Division Environment and Infrastructure
TERNA Wind Energy Programme

# Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

## 23 Country Analyses
## Chapter Nicaragua

Eschborn, September 2007

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## New Edition of the TERNA Country Survey

Since the first edition of the TERNA country survey appeared in 1999, there has been a distinct heightening of public and political awareness of the consequences of climate change and of energy provision as a key factor in sustainable development. In Germany and other industrialised countries, a political tailwind, effective promotion mechanisms and rising energy prices have created the conditions for a dynamic market in which renewable forms of energy are exhibiting high growth rates within the energy mix. In 2006, global new investment in renewables amounted to US$ 70.9 billion – an increase of 43 % over 2005.

Strong economic development in many emerging countries has triggered rapidly rising demand for energy and competition on the international oil market. Against the background of the rising cost of fossil fuels, supply risks and damage to the environment, the significance of renewable energy as a means of generating electricity is growing – also in developing and emerging countries: according to analyses conducted by the Renewable Energy Policy Network for the 21st Century (REN21), 39 countries have set expansion targets for renewable energy sources and introduced promotion mechanisms, nine of which are developing or emerging countries. Of total new investment in renewable energy around the world, US$ 15 billion was invested in developing and emerging countries. Nevertheless, the majority of countries still have a long road ahead of them before they overcome existing barriers to the successful introduction of renewable forms of energy.

The German and European market acts as the driving force for the wind energy industry and provides an indispensable background of experience. However, growth in the industry is also increasingly apparent in developing and emerging countries. It is the successes in countries such as India, China and Brazil which encourage commitment beyond the borders of industrialised nations. In those three countries there is a growing proportion of local content in the systems and equipment they produce – and not only for supply to their own domestic markets.

A number of other countries though, too, are erecting their first wind farms, thereby establishing the basis for gaining experience to be utilised in future markets.

To help interested players gain access to the new markets, this survey provides detailed descriptions of the framework conditions for electricity markets and renewable energy in 23 developing and emerging countries.

| Latin America | Africa/Middle East | Asia |
|---|---|---|
| Argentina | Egypt | Bangladesh |
| Brazil | Ethiopia | China |
| Caribbean States | Jordan | India |
| Chile | Morocco | Indonesia |
| Colombia | Namibia | Pakistan |
| Costa Rica | South Africa | Philippines |
| Dominican Republic | Tunisia | Viet Nam |
| Mexico | | |
| Nicaragua | | |

This latest country survey and the previous editions are available on our homepage: www.gtz.de/wind. For the first time, the publication is also available on CD-ROM. For information on how to obtain this, again, go to the homepage.

Our grateful thanks go to a large number of GTZ staff members and other experts in the field for their help in putting this information together.

Eschborn, September 2007

## Legal Information

1. The data used in this study is based on both publicly accessible sources of information (publications, specialist articles, internet sites, conference papers etc.) and non-public papers (for example internal expert reports from promoting institutions), as well as personal interviews with experts (for example officials at energy ministries in the investigated countries and project staff at promoting institutions). Although all information has been checked as far as possible, errors cannot be ruled out. Neither the GTZ nor the authors can therefore provide any guarantee of the accuracy of the data included in this study; no liability can be accepted for any loss or damage resulting from use of the data included in the study.

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## The TERNA Wind Energy Programme

There is great potential for generating electricity from renewable energy sources in many developing and emerging countries. Obstacles to the exploitation of such sources include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of national actors.

The purpose of the TERNA (Technical Expertise for Renewable Energy Application) wind energy programme, implemented by GTZ on behalf of the Federal German Ministry for Economic Cooperation and Development (BMZ), is to assist partners in developing and emerging countries in planning and developing wind power projects. Since 1988 the TERNA programme has pursued the twin goals of laying the foundations for sound investment decisions while at the same time enabling partners to assess wind energy potentials, plan wind energy projects and improve energy-policy frameworks for renewable forms of energy.

The TERNA wind energy programme's partners are institutions in developing and emerging countries that are interested in commercial exploitation of wind power. These include, for example, ministries or government institutions which have the mandate to develop BOT/BOO projects, state-owned or private energy supply companies (utilities) and private enterprises (independent power producers).

TERNA offers its partners expertise and experience. In order to initiate wind power projects, favourable sites must be identified and their wind energy potential ascertained. To do this, wind measurements are normally taken over a period of at least twelve months and wind reports are drawn up. If promising wind speeds are found, the next step is to conduct project studies investigating the technical design and economic feasibility. TERNA also provides advice to partners on matters of finance, thus closing the gap between potential investors and offers of funding from national and international donors.

If required, CDM baseline studies can be prepared and advice can be offered to potential operators on setting up an efficient operator structure. In order to ensure as much transfer of know-how as possible, efforts are made to ensure cooperation between international and local experts, for example when preparing the studies.

In successful cases, TERNA initiates investment-ready wind farm projects by this method. TERNA itself is not involved in financing. In addition to the activities that are tied to specific locations, TERNA advises its partners on how to establish suitable framework conditions for the promotion of renewable energy sources.

Up until 2007, TERNA has been active in over ten countries around the world.

Further information on GTZ's TERNA wind energy programme, the application procedure etc. is available at www.gtz.de/wind or directly from:

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# 8 Nicaragua

## 8.1 Electricity market

### Installed capacity

At the close of 2006, Nicaragua's national interconnected grid possessed a rated installed electrical generating capacity of 751.2 MW, while effective available generating capacity amounted to only 588.6 MW, 62% of which was based on oil-fired power generation, 14% on bagasse, 17% on wind power and 7% on geothermal energy.[1] This differential between rated and effective power output is due to the poor technical condition of a number of thermal power plants as well as a loss of geothermal sources.

In the case of cogeneration of heat and power using bagasse as the fuel, actual electrical output effectively fed to the interconnected grid corresponds to the difference between the rated installed capacity and plant-internal power consumption required for sugar production (see Table 1).

| Power plants | Rated | Effective |
|---|---|---|
| | MW | |
| Thermal (oil-fired) | 432.5 | 367.6 |
| Cogeneration of heat and power (firing sugarcane bagasse) | 126.8 | 81.0 |
| Hydropower | 104.4 | 98.2 |
| Geothermal energy | 87.5 | 41.7 |
| **Total of connected grid** | **751.2** | **588.6** |

**Tab 1: Installed rated and effective generating capacity per power source in Nicaragua; MW; 2006**

### Spot market

An acute energy crisis was felt in Nicaragua in 2006, with frequent power rationing hitting all consumer groups, brought about by a lack of investment to expand electrical generating capacity, the low availability of thermal power plant capacities, extremely low water levels in dammed reservoirs and rising oil prices. Failure to implement timely expansion of the country's electrical generating capacities proved to be the principal cause of this energy crisis, resulting in an extreme rise in electricity prices on the spot market. There, the average megawatt-hour charge in 2006 rose as high as 158 US$/MWh and the demand price to 168 US$/MW.

### Electricity generation

Net power generation in 2006 amounted to 2,829 GWh. State-owned power plants contributed 19% of this electricity production while the share contributed by privately owned power generating units came to 81%. Currently, power generation in Nicaragua is predominantly based on oil-fired units.[2]

The hydroelectric plants belonging to the power producer HIDROGESA are located in Jinotega department in the north of the country, while those belonging to CENSA, ORMAT, GEOSA and PENSA are in Leòn department, and EEC and the Monte Rosa and NSEL sugar factories are based in Chinandega department. GECSA and Tipitapa Power operate in the department of Managua.

1 Source: Statistics of the Nicaraguan Energy Institute (Instituto Nicaragüense de Energía – INE).
2 Ibid.

| Interconnected grid | Power generation |
|---|---|
| | GWh |
| **State-owned power providers** | **547.6** |
| Hidroeléctrica S.A. (HIDROGESA) | 299.2 |
| Eléctrica Central S.A. (GECSA) | 248.3 |
| **Private power providers** | **2281.1** |
| Corporación Eléctrica de Nicaragua S.A. (CENSA) | 314.2 |
| Empresa Energética Corinto (EEC) | 528.4 |
| Generadora Momotombo S.A. (GEMOSA) | 225.6 |
| Generadora Eléctrica de Occidente S.A. (GEOSA) | 547.0 |
| Tipitapa Power | 420.2 |
| Ingenio Monte Rosa | 93.9 |
| Nicaragua Sugar State (NSEL) | 100.4 |
| Polaris Energy S.A. (PENSA) | 51.4 |
| **Total power generated within the national interconnected grid SIN** | **2,828.7** |

**Tab. 2: Net electricity generation by power provider in GWh; Nicaragua; 2006**

## Electricity transmission and distribution

Nationwide, the electrical power network in Nicaragua consists of the national interconnected grid SIN (Sistema Interconectado Nacional), which roughly covers the half of the country with the highest consumer density, and isolated, stand-alone systems supplied in most cases by diesel generators.

## Electricity consumption

Total consumption of electric power in the period from January to November 2006 came to 1,716 GWh, with the household sector accounting for 34%, trade and commerce almost 31% and the industrial sector just over 20%.

| Sector | January - November 2006 | |
|---|---|---|
| | GWh | % |
| Households | 580.5 | 33.8 |
| Trade | 523.6 | 30.5 |
| Industry | 345.0 | 20.4 |
| Irrigation | 59.5 | 3.5 |
| Street lighting | 64.9 | 3.8 |
| Pumps (water supply systems) | 137.5 | 8.0 |
| **Total consumption** | **1,716.0** | **100.0** |

**Tab. 3: Power consumption by sector in Nicaragua; GWh and %; 2006[3]**

## Electricity prices

Electricity tariffs in Nicaragua are determined on the basis of existing power purchase agreements as well as by supply and demand on the spot market, which makes up about 9 to 11% of the total market. One exception in this regard was the year 2005, when the spot market share reached 25%.

Expenditure on fuels (oil and oil derivates) accounts for approximately 70% of the total costs dictating electricity prices for end customers.

| Sector | Electricity tariff |
|---|---|
| | US$/kWh |
| Households | 0.15 |
| Trade and crafts | 0.18 |
| Industry | 0.14 |
| Irrigation | 0.12 |
| Pumps (water supply systems) | 0.12 |

**Tab. 4: Average electricity tariffs by consumer sector in US$/kWh; Nicaragua; 2006[4]**

3 Ibid.

4 Source: own calculations based on energy sector statistics; the average tariff is calculated on the basis of the quotient from electricity sales revenue and the actual energy quantity billed.

### Expansion planning

The recently established Ministry of Energy and Mines (Ministerio de Energía y Minas), previously organised as the National Energy Commission (CNE), is responsible for planning to expand the nation's electrical generating capacities. In May 2005, CNE presented its Indicative Plan for expanding electricity generation over the period from 2005 to 2016.[5] This plan analyses two scenarios for development of an interconnected interstate electrical grid system in Central America (SIEPAC):

(I) "Integration" scenario:
This scenario is based on the assumption that a uniform interconnected grid system will be created at the regional level by implementing new projects and intermeshing the existing national grids in the region. However, this scenario is very unrealistic, as it would require complete integration of all existing networks within and across international borders.

(II) "Coordinated operation of isolated networks" scenario:
In this scenario, it is assumed that the Central American countries will develop their power grids autonomously according to demand in each country, but nevertheless in a coordinated form enabling operation across international borders.

## 8.2 Market Actors

### Power producers

Electric power generation in Nicaragua is provided by state-owned and privately owned utilities.

### State-run utility ENEL

Empresa Nicaragüense de Electricidad (ENEL) is the state-owned energy utility company that consolidates as holdings within its enterprise the power producer HIDROGESA, which operates the sole hydropower plant, and the power producer GECSA, which generates electricity on an oil-fired basis.

In addition, ENEL owns and operates the country's isolated, stand-alone systems (fuelled mostly by diesel). ENEL is currently planning to erect new power plant generating capacity based on hydropower.

### Private power producers

GEMOSA, a geothermal power plant, is leased to the private power producer ORMAT, while the GEOSA enterprise, operator of two oil-fired thermal power plants, was privatised in 2006.

The following table shows the installed electrical generating capacities of Nicaragua's private power producers that have gone into operation since the liberalisation of the electricity sector in 1992.

| Private power producer | Electrical generating capacity [MW] | | Year operation began |
|---|---|---|---|
| | rated | effective | |
| Corporación Eléctrica Nicaragüense, S.A. (CENSA) | 63.9 | 56.9 | 1997 |
| Empresa Energética Corinto (ENRON) | 74.0 | 70.5 | 1999 |
| Tipitapa Power Company | 52.2 | 50.9 | 1999 |
| Nicaragua Sugar Estates Limited (NSEL) | 59.3 | 30.0 | 1999 |
| Monte Rosa, S.A. (IMR) | 67.5 | 30.0 | 2002 |
| Polaris Energy Nicaragua, S.A. (PENSA)[6] | 10.0 | 7.5 | 2005 |
| **Total** | 326.9 | 245.7 | |

**Tab. 5: Installed electrical generating capacity of private power producers in Nicaragua; MW**

The 60 MW effective generating capacity of the two sugar factories NSEL and IMR represents the maximum power output these units can feed to the SIN interconnected grid during the sugarcane harvest. This output slackens towards the end of the sugarcane harvest owing to the diminishing availability of bagasse.

5 Plan Indicativo de la Expansión de la Generación 2005–2016.
6 Polaris recently lost its generating licence (at least temporarily) due to technical problems with existing facilities.

### Electricity transmission and distribution companies

#### Unión Fenosa

In September 2000, the two state-run electricity distribution enterprises were sold to the Spanish Unión Fenosa group, which was thereby granted an exclusive licence for power distribution within its concession area.

Unión Fenosa does not own any concession in the Atlántico Norte and Atlántico Sur Autonomous Regions, nor in parts of the departments of Jinotega, Matagalpa, Chontones or Río San Juan. These are rural areas marked by low population density, difficulty of access and little demand for electric power. Some of these rural communities have been provided with small diesel generators by ENEL or non-governmental organisations.

#### ENATREL

Empresa Nacional de Transmisión Eléctrica[7] (ENATREL) is the state-owned electricity transmission company that transmits electric power to national and international customers via 69 kV power lines (including transformer substations).

#### CNDC

Centro Nacional de Despacho de Carga (CNDC) is the grid operator of the national interconnected power network SIN, and forms an organisational unit within ENATREL.

### Economic situation of power producers

Pricing of electricity takes place on the power purchase agreement market and a spot market. The spot market takes account of the marginal costs of hourly demand for electricity (coste marginal horario). The National Energy Institute (INE) calculates the wholesale prices for energy and power for the months November to October of each given year based on existing power purchase agreements and the prices prevalent on the spot market. These provisional wholesale prices are recalculated every 12 months and applied to the tariffs as of May of the following year.

If the monthly accumulated deviation between the forecasted and actual electricity prices exceeds 10%, the tariffs are adjusted accordingly.

According to the power distribution company, the fact that the tariff adjustments it continually seeks in view of rising oil prices are not approved in full by the regulatory authority to the amount or for the time period requested results in a financial deficit that, in turn, leads to a failure to make payments to the power producers, ultimately giving the latter cause to ration power supply and shut down power plants.

## 8.3 Legal Framework

After a period of 13 years in which the electricity sector in Nicaragua remained unaltered in the hands of the state, approval was granted in 1992 to allow private-sector power generation, whereby the state remained the sole buyer.

In 1998, a fundamental restructuring of the energy sector was launched when a new Electricity Law (Ley 272: 'Ley de la Industria Eléctrica') came into force. The production, transmission and distribution (including sale) of electricity were split, and power generation and distribution (including sale) were privatised while electricity transmission remained with the state enterprise ENATREL.

These reforms also included introduction of a wholesale market for electric power (mercado mayorista), power trading between producers and distributors as well as between producers and major consumers, and the trade on the spot market. Law No. 272 provided for splitting of the state-owned energy provider ENEL into separate economic enterprises for power generation (GEMOSA, GEOSA, HIDROGESA and GECSA), power transmission (ENTRESA, now reorganised as ENATREL) and power distribution (DISNORTE und DISSUR).



7 Formerly ENTRESA.

The law designates INE to act as the regulatory authority for the energy sector, its main tasks being to prepare, implement and enforce technical codes and standards, monitor to ensure compliance with the Electricity Law and its provisions, monitor the electricity market, protect the rights of consumers, grant licences and concessions, approve tariffs for regulated consumers and to mediate disputes between market participants.

Furthermore, the law led to the establishment of the National Energy Commission (CNE, Comisión Nacional de Energía), whose principal function is to formulate energy policy based on the indicative planning of the energy sector.

In January 2007, Nicaragua's Law No. 290 came into effect by which the new government created a new Ministry of Energy and Mines to replace CNE in all its functions as well as to assume several additional functions performed up to now by INE, such as granting licences and concessions as well as approving technical codes and standards for the electricity and hydrocarbons sectors.

## 8.4 Policy Promoting Renewable Energy Sources

### Law promoting electricity generation using renewable energy

Nicaragua's Law No. 532 for the promotion of electricity generation from renewable energy sources (Ley No. 532: Para la Promoción de Generación Eléctrica con Fuentes Renovables) serves to regulate efforts to foster hydropower, geothermal, wind and solar energy as well as biomass by implementing the following incentive mechanisms:

- Exemption from value-added tax on equipment and accessories for renewable energy projects, from preparatory planning to design and erection of the power plant and transmission lines to the nearest transformer substation (Art. 7.2.)

- Exemption from income tax (impuesto sobre la renta) for seven years beginning at the time of commissioning of a power generating facility based on renewable energy; revenues from the sale of certified emission reductions within the framework of emissions trading likewise remain tax-free for the same period of time (Art. 7.3.)

- Partial exemption from municipal taxation on revenues received from the operation of power generating facilities for a period of ten years according to the following schedule (Art. 7.4):
  - Exemption from 75 % of municipal taxation for the first three years
  - Exemption from 50 % of municipal taxation for the subsequent five years
  - Exemption from 25 % of municipal taxation for the final two years

- Exemption from taxation on the utilisation of natural resources – such as that levied for geothermal projects or as provided for in the new Water Act – for the first five years subsequent to facility commissioning (Art. 7.5)

- Producers of electricity from renewable energy sources have the choice of selling the power they generate either by way of power purchase agreements or on the spot market; power purchase agreements have a minimum period of validity of ten years; the law obligates electricity distribution companies to give priority to purchasing power generated from renewable energy sources, and grants INE the right to specify minimum quantities for power supplies (Articles 12 and 13)

- In order to establish and ensure equal opportunity in the evaluation of bids submitted within the scope of invitations to tender, bidders offering power from thermal energy sources must include their fuel costs without tax exemption in their proposals (Art. 15)

- The spot market prices for electricity generated from renewable energy sources are fixed within a range of 55 to 65 US$/MWh; INE may update this price range on the basis of the energy policy of the Ministry of Energy and Mines (formerly the CNE) (Art. 16)

- Producers of electricity generated from renewable energy sources must comply with the regulations governing required back-up capacities and other auxiliary services ("reserva rodante y servicios auxiliares") that are defined in the operating codes and standards; the initial 20 MW of installed generating capacity utilising wind energy are exempt from rules requiring verification of dynamic grid stability, but must nevertheless satisfy all other requirements applicable for power feed to the SIN interconnected grid.

### Clean Development Mechanism

To date, nine energy projects in Nicaragua have been registered under the Clean Development Mechanism with the Designated National Authority (DNA), which falls under the authority of the Ministry of Environment and Natural Resources (MARENA). Three of these projects are currently at an advanced stage of negotiations with interested purchasers of the CERs; these could be concluded in the first half of 2007.

## 8.5 Status of Renewable Energy Resources

CNE[8] estimates the nation's technically and economically exploitable potential of renewable energy (hydropower, wind power and geothermal energy) to total approximately 4,500 MW. Despite this enormous potential, however, Nicaragua has made use of only a relatively small proportion of the available resources up to now.

### Hydropower

Hydropower is the best researched and documented renewable energy sector in Nicaragua. Studies conducted in the 1980s (e.g. the 1980 Master Plan) and subsequent updates reveal a hydropower potential amounting to 3,760 MW.[9]

A study conducted by CNE of possible known hydropower project sites envisages a gross electrical generating potential of some 3,280 MW, as shown in the table below.[10]

| Capacity range [MW] | Number of identified project sites | Share of identified total potential [%] | Potential in this capacity range [MW] | Share capacity range represents of total potential [%] | Comments |
|---|---|---|---|---|---|
| 0.1–1 | 30 | 29 | 10 | 0.3 | 30 small hydropower projects identified in the UNDP project, including two PERZA projects |
| 1–10 | 14 | 13.5 | 60 | 1.8 | Data from CNE and from other studies |
| 10–25 | 22 | 21 | 416 | 12.7 | |
| 25–272 | 38 | 36.5 | 2,796 | 85.2 | |
| Total | 104 | 100 | 3,282 | 100 | |

**Tab. 6: Identified hydropower project sites and estimated generating potential; Nicaragua; MW and %**

8 CNE has been replaced by the Ministry of Energy and Mines. Nevertheless, the term CNE continues to be used in the following, as all of these studies of renewable energy sources were conducted by CNE.

9 BID/CNE: Políticas Energéticas Indicativas, Borrador, Managua, Nicaragua, August 2001.

10 Thomas Scheutzlich: Policy Strategy for the Promotion of Renewable Energy – Situation and Perspective of Hydroelectric Generation in Nicaragua, ESMAP study commissioned by the World Bank, Nicaragua 2004.

Estimated gross annual electrical generating potential from hydropower totals approximately 33,000 GWh. However, only about 9,500 GWh of this is classified as being technically exploitable and 6,500 GWh currently as economically exploitable as annual energy potential. Currently installed hydropower generating capacity totals only about 100 MW, i.e. 5 % of available potential.[11]

From the data gathered in numerous investigations and studies, CNE prepared a list of 24 projects that offer promising prospects for implementation, with generating capacities ranging from 7 to 33 MW for a total potential of perhaps 490 MW. CNE furthermore singled out 12 large-scale projects with power outputs of between 41 and 425 MW, including the Copalar project with 350 MW and Tumarin project with 425 MW.

CNE (i.e. now the newly established Ministry of Energy and Mines) is presently conducting a project in which 30 potential hydroelectric plants ranging in output from 100 kW to about 5 MW have been identified and investigated at the pre-feasibility level. Three of these projects are currently under construction, with co-financing from GEF/UNDP and COSUDE.

A fourth project, El Naranjo, will be implemented in 2007 with co-financing by the EnDev-Nicaragua[12] project.

### Wind energy

Information available up to now enables only a rough estimate to be made of wind power potential in Nicaragua. CNE, i.e. now the Ministry of Energy and Mines, is currently conducting wind potential assessment studies with the aid of international organisations. An investigation of wind power potential and the wind energy market was carried out in 2003-2004 within the scope of an ESMAP study commissioned by the World Bank.[13]

In October 2002, CNE signed an accord with UNEP to determine wind power potentials and prepare a solar and wind atlas. The UNEP project Solar and Wind Energy Resource Assessment (SWERA), currently under execution with CNE, has already contributed towards mobilising the wind energy sector investment projects noted below.[14]

Collated wind data confirm that Nicaragua's wind energy resources range from good to excellent (Classes 4 to 7), in particular in the previously noted southern regions around Rivas, Lake Nicaragua and the lake's islands, the hilly areas around Managua and Juigalpa, in the west of the country north of Managua and in offshore areas of the southern Pacific coastline near Rivas. The Caribbean coast and nearby islands display good wind conditions (Classes 3 and 4).

It is anticipated that SWERA will continue to yield constructive impulses enabling investment decision-making and formulation of national energy policy and development strategies.

Wind measurement programmes carried out to date have identified a total area of 76 $km^2$ with wind speeds of over 8 m/s (at a height of 10 m). The resultant theoretically exploitable potential comes to 760 MW.

Based on these resources, various private companies have applied to INE for exploration licences[15] and are already performing wind measurements for investment projects in the following regions:

1. El Crucero (since October 2003)
2. El Sauce (since February 2004)
3. Island of Ometepe (in Lake Nicaragua)
4. Hato Grande
5. Grenada (since February 2004)
6. Corn Island (since July 2004)
7. Zona del Istmo de Rivas (Juigalpa and Rivas in the south on the border to Costa Rica)

11 Ibid.
12 Energizing Development – a project of the Dutch Government under implementation by GTZ.
13 Policy Strategy for the Promotion of Renewable Energy in Nicaragua, substudy on wind power, ESMAP study commissioned by the World Bank, Nicaragua 2004.
14 The SWERA country report for Nicaragua is available on-line at http://swera.unep.net.
15 These are provisional licences valid for a limited period of time (as a general rule, two years) to allow performance of site studies and wind measurements.

Currently, completed wind measurement data have been submitted for two wind energy projects that are already at the planning stage:

1. The Amayo project by ENISA – CDC, with a planned capacity of 40 MW, located on the Istmo de Rivas.
2. The Hato Grande project by VENTUS S.A., with a planned capacity of 20 to 25 MW, located in Chontales.

Unión Fenosa has agreed to purchase the power produced from a total of 40 MW of installed wind-generated capacity, while the national water utility Empresa Nicaragüense de Acueductos y Alcantarillados (ENACAL) has announced it will purchase 20 MW of wind energy.

### Biomass

Next to hydropower, biomass is one of the most important renewable energy sources in Nicaragua, with a fuel volume estimated to total some 42 million tonnes per year. This biomass accumulates in the form of agricultural and forestry waste. In addition, a considerable though not yet quantified potential is seen for cogeneration of heat and power based on sugarcane bagasse, as well as in the significant quantities of available eucalyptus wood waste.

Only two companies in Nicaragua are generating electric power from biomass on any large scale destined for the SIN interconnected grid: the two sugar factories NSEL and Monte Rosa. The table below presents an overview of estimated biomass potential in Nicaragua.[16]

| Area | Agricultural waste | Forestry waste | Consumption of firewood | Biomass available for other purposes |
|---|---|---|---|---|
| ha | t/year | | | |
| 11,855,800 | 16 million | 29 million | 2.9 | 42.1 |

**Tab. 7: Estimated biomass potential; Nicaragua; t/year**

### Solar energy

CNE, with the support of the SWERA[17] programme of UNEP[18], has investigated the country's solar irradiation potential and developed a solar atlas of Nicaragua. According to this atlas, the area of strongest solar irradiation is located in the country's northwest, in particular in the departments of León and Chinandega.[19]

The investment costs for photovoltaic (PV) solar energy systems currently remain high compared to other renewable energy technologies. As a result, large photovoltaic projects – for which investment costs per MW are some five times higher than for hydropower or wind power projects – are uneconomical, or economical only under particular conditions.

Nevertheless, several PV system projects are currently being implemented in rural areas that possess no hydropower or wind power potential.

### PERZA project[20]

A programme for developing Nicaragua's solar energy market has been underway since April 2005, financed by a loan from the World Bank and a grant from the GEF. With a project volume valued at US $ 2.9 million, its goal is to supply some 18,000 inhabitants throughout the country with electricity generated from solar energy.

16 Source: Guía del inversionista-CNE (CNE Investment Guide).
17 Solar and Wind Energy Resource Assessment.
18 United Nations Environment Programme (UNEP).
19 Source: Guía del inversionista-CNE (CNE Investment Guide).
20 Proyecto de Eléctrificación Rural en Zonas Aísladas (PERZA) (Project for Rural Electrification in Isolated Areas).

### 'Francia Sirpi' subproject

The Francia Sirpi project, launched in November 2006, is likewise being financed by funding from World Bank and the GEF, amounting to some US$ 215,000. The object of this project is to establish a solar-powered battery charging station in the RAAN[21]Autonomous Region that will generate an electrical output benefiting some 2,200 potential users.

### 'San Juan de Nicaragua' subproject

This project is also being financed by funds from a loan provided by the World Bank and the GEF. The loan for US$ 315,000 is being used to finance a solar-diesel hybrid system scheduled to commence operation in 2007.

### PV Systems Project of IDB (Proyecto Sistemas Fotovoltaicos)

This project, financed by the Inter-American Development Bank (IDB), is taking place in Waspán (in the RAAN Autonomous Region). It will supply 1,422 families with individual solar home systems being installed, maintained and managed by a private company.

### Geothermal energy

Although Nicaragua possesses enormous geothermal energy potential, the scope of this potential has not yet been thoroughly identified. Preliminary studies speak of resources totalling an electrical generating capacity of 1,500 MW. A potential and market analysis was carried out in 2003-2004 within the scope of an ESMAP study by the World Bank.[22]

In 1999 and 2000, INE issued two licences for project implementation. In March 2006, licences for exploration of the El Hoyo-Monte Galán and Managua-Chiltepe projects were granted to Geotérmico GeoNica, a consortium founded jointly by the Compañía Geotérmica Salvadoreña LaGeo and the Italian power provider ENEL.

### Future projects

### Hydropower

The following tables list projects presented in the CNE Investment Guide (Guía del Inversionista-CNE, 2003) which are to be opened up to private-sector investment in coming years for realisation. Step by step, the legal framework for private-sector participation has been considerably improved in recent years such that the opportunities for project implementation from this portfolio are thoroughly feasible.

| Project | Generating capacity in MW |
|---|---|
| Tumarín | 425 |
| Mojolka | 119 |
| Brito | 260 |
| Copalar | 350 |
| Valentin | 62 |
| Pintada | 203 |
| Kuikuinita | 63 |
| Paraska | 41 |
| Kayaska | 54 |
| Piedra Fina | 102 |
| Paso Real | 48 |
| Tendido | 94 |
| **Total generating capacity** | **1,821** |

**Tab. 8: Hydropower projects > 30 MW; Nicaragua**

21 Región Autónoma del Atlántico Norte (RAAN).

22 Policy Strategy for the Promotion of Renewable Energy in Nicaragua, substudy on geothermal energy, ESMAP study commissioned by the World Bank, Nicaragua 2004.

| Projects | Generating capacity in MW |
|---|---|
| Namasli | 9 |
| Coco Torres | 19 |
| Kinunu | 8 |
| Kayasla | 33 |
| Daka | 5 |
| Arrawas | 7 |
| Esquirin | 14 |
| Paso Real | 30 |
| Santa Elisa | 18 |
| Lipo | 22 |
| Zopilota | 18 |
| Quililon | 22 |
| Sofana | 26 |
| Loro | 20 |
| Bosayan | 18 |
| Posa Brűjula | 22 |
| Consuelo | 31 |
| Pajarito | 23 |
| La Estrella | 19 |
| Piedra Pintada | 25 |
| El Salto | 27 |
| Pantasma | 24 |
| Larreynaga | 17 |
| La Sirena | 33 |
| **Total generating capacity** | **490** |

**Tab. 9: Other hydropower projects; Nicaragua; MW**

| Project | Generating capacity in MW |
|---|---|
| El Hoyo Monte Gala | 200 |
| Managua Chiltepe | 150 |
| **Total generating capacity** | **350** |

**Tab. 10: Geothermal energy projects currently underway; Nicaragua; MW**

### Wind energy

The regional development council (Consejo de Desarrollo Departemental) in Estelí has expressed interest in siting and promoting a wind power project in the region of San Nicolas south of Estelí. Further details of these plans are not yet known.

The National University in Managua (Universidad de Ingeniería, UNI) intends to prepare a detailed national wind atlas and conduct feasibility studies for eight commercial wind farms in the communities of El Sauce, San Nicolas, Matagalpa, Rancho Grande, Chontales, Puerto Cabezas, Bluefields and Corn Island.

## 8.6 Rural Electrification

CNE has prepared a National Plan for Rural Electrification (Plan Nacional de Electrificación Rural, PLANER) covering the timeframe 2003 to 2013, the main goal of which is to increase the national electrification rate of 55 % (2003) to 71 % by 2013. An investment volume of US$ 270.4 million has been earmarked for implementation of this plan, in which those regions where no concessions are granted for PV solar systems and/or hydropower projects are to be given priority. This funding is to come from bilateral and multilateral sources and administered by the Development Fund for the National Electricity Industry (Fondo para el Desarrollo de la Industria Eléctrica Nacional, FODIEN). Most of the investment implemented to date within the scope of rural electrification has targeted grid expansion projects in concession areas of Unión FENOSA.

Nicaragua's Ministry of Energy and Mines is continuing to pursue the national energy policy defined by CNE, addressing the following objectives:

- Development of the National Plan for Rural Electrification (PLANER). Priority is being given to those regions with the greatest potential for increasing productivity.

- The guidelines of the Development Fund for the National Electricity Industry (FODIEN) are undergoing reform with the objective of achieving sustainable and transparent acquisition of international funding for implementation.
- Funding for implementation of the PLANER electrification programme is being allocated from the state budget and administered by the FODIEN development fund.
- Efforts are being made to establish a pricing and subsidisation policy for rural areas to enable granting of direct and transparent subsidies for rural electrification projects.
- Utilisation of renewable energy sources for rural electrification is being promoted.
- New codes and standards are being introduced to the electricity sector to meet needs dictated by the particular conditions of rural electrification and isolated off-grid systems.

The measures noted above were initiated and promoted by CNE. However, they have either not yet been approved by the government – in particular those measures that require direct subsidisation and commitment of government funding – or not yet been implemented by the appropriate regulatory authority.

### Rural electrification projects

Projects for conventional power grid expansion as well as those based on renewable energy sources are being conducted within the scope of the PLANER rural electrification programme.

### Grid expansion projects

Puerto Cabezas: The objective of this project is to improve the quality of the power supply system in Puerto Cabezas and 12 adjacent municipalities. Funding budgeted for this project comes to US$ 1,925,000.

Rural electrification in six departments: In this project, electricity networks are to be expanded, thereby connecting 33 municipalities (1,294 households; 7,551 inhabitants) in five departments (Estelí, Matagalpa, Jinotega, Madriz and Boaco) to the grid. The project budget amounts to US$ 1,750,000.

Development of the milk industry in Boaco and Chontales: This project targets promotion of productivity in the region by improving technological processes and introducing new alternatives. Plans call for a commercial-level power supply system (120/240V) for 19 dairies in the municipalities of Boaco and Chontales and electrification of 13 municipalities located in the vicinity of the planned grid lines. The total budget for this project comes to US$ 3,000,000.

Productive zones of the concession area: The goal of this programme is to significantly increase the number of households with access to electricity in rural areas, in particular in communities that demonstrate clear potential for economic development. Planning envisages expanding the grid by 278 km in the RAAS Autonomous Region and the departments of Río San Juan, Boaco und Chontales. Some 38,000 inhabitants in 163 municipalities are meant to benefit from these efforts. The programme budget totals US$ 4,750,000.

Rural electrification fund (Fondo Electrificación Rural, FAROL-ER): The project area is in Nicaragua's north in the Nueva Segovia, Jinotega, Matagalpa, Madriz and Estela departments and the DISNORTE concession area. Here as well, rural areas where there is considerable potential for economic development are to be given preference.

**Electrification projects utilising renewable energy sources:**
Implementation of the following hydroelectric projects is underway within the framework of the UNDP/GEF project 'Uso Productivo por medio de Minicentrales Hidroeléctricas', financed by GEF/UNDP and COSUDE (Swiss Government) as well as in part by the GTZ project 'EnDev Nicaragua':

- Rio Bravo small hydropower project: This project, with an installed electrical generating capacity of 170 kW, is located in the Waslala municipality of the RAAN Autonomous Region. Installation work on the hydropower facility was begun in 2006, and operation is scheduled to commence in the first half of 2007.
- Bilampí small hydropower project: This project, with an installed electrical generating capacity of 300 kW, is located in the department of Matagalpa. Installation work on this hydropower facility likewise began in 2006, and the plant will go into operation in the first half of 2007.
- El Najanja small hydropower project: This project, with an install electrical generating capacity of 210 kW, is located in the municipality of El Najanja, the Waslala area of the RAAN Autonomous Region. Investment in this hydropower facility is being co-financed within the scope of the GTZ project 'EnDev Nicaragua'. Project implementation is scheduled to begin in 2007.
- El Bote small hydropower project: This project, with an installed electrical generating capacity of 900 kW, is located in Matagalpa in the Waslala area of the RAAN Autonomous Region. Installation began in 2004, and the plant has been in operation since early 2007. The project was co-financed by the Government of Switzerland.
- Salto Kepí small hydropower project: This project, with an installed electrical generating capacity of 1.5 MW, is located in the municipality of Mulukukú in the Paiwas area of the RAAN Autonomous Region. The project is scheduled for implementation in 2007.
- Salto Molejones small hydropower project: This project, with an installed electrical generating capacity of 630 kW, is located in the north of the municipality La Esperanza in the RAAS Autonomous Region. This project is likewise scheduled for implementation in 2007.

Further projects for rural electrification are based on photovoltaic systems and currently under execution within the scope of projects noted above, i.e. PERZA (WB), 'Francia Sirpi' (WB/GEF), 'San Juan de Nicaragua' (WB/GEF) and 'Proyecto Sistemas Fotovoltaicos' by IDB in Waspán (RAAN Autonomous Region).

Exchange rate (6 May 2007):
1 Nicaraguan cordoba (NIO) = 0.0418 euro (EUR)

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There is great potential for generating electricity from renewable energy sources in many developing and emerging countries. Obstacles to the exploitation of such sources and to the involvement of foreign investors include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of national actors. This fourth, updated and expanded edition is aimed at overcoming barriers such as these.

The electricity markets and their respective actors are investigated for 23 countries in various regions: Latin America, Africa – Middle East and Asia. The country studies analyse the energy-policy framework conditions and closely examine the status of and promotion policy for electricity generation on the basis of hydropower, wind power, solar power, biomass and geothermal energy. The chapters on each country are rounded off by information about rural electrification.

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