



Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses Chapter Colombia

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.
2. The sole authorised user of this study for all forms of use is the GTZ. Duplication or reproduction of all or part of the study (including transfer to data storage media) and distribution for non-commercial purposes is permitted, provided the GTZ and the TERNA Wind Energy Programme are named as the source. Other uses, including duplication, reproduction or distribution of all or part of the study for commercial purposes, require the prior written consent of the GTZ.

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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6 Colombia

6.1 Electricity market

Installed capacity

At the end of 2005, the installed generating capacity¹ connected to Colombia's national power grid totalled approximately 13,330 MW. That figure was marginally lower than at the end of 2002 (13,468 MW). Hydropower accounts for 67% of the total installed capacity, with the remainder based on conventional thermal energy.

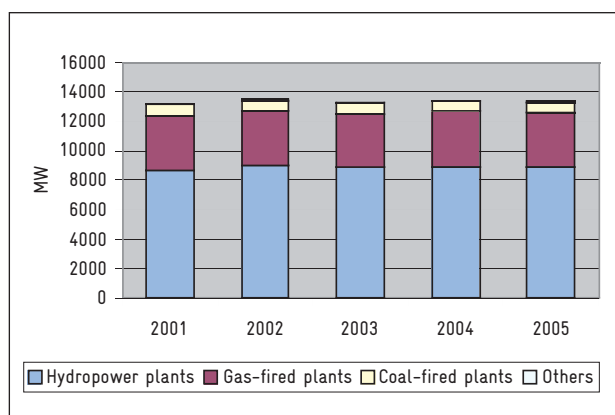


Fig. 1: Generating capacities on the interconnected grid; Colombia; 2001–2005; MW²

In the course of the 1990s, Colombia's once nearly complete dependence on hydropower and (to a small extent) coal for generating electricity was overcome with the commissioning of several gas-fired power plants. Despite the dominant growth in gas-fired generating capacities, however, the Colombian power-plant landscape is still largely defined by hydropower, the problem being that the technology's dependence on climatic effects leads to fluctuations in generation yields from year to year and exerts a considerable influence on the electricity price situation.³ The next few years can be expected to see hydropower regain in its dominance within the power-plant mix.

All in all, 31 large-scale hydropower plants with ratings above 20 MW and 20 thermal power plants, some of which comprise two or more generating units, feed power into the national interconnected grid.

Around 97% of the total installed generating capacity is managed via the central load control facility, while primarily small-scale hydroelectric facilities⁴ feeding into the national grid (approx. 380 MW), together with the country's sole wind farm, are not subject to any form of load control.

Power generation

Following a recession in the late 1990s, with attendant decreases in electricity consumption, the new decade has seen considerable growth in demand. In 2005, some 50,415 GWh of electricity was generated within the interconnected national power grid (Sistema Interconectado Nacional – SIN). That amounted to a 3.7% increase over 2004. The major hydropower plants contributed 72% (36,377 GWh) of the total, while small (mini and micro) hydroelectric facilities injected 9%, gas-fired generators 14% (6,980 GWh), and coal 4% (2,086 GWh). Cogenerating plants and wind turbines in turn contributed 0.2% and 0.1%, respectively. Due primarily to favourable hydrological conditions and to the decommissioning of several conventional thermal power plants, the percentage share of hydropower-generated electricity was significantly higher in 2004 and 2005 than it had been in previous years.

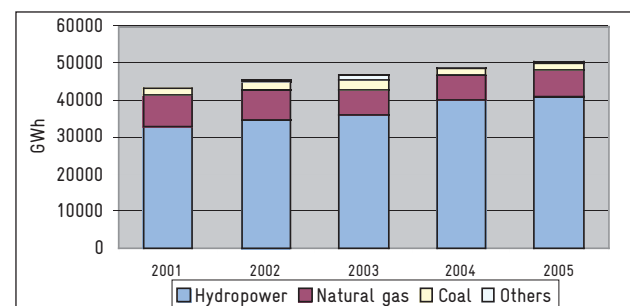


Fig. 2: Net power generation within the interconnected national grid, by primary energy source; Colombia; 2001–2005; GWh

1 Colombian statistics speak of effective net capacity. The mean daily availability of all on-grid power plants is actually lower by about 1,700 MW due to downtime for maintenance.

2 The numerical data for hydropower includes small, decentralised power plants (2005: 391 MW). The "Others" category includes combined heat and power (CHP) plants and autonomous generation facilities.

3 Colombia's dependence on hydropower, which still amounted to about 78% in the early 1990s, has since decreased considerably.

4 In Colombian statistics, the term "small hydropower" is not particularly selective. As a rule, it encompasses all plants with ratings below 20 MW. On the other hand, the list of large-scale facilities includes one hydropower plant with a rating of only 5 MW.

Colombia is in the comfortable position of still being able to generate its electricity largely without need of imported raw materials. Colombia is South America's biggest producer and exporter of coal and is also a net exporter of oil, especially to the USA. In the medium term, though, Colombia is destined to become a net importer due to its limited reserves of natural gas and petroleum.

Power transmission

The national transmission network (Sistema de Transmisión Nacional – STN) consists of two grids, one serving the Atlantic coast in the north and the other serving the interior, with numerous interconnectors running between the two. The STN comprises three voltage levels (110 kV, 220 kV and 500 kV) and has a total length of some 15,000 km.⁵ A new 500 kV transmission line put up by private investors between the Atlantic coast (Bolívar) and Bogotá – a distance of around 1,000 km – was commissioned in early 2007.

It ties into the Venezuelan transmission network, although the connection has hardly been made use of to date. Two new junction lines connecting Ecuador and Colombia went into service in 2003. They are constituents of an agreement between the five Andean countries (Bolivia, Colombia, Ecuador, Peru and Venezuela) which intend to integrate their respective electricity markets into a supraregional electricity market in the medium term. In 2005, most of the power carried by that line was being exported to Ecuador (4,570 GWh), while only a very small volume was imported (132 GWh).

Once again in 2005, the technical and non-technical power losses, at more than 23%, were very high. Losses in the interconnected grid accounted for only 2.5%, while all the rest occurred at the distribution level.

Power consumption

After a brief economic recession at the turn of the millennium, Colombia's power consumption has since risen continuously, reaching approx. 38.4 TWh in 2005. Also, according to present estimates, total demand now exceeds the power production capacity by some 10 TWh.

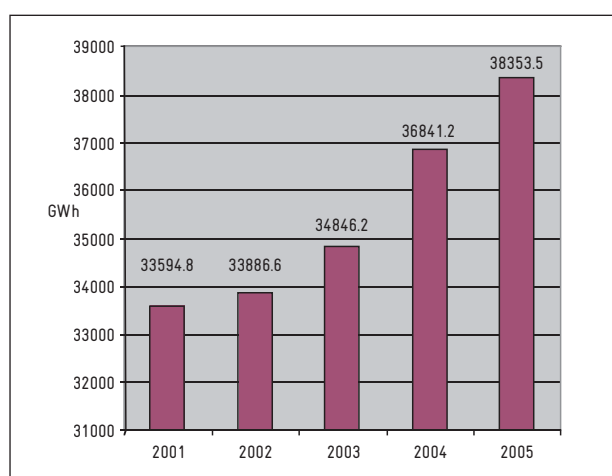


Fig. 3: Trend in power consumption 2001–2005; Colombia; GWh

Between 1999 and 2005 there was a downward trend in the proportion of consumption by private households, from 48% to 42% (Fig. 4).

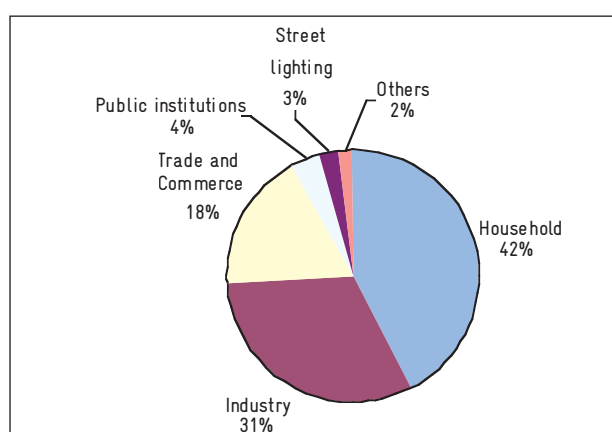


Fig. 4: Power consumption according to user group; Colombia; 2005; %⁶

⁵ The continental regions Amazonas, Antioquia, Arauca, Caquetá, Casanare, Cauca, Chocó, Guainía, Guaviare, Meta, Nariño, Putumayo, Vaupés, Vichada and the islands of San Andrés and Providencia are not connected to the public power grid.

⁶ Source: Comunidad Andina (CAN), 2004.

Peak load has been increasing by 2.7% annually, on average, since 1999. While the interconnected grid system had available power totalling 11,000 MW in late 2005, peak load at that time amounted to only 8,638 MW (or 3.7% more than the year before). That excess generating capacity, however, can quickly dwindle during dry spells. Hence, if demand keeps rising, supply bottlenecks cannot be ruled out.

An increase in power generating capacity to 67,365 GWh is predicted for the year 2014, at which time peak demand is expected to reach 12,085 MW.

Electricity prices

Electricity prices vary widely from one utility company to another. For example, the price span for private household consumption is 3.5-8.3 euro cent (98 to 230 pesos) per kWh; for industrial consumers, it ranges from 3.3 to 14.2 euro cent (92 to 394 pesos), while trade and commerce pay between 2.1 and 15.0 euro cent (58 to 417 pesos) per kWh. On average, the industrial tariffs are considerably higher than those found in practically any other Latin American country. The price fraction accounting for power generation was estimated at 1.9 euro cent per kWh in December 2003.

Expansion planning

According to the latest energy statistics dating from 2005, some 10,500 MW of additional power generating capacity is presently either under construction or at the planning stage – including approximately 1,230 MW from conventional thermal power plants (186 MW of which was already commissioned in 2006), 8,730 MW from large hydropower plants, and just under 470 MW from small and medium-size hydropower plants.

6.2 Market Actors

At the end of 2005, the actor structure on the Colombian electricity market presented itself as follows: 50 companies were active in the power-generating sector, and 55% of all power-generating capacity was in private ownership. There were 74 electricity trading companies and 11 (regional and supraregional) transmission companies. A total of 75 regulated companies were involved in the interconnected national power grid (Sistema Interconectado Nacional – SIN), only three of which were completely vertically integrated, i.e. active at all levels (generation, transmission, distribution, sale): EEPPM, EPSA and ESSA.

Power producers

The main power producers are EEPPM, with approx. 2,600 MW of installed generating capacity, EMGESA, with roughly 2,250 MW, and ISAGEN with about 2,100 MW.

Transmission and distribution network operators

The supraregional transmission network Sistema de Transmisión Nacional (STN) is divided up between seven companies that emerged from the old power utilities in the course of the vertical disintegration process, including Interconexión Eléctrica S.A. (ISA), which owns about 70% of the overall network.⁷ Four of the companies (ISA, TRANSELECTRA, EEB and DISTASA) are only concerned with power transmission. The former central grid operator ISA, 59% of which still belonged to the Government of Colombia in 2005, is responsible for coordinating, operating and managing the interconnected national grid. Some of the co-owners of STN also hold shares in ISA (for example Empresas Públicas de Medellín – EEPPM, with 10.6%). The regional and local networks are allocated to the various distribution companies, in which power generators are allowed to hold up to 20% capital interest.

⁷ The other owners are: Empresa de Energía de Bogotá – EEB, Corporación Eléctrica de la Costa Atlántica – CORELCA, Empresas Públicas de Medellín – EEPPM, Empresa de Energía del Pacífico – EPSA, Electricadora de Santander – ESSA, Distasa S.A., Central Hidroeléctrica de Caldas – CHEC, Centrales, Eléctricas de Norte de Santander – CENS, Central Hidroeléctrica de Betania – CHB and Electricadora de Boyacá – EBSA.

For a number of years now, the Colombian power sector has seen itself confronted with guerrilla attacks on its integrated power grid, and some substantial supply problems have resulted. In 2005 alone, 227 attacks on high-tension line towers were reported, and several electricity exporting regions were cut off from their consumer markets. The persistent problems affecting the supply of electricity have contributed to the fact that a number of planned privatisations have had to be temporarily postponed.

Other Actors

Regulatory commission

A national commission (Comisión de Regulación de Energía y Gas – CREG) was set up to regulate the electricity market. This body regulates the general conditions for the efficient supply of electricity, the step-by-step liberalisation of the electricity market, the standards to be applied to the wholesale market, free network access, the transmission and distribution charges, the tariffs for regulated end consumers, protection of the consumers' interests, and matters pertaining to the vertical disintegration of the electricity industry.

Planning unit at the Energy Ministry

Following the reform of the power sector, the state's tasks were essentially restricted to planning functions. The Unidad de Planeación Minero-Energética (UPME), organised within the Ministry of Mining and Industry, is responsible for analysing future energy requirements and the corresponding supply situations and for drawing up the National Energy Plan (Plan Energético Nacional) as well as the plan to expand the electricity sector (Plan de Expansión del Sector Eléctrico). However, this planning is now only of an analytical nature and is no longer a binding stipulation for the expansion projects.

6.3 Legal Framework

Restructuring

A sectoral reform was introduced with enactment of the Law on the Organisation of Public Services (Law no. 142, dated 11 July 1994, Régimen de Servicios Públicos Domiciliarios) and the Electricity Law (Law 143, dated 11 July 1994, Ley Eléctrica). The generation, transmission, distribution and marketing of electricity were separated, and the previous regional monopoly of utility companies was broken up. Free competition was introduced in areas where there is no natural monopoly, i.e. in the generation and marketing of electricity, while the other areas are still regulated and monitored by the state.

The operators of the interconnected grid system, the regional transmission companies (Sistema de Transmisión Regional – STR) and the local power distribution companies (Sistema de Distribución Local – SDL) therefore have to open their networks to every user and generator (non-discriminatory access).⁸ Wide-ranging privatisation was also introduced, which has affected all areas of the electric power industry although the process has not yet been completed. Any economic player is free to build additional power generating capacity, as long as the framework of other legal provisions is adhered to.

Wholesale market

Generating companies whose plants supply power to the national interconnected grid system and have a capacity of at least 20 MW are obliged to participate in the wholesale market (Mercado de Energía Mayorista – MEM) that was established in 1995 (per Resolution CREG-054 of 1994).⁹ The power generators must address hourly offers for the next day to the national dispatching centre in Medellín, where they are entered in the load distribution list in accordance with their quotations. There is no preferential treatment for certain types of power station in this process.

⁸ The conditions of access for power generating companies are set out in Resolution CREG-030 of 1996. General information on the legal requirements for regional power transmission companies and local distributors is given in Resolutions CREG-003 of 1994 and CREG-099 of 1997.

⁹ All electricity traders who supply electricity from the interconnected grid directly to end consumers are obliged to purchase the electricity via the MEM. Operators of plants with ratings between 10 and 20 MW can participate in the MEM voluntarily, while those with less than 10 MW generating capacity are automatically excluded from the MEM. Autonomous suppliers can use the interconnected grid to obtain replacement power or additional power. Operators of combined heat and power plants (cogenerating facilities) can supply themselves or others with electricity and heat for industrial or commercial purposes.

In order to prevent anyone from gaining a dominant position on the market, no electricity supplier is allowed to provide more than 20% of the total generated quantity, including their capital involvement in other generating companies. Customers are not allowed to address offers directly to the pool. The pool operator compares the offers with the estimated demand as a basis for setting the hourly pool prices. Further distributors and large-scale consumers are allowed to enter into bilateral agreements with power generators, as long as the agreements are registered with the pool operator for invoicing purposes.

Power trading is based primarily on long-term agreements. The Colombian electricity bourse is characterised by uncertainty and widely fluctuating price situations resulting from the country's heavy dependence on hydropower and, in turn, the latter's dependence on sufficient precipitation. Hence, the average price of long-term agreements in dry years regularly drops below the bourse (pool) prices but climbs to above that level in times (years/months) of abundant rain. In 2005, for example, the mean price in bilateral agreements was 2.5 euro cent/kWh (71 pesos/kWh), while the average pool price was somewhat higher at 2.8 euro cent/kWh (76.5 pesos/kWh). On the other hand, the pool price during the wet month of June was only 2.1 euro cent/kWh (59.5 pesos/kWh), while the long-term contact price was situated at 2.5 euro cent/kWh (68.7 pesos/kWh).

Unregulated consumers

Since 1 January 2000, regulation has no longer been binding for end consumers with power requirements exceeding 100 kW or consumption of at least 55 MWh/month, who are therefore now allowed to enter into direct power supply contracts with power producers.

6.4 Policy Promoting Renewable Energy Sources

A development plan for alternative energies (Plan de Desarrollo Nacional de las Energías Alternativas) dating from 1995 proposed measures intended to help promote the use of renewable energy sources. In practice, however, these announcements did little more than pay lip service to the problem and had no discernible impact.

National energy plans

The National Energy Plan of 1997 (Plan Energético Nacional) underscored the importance of renewable energy while emphasising the fact that, thus far, only very inadequate use has been made of it, at least in connection with power generation. Nevertheless, the 1997 National Energy Plan assigned little more than a niche existence to renewable energy sources – with the exception of major hydropower stations – for urban and non-electrified fringe areas or rural and isolated settlements. That remained so in the 2003 National Energy Plan, too, in which the use of natural gas and coal is even more emphatically recommended than before, while the use of renewable energies is only recommended in connection with the further development of small-scale hydropower and pilot projects based on other renewables.

2001 law on the promotion of renewable energy sources

With Law no. 697, of 3 October 2001, the Colombian Government created a framework for promoting the use of renewable energy sources by instituting a programme for the rational use of energy and for the utilisation of renewable forms of energy (Programa de Uso Racional y Eficiente de la Energía y demás formas de Energía No Convencionales – PROURE) under the auspices of the Ministry of Mining and Energy. It is also intended to develop political guidelines and strategies along with instruments to promote non-conventional energy sources, with the main emphasis being placed on regions that do not have access to electricity. Companies that manufacture or import components for use in exploiting renewable energy sources were to receive special assistance.

The law was implemented by way Decree 3683 of 19 December 2003. A supra-institutional commission (CIURE) was set up, headed by MME, with its other members being the Ministry of the Environment and Foreign Trade, the regulatory authority CREG, the Colombian institute for the development of science and technology (Colciencias), the energy planning unit (UPME) and several other expressly invited institutions.

Tax exemptions

The first concrete assistance measure in connection with PROURE is a provision of Law 788, dated 27 December 2002, according to which the sale of electricity from wind energy, biomass or agricultural waste is to be exempted from income tax for 15 years, as long as the following criteria are satisfied: participation in CO₂ permit trading in accordance with the Kyoto Protocol, and reinvestment of at least 50% of revenues from the sale of permits in social projects situated within the area served by the utility. According to Article 95, imported plant and equipment for and to the benefit of CER trading is also to be exempted from value-added taxation.

Moreover, Law 818 and Decree 3172 of 2003 qualified as tax write-offs all investments that serve the cause of environmental protection. To qualify, however, the project developers must apply for an appropriate certificate from the Ministry of the Environment.

Electrification fund for off-grid regions

Law 633 (2000) and Decree 2884 (2001) already established a Support Fund for the Electrification of Non-interconnected Zones (FAZNI). Since July of 2003 the fund has been receiving one peso for each kilowatt hour of electricity that is sold on the interconnected grid. It also benefits electrification projects based on renewable energy resources, such as the installation of hydropower plants.

As yet there are no other incentive programmes in force that focus specifically on the use of renewable energy sources, and in particular any that would feed power into the interconnected grid, because the government is giving first preference to a competition-oriented policy in the development of the electricity industry.

Clean Development Mechanism

Colombia put the provisions of the Kyoto Protocol into national legislation with Law 629 on 30 November 2001. Since May 2002 the Designated National Authority (DNA) has been set up within the Ministry of the Environment, Housing and Territorial Development. In 2005, Resolutions 1812421 and 1812422 defined the greenhouse gas factors to be applied to renewable energy projects of various magnitude that feed into the interconnected national grid. One of the declared goals is to direct at least part of the investment in CDM projects toward schemes geared to improving rural electrification by the use of renewable energy resources, with one of the long-term targets being to replace the estimated quantity of more than 1,000 small diesel generators that are still in use as isolated sources of power in rural regions.

In addition to the Jepirachi wind power project¹⁰, the CDM Executive Board has also registered three other hydropower projects: the Agua Fresca project in Departamento Antioquia, with a rating of 7.5 MW and an annual power output of 63.3 GWh; the Santa Ana project, which is to be integrated into the Bogotá potable water supply system and will provide 13.4 MW; and a pair of facilities on the La Herradura River, also in Departamento Antioquia, with respective ratings of 19.8 and 11.7 MW.

6.5 Status of Renewable Energy Sources

Apart from the use of hydropower, even on a relatively small scale, the penetration of technologies based on renewable energy, including for the electrification of rural regions, remains considerably lower in Colombia than in other Latin American countries. The government's lack of financial leeway has been a contributing factor to this situation, as has the central authority's partial lack of control over large rural areas of the country.

Statistical records on the use of renewable energy in isolated networks and for autonomous supply are broadly lacking, so no precise details of the extent to which the corresponding technologies are in use can be given here. On the other hand, the National Energy Plan of 2003 does contain at least a brief assessment of the renewable energy sources available for use in Colombia. The following information is based in part on that assessment.

Hydropower

Thanks to geography and ample annual precipitation in large parts of the country, Colombia enjoys good prerequisites for hydroelectric power. In early 2007, UPME and the national meteorological institute IDEAM¹¹ jointly produced a first atlas of hydro energy resources.

In 2005, hydroelectric power was by far the most important source of energy in the field of electricity generation, both in terms of installed capacity (67%) and as regards power production (82%). The use of hydropower for generating electricity in Colombia dates back to about 1920, when it was first employed as a means of supplying electricity to villages along the Atlantic coast. By the 1960s, most large, inland communities had begun to meet their demand for electricity by installing and operating their own mini-hydropower plants.

The oldest hydropower plant contributing to the interconnected national grid dates from 1957. Beginning in the 1960s, numerous large-scale projects were implemented, often with profound social and ecological impacts, and a need for foreign capital. This, coupled with the progressive connection of towns and cities to the interconnected power grid, led to the decommissioning of most small hydropower plants, because they were no longer profitable. The largest plant of all, the 1,240 MW San Carlos hydropower station in the province of Antioquia, was commissioned in 1988. Three more large-scale facilities with ratings ranging from 344 to 411 MW have been added since the beginning of the present decade.

The fact that the power sector accounts for a large share of Colombia's foreign debt, coupled with increased costs of electricity transmission and distribution and greater efforts to broaden rural electrification, has led to the revitalisation of small-scale hydropower now being targeted.¹² At the end of 2005, almost 400 MW of generating capacity was connected to the interconnected grid, distributed between over 70 different generating stations.

Wind energy

In 2006, UPME and the meteorological institute IDEAM presented their first wind atlas based on long-term meteorological observations at more than 200 reference locations. Colombia enjoys good to very good regional wind conditions. The La Guajira peninsula in the extreme north of the country, where mean wind velocities of up to 11 m/s prevail at a height of 10 m, is regarded as Colombia's most attractive wind region. The coastal strip southwest of La Guajira, in the Departamentos Magdalena and Atlántico, also has some good locations to offer for the harnessing of wind power. Likewise, mountainous regions in the Departamentos César, Norte de Santander and Santander, as well as the Caribbean islands of San Andrés and Providencia, also have good wind regimes.

11 Instituto de Hidrología, Meteorología y Estudios Ambientales.

12 Below 20 MW.

Colombia's only wind power project to have been completed to date is the Jepírachi project by the generating and supply company Empresas Públicas de Medellín (EEPPM) in the Alta Guajira region on the Caribbean coast, which was implemented with support from the GTZ. The site is located near the coal port Puerto Bolívar and therefore has access to the national high voltage grid. EEPPM is presently investigating the possibility of building another wind farm of approximately the same size just a short distance from the first site.

Jepírachi wind power project

The Jepírachi wind farm entered service in December 2003. It is rated at 19.5 MW (comprising 15 N 60 turbines from the German company Nordex). Based on a power factor of 40%, the annual yield was expected to be 68 GWh, calculated on the basis of mean measured wind speeds of close to 10 m/s at a height of 50 m. However, the farm delivered only somewhat less than 52 GWh in 2004 and a mere 49.5 GWh in 2005. Due to technical problems stemming from high temperatures and unstable network conditions, the generators' availability was substantially curtailed at times.

EEPPM invested US\$ 27.8 million to build the wind farm. The World Bank is contributing US\$ 3.2 million to the project within the framework of the Prototype Carbon Fund (PCF) in order to achieve the 800,000-tonne CO₂ emission reduction target by 2012.¹³ The subsidy is being paid out in regular instalments subject to the presentation of tradable emission permits to PCF by EEPPM in accordance with the Clean Development Mechanism. Despite the good wind conditions, the cost of power generation is estimated at about US\$ 49 per MWh, partly because the tie-in to the grid requires a trunk feeder with a length of 8 km. In order to enable cost-effective operation of the wind farm, Colombia's institute for the development of science and technology COLCIENCIAS recognised it as a 'technical innovation project', thus allowing EEPPM to deduct the initial investment from its taxable gains.

GTZ activities within the scope of the TERNA programme

Preparations for a wind farm project were supported by GTZ within the framework of the TERNA programme, with planning commencing in 1998. From May 2000, EEPPM operated a wind monitoring station near the intended site. After three years of monitoring, an exploitable wind potential of about 5 GW was determined for the Guajira region. GTZ helped EEPPM select the site, perform the wind measurements and evaluate the technical and financial possibilities via wind-yield and feasibility studies. In addition, GTZ advised EEPPM in connection with drafting and evaluating the tendering documents for the wind farm. The first turbines were commissioned in December 2003; ultimately the wind farm is to have a capacity of 19.5 MW.

Biomass

Colombia is rich in biomass resources that could be exploited for energy-generating purposes, although no systematic identification of these potential resources has yet taken place. UPME, IDEAM and COLCIENCIAS are planning to devise an initial atlas for quantifying biomass energy potentials in 2007/08.

The (documented) contribution of biomass to the generation of electricity in Colombia has been very small to date. The main raw material for such applications is bagasse, from sugar cane, usually for use as fuel in combined heat and power facilities. The cumulative output of all such plants amounts to approximately 25 MW. If the biomass used as a supplementary fuel in power generation (for example bagasse in coal-fired power plants) is included, the overall capacity increases to about 100 MW. In addition, various agro-industrial residues such as marc or the husks of rice and other grains are used for heat-generating purposes.

¹³ In this respect, UPME and Colombia's Ministry of the Environment performed the necessary calculations for the sale of tradable emission permits and submitted them to PCF, which subsequently approved both the employed method of calculation and the resultant reduction volumes.

Solar energy

In 2005 UPME and the meteorological institute presented their newly revised solar atlas, which had first been published in 1993. According to the atlas, Colombia enjoys excellent solar irradiation conditions, experiencing levels of 4.0-4.25 kW/m²d in the south-westerly regions and along the Pacific coast, and 5.5-5.75 kWh/m²d in the Guajira region. This corresponds to between 58% and 84% of the insolation levels that are recorded in Saudi Arabia, the country with the highest solar irradiation levels in the world. Nevertheless, the use of solar energy for obtaining electricity from solar home systems or for heating water with the aid of solar collectors has remained marginal, even in remote areas.

According to the National Energy Plan of 2003, only around 2 MW of photovoltaic capacity is in place in Colombia. A sizeable photovoltaic facility used for supplying electricity to a small settlement (including a school and a health centre) was installed in the Vichada district in 1995. Then, in October 2003, the power utility Empresa Antioqueña de Energía S.A. (EADE), a subsidiary of Empresas Públicas de Medellín (EPPM), launched a competitive contracting programme for 60 small photovoltaic systems for village schools situated within in its own service area. Each such system was available for purchase for 500,000 pesos (roughly EUR 156). Above all EADE intended this measure to help stimulate interest in solar home systems.

Geothermal energy

Despite several preliminary studies on the use of geothermal energy over the past 35 years and initial exploratory drilling performed by Geoenergía Andina S.A. (GESA) in 1997, Colombia's geothermal potential is still largely untapped, mainly because other domestic sources of energy, coal in particular, have been so plentiful. The only instance of any geothermal resource being put to use at all in Colombia at the present time is the use of hot spring water for heating medicinal baths.

6.6 Rural Electrification

Within the interconnected zones (zonas interconectadas), some 90% of all electricity users are already connected, and close to 100% is being targeted for the year 2019. In off-grid regions (zonas no interconectadas – ZNI) the electrification level is presently 75.5%.

In 1999 the Ministry of Mining and Energy initiated the implementation of 93 rural electrification projects via the Institute for the Investigation and Application of Energy Solutions for Off-grid Regions (Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas No Interconectadas – IPSE).¹⁴ These projects concentrate on the expansion of existing networks and the establishment of stand-alone solutions, mainly through the installation of diesel generators.

In the meantime, the PROURE programme appears to be engendering intensified interest in the use of renewable energy sources for rural electrification purposes, too, but the implementation process remains sluggish.

Exchange rate (February 2007):

100 Colombian pesos (COP) = 0.03605 euro (EUR)

1 EUR = 2.774 COP

14 See www.ipse.gov.co.

6.7 Information Sources

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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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