Division 44
Environmental Management, Water, Energy, Transport

Producing Electricity from Renewable Energy Sources:

Energy Sector Framework in 15 Countries in Asia, Africa and Latin America

Part of the supraregional
TERNA Wind Energy Programme

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Excerpt Kazakhstan

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Background to the New Edition of the Study

Structural changes in the energy sector, accompanied by liberalisation of the relevant markets, have been continuing in many developing and more advanced 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 wind power and solar energy in Germany is a subject that is being followed with interest, even outside Europe. It is apparent in this case that, by creating the framework conditions and targeting appropriate promotion measures, politics is capable of setting the trend towards exploitation of renewable energy.

The German and European market acts as the motor for a wind energy industry differentiated according to the principles of division of labour, and provides an indispensable background of experience. In the long term, however, the level of growth in this sector seen over the past decade in the German domestic market is not sustainable. Project developers are therefore initially turning their attention to off-shore projects, other parts of Europe, and the Mediterranean states. The same is true of the large market for other renewable energy technologies which are increasingly being used in developing and more advanced countries, particularly in the field of rural electrification. Although there is recognition of the considerable potential of non-European countries, a lack of knowledge of the framework conditions prevailing in the energy industry in those countries together with a lack of transparency with regard to the prior experience and interests of the national actors forms an obstacle to gaining a foothold in this sphere.

This study aims to make it easier to gain such a foothold. It is based on the first edition dating from the spring of 1999, which was in great demand from the group of export-oriented suppliers, project developers, finance houses and operating companies involved in renewable energy technologies. In order to keep the study up to date, GTZ commissioned a revision and expansion of the study in the summer of 2001. The choice of countries was based in particular on the interests of the wind power sector, this being the most important export branch at present.

The information on the following eight countries was revised: **Brazil, Argentina, China, Turkey, India, South Africa, Morocco and Jordan**.

The following countries were included in addition: **Chile, Colombia, Mexico, Dominican Republic, Cuba, Tunisia and Kazakhstan**.

The following four countries were included in the first edition only: **Egypt, Indonesia, the Philippines and Thailand**. Information about these countries (status as of February 1999) can be downloaded from the Internet at the following address: http://www.gtz.de/wind/deutsch/studie.htm.

The study provides information about the crucial framework conditions for supplying electricity from renewable energy sources to public supply networks. It also looks at country-specific programmes and projects aimed at decentralised electricity generation without a connection to the public grid.

Once again GTZ commissioned the engineering consultancy Loy Energy Consulting to undertake the revision of the study – the company that was responsible for producing the first edition.

Collecting the relevant data and information entailed consulting the ministries and regulatory authorities responsible for energy, project executing agencies, the chambers of foreign trade and commerce and embassies of the countries concerned, GTZ experts in Germany and other countries, the Federal German Agency for Foreign Trade and Payments and national and international promotion institutions. This research was supplemented by evaluating other sources of information, such as conference papers, specialist publications, official documents and presentations on the internet.

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Legal Information

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 are also impossible without the acquisition of such information. These analyses in turn serve as the basis for negotiations on financing, because capital and lenders are available for wind power.

This was why the Federal German Ministry for Economic Cooperation and Development (BMZ) set up the TERNA (**T**echnical **E**xpertise for **Ren**ewable Energy **A**pplication) wind energy programme in 1988. In order to compensate for the lack of available knowledge, the programme is targeted at providing technical advice and support. It is intended to enable prospective operators of wind farms in developing and more advanced countries to assess the technical and economic potential of wind power projects and to develop promising schemes to the stage where they are ready for implementation. Thus in the long term it contributes to improving the supply of energy to the population.

The project is being implemented by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). The BMZ is financing the measures, but in view of their supraregional nature it is not using funds from the country quotas that are agreed separately with the various partner countries. From the standpoint of the partner countries, therefore, TERNA provides additional resources which are dedicated specifically to wind energy.

The programme promotes wind power projects that operate in grid-coupled operation. A capacity of at least 10 MW is used as a guide value. The sites must be in windy regions with access to an electricity grid. There are no restrictions on the choice of countries, although the emphasis is plainly on states where the framework conditions are adequate to provide for economic operation of the installations. Small-scale individual facilities or isolated wind-diesel systems are not promoted, nor are projects of an R&D nature.

TERNA pursues the goal of initiating wind power projects in the megawatt range. In order to achieve this, the programme passes on the necessary knowledge about planning and implementation to potential operators. It is therefore aimed at conventional energy supply companies (public utilities) just as much as at independent investors and private electricity producers (IPPs) as possible operators of wind farms.

The programme offers its partners comprehensive know-how and experience. In order to initiate projects, favourable sites must be identified. Wind measurement and site selection procedures come into play here. This step is followed by practical planning of the installations, in which the design and cost-effectiveness need to be analysed. TERNA also provides advice to project developers on financing matters. The assistance is provided by experts with experience in the relevant fields.

In successful cases, TERNA can thus accompany investment-ready wind farm projects as far as the tendering or contract award stage. The programme does not then become involved in the financing itself. However, TERNA does aim to build bridges to available financing instruments provided by national and international donors.

The services offered by TERNA cover the transfer of know-how relating to siting, planning, implementation and technical and administrative regulatory matters. The partners and GTZ choose the appropriate measures from the set of TERNA instruments to complement the experience already available to them. In particular, the areas of possible cooperation are as follows:

Preparation:

Support for wind measurement campaigns, installation of wind measurement instruments, evaluation of data, advice on siting

Transfer of know-how:

Running training programmes (workshops) for partners' experts;
subject matter: wind measurement, assessment of potential, wind farm configurations and connection to the grid

Planning:

Calculation of investment and project costs, performance of economic feasibility studies and risk assessments

Initiation:

Provision of advice to public bodies on inviting tenders for wind farm projects; preparation of project documents for applications for assistance funds

Further information and advice about the programme is available from the GTZ (on the Internet: http://www.gtz.de/wind). Applications for a specific project must be submitted to the German Embassy by the responsible ministry in the country.

KAZAKHSTAN

Electricity Market

Obsolete power stations

Since Kazakhstan gained its independence in 1991, the country's electricity sector has been in the hands of the state-owned supply company Kasakh-stanenergo. Extremely poor paying habits among the country's electricity customers made investment in the outdated, unreliable transmission and distribution network and in the obsolete power stations impossible,[168] and together with a lack of spare parts and poor maintenance this has resulted in numerous power outages and in a general deterioration in the state of electricity supplies in the country (see Fig. 10). Entire regions were without power supplies during the recent winter periods. Even the industrial areas in the north of the country, which consume about 70 % of the electricity, have only been able to expect sparse supplies over recent years, despite the fact that their consumption has fallen by more than half since the col-lapse of the Soviet Union.

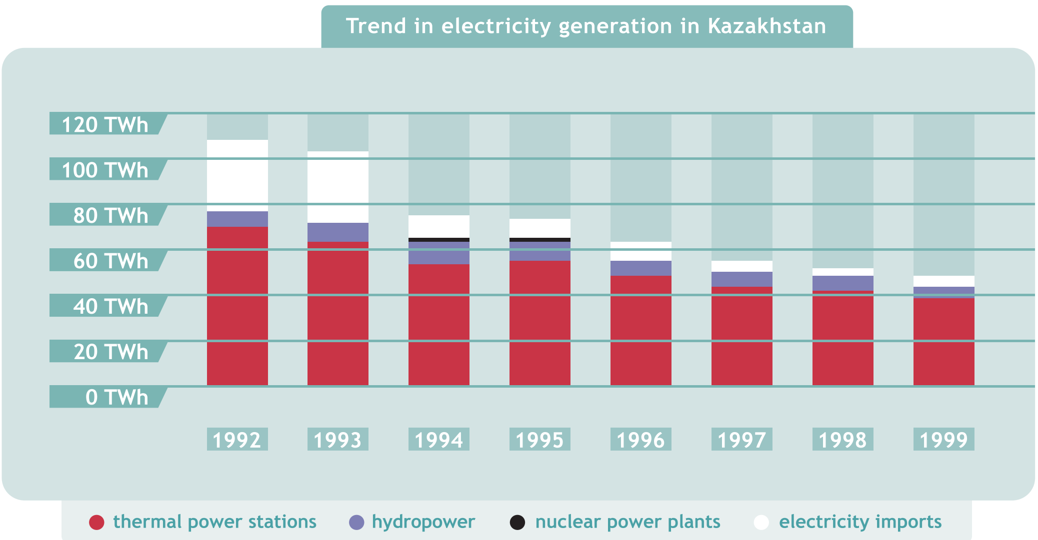

Fig. 10
Trend in electricity generation from 1992 to 1999 [169]

Installed capacity

In the year 2000 Kazakhstan had 54 thermal power stations, primarily situ-ated in the north of the country, 5 hydroelectric plants and one nuclear power station in Aktau. The total installed electrical capacity amounted to 17.5 GW in 1999, and was therefore 10 % lower than in 1995 (see Fig. 11).

168 94 % of the gas turbines, 57 % of the steam turbines and 33 % of the steam boilers have already been in service for 20 years or more. According to figures from the bfai Country Report for Kazakhstan of 5.3.2001 for 1998 and 1999, the losses in generation, transmission and distribution amount to more than 8 TWh per year (17 %-18 %).

169 Source: An Energy Overview of the Republic Kazakhstan; U.S. Department of Energy, Office of Fossil Energy; March 2001

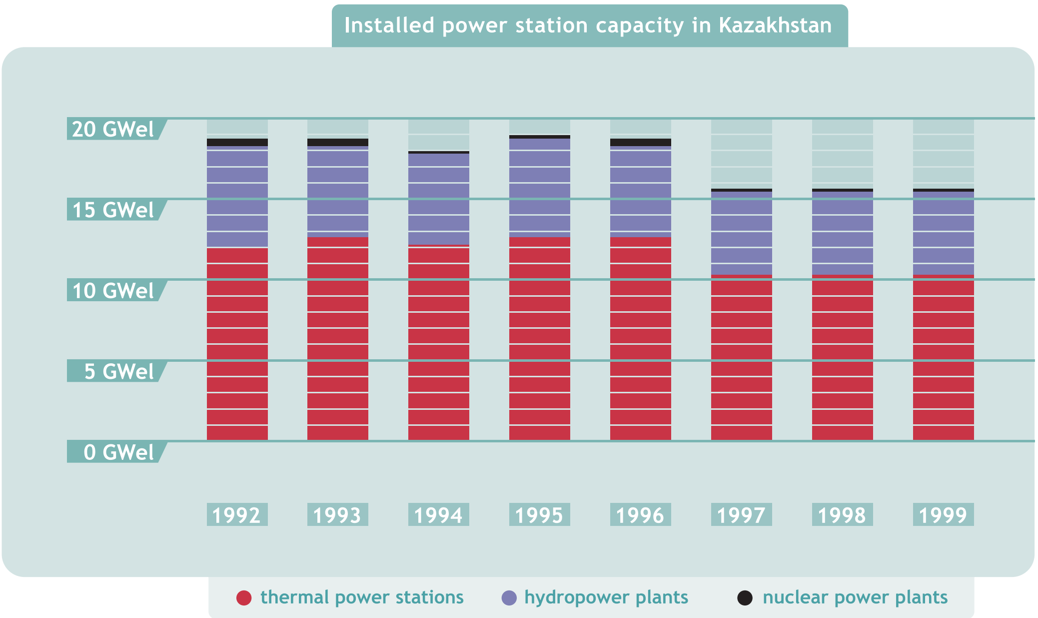

Fig. 11 Installed power station capacity [170]

Expansion plans

Plans drawn up by the government envisage the construction of five new power stations using combined heat and power technology with a total capacity of 2,680 MW_{el} in the coming years. It is also planned to build a 1,920 MW nuclear power station near to Lake Balkash, but in view of the high costs involved realisation of this project is doubtful.

Privatisation of electricity generation

Kazakhstan was one of the first of the Caspian states to open its electricity market in 1997, and it privatised almost all of its generating units. The state-owned power utility retained the poorly maintained and in some cases obsolete networks and the associated installations, and was transferred into the joint-stock company Kazakhstan Electricity Grid Operating Company (KEGOC).

In 1999 51 % of the last power station still held in state ownership, Ekibastuz State Regional Power Station 2, was transferred to the Russian electricity supply company UES as payment for electricity supplies valued at US$ 249 million. Another important actor in the Kazakh electricity sector is the US company Access Industries. This company operates a 350 MW power station in the north of Kazakhstan and also two of the three coal mines in Ekibastuz, and thus supplies 70 % of the coal to power stations in Kazakhstan.

Rehabilitation of the networks

KEGOC estimates the amount of investment needed to bring the transmission and distribution systems up to present-day requirements at US$ 258 million. The Electricity Transmission Rehabilitation Project was approved at the end of 1999, which envisages credit financing by the World Bank and the EBRD. The project covers the upgrading and modernisation of the Ka-

170 Source: U.S. Department of Energy, Office of Fossil Energy, An Energy Overview of the Republic Kazakhstan, March 2001

zakh networks, improvement of management and the establishment of an electricity spot market. It is scheduled to be completed in 2005.

Interconnection with neighbouring countries

Because of its geographical situation[171] and its history as part of the former Soviet Union, the Kazakh transmission system is connected to those in its neighbouring countries. The northern network, in which 70 % of the country's electricity is generated and consumed, is connected to the Russian grid, while the southern network is connected to the Central Asian transmission system and to the northern Kazakh network via a 500 kV line. The western network has no connection to the two other national networks, but is linked only to the Russian grid, from which it also imports electricity.

In the north and west KEGOC cooperates with the Russian company RAO ES, and in the south with the national power utility companies in Kyrgyzstan, Turkmenistan, Tajikistan and Uzbekistan.

Privatisation of the distribution networks

The privatisation of the distribution networks that was begun in 1997 has not yet progressed very far. Of the total of 18 regional distribution companies, the first two to be privatised were Almatyenergo [172] and Karagandaenergo [173]. In July 1999 management of the two distribution companies UST-Kamenogork and Semipalatinsk was transferred to the American AES Corporation[174], the largest foreign investor in the energy sector in Kazakhstan. In November 2000 the East Kazakhstan Region Electric Company, a subsidiary of AES, signed a fifteen-year contract with the Kazakh government for operation of the electricity grid in East Kazakhstan.

Regulatory authority

The electricity sector is subject to the control of the Authority for Natural Monopolies and the Protection of Competition, which reports directly to the Prime Minister. It approves the electricity transmission tariffs, the framework for which was laid down in a resolution passed on 19 August 1998. KEGOC is granted the right to apply for higher tariffs for transmission every quarter, if its costs have demonstrably risen. The regulatory authority also sets maximum prices for bilateral electricity sales contracts. Otherwise the contracts the electricity generating companies enter into with the distribution companies and large industrial customers are not subject to any governmental stipulations and are freely negotiable.

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171 With an area of 2.7 million km², Kazakhstan is the ninth-largest country in the world and is as large as Western Europe. With just 16.8 million inhabitants, though, it is only thinly populated.

172 The operator was Almaty Power Consolidated, a Belgian start-up, which has been sold back to the Kazakh government in the meantime.

173 The operator is National Power (U.K.) and Ormand.

174 AES holds licences with a duration of 20 years for two hydroelectric plants and four CHP plants with a total capacity of 1,300 MW_{el}. Since 1996 the company has owned the largest coal-fired power station in the country with an installed electrical capacity totalling 4,000 MW, i.e. almost 25 % of the total national power station capacity. AES supplies 10 % of the electricity customers in Kazakhstan.

Renewable Energy

Potential

The potential for renewable energy sources in Kazakhstan is very high, but it was never developed under the government of the former Soviet Union. It is only in recent years that the interest of the Kazakh energy industry in exploiting renewable energy has grown. The Kazakh government at all levels is highly interested in promoting renewable energy for the electrification of rural areas[175] in particular. Wind power and small hydropower projects have especially large potential. Currently there are no specific plans for exploiting other renewable energy sources, such as solar energy, geothermal energy or biomass, and because of the relatively high investment requirements nor will any be developed for the time being.

Hydropower

Hydropower potential

The hydropower potential in Kazakhstan is concentrated in the eastern, southern and south-eastern parts of the country (95 % of the total potential) and is estimated at an annual figure of 170 TWh, of which 23.5 TWh is achievable from a technical and economic standpoint. To date, only 30 % (7.1 TWh) of this is being utilised.

Small hydropower

The small hydropower sector (< 10 MW) is of particular importance for the electrification of the country. More than 450 locations in this output range with a total capacity of almost 1.4 GW and potentially 6.3 TWh of generating capacity have been identified so far. Table 20 shows the extent of the technically and economically feasible small hydropower potential.

Tab. 20
Small hydropower development projects in Kazakhstan [176]

Capacity range	Number of projects	Capacity (in MW)
≤ 2 MW	227	250
> 2 MW / ≤ 10 MW	226	1,131
> 10 MW / ≤ 30 MW	54	973
Total / < 30 MW	**507**	**2,354**

Solar Energy

Solar potential

Although Kazakhstan counts among the northerly countries, it has relatively high levels of solar irradiation because of its dry climate.[177] Investigations

[175] According to a report by the UNDP/World Bank there are some 5,100 remote villages without electricity which it would be uneconomic to connect to a supply network.

[176] Source: Kazakhstan and Kyrgyzstan – Opportunities for Renewable Energy Development ; Report No. 16855 KAZ of the UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP), November 1997

[177] 2,200 – 3,000 hours of sunshine and irradiation of 1,300 – 1,800 kWh/m² per year

by the Japanese New Energy and Industrial Technology Development Organization (NEDO) revealed that the highly reflective surface of the ground in the desert and semidesert areas, which make up large parts of Kazakhstan, additionally increases the intensity of solar irradiation for photovoltaic applications.

There is a general requirement for solar energy applications for the electrification of remote rural areas, specifically through the use of portable solar home systems for supplying nomadic families.

Wind Energy

Wind power potential

Thanks to its geographical and meteorological situation, Kazakhstan is one of the countries that is best suited to the utilisation of wind energy. In the past years, though, use of this energy source has not developed beyond the very early stages. The most significant barriers to its use have proved to be large, easily developable coal deposits and their use for electricity generation in central units[178], low-cost electricity imports from neighbouring countries, enormous gas and oil fields in the western parts of the country and a constant decline in demand for electricity in the nineties.

Increase in demand for electricity

In the view of the state economic planning authority, the demand for electricity will begin to rise again in this decade. Against this background, from the economic standpoint there are good opportunities in the long term for using wind energy for electricity generation. Especially in areas that are far from the large coal-fired power stations in the north and north-east of the country, and which can only be supplied by incurring large losses because of the great distances involved, it can be expected that electricity generation from wind power will be economic in future.

GEF project

A project for developing the wind energy market in Kazakhstan (Wind Power Market Development Initiative) assisted by the Global Environment Facility (GEF) was launched in 1995. So far two feasibility studies have been completed in this connection.

Favoured areas

Meteorological data from the Kazakh authorities and data from independent organisations such as the US National Renewable Energy Laboratory (NREL) identify excellent conditions for large-scale generation of electricity from wind energy for two regions of the country, as described below.

Djungar Gate

The “Djungar Gate”, situated in the district of Alakolskij, is an outstanding site for wind turbines, with a forecast availability of 50 %. The long, shallow mountain pass, which links two large plains to each other, lies on the border to China and has always been well known for its strong and persistent

[178] According to the bfai Country Study “Kazakhstan Energy Industry” of 19.10.2000 the producer prices for wind energy in the year 2000 were US$ 0.05 – 0.06 /kWh and for electricity from coal US$ 0.01 – 0.02 /kWh.

winds[179]. The wind power potential of the region is estimated at 1 GW. A range of other favourable parameters make this area a promising site for wind turbines:

- The proximity of the area to a high-voltage transmission route
- Wind potential matching the load curve (considerably higher wind velocities in winter than in summer)
- Well developed transport routes
- A regional electricity sales market
- The possibility of exporting electricity to the neighbouring Chinese province of Xinjiang

Chilik corridor

The second outstanding location is the Chilik corridor, which lies between the towns of Chilik and Charyn, roughly 150 km north-east of Almaty. A technical availability of 35 % has been calculated for this region. Data from the local meteorological station in Nurly and records from a 30-meter-high measuring tower revealed average wind velocities of 9 m/s in winter and 5 m/s in summer. The infrastructural parameters for wind farms are not as good in this region as in the Djungar Gate and would have to be developed first.

Demonstration scheme

In 1999 the UNDP together with the Kazakh government initiated a demonstration scheme within the framework of the above-mentioned GEF project to construct a 500 kW wind turbine. Technical implementation has so far failed due to a lack of additional funding.

Other Renewable Energy Sources

Geothermal energy

Kazakhstan has a range of geothermal sites, although the temperatures of these are not high enough for electricity generation.

Biomass

Interest in the use of biomass for electricity generation is very low. The reasons for this are as follows:

- Low, subsidised electricity prices
- Residues from agriculture are used for other purposes (composting, manufacture of fertiliser, direct combustion for cooking and heating)
- An uncertain future for animal production, which hampers investment in this field
- A lack of national experience with biomass technologies

Incentive Systems for Electricity from Renewable Energy

The Kazakh government is highly interested in expanding the utilisation of renewable energy sources for the southern parts of the country in particular.

179 Average wind velocity: 7 – 9 m/s (peak velocities of up to 60 m/s), calculated from measurements at three local meteorological stations and a 25 m-high wind measuring tower.

Wind power and small hydropower projects are supported by the authorities at all levels by the best means available to them. In many cases, though, there is a lack of a coordinated approach. Responsibility for the development of renewable energy sources is spread between a range of institutions and organisations. There is as yet no multisectoral strategy to promote renewable energy. Consequently there are also no corresponding incentive systems or legal provisions.

In general terms there is a wide range of opportunities for foreign investors in the energy sector. The tax laws do not differentiate between domestic companies and those with foreign involvement.

Exchange rate (6.12.2001):
1000 tenge = € 7.88

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