Division Environment and Infrastructure
TERNA Wind Energy Programme

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

21 Country Analyses

Eschborn, June 2004

Part Brazil

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PO Box 5180
65726 Eschborn
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Internet: http://www.gtz.de

Edited by:
Dr. Jens Drillisch
Tel. +49 (0)6196 79-1380
E-mail: jens.drillisch@gtz.de

Authors:
Dipl.-Ing. Detlef Loy (responsible),
LOY ENERGY CONSULTING, Berlin; www.loy-energy-consulting.de,
Dipl.-Ing. Hinnerk Fütterer, Dipl.-Wirtschaftsgeograph Patrick Jüttemann, Dr. Danyel Reiche

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Verena Siebert

Background to the New Edition

Structural changes in the energy sector, accompanied by liberalisation of the relevant markets, have been continuing in many developing and transition countries in recent years. Growing demand for electricity and the ongoing climate debate are increasing the level of interest in technologies for generating electricity from renewable energy sources in these countries.

The rapid expansion of the use of renewable energy in Germany is a subject that is being followed with interest, even outside Europe. Experience here shows that the creation of a conducive political and economic framework and the implementation of appropriate promotion measures can speed up the exploitation of renewable energy.

The German and European market acts as the motor for a wind energy industry and provides an indispensable background of experience. The level of growth in this sector within Germany has slowed down, however. Project developers are therefore increasingly turning their attention to off-shore schemes, other parts of Europe, and the Mediterranean states. The markets for technologies based on other renewable energy sources are also experiencing growing interest. While it is true that the potential for hydropower, wind power, solar power, biomass and geothermal energy in developing and more advanced countries is often considered to be high, obstacles to entry into this field include insufficient knowledge of the framework conditions prevailing in the energy industry in those countries and a lack of transparency with regard to the prior experience and interests of the national actors.

One of the aims of this third, updated and expanded edition of the study – under a new title – is to facilitate entry into the field of renewable energy. It is based on the previous editions from 1999 and 2002, which were published under the title 'Producing Electricity from Renewable Energy Sources: Energy Sector Framework in 15 [or 12] Countries in Asia, Africa and Latin America'. These studies have been much in demand, not only by suppliers and project developers but also by financing and operating companies involved in renewable energy technologies.

The analyses of the individual countries comprise sections on the respective electricity markets and the actors in those markets, along with information on the energy-policy framework. The policy for promoting electricity generation from renewable energy sources is examined, and the status of the various forms of renewable energy is analysed in detail. The chapters on each country are rounded off by information about rural electrification.

In comparison with the 2002 edition, eleven new countries have been added. The information about a further ten countries has been updated:

New since 2002		**Updated**	
Albania	Philippines	Brazil	India
Bosnia - Herzegovina	Senegal	Chile	Mexico
Croatia	Sri Lanka	China	Morocco
Georgia	Vietnam	Colombia	South Africa
Jamaica	Yemen	Dominican Republic	Tunisia
Pakistan			

Information about Argentina, Cuba, Jordan, Kazakhstan and Turkey is given in the 2002 edition. Analyses of Egypt, Indonesia and Thailand were conducted in the 1999 edition. These previous editions are available in electronic form free of charge from www.gtz.de/wind/english/downloads.html.

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

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The TERNA Wind Energy Programme

Specialised knowledge and experience are needed to determine what wind energy resources a country possesses and to identify suitable locations. Technical and economic analyses of wind power projects are also impossible without hard information about wind conditions. Such analyses, however, form the basis for the financing and ultimately the successful implementation of a wind farm.

The purpose of the TERNA (Technical Expertise for Renewable Energy Application) Wind Energy Programme, implemented by the GTZ on behalf of the Federal German Ministry for Economic Cooperation and Development (BMZ), is to assist partners in developing and more advanced countries in planning and developing wind power projects. Since 1988 the aim within the TERNA framework has been to lay the foundations for sound investment decisions while at the same time enabling partners to plan and develop further wind power projects in the future.

The TERNA Wind Energy Programme's partners are institutions in developing and more advanced 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 know-how 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.

The prerequisite for promotion by the TERNA wind energy programme is that project development has a realistic prospect of implementation: if the underlying conditions in the electricity sector are sufficiently favourable, and if the proposed wind farm project has a minimum capacity of roughly 20 MW and is situated in a windy area (expected annual average wind speeds of over 6 m/s at a height of 10 m above ground level). Small individual installations or decentralised wind/diesel systems are not normally eligible for promotion, nor are research projects.

Up until 2004, TERNA has been active in over ten countries around the world. In Colombia the first wind farm started operation at the end of 2003 with the help of the TERNA programme. The municipal utility of Medellín built the 19.5MW Jepírachi wind farm on the Guajira peninsula with a total investment volume of some 27 million euros. The 800,000 tons of carbon dioxide saved by the wind farm by 2012 will be documented and sold to the Prototype Carbon Fund (PCF), which will mean additional revenues of around 3.2 million euros for the investor.

The TERNA projects are not financed from the country quotas which the Federal Germany Government agrees with individual partner countries. From the viewpoint of the partner country, therefore, TERNA offers additional funds for wind energy.

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

Deutsche Gesellschaft für Technische Zusammenarbeit
(GTZ) GmbH
Postfach 5180
65726 Eschborn
Germany

Dr. Jens Drillisch
Tel. +49 (0)6916 79-1380
Fax +49 (0)6916 7980-1380
E-mail: jens.drillisch@gtz.de

Dr. Rolf Posorski
Tel. +49 (0)6916 79-1352
Fax +49 (0)6916 7980-1352
E-mail: rolf.posorski@gtz.de

Dr. Jasper Abramowski
Tel. +49 (0)6916 79-1760
Fax +49 (0)6916 7980-1760
E-mail: jasper.abramowski@gtz.de

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Brazil

Electricity Market

Generating capacity

At the end of 2003 Brazil's total generating capacity was about 85.3 GW. Some 6 GW of this is used purely for on-site provision. More than 50% of production capacity is located in the three federal states of Minas Gerais, São Paulo and Paraná. The total capacity licensed by the regulatory authority in the public supply sector and at independent power producers and self-generators, in other words also including projects at the planning and construction stage, was about 130 GW at the end of 2003.

	In operation		U. constr.		Approved	
	Number	MW	Number	MW	Number	MW
Hydropower	536	67,534	0	0	121	7,157
Thermal power stations	765	17,745[1]	50	4,626	242	8,854
Wind energy	9	22	0	0	0	0
Wind energy	1	0,02	22	5,610	90	12,825
Total	**1,311**	**85,301**	**72**	**10,236**	**453**	**28,836**

Table 1: Electricity generating capacities; Brazil; end of 2003; MW

Electricity generation

In 2002 electricity generation totalled 381 TWh. Production by public utilities amounted to 315 TWh (4.6% above the previous year's level). Self-generators accounted for 29 TWh and electricity imports totalled 37 TWh. The technical and non-technical losses in the public supply network amounted to 60 TWh (18%). Domestic electricity generation is based almost 80% on hydroelectric power. The rest is provided almost exclusively by thermal power stations fired by coal and gas, as well as by two nuclear reactors. Since natural gas resources have been newly tapped within Brazil, and following installation of a gas pipeline from the neighbouring country of Bolivia[2], the share of thermal power stations is expected to increase substantially in the coming years.[3]

	Electricity generation (TWh)
Natural gas	9.8
Coal	5.0
Diesel	4.3
Heavy oil	3.7
Nuclear	13.8
Hydropower	278.7
Total	**315.3**

Table 2: Public electricity supply – generation; Brazil; 2002; TWh

Self-generators

On the other hand, due to links with the agricultural and industrial sectors, the energy resource base for self-generators is much more widely dispersed and in particular makes use of organic residues. The number of self-generators roughly doubled in absolute terms during the last decade and some years during this period showed very steep increases indeed.

Energy source	Electricity generation (TWh)
Natural gas	3,4
Coal	0,2
Wood	0,7
Sugar cane bagasse	5,4
Black liquor[4]	3,5
Other waste products	4,2
Diesel	1,5
Heavy oil	1,7
Coke	0,7
Hydropower	6,3
Others	1,7
Total	**29,3**

Table 3: Self-generated power; Brazil; 2002; TWh

Electricity imports

A first block of 50 MW was imported from Paraguay in July 1999. In addition there is a transnational link with Argentina via which 2,150 MW can be imported to Brazil, as well as to Venezuela and Uruguay.

1 Including some 2,000 MW in the nuclear power plants.
2 This pipeline crosses the south of Brazil and also touches on the heavily populated and industrialised regions of São Paulo.
3 It is expected that in 2030 gas will account for 25% of electricity generation.
4 Black liquor is a residue product of the paper and cellulose industry that contains not only organic residues.

Transmission grid

At the end of 2002 the transmission network extended to 72,000 km and consisted of transmission lines at the levels of 230–750 kV. All major producing and consumer centres are connected via this national interconnected grid. However, during recent years there have been bottlenecks in supply as a result of the low transmission capacities between the North and North-East on the one hand, and the South of the country on the other.

Electricity consumption

Following years of growth, total electricity consumption dropped drastically in 2001 by comparison with the previous year due to a decline in water resources. The consumption level of the year 2000 was only reached again in 2003, at around 330 TWh. In particular public electricity generation and imports declined substantially in the meantime, while the self-generators increased their output. Concession-holding distributing firms and electricity traders (public sector supply) supplied some 300 TWh in 2003 (+3.7% by comparison with the previous year). However, due to a further expansion of self-generators increasing capacity to almost 30 TWh (including the craft & trades sector), the growth of the industry remained within bounds. Part of the growth in previous years is also attributable to new consumers being connected, as grids were expanded in rural areas.

Sector	Electricity consumption (GWh)
Households	76.2
Craft & trades	47.5
Industry	129.9
Other customers	47.1
Total	**300.6**

Table 4: Electricity consumption by sector – public supply; Brazil; 2003; GWh

Between 2000 and 2002 electricity consumption dropped sharply from 84 to 73 TWh, especially in the household sector, as a result of the drastic economy measures, and has not yet been able to reach its former level, even in 2003 when it rose to 76 TWh. The average monthly consumption in households fell from 173 kWh in 2000 to 140 kWh at the end of 2003. The decline in the South-East/Mid-East as well as in the North-East of the country was particularly marked. Interestingly enough, average household consumption has only risen insignificantly even after the end of the electricity crisis.

Considered geographically, electricity consumption is concentrated above all in the South-East region of the country with its industrial conurbations, as well as in the Centre-West (South-East/Centre-West interconnected grid), where altogether about 60% of national electricity demand was located. In 2002 almost 40 TWh of total household electricity consumption was accounted for by the three South-East federal states of Minas Gerais, São Paulo and Rio de Janeiro alone.[5]

Since the beginning of the 1970s the increased growth in electricity consumption has regularly been well above the rates of growth in GNP. Even economic crises failed to damp this development much in the past. Only the electricity crisis of 2001 and Argentina's economic problems broke this trend.[6] Despite these dips, forecasts for the 10-year period 2003–2012 in the reference scenario assume an average growth in consumption of 5.7% a year. Consequently a total consumption of about 577 TWh is assumed for the year 2012, to which distribution companies with concessions are expected to contribute 510 TWh.

Electricity prices

In mid-2003 the average electricity prices were 167 R$/MWh (49 €/MWh), fluctuating between 130 R$/MWh (37 €/MWh) in the North and 181 R$/MWh (52 €/MWh) in the Centre-West region. Prices for the household sector averaged 239 R$/MWh (68 €/MWh), and in the industrial sector 112 R$/MWh (32 €/MWh)[7]. The prices were increased by high taxes and charges that account for almost 30% of the total electricity bill.

Economic situation of electricity suppliers

Brazil's supply companies are in a troubled financial situation as a result of the declines in electricity consumption triggered by the electricity crisis. Estimates talk of losses amounting to R$ 5 billion (€ 1.43 billion) for 2003 alone and put unutilised capacities at 7,500 MW. At the same time the companies lack finance for maintenance and fundamental investments. Restructuring of

5 In 2003 only 6.2 TWh was consumed in the isolated networks that supply above all the settlement centres in the north of the country (with Manaus as the largest consumer unit) and are under the control of concessionaires. The situation in smaller communities that frequently generate electricity themselves with diesel generators is generally described as precarious in view of the outmoded plant technology.

6 Energy efficiency programmes have lowered current consumption by about 20% and the peak load by 5 GW.

7 These prices are net without taxes and charges.

the electricity sector announced in 2003 aims in particular to reduce consumer tariffs by purchasing electricity from the most favourable production sources. However, this could slow down the development of new renewable energy sources.

Market Actors

Brazil's electricity market has been undergoing a process of great change for some years now. After completion of the restructuring operation, the original state-monopoly supply sector is set to give way to a largely privatised, liberalised and competition-oriented service sector. However, following the sale of many distribution companies, privatisation has largely come to a standstill in recent years and expressly excludes the generating sector, which is still centrally controlled by the state.

Structure of the public electricity sector

The (public) Brazilian electricity sector is essentially divided up into the state holding Eletrobrás with the binational hydropower station Itaipú (operated jointly with Paraguay), an operating company for the nuclear power stations, three large electricity producers as subsidiaries[8], many independent and individual state electricity suppliers, a relatively large number of distribution companies at regional – in other words mainly federal state – level, and a series of locally-oriented supply companies in the larger municipalities[9]. Only some of the regional and municipal suppliers have their own generating capacities. They generally purchase their electricity from the central electricity generators.

Companies	Installed capacity (MW)
Companhia Hidro Elétrica do São Francisco (CHESF)	10,484
Furnas Centrais Elétricas S/A.	9,407
Companhia Energética de São Paulo (CESP)	7,455
Tractebel Energia S/A	6,503
Itaipu Binacional	6,300
Companhia Energética de Minas Gerais (CEMIG)	6,043
Centrais Elétricas do Norte do Brasil S/A (ELETRONORTE)	5,874
Copel Geração S/A	4,541
AES Tietê S/A	2,651
Duke Energy Internacional, Geração Paranapanema S/A	2,299

Table 5: Generating capacities of the major electricity suppliers; Brazil; 2003; MW

Generating sector

The generating sector is dominated above all by government-run enterprises. At the end of 2003 altogether 931 electricity generators were registered (companies with permits to generate electricity), including 70 public suppliers, 416 self-generators and 392 independent power producers. However, these figures also include many companies which have yet to begin electricity generation.

The function of Eletrobrás is still significant, despite curtailment of its scope of tasks following the unbundling of part of the generation and distribution sector. It forms the umbrella of a holding company for the important remaining undertakings. In view of its technical and organisational competence it also plays a major role in conjunction with the Ministry of Mining and Energy (MME) in higher-level energy planning, and now also performs important tasks as a financing institution for the electricity sector.

Regulatory authority ANEEL

At the end of 1997 the new, independent regulatory authority ANEEL (Agência Nacional de Energia Elétrica) was established.[10] Its task is mainly to issue concessions for electricity generation and distribution, and to spe-

8 Furnas, CHESF and Eletronorte.

9 However the three largest of these municipal and regional suppliers contribute almost 40% to Brazi's electricity resources.

10 On the basis of Law 9.427/96. The structure and tasks of ANEEL are described comprehensively in Regulation 2.335 of 6 October 1997. This was partly amended by Law 10.848 of 15 March 2004.

cify tariffs and entitlements for access to the grid and for the regulated sector of final electricity consumption.[11]

Electricity imports

ANEEL must approve the import and export of electricity as well as the associated construction of transmission lines and other facilities. Since July 1999 approvals have been issued for importing 5,420 MW, including 5,050 MW from Argentina, 300 MW from Bolivia, 70 MW from Uruguay and 50 MW from Paraguay. However, implementation of these approvals has fallen behind expectations, since the demand for electricity has not grown at the rate forecast due to the supply crisis in the meantime and the poor rate of economic development.

Legal Framework

Privatisation

The national privatisation programme (Programa Nacional de Desestatização, Law No. 8.031) was launched in 1990. This also provided for the privatisation of sectors of electricity generation and distribution for which Eletrobrás had been responsible. The basis for a fundamental reform was set with the Concession Laws 8987/95 and 9074/95 in 1995, which also aimed to set up new regulatory bodies. A first step was taken with the privatisation of the distribution company Escelsa in 1995, and this was followed by many other sales, primarily to foreign investors. However, within the restructuring of the electricity sector under the present government, Eletrobrás and the electricity suppliers that it controls, i.e. Furnas, CHESF, Eletronorte, CGTEE (Companhia de Geração Térmica de Energia Elétrica),[12] along with the transmission firm Eletrosul are excluded by law from privatisation.[13]

Limitation of market dominance

ANEEL Resolution 278 of 19 July 2000 states that no electricity generator or the companies controlling it (the same applies to electricity distributors too) may hold more than 20% of the total capacity of the national grid or more than 25% of the southern interconnected grid and 35% of the northern interconnected grid. In December 2003 Eletrobrás held more than 33% of total capacities, its subsidiary CHESF a little over 12%, Eletronorte at least 11% and Furnas almost 7%, so that the central government share in generation still accounts for about two thirds of the installed capacity.

Interconnected grid operator ONS and wholesale market

Further foundations for a competition-oriented electricity market were created with Law 9648/98 and Decree 2655/1998 for setting up the Operador Nacional do Sistema Elétrico (ONS), which commenced its tasks on 1.3.1999, and for instituting a wholesale electricity market (MAE–Mercado Atacadista de Energia[14]) ONS ensures non-discriminatory access by market participants to the interconnected grid (Sistema Interligado Nacional – SIN) and coordination between supply and demand. The generators, distributors, traders, bulk consumers and representatives of the other consumer groups hold shares in this private-sector company. In September 2003, 68 electricity generators and 75 electricity buyers participated in the wholesale market. As of the year 2006 the electricity market is to be based solely on bilateral contracts (85 to 90% of the total electricity volume) and a short-term spot market.

Concessions for distributing electricity

Concessions are awarded to distribution companies on the basis of public auctions. Distributors have a prior right to supply consumers in their own supply territory, but large-scale consumers can also enter into contracts with other suppliers.

Independent electricity generators and owner-operators

Regulation 2003 of 10 September 1996 granted independent power producers and self-generators the right to operate. Any consumer with more than 10 MW installed load[15] was already granted the right to select their own electricity supplier under Concession Law 8987/95.[16] Independent power producers and self-generators have free access to the interconnected grid and to the electricity grids of the distributors by paying the transmission charges.[17] ANEEL drew up a comprehensive set of rules on calculating this in 1998 with which the transmission

11 However only a few suppliers operate across the board in all three sectors, for example CEMIG in the federal state of Minas Gerais.
12 CGTEE operates three thermal power stations and belongs to Eletrobrás since July 2000.
13 Law 10.848 of 15.3.2004, Art. 31.
14 Converted by law in the meantime into the private law company Câmara de Comercialização de Energia Elétrica–CCEE.
15 A further condition is that the supply must be provided via a connection of at least 69 kV.
16 New consumers can do so from a lower threshold of purchased power, 3 MW, and for supplies from hydropower the figure is 500 kW.
17 However it is problematic for smaller units feeding in electricity that access to the distribution level is not regulated yet.

price is formed for each individual case in accordance with the respective parameters (transmission lengths, voltage level, electricity quantity etc.). The supply limit for free selection of suppliers was lowered to 3 MW in the year 2000.

Independent power producers can sell their electricity to:

- a licensed electricity supply company (or grid operator)
- consumers who can select their electricity generator freely on the basis of the minimum power requirements described above
- consumers who also purchase heat at the same time (in other words in cogeneration)
- consumer communities in agreement with the local electricity supply company
- any consumer who proves that he has not been supplied by the local electricity supply company 180 days after signing an electricity supply agreement

With special permits, self-generators can exchange electricity between themselves or sell surplus electricity to the local electricity supply company. However, there is no legal obligation for grid operators to purchase the electricity offered from either independent producers or self-generators.[18] In view of the very high peak-load tariffs many self-generator plants are run primarily to avoid these peaks and are not operated for base-load supply, so that it is frequently not cost-effective to cover heat requirements at the same time.

Clean Development Mechanism

Brazil ratified the Framework Convention on Climate Change in February 1994 and the Kyoto Protocol in August 2002. It has not yet submitted a national climate protection report, although this is now well overdue.[19] Since July 1999 an Interministerial Commission coordinated by the Ministry of Science and Technology (Comissão Interministerial de Mudança Global do Clima) has been responsible for climate and hence for CDM projects too. The private sector and NGOs participate via the Brazilian Forum on Climate Change (Forum Brasileiro de Mudanças Climáticas). The Ministry of the Environment also plays a major role in selecting CDM projects. Various projects have already been suggested for trading in emission permits during recent years. The sugar factory Vale do Rosário that aims to substantially increase its bagasse-based electricity generation obtained a first certification by TÜV Süddeutschland in 2002. Further information on CDM projects can be found on the Internet, including the site of the German-Brazilian Chamber of Trade.[20]

Policy for Promoting Electricity Generation from Renewable Energy Sources

The Proinfa programme (Programa de Incentivo às Fontes Alternativas de Energia Elétrica) was introduced with Law 10.438 of 26 April 2002[21]. In two phases, this law provides for the purchase of electricity from plant operators that use renewable energy sources and supply the electricity generated to the interconnected grid. The goal expressly targets greater market participation by independent producers who are not governed by concessionaires in the public supply sector. A special status is granted to those operators that work with plant manufacturers who supply at least 60% (in the second phase 90%) of nationally produced components.

Proinfa – first phase up to end of 2006

In the first phase up to the end of 2006, 1,100 MW each of wind power plants, small hydroelectric power systems and biomass power stations are to start operation and supply electricity to the interconnected grid at defined price rates that have been agreed with Eletrobrás for a period of 20 years. The prices determined by the Ministry of Energy must satisfy certain minimum rates that are oriented to the average electricity tariffs for final consumers (Tarifa Média Nacional de Fornecimiento ão Consumidor Final–TMNF): at least 90% for wind energy, at least 70% for small hydroelectric power, and at least 50% for biomass. The prices are limited by maximum ceiling values resulting from the uniform spread of the additional costs among all electricity consumers. Consumers with very low consumption (up to 80 kWh/month) will be exempted from all additional costs.

18 An exception here is formed by electricity from renewable energy sources produced within the framework of Proinfa.
19 A preliminary version can be found on the Internet page www.mct.gov.br/clima.
20 http://www.ahk.org.br/cdmbrazil/index.htm.
21 Partially amended by Law 10.762 of 11.11.2003. For implementation see Decree 5.025 of 30.3.2004.

Remuneration rates and selection of projects

At the end of March 2004 the price tariffs were published for plants that will enter service in the course of 2006.[22] Here it is planned to adjust the tariffs in line with general price developments up to the conclusion of the contract.

	Feed-in-tariff[23]		Lower limit[24]	
	R$/MWh	€/MWh	R$/MWh	€/MWh
Small hydropower	117.02	33.38	117.02	33.38
Wind power	180.18 – 204.35[25]	51.40 – 58.29	150.45	42.92
Biomass				
Sugar cane bagasse	93.77	26.75	83.58	23.84
Rice husks	103.20	29.44	83.58	23.84
Wood	101.35	28.91	83.58	23.84
Landfill gas	169.08	48.23	83.58	23.84

Table 6: Remuneration rates within the framework of Proinfa; Brazil; March 2004; R$/MWh, €/MWh

A first contract round for those projects possessing the necessary permits under electricity and environmental law is planned for the end of May 2004. If necessary, further electricity suppliers are to be contracted in a second public call for tenders at the end of October 2004. Limits were introduced for the projects that can be realised under Proinfa in each federal state (220 MW[26] each for wind energy and biomass, 165 MW for hydropower). While independent autonomous producers enjoy priority for small-scale hydropower and biomass, autonomous producers and independent non-autonomous producers are to be treated equally for wind energy (max. 550 MW each). Further details of the documents necessary for submitting an application to Eletrobrás can be taken from the application guidelines of the Ministry of Energy.

In addition the National Development Bank BNDES will provide low-interest credits for Proinfa projects on the basis of hydropower and wind energy up to the end of 2005 and for a maximum of ten years.

Proinfa – second phase

In the second phase scheduled to start after the target of 3,300 MW is reached, further projects are to be realised in order to ensure that renewable energies (not including large-scale hydropower) account for a share of 10% of annual electricity demand within a period of twenty years. At least 15% of the annual growth in electricity generation should originate from these sources. The purchase prices, also guaranteed for 20 years by Eletrobrás, are to be oriented to the production costs of new hydropower plants with more than 30 MW and new natural gas power stations. Operators will also be granted a right to compensation for additional costs up to a remuneration rate fixed by the government (valor econômico) outside the electricity purchase agreements.

ANEEL resolutions

ANEEL Resolution 112 of 18 May 1999 decreed simplified rules for approving small hydropower plants and other facilities on the basis of renewable energy sources under electricity law, including those for wind power plants. Accordingly ANEEL can authorise the construction and operation of such plants without prior public calls for tender.

ANEEL Resolution 245 of 11 August 1999 expanded a fund for the use of fossil energies in isolated grids (Conta Consumo de Combustíveis Fósseis–CCC), originally set up to cushion the high cost burdens in off-grid regions, to finance renewable energies provided that these replace mineral oil products in isolated grids in the North.

ANEEL Resolutions 22 and 256 from the year 2001 defined new bases of calculation and maximum values for specifying electricity tariffs by distribution companies. This includes special 'normative values' (valor normativo) that can be passed on as boundary values to consumers for additionally purchased renewable energies.[27] However, the values for small-scale hydropower and biomass still lie below the mark for electricity from thermal power stations (with the exception of national coal).

22 Ministerio de Minas e Energia, Portaria No. 45 of 30.3.2004.

23 Valor Econômico da Tecnologia Específica da Fonte–VETEF.

24 The base value is the average electricity price of 167.16 R$/MWh.

25 The remuneration rate for wind energy is dimensioned according to the ratio between the potential yields and a reference yield determined by an ANEEL resolution.

26 These limits can however be shifted or exceeded if this quota is not exhausted in individual federal states.

27 Does not apply to plants within the framework of the Proinfa programme.

Law 10.438 of 26 April 2002 (Art. 17) and ANEEL Resolution 219 of 23 April 2003 specified that the transmission and distribution tariffs may not exceed 50% of the prices normally allotted if hydropower, biomass or wind energy is used in power units between 1 and 30 MW. This ruling was extended by Law 10.762 of 11 November 2003 to hydropower plants up to 1 MW and generally for wind energy and biomass plants up to 30 MW.

SWERA

Within the framework of the multinational, GEF-supported project 'Solar and Wind Energy Resources Assessment (SWERA)' that has been ongoing since 2002, the existing national wind atlas is being improved and similar information is being gained for solar irradiation. In the solar sector the country is represented by the National Space Institute, and in the wind sector by the National Wind Centre in Recife. The research facility CEPEL is also involved.

Energia Produtiva

In September 2003, with support from USAID, the international development institute Winrock launched the 'Energia Produtiva' (2003–2007) programme involving eight Brazilian institutions that belong to the RENOVE[28] network, which has existed since June 2000. The goal of the programme is to use renewable energy sources in the North and North-East of the country to develop or expand productive activities.

Status of Renewable Energy Sources

The use of renewable energy sources is traditionally accorded a high ranking in electricity generation as well as in the provision of energy supplies to rural areas of Brazil. Recently efforts to develop renewable energy sources (especially sun, wind and biomass) have increased substantially in the research and development sector, as well as in application-oriented implementation. The abundant renewable resources are hardly used at all in urban and industrialised centres, however.

Hydropower

The hydropower potential is quoted as being about 260 GW that would be hypothetically available, and is concentrated above all in the northern region (Amazon territory, approx. 40%) and in the South and South-East of Brazil. About one quarter of this potential (67.5 GW) is currently utilised, whereby hydropower contributes more than 40% to primary energy resources and about 90% to electricity generation. At the end of 2003 some 4.6 GW of generation capacity was under construction, and there were generating concessions in place for almost another 9 GW, divided between 242 plants. More than half the expansion of electricity generation will be attributable to hydropower in the coming years. An additional 90 GW is considered to be secured and economically exploitable. Beyond the hydropower plants already in operation the total energy volume can only be developed to a relatively small extent in practice, however, since intervention in nature to build large dam projects appears unjustifiable in many cases, especially in the flat north of the country. In the South and South-East, on the other hand, over 50% of the available capacity is already being used.

Small-scale hydropower

Hydropower plants rated at between 1 and 30 MW are defined as small-scale hydropower plants, and provided that the associated reservoir is not larger than 3 km^2 and they are operated by independent power producers or self-generators, they only need a simple permit under electricity law, which is granted to the first suitable applicant.[29] In exceptional cases public auctions may also be held. Concessions are granted for a period that allows refinancing of the investment, but at most for 35 years.

Small-scale hydropower plants are currently concentrated above all in the mountainous regions of the South and South-East of the country.

28 Rede Nacional das Organizações da Sociedade Civil para as Energias Renováveis, www.renove.org.br.

29 ANEEL Resolution 394 of 4 December 1998 and 395/1999. According to ANEEL Resolution 652 of 9 December 2003 larger reservoirs are also authorised in specially defined cases.

Region	Output (MW)
South	287
South-East/Centre-West	498
North	41
North-East	76
Total	**902**

Table 7: Small-scale hydropower plants in operation; Brazil; 2004; MW

Despite the investment incentives and the large number of permits issued under electricity law (3,900 MW from 1998 to March 2004), the building of additional capacity has remained very limited in recent years. However, it is to be expected that a number of new plants will be constructed within the scope of the first phase of Proinfa. Altogether the potential for small-scale hydropower plants is quantified at 7 to 14 GW. It is estimated that 700 MW alone can be developed by expanding and improving existing plants and reactivating dormant power stations.

Promotion of small hydropower plants

Various incentives have been used to stimulate the construction of new small hydropower plants in recent years: [30]

- At most 50% of the normal tariffs are to be paid for electricity transmission and distribution, whereby a discount of as much as 100% was granted for small hydropower plants that went into operation up to the end of 2003.
- Exemption from compensation payments for flooded areas and from tax payments for water use.
- Consumers with a demand of 500 kW or more (or 50 kW for isolated supply) can negotiate agreements freely.

Wind Energy

Despite good to very good wind energy conditions, the use of wind to generate electricity is still in its infancy in Brazil. At the start of 2004 the total installed capacity, shared between a few locations, was only 29 MW. Yet the production potential is estimated at more than 140 GW and the amount of electricity that can be produced is considered to be 272 TWh a year. Not least the coastal regions in the North and North-East where mean wind speeds of 8 m/s and more prevail at a height of 50m are ideally suitable for using wind energy.

Wind use to date

So far however there have been only a few examples of wind power installations with significant output being implemented in practice, including two wind farms near Fortaleza (Ceará state) with 5 MW (Taíba) and 10 MW (Prainha), which entered service in 1999. Both projects were erected by Wobben Windpower[31], a subsidiary of the German firm Enercon, which operates them on the basis of bilateral agreements with the regional electricity supplier Coelce. In both cases the German investment and development consultancy Deutsche Investitions- und Entwicklungsgesellschaft (DEG) financed the projects with low-cost credits.

Wind measurements

Thanks to international programmes and other assistance, most of the wind-rich areas are well surveyed and documented. Wind measurements were carried out at three coastal locations in the state of Ceará as long ago as 1990/91 within the framework of GTZ's TERNA programme in conjunction with the electricity supply firm Coelce. They revealed excellent wind potential at a highly constant level. The Brazilian Centre for Wind Energy published a first wind atlas for the North-East in 1998. At state level wind atlases are available for Ceará[32] and Paraná. The first version of a pan-Brazilian wind atlas by the Reference Centre for Solar and Wind Energy CRESESB (Centro de Referência para Energia Solar e Eólica Sérgio Brito) at the Research Centre for Electrical Energy (CEPEL) was completed in 2002. This atlas is based on measurements by various supply companies and other actors.

Brazil has important know-how resources for future development, in the form of the Brazilian Centre for Wind Energy in Recife, which has a test facility, and CRESESB in Rio de Janeiro. Academic institutions in other federal states are also looking at wind energy more closely and are contributing to training specialists. In the past, training measures for Brazilian energy and finance experts have

30 In July 2000 the programme was launched for developing and commercialising electricity from small-scale hydroelectric plants, limited to the period 2001–2003 (PCH-COM). Due to a lack of implementation provisions and insufficient remuneration, however, this programme hardly produced results and was replaced by the PROINFA programme following the enactment of Law 10.438 in April 2002.

31 Wobben Windpower is so far the only plant manufacturer in Brazil with factories in the states of São Paulo and Ceará.

32 See www.seinfra.ce.gov.br.

been held repeatedly with German assistance (InWEnt and Deutsches Windenergie-Institut).

Wind energy within the framework of Proinfa

After a number of political approaches towards intensifying investment in wind energy failed (for example the emergency programme 'Proeólica' of 2001), with the publication of the rules on remuneration in the Proinfa programme attention is now being focused on the period up to the end of 2006 in which 1,100 MW of wind power is due to go onto the grid. By the end of March 2004 altogether 161 wind projects had received electricity generation licences from ANEEL for a total of some 8,560 MW. Applications were made by a number of different operating firms. However, some of these licenses have already expired or were returned by the operators. Most of the proposed plant locations are in the states of Rio Grande do Norte and Ceará. After presentation of the necessary environmental permit and depending on the production cost situation at the relevant locations, it will become apparent which projects will remain in the running and enter into an agreement with Eletrobrás, and be realised within the specified timeframe.

Wind farm projects in Ceará

The supply company Coelce in the state of Ceará, with finance from Japanese development cooperation (Overseas Economic Cooperation Funds–OECF), has been preparing two wind farms at Paracuru and Camocim of 30 MW each for a number of years now; a pre-qualification round was held at the beginning of 2001. Both projects are to be handed over on a turnkey basis and subsequently be operated by Coelce.

Biomass

Brazil has wide-ranging biomass resources at its disposal that already account for almost a quarter of primary energy consumption and contribute about 2% to electricity generation. However, often these resources are not exploited sustainably at present; for instance charcoal is burned without there being any specific reforestation measures in place.

Proálcool

The best-known example of a different energy-specific use of biomass is the Proálcool programme, which has been ongoing since the mid-1970s to substitute alcohol on a sugar-cane basis for mineral oil in the transport sector. Thus in the period 2003/2004, 14 million m^3 of ethanol was gained from the harvest of 350 million t sugar cane in addition to the sugar. This programme is still being supported by government subsidies, since the mineral oil price has not increased to the extent necessary to make this alternative fuel cost-effective.

Potential for electricity generation

At the end of 2002 ANEEL published an inventory of the biomass potential that can be additionally developed for electricity generation at short notice in agriculture and forestry in the different parts of the country.

	North	North-East	Centre-West	South-East	South
	MW	MW	MW	MW	MW
Sugar cane	10	120	60	353	42
Oilseed crops	Pará: 157	45	No data	No data	No data
Rice husks	33	34	68	13	190
Forestry[33]	13	52	3	121	127
Coconut shells	6	36	-	5	-
Cashew nut shells	-	13	-	-	-

Table 8: Biomass potentials exploitable at short notice for electricity generation, by region; Brazil; MW[34]

However, with regard to the resources already used, above all in sugar production and in sugar-cane cropping[35], which has grown substantially in the last few years, the identified potentials are more likely to be a conservative estimate. The Ministry of Energy quantifies the technical production potential in the alcohol and sugar sector at around 4,000 MW and in rice growing and the paper and cellulose industry at 1,300 MW.[36] The technical electricity generating potential that can be utilised at short notice through the use of timber residues, rice husks and sugar-cane components in the southern states of Santa Catarina, Paraná and Rio Grande do Sul alone is estimated at several hundred megawatts.

33 Only timber residues from forestry.

34 Data source: ANEEL, 2002.

35 In the medium term a further increase of the harvest by 100 to 150 million t of sugarcane is expected.

36 Other estimates quote a possible electrical capacity of CHP stations on a sugar-cane basis of 6,000 MW for the state of Sao Paulo alone. For the whole of Brazil the prospect is held out that the energy potential could even be more than 21,000 MW, provided that high efficiency techniques are used by 2010.

Use of biomass

So far the main instances where biomass is used for generating electricity are in industrial self-generation. Mostly this involves the use of bagasse from sugar production and (the associated) alcohol production[37] as well as the use of residual substances in the timber and paper industries. About three quarters of the electricity-generating biomass plants with a total capacity of about 2,500 MW are combined heat and power plants, where bagasse is used almost exclusively.

In 2002, 128 of a total of 377 sugar factories possessed licences as self-generators, and 35 were authorised to operate as independent power producers (supplying surplus electricity to the public grid). In the state of São Paulo alone, the most important location in the Brazilian sugar industry with 165 factories, more than 850 MW was installed in such plants for electricity and heat production in 2002.

Promotion of industrial biomass use

In future more surplus electricity is to be provided for the public grid by improving the efficiency of converting biomass and thanks to promotion by the Proinfa programme. In May 2001 an operational programme was also started for company-owned combined heat and power plants on the basis of residual substances from sugar production. The national development bank BNDES meets up to 80% of plant costs via credits in order to enhance willingness to invest.

Other biomass resources

At the same time the development of further biomass resources is being discussed and partly already being implemented on a small scale. Attention is focused here not only on organic constituents of domestic waste, but also on residues of other agricultural products, for example cocoa and coffee husks, and on oleaginous fruits that could play a major role above all in rural electrification of the North and North-East with the use of internal combustion engines. The first electricity-generating plant designed to utilise rice husks began operation in 1996.[38] The Dutch CDM fund (Netherlands Clean Development Facility) intends to purchase tradable permits generated by the use of landfill gas from two landfill sites for domestic waste in Nova Iguaçu in the federal state of Rio de Janeiro for generating electricity. First estimates quantify the generation potential from landfill gas for Brazil under current conditions of waste storage at 300 to 500 MW. There are also some initial pilot projects examining the use of sewage gases from waste water purification.

Biodiesel and pure plant oil

The National Reference Centre for Biomass (CENBIO) intends to start supplying electricity to an isolated community in the state of Ceará using a biodiesel engine in the second half of 2004. Further-reaching plans are being pursued by the supply company Ceam (Centrais Elétricas do Amazonas), a subsidiary of the state-owned Eletronorte, which intends to convert its 91 isolated grids in the Amazon territory to biodiesel step by step. These projects are also being advanced by a biodiesel programme in the transport sector, according to which biodiesel is supposed to account for 5% of total diesel use by 2010. CENBIO also converted a conventional diesel engine to operation with pure plant oil within the framework of the PROVEGAM project in 2002/2003 in order to supply electricity to a community in the state of Pará.

Solar Energy

The Federal University of Pernambuco presented the new version of a solar atlas for Brazil in 2001 on the basis of results from 350 measuring stations. Thanks to its position close to the equator, Brazil has good to very good solar conditions in all parts of the country. Average daily irradiation ranges between 4.5 kWh/m^2 on the coast of the state of Paraná and 6.3 kWh/m^2 in the interior of the country in the North-East (Sertão region). There is a regional solar radiation atlas for the state of Santa Catarina which was prepared in partnership between the regional energy supply company and the Federal University.

Photovoltaic use

During recent years solar electricity was used above all within the framework of the federal PRODEEM programme. Initial experience with a grid-coupled plant was gained in the grounds of the Federal University of Santa Catarina. Altogether the potential for photovoltaic facilities within the framework of the target determination of PRODEEM is estimated at about 35 MW. Solar home systems for elementary supply of private

37 With electricity generation of more than 4,000 GWh a year.

38 At São Gabriel in the state of Rio Grande do Sul.

households were distributed above all within the scope of bilateral development projects. However, due to insufficient market density and a lack of maintenance, the failure rate of PV systems has been very high in the past. It is hoped that such faults will be avoided in future by greater market integration of PRODEEM and direct involvement of the distribution companies in the electrification measures within the framework of the new programme 'Luz para Todos'. The firm Heliodinâmica is the sole national manufacturer of solar cells and modules, but its production volume is only very low to date.

Solar-thermal electricity generation

Since 1996 Brazil has been participating in the international SolarPACES project (Solar Power and Chemical Energy Systems) through the research facility CEPEL (Centro de Pesquisas de Energia Elétrica). No specific consideration has been given to building solar-thermal power stations.

Geothermal Energy

Due to its geological features, Brazil does not have favourable conditions for using geothermal energy. It has not yet been explored whether there are any local potentials for using geothermal energy to produce electricity.

Rural Electrification

Due to its territorial size, low population density in large parts of the country, and severe poverty in rural regions, Brazil still has a high proportion of non-electrified communities and households.[39] According to the 2000 census, some 3.1 million households (corresponding to 6.5% of the total) do not have electric lighting.[40] This rate is much higher in rural areas at 29% (2.2 million households) than in urban areas (2.6%). Some 63% of the rural population in the North and almost 40% in the North-East do not yet have any access to electricity. In some states the supply to the rural population is particularly underdeveloped. For instance in the northern states Acre and Amazonas more than 70% of rural households do not have any electricity connection. In absolute figures the need is particularly high in the North-East, at about 1.3 million households. In the relatively populated state of Bahia alone the number of households in rural regions without electricity supplies is put at about 440,000.

'Luz para Todos' programme

To improve electrification in rural areas the 'Luz para Todos' ('Electricity for All') programme was launched in November 2003.[41] According to this, all 12 million people without access to electricity are to be supplied with electricity as soon as 2008 (10 million of these in rural areas). The programme is being coordinated by the Ministry of Energy with participation by Eletrobrás and the companies it controls. For 2004 it is planned to connect 400,000 households, and 500,000 each in 2005/2006, followed by 300,000 in each of 2007 and 2008. It was expected that the first pilot projects would be implemented in 2003.

The distribution companies had to set out their relevant targets for 2004 by the end of August 2003. A plan for the subsequent years has to be drawn up in 2004. Priority is assigned to projects in communities with a connection rate of less than 85% and projects providing for productive use of electrical energy or in state schools, health stations, or for water supply.

Electrification is to be achieved through network expansion, distributed generating systems with isolated networks or individual plants, whereby renewable energies can also be used for generating electricity in addition to diesel. Regionally graded tariffs serve to provide economic balance, and if these are exceeded alternatives to expanding the network should be considered. The marginal costs in the North-East, for instance, are R$ 5,200 (approx. € 1,500) per consumer.

The funds for the programme, estimated to total US$ 7 - 9 billion, originate at least partly from the concession fees and fines paid by the energy supply

39 Non-electrification is to be understood literally in this connection, since even diesel generators for elementary autonomous supply are generally not available and frequently only batteries can be procured for basic needs (for example for operating radio sets). Communities are to be interpreted as local communities whose residents are frequently settled over a wide area but do not necessarily possess individual land property. That is why in Portuguese the term used is more frequently 'Propriedade' ('property').

40 According to estimates in 2002 Brazil's total population numbered 176 million. Moreover in many regions the existing electricity supplies are frequently interrupted and thus only available for part of the time.

41 Decree 4.873 of 11 November 2003, which relates to Law 10.438 (Art. 14 and 15). The new project follows the 'Luz no Campo' programme managed by Eletrobrás with which about 1 million rural households and buildings were to be supplied with electricity within four years. However, due to the fact that promotion funds were only granted on a credit basis for supply companies with concessions and rural cooperatives, the programme did not lead to the desired success.

companies and collected by ANEEL, as well as from the CDE (Conta de Desenvolvimento Energético), a fund which is paid into by all electricity consumers. The rest is to be contributed by the federal states and the actors in the electricity market. Electricity consumers do not have to pay for any network expansions.

GTZ projects

In a new project scheduled to run until 2007, the GTZ is supporting rural electrification with renewable energy sources in the North and North-East of Brazil. With reference to the government electrification programme, the cooperation between Eletrobrás and the other energy supply companies in testing and developing models for rural electrification based on renewable energies is to be strengthened in a first phase.

PRODEEM

In order to at least start to improve the poor supply situation in rural areas, the electrification programme PRODEEM (Programa para o Desenvolvimento da Energia nos Estados e Municípios) was launched at the end of 1994. The project aims above all to equip community facilities such as schools, health centres and churches with electricity generating systems based on renewable energy sources. A further priority area comprises projects that can contribute to improving income situations, for instance by irrigation systems in agriculture, or that supplement diesel generators in isolated facilities.

In practical implementation, solar energy using PV systems has developed into almost the sole energy source, while for example hydropower and wind resources do not yet play any role.[42] Solar home systems (SHSs) for supplying individual private households are not promoted within the scope of PRODEEM.

MME bears the costs of PV modules, inverters, charging regulators, batteries and pumps, as well as of international transport.[43] In return the federal states, local authorities or responsible prefectures (district governments) are expected to assume the costs of national transport, installation and installation materials, and of maintenance. The programme also targets the involvement of supply companies, banks and other domestic and foreign financial donors.

Federal state promotion programmes

Some federal states have conducted or are still conducting their own programmes for solar electrification, partly supported by foreign donors, even if these programmes are of a comparatively modest nature. In the states of Pernambuco and Ceará investment of at least 2% of annual turnover for electrifying rural areas was contractually agreed in the privatisation of the relevant regional supply companies.[44]

Exchange rate (Novembre 2003): 1 Brasilian Real = 0,294 €; 1 € = 3,408 Real

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42 Within the framework of PRODEEM only two wind power systems were procured in 1996, each rated at 10 kW, one of which is used for pumping water and the other for generating electricity. In addition a small hydropower plant with 40 kW entered service in May 1999 and a further plant with 25 kW in October 1999.

43 Altogether six international calls for tender were held in the years 1996 to 2001 by the MME and with the aid of CEPEL for central procurement of the necessary components. In Phases I to IV and a so-called special phase to overcome a drought period by using water pumps at the end of 1998 almost 6,000 PV systems with a total capacity of just under 3 MW were ordered and almost all installed by the end of 2001. Of these, 2,500 units alone are used for pumping water. 3,000 systems with a capacity of almost 2.2 MW were planned for Phase V, which started at the beginning of 2002.

44 In Pernambuco only 1% as of 2008.

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www.jb.com.br
www.electrica.com.br
www.canalenergia.com.br

Contact Addresses

GTZ Office Brasilia
Edificio Brasilia Trade Center/SCN Quadra 01 Bloco C / Sala 1501 Zona Central
Caixa Postal 01991
70.259-970 Brasilia/DF, Brazil
Tel. + 55 61 3 262 170
Fax + 55 61 3 289 149
E-mail: gtz-brasilien@br.gtz.de

Ministério de Minas e Energia (MME)
Secretaria de Energia
DNDE – Departamento Nacional de Desenvolvimento Energético
Esplanada dos Ministérios, Bloco U
70065-900 Brasilia - DF
Tel. 0055 (61) 319-5012
Fax 0055 (61) 224-1973
www.mme.gov.br

Agência Nacional de Energia Elétrica – ANEEL
SGAN - Quadra 603 – Modulo 'J'
70830-030 Brasilia – DF
Tel. 0055 (61) 312 59 50
Fax 0055 (61) 312 56 23
E-mail webmaster@aneel.gov.br
www.aneel.gov.br

Operador Nacional do Sistema Elétrico – ONS
Escritório Central
Rua da Quitanda 196
20091-000 Rio de Janeiro
Tel. 0055 (21) 2203 9400
Fax 0055 (21) 2203 9444
E-mail: info@ons.org.br
www.ons.org.br

Eletrobrás
Av. Presidente Vargas 409
20071-003 Rio de Janeiro
Tel. 0055 (21) 2514-5151
Fax 0055 (21) 2507-8487 and 2224-0535
www.eletrobras.gov.br

Associação Brasileira das Grandes Empresas Geradoras de Energia Elétrica (ABRAGE)
Rua Alvarenga Peixoto, 1408 – sala 906
Santo Agostinho
30180-121 Belo Horizonte – MG
Tel. 0055 (31) 3292-4805
Fax 0055 (31) 3292-4682
E-mail: abrage@abrage.com.br
www.abrage.com.br

Associação Brasileira dos Pequenos e Médios Produtores de Energia Elétrica (APMPE)
Ed. Palácio do Rádio II – SRTV/SUL
Q. 701 CJ.E
Bl. 2 e 4, Sala 537
70340-902 Brasilia – DF
Tel. 0055 (61) 224 5986
Fax 0055 (61) 223 3930
www.apmpe.com.br

Associação Brasileira de Distribuidores de Energia Elétrica (ABRADEE)
Rua da Assembléia 10 – sala 3201
20119-901 Rio de Janeiro
Tel. 0055 (21) 2531-2053
Fax 0055 (21) 2531 2595
www.abradee.com.br

Associação Brasileira das Grandes Empresas de Transmissão de Energia Elétrica (ABRATE)
Rua Deputado Antonio Edu Vieira, 999 – Pantanal
88040-901 Florianópolis / SC – Brasil
Tel. 0055 (48) 231-7215 / 233-5647
Fax 0055 (48) 233-5551
E-mail: abrate@abrate.org.br
www.abrate.com.br

Associação Brasileira dos Produtores Independentes de Energia Elétrica (APINE)
SCN Qd. 02 Ed. Centro Empresarial Encol –
Torre 'A' Salas 626/8
70710-500 Brasília – DF
Tel. 055 (61) 315-9182 / 4 or 328-5707
Fax 0055 (61) 327-2069
apine@apine.com.br
www.apine.com.br

Mercado Atacadista de Energia Elétrica (MAE)
Alameda Santos, 745 – 9º andar
Cerqueira César
01419-001 São Paulo – SP
www.mae.org.br

Associação Brasileira dos Grandes Consumidores de Energia Elétrica (ABRACE)
Av. Paulista, 1439 – 11. andar – conj. 112
01311-926 São Paulo – SP
Tel. 0055 (11) 3284-4065
Fax 0055 (11) 288-3882
E-mail: info@abrace.org.br
www.abrace.org.br

Centro de Referência para Energia Solar e Eólica – CRESESB
Av. Hum s/nº, Cidade Universitária – Ilha do Fundão
21941-590 Rio de Janeiro – RJ
Caixa Postal: 68007
Tel. 0055 (21) 2598-2174 / 2187
Fax 0055 (21) 2260-6211
E-mail: crese@cepel.br
www.cepel.br

Centro Brasileiro de Energia Eólica CBEE
Centro de Tecnologia da Universidade Federal de Pernambuco (UFPE)
50740-530 Recife – PE
Tel. 0055 (81) 453-4662 / 453-4453 / 453-2975
Fax 0055 (81) 271-8232
E-mail: eolica@eolica.com.br
www.eolica.com.br

Centro Nacional de Referênzia em Biomassa
Av. Professor Luciano Gualberto, 1289 – Cidade Universitária
05508-010 São Paulo – SP
Tel. 0055 (11) 3091-2655 and 3091-2654
Fax 0055 (11) 3091-2649
E-mail: armando@cenbio.org.br
www.cenbio.org.br

Grupo de Estudos de Energia Solar / Green Solar
Av. José Gaspar Talento, 500 –
Vizinhança Coração Eucarístico
30535-610 Belo Horizonte – MG
Tel. 0055 (31) 319-4387
E-mail: green@pucmg.com.br
www.green.pucmg.br/

Centro Nacional de Referência em Pequenos Aproveitamentos Hidroenergéticos – CERPCH
Escola Federal de Engenharia de Itajubá
Avenida BPS, 1303
Bairro Pinheirinho
37500-903 Itajubá – MG
Tel. 0055 (35) 3629-1278
Fax 0055 (35) 3629-1265
E-mail: cerpch@cpd.efei.br
www.cerpch.efei.br/

Ministério do Desenvolvimento, Indústria e Comércio Exterior
Secretaria de Comércio Exterior
Esplanada dos Ministérios, Bl. j, 8. andar
70065-900 Brasilia – DF
Tel. 0055 (61) 329 70 80
E-mail: administrator@secex.mdic.gov.br
www.mdic.gov.br

Banco Nacional de Desenvolvimento Econômico e Social (BNDES)
Av. República do Chile 100
20139-900 Rio de Janeiro
Tel. 0055 (21) 2277-7447
www.bndes.gov.br

Associacão de Comercio Exterior do Brasil
Av. General Justo 335, 4. andar
20021-130 Rio de Janeiro – RJ
Tel. 0055 (21) 2544 0048
Fax 0055 (21) 2544 0577
E-mail: aebbras@embratel.net.br
www.aeb.org.br

Brazilian Embassy in Berlin
Wallstrasse 57
10179 Berlin
Tel. (030) 726 28 – 0
Fax (030) 726 28 – 320
E-mail: brasil@brasemberlim.de
www.brasilianische-botschaft.de

The potential of renewable sources of energy in developing and emerging countries is often considered high. Obstacles to their exploitation and foreign investors' engagement often include a lack of knowledge of framework conditions in the energy industry and insufficient transparency with regard to the prior experience and interests of the national actors. These are barriers which this third, updated and expanded new edition intends to overcome.

The **electricity markets** and their respective **actors** are investigated for **21 countries** in various regions: **Latin America – Caribbean, Africa, Europe – Caucasus** and **Asia – Pacific.** The country reports 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**.

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

Dag-Hammarskjöld-Weg 1-5
Postfach 51 80
65726 Eschborn
Telefon (0 61 96) 79 - 0
Telex 4 07 501- 0 gtz d
Telefax (0 61 96) 79 -11 15
Internet: http://www.gtz.de

German Development Policy