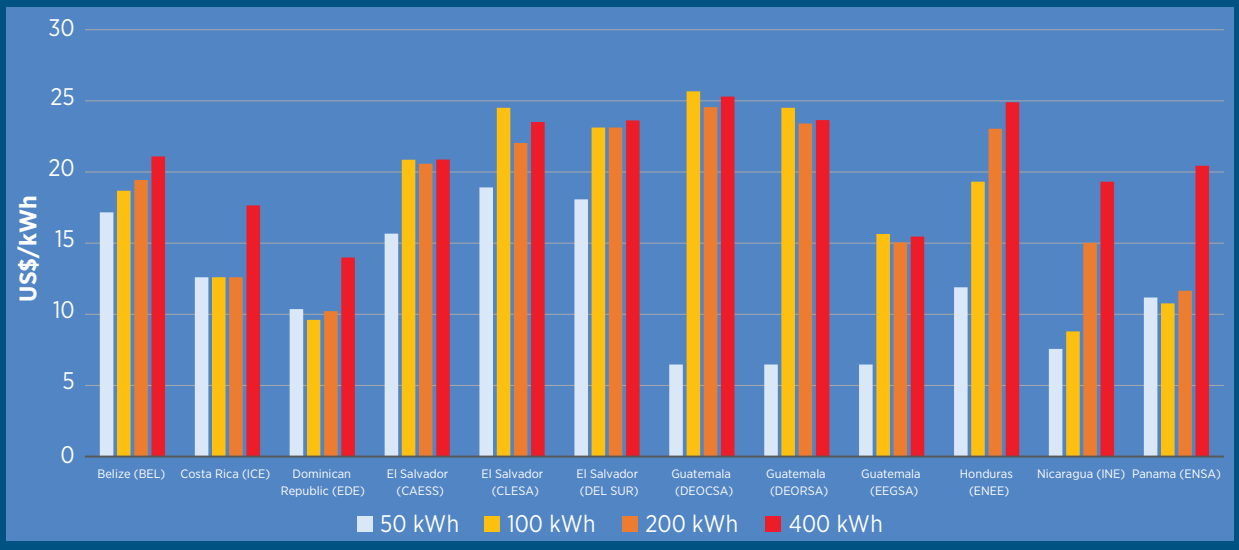
Box 2. **Electricity tariffs**

During the 1990s, the country's power generation portfolio witnessed an influx of conventional thermal units, which led to a higher fossil-fuel dependency. This was despite the traditionally significant role of hydro and geothermal power generation in the energy system.

During the following decades, global oil market price volatility provoked an increase in electricity tariffs, giving El Salvador one of the highest residential rates in Central America (see Figure 18). Between 1998 and 2015, the average electricity tariff in El Salvador increased by 53.5%, due to the rise in international oil prices. Generation costs (including fuel and transmission costs) corresponds to an estimated 80% of the final electricity price, while the remaining 20% is mostly distribution and commercialisation charges. The latter decreased dramatically in 2015, however, due to the entrance of new actors in the country's distribution market (Superintendence of Competition of El Salvador, 2017).

The government of El Salvador believes that renewable energy sources are the key to mitigating dependency on fossil-fuels in power generation, with their use also contributing to a reduction in electricity tariffs (CNE, 2010). Additionally, the current high costs of electricity require the use of subsidies to provide services to all the inhabitants, resulting in high expenditure for the country. Therefore, among the main objectives of the new National Energy Policy 2020-2050 is a reduction of the electricity tariff through the promotion of renewable energy generation, facilitating the removal of electricity subsidies towards the end of the policy period.

Figure 18. **Residential electricity rates of some of the main distribution companies in SICA, for consumption of 50, 100, 200, and 400 kWh - December 2018**



Based on: (UN ECLAC, 2019)

Renewable energy resources

The range of renewable energy resources available in the Latin American and Caribbean regions is a wide one – although much of this potential has yet to be realised. While more than a quarter of the total primary energy supply in the region came from renewables in 2017 – twice the global average – the regions' total renewable generation represents just 6% of its overall renewable power potential.

A renewable energy installed capacity of 50 GW of bioenergy, 186 GW of hydro, 108 GW of solar PV and 93 GW of wind is achievable by 2030, and in line with the Paris Agreement (IRENA, 2020b). These estimations do not consider the geothermal or ocean energy resource potential, which will also play an important future role in the region's energy supply.

El Salvador is not an exception to these regional characteristics. Given its geographical position, the country's renewable energy potential is abundant and diverse, and includes bioenergy, geothermal, hydropower, ocean, solar and wind. While the country has recently made significant advances in diversifying its energy supply, much of its renewable resource potential remains untapped.

Bioenergy

In terms of installed power capacity, by 2019, El Salvador's solid biomass had reached 298 MW while biogas totalled nearly 7 MW (IRENA, 2020a). The estimated net primary production of bioenergy in El Salvador is around 10.5 tonnes of carbon per hectare per year (tC/ha/yr), which is well above the global average of between 3 tC/ha/yr and 4 tC/ha/yr (IRENA, 2019). In 2018, bioenergy (sugarcane bagasse and firewood) stood at over 18% of primary energy supply.

A range of factors govern the quantity of residues available to the bioeneregy sector, including the overall level of activity in the economy. This is also largely the case for solid waste from urban areas and sawmill residues, which are beyond the scope of this report.

Geothermal energy

The exploitation of geothermal resources in El Salvador started back in the 1960s with the identification of 18 potential geothermal sites in the country. The first geothermal power plant was commissioned in 1975 in Ahuachapán.

This relatively long history in the sector has given El Salvador a leading role within the regional geothermal sector. There are now significant numbers of experienced scientists and technicians available in the country, with these often sharing their expertise via the Geothermal Centre of Excellence in El Salvador (Box 3). This provides young professionals from the country and around Latin America and the Caribbean with training courses and workshops in many aspects of geothermal energy.

Nowadays, utility company LaGeo operates roughly 200 MW of geothermal power capacity across two geothermal fields. Following a public tender in 2001, Enel Green Power purchased a 9% share of LaGeo, gradually increasing this to 36%, with the government of El Salvador holding the remaining shares. In 2008, the government obtained full ownership of LaGeo, after Enel Green Power sold its ownership share (Sanyal et al., 2016).

Regarding direct use of geothermal energy, an installed capacity of 3.36 MWt is estimated for 2015, including a variety of applications for swimming and bathing, as well as pilot projects in the agri-food sector, such as greenhouse heating, fish farming and food drying (Lund and Boyd, 2015).

Box 3. **The Geothermal Centre of Excellence in El Salvador**

Blessed with extensive geothermal resources, El Salvador is fortunate in having a history of geothermal energy development that now dates back to the 1950s. This has given it an unprecedented level of expertise in the field within the region – a factor now capitalised upon by the Geothermal Centre of Excellence in El Salvador.

A joint project between LaGeo and the GRÓ GTP Geothermal Training Programme from Iceland (previously known as the United Nations University-Geothermal Training Programme), the Centre has established the country as a leading location for training in the geothermal industry.

Young professionals from El Salvador, other Latin American countries and the Caribbean have been able to share the extensive technical, scientific and managerial experience and knowledge accumulated by the Centre via a range of workshops and courses.

The five-month Geothermal Diploma Course for Latin America is a flagship amongst these, helping El Salvador set the standard for geothermal training in the region. The Diploma brings together experts from El Salvador and Iceland – another key country in the global geothermal industry – thanks to a co-operation agreement between LaGeo and GRÓ GTP.

The Centre has so far provided the Diploma course – and other, shorter training programmes –to over 700 professionals. In addition to those from El Salvador who have enrolled on these courses, students have included professionals from Montserrat, Saint Kitts & Nevis, St. Vincent and the Grenadines in the Caribbean, and Argentina, Bolivia, Chile, Colombia, Costa Rica, Dominica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, and Peru from elsewhere in Latin America.

Source: GGA (n.d.)

Hydropower

Hydropower continues to have the largest share of renewables in El Salvador's electricity mix.

In recent years, CEL has carried out an 80 MW expansion project at the 5 de Noviembre hydroelectric plant, with 2 January 2017 seeing the plant's two new, 40 MW generating units begin commercial operation. This allows them to harness the surplus water that accompanies the rainy season. Meanwhile, the El Chaparral hydroelectric plant is under construction and will have an installed generation capacity of 65.7 MW on completion. It is expected to start operations in 2021.

Ocean energy

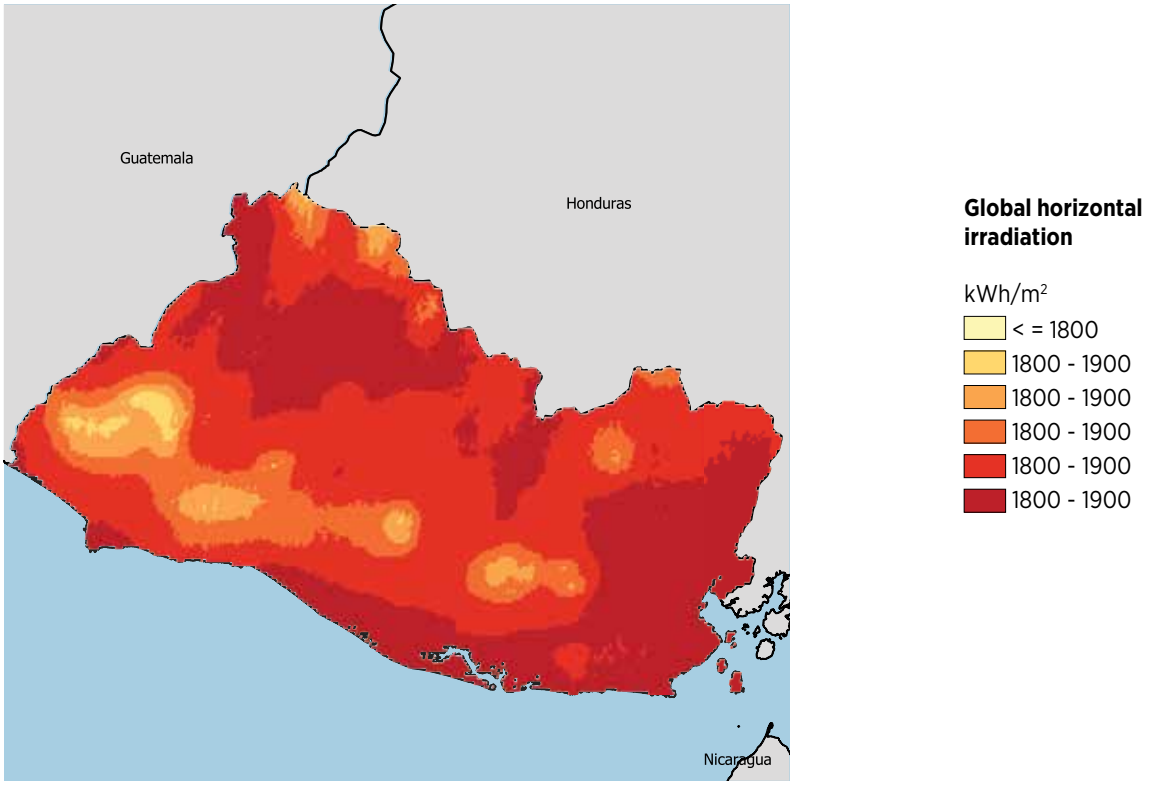
Preliminary research on Mizata beach (La Libertad Department) has been carried out to determine the energy potential of marine waves. (LaGeo, n.d.). LaGeo's renewable energy unit, the entity conducting the study, collected the necessary data using a sensor that measured: (i) height, speed, temperature, direction and flow of the energy contained in one metre of wave front; and (ii) the height variation of the tides.

Solar energy

Figure 19 presents an overview of the solar irradiation for El Salvador, according to the IRENA Global Atlas. The solar irradiation in the country is uniformly consistent across the territory, being in average larger than 2 000 kWh/m^2. Likewise, more than 80% of the Salvadorian territory shows estimated annual generation per unit of installed PV capacity in the range of 1600 kilowatt hours per kilowatt peak per year (kWh/kWp/yr) and 1800 kWh/kWp/yr (IRENA, 2019).

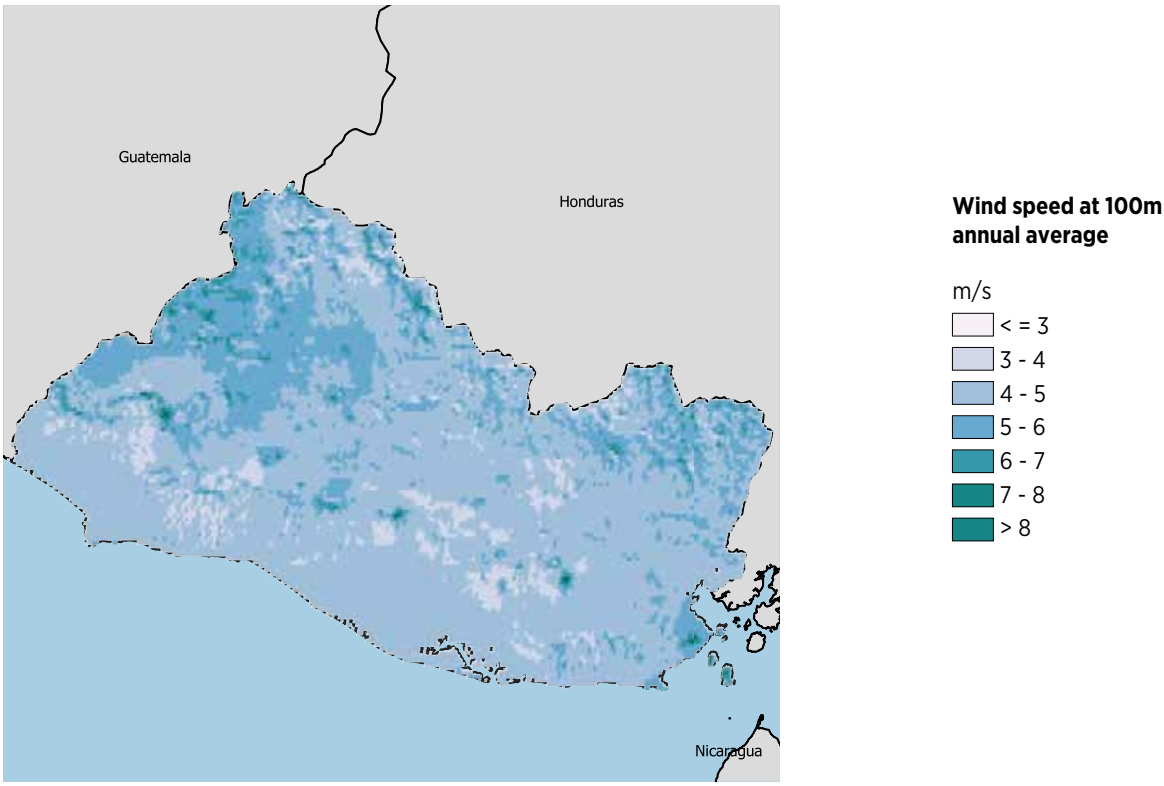
Several solar PV projects have become operational in recent years, totalling over 166 megawatt peak (MWp) of installed power capacity, by 2018. Solar irradiation in El Salvador is high, which provides excellent yields and favourable cost-benefit conditions for the development of solar PV plants.

Figure 19. **El Salvador: Global horizontal irradiation, kWh/m², 1km 1994/1999/2007-2015**



Source: IRENA: Global Atlas, Map data: ESMAP, 2019, [2019] OpenStreetMap contributors

Figure 20. **El Salvador: Average wind speed at 100m hub height**



Source: IRENA: Global Atlas, Map data: DTU, 2019, [2019] OpenStreetMap contributors

Box 4. **IRENA Global Atlas Geospatial and Site assessment services**

Resource mapping is the first phase in planning a cost-effective renewable energy project for subsequent development.

IRENA's geospatial assessment services aim to identify areas and zones (and attributes) in a country that are appropriate for deploying utility-scale wind and solar PV power projects. The methodology combines resource maps and ancillary data, such as transmission lines and road networks, protected areas, land cover, topography, and population growth. These factors are assessed in order to identify areas and zones that have good resource availability, are within reasonable proximity to the necessary infrastructure, and have low environmental and social impact, based on local conditions. Furthermore, the assessment calculates the maximum installable capacity, identifies the energy generation potential and suggests possible storage opportunities for each zone. Such information supports adequate generation and transmission expansion planning, reduces the risk of investing in unsuitable areas, supports countries in making strategic decisions on energy security, and increases the share of sustainable sources of electricity generation.

IRENA's site assessment service aims to evaluate the technical and financial viability of sites for solar PV and wind project development. The methodology uses high resolution site-specific time series resource data, site characteristics and technological parameters to calculate the annual energy production (AEP) at different exceedance probabilities for each site. It further simulates the levelised costs and tariffs at which the sites would become viable for further investment in in-situ measurements and subsequent development. This information is of critical value to local authorities, which can screen these sites by comparing the pro-forma tariffs or levelised costs to a benchmark, ensuring resources are invested only in worthy locations.

Wind energy

Despite the country's interest in promoting wind power plants, the prices achieved in El Salvador's first auction in 2014 were over the ceiling prices, so no wind projects were awarded. During the country's second auction, one project was awarded, but as of 2019, it has not come online.

Several studies looking at measurements from meteorological stations have detected wind speeds of between 1.1 metres per second (m/s) and 4.3 m/s (MARN and UCA, 2005). Figure 20 presents an overview of the average wind speed at 100 m hub height, showing that this averages between 4 m/s and 5 m/s. Likewise, around 70% of Salvadorian territory has a potential wind power density (at 100 m high) of below 260 watts per square metre (W/m^2) (IRENA, 2019). Few areas have shown high and relatively constant wind speeds. One site that has proved to have high wind speeds is the 54 MW project developed by Ventus in Metapán, which has an average speed of 6.6 m/s at 50 metres high

Renewable energy master plan

In 2012, in collaboration with the Japan International Cooperation Agency (JICA), CNE developed the Master Plan for the Renewable Energy Development of El Salvador. This plan identifies the renewable energy sources that have potential in the country, and highlights an indicative roadmap for the development of those resources out to 2026. The estimated potential capacity additions by then, as per each energy source, are provided in Table 2.

This master plan aims to promote the diversification of the energy mix, by adopting clean energy sources. The development of this plan also encouraged the implementation of other supporting mechanisms for renewable energy, such as auctions, long term contracts, and others.

Table 2. **Additional installed capacity per source by 2026**

Energy source	Small hydro (<20 MW)	Wind	Solar PV	Solar thermal*	Geothermal	Biomass	Biogas
Installed capacity (MW) in 2012	35	-	0.5	-	204.4	109.5	6.3
Additional installed capacity to 2026 (MW)	162.7	60	90	200	60-89	45	35

Source: CNE and JICA (2012)

* Power generation capacity estimation.

Box 5. **IRENA Regional REmap & FlexTool**

IRENA is currently developing a regional REmap (Renewable Energy Roadmap) study for Central America. This will include the countries of Belize, Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua and Panama and be complemented by a power system flexibility assessment using IRENA's FlexTool. This is a publicly and freely available tool that analyses power system flexibility in detail.

The regional REmap study explores technology options that enable an energy transition at the regional level, through the accelerated development of renewable energy in the energy mix. The study covers electricity generation, the end-use sectors (transport, industry and buildings) and energy efficiency. Additionally, using the FlexTool, the energy scenarios resulting from the REmap analysis are analysed in terms of power system flexibility, in order to check their technical feasibility and provide feedback to the REmap team.

The project began in May 2019, with its first step a major effort to engage country counterparts and institutions and scope the vision for the analysis. This involved several conference calls, including with member countries and regional institutions, with the aim of securing their interest and participation in the project. As a culmination of this first step, IRENA organised the First Regional Workshop: A renewable energy roadmap and flexibility assessment for Central America, which was hosted by the National Energy Secretariat of Panama and took place in Panama City between 4-5 September 2019.

During the workshop, the countries involved in the study, partner institutions and IRENA assessed policy objectives and priorities at the national and regional levels, along with the status of the energy system in each country. The workshop also served to evaluate the current status of renewable energy development, existing planning models and the vision of regional integration. Regional institutions that joined the workshop included the Latin American Energy Organisation (OLADE – Organización Latinoamericana de Energía), ECLAC, World Bank, the Inter American Development Bank (IDB), UNFCCC, SICA, EPR and EOR.

As a follow-up to the first workshop, individual data requests were sent to each country and conference calls were organised to discuss the data input for the study. Having collected most of the data needed for the analysis, the project is currently at the phase of developing the energy system reference and REmap scenarios that will then serve as an input for the flexibility assessment.

A 2nd workshop was scheduled for the last week of March 2020 to help in the development of the reference scenario. The workshop was confirmed with the participation of all countries and regional institutions, but had to be cancelled due to the coronavirus pandemic. The workshop will be replaced by bilateral calls with countries. The calls should take place during the second half of 2020, with the overall final results of the project expected to be concluded and presented by the end of that year.

Renewable energy support mechanisms in the power sector

El Salvador utilises a range of support mechanisms to incentivise renewable energy development in the power sector. The main instruments, as shown in Table 3, can be segmented into the following categories: a) Fiscal incentives; b) access to electricity transmission grid; c) regulatory instruments; d) financial instruments; and e) others (IRENA, 2016).

Fiscal incentives

- **Value added tax (VAT, 13%):** Provisions for VAT exemption related to pre-investment work and investments in the construction of renewable energy projects (Legislative Assembly Executive Decree No. 462, 2007 – Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 462, 2007).

- **Income tax:** For projects larger than 10 MW in size, there is a five year income tax exemption. For those smaller, the exemption is for ten years.

- **Import tax (5%):** Tax benefits for the import of equipment, services or products intended for renewable energy projects.

- **Certificates of Reduced Emissions (CERs):** Under the framework of the Kyoto Protocol's Clean Development Mechanism – and other, similar carbon markets – income derived from the sale of CERs is completely tax exempt.

Access to electricity transmission grids

- **Grid access:** Generators are guaranteed grid access, including renewable energy generators.

- **Priority dispatch:** Article 67-E, which is included among the reforms made to the General Electricity Law, establishes that renewable generation plants (from solar, wind and biomass) have dispatch priority, and therefore their marginal cost is considered to be zero (Legislative Assembly Executive Decree No. 80, 2012 – Asamblea Legislativa de la República de El Salvador, Decreto Ejecutivo No. 80, 2012).

Regulatory instruments

- **Renewable energy auctions:** Technology-specific auctions are implemented to procure renewable energy capacity resulting in long-term power purchase agreements (PPA).

- **Distributed generation:** Net metering regulations enable eligible self-producers of renewable energy to inject surplus production into the local distribution grid (SIGET, 2017a). Likewise, there are rules set for renewable distributed generation auctions in the Agreement No. 120-E-2013.

Financial instruments

- **Dedicated fund:** A public fund (FINET) finances projects related to energy generation or the improvement of energy infrastructure in rural areas.

- **Eligibility fund:** A public fund of the El Salvador Development Bank (BANDESAL – Banco de Desarrollo de El Salvador), provides financing for renewable projects.

Others

- **Social support requirements:** Renewable energy projects are required to allocate a percentage of their revenue to either directly support local community projects, or to support the overall financing of community development. (REN21, 2017).

Table 3. **Support instruments to promote renewable energy**

	Supporting instrument	Existing supporting instrument
Fiscal incentives	VAT exemption	Yes
	Income tax exemption	Yes
	Import fiscal benefit	Yes
	Tax exemption from the sell of CERs	Yes
	National exemption of local taxes	No
	Accelerated Depreciation	No
Grid	Grid access	Yes
	Preferential dispatch of energy	Yes
Regulator	Auctions of PPAs	Yes
	Feed-in tariff	No
	Net metering	Yes
Finance	Dedicated fund	Yes
	Eligible fund	Yes
	Pre-investment support	Yes
Other	Social requirements	Yes
	Renewable energy in rural access programs	Yes

Based on: BNEF (2012)

Renewable energy auctions

The reform of the General Electricity Law in 2007 established the procedures and regulations for the use of bidding processes to procure power capacity. Under these, the winning bidders enter into long-term PPAs with the off-taker, a distribution company.

There are two types of renewable energy auctions in El Salvador, for generators connected to the grid and for distributed generation projects.

Some of the most relevant aspects of the auction methodology in El Salvador are the following (USAID, 2018):

- The contracted amounts per auction are allocated proportionally among all of the distribution companies, based on their shares in the wholesale market.
- The auctions aim to be transparent and are therefore publicly announced, with a publicly disclosed process available to view on the website of the distribution company leading the auction process.
- Based on the result of the power planning process, CNE and SIGET agree on scheduling the tender process. There is not, however, an established schedule for the implementation of auctions in the long term.
- The auctions are technology specific, with defined quotas and a reallocation mechanism. If the target for one technology has not been met, additional amounts of other technologies can be contracted to fill the gap.
- There is a pay-as-bid pricing mechanism (prices as bid). Auction winners are paid a price equal to the bids of the offeror.

- Ceiling prices are disclosed after the submitted bids are opened. SIGET is responsible for setting the ceiling prices for each technology and approving the bidding documents.

- There is no specified location for project development, and bidders can propose project sites.

- The winners of the bidding process are obliged to deliver the total amount of electricity generation awarded to them under a PPA that runs for a 20 year period. The PPA guarantees that the distribution companies will buy all the energy produced by the generator at an established rate, as a take or pay commitment. For distributed generation, the bidding process offers PPAs for a period of five to 20 years, but most of the PPAs awarded so far have been for 15 years.

- The PPA establishes a determined tariff for the energy in US dollars, including yearly indexation. The payment for the energy is made on a monthly basis.

- The PPA includes commitments for the generators related to the construction period and commissioning of the power plant. Commissioning delays may lead to the execution of a completion bond.

Wholesale market auctions

The first energy auction process, implemented in December 2012, saw 355 MW of LNG generation procured in August 2013 (for more information, see Section 3). Following this, in September 2013, electricity distributor DELSUR opened El Salvador's first renewable energy auction. This tendering process aimed to purchase a total capacity of 100 MW from non-conventional renewables projects, stipulating that these must be at least 5 MW in capacity. In this auction, the PPA contracts were set with 20-year terms. Ceiling prices for bids, revealed post-bidding, were USD 123.41/MWh for wind projects and USD 165.53/MWh for solar PV projects.

This first auction contracted 94 MW of solar PV capacity under 20-year PPAs, while no wind projects were allocated, as offers exceeded the ceiling price. The winning companies were also required to direct 3% of project profits to social development programmes in the cities where the projects were based.

El Salvador's second renewable energy auction began in 2016, when DELSUR opened a bidding process to procure a total capacity of up to 170 MW of non-conventional renewables (70 MW of wind, 100 MW of solar PV). The PPA contracts were set to 20-year lengths, with the auction rules stipulating that solar PV projects had to be online and operational by April 2019, while wind projects had to come online by April 2020. Additionally, solar PV and wind projects had capacity requirements of between 5 MW and 50 MW.

DELSUR again represented a group of the same seven distribution companies participating in the first and second auction processes, with 62 companies registered to participate in this tender. DELSUR received 29 bids from 19 companies, resulting in four solar PV projects and one wind project winning PPAs, for a total awarded capacity of 169.9 MW (see Table 4).

The price reduction over the course of the two rounds of grid-connected generation reflects a learning curve in local project development. Several obstacles were identified during the first auction round and later improved. These improvements included: a greater ability for small projects to negotiate more competitive equipment prices; increased experience in Salvadoran commercial banks with renewable energy project finance; and stronger interest from multilateral investment banks and development banks in funding small projects in El Salvador.

Distributed generation auctions

El Salvador's distribution companies, together with the CNE and SIGET, then opened the country's first distributed renewable energy auction, to contract a total capacity of up to 15 MW. Of this, 4 MW was to come from small hydropower, 6 MW from solar PV, 4 MW from biogas, and 1 MW from residential customers with renewable energy self-generation systems up to 5 kW.

In this first auction, SIGET received bids for 58 small-scale renewable energy projects, mainly from national project developers, from which SIGET selected a total of 35 projects for the off takers, comprised of seven distribution companies. In this first auction, the PPAs carried a 15 year contract term, fixed in US dollars, with prices indexed to the CPI for all urban consumers in the USA. The project developer had to present a guarantee for maintenance of the offer and a guarantee for fulfilment of the contract. In this auction, many bidders were unable to reach financial closure on their projects. As a result, most of these developers sold their PPA to a private equity firm based in the USA.

In 2018, CNE launched a new tender process for distributed renewable energy sources. This technology specific tender process focused on the following technologies with the respective auctioned capacity: rooftop solar PV (10 MW), biogas (8 MW) and on-ground solar PV (10 MW) (CNE, n.d.). The results of this auction were published in March 2019 and can be found in Table 5.

Table 4. Summary of results among conducted wholesale market renewable energy auctions in El Salvador

Auction date	Target capacity	Capacity awarded	Average prices
2014	• 100 MW from non-conventional renewable energy	• 94 MW solar PV (4 projects)	• USD 109.68/MWh
2016	• 100 MW solar PV • 70 MW wind	• 119.9 MW solar PV (4 projects) • 50 MW wind (1 project)	• USD 61.44/MWh

Based on: USAID (2018); CNE (n.d.)

Table 5. Summary of results among conducted renewable distributed generation auctions in El Salvador

Auction date	Target capacity	Capacity awarded	Average prices
2013	• 15 MW	• 12.36 MW solar PV (31 projects) • 500 kW small hydro (2 projects) • 450 kW biogas (2 projects)	• USD 179.47/MWh
2019	• 10 MW rooftop solar PV • 8 MW biogas • 10 MW on-ground solar PV	• 2 MW biogas (2 Projects) • 8.48 MW on-ground solar PV	• USD 93.17/MWh

Based on: USAID (2018); CNE (n.d.)

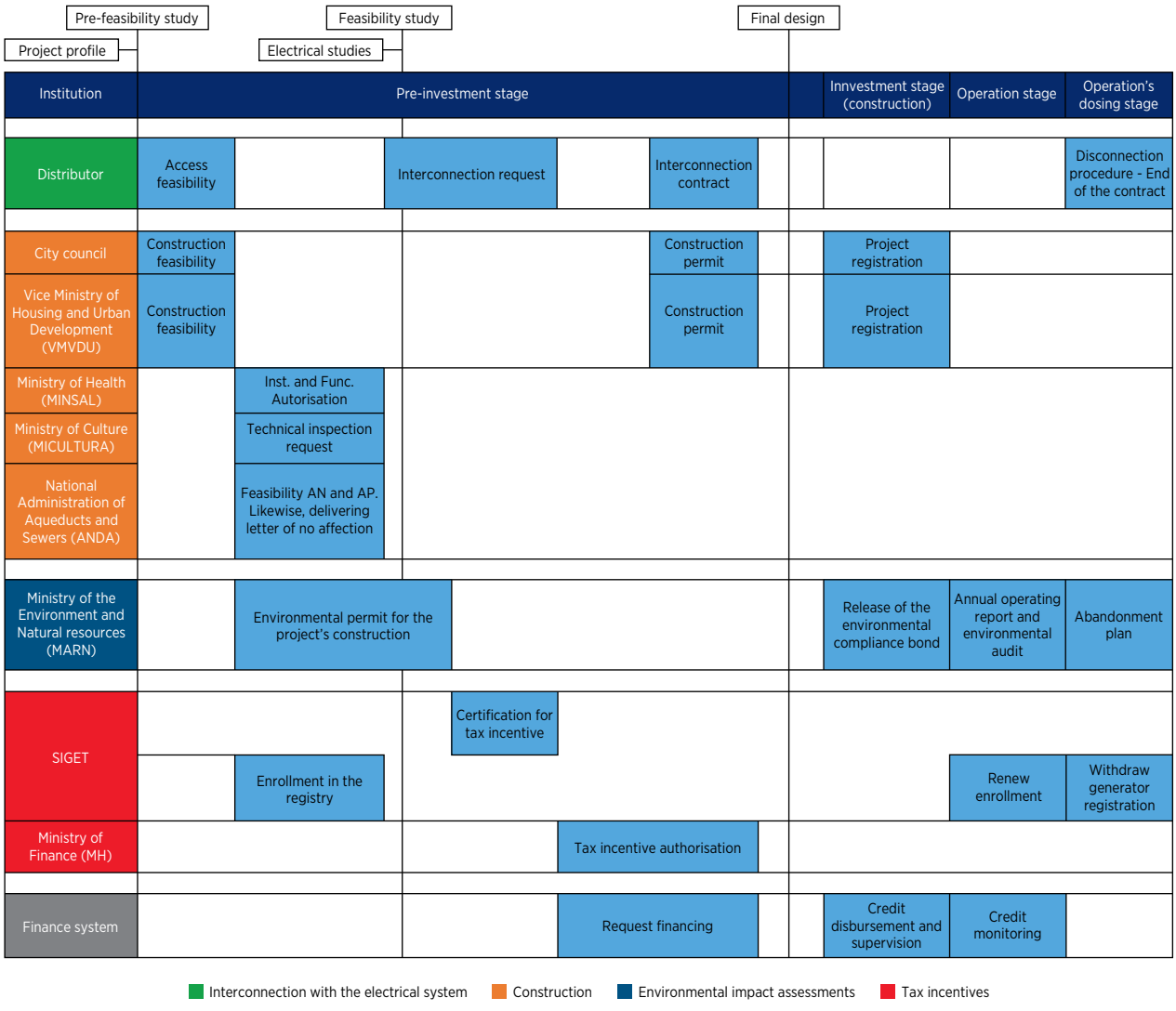
Ventus wind project in Metapan, El Salvador

Image credit: CEL

Renewable energy project procedures and permits

The development of renewable energy projects in El Salvador requires that a number of procedures be followed and various permits acquired. A range of government offices deal with these, at different stages of the project development lifecycle. These procedures are carried out and permits obtained sequentially, beginning with the project profile formulation and the pre-feasibility study. In the pre-investment stage, the feasibility, electrical and the environmental impact studies are carried out until the final design of the project is concluded.

Figure 21. **Permitting stages**



Source: CNE (2013)

The procedures indicated in Figure 21 are carried out by different agencies within the power sector, including:

- distribution companies – responsible for network access feasibility, interconnection application, interconnection agreement
- ETESAL – responsible for network access feasibility, interconnection application, interconnection contract
- System Operator and Market – responsible for application to sign interconnection contract
- SIGET – responsible for the application for studies, registration, concession request for hydro and geothermal projects, tax incentive certification.

The procedures listed above are performed by the following government institutions:

- the major's office, for building permits
- the Department of Housing and Urban Development (VMDU – *Viceministerio de Vivienda y Desarrollo Urbano*) for construction feasibility, and building permits
- the Ministry of Health (MINSAL – *Ministerio de Salud*) for authorisation of the project permit
- the Ministry of Culture (MICULTURA – *Ministerio de Cultura*) for technical inspection requests
- the National Administration of Aqueducts and Sewers (ANDA – *Administración Nacional de Acueductos y Alcantarillados*) for feasibility studies
- the MARN for environmental building permits
- the MH for tax incentive approvals.

During the investment stage for project construction, the procedures for property inscription at the mayor's office, work reception by the VMVDU and for release of the environmental compliance bond are performed.

Once the project is operational, the generator should make a payment to SIGET for the registration update, which considers the amount of electricity generated (MWh) and injected into the grid during the previous year. Additionally, it is essential to submit annual operation and environmental audit reports to the MARN. At the end of a project's operations, the disconnection procedures, the abandonment plan and the withdrawal of the generator register in the SIGET are carried out.

The General Electricity Law states that geothermal and hydropower projects require different concession procedures. Once a project developer has developed the feasibility studies for the exploitation of the resource in a determined area, the concession should go through an open tender process, where it is awarded to the lowest price bidder, unless the following happens after the auction:

- The hydropower developer that carried the costs of the feasibility study offers a bid of at least 90% of the winning bid.
- The geothermal developer that carried the costs of the feasibility study offers a bid of at least 85% of the winning bid.

Additionally, the General Electricity Law streamlines licensing procedures for hydro and geothermal power projects below 5 MW of installed capacity, which are specified under the Regulatory Law for the Concession of Small-Scale Power Generation Projects.

According to private sector officials and several project developers, the project procedures and permitting processes currently in place have created unfavourable cost implications, delays and uncertainty for renewable energy projects. Despite a certain degree of learning and improvement in the documentation of procedures, it has been suggested there remains insufficient technical knowledge in several public offices to enable them to effectively carry out the permitting procedures. The necessary paperwork is also dispersed across various institutions, with a lack of clarity on responsibilities.

Renewable energy project pipeline

In addition to being the state company that has historically been in charge of developing renewable energy and fossil energy resources in El Salvador, CEL also formulated the National Plan for Integrated Energy Development (1988 2000). After this, several feasibility studies and investment plans were created to outline future development of generation from renewable energy resources, including hydropower, geothermal, solar PV, wind, and biogas, as well as the introduction of ocean energy (tidal energy).

As mentioned above, in recent years, CEL has carried out an expansion of the 99.4 MW hydropower plant 5 de Noviembre, with the addition of two new generating units of 40 MW each. These came online in 2017 and will allow the plant to harness surplus water that occurs during the rainy season. CEL's 65.7 MW El Chaparral hydropower plant is also under construction, and is expected to begin operations in 2021.

LaGeo has advanced research in two geothermal reservoirs with generation potential, at project sites known as Berlin and Chinameca. The development of the 7 MW binary cycle Project II at Berlin has been completed and is expected to be operational by 2021.

As part of its duties, the CNE is tasked with preparing the Indicative Plan for Generation Expansion 2018 2028, which identifies potential candidate projects for development.

This plan assesses the status of the current Salvadoran electricity system to evaluate capacity expansion options that can promote renewable energy resources, support the reliability of the power system and help ensure electricity supply at competitive prices.

Projects included in the generation plan, shown in Table 6, have undergone studies and consultations between the CNE and project owners. The list of projects does not include those that are already under construction, nor those that have long-term PPAs, as these are considered firm projects that could be part of the generation system.

Table 6. **Candidate power plant projects**

Name	Resource	Tentative Date of Operation	Power (MW)	Investment (USD/kW)	O&M % of Investment
Berlín U5	Geothermal	1/1/2021	8	6 500	1% - 2%
Wind CEL	Wind	1/1/2022	40	2 631	2% - 4%
Ahuachapán U4	Geothermal	12/1/2023	6	6 500	1% - 2%
Chinameca	Geothermal	1/1/2023	8	6 500	1% - 2%
Motor 1	Bunker	1/1/2023	100	2 631	1% - 2%
Motor 2	Bunker	1/1/2023	100	2 631	1%
Motor LNG	LNG	1/1/2023	150	1 338	1% - 3%
Solar 1	PV	1/1/2023	50	700	1% - 3%
Solar 2	PV	1/1/2023	15	700	1% - 3%
Solar 3	PV	1/1/2023	60	700	1% - 3%
Solar 4	PV	1/1/2023	20	700	1% - 3%
Solar 5	PV	1/1/2023	80	700	1% - 3%
Solar 6	PV	1/1/2023	25	700	1% - 2%
San Vicente	Geothermal	1/1/2024	8	6 500	1% - 2%
Berlín U6	Geothermal	1/1/2026	28	6 500	1% - 2%
Expansion Chinameca	Geothermal	1/1/2026	34	6 500	1% - 2%
Expansion San Vicente	Geothermal	1/1/2026	14	6 500	1% - 2%

Source: CNE (2019)

The list of projects in the generation plan includes four geothermal generation units, totalling 30 MW of installed capacity, which are already in the development phase. It also includes a total of 76 MW of installed capacity expansion at three existing geothermal power stations. In addition, the plan includes six solar PV plants, totalling over 250 MW of installed capacity and one 40 MW wind project. Several potential fossil fuel generation facilities are also included in the plan, including two bunker-oil generation plants, totalling 200 MW of installed capacity, and an LNG plant with 150 MW of installed capacity.

Furthermore, in 2017, SIGET evaluated and certified a set of nine renewable energy projects, representing a potential of over 150 MW of installed solar PV and biomass capacity (see Appendix 4). This certification was a necessary step for compliance with the renewable energy fiscal incentives law, and thus exemption of the relevant taxes for project owners. There is some uncertainty, however, whether these projects will be completed.

In 2017, too, SIGET issued agreements for three hydropower projects (see Appendix 5), which will be presented before the Legislative Assembly in order to be granted concessions for the use of water resources.

The CNE has also developed an online portal[5] listing renewable energy projects in El Salvador. In addition to those projects that have obtained PPAs in auctions, the portal presents a set of renewable energy projects that includes distributed generation in the retail market, small hydropower projects, and bioenergy power plants.

El Salvador also has considerable experience in the installation of solar PV systems in the off grid sector. A register of solar PV systems carried out by CNE reports 3 182 solar PV systems of 75 W each installed in 167 rural communities, serving an estimated 3 000 families.

An additional project, which will have important implications for the future of the power sector, given its capacity size, is the 380 MW EDP LNG project, expected to be commissioned in 2021. This project already holds a PPA, which was awarded during the first energy bidding process in El Salvador back in 2012. It will also cover a large part of the distribution companies' demand. Following the plant coming online, the allocation of new PPAs for renewables will likely depend on the growth of electricity demand and future energy policy.

The price of the electricity generated by EDP (according to the project's financial contract) depends on the international price of natural gas. In the case of the gas supply contract, this price is indexed in turn to Brent oil. Therefore, the prices of electricity generated by EDP will depend on the development of oil prices. It is expected that a gas power plant shows a lower variable generation cost than other thermal plants. Thus, following the order of merit, EDP electricity would be dispatched first and those thermal plants based on Bunker C fuel oil, with higher prices, would be dispatched later.

The Indicative Plan for the Expansion of Electricity Generation of El Salvador 2018-2035 also shows the EDP plant displacing thermal plants based on Bunker C fuel oil in dispatch. This Indicative Plan shows that the marginal cost of operation (equivalent to the wholesale price of electricity for a cost-based system) would be lower during the EDP plant's first years of operation. In later years (between 2023 to 2035), the marginal cost then tends to stabilise, between USD 64/MWh and USD 117/ MWh.

The other component in the tariff price is the cost of the contract price. This is composed of the variable costs of generation associated with the cost of fuel and machinery efficiency, operation and maintenance (O&M) costs, and the premium component, which covers the investment costs, fixed costs and the expected profit by the project's investors (SIGET, 2012).

The electricity sale price in the contract should be similar to the costs of thermal plants based on Bunker C. For this reason, the EDP project is not expected to contribute to a decrease in electricity prices. Based on these assumptions, market prices in the future can be expected to allow renewable energy power plants to be economically viable, displacing thermal Bunker C and other fuel oil-based thermal plants along the way.

5 http://energiasrenovables.cne.gob.sv/

Renewable energy financing

In the 1990s, El Salvador's energy reform process provided a starting point for future renewable energy investment flows in the country. Regulatory stability and enabling policies are critical to renewable energy finance, as they help ensure the transparency essential for market-based financing schemes (IRENA, 2016).

In this context, El Salvador's liberalised approach to the energy sector provides the basis for the enabling framework needed to scale-up future private financing within the sector, with the initial support of public financing. Thus far, renewable energy investments in the country have largely been the result of public financing.

The Central American Bank for Economic Integration (CABEI) provides key investment support for renewable energy projects. CABEI's objective is to finance projects that have an impact on economic and social development and help fulfil the bank's broader mission of economic integration in the region. As part of its past financing efforts, the bank has provided funding for the SIEPAC project, renewable energy generation initiatives at local and regional level, energy diversification programmes, and transmission and distribution system projects. In 2017, CABEI approved loans for the energy sector that amounted to USD 632.3 million, representing 32.8% of its approved loans for the year (CABEI, 2018).

CABEI, together with the German Development Bank (KfW), administer a funding programme in the region under the Latin America Investment Facility (LAIF) from the European Union (EU) that comprises renewable energy projects. One such project to receive financing support was the expansion of the 5 de Noviembre hydroelectric plant, mentioned above.

BANDESAL, as the national development bank, provides financing to support feasibility studies and other pre-investment activities for renewable energy projects. The bank can fund renewable projects either directly or through first-tier commercial banking. Beyond BANDESAL, at the national level, the Banco Hipotecario state bank and several commercial banks in El Salvador also offer financing lines with their own resources for the construction of renewable energy projects.

Based on its objectives, the IDB supports El Salvador in financing projects for the development of renewable energy, for research projects and the development of pilot programmes to verify the viability of renewable energy alternatives.

Together with the Netherlands Development Finance Company (FMO) and the French development bank, Proparco (Société de Promotion et de Participation pour la Coopération Economique S.A.), IDB provided a financial package for the construction of El Salvador's Capella solar PV project. Capella is the second largest solar power generation project in the country, with 140 MW of installed capacity. The financial package for the project has a tenor of up to 18 years and is comprised of three loans of USD 28 million each (IDB Invest, 2018).

In addition, IDB seeks new opportunities for promoting national and regional energy integration. It aims to minimise fluctuations in energy prices, reduce waste and losses in transmission, and thus increase energy security in the Americas and the Caribbean. The Bank is aware that by diversifying the energy mix of each country, it will help reduce the effects of climate change and the costs of system operation (IDBa, 2018).

In recent years, there have been efforts made to support small and medium sized enterprises (SMEs), for energy efficiency and renewable energy investments. IDB has, for example, provided a USD 20 million loan to El Salvador for the creation of a financing line aiming to promote SMEs investment in energy efficiency. This programme is supplemented by a non-reimbursable technical co operation component, which will develop energy savings measurements, and a financial risk transfer instrument, which favours energy efficiency investments (IDBb, 2018).

Recently, CABEI also launched the Green SME initiative. This creates credit lines to finance investments of up to USD 5 million in projects that aim to reduce SME energy consumption by 15%, and/or renewable energy projects with a maximum installed capacity of 5 MW. This credit line is supported by KfW and the EU (CABEI, 2020).

Meanwhile, private investment in existing infrastructure in El Salvador is still limited. The country has, however, facilitated the financing of renewable energy projects awarded in the framework of the tendering process, as in the case of private equity funds supported by institutional investors. Additionally, export credit agencies have also provided financing in the form of long-term credits.

El Salvador has functioning capital markets, with private pension funds investing in corporate bonds securitised by future cash flows from public infrastructure. This has become an important source of financing for renewable energy project developers in the country (USAID, 2018).

Box 6. **Climate Investment Platform (CIP)**

The CIP is a global initiative supported by IRENA, the United Nations Development Programme (UNDP) and Sustainable Energy for All (SE4All), in co-operation with the Green Climate Fund (GCF). The CIP's objective is to step up climate action and translate ambitious national climate targets into concrete investments on the ground (IRENA, n.d. a). Whilst initially focused on energy transition, the ultimate goal of the initiative is to accelerate investments in renewable energy and enable the success of the Nationally Determined Contributions (NDCs).

The platform offers an avenue to strengthen existing collaboration and presents an opportunity to consider new ways for more effectively bringing together stakeholders to catalyse action, all within existing institutional structures and in line with the respective mandates of the partner organisations.

In this context, investment forums, a key element of IRENA's strategy to facilitate investments in renewable energy, offer an effective organising framework for the implementation of the CIP through a sub-regional approach.

The sub-regional forums have two main aims: to strengthen the ability of decision-makers to build a strong enabling environment for renewable energy investments; and to support developers in preparing bankable projects and accessing finance. Post-forum project support is also provided.

In operationalising the CIP, IRENA intends to work closely with multilateral, bilateral and local financial institutions, development partners and other institutions that are prepared to provide financial and/or technical resources, and/or support the realisation of projects, as well as private companies and private investors.

In Latin America and the Caribbean, IRENA aims to implement two sub-regional investment forums: one for Central America and the Caribbean and a second one for South America. Both events aim to scale up renewable energy investments in the region, support project development and implementation, and contribute to the creation of policy and regulatory frameworks conducive to renewable energy investments. Key forum activities will include matchmaking between project developers, potential financiers and investors. Renewable energy projects, along with renewable-based electricity grid and energy efficiency projects, may be considered for support (IRENA, n.d. b).

4. Recommendations for addressing the main barriers hindering the deployment of renewable energy

This section presents the main challenges to the deployment of renewable energy in El Salvador identified during the RRA process. This included a review of the literature, insights from respondent interviews, outcomes from focus groups and multi-stakeholder roundtable discussions held during consultative workshops, along with subsequent exchanges with selected stakeholders.

Each of these challenges is presented below, together with a set of corresponding short- to medium term recommendations aimed at addressing them, including, where relevant, actions being taken by the government.

Enhance long-term planning and policy for the renewable energy sector

The National Energy Policy 2010-2024 provided the momentum needed to promote the development of renewables and diversify the country's energy supply, after years of fossil fuel based generation and a slow-paced development of renewable energy. In recent years, the introduction of competitive tendering processes and various fiscal incentives for renewable electricity has contributed to a positive business environment for renewables in El Salvador.

During the RRA consultation process, however, numerous stakeholders highlighted the negative impact on renewable energy development from a lack of institutional co-ordination on long-term energy plans. Therefore, an inclusive approach between all parties is vital when developing renewable energy targets and long-term plans. Positive implementation can lead to a strengthened investment environment for renewables and improve the country's policy stability.

Indeed, a long term national energy plan should take a holistic approach to cover the diverse aspects of the energy sector. This approach should include: the use of clean technologies for the heating sector; expansion of the generation fleet and transmission infrastructure; and integration with the regional electricity market, which is very relevant for El Salvador, due to its regional interconnection via SIEPAC.

Action 1: **Establish a long-term plan for the energy sector**

During the RRA process, stakeholder consultation revealed the need for a more comprehensive national energy plan. This plan should encompass all energy technologies, suppliers and consumers through an integrated analysis of the current market conditions, and include an evaluation of energy demand, power and heat availability, grid expansion, off-grid strategies, and other subjects. By undertaking this long-term plan, a more co-ordinated approach can be sought for the expansion of the generation and transmission system.

The CNE prepares the Indicative Plan for Generation Expansion, which analyses the expected evolution of electricity demand over a period of approximately 10 years and proposes different technologies for its supply. This study assesses scenarios for the growth of energy demand in different sectors of the economy

(industrial, services, transport, etc.), analysing the national capacity for supply. Likewise, ETESAL is responsible for carrying out the long-term expansion plan of the national transmission network. Both reports are an important input in the development of a national energy plan, but require better co-ordination between both institutions to achieve an efficient development of power sector infrastructure. Additionally, it is recommendable to have a closer involvement of SIGET in the whole process, to ensure the appropriate approval of the plan.

Furthermore, power system expansion plans need to address the issue of operational flexibility in the power system. The deployment of VRE generation has to be accompanied by actions that give the system the operational flexibility it needs to cope with short term variability and to allow the system to operate reliably. Planning efforts should explore all possible options, including investments in transmission and storage, as well as other base-load technologies such as geothermal and hydropower, which can enhance flexibility. These efforts should also look at the specification of the technological mix of renewable generation capacity additions that results in the lowest overall costs for the system, together with additions without short term variability, such as geothermal or biomass.

Action 2: Promote renewables for end uses in buildings, heat and transport.

El Salvador has focused its efforts on renewable energy penetration of the power sector. This has led to an increasing share of renewables in the electricity mix and a reduction in the sector's reliance for fossil fuels. When analysing the national energy mix, however, the consumption of electricity in end use sectors represents about 20%, with approximately 79% of final energy consumption supplied by fossil fuels. Thus, the share taken by renewable energy remains low in these sectors.

El Salvador does not currently have targets for renewables in end-use sectors, either. Establishing targets for renewable energy in transport, heating and cooling, agriculture and industry could contribute to a further scale-up of renewables in the country, and help achieve emissions reduction targets while creating new business opportunities. Furthermore, renewable energy in end-use sectors can help facilitate the integration of ancillary services, such as storage applications.

Currently, through an extensive stakeholder consultative process, CNE is developing its long term National Energy Policy for the period 2020-2050. This includes targets for the share of clean energy technologies in end-use sectors, such as industry and transport. Moreover, the new National Energy Policy aims to promote the development of pilot projects in the direct use of renewable energy resources in the industrial and agri-food sectors.

Action 3: Align with the regional, ECLAC-SICA Energy Strategy 2030

Regional integration in Central America has played an important role in the Salvadorian power system. SIEPAC acts as a backbone for the electricity network, with the country playing an active role in the MER as one of the largest importers of power.

El Salvador can continue benefiting from regional integration by aligning its efforts with regional strategies for electricity development. SICA and ECLAC are currently developing the 2030 energy strategy for SICA countries, which provides a comprehensive approach for regional energy development, and identifies priorities for countries in pursuit of sustainable energy development. El Salvador should incorporate this strategy in its national long-term planning efforts, in order to maximise renewable energy resources from outside the country. This strategy must also remain in line with the country's overall development strategy, assuring the participation of both public and private sectors.

Some progress has already been achieved in this, by including regional energy integration as one of the strategic components of the new, El Salvador National Energy Policy 2020-2050. This should also be reflected as part of a more comprehensive national energy plan, however.

Action 4: Incorporate distributed power generation into comprehensive long-term electricity planning

As is the case in many countries, net-metering can be an effective instrument to spur the development of distributed renewable power generation. Careful implementation is critical, however, to avoid risking efficient cost-recovery in the system and to prevent cross subsidisation between those customers who self consume and those who do not (IRENA, IEA, REN21, 2018).

The SIGET self-generation regulation offers an opportunity to exploit widely available and geographically scattered solar energy. Given the importance of grid stability and the financial viability of the distribution companies, a comprehensive national distributed power generation strategy should be pursued.

This strategy would need to be based on integration with El Salvador's indicative generation plan. It should also include a rigorous analysis of distributed power generation potential and its impact on the economics of the power market. This is important to encourage self consumption, which can drive producers to more system friendly behaviour, while ensuring the fair distribution of anticipated dividends, so that net-metering may be seen as mutually beneficial to both buyer and seller.

This strategy should also incorporate studies on current levels of distributed renewable energy generation and future maximum penetration levels. Obtaining statistics would help provide distribution companies with the necessary analyses needed to accurately forecast demand, as well as indicate the growth potential of the distributed generation market to project development companies. The strategy could also consider the implementation of new technologies as distributed storage, which could promote a wider use of distributed renewables development, without the constraint of having maximum penetration levels.

Moreover, this strategy should be fully integrated with long term electricity planning efforts. The evolution of distributed generation must be understood in the wider context of the evolution of the power system as a whole. The strategy must also reflect the extent to which distributed generation offers a meaningful alternative, from both the technical and the economic point of view, in meeting the country's electricity needs.

Create enabling conditions for geothermal energy development

Despite having a long tradition of geothermal energy use, mainly for power generation, El Salvador's geothermal development has stagnated in recent years, with a limited number of new projects for geothermal power generation, or heating applications.

Geothermal power projects face challenges with the existing remuneration scheme, being sometimes at a disadvantage compared to other renewable energy sources – especially in accessing long-term energy purchase contracts. Likewise, geothermal project developers struggle to access financing instruments at a local level. This is because financing institutions do not have the capacity for geothermal project financing, or for overcoming high upfront investment costs to achieve bankable projects. Most of the current existing financing mechanisms are provided by multilateral development banks and international organisations in Central America, such as the Geothermal Development Facility for Latin America (GDF).

In addition, the existing regulatory framework for geothermal energy in El Salvador focuses mainly on power generation and does not address direct use applications of the resource. The absence of a regulatory framework for direct use applications for geothermal energy hampers the scaling-up of existing pilot projects and the provision of a proper investment environment for the attraction of private finance to the sector.

Action 5: Improve geothermal energy policy and regulatory frameworks

El Salvador only has a regulatory framework covering power applications. This includes streamlined concession procedures for small-scale hydro and geothermal projects below 5 MW. To improve this situation, it is recommended to establish a classification of the geothermal resources by temperature, including adequate procedures for the different potential uses of the geothermal resource.

The definition and classification of resources as low, medium and high temperature could enable the formulation and implementation of streamlined regulatory frameworks for the direct use of geothermal heat, while also boosting opportunities for the exploitation of geothermal resources.

Currently, the use of geothermal heat for other purposes, such as air conditioning, agriculture industry, tourism and medicine, only requires complying with environmental procedures and obtaining construction permits from the respective municipality. A process therefore needs to be initiated to devise a special regulatory framework for this type of application, providing an opportunity for scaling-up such projects to an industrial level. A clear regulatory framework for direct use applications will serve to attract investors and leverage private finance for geothermal direct use projects.

An increased deployment of direct use applications would also bring a range of benefits to El Salvador.

Such uses of geothermal heat can create a more sustainable energy future for the country, increase food security and decrease dependency on fossil fuels. This diversification into direct use can also increase the benefits received by communities located close to geothermal resources. Indeed, some direct use pilot projects already implemented in the country provide strong evidence of such benefits to the community.

While El Salvador has established a tendering process for PPAs in renewable energy, this has only been granted to solar, wind, bioenergy and small-scale hydropower projects. These long-term contracts provide a secure remuneration mechanism through a guaranteed, stable price, helping to attract investment in projects and allow investment recovery. Utilising a similar contract structure tailored for geothermal projects could improve the investment environment by guaranteeing financial stability for those projects commissioned.

El Salvador has also undertaken four rounds of renewable energy auctions for generation as part of the wholesale market and distributed generation, in which geothermal did not participate. As the economics of geothermal projects generally require higher upfront investment for the initial development phase, compared to solar and wind projects, they can struggle to compete in renewable energy tenders based purely on a cost bid basis (US dollars per kWh). It is recommendable to initiate an assessment to determine the best mechanism to allow geothermal projects to compete equally with other renewable technologies in future tender processes. This could be done by eventually adjusting the parameters of El Salvador's renewable energy auction scheme, while also accounting for advantages associated with dispatchable power generation, such as providing balancing support and enhancing system flexibility.

Additionally, the current regulation for the concession of geothermal and hydropower projects should be assessed to generate an environment of trust for project developers, attracting investments in the early stage of development of geothermal projects, including feasibility studies and environmental permits.

Action 6: Build capacity in geothermal project development

There is limited capacity and awareness at the national level of geothermal project financing and how to overcome high upfront investment costs to achieve bankable projects. As such, a geothermal project development capacity building programme for local financial institutions and project owners could contribute to an increased understanding of geothermal project financing and risks.

In addition, the capacity of project developers in project financing aspects, such as pricing mechanisms, inflation, and other key project parameters, needs to be strengthened in order to improve the preparatory stage of geothermal projects. Likewise, the possibility could be considered of creating a governmental entity that provides technical and administrative support to investors and developers, both for the implementation of geothermal direct-use projects and for small-scale projects from any renewable resource.

Furthermore, available risk mitigation instruments are specifically designed for electricity generation projects. The need therefore remains to identify – or possibly create – similar financial instruments that support the development of geothermal direct use projects for applications beyond the power sector. Some opportunities can be found within existing platforms, such as the GDF, or funds for industrial development.

Furthermore, the adoption of the United Nations Framework Classification (UNFC-2009) as a standardised methodology for reporting the estimates of geothermal potential could contribute to unlocking financing for geothermal projects. This methodology provides transparency in assessing the favourability of the social and economic conditions in the country necessary to support the establishment of geothermal projects. It also assesses the maturity of relevant project studies and commitments in the implementation of the project, as well as looking at the level of confidence in the potentially recoverable resource. Therefore, through the application of this methodology, investors are able to compare different geothermal projects across different countries – and against other energy resources – before making investment decisions.

Action 7: Promote innovation in geothermal technology through academic partnerships and international co-operation

The partnership between industry and academia has contributed to the promotion of research and development in El Salvador. Students have prepared geothermal projects in their graduation year, addressing current challenges for the industry.

Yet, while this co-operation has had good results in the past, it has not been established as a regular activity. The research undertaken by universities has

important potential in developing local technology, especially in the area of geothermal direct use. Chile and Mexico provide good examples from elsewhere in the region. There, universities have an important part in innovation, developing new equipment for the geothermal industry that can also, potentially, be scaled up for use in meeting a wide variety of challenges. Partnerships should be promoted between the geothermal industry and universities, guaranteeing a continuous collaboration between both actors.

To promote the direct utilisation of geothermal resources, El Salvador could also learn from more experienced countries. This co-operation can be financial or technical, or include technology transfer for many geothermal direct use applications. Co-operation can take place using existing platforms, thanks to the presence in the region of multilateral organisations that promote exchanges between educational institutions in geothermal energy research. These include El Salvador's Geothermal Centre of Excellence (see Box 3), as well as co-operation projects created under South-South/triangular co-operation modalities.

Action 8: Increase public awareness of geothermal energy potential

The government of El Salvador, along with the geothermal industry, should guarantee the continuity of public awareness campaigns, in order to actively communicate the various socio-economic advantages of geothermal energy to the public, especially at the local level. In doing so, the potential for scaling-up direct-uses of geothermal energy could be promoted, while the need to involve local communities in the development of these resources could be addressed – a particularly important factor when issuing or renewing licences for geothermal development.

Currently, campaigns are in place in El Salvador that aim to raise public awareness of geothermal energy's potential. These campaigns are important, not only in showing how geothermal energy can help address key macroeconomic challenges related to energy security and climate change, but also in offering local economic opportunities and benefits. Furthermore, as a baseload generation resource, geothermal energy can contribute to the efficient integration of an increasing level of VRE in the power system, by acting as a balancing resource.

Establish clear institutional frameworks and co-ordination

Currently, responsibilities among institutions in the energy sector remain decentralised. Although the planning and co-ordination roles were assigned to the CNE in 2009, the current performance of the energy sector suggests that the government may consider different options to improve co-ordination and distribution of responsibilities in the Salvadorian energy sector. Such considerations may include the creation of an entity that centralises sector development and directives. For that purpose, a review is needed of the legal and regulatory framework in response to the needs of the energy sector.

The strategic development of that sector is also hindered by the absence of longer term co-ordination of different participant's action plans. Improving these institutional frameworks is critical in creating a clear path towards a sustainable energy future, which goes beyond the power sector by including renewables in transport, heating, cooling and direct use.

Action 9: Improve co-ordination of expansion planning for transmission and generation

Currently, the development of the national transmission system and of new generation facilities are tasks undertaken separately. In addition, the transmission planning structure does not consider the short construction periods of VRE sources, such as solar PV, that often require only around two years to be commissioned. As a result, generation and transmission planners in El Salvador must frequently revise and update plans, while new potential renewable generation is not included in transmission expansion plans.

ETESAL and CNE should therefore co-ordinate more closely on those expansion plans, to ensure that renewable energy projects are not forgone arbitrarily due to expansion timelines. One such measure to overcome this challenge is to embark on the identification of renewable energy zones for the most suitable areas for project development. These zones would then inform both transmission and generation planners, facilitating a co-ordinated planning effort.

Inter-institutional co-ordination will be crucial in carrying out effective planning. In addition, the involvement of SIGET throughout the planning process will accelerate the approval process and enhance the dissemination of the planning exercise.

Action 10: Enhance power system flexibility

Besides ensuring that planning efforts address the topic of flexibility, in order to accommodate increasing shares of VRE generation technologies, regulation and market design must be adjusted to unlock all possible sources of flexibility in the power system.

The country has created a strong policy and regulatory framework to promote renewable energy penetration in the power sector. Nevertheless, additional measures can include: adapting dispatch and pricing procedures to ensure that controllable generators deliver all the operational flexibility they can; adjusting the grid code technical performance requirements of inverter-connected variable generators to ensure that they do not unnecessarily increase the systemic demand for flexibility; eliciting demand response; promoting a market for auxiliary services (through systems that provide flexibility); and others.

The pace at which such measures will be implemented depends on the rate of increase of the share of VRE generation in the system. In this sense, the planning effort must serve to inform regulators and policy makers, allowing them to implement such measures in a timely fashion, adapting the regulatory framework to new requirements. Considering the possibility of addressing flexibility needs via improvements to the regulation and market design can complement strategies based on new investments – and thus represent savings to electricity users.

Some first steps have been taken within regulatory adjustments to encourage the penetration of VRE in the national electricity system. These adjustments have included various amendments in the regulations for the operation of the transmission system and the wholesale market, based on production costs for dispatching. They also include conducting studies of the spinning reserve with a view to the further integration of VRE.

Assess the implementation of distributed power generation

Despite the effectiveness of the net metering scheme implemented in 2017,[6] periodic reports are also needed on the energy generated by end-users, who are generally residential and commercial customers. They can generate their own renewable electricity and feed the excess generation back into the grid. The lack of centralised measurement for these systems creates a problem of distortion in the global statistics on demand growth. In turn, this can distort macroeconomic data, while also negatively impacting planned generation expansion and development programmes for the transmission and distribution networks. The significance of this becomes apparent, too, when considering that self-generators receive credit in kWh which can then be used to reduce their cost electricity consumption during their particular billing period.

The implementation of this net-metering scheme has seen mixed results. While rooftop solar PV generation has increased since the introduction of the regulation, studies have yet to be undertaken to establish current levels of distributed generation in the grid, or the maximum penetration levels of VRE in the distribution grid.

As such, several distribution companies have expressed concerns about the impact of growing distributed generation on the reliability of the power system. Moreover, although growing self-generation would increase overall renewable generation capacity in El Salvador, excessive distributed generation capacity installation is likely to alter the demand profile for distribution companies, as well as challenge their financial liquidity.

Simultaneously, several project developers expressed concerns that an uneven playing field currently exists in developing distributed generation projects, given that subsidiaries of distribution companies also compete in the market. These companies may already have a commercial relationship with the customers, and thus have access to customer information not available to other project developers. Furthermore, project developers may face obstacles and delays in realising rooftop solar PV projects, as distribution companies do not want to lose electricity demand from a customer (and thus revenue).

Action 11: Assess the impact of distributed generation systems

With the implementation of the Norm for End User Producers of Electrical Energy with Renewable Energy Sources, the use of solar rooftop systems has been growing in El Salvador, especially in the commercial sector.

Measuring the impact of this on the energy market accurately requires some important steps. These include registering all the existing self-generation

6 Agreement No. 367-E-2017 Norm for End User Producers of Electrical Energy with Renewable Energy Sources.

solar panels in use, with this registration including details of the potential amount of electricity they can inject into the grid and how much of the power generated is for self-use. This first step can provide important information to assess the impact that the implementation of distributed generation can have on the different energy stakeholders, such as grid operators, distribution companies, final users, and others. This first assessment of distributed generation should not just focus on rooftop solar technologies. It should also include other power generation systems existing in the country, such as biogas and small hydro.

Better understanding of the impact of the implementation of distributed generation in El Salvador among the different, key energy sector actors can contribute to the assessment of the existing regulatory framework for the use of self-generation.

The regulatory aspects for distributed generation must consider the stability of the grid and the existing distribution market. They must also empower the end user with the flexibility of energy management. This can be reflected in the commercialisation of the distributed generation market, the conditions given by long term contracts and the application of innovative technologies, such as digitalisation and blockchain, that facilitate transactions among the distribution actors. El Salvador could use the experience of other countries in the application of such technologies, and evaluate a more adequate strategy for implementation, based on market growth.

Foster project development and financing for renewables

There have been significant achievements and progress in the adjustment of the regulation for the development of renewable energy in El Salvador. Reforms of the General Electricity Law must be deepened, however, to guarantee that the benefits of introducing renewable energy reach all final consumers.

Additionally, in El Salvador, administrative procedures and permits for the development of renewable energy projects are still an important barrier. These are not centralised, with registration applications, feasibility and interconnection studies and agreements, as well as concession requests all carried out by different power sector agencies. These include distribution companies, ETESAL, the UT, and the regulator. Moreover, building permits, construction feasibility studies, technical inspections, environmental permits and tax incentive approvals are under the remit of municipal offices, VMVDU, MINSAL, MICULTURA, ANDA, MARN, and the MH.

While these procedures and permits are carried out in a sequential order, there is often repetition among permitting offices, a limited technical capacity in issuing agencies, and a lack of legal clarity concerning feedback issued to project developers. At the same time, municipal tax structures for projects are unstable and often subject to change at the request of a mayor's office, once approved by the Legislative Assembly. Furthermore, according to the private sector, compliance with the Law of Legal Stability and the Money Laundering Law has led to instances of excessive document requests and irrelevant project information being required.

Indeed, private sector representatives have indicated that this lack of co-ordination in the current process of obtaining permits and permissions has negative cost implications, creating delay and uncertainty surrounding renewable energy project development.

When it comes to financing such projects, it is public financial institutions, including national and international development organisations, that are the main players in the renewable energy debt market. On the other hand, via the implementation of guarantees and other risk mitigation tools, private financial institutions play a key role in renewable energy project finance. Yet, the availability of such private financing is still limited. A full assessment of the sufficiency of the current sources of public and private instruments in financing the transition towards a sustainable energy future needs to be carried out in the country, with alternatives that would expand the participation of private financing identified and deployed.

Action 12: Streamline administrative procedures and facilitate their enforcement

Streamlining these administrative procedures is an important step in removing a key barrier to renewable energy project development in El Salvador. Regulation in this area should ensure procedures are transparent and timetables for various permitting processes have been defined clearly. Moreover, co-ordination should be enhanced among the various government offices involved in issuing permits, in order to reduce project delays and reduce development costs.

One such mechanism used in many countries to consolidate the responsibilities of administrative procedures and project permitting is to develop a

single office (a "single-window agency") to handle and resolve most of the applicable licenses and permits for renewable energy projects. This entity can be created as an independent legal body, or under an existing government office, and can be an important mechanism in encouraging renewable energy investments and expediting project development timelines.

In addition, several project developers expressed the need to develop a single compliance certificate for the Money Laundering Law, valid for all institutions. Utilising this certification approach could help cut down project delays and provide clarity for project owners.

Action 13: Assess sufficiency of prevalent financial instruments

The sufficiency of the prevailing alternatives for financing renewable energy in El Salvador must be assessed in light of the plans to deploy renewable energy in the country. While the low costs of finance from public institutions can certainly have a positive impact on the capital mix of renewable projects, limitations on the availability of such instruments must also take account of the volumes needed to realise El Salvador's long-term deployment ambitions for renewables. A realistic assessment for the long term is necessary, due to the time usually needed for those measures that are eventually implemented to expand the range of financial sources.

On the other hand, existing mechanisms and conditions for finance and risk mitigation provided by private institutions must also be clear, to ensure that project developers can make use of these instruments for renewable energy projects. Existing financial instruments in El Salvador must be evaluated in order to improve and maximise them. This would include an evaluation of improvements that could be made in the regulatory and contractual conditions that impact the remuneration of renewable energy projects, as well as in partially re-directing public financing to de-risking instruments that enable the participation of private lenders.

An assessment of other types of financial instrument that might be used to finance renewable energy projects in the country – such as Green Bonds – should also be undertaken.

At present, national or international development agencies, such as the World Bank, IDB, KfW, CABEI and BANDESAL, account for the bulk of the financial instruments deployed in financing the capital structures of El Salvador's renewable energy projects. Financial instruments provided by private institutions have, however, also been important in providing funding for the energy transition in the country, especially instruments related to loans and risk mitigation mechanisms provided by guarantees.

Action 14: Create capacity for local private financing of renewable energy projects

An additional uncertainty for financial agencies when it comes to renewable energy projects in El Salvador is the relative lack of experience such agencies have in financing projects of this type. This limits the involvement of even those private financial institutions that do undertake risk mitigation in the renewable energy arena. The capacities of local private financiers must therefore also be built up, in order to remove the knowledge barrier to renewable energy market entry.

Making local private institutions more familiar with this market can generate more interest from them in financing sector projects. At the same time, familiarity can improve the capability of existing mechanisms in facilitating access to project developers. Additionally, the enhancement of local finance capacity can also promote the creation of new and potentially innovative mechanisms, making El Salvador's renewable energy market more attractive to investors.

15 de Septiembre hydropower plant in San Vicente, El Salvador

Image credit: CEL

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Appendices

Appendix 1. **Overview of entities in the energy sector**

National institutions	
National Energy Council (**CNE** – *Consejo Nacional de Energía*)	The governing authority for the sector, the CNE has responsibility for policy and national energy strategy development, with the goal of fuel and electricity sector expansion.
Ministry of Economy (**MINEC** – *Ministerio de Economía*)	Before CNE was created, MINEC was in charge of the management and co-ordination of the energy sector through its two directorates, the directorate for electricity and the regulatory directorate for hydrocarbons and mines; this last one still exists as part of MINEC.
Ministry of the Environment and Natural Resources (**MARN** – *Ministerio de Medio Ambiente y Recursos Naturales*)	The governmental institution charged with the oversight of all environment and natural resource issues in El Salvador. The MARN also sends a representative to the board of CNE.
General Electricity and Telecommunications Superintendence (**SIGET** – *Superintendencia General de Electricidad y Telecomunicaciones*)	As the regulator for the electricity and telecommunications sector, SIGET has responsibility for application and enforcement of the legal frameworks in these areas. Also within its portfolio is the task of establishing a legal framework to encourage investment in these sectors, along with the establishment of competition. Other duties include regulating final consumer tariffs and guaranteeing user and operator rights.
The Superintendence of Competition (**SC** – *Superintendencia de Competencia*)	The SC is in charge of monitoring the markets to promote and protect competition, and increase economic efficiency and consumer welfare.
National Investment Fund for Electricity and Telephony (**FINET** – *Fondo de Inversión en Electricidad y Telefonía*)	FINET is part of the Social Investment Fund for Local Development (FISDL – Fondo de Inversión Social para el Desarrollo Local), and is in charge of managing and allocating subsidies to low-income users, as well as the expansion of rural electrification.
Regulatory Directorate of Hydrocarbons and Mines (**DRHM** – *Dirección Reguladora de Hidrocarburos y Minas*)	DRHM is the institution in charge of regulating the hydrocarbons sector. It oversees imports, transport, distribution and marketing, inspection, and control, while also supervising compliance with the current legislation for hydrocarbon trading. This entity also establishes the weekly reference price for gasoline and diesel, as well as the parity price of imported LPG for domestic consumption.
Executive Hydroelectric Commission of the Lempa River (**CEL** – *Comisión Ejecutiva Hidroeléctrica del Río Lempa*)	CEL is an independent, public electric utility in charge of developing, conserving, managing, and using the energy resources of El Salvador. Clean energy is generated in four hydropower plants located at different points in the Lempa River basin.

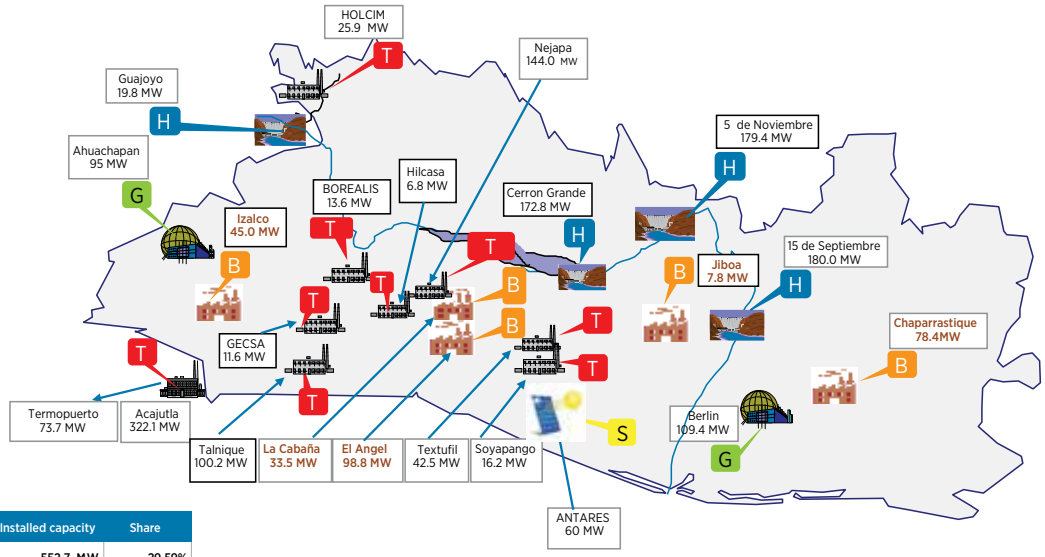
Transmission Company of El Salvador (**ETESAL** – *Empresa Transmisora de El Salvador*)	ETESAL is El Salvador's transmission system owner. The institution was created to ensure the safe, non stop supply of electricity. It makes possible transactions between market participants within the country, as well as with other regional countries through the Electrical Interconnection System for Central America.
Salvadorean Geothermal (**LaGeo** –*Geotérmica Salvadoreña*)	LaGeo, a CEL subsidiary, is a company dedicated to the production of electricity using geothermal resources in a rational and sustainable way. The institution currently has a total installed capacity of 204.4 MW and a net production equivalent to 21.8% of the electrical energy produced in El Salvador.
Cucumacayán Electricity Company (**CECSA** – *Compañía Eléctrica Cucumacayán*)	CECSA, a CEL subsidiary, is a company dedicated to the generation of electrical energy through small hydropower plants.
Energy Investments (**INE** – *Inversiones Energéticas*)	INE, a CEL subsidiary, is a company in charge of commercialising the energy generated by the El Talnique thermal power plant. It was the first thermal generation project developed by the government after electric sector reforms.
Transactions Unit (**UT** – *Unidad de Transacciones*)	UT is a private institution in charge of El Salvador's wholesale electricity market operations. Its functions are operating the electricity transmission system and ensuring the safety and quality of this service.
Regional institutions	
Regional Commission for Electrical Interconnection (**CRIE** – *Comisión Regional de Interconexión Eléctrica*)	CRIE started operations in 2000 as the regulatory authority of the regional market with its legitimacy recognised by all parties to the Marco Treaty of the Electricity Market of Central America, signed in 1996. It has an Executive Secretary and a Board of Commissioners, consisting of one representative from each country, who is often a member of the national regulatory board.
Regional Operating Entity (**EOR** – *Ente Operador Regional*)	EOR is the regional system operator and market administrator. This entity was also created as part of the Marco Treaty of the Electricity Market of Central America, signed in 1996.
Enterprise owner of the Regional Electric Grid (**EPR** – *Empresa Propietaria de la Red*)	EPR is the entity that owns the SIEPAC line. The regional transmission line (RTL) of SIEPAC has a transfer capacity at all borders in the region of 300 MW in one circuit. This regional entity was also created as part of the Marco Treaty of the Electricity Market of Central America, signed in 1996.
Council of the Regional Electricity Market (**CDMER** – *Consejo Director del MER*)	CDMER is the body in charge of revising regional integration policies in Central America.

Appendix 2. **Installed and available capacity of power plants, 2018**

No	Name	Type	Unit number	Installed capacity		Available capacity	
				(MW)	(%)	(MW)	(%)
Hydro				**552.7**	**30%**	**530.74**	**32%**
1	Guajoyo	Hydro	(1x19.8)	19.8	1%	19.8	1%
2	Cerrón Grande	Hydro	(2x86.4)	172.8	9%	172.8	10%
3	5 de Noviembre	Hydro	(3x20)+(1x18.0)+(1x21.40)+ (2x40.07) (1x0.55)	180.09	10%	158.1	9%
4	15 de Septiembre	Hydro	(2x90)	180	10%	180	11%
Geothermal				**204.4**	**11%**	**175**	**10%**
5	Ahuachapán	Geothermal	(2x30.00)+(1x35.00)	95	5%	74.7	4%
6	Berlín	Geothermal	(2x 28.10)+(1x44)+(1x9.2)	109.4	6%	100.3	6%
Fossil				**204.4**	**11%**	**175**	**10%**
7	Orazul Acajutla	-	-	**322.1**	**17%**	**297.8**	**18%**
7. 1	Acajutla	a) Vapor	(1x30.0)+(1x33.0)	63	3%	59.5	4%
7. 2	Acajutla	b) Gas	(1x82.1)	82.1	4%	64	4%
7. 3	Acajutla	c) Motors	(6x16.5)+(3x17)	150	8%	147.3	9%
7. 4	Acajutla	d) FIAT U-4	(1x27)	27	1%	27	2%
8	Orazul Soy ap ango	Motors	(3x5.4)	16.2	1%	15.3	1%
9	Nejapa Power	Motors	(27x5.3)	143.9	8%	141.5	8%
10	Holcim	Motors	(3x6.40)+(1x6.70)	25.9	1%	25.9	2%
11	Inversiones Energéticas	Motors	(3x16.5) + (6x8.45)	100.8	5%	100.8	6%
12	Textufil /2	Motors	(2x3.4)+(2x6.8)+(1x7.1)+(2x7.5)	42.5	2%	42.5	3%
13	GECSA	Motors	(3x3.8704)	11.6	1%	11.2	1%
14	Energía Borealis	Motors	(8x1.7)	13.6	1%	11.1	1%
15	HILCASA Energy	Motors	(4x1.7)	6.8	0%	6.5	0%
16	Termop uerto Limitada	Motors	(1x1.5)+(1x2)+(1x7.5)+(1x10)	73.7	4%	71.6	4%
Biomass				**293.6**	**16%**	**179.7**	**11%**
17	CASSA	-	-	**123.4**	**7%**	**61**	**4%**
17. 1	Central Izalco	Turbogenerators	(1x25)+(1x20)	45	2%	26	2%
17. 2	Ingenio Chaparrastique	Turbogenerators	(1x1.5)+(1x2)+(1x2.5)+(1x10)+(1X62.4)	78.4	4%	35	2%
18	Ingenio El Angel /1	Turbogenerators	(1x10)+(1x12.5)+(1x25)+(1x3.5)	95.3	5%	53.8	3%
19	Ingenio La Cabaña /1	Turbogenerators	(1x1.5)+(1x2)+(1x10)+(1x20)	30	2%	30	2%
20	Ingenio Jiboa	Turbogenerators	(1x1.5)+(1x2)+(1x7.5)+(1x10)	44.9	2%	34.9	2%
Photovoltaic				**60**	**3%**	**60**	**4%**
21	Providencia Solar	Solar PV	239,358 Paneles FV	60	3%	60	4%
-	**TOTAL**			**1867.81**	**100%**	**1669.7**	**100%**

Source: SIGET (2019)

Appendix 3. **Location of on-grid power generators, 2018**



	Installed capacity	Share
H = Hydro	552.7 MW	29.59%
T = Fossil fuel	757.1 MW	40.54%
G = Geothermal	204.4 MW	10.94%
B- Bioenergy	293.6 MW	15.72%
S-Solar	60.0 MW	3.21%
TOTAL	1,867.81 MW	100.00%

Source: SIGET (2019)

Appendix 4. Certified electricity generation projects using renewable resources, 2017

Project developer	Project name	Capacity (MW)	Resource	SIGET Agreement No.
INDUFOAM ENERGY SUPPLY, S.A. DE C.V.	Photovoltaic Solar Installation on Roof up to 4 MWp INDUFOAM 1	2.604	PV	79-E-2017
INGENIO EL ÁNGEL, S.A. de C.V.	Sugar Cane Processing Plant Cogeneration Phase IV	47.80	Biomass – Sugar cane bagasse	84-E-2017
POTENZA, S.A. de C.V.	Plant Photovoltaic La Independencia	10.00	PV	124-E-2017
INJIBOA, S.A. DE C.V.	Generation Plant Sugar Cane Processing Plant Jiboa S.A.	34.90	Biomass – Sugar cane bagasse	221-E-2017
VASES INGENIEROS, S.A. de C.V	Photovoltaic Generating Plant Tangolona	0.475	PV	244-E-2017
ACAJUTLA ENERGÍA SOLAR I, LTDA. de C.V.	Solar plant Los Remedios	28.00	PV	260-E-2017
BOSFORO, LTDA. DE C.V.	PFV PASAQUINA	10.00	PV	384-E-2017
	PFV EL CARMEN	10.00	PV	421-E-2017
	PFV CONCHAGUA	10.00	PV	422-E-2017

Source: SIGET (2017a)

Appendix 5. Small projects that obtained a concession to generate hydroelectricity, 2017

Project name	Capacity (kW)	Agreement No.	Legislative decree
PCH San Simón I	230 kW	125-E-2017	693/2017
PCH San Simón II	400 kW	126-E-2017	694/2017
PCH Velesa Energy	120 kW	127-E-2017	695/2017

Source: SIGET (2017a)

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