



Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses Chapter Egypt

Eschborn, September 2007

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New Edition of the TERNA Country Survey

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

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

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

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

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

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

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

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

Eschborn, September 2007

Legal Information

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

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

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

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

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

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

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

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

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

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10 Egypt

10.1 Electricity market

Installed capacities

At the end of 2005 Egypt possessed installed power generating capacities totalling 20,593 MW. Compared with the previous year (20,168 MW), that amounted to a 2% increase in overall output capacity. The generating capacities of EEHC, the government-owned and -operated Egyptian Electricity Holding Company, consisted of the following elements in 2005: 62% conventional steam power plants, 14% combined-cycle power plants (CCPs), 8% gas turbine power plants, 15% hydropower plants and 1% wind energy conversion systems (WECS). Since 2003 three private-sector power utilities have been contributing an additional 2,049 MW of generating capacity (10% of overall countrywide capacity) from three gas-fired steam power stations.

	2000	2001	2002	2003	2004	2005
	Installed generating capacity (MW)					
Gas turbines	715	715	715	1055	1,019	1,519
CCPs	2,605	2,605	2,605	2,605	2,605	2,605
Steam	8,498	9,158	10,525	11,203	11,610	11,535
Hydropower	2,745	2,745	2,745	2,745	2,745	2,745
Wind power	68	68	68	98	140	140
Private sector (steam)			683	2,049	2,049	2,049
Total	14,631	15,291	17,341	19,755	20,168	20,593

Tab. 1: Installed capacity by generation method; power plants serving interconnected power grid system; 2000–2005; MW¹

The once outstanding importance of the Aswan dam for Egypt's power sector has declined markedly over the past 30 years. In 1978, the annual output of the dam's 2,100 MW hydropower plant (8,153 GWh) sufficed to cover 54% of the country's power requirement. Now, however, even considering the increase in the plant's output to a good 9 TWh/a by 2005, it is no longer of central importance for the country's present total overall power production of 101 TWh per annum.

Egypt has 34 power-generating facilities situated in remote areas that are not connected to the national grid. They supply electricity to local users, including various tourist resorts. Together, these facilities have a total generating capacity of 280 MW and produced 303 GWh of electricity in 2005.

The five-year plan for the period from 2002 to 2007 assumed that the total power plant output would increase by 7.5% annually. Plans called for 5,610 MW of new power plant capacity, including 4,500 MW in the form of combined-cycle plants (with 1,500 MW each in Cairo and Nubaria, as well as 750 MW each in Talkha and El-Kureimat).

Power generation

Four regional utilities and one company responsible for hydropower are the main contributors to the Egyptian power grid. All five emerged from the break-up of the erstwhile national power utility and belong to the government-owned Egyptian Electricity Holding Company (EEHC). The power plants operated by those five producers generated some 87 TWh in 2005.

In addition to that, independent power producers generated 13,200 GWh, while the Zafarana wind farm produced 523 GWh and 69 GWh of surplus power was bought in from industrial enterprises. Altogether, this adds up to some 101 TWh produced for the country-wide public power grid.

¹ Source: Egyptian Electricity Holding Company (EEHC).

Sector	2004 GWh	2005 GWh	% change
Conventional steam power plants	50,781	54,300	+ 6.9
Gas turbines	564	3,360	+ 496
Combined-cycle plants	16,603	16,900	+ 1.8
Total thermal	67,948	74,560	+ 9.7
Hydropower	13,019	12,644	- 2.9
Wind power (Zafarana)	368	523	+ 42.1
Total public grid	81,335	87,727	+ 7.9
Purchased from industrial sector	77	69	- 11
Independent power producers	13,501	13,200	- 2.2
Sum total	94,913	100,996	+ 6.4

Tab. 2: Power generation for public grid according to source; 2004, 2005; GWh²

Power production for the public grid grew, on average, 7.8% per year between 2001 and 2006.

Year	2001	2002	2003	2004	2005	2006 ³
Generated power [GWh]	77,956	83,003	88,951	94,913	100,996	108,690

Tab. 3: Time history of power production (incl. wind and independent power producer output); 2001–2006; GWh⁴

Since Egypt has been successful in developing its natural gas resources while crude oil production declines, the country is now endeavouring to generate as much power as possible with natural gas. In 2005, 76% of all fuel consumed in Egyptian power plants was natural gas.

Power transmission and distribution

The government-owned Egyptian Electricity Transmission Company (EETC, an EEHC subsidiary) is responsible for the countrywide transmission of electricity. Via its national load distribution centre and regional control centres, the company ensures that the generated power reaches the regional and local distributors through a countrywide network of high voltage power lines.

	500 kV	400 kV	220 kV	132 kV	66 kV	33 kV
Transformer capacity [MVA]	7,765	n.s.	25,240	3,491	31,170	1,783
Total length of power lines [km]	2,262	33	13,920	2,467	16,248	2,725

Tab. 4: The Egyptian transmission network, key figures; 2005⁵

In 1998, Egypt and the neighbouring countries of Libya and Jordan interconnected their power transmission grids, and Syria joined the international grid-connected system in 2000. This interconnection made it possible for the countries' individual markets to share electricity and helped stabilise their individual grids. According to EETC, the measure has served well both technically and economically.

	Libya	Jordan
Voltage level [kV]	220	400
Max. capacity [MW]	150	250
Exported current [GWh]	123	750
Imported current [GWh]	104	70
Difference (export surplus) [GWh]	19	680

Tab. 5: Power-sharing network; 2005⁶

2 ibidem.

3 Relevant to the 2005/2006 accounting period.

4 Source: EEHC.

5 ibidem.

6 Source: ibidem and North African/Middle East/European Electricity Cooperation & African Interconnection Report (NREA).

In November 2002, Egypt was chosen as the host country for the international coordination and control centre, the purpose of which is to distribute the electricity through a planned integrated Mediterranean power grid. In addition to the countries already mentioned, a number of others are also intending to participate in this international power pool: Lebanon, Iraq, Turkey, Tunisia, Algeria and Morocco.

In 2001, in connection with the restructuring of Egypt's power sector,⁷ nine regional and local companies were commissioned to distribute electricity to ultimate users. The various distributors each have their own grids with medium- and low voltage lines, and they are also responsible for operating isolated grids with no connection to the national network. Altogether, the power utilities had 129,647 km of medium voltage lines and 213,960 km of low voltage lines in 2005.

Power consumption

Annual per capita power consumption in Egypt amounts to about 850 kWh. A sectoral breakdown of ultimate users, i.e. of the distributing companies' customers, yields the following profile in terms of electricity sold countrywide:

	Number of customers	%	Electricity sold [GWh]	%
Industry	415,171	2.2	13,609	20.3
Agriculture	60,402	0.3	2,646	3.9
Government/public authorities	165,424	0.6	8,181	12.2
Private households	15,687,337	86.0	31,312	46.7
Small businesses, trades and crafts	1,176,203	9.1	2,127	3.2
Miscellaneous	330,205	1.5	3,219	4.8
Street lighting	n.s.		5,919	8.9
Total	17,834,742		67,013 ⁸	100.0

Tab. 6: Customer breakdown and electricity sold by Egyptian distribution companies; 2005⁹

7 See section entitled "Market Actors/Public Power Corporations".

8 The difference between electricity produced and electricity sold is primarily attributable to technical and non-technical losses (power theft). No precise pertinent data are available.

9 Source: Egyptian Electricity Holding Company (EEHC).

10 *ibidem*.

Peak load situation

Peak loads in the Egyptian interconnected power grid increased by approximately 27% annually between 2001 and 2005. In 2004 and 2005, power consumption peaked between 9 p.m. and 10 p.m. on 19 and 20 June, respectively.

	2001	2002	2003	2004	2005	2006
Peak load [MW]	12,376	13,326	14,401	14,735	15,678	17,300

Tab. 7: Peak loads in the interconnected power grid; 2001–2006¹⁰

Electricity prices

The price of electricity in Egypt counts among the lowest in the world. Low voltage users pay 2.0 euro cents (0.148 EGP)/kWh on average, while high voltage customers are charged 1.5 euro cents (0.111 EGP)/kWh. The prices are fixed by the Egyptian government, by cabinet decision, and apply in equal measure to all regions. Ninety percent of all households receive electricity at a price that covers less than 50% of the cost of generation.

In October 2004 several electricity tariffs were raised, by an average of 8.6%, for the first time since 1992, and further 5% price increases were set for all electricity customers for each of the following five years. This step is intended to gradually accommodate the electricity tariff to the cost of generation. On the other hand, in the face of annual inflation rates exceeding 5%, these increases may not suffice.

The price levels for private and commercial customers are conspicuously progressive.

Tariff group	Electr. price [€ ct/kWh]	Electr. price [millim/kWh]
High voltage (220/132 kV)	1.52	111
High voltage (66/33 kV)	1.83	134
Housing societies	1.76	129
Medium voltage (22/11/6.6 kV) and low voltage (380/220 V) purchased volume > 500 kW (monthly demand rate: 1.18 €/kW)		
Energy rate	2.50	183
Private (kWh/month)		
0-50	0.68	50
51-200	1.37	100
201-350	1.86	136
351-650	2.68	196
651-1000	3.83	280
> 1000	4.68	342
Commercial (kWh/month)		
0-100	2.91	213
101-250	4.23	309
251-600	5.38	393
601-1000	6.66	487
> 1000	6.99	511
Local government and clinics	2.94	215
Public lighting	4.87	356

Tab. 8: Electricity tariffs for public power supply; as of December 2006; in € ct/kWh and millim/kWh¹¹

Development planning

The government-owned Egyptian Electricity Holding Company (EEHC) is projecting a peak load of 23,800 MW for 2012. New generating capacities totaling nearly 7,000 MW are supposed to be established between 2008 and 2012. Cogenerating facilities (CCPs) will account for 5,250 MW, and conventional gas-fired steam power plants the remaining 1,675 MW.

The Egyptian Ministry of Electricity and Energy announced in June 2002 that Egypt is planning to build a nuclear power plant on the Mediterranean coast, some 150 km west of Alexandria. In cooperation with the International Atomic Energy Agency (IAEA), studies were conducted to clarify the design and type of power station, which is also intended to be used for seawater desalination. According to the competent minister in September 2006, a 1,000 MW nuclear power plant will be constructed at El-Dabaa. It is scheduled to come on stream by 2015.

10.2 Market actors

Public power corporations

Prior to the sector's nationalization in the early 1960s, private enterprises produced and distributed electricity in Egypt. With the amalgamation of the production, transmission and distribution segments under the auspices of a single government agency in 1965, the state effectively bundled the entire power sector.

In the late 1970s there emerged some initial signs of a tendency to decentralise and regionalise the monolithic, since dismantled Egypt Electricity Authority (EEA).

Seven regional electricity supply companies, each responsible for generating and distributing electricity in their respective region, were established in 1998. The EEA served as the parent company of those various regional power utilities and retained responsibility for the countrywide transmission of electricity.

In connection with a reform of the power sector in the year 2000¹² to open it up for private investors, the production, transmission and distribution sectors were legally separated and partially regionalised. This yielded 13 individual companies, comprising four operating companies for thermal power plants, one operator for hydropower plants, one national power transmission company, and seven local/regional distribution companies.

¹¹ Source: Egyptian Electric Utility and Consumer Protection Regulatory Agency.

¹² Based on law no. 164 from the year 2000: "Transferring the Egyptian Electricity Authority into an Egyptian Joint Stock Company".

Two of the latter were split up again a few years later, so that there now 15 (+1)¹³ public power corporations organised within the state-owned Egyptian Electricity Holding Company (EEHC): five power plant operating companies, one national power transmission company, and nine distribution companies. The holding itself is supervised by the Egyptian Ministry of Electricity and Energy (MEE).

Independent power providers

In addition to the public-sector electricity undertakings (public power corporations - PPC), the electricity sector in Egypt is also populated by a number of private-sector companies (independent power providers – IPP) including three independent power plant operators, three private, vertically integrated electricity companies on the Red Sea, and three small, privately operated power corporations that generate and/or transmit electricity for the interconnected power grid in the greater Cairo and Alexandria areas.

Generation companies	Head office	Installed capacity [MW]	Annual output [GWh]
West Delta Generation Company	Alexandria	4,024	17,274
East Delta Electricity Generation Company	Al-Dakahleya	4,819	24,256
Cairo Electricity Generation Company	Cairo	3,681	21,926
Upper Egypt Electricity Generation Company	Giza	1,968	11,104
Hydro Plants Electricity Generation Company	Aswan	2,783	12,644
New and Renewable Energy Authority – NREA (wind power)	Cairo	140	523
Transmission companies		Supply system [km]	
Egyptian Electricity Transmission Company	Cairo	37,655	
Distribution companies		Transforming capacity [MVA]	Electricity sold [GWh]
Alexandria Electricity Distribution Company	Alexandria	3,413	6,330
South Cairo Distribution Company	Cairo	9,172	16,178
North Cairo Electricity Distribution Company	Cairo	7,283	13,232
El Behaira Electricity Distribution Company	Damnhour	2,905	4,930
South Delta Electricity Distribution Company	Tanta	2,717	6,578
North Delta Electricity Distribution Company	Mansoura	3,105	7,182
Upper Egypt Electricity Distribution Company	Aswan	3,001	5,966
Middle Egypt Electricity Distribution Company	Minia	3,116	6,895
Canal Electricity Distribution Company	Ismailia	3,901	12,643

Tab. 9: Overview of public power corporations organised within EEHC; 2005¹⁴

13 The NREA – actually a research institute – also presents itself as the operator of the Zafarana wind farm and is therefore included here as a generation company.

14 Source: EEHC.

It was mainly the expectations of international donors that disposed Egypt to open up its electricity sector for private investors in the 1990s. The first contract for a privately operated power plant with foreign investors was concluded in 1998 according to the BOOT principle.¹⁵ Two further such agreements followed in 1999.¹⁶ The three practically identical gas-fired steam power plants that went on line in 2002 (Sidi Krir) and 2003 (Suez and Port Said), with their combined output of 2,049 MW, account for approximately 10% of the country's installed generating capacity.

Generation companies	Installed capacity [MW]	Annual output [GWh]
Port Said East Power Company	683.0	3,850
Suez Gulf Power Company	683.0	4,300
Sidi Krir Generating Company	682.5	4,600

Tab. 10: Survey of independent power producers; MW, GWh, 2005¹⁷

The following table lists some additional private enterprises in the field of electricity generation and distribution.

	Installed capacity [MW]	Annual auto-production [GWh]	Distributing capacity [MVA]	Electricity sales [GWh]
Distribution companies				
Egyptian Chinese Joint Venture Company for Investment			30	3
Generation and distribution companies				
Global Energy Company	13.0	0.12	108	119
Alexandria Carbon Black Co. SAE	23.8	128	10	6
Om El Goreifat Company	7.0	13	8	13
National Electricity Technology Company (Kahraba)	6.4	42	8	42
Mirage Company	6.8	9.35	8	28
Sendeian Company for Paper Industry	14	99	17	99

Tab. 11: Overview of independent power producing and distributing companies; 2005¹⁸

Other Actors

Regulatory authority EEUCPRA

The regulatory authority for the electricity sector was established by decree in 1997.¹⁹ The Egyptian Electric Utility and Consumer Protection Regulatory Agency (EEUCPRA) is seated in Cairo and came into formal existence in 1998. It was, however, not until 2002 that the agency actually commenced operations following the instalment of its first general manager. Officially, it is directed by the Minister of Electricity and Energy, an arrangement which relativises its independence from government institutions.

15 Build Own Operate Transfer - when this plant has logged 20 years of operation, its ownership will be transferred to EEHC.

16 The investors were InterGen (a joint venture between Shell and Bechtel), Edison and EdF (Electricité de France). In 2006, EdF sold both plants (in Suez and Port Said) to the Malaysian company Powertek.

17 Source: EEHC.

18 ibidem.

19 Basis: Decree no. 326 of 1997: "Establishing The Electric Utility and Consumer Protection Regulatory Agency".

The primary task of the regulatory authority is to balance the interests of power producers, power providers and ultimate consumers. It is supposed to ensure a reliable long-term supply of electricity while promoting and supervising environmental protection and operational reliability in the energy sector. It is also responsible for licensing the construction and operation of power generation, transmission and distribution facilities as well as for electricity trading.

One of the authority's declared objectives is to create an enabling environment for market-based competition within the framework of existing laws and to prevent the formation of commercial monopolies in the energy sector. In view of the present primacy of national, governmental approaches in Egypt's policy toward further development of the energy sector, however, the authority seems not to be able to achieve the aims it has set itself.

The following functions are also ascribed to EEUCPRA:

- Assessing plans for expansion of the generation system and extension of the power grid to ensure that capacities develop in line with demand
- Controlling the cost of electricity generation, transmission and distribution
- Ensuring that profits from power generation suffice to provide a sound basis for the further development of power generating capacities²⁰
- Supervising the national coordination and control centre, the purpose of which is to ensure optimal countrywide distribution of produced power while allowing for the interests of all participating operators
- Assuring the quality of all technical and administrative services that are offered to ultimate consumers.

Actors in the renewable energy sector

A number of Egyptian organisations are working to further the use of renewable energy sources and to increase energy efficiency.

New and Renewable Energy Authority (NREA)

The Ministry of Electricity and Energy established the NREA in 1986 for the purpose of bundling activities aiming to promote both renewable sources of energy and energy efficiency. Its task scope includes the development of technologies for utilising renewable resources on a commercial scale. In the long term, its activities are intended to reduce the country's dependence on fossil fuels and to prevent detrimental effects on the environment.

Together with other competent Egyptian and international institutions, the NREA is supposed to develop and implement renewable resource utilisation programmes. For example, it recently completed a pan-Egyptian wind atlas for which data were collected since 1991. The atlas was published in 2006. The NREA also operates some wind power installations, which up to now have served mainly as demonstration projects: a hybrid wind/diesel system in Matrouh governorate and a 5.2 MW wind farm near Hurghada on the Red Sea coast. The latter, which was commissioned in 1993, includes wind generators from various international producers.

In addition to such test and model facilities, the NREA also operates the commercially oriented Zafarana wind farm on the Gulf of Suez. Beyond its wind-sector activities, the agency also and primarily works to advance solar thermal research projects and is active in the field of biomass utilisation. As well as this, the NREA has a central laboratory for testing and certifying apparatus and equipment for utilising renewable energy resources. Finally, the NREA offers training and upgrading courses, organises workshops and conducts studies – both on its own and in cooperation with international partner organisations.

²⁰ ... albeit with no direct influence on tariffing. The government sets electricity rates by cabinet decision.

Organization for Energy Conservation & Planning (OECF)

This governmental organisation was established by decree in 1983. It attends to Egypt's long-term energy planning. Since the early 1990s the organisation's experts have increasingly been investigating matters concerning energy efficiency. The OECF performs energy audits in the public sector and for private companies. The organisation views itself as a mediator between the concerns of sustainable development and other national interests. It addresses the Egyptian public directly with diverse publications on energy conservation.

Egyptian Solar Energy Society

The ESES is a non-governmental society, the members of which are persons engaged in the generation, development and utilisation of renewable energy resources and who work together to establish renewable energy resources as a strong industrial sector. Since 1986 the ESES has been hosting the triennial International Conference on Applications of Solar and Renewable Energy (ASRE) in Cairo. ESES members are developing wind-powered water pumps with the aid of funding from the Global Environment Facility (GEF). Their pumps are already being built and successfully marketed by an Egyptian licensee. The ESES holds national-level conferences and workshops, provides upgrade training, and publishes its own periodicals. The society also represents Egypt in the International Solar Energy Society (ISES).

10.3 Legal Framework

Reform of the electricity sector

But for some minor concessions, the clearly government-dominated electricity market is still resisting all further-ranging liberalisation and privatisation efforts. Article 7 of Law No. 100 dating from 1996 stipulates that local and international investors can obtain concessions for building and operating power plants. A new investment law enacted in 1997 includes various incentive mechanisms such as state guarantees for investors.

At the time of contract negotiations concerning the supply of electricity from privately built power plants in the late 1990s, an initial public offering of stock in all seven of Egypt's state-owned monopolistic power providers was in preparation for the Egyptian stock exchange. However, due to lack of interest among investors, the plan was never implemented.

The last significant step of reform took place in the year 2000, when the Egyptian Electricity Authority was restructured to become the Egyptian Electricity Holding Company (EEHC). That conversion is regarded as a step toward a more entrepreneurial approach because, for example, EEHC is expected to finance future projects out of its own budget and with no governmental intervention.

The conversion also included the break-up of formerly vertically integrated utility companies into individual enterprises (see above), each of which is now an independent undertaking with its own, autonomous management and separate accounting. An internal bidders pool for the exchange of power between the companies is intended to yield market-based incentives.

EEHC was created as a new approach to the privatisation of its subsidiaries, but no part of any state-owned enterprise has yet been sold. Via EEHC, the Egyptian government still controls 90% of all power production and is maintaining its monopoly on power transmission and distribution.

Cross-subsidisation is a common phenomenon on the Egyptian electricity market, despite the fact that the reduction of such practices is a declared objective. The state's influence is underlined by the circumstance that the Minister of Energy is also the chairman of EEHC.

Despite hesitant reform efforts to date, the government is still planning to establish a future electricity market in which direct, freely negotiated, bilateral agreements between electricity consumers and electricity producers will be possible. It also envisions opening up the power transmission network for the pipelining of power. Independent power producers need to have access to the electricity market without having to commit themselves to long-term agreements with EEHC that can last for decades.

In this regard, the regulatory authority has proposed that, to begin with, 70 major industrial power consumers would be allowed to cover 20% of their annual additional power requirements via direct agreements with power producers. That way, the situation on the Egyptian electricity market should gradually become more flexible, but the Ministry of Energy is still refusing to approve any such opening up of the market on the grounds that neither the power plant operators nor the ultimate consumers are adequately prepared for such flexibilisation.

EEHC itself has stated a number of future reform objectives. Break-even electricity tariffs are supposed to be introduced by 2009. An independent electricity trader is supposed to ensure that supplies to major customers take place under competitive conditions. The distribution companies are to be commercialised and their business practices reorganised.

At present, however, no one is planning any further competitive contracting for private investments in the power generation sector. Even in the booming wind sector, there is no sign of any private investors being invited to participate in new projects.

10.4 Policy Promoting Renewable Energy Resources

The Egyptian Ministry of Electricity and Energy began concerning itself with renewable energy resources in the 1970s. A strategy for including renewable energy resources in the scope of national energy planning was developed in the 1980s and has since repeatedly been adapted against the background of emerging opportunities for the utilisation of renewable energies. Present plans call for three percent of the demand for electricity to be met by renewable energy²¹ – primarily wind and solar energy – by 2010.

International Promotion

On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), Germany's Kreditanstalt für Wiederaufbau (KfW) is engaging in financial cooperation with Egypt on a number of projects in the energy sector, including information and training initiatives on renewable energies, the construction of mini-hydropower plants, wind farms in Zafarana and Gabal El-Zayt, the ecological upgrading of existing power plants, and the rehabilitation of transformer substations and generators at the Aswan dam.

The planning for an international "Centre of Excellence for Renewable Energies" in Egypt is still ongoing. The centre's envisaged research and training activities will be devoted to promoting the development of renewable energy resources in the Middle East and North Africa.

Over the past ten years, some 70 million US\$ has been appropriated for energy and climate protection projects in Egypt within the scope of Global Environment Facility projects. Most of that money, more than 50 million US\$, is accounted for by the 150 MW hybrid power plant in Kuraymat, the promotion of which was pledged in 2004.²²

21 In addition to the use of large-scale hydropower.

22 GEF Project ID 1040.

Clean Development Mechanism

Egypt signed the Kyoto Protocol on 15 March 1999, and ratified it on 12 January 2005. A study conducted in 1997 with the support of the National Strategy Studies Programme²³ was intended to encourage consideration for environmental and climate change related aspects of future developments in the energy sector. The study provided a foundation for Egypt's national CDM strategy,²⁴ which was adopted in October 2002. That strategy comprised the establishment of the requisite administrative framework for CDM projects and a portfolio of potential CDM projects that could provide a basis for as quick a start as possible in Egypt.

The Designated National Authority (DNA) established in 2005 serves as the contact point for all CDM-related matters. Organisationally it is part of the Egyptian Environmental Affairs Agency (EEAA).

In the meantime, a number of legal, technological, social and ecological criteria to be met by CDM projects have been elaborated and written down in the Guide Book for Project Developers, which is available from the DNA website.²⁵ The Guide Book includes much other useful information for planners wishing to implement CDM projects in Egypt.

As of this writing, two Egyptian CDM projects have been registered with the CDM Executive Board.²⁶ One of them, a landfill gas project in Alexandria, has the capacity to reduce annual greenhouse gas emissions by a CO₂ equivalent of some 371,000 tonnes.

In its CDM portfolio the Egyptian DNA features further 22 potential projects in the following fields: renewable energy (five projects), industry (four projects), energy efficiency (six projects), fuel switching (six projects) and afforestation (one project).

10.5 Status of Renewable Energy Sources

Since Egypt has its own natural gas resources, the country is still largely reliant on fossil fuel for generating electricity, but it is nonetheless active in nearly all areas of the renewable energy sector.

Hydropower

Egypt has been using hydropower to generate electricity since 1960. The first (low) dam to straddle the Nile near Aswan was mainly intended to help control water levels for irrigation. The new (high) Aswan dam and power station, located 7 km south of the first, was commissioned in 1967. A third Aswan power plant was put into operation in 1985. Then, in 1995, a new set of locks was installed across the Nile at Esna (approx. 50 km south of Luxor). In 2005, hydropower accounted for 12.5% (or 12,644 GWh) of all electricity produced in Egypt.

Plant	2004	2005
	GWh	
High Aswan Dam	9,374	9,049
Aswan I	1,492	1,497
Aswan II	1,690	1,663
Esna	446	420
Naga Hamady	17	15
Total	13,019	12,644

Tab. 12: Power output of Egyptian hydropower plants; 2004, 2005; GWh²⁷

Future hydropower projects now at the planning stage encompass a total generating capacity of 114.5 MW. A new power plant in Naga Hamady is scheduled to bring its 64 MW on line some time in 2008. New hydropower plants with ratings of 5.5 MW and 32 MW, respectively, are being built in Zefta and Assuit. Another new power plant rated at 13 MW, in Kanater, is scheduled for completion by the end of 2009.

23 The National Strategy Studies Programme was a joint initiative of the World Bank and the Swiss Government.

24 Egypt National Strategy Study on the Clean Development Mechanism [www.cdmegypt.org/NSS.htm].

25 See: www.cdmegypt.org/publications.htm.

26 Status: January 2007.

27 Source: Egyptian Electricity Holding Company (EEHC).

Mini- and micro-hydropower plants

A UNEP study²⁸ dating from April 2004 lists Egypt's maximum potential for mini- and micro-hydropower generating facilities as 30 MW. Certain points along the Nile and a few of its tributaries make suitable locations for such power plants. In addition to the aforementioned sites and facilities, the study also makes mention of four more potential sites for small-scale stations²⁹ with a total estimated generating capacity of 7.4 MW. The study cites 15 possible locations for plants with ratings between 150 kW and 1,200 kW. All in all, these facilities could generate close to 50 GWh annually.

Wind energy

Wind potential

Egypt has outstanding siting conditions for wind energy. In the coastal regions in particular, high wind speeds are frequent and the thinly populated areas are relatively easily accessible to allow the construction of large wind farms without too much difficulty. The addition of wind-generated power to the country's generation portfolio will diversify the available range of energy options as the proportional contribution from hydropower declines. All wind energy projects to date have been implemented and operationally backstopped by NREA. For the time being, private-investor involvement is not advocated.

A detailed wind atlas is available.³⁰ Its database was built up from measurements conducted between 1998 and 2005 in a joint effort by NREA, the Egyptian Meteorological Authority (EMA) and the Danish UNEP research centre Risø. The purpose of the project was to establish a solid meteorological basis for evaluating the country's wind resources.

Particular attention was paid to six promising areas: the northwest coast, the northeast coast, the Gulf of Aqaba, the Gulf of Suez, the Red Sea and the Western Desert. In addition to those data records, the atlas also surveys the Egyptian wind conditions on the basis of wind models and offers detailed, meteorologically founded information on siting requirements for medium-sized and large wind farms.

	WAsP ³¹	KAMM ³²
	m/s	
Aswan	9.9	7
Dakhla	5.8	6
Kosseir	7.7	8
Sharm el-Sheikh	13.7	9.5

Tab. 13: Average wind speeds at selected sites in Egypt; m/s³³

A special wind atlas³⁴ for the Gulf of Suez was completed in 2003. For this, NREA and the UNEP Risø Research Centre collected data at 13 stations around the Gulf from 1991 to 2001. A potential overall capacity of 20,000 MW for wind power projects was determined for the uninhabited desert regions to the west of the Gulf. Average wind speeds in excess of 7 m/s are encountered there at a height of 10 m. At heights of 50 to 60 m, wind energy densities ranging from 430 to 1,000 W/m² can be anticipated.

28 UNEP Risø Centre (United Nations Environment Programme), Prospects for renewable energy technologies in the Middle East and North Africa region, Sami Kamel, UNEP Risø Centre, Denmark, April 2004.

29 Rosetta Branch, Dairout, El Azab, Tamiya.

30 Mortensen et al. (2005), Wind Atlas for Egypt, Measurements and Modelling 1991-2005, and www.windatlas.dk/Egypt/About.html

31 Wind Atlas Analysis and Application Program (wind modelling method with fine spatial resolution, based on measured data).

32 Karlsruhe Atmospheric Mesoscale Model (wind modelling method with medium spatial resolution, based on numerical climate simulation).

33 Source: NREA, OME.

34 Mortensen et al. (2003), Wind Atlas for the Gulf of Suez. Measurements and Modelling 1991-2001.

Region	m/s
Ras Sedr	7.5
Abu Aldarag	8.8
Zafarana	7.5-9.2
St. Paul	8.4
Ras Ghareb	10.0
El-Tour	5.6
El-Zayt	10.3-10.8
Hurghada	6.7

Tab. 14: Average wind speeds at selected locations on the Gulf of Suez; m/s; measured at a height of 25 m³⁵

The meteorological data gleaned from ten weather stations situated along the Mediterranean coast were evaluated in a brief study.³⁶ Three locations – Sidi Barrani, Mersa Matruh and El Dabaa – were found to have average wind speeds of 5 to 6 m/s. As such, they would make suitable sites for wind power plants. The local wind energy density ranges between 180 and 230 W/m² at a height of 30 meters, and between 260 and 330 W/m² at a height of 50 meters. Model computations for a 1 MW turbine at the El Dabaa site showed an annual yield of over 2.7 GWh.

Hurghada wind farm

Egypt's first wind farm, encompassing 42 turbines from various manufacturers with ratings between 100 and 300 kW, was erected near Hurghada on the Red Sea coast in 1992. This 5.2 MW facility is situated directly adjacent to a wind technology centre with three small test units. Beginning in 1993, the farm's output was successively injected into the local municipal grid.

Year	2000	2001	2002	2003	2004	2005	2006
Installed capacity [MW]	5	38	68	98	145	145	230
Annual output [GWh]	n.s.	n.s.	224	214	387	533	552 ³⁷

Tab. 15: The evolution of wind power in Egypt; MW, GWh; 2000-2006³⁸

Zafarana wind farm

This wind project at Zafarana on the Gulf of Suez marked Egypt's initial venture (in 2001) into the use of wind power for feeding electricity into the interconnected power grid. An 80 km² area was set aside by decree for NREA wind power projects. The first stage involved the installation of 140 MW of generating capacity by 2004 with German financial and technical assistance. In 2005/06, the farms in Hurghada and Zafarana together produced 552 GWh of electricity.

By 2003, facilities totalling 60 MW were brought online with additional international assistance. The calculated annual output of all these plants comes to approximately 210 GWh, given a capacity factor of 40%. In parallel with that project, additional plants with cumulative capacities of 33 and 47 MW respectively were installed in March 2001 and June 2004, financed by loans from Germany's Kreditanstalt für Wiederaufbau (KfW). These plants have a total anticipated annual output of 305 GWh for a capacity factor of 43.5%. Another complex, this one with a capacity of 85 MW, was installed and commissioned in 2006. Here, production for the national grid is supposed to amount to 320 GWh annually. All plants feeding into the interconnected power grid receive remuneration amounting to 1.7 euro cents/kWh (0.12 EGP/kWh). Despite favourable wind conditions, this is unlikely to enable self-supporting operation. A new development stage that will add another 80 MW is presently close to completion and is also being financed with a KfW loan of € 75 million. Commissioning is scheduled for early 2008.

35 Source: NREA.

36 A.S. Ahmed Shata, R. Hanitsch (2005), Evaluation of wind energy potential and electricity generation on the coast of the Mediterranean Sea in Egypt, Faculty of Electrical Engineering and Computer Science, Institute of Energy and Automation Technology, Technical University Berlin.

37 Specific to the 2005/2006 accounting period.

38 Source: Global Wind/2005 Report (Global Wind Energy Council).

This project will be the first in which a private company will operate and maintain the plant for the first five years. Also at the Zafarana site, two more wind power projects rated at 120 MW each are to be installed with initial commissioning set for late 2008. It is planned to part-finance all new facilities through the sale of emission certificates under the CDM. The Egyptian DNA has already approved several wind farms, and contracts for the purchase of certificates have been concluded.

Further extension plans

Another 700 km² area bordering on the Gulf of El Zayt on the Red Sea coast has been identified as suitable for wind farms totalling up to 3,000 MW. Mean wind velocities in this area are 10.5 m/s.

With the assistance of KfW Entwicklungsbank (KfW Development Bank), initially an 80 MW wind farm is to be erected there. A feasibility study is currently being prepared, and is scheduled for completion by October 2007.

A corresponding study has already been completed for another complex with a capacity of 200 MW, which is to be built with international assistance.

NREA plans to achieve a total installed capacity of 1,050 MW by 2011. A target of 5,000 MW of wind generating capacity is targeted for 2021/22.

Year	2007/2008			2009		2010
Additional capacity [MW]	120	80	60	60	80	220
Location	Zafarana			Gabal El-Zayt		
Total wind generating capacity [MW]	430	490	630		850	
Anticipated power output [GWh]	1,690	1,930	2,480		3,350	

Tab. 16: Evolution of wind power at the Zafarana and El Zayt sites up to 2010³⁹

Biomass

In the rural areas of Egypt, people obtain 76% of their energy needs from burning plant residue and dry manure. Their traditional stoves are characterised by very poor efficiency (5-10%) in the use of biomass. If the plant residue and farm manure⁴⁰ were instead converted to biogas, the available biomass could be used much more efficiently.

The Basaisa Community Development Association (Basaisa-IRTECTAP), the Agricultural Research Centre (ARC) and the technology transfer centre of the National Agricultural Research Project (NARP-TTC) have therefore developed a programme intended to make the merits of biogas known to the rural population. Within the scope of that programme, 18 family size fermenters and two biogas plants for large farms were installed in the late 1990s. Forty people were trained to operate the biogas plants.

Solar energy

Thanks to its location in northern Africa's sunbelt, Egypt enjoys all the best prerequisites for exploiting solar energy. According to a solar atlas dating from 1991, the direct insolation ranges between 2,000 kWh per square meter and year in the north and 3,200 kWh/m² a in the south. The sun shines for 9 to 11 hours a day, with only a few cloudy days per year.

Photovoltaics

All in all, PV generating capacities totalling 4-4.5 MW are presently in operation in Egypt at distributed locations. PV technology is being used in various sectors. In 2005, the overall output was distributed as follows: communications 40%, lighting 33%, seawater desalination 12%, advertising 10%, cathodic protection 3% and water pumps 2%.

39 Source: EEHC, NREA.

40 Farm manure consists of organic residue, mainly animal excreta with litter material, in the form of semi-liquid, liquid and solid manure.

In cooperation with the Italian Ministry of the Environment, the New and Renewable Energy Authority (NREA) is planning a solar electrification project for four remote settlements in the Matrouh governorate that have no access to the national power grid. PV systems with a total output of 43 kW are to be installed there. Further information about this project can be found in the section on rural electrification.

Solar thermal hybrid project

An integrated solar combined-cycle system (ISCCS) is under construction in Kuraymat, 90 km south of Cairo. The plant comprises two natural gas-driven turbines rated at 41.5 MW each, two steam generators that utilise the exhaust heat from the gas turbines, and one 68 MW steam turbine. A field of parabolic trough concentrators designed to generate electricity from solar-thermal energy, with a maximum output of 30 MW, is being installed adjacent to the conventional power plant. Solar energy will account for 6.6% of the facility's total annual power output of just under 1,000 GWh. This will save approximately 38,000 t/a CO₂ emissions. The plant is being built as part of a World Bank/GEF programme geared to activating the commercial exploitation of solar-thermal power generation. The GEF is injecting US\$ 50 million into this Egyptian project. The designated site has already been developed, and an environmental impact assessment conducted by the Egyptian environmental authorities came to a positive conclusion. Commissioning is planned for mid-2009.

Solar-thermal water heating

According to the New and Renewable Energy Authority (NREA), some 200,000 solar water heating systems are in operation in Egypt. National standards have been drawn up for such systems, and eight local contractors are active in the field of solar-thermal hot water generation. However, since the initial cost exceeds the price of inexpensive gas and electric boilers, the solar systems are not yet particularly popular. Consequently, NREA is campaigning in favour of the technology.

SOLATERM project

The SOLATERM project aims to promote the dissemination of solar-thermal generating systems in the southern Mediterranean area. Eighteen partner organisations in eight southern Mediterranean countries and five European countries intend to improve the prevailing general conditions for the application of solar thermal technology while pressing ahead with relevant research. SOLATERM is being financed with EU funding, with a total budget of € 800,000. The initiative is headed by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). Egypt is represented by NREA and the Centre for the Environment and Development for the Arab Region and Europe (CEDARE). The project was launched in November 2006 with a term of 24 months.⁴¹ According to SOLATERM estimates, Algeria, Egypt, Morocco and Tunisia have a combined installed collector area of only 500,000 m², most of which is located in Egypt. The actual potential of this technology, however, is well above that.

Industrial solar thermal pilot plant

With assistance from the African Development Fund, an Egyptian pharmaceuticals company has built a solar steam generator plant in which 1,900 m² of collectors generate 1.3 t of steam per hour at a pressure of 8 bar and a temperature of 175 °C. The local component is 70%, including the sealed parabolic trough collectors.

10.6 Rural Electrification

With a countrywide electrification rate of 99%, most of Egypt's rural population already has access to the public power grid. For the few remaining remote settlements, however, the decentralised use of renewable energy resources is under consideration as an alternative to actual grid access.

Within the scope of a joint project being conducted by NREA and the governorate of North Sinai, the Egyptian environmental authorities, the Rural Electrification Agency (REA) and the Italian Ministry of the Environment, four villages comprising roughly 25 families. Each of them are to be equipped with photovoltaic systems. The project is intended to show how potential electricity users in remote regions can be supplied with electricity at reasonable cost.

Roughly 1,000 people will be affected. Not only the people's homes, but also the schools, mosques, health centres and street lighting are to receive solar electricity. The cost of investment will be about € 500,000. PV modules with a total generating capacity of 43 kW will be installed. The targeted annual power output is 78,000 kWh. The cost will therefore amount to € 0.10/kWh over the next 20 years. Comparable electrification with diesel generators would incur approximately the same cost per kWh.

Exchange rate (as of 19 January 2007):

1 Egyptian pound (EGP) = 0.14 euro (EUR)

1 EUR = 7.31 EGP

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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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