Inter-American Development Bank

Renewable Energy Experiences in Nicaragua to Generate Electricity

Knowledge Sharing Forum on Development Experiences: Comparative Experiences of Korea and Latin America and the Caribbean

Multiconsult y CIA. LTDA.

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Contents

Figures

Tables

Executive Summary

In 2013, Nicaragua ranked third in Latin America for investments in renewable energy. This was because Nicaragua's energy composition had a high level of renewable sources and investments in renewable energy were high relative to the size of its economy. In 2008, electricity generated in Nicaragua from fuel oil was 68 percent while renewable energy was responsible for only 32 percent. By 2014, however, the electricity generated using renewable resources increased to 52 percent.

Multiple institutions share responsibility for governing Nicaragua's electricity sector. The main institution is the Ministry of Energy and Mines (MEM), which is in charge of producing policies and strategies to develop the national electricity sector and granting the authorizations to generate, transmit and distribute electricity. This Ministry plays an important role in developing renewable energy in Nicaragua and its main goal is to maintain an energy policy that allows continued electricity generation from renewable resources.

Nicaragua is determined to transform its energy composition from one heavily reliant on fuel oil to one based principally on renewable energy. For that reason, the Nicaraguan government has approved specific laws that provide incentives to boost electricity generation through the development of renewable energy projects.

The electrification rate has increased steadily in Nicaragua, from 47 percent in 2002 to 80 percent in 2014. Part of this increase is due to small hydroelectric power plants in rural areas. The development of renewable energy in Nicaragua has led to a number of positive outcomes that include the improved governance and regulation of the energy sector, stabilization of energy policy, creation of an investment promotion agency with private-sector participation, and increased international cooperation.

In the last 3 years, increased electricity generation through renewable energy has stabilized energy prices for consumers. Nicaragua's goal is to generate 90 percent of its electricity from renewable resources by 2020.

1. Introduction

This report analyzes Nicaragua's experiences with sustainable energy development as presented and discussed in the "Knowledge Sharing Forum on Development Experiences: Comparative Experiences of Korea and Latin America and the Caribbean" during the Inter-American Development Bank/Inter-American Investment Corporation (IDB/IIC) Annual Meeting held in Busan, South Korea on March 26, 2015. The Forum's objective was to exchange experiences and emerging trends in development, including sustainable energy, between Korea and Latin American Countries. The report has the following contents:

I. **The Institutional Framework for Nicaragua's Energy Sector.** This chapter presents the institutional history of the energy sector and the major institutions currently responsible for energy sector governance.

II. **The Regulatory Framework for Nicaragua's Energy Sector.** This chapter describes the laws and decrees established to develop and promote renewable energy projects for electricity generation.

III. **The Evolution of Electricity Generation.** This chapter presents the evolution of electric power generation in Nicaragua, an analysis of wholesale prices, and a history of the role of renewable energy in the sector.

IV. **Electricity Consumption.** This chapter describes electricity consumption trends in Nicaragua.

V. **Electricity Prices.** This chapter analyses the history of electricity prices in Nicaragua.

VI. **Energy Indicators.** This chapter presents Nicaragua's energy intensity and electrification rates.

VII. **Identification of Experiences.** This chapter describes how Nicaragua's energy projects increased the use of renewable sources for energy production.

VIII. **Future of the Renewable Energy Sector.** This chapter presents examples of planned renewable energy projects that will be operational starting in 2015.

IX. **Central American Regional Market.** This chapter discusses the Central American Regional Market and the role Nicaragua could play as an exporter of renewable energy to the region.

X. **Financing Requirements.** This chapter discusses the availability of finance for renewable energy projects in Nicaragua from domestic and international banks.

XI. **Lessons Learned.** This chapter describes useful lessons learned and areas for improvement for renewable energy project development in Nicaragua.

2. The Institutional Framework for Nicaragua's Energy Sector

A. Evolution of the Institutional Framework

In 1991 Nicaragua had a single, vertically integrated, public electric company – The Nicaraguan Energy Institute (INE). The Nicaraguan Energy Institute was responsible for: i) electricity generation, transmission and distribution; ii) energy policies; and iii) energy resource management. Additionally, INE was also in charge of sector regulation and tariff approval. Following an evaluation of this vertically integrated model, the Government of Nicaragua (GoN) decided to permit new private power plant construction.

In 1994 GoN created a new state entity, the Nicaraguan Electricity Company (ENEL), which became responsible for electricity generation, transmission, and distribution. The Nicaraguan Energy Institute, meanwhile, continued to formulate energy policy and manage energy resources; INE was also now responsible for sector regulation.

In 1998 Nicaragua passed a new electricity industry law that established the necessary conditions to begin sector privatization. One objective of the privatization process was to divide ENEL into separate firms that would only be responsible for a single sector function: energy generation, transmission, or distribution. The current ENEL affiliated firms are as follows:

- Generation companies: Central Generating Power, S.A. (GECSA); Western Electric Generating, Inc. (GEOSA); Hydroelectric Generating, Inc. (HIDROGESA); and Momotombo Generating, Inc. (GEMOSA).
- Transmission company: National Electricity Transmission Company S.A. (ENTRESA).
- Distribution companies: North Distribution (DISNORTE) and South Distribution (DISSUR).

GEMOSA, the private geothermal plant, has been operating under an association contract to the Israeli company Ormat International Inc. since July, 1999.The first private sector financed

power plant, CENSA-AMFEL, was established in Nicaragua in 1996. CENSA-AMFEL, The Corinthian Energy Company Ltda., and Tipitapa Power Company became operational in 1997, 1998 and 1999, respectively.

In 1998 the National Energy Commission (CNE) was created and replaced INE as the institution responsible for energy sector policy. The Nicaraguan Energy Institute continued to be responsible for energy resource management and sector regulation.

The Nicaraguan government privatized electricity distribution in October 2000. The Spanish company Union Fenosa acquired the North Distributor, DISNORTE, and the Southern Distributor, DISSUR. Two years later in October 2002 the Nicaraguan government sold the state electricity generating company, Western Electric Generating, Inc. to the American company Elusa Power Texas.

By 2007 CNE's policymaking and INE's energy management functions were incorporated into the newly created Ministry of Energy and Mines (MEM). The Nicaraguan Institute of Energy continues to serve as sector regulator.

Also, the National Water Authority (ANA) was established in 2007. The National Water Authority is in charge of national water resources management. It grants authorizations for national hydropower electricity generation, and regulates other uses of national water assets.

B. Current Situation

The Institutional Framework for Nicaragua's electricity sector includes the following organizations:

1) The **Ministry of Energy and Mines** (MEM). Created in January 2007, MEM is in charge of producing policies and strategies to develop the national electricity sector and granting permission to generate, transmit and distribute electricity. The Ministry plays an important role in transitioning Nicaragua to greater renewable energy use. Its main goal is to establish plans of action to transform the country's energy composition away from fuel oil based power plants and towards renewables, establish an energy policy that allows the exploitation of renewable resources, and ensure environmental and socio-economic sustainability.

It is important to highlight that before 2007 CNE, not MEM, was responsible for formulating policies and plans for the energy sector. Moving these functions from a Commission to a Ministry elevated the energy sector's importance in Nicaraguan development policy and planning. Unlike CNE, MEM is a member of the President of the Republic's cabinet. Also, the

creation of a ministry can attract investment for renewable energy projects because the energy sector is governed at the ministerial rather than less influential commission level.

2) The **Nicaraguan Energy Institute** (INE). Created in 1979, INE is the energy sector's independent regulatory body. Prior to the creation of MEM, INE was in charge of sector planning, policy development, regulation, and taxation. It also negotiated contracts and concessions with private investors. In 1998, CNE was created, which assumed sector planning and policy development responsibilities. Currently, INE is only in charge of sector regulation and tariff approval. The Nicaraguan Energy Institute applies policies defined by MEM and there is a good working relationship between the two organizations.

3) The **Ministry of Environment and Natural Resources** (MARENA). This Ministry is in charge of conserving, protecting, and regulating the sustainable use of Nicaragua's natural resources. It also grants required permits before the start of electricity generation, transmission or distribution projects.

All three organizations play a specific role in sustainable energy promotion and environmental protection. The Ministry of Energy and Mines is part of a committee formed by local governments, MARENA conducts environmental assessments of projects, and INE, while not part of this committee, is invited to comment on the committee's activities.

4) The **National Water Authority** (ANA) is responsible for the management of national water resources to ensure that they are being used appropriately. It also grants authorizations for the use and exploitation of water. A permit is required to use national water resources for the development of hydropower projects between 1 and 30 MW. This permit is provided by ANA under the Law of The National Waters.

The Electricity Industry is comprised of the following components:

Generation: In Nicaragua 91 percent of effective energy capacity is private and the remaining 9 percent is state-owned. There are 39 working generators, of which 28 are privately owned and 11 are state-owned.

Transmission: The **National Electricity Transmission Company** (ENATREL) is responsible for the operation and maintenance of the national transmission system. It is a public company. The **National Load Dispatch Center** (CNDC), a part of ENATREL, manages the electricity market and operation of the national interconnected system.

Distribution: The distribution company **DISNORTE - DISSUR** controls almost 95 percent of electricity distribution in Nicaragua. It pays a toll to purchase electricity from power plants and supplies power to final consumers *via* the transmission network.

The **Nicaraguan Electricity Company** (ENEL), a state-owned company, generates and distributes electricity similar to a small private distributor that supplies power to remote, especially rural, areas.

3. The Regulatory Framework for Nicaragua's Energy Sector

Nicaragua has a regulatory framework that governs the energy sector's myriad activities. The country also has special laws that apply to renewable energy generation.

Law of The Electricity Industry (**Law No. 272) approved in 1998**

This law's objective was to establish the legal framework for the electricity industry's activities, which include the generation, transmission, distribution, merchandising, importing and exporting of electricity.

It is important to indicate that this law declares that the electricity industry's activities are in the national interest and essential to the Nation's progress. Thus, the development of such activities is a priority to the state and the state's declaration of easements or public use may affect the private and public sector's assets and rights.

This law states that generators cannot be transmitters and distributors of electricity if they are connected to the National Interconnected System (SIN). Distributors, however, can generate up to 10 MW of electricity. The Transmission Company belongs to the National Transmission System and is state-owned. However, there are no limitations in the case of isolated systems. Distributors may engage in activities of generation, transmission, distribution and merchandising, though they must have the necessary generating capacity to meet demand through either their own power stations or agreements with third parties.

For projects larger than 1 MW, an electricity generating entity must obtain a license or concession to legally generate electricity.

Distributors can buy energy via tender or direct negotiation; however, use of direct negotiation should not result in increased prices to the consumer.

National Energy Policy (Decree No. 13-2004)

The main objectives of the National Energy Policy are to: i) ensure the country's energy requirements; ii) prioritize the usage of clean renewable energy sources; and iii) allocate resources and mechanisms in order to maximize benefits. The policies of the renewable energy sector also provide for the following:

- Promote laws to establish incentives for energy development and exploitation.
- Update master plans that adequately quantify renewable resources.
- Provide funding for development research.
- Promote strategies to facilitate the development of large hydro, geothermal or other regional-scale renewable energy projects.
- Promote initiatives that establish treaties and agreements for technical cooperation on development.
- Promote a vision to identify and facilitate market opportunities.
- Remove obstacles in laws, regulations, and policies.
- Promote the use of renewable energy sources for rural electrification.
- Expand rural electricity coverage through photovoltaic systems or other renewable energy alternatives.

Specific Laws for Renewable Projects

The Nicaraguan government has approved three laws that provide incentives to invest in renewable energy. The first Law pertains to the Promotion of Electricity Generation with Renewable Resources (Law N°. 532) and includes duty free imports of capital goods along with income and property tax exemptions. The second Law is the Sub-sector Hydroelectric Promotion Law (Law N° 467), and the third law is the Law of Exploration and Exploitation of Geothermal Resources (Law N° 443).

1) The Law on Promotion of Electricity Generation with Renewable Resources (Law N°. 532) approved in April 2005

This law declares that renewable energy generation is in the national interest. Additionally, it establishes economic incentives and priority rights for new renewable energy generation initiatives. The law establishes the following incentives for all equipment and materials necessary to establish renewable energy generation:

- Exoneration of import taxes.
- Exoneration of value added taxes.
- Exoneration of income taxes for seven years for the operation of renewable energy power plants.
- Exoneration of local taxes for ten years.
- Exoneration of taxes for natural resources exploitation for five years.
- Exoneration of Stamp Taxes.
- Obligation for utilities to buy power generated from renewable energy plants in an energy bidding process.

The incentives established in this law were available until April 2015, however, the government is working on a new proposal that would continue and guarantee renewable energy incentives.

2) The Law on Sub-sector Hydroelectricity Promotion (Law N° 467) approved in July 2003

This law establishes a ceiling on the amount of hydroelectricity private investors can generate and the requirements for obtaining a permit for hydroelectricity generation initiatives. This law also establishes the same incentives for hydroelectric projects as the Law on Promotion of Electricity Generation with Renewable Resources, Law N° 532, does for renewable resources more generally.

3) The Law of Exploration and Exploitation of geothermal resources (Law N° 443) approved in October 2002

This law establishes basic regulations for geothermal resource exploration and exploitation. This law also establishes the same incentives for geothermal resources as Law N° 532 establishes for renewable resources except for two modifications:

1) Exoneration of taxes on exports.
2) Exoneration of local taxes for five years instead of ten years.

4) The Rural Electrification Policy (Decree No. 65-2005)

This Policy promotes and facilitates electricity expansion in rural areas. It suggests prioritizing the use of renewable sources in remote areas as well as promoting local capacity for renewable energy project development at smaller scales.

Rates and Subsidies for Electric Sub-sector Policy (Decree No. 6-2006)

This policy establishes economic incentives to gradually promote renewable energy sources in the electricity sector so that they become the dominant energy sources in Nicaragua. To fulfill this objective, the following policies have been established:

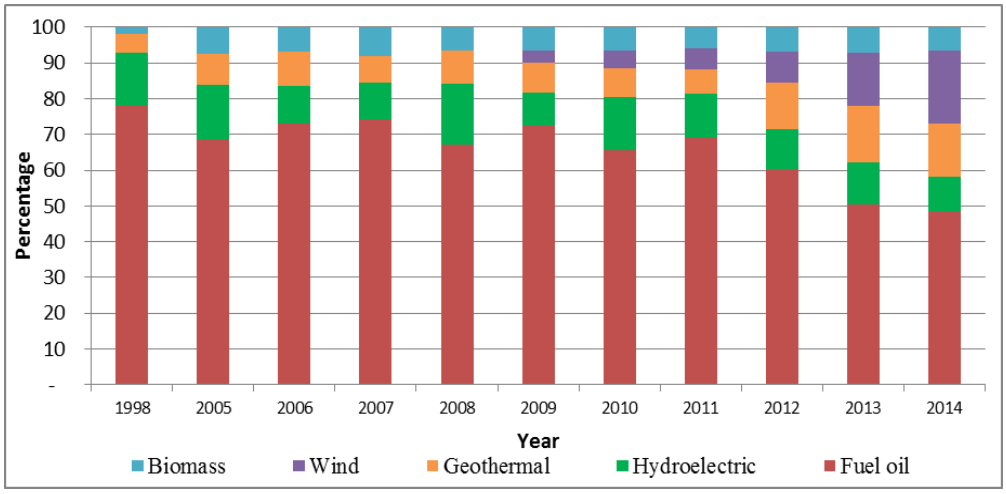
- Promote the inclusion of energy generation projects based on renewable sources.
- Facilitate the expansion of transmission lines to new energy generation projects for rural electrification as outlined in MEM's Indicative Generation Plan and the National Plan for Rural Electrification (PLANER).

This policy has allowed subsidies for SIN and investments in rural electrification projects, which have resulted in increased electricity consumption.

4. The Evolution of Electricity Generation

Nicaragua is determined to transform the power sector from one based on fossil fuels (e.g. fuel oil) to one rooted in renewable energy sources such as hydropower, geothermal, wind, and biomass, among others.

Figure 1 Evolution of Electricity Generation in Nicaragua



Source: Based on statistics of the Nicaraguan Energy Institute, 2014.

In 1998 seventy-eight percent of all electricity was generated from fuel oil and the remaining 22 percent was from renewable sources. In 2005, electricity generated from fuel oil decreased by 10 percent to 68 percent. In 2014 renewable energy generated almost 60 percent of all electricity and wind power alone accounted for almost 22 percent.

In *Climatescope 2013*, a report published by the Inter-American Development Bank, Nicaragua was ranked third in Latin America (behind Brazil and Chile) for investments in renewable energy, first in Central America for support of green micro-financing, and first in enabling the necessary framework for green energy projects. According to the report, Nicaragua's high rankings were the result of the high penetration of renewable sources into the country's electricity sector and the significant flow of investment in renewables relative to the size of its economy.

As part of the government's strategy to change Nicaragua's energy composition between 2007 and 2013, more than US$ 1,182 million have been invested in the sector with US $919 million accounting specifically for renewable energy sources. Foreign investment in renewable sources comes to Nicaragua mainly from Canada, the United States and Brazil. The Government of Nicaragua's goal is to generate 74 percent of its electricity from renewable sources by 2018.

Wholesale Prices

The wholesale price of electricity generation in the last decade has varied between 90 MWh/US$ and 172 MWh/US$. In 2005, the wholesale price of electricity in Nicaragua was 90 MWh/US$. This price did not increase until 2008, when it climbed to 137 MWh/US$. However, the price decreased sharply to 120 MWh/US$ in 2009 because the country's first wind power plant became operational.

Despite the considerable increase in renewable energy use from 2009 on, wholesale prices continued to increase because Nicaragua depended largely on fossil fuel to generate electricity.

The positive effect of renewable energy generation on wholesale prices returned in 2012. Over the next two years wholesale prices decreased. The table below shows the evolution of wholesale prices in Nicaragua between 2005 and 2014.

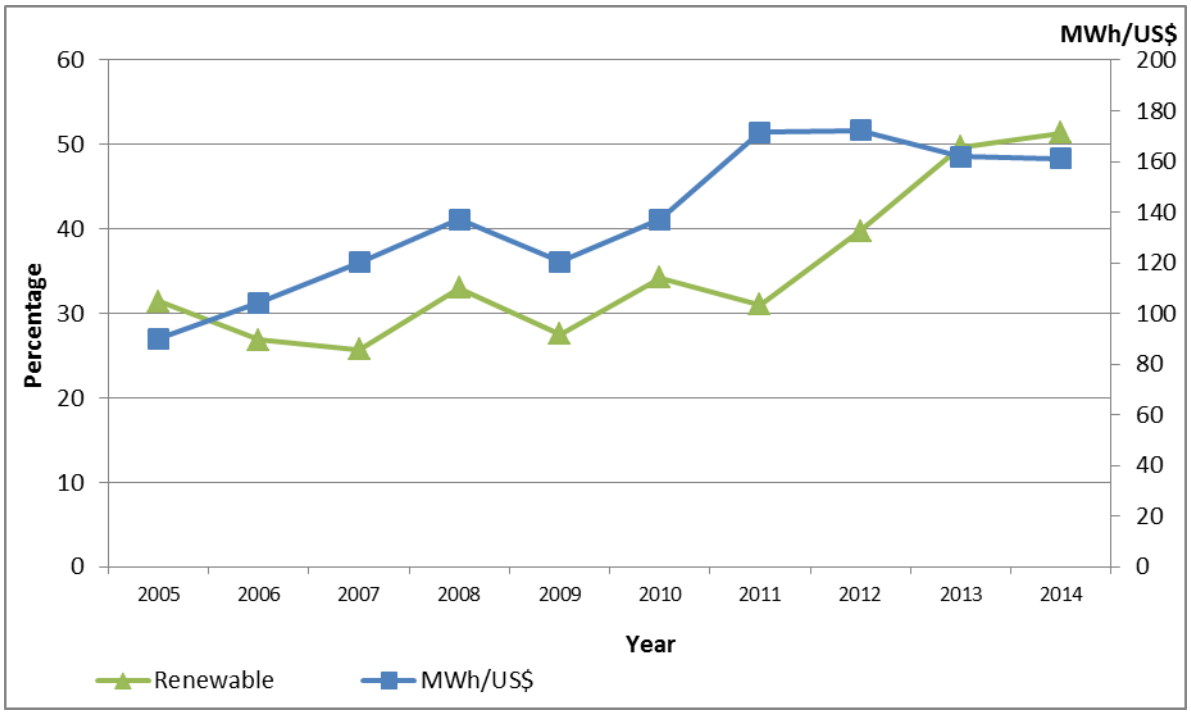
Table 1 Evolution of Wholesale Prices in Nicaragua

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MWh/US$	90.1	104.4	120.2	137.1	120.3	137.0	171.5	172.2	161.8	161.1

Source: Based on statistics of the Nicaraguan Energy Institute, 2014.

The following graph shows a comparison between wholesale prices and the evolution of renewable energy in Nicaragua:

Figure 2 Wholesale Prices and the Evolution of Renewable Energy in Nicaragua



Source: Based on statistics of the Nicaraguan Energy Institute, 2014.

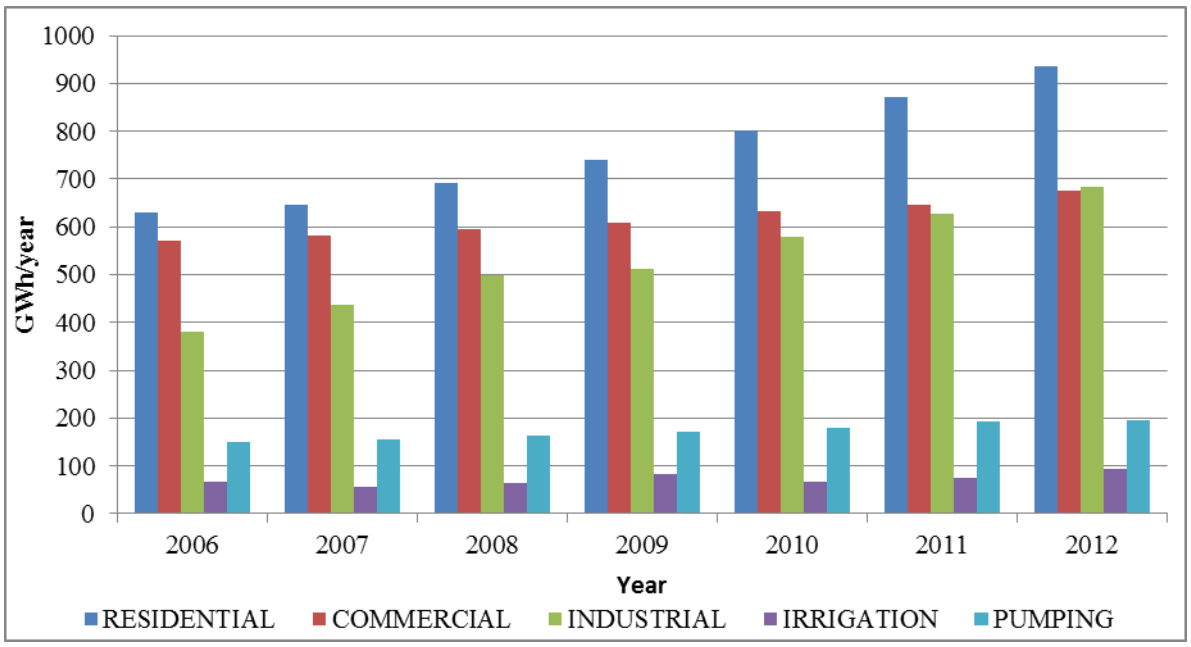
5. Consumption of Electricity

Electric energy consumption increased by 12 percent between 2006 and 2009 and 22 percent between 2009 and 2012. These consumption increases were largely due to increases in electricity coverage rather than increases in per capita consumption, which has only grown modestly. Total electricity consumption increased an average of 6 percent per year while per capita consumption increased on average 3 percent per year. The average electricity consumption

per customer in the National Interconnected System was 95 kWh/month in 2012. This shows the importance of domestic consumption *vis-a-vis* industrial and commercial (business and services) consumption.

The following graph shows the increase of the total electricity consumption, annually and by sector, during the 2006-2012 period.

Figure 3 Electric Energy Consumption by Sector

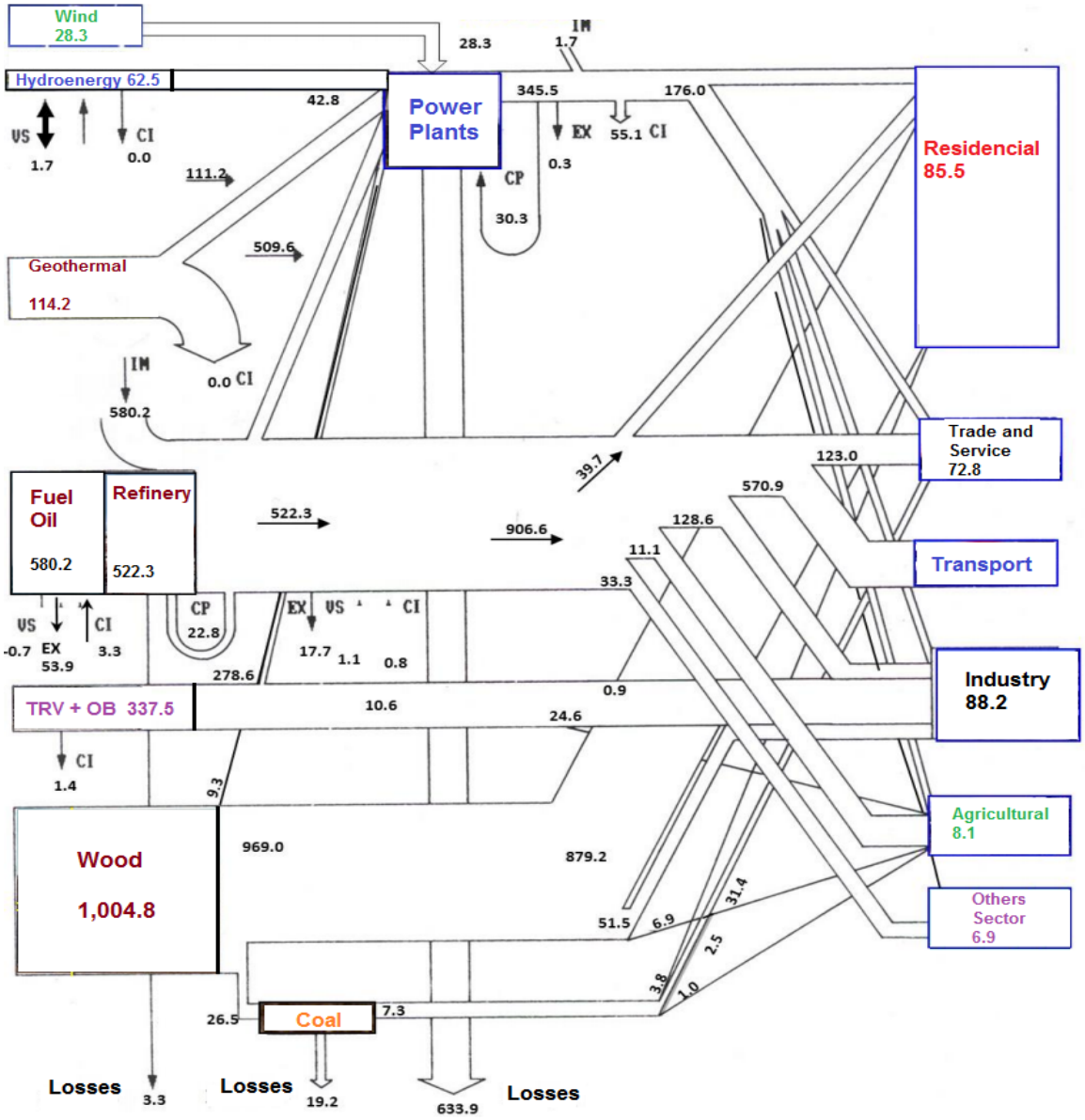


Source: Based on statistics of the Nicaraguan Energy Institute, 2006-2012.

Energy Flow

The following figure shows the flow of energy from the primary source to end-use. Renewable electricity generation (wind, hydroelectric and geothermal energy) plays an important role.

Figure 4 Energy Flow, in Thousands of TEP



Source: National Energy Balance, MEM 2012.

Fuel oil products such as gasoline and diesel are used mostly in the transport sector. Wood is an important primary source, which is mostly used for cooking in the residential sector.

6. Prices of Electricity

Electricity in Nicaragua is relatively expensive. The average price per kWh in 2012 reached US$0.245. The commercial sector pays the highest price at almost US$0.30 per kWh. The irrigation sector (agricultural crops) pays the lowest price at US$0.19, although this is higher than last year's price. Finally, the residential sector's price is somewhere in between with an average price of US$0.229.

Energy consumption levels determine residential tariffs. Residential customers consuming up to 150 kWh/month pay less than the average tariff and those consuming in excess of 201 kWh/month pay more than the average. A customer with consumption between 151 and 200 kWh/month pays the average price. The following chart shows the average energy consumption and price per kWh by customer type.

Table 2 Consumption per Customer and Average Price from kWh, 2012

Sector	kWh/customer	US$/kWh
Residential	1,166	0.150
Commercial	13,488	0.266
Industrial	95,057	0.204
Irrigation	87,243	0.172
Pumping	177,713	0.183

Source: Based on statistics of the Nicaraguan Energy Institute, 2012.

According to statistics published on MEM's website, in 2012 SIM distributors had 25,000 electricity consumers that qualified as "spontaneous deals" - homes that have unregulated connections to the electricity distribution network. These are incorporated into the distributor's commercial management system regardless of whether or not the electricity meter was hacked. Thus, consumers that began as illegal are billed for a level of energy consumption (kWh) that is lower than actual energy consumed and generally lower than what regulated residential users consume. We have to take into account that regulated residential users have higher electricity consumption levels than illegal ones.

Outside the official distributors' (DISSNORTE-DISSUR) concession area there are several distribution companies that generate their own electric power (isolated systems not

connected to SIN). Such systems belong to ENEL, which grants consumption subsidies that result in prices per kWh prices that are lower than those found in SIN. The table below shows these results for 2012.

Table 3 Average Price of kWh in Isolated Systems from ENEL, 2012

System	US$/kWh	System	US$/kWh
Bluefields	0.121	Mulukukú	0.166
Bonanza	0.164	Plan Grama	0.158
El Ayote	0.177	Rosita	0.176
El Bluff	0.119	Sahsa	0.164
Kukra Hill	0.176	Siuna	0.177
L Perlas	0.17	Wiwilí	0.157

Source: Based on statistics of Nicaraguan Energy Institute, 2012.

The average prices per kWh in 2012 for private systems that do not belong to ENEL are shown in the table below. These figures show that the average prices for two of the systems is higher than the average at DISNORTE-DISSUR. This is because these two systems do not receive any subsidies. By contrast, ATDER-BL is a small hydroelectric plant (PCH) that sells excess power to DISNORTE-DISSUR.

Table 4 Average Price for kWh in Isolated Private Systems

System	US$/kWh
Zelayaluz	0.278
Aprodelbo	0.240
ATDER-BL	0.153

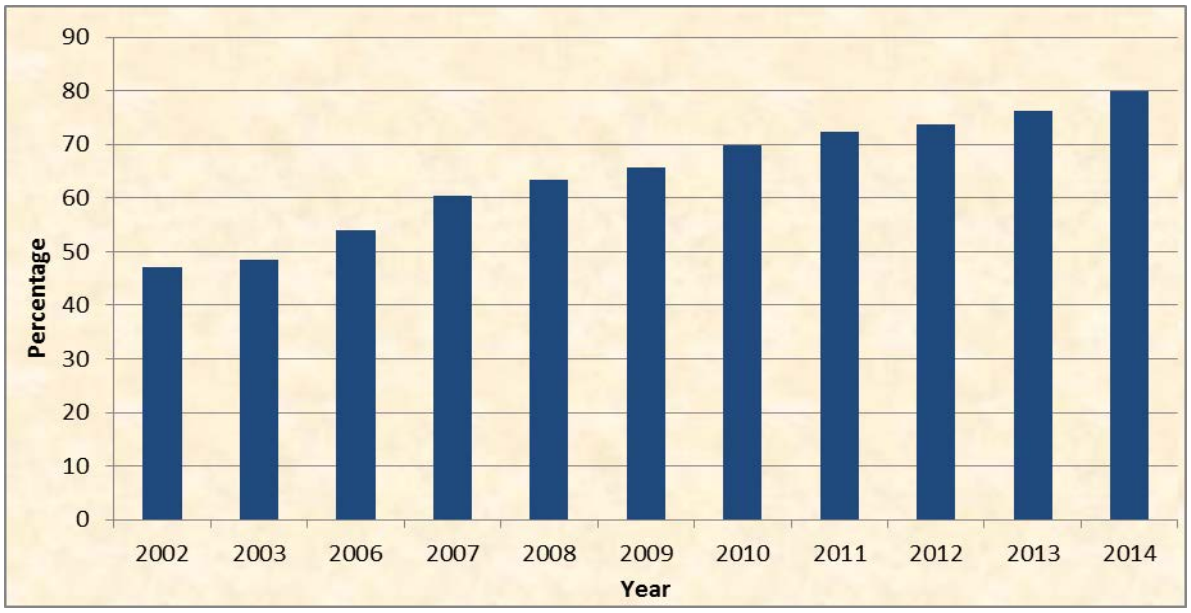
Source: Based on statistics of the Nicaraguan Energy Institute, 2012.

7. Energy Indicators

Electrification Rate

The number of residential customers with electric power has increased steadily in Nicaragua. In 2002, the rate of electrification was 47 percent but by 2014 the rate climbed to 80 percent, representing a significant increase. The following graph illustrates the trend in this indicator during the 2002-2014 period.

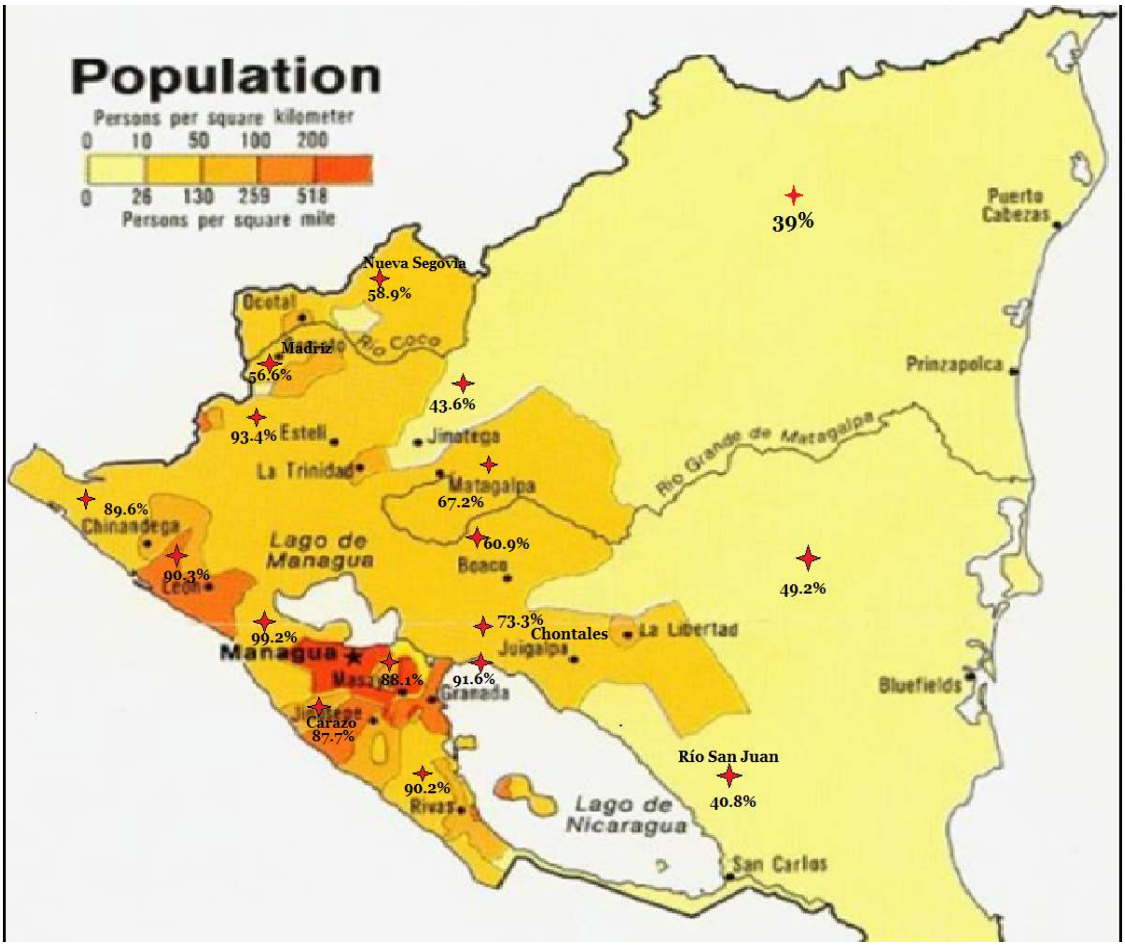
Figure 5 Electrification Rate in Nicaragua, 2002-2014



Source: Based on The Annual Report of Electrification Rate in Nicaragua, MEM.

In general, the electrification rate has increased for all cities in Nicaragua during the same period, with relatively lower increases in Chontales, RAAS, Rio San Juan and Jinotega.

Figure 6 Electrification Rate by Sector

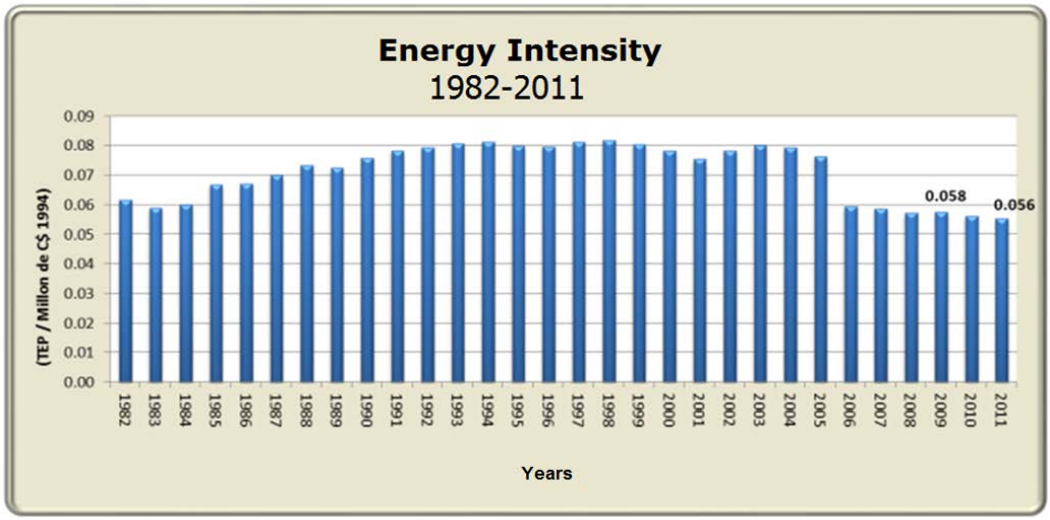


Source: Based on The Annual Report of Electrification Rate in Nicaragua, MEM.

Energy Intensity

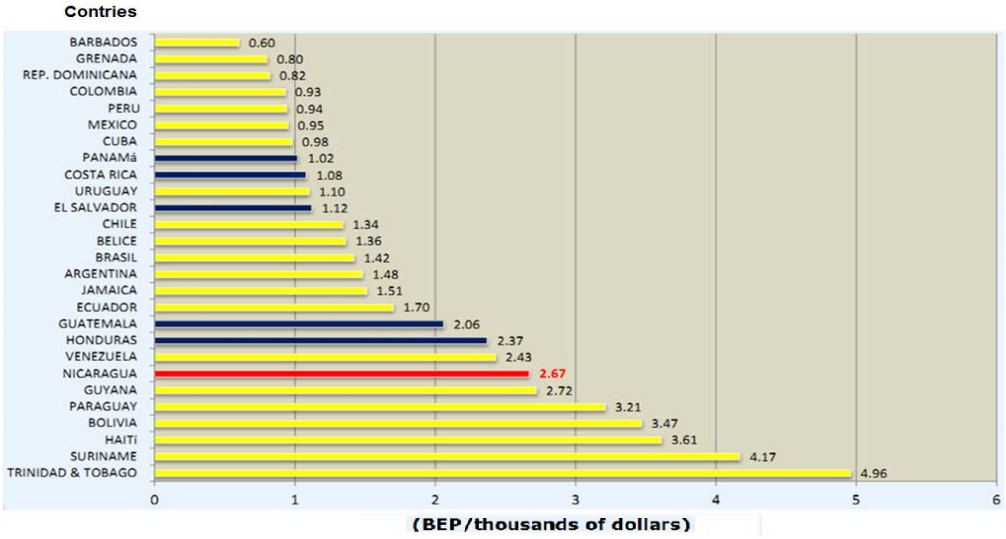
Energy intensity is the relationship between national energy consumption and gross domestic product (GDP) (in constant money terms for a specific year). Trends in this indicator are used to assess the level of energy use efficiency for achieving economic growth. The lower the energy intensity, the less energy consumption that is required to raise GDP levels. Similarly, higher energy intensity levels means more energy consumption is necessary to reach a particular GDP rate. In Nicaragua, energy inensity decreased sharply in 2006 and has continued to decrease up until 2011 (the latest year for which data is available). However, Nicaragua has the highest energy intensity rate in the Central American region.

Figure 7 Energy Intensity in Nicaragua, 1982-2011



Source: National Energy Balance, MEM 2011.

Figure 8 Energy Intensity, 2010



Source: Presentation on Renewable Energy in Nicaragua. Julio Pérez, MEM cited as a source OLADE 2011.

8. Identification of Experiences

National Sustainable Electrification and Renewable Energy Program: In 2010, the National Sustainable Electrification and Renewable Energy Program (PNESER) was created. The Program's objective is to support the Nicaraguan Government's efforts to reduce poverty through the expansion and improvement of electricity services. The Program also promotes the

use of renewable sources for electricity generation to both produce a change in Nicaragua's energy composition and contribute to climate change mitigation. On paper the executing agency for PNESER is MEM, but in reality ENATREL administers the Program.

Off-Grid Rural Electrification Project: Created in 2003 and concluded in 2011, the main objectives of The Rural Electrification Project in isolated areas (PERZA) are to: i) support the sustainable provision of electricity services and their associated social and economic benefits in selected rural sites in Nicaragua; and ii) strengthen the Nicaraguan government's institutional capacity to implement its national rural electrification strategy.

The Fund for the Development of the National Electric Industry (FODIEN) was developed in 2004 and formally regulated by 2006 through the 1998 Electricity Industry Law. This Fund is responsible for managing rural electrification projects and cooperative agreements with external organizations. Since its official launch, FODIEN has received project funding and technical assistance from various co-operation agencies, multilateral organizations such as the IDB, World Bank, European Union, Global Environment Facility and bilateral government agencies from Canada, Finland, Switzerland, Norway, Korea and Japan, among others. The Fund's main investments have been in electricity network extension projects. Other types of projects include:

The Rural Electrification Project in Isolated Areas, or PERZA PROJECT: The World Bank funded the PERZA project. Its objective was to improve rural Nicaraguans' living conditions through the provision of sustainable electricity services. The Project provided national level support to the Government of Nicaragua for the design and implementation of a rural electrification strategy. In addition, PERZA aimed to implement an innovative off-grid, public-private electricity supply mechanism in several pilot sites for potential scale-up at the national level in the future. The pilot sites also served as demonstration areas for the role of rural micro-finance and business development services (SDEs) in rural electrification, which have the potential to significantly increase rural electrification's development impact.

When the PERZA project was initiated, approximately half of rural residences without power could potentially access electricity through an extension of the electricity distribution network. However, the other half was so sparsely located and at such a great distance from the existing network that extending the network to these residences would have been cost

prohibitive. The PERZA project targeted this population with services that could serve as a substitute to formal network expansion and extension.

The PERZA project also conducted market research and a series of consultations with stakeholders to identify rural electrification opportunities for small businesses. These efforts produced technical designs, economic and financial projections, and business development investment incentives to determine the most attractive terms for small business led electricity provision.

Among the many important activities of PERZA, the three most important were: i) massively spreading solar energy use through the installation and use of both photovoltaic solar panels and battery load centers; ii) training local rural populations to install and use these technologies; iii) implementing, for the first time, microcredit for energy projects in rural areas; iv) installing small-scale hydro power for electrification and sale of the surplus power back to the national network; and v) organizing and training local communities to manage small-scale hydro power systems.

The project lasted almost 8 years and achieved the following results:

- Solar photovoltaic systems installed: 6863
- Battery load centers installed: 7
- Small hydroelectric plants and electricity distribution networks created: 5
- Microfinance institutions providing funding for the installation of rural solar systems and small business development: 5
- Companies that distribute solar systems accredited: 3
- Customers to whom business development services provided: 43
- The Nicaraguan Government adopted a national strategy for sustainable rural electrification
- Creation and operation of FODIEN
- Promotion of social participation and communication diagrams

Solar Systems: There are approximately 120,000 residential solar systems installed in rural Nicaragua. Investment in these systems to date has been US$22.85 million with half of that total going towards solar systems that connect to the national distribution network:

- About 7000 Individual Photovoltaic Systems have been installed in 220 communities benefiting 41,328 families. Most of these systems have been installed in the RAAS region, which has one of the lowest electrification rates in the country.
- Photovoltaic Systems have been installed in 42 communities of the RAAN region, which has the lowest electrification rate in the country.
- Seven solar battery charging centers were installed in the RAAN region.
- The first ever photovoltaic solar system (1.38 Wp) in Diriamba Municipality, Department of Carazo, was connected to the national network.

Small and Micro Hydroelectric Plants: Five small hydroelectric plants (PCH) and 20 micro-plants were built with a total investment of US$12.5 million between 2007-2013 and completed in 2013, supplying energy to 1,814 families. The construction of four additional micro-hydro plants and one additional PCH plant with a total cost of US$2.9 million will serve 3,067 families. Additionally, 12 power plants, six PCH and six micro-plants are expected to be constructed by the year 2016 at a total cost of US$25.7 million and connect 5,271 families. Financial support has been requested for the construction of 10 more PCHs to connect an additional 10,950 families. There is a plan to generate designs for 25 small-scale projects and develop feasibility studies for another forty-six.

The National Program for Sustainable Electrification and Renewable Energy, PNESER: This Program was initiated by the Nicaraguan government to support the National Plan for Human Development, whose goal is to promote the socio-economic development of the country's urban and rural areas. This program will contribute to this goal by significantly increasing access to efficient and sustainable electricity. This will increase the national electricity coverage rate and substantially increase renewable energy generation. Furthermore, PNESER hopes to improve climate change mitigation and adaptation efforts as well as promote energy efficiency.

Established in 2012, PNESER's objectives are to: i) increase the electricity coverage rate to 90 percent by 2020; ii) achieve a renewable energy generation rate of 99 percent; iii) bring electricity loss rates in human settlements down to 4.5 percent from the current rate of 11 percent; iv) reduce the consumption of energy efficiency in the last use in 221 GWh; and v) increase reliability of electricity services by reinforcing the transmission system at 94 percent. The Program has a budget of US$404 million and is carried out through seven components:

1) Rural electrification through network extension.
2) Service standardization in human settlements.
3) Renewable energy expansion in isolated areas.
4) Renewable energy generation project studies and pre-investment analyses.
5) Energy efficiency programs.
6) Transmission system reinforcement in rural areas.
7) Sustainability of isolated power systems.

Under PNESER, the Nicaraguan Government is also preparing the National Plan of Rural Electrification 2014-2024 (PLANER).

9. Future of the Renewable Energy Sector: The Expansion Plan

New electricity generation projects built between 2015 and 2027 will be based on renewable energy. They will modify Nicaragua's energy generation composition by reducing fossil fuel based energy generation from 60 percent to 9 percent by the year 2027.

The following table presents the power generation projects in GoN's Indicative Plan that will become operational sometime between 2015 and 2027.

Table 5 Nicaragua Expansion Plan, 2015-2027

Projects	Source	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Boboké	Hydroelectric						70 MW							
Larreynaga	Hydroelectric	17 MW												
Tumarín	Hydroelectric				253 MW									
Piedra Puntuda	Hydroelectric				15 MW									
El Diamante	Hydroelectric		5 MW											
Copalar Bajo	Hydroelectric							150 MW						
Salto Y-Y	Hydroelectric							25 MW						
El Carmen	Hydroelectric								100 MW					
Piedra Cajon	Hydroelectric								22 MW					
Valentin	Hydroelectric										28 MW			
Corriente Lira	Hydroelectric												40 MW	
Mombacho	Geothermic						25 MW							
Casitas	Geothermic		35 MW											
Apoyo	Geothermic						36 MW							
Chiltepe	Geothermic						35 MW							
Biomasa 1	Biomass						30 MW							
Biomasa 2	Biomass										30 MW			
CASUR	Biomass	24 MW												
Montelimar	Biomass		30 MW											
MMV	Fuel Oil	140 MW												

Source: Indicative Plan for expansion of electricity generation 2013-2027, MEM.

It is important to emphasize that this Plan for energy generation expansion is almost entirety reliant on renewable energy. Only one of the twenty projects is based on non-renewable sources. This single fuel-oil based project is estimated to produce 140 MW of power and, according to ENATREL, is required to ensure the quality, safety and reliability of the overall system and guarantee operation of the national grid.

In the period analyzed, a total of 970 MW of installed capacity will be generated from renewable energy sources, most of which will come from hydroelectric projects with an estimated power generation capacity of 725 MW. Hydroelectricity is followed by geothermal projects that hold an estimated power generation capacity of 131 MW and finally biomass projects that hold an estimated power generation capacity of 114 MW.

10. Central American Regional Market

The Regional Electricity Market is a market among six Central American countries: Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama. It is conceptualized as a seventh market superimposed onto the six existing national markets or systems and works through the Electrical Interconnection System of the Central American Countries (SIEPAC).

The main objectives of the Regional Electricity Market are to contribute to the reduction of energy costs in each country, improve the reliability of energy supply, produce economies of scale, generate higher levels of competition in domestic markets, and provide incentives to foreign investors.

Currently, the transmission capacity of electric power in the Central American Regional Market (MER) is 300 MW, which is slated to increase to 600 MW by 2016. The following figure illustrates the SIEPAC connection across the six Central American countries.

Figure 9 Electrical Interconnection System of the Central American Countries

Source: Achievements and Future Expansion, EPR November 2014.

The institution in charge of regulating and coordinating operations of MER are:

- **Regional Electricity Interconnection Commission (CRIE).** The Commission is responsible for both regulating relations between public and private institutions that connect to MER and setting electricity rates. It is headquartered in Guatemala City, Guatemala and is comprised of the regulatory bodies in each Central American country. Nicaragua's representative for CRIE is INE.
- **Regional Operating Agency (EOR).** The Agency is responsible for dispatching and exchanging energy between countries. It is headquartered in San Salvador, El Salvador and is composed of each Central American country's Load Dispatch center and/or electricity market administrator. Nicaragua's representative is the National Load Dispatch Center.

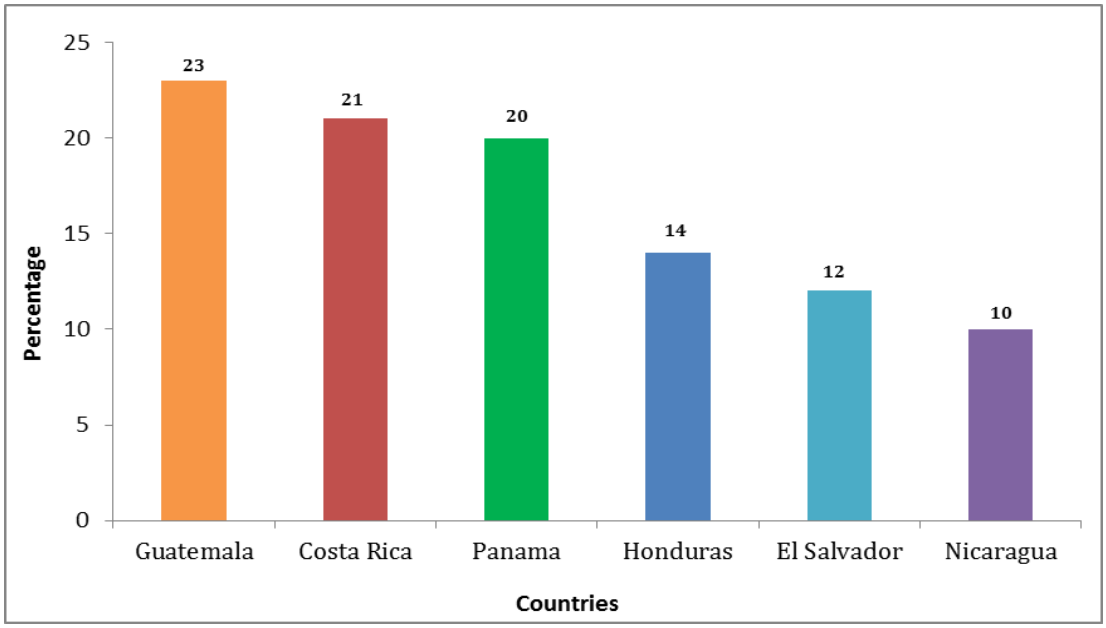
Demand and Supply of Energy in MER

Nicaragua has the potential to generate 4,500 MW from renewable energy sources. Some of this energy can in turn be contributed to MER. Because Nicaragua is located in the center of the Central American isthmus it can supply energy more competitively to all other countries in the region.

In 2013, the installed capacity of MER's six Central American systems was 12,877 MW. This total reflects a 3.5 percent increase in capacity from 2012 according to figures released by the United Nations Economic Commission for Latin America and the Caribbean (CEPAL).

Guatemala, Costa Rica and Panama had the highest contribution to installed capacity in MER. They were followed by Honduras, El Salvador and Nicaragua. The figure below shows each country's contribution as a percentage of total installed capacity.

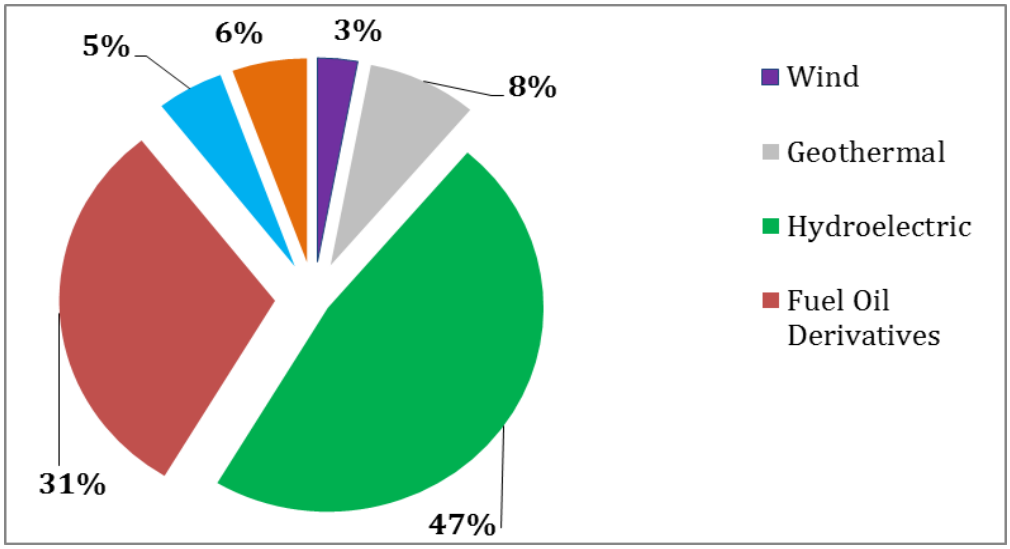
Figure 10 Installed Capacity by Country



Source: Calculated using electricity Subsector Statistics 2013, CEPAL.

By 2013, total electricity generation in the region reached 45,807 GWh (a 3.4 percent increase from 2012). Approximately 64 percent of this amount is generated from renewable energy and the remaining 36 percent is generated from fuel oil. The graph below shows the percentage of total electricity generated by different sources.

Figure 11 Percentage of Total Electricity Generated by Energy Source



Source: Adapted from Electric Subsector Statistics 2013, CEPAL.

In 2013, total energy contributions to MER totaled 690 MWh while withdrawals totaled 687 MWh. Nicaragua has only transacted with MER through the spot market; no transactions have occurred in the contract market.

11. Financing Requirements

Local banks in Nicaragua have offered financing for renewable energy project construction for the past five years. Funding is available for solar photovoltaic projects of up to 5 MW and hydroelectric, wind, and biomass projects of up to 10 MW of generating capacity. The interest rate varies between 8 percent and 10 percent depending on the generating capacity of the project.

For larger projects of up to 10 MW there is financing from multilateral banks such as the Central American Bank for Economic Integration (CABEI), which provides funding for project feasibility studies, design and construction. The maximum amount of single-source financing is up to US$6 million. For projects requiring more than US $6 million financing is combined with other banks.

12. Lessons Learned

Positive Aspects

A changed institutional framework for Nicaragua's energy sector: Elevating energy policy to the ministerial level by transferring responsibility for energy policy from the National Energy Commission to the newly created Ministry of Energy and Mines provided for more centralized management of the energy sector and strengthened ties with the Nicaraguan government's executive branch.

The sustainability of a National Energy Policy: The Energy Policy continues to advance the same principles, objectives, and areas of focus as when it was established in 2004. The current administration has not repealed the Policy despite it having been enacted by a different administration.

Specific laws for renewable energy projects: the Nicaraguan government has approved three laws that provide incentives to invest in electricity generation from renewable sources. The first law is the Law of Promotion of Electricity Generation with Renewable Resources, which created tax exemptions and made imports of capital goods duty free. The second law is the Law

of Promotion of the Hydroelectric Sub-sector. The third law is the Law of Exploration and Exploitation of Geothermal Resources.

Support from the National Investment Promotion Agency, PRONicaragua: The nation's investment promotion agency has supported, in part through private-sector participation, investment in energy generation and renewable energy production. It is considered by similar agencies around the world as one of the best of its kind.

Reducing the time it takes to start construction on a renewable power plant: The Ministry of Energy and Mines is streamlining authorization procedures and permissions for new power plant initiatives so investors can begin construction on projects more quickly.

International cooperation: International support has been essential in developing small-scale projects and has also been central to providing electrical power to many isolated communities in rural areas with low electrification rates.

Allowing direct negotiation in power purchasing transactions: Tendering processes have made power purchase transactions more transparent and consumer prices more competitive. Allowing well regulated direct negotiation, however, has also supported many renewable power plant developments and competitive renewable energy prices.

Energy Prices Stability: over the last 3 years, renewable electricity generation has stabilized consumer energy prices.

Areas for Further Improvement

Improve the strength and independence of the regulatory agency: The Nicaraguan Energy Institute exercised weak oversight over the sector, which relies on a natural monopoly model of energy distribution. Stronger regulation is necessary for providers to comply with service quality standards and maintain consistent consumer electricity prices. While the use of renewable resources is on the rise, Nicaragua still relies a good deal on fossil fuel based power generation. Consumer prices are vulnerable to the price of oil, which can fluctuate on world markets. Also, electricity producers and distributors raise consumer electricity prices more readily when oil prices go up than lower consumer prices when oil prices go down.

Establish a regulatory framework for distributed energy generation: The Law of Promotion of Renewable Electricity Generation was in effect until May 2015 and the Nicaraguan government is working to recommend that Congress extend it. The new version should include provisions for distributed generation or develop a new law for distributed generation that

includes a balance between the interests of the national distribution company and individual investors.

Improve the technical conditions of the electricity distribution circuits: The condition of the distribution company's current electricity grid is limiting the amount of energy that it can be absorbed from the electricity generation process.

Boost hydroelectric power plants: Nicaragua does not have enough hydroelectricity in operation to provide ancillary services to the national electricity system. While internal combustion engines are being installed to cover services gaps, they are more costly than hydropower plants. Hydroelectricity must be promoted more heavily to provide sufficient energy and ancillary services.

Organize rural communities to manage power plants: Currently communities have been trained only for the operation, maintenance, administration and environmental management of small power plants. The Nicaraguan government also needs to involve communities from the bidding process up through power plant construction. At this time only the Nicaraguan government manages this process. In the past, when problems occurred, communities had to apply for government aid, which in the end requires more time to solve problems and may not even result in electricity access for communities. The government must relinquish some control over power plant governance.

Increase demand for renewable electricity generation: Presently wind generated power is restricted during hours of low demand. While renewable energy investors are aware of this regulation, that does not prevent the restrictions from diminishing their incomes. Increasing demand for wind-generated power can reduce restrictions on generation, improve investors' balance sheets, and increase investment in the renewable energy sector.

Develop the regional energy market: While the Central American regional energy market is a big consumer, its regulatory framework is not advanced enough to permit energy sales through long-term contracts.

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