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TERNA Wind Energy Programme

Energy-policy Framework Conditions for Electricity Markets and Renewable Energies

23 Country Analyses
Chapter Ethiopia

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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11 Ethiopia

11.1 Electricity Market

Installed capacity

Total installed generating capacity in Ethiopia at the end of 2006 amounted to some 752 MW. Of this, almost 670 MW was installed in hydroelectric power schemes, 7.3 MW in a geothermal plant and roughly 75 MW in diesel generators.

Power generation

98 % of actual electricity production is based on hydropower. The other 2 % is produced by diesel generators, mostly relatively small. In the 2003-2004 financial year the state-owned utility EEPCo (Ethiopian Electric Power Corporation) generated 2,318 GWh of electricity. This was an increase of about 37 % over the year 1999/2000. The lion's share was accounted for by hydropower, at 2,279 GWh.

Year	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
	GWh				
Hydropower	1,645.8	1,789.8	1,991.8	2,023.6	2,279.0
Diesel	23.0	16.9	16.6	40.1	38.8
Geothermal	20	5.1	1	0	0
Total	**1,688.8**	**1,811.8**	**2,009.4**	**2,063.7**	**2,317.8**

Tab. 1: Trends in electricity production according to generation method, GWh/year; Ethiopia; 1999/2000-2003/2004[1]

Power transmission and distribution

On-grid electricity supply is operated by EEPCo. About 98 % of the electricity sold is supplied via the Interconnected System (ICS). The ICS extends across the entire country with the exception of the southeast. Power is not provided in all areas, however. Almost all the large hydropower plants are integrated into the ICS.[2] A further 2 % of the electricity is supplied through several isolated grids in what is called the Self Contained System (SCS), with production from diesel generators and three small hydropower units.

Ethiopia has about 6,000 km of high voltage lines in its transmission grid (230 kV/132 kV/66 kV/45 kV) and 22,000 km of medium and low voltage lines in its distribution grid (15 kV/380V/220V). Various programmes to expand the power grid are currently in progress. Between 2002 and 2006 alone, EEPCo connected about 400 villages to the grid for the first time. By 2010 the degree of electrification across the country is supposed to have reached 50 %.[3]

As well as the expansion measures aimed at the electrification of rural areas, projects are also being advanced to establish grid connections with other countries. As of 2010, Ethiopia would like to be a net exporter of electricity. The construction of a link to Djibouti has made the most progress so far. The African Development Fund granted a loan of US $ 59 million for this in 2005. The scheme is due to be completed by 2009.

The link with the Kenyan grid was decided upon at the end of 2006 and is supposed to be in place by 2014. Financing is to be provided through loans from the African Development Bank, Arab Bank, European Investment Bank and East African Development Bank and through the regional NEPAD programme (New Partnership for Africa's Development).[4] Another link, to Sudan, is at the planning stage.

1 Source: EEPCo 2006.
2 A grid map is available on the internet at swera.unep.net.
3 See also section headed Rural Electrification.
4 NEPAD (The New Partnership for Africa's Development) is an initiative brought into being by the African Union with the aim of promoting the economic and social development of the continent. Among other things it promotes infrastructure projects in the energy sector with ideas and policy inputs (www.nepad.org).

Electricity consumption

Electricity provision in Ethiopia is extremely underdeveloped. With a per-capita electricity consumption of 28 kWh per year, Ethiopia has one of the lowest rates in the world. Only about 15 % of the population has access to the electricity grid. In rural areas, where some 85 % of the 77 million inhabitants of Ethiopia live, the figure is just 1 %. The capital Addis Ababa accounts for roughly 50 % of all consumption, with a further 20 % in the second-largest city Nazareth. In the 2003/2004 financial year electricity consumption totalled 1,846.7 GWh.

1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
GWh				
1,375.8	1,413.0	1,621.4	1,706.8	1,846.7

Tab. 2: Electricity sold by EEPCo, GWh; Ethiopia; 1999/2000-2003/2004[5]

According to its own information, EEPCo supplied over 777,000 end customers in mid-2004. Around 85 % of EEPCo's customers are private households, 14 % belong to the commercial sector and only 1.3 % to industry. Just 0.2 % of consumption is attributable to street lighting.

Between 1992 and 2002 electricity consumption grew at an annual rate of about 3 %. In the wake of expansion of the energy infrastructure, there is expected to be a considerable rise in demand for electricity in the near future.

	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
	Number of consumers				
Households	508,407	534,106	559,205	597,976	667,100
Commerce	78,899	81,794	85,913	90,167	98,837
Street lighting	918	970	1,043	1,207	1,352
Industry	7,926	8,121	8,180	8,444	9,106
Major industry	89	94	99	96	104
EEPCo (internal)	398	411	445	470	508
Total	**596,637**	**625,496**	**654,885**	**698,360**	**777,007**

Tab. 3: Number of consumers, EEPCo; 1999/2000-2003/2004[6]

Electricity price

For many years the average price charged by EEPCo remained stable at about 5 US cents/kWh, and considering the ongoing investment in the energy infrastructure was therefore well below the cost of provision.[7] Foreign advisers and donors, such as the World Bank, have therefore repeatedly recommended increasing the price of electricity. In June 2006 the tariff was raised by 22% to an average of 6.2 US cents/kWh, although this is still not considered sufficient.

Expansion planning

The electricity market in Ethiopia is currently undergoing a process of marked change. Both capacity and the level of electrification across the country are supposed to be massively increased in the coming years, among other things through the construction of several large hydropower plants.

5 Source: EEPCo 2006.

6 Source: EEPCo 2006.

7 Production costs with diesel generators are estimated at between 13 and 25 US cents/kWh. In the case of relatively new hydropower plants the figure is put at between 3 and 4 US cents/kWh. The costs incurred for transmission and distribution of the electricity must be added to this. EEPCo presently has high levels of expenditure because of the expansion of the power grid and investment in energy infrastructure.

11.2 Market Actors

Electricity generation, the electricity grid and the supply of energy are largely under state control in Ethiopia. An important part is also played by international donor organisations in the funding of large-scale projects. The central operator on the market is the EEPCo.

Ethiopian Electric Power Corporation (EEPCo)

The Ethiopian Electric Power Corporation (EEPCo) is a state-owned enterprise. Within the power sector it is responsible for production, transmission, distribution and supply. EEPCo is the key institution for the creation of new grid-coupled power station capacity.

Other Actors

Ministries

Various ministries have either direct or indirect responsibility for the energy sector. The central actor is the Ministry of Mines and Energy. It is responsible for national energy policy and expansion of electricity provision. It has authority over EEPCo and the Ethiopian Electricity Agency (EEA). For matters relating to rural electrification the Ministry of Rural Development also has a role to play. The Ministry of Water Resources is responsible for the protection and utilisation of the nation's water resources. In view of the great significance of hydropower, this ministry is particularly important for the Ethiopian electricity sector.

Ethiopian Electricity Agency (EEA)

The Ethiopian regulatory authority with responsibility for the electricity sector, the EEA, has been in existence since 1997. Its tasks include price regulation, the licensing and supervision of independent power producers, the approval of power purchase agreements (PPAs) and regulating access to the grid by private actors. It is also responsible for organising programmes in the field of rural electrification and establishing the framework conditions for private investors. On account of structural shortcomings and a lack of personnel, however, the EEA is not yet in a position to perform these tasks to the full.[8]

Ethiopian Science and Technology Agency (ESTA)

ESTA is a state institution that answers to the Ministry of Education. Among other things the ESTA has maintained a department for mining, water and energy since 1994, which has run a programme researching into photovoltaics and solar thermal energy in cooperation with Swedish donor organisations.

Ethiopian Rural Energy Development and Promotion Centre (EREDPC)

In the field of rural electrification there are also a number of more recently established institutions, most of which receive assistance from external donors in the form of financial and human resources. EREDPC was founded in 2002. It is answerable to the Ministry of Rural Development, and in collaboration with non-governmental organisations it concerns itself with measures to spread the use of renewable energy sources in rural areas. It also draws up studies into the demand for energy and into the cultural, technical and economic conditions for the electrification of rural regions.[9]

8 Sources: Proclamation No. 86/1997; Rural Electrification Strategy 2002 (Ministry of Infrastructure).
9 Proclamation No. 269/2002.

International institutions

Ethiopia is heavily dependent on international aid. In 2004, development assistance payments accounted for 22.3 % of gross domestic product. In particular, this also relates to financial and technical assistance for infrastructural measures in the energy sector. The most important institutions in this field include the Global Environmental Facility (GEF), the World Bank, the International Monetary Fund, the European Investment Bank and the African Development Bank. Other organisations active in the energy sector include for example the Austrian Development Agency (ADA), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), the Italian development cooperation organisation DGCS and the British organisation EDS (Energy for Sustainable Development).

11.3 Legal Framework

Laws and other statutory instruments

Since the end of the 1990s the Government of Ethiopia has issued numerous decrees and regulations that are aimed at bringing about a liberalisation of the energy market. The establishment of the regulatory authority, EEA, laid the foundations for the opening of the electricity market. According to Proclamation No. 86/1997, the EEA is responsible among other things for setting the tariffs and regulating access by private operators to the electricity grid. In the same year, Proclamation No. 37/1997 paved the way for private domestic investors to generate electricity and feed it into the grid with plant capacities of up to 25 MW. Only foreign organisations are permitted to invest in power stations with a capacity of over 25 MW. Council of Ministers Regulations No. 7/1996 and No. 36/1998 introduced additional tax relief and improved import regulations as incentives for private investment. Nonetheless, the electricity sector is still controlled by the state. Private investment is subject to numerous restrictions. [10]

Government objectives

For a number of years now energy policy has enjoyed a high priority on Ethiopia's political agenda. The government's declared aim is a huge expansion of the infrastructure in the energy sector. A crucial reference framework for the government's aims and for developments on the electricity market is provided by EEPCo's five-year plans, the power sector development programmes for 2000-2005 and 2005-2010.

Among other things the five-year programme for 2000-2005 envisaged doubling the generating capacity of 327 MW in 2000 by 2005, increasing the number of towns connected to the electricity grid from 458 to 651 and raising the proportion of the population with access to the grid from 13 % to 17 %. At least in terms of the expansion in capacity, which was roughly 750 MW by the end of 2006, these objectives were more than met, which can be seen as an indication of the government's resolve to push through with its intentions.

According to the development objectives set for 2010, 50 % of households are to be connected to the electricity grid. The capacity expansion to allow for this is to be provided in particular by the construction of additional hydropower plants, bringing the total to over 4,000 MW. Electricity consumption is likely to rise from about 2,300 GWh in 2004 to 6,978 GWh in 2010. The government is also aiming to become a net exporter of electricity by 2010. Although in recent years the Government of Ethiopia has proved that it takes the expansion of electricity provision seriously and is pressing ahead with it on a broad scale, doubts must remain whether the highly ambitious targets – particularly with regard to rural electrification – can be achieved within the proposed period.

10 The main disincentives to investment prove to be the inadmissibility of private ownership of land, as enshrined in the constitution, political and social instability, corruption, institutional weaknesses and the relatively low price of electricity.

11.4 Policy Promoting Renewable Energy Sources

To date, Ethiopia has not had a systematic national policy in place targeting the promotion of renewable energy sources. That said, it should be mentioned that the proportion of electricity generated from fossil fuels is only about 2 % anyway, and will fall further in the coming years. Nonetheless, alternative energy sources are often taken into consideration in cooperation with foreign partner organisations and within the framework of the rural electrification programmes. Over and above that, EEPCo is showing greater interest in alternative energy sources as cost-effective alternatives to diesel generators and as a means of diversifying electricity supplies.

Rural Electrification Fund (REF)

Other institutions emerged on the back of the Ethiopian Government's strategic plan for rural electrification in 2002. The Rural Electrification Fund (REF) has been in existence since 2003. The REF receives US $ 15 million in funding from the World Bank and GEF under the Energy Access Program. This allows the granting of loans and the promotion of energy projects in rural areas in collaboration with private actors and local authorities. In formal terms it is administered by the Rural Electrification Board (REB) and the Rural Electrification Executive Secretariat (REES).

The REB determines the criteria for project promotion and coordinates cooperation with other programmes. The Board also decides on whether to proceed with the submitted project proposals. The REB's members are employees of the Ministry of Water Resources, the Ministry of Mines and Energy, the EEA and the EREDPC and representatives of the private sector.[11] The resources available to the REF are used to subsidise 85 % of the cost of rural electrification projects. Renewable energy sources are entitled to a higher subsidy of 95 %. Most of the projects that receive assistance, however, are based on electricity generation with diesel generators.

Clean Development Mechanism

Ethiopia ratified the Kyoto Protocol on 14 April 2005. The institution responsible for the CDM in Ethiopia is the Environmental Protection Authority (EPA). So far, trading in emissions permits has not been used as a promotional tool in the energy sector. No projects have been registered yet with the Executive Board of the UNFCCC. Thanks to the high proportion of emissions-free hydropower in electricity production, the specific emission factor is only 16.92 t CO_2/GWh. The potential for financial promotion within the scope of the CDM is therefore relatively low. It is still possible, though, that the CDM instruments will be used for the planned wind farms in Mesobo-Harena and Ashegoda.

11.5 Status of Renewable Energy Sources

While the intensive use of large-scale hydropower forms the basis for electricity supply across the country, so far renewable energy sources have been used in only a few isolated cases for decentralised power generation.

Hydropower

Hydropower is of paramount importance in Ethiopia, accounting for 98 % of electricity generation. At the end of 2006, total installed capacity amounted to 668.8 MW. The theoretical potential is estimated to be some 30,000 MW, many times the amount presently utilised. Altogether up to 160,000 GWh of electricity could be produced per year. The terrain of the country is considered particularly advantageous, with large differences in altitude. Average annual precipitation ranges between 2,400 mm in the southwest of the country and 150 mm in the north. However, average precipitation is subject to wide fluctuations from year to year, even as far as recurring periods of drought.

11 Proclamation No. 317/2003; ethiopiaref.energyprojects.net.

According to EEPCo's current five-year programme and as part of other projects, it is planned to expand capacity to approximately 4,300 MW by 2013.[12] At present there are several large-scale projects being planned or already under construction.

Power plants

Power plant (*planned or under construction)	Capacity (MW)	Commissioning date (*planned)
Koka	43.2	1960
Awash II	32.0	1966
Awash III	32.0	1971
Finchaa	134.0	1973, 2003
Melka Wakana	153.0	1988
Tis Abay I	11.4	1964
Tis Abay II	73.0	2001
Gilgel Gibe	184.0	2004
3 plants in SCS, total:	6.2	1991, 1992, 1994
Installed capacity, end 2006	**668.8**	
Gilgel Gibe II*	480.0	2008*
Beles*	453.0	2009*
Tekeze*	300.0	2010*
Halale Worbesa*	436.0	2010*
Ficha-Amerti-Neshe*	96.0	2010*
Gilgel Gibe III*	1,870.0	2013*
Planned installed capacity by 2013	**4,303.8**	

Tab. 3: Capacity and date of commissioning of hydroelectric power plants in Ethiopia; MW[13]

The Gilgel Gibe I hydroelectric power plant came on stream in February 2004, and has a capacity of 184 MW. The project was financed by EEPCo, the World Bank, the Austrian Government and the European Investment Bank. Another power plant – Gilgel Gibe II – is currently being built directly adjacent to it, with a planned capacity of 420 MW and annual electricity production of 1,500 GWh. It is due to be completed in 2008. The cost amounts to € 490 million, of which roughly 50 % is being met by the Government of Ethiopia, about one third is being paid by the Italian state and the remaining 16 % is being financed by a loan from the European Investment Bank. A 400 kV transmission line will be built to connect the plant to the EEPCo power grid, to supply the capital, Addis Ababa.

The hydroelectric plant in Beles is due to be completed by the end of 2009. The total cost of the 453-MW scheme is estimated at € 520 million. Part of this, € 400 million, will be funded by the Italian Government in the form of direct payments and loans. Construction of the Tekeze power plant, with a capacity of 300 MW, is scheduled to be completed by 2010. The organisation that has assumed responsibility for building the plant since 2002 is a Chinese joint venture made up of China National Water Resources and Hydropower Engineering Company (CWHEC) and China Gezhouba Water and Power (Group) Ltd.

The Ficha-Amerti-Neshe plant is also being built under Chinese lead management. EEPCo signed an agreement with China Gezhouba Group Corporation (CGGC) in December 2006. The capacity of the plant is expected to be about 96 MW, and work is due to be completed by early 2010. The Chinese Government will cover 85 % of the cost of some € 104 million.

By far the largest project is Gilgel Gibe III, with a capacity of 1,870 MW. This power plant is scheduled to be built by 2013 and will cost about € 1.39 billion. Financing is to be provided by the Ethiopian Government and international donors such as the World Bank.

Other large-scale projects that are planned are Chemoga Yeda (approx. 440 MW), Halale Worbesa (436 MW), Aleltu East (189 MW), Kara Dombe/Blue Nile and Gojeb (150 MW).

12 These are estimates, because many of the projects are still only at the planning stage. Accordingly the details of commissioning dates and anticipated capacity vary, depending on the source.

13 Source: EEPCo 2006, bfai 2006.

Small-scale hydropower

Compared with the major projects described above, the role of small-scale hydropower is relatively modest. Three plants, each rated at less than 5 MW, are connected to the SCS belonging to EEPCo. In principle the huge unused potential for hydropower also opens the way for wide-ranging possible applications for small hydropower plants. Especially in areas remote from the EEPCo electricity grid there are a large number of good sites located close to consumers. Programmes promoting small-scale hydropower are supported by the Austrian Development Agency (ADA), the World Bank, the Global Environmental Facility (GEF)[14] and Irish Aid.

Wind energy

As yet there are no commercial wind power plants used for generating electricity. Since January 2007 a 2.5-kW installation has supplied power to a hospital and other public buildings in the village of Debo. The project was implemented by a church parish in Saxony, Germany. EEPCo is planning to build turbines with a total capacity of 200 MW by 2012. This is intended to reduce dependency on hydropower. Moreover, because of the major grid expansion currently ongoing, there is expected to be a shortage of supply from 2008 onwards. Wind power is considered as a possible alternative to the use of additional diesel generators for increasing electricity generating capacity in the short term. In the long term it is also seen as a possible complement to hydropower in Ethiopia, as these two forms of energy unfold their potential anticyclically: strong winds occur primarily during the dry season.

Wind atlases

The total theoretical potential for wind power in Ethiopia is estimated at 10,000 MW.[15] Good locations for exploiting wind power are mainly to be found in the east and north of the country. The first, imprecise measurements were taken as long ago as the 1970s and 1980s by the NMSA (National Meteorological Services Agency).[16] The SWERA (Solar and Wind Energy Resource Assessment) programme by UNEP is currently working on a wind atlas for Ethiopia.[17] Provisional results indicate that the average wind speed throughout the year ranges between 3.5 m/s in the west of the country and over 5 m/s in the east. The latter region, however, is not connected to the EEPCo power grid. The wind speed figures are only averages, though; suitable locations where local winds are stronger are not identified. The most detailed site-related survey of wind resources to date was conducted as part of GTZ's TERNA wind energy programme. EEPCo is planning further measurements at various locations for the coming years.

GTZ – TERNA wind energy programme

Within the framework of the TERNA wind energy programme, GTZ is cooperating with EEPCo in planning two grid-coupled wind farms with a capacity of 40 to 60 MW each. Preliminary work began in December 2004 and is initially scheduled to end by June 2007. The project covers the selection of suitable sites, wind measurements, the evaluation of wind potential and the drafting of feasibility studies. Training programmes are also being implemented, in cooperation with the Austrian Development Agency (ADA).

14 In 2003 the World Bank in cooperation with the GEF, the European Investment Bank and the Government of Ethiopia launched the Energy Access Project, scheduled to run for five years. The funds made available for this total US$ 183.79 million. The project's objectives include institutional capacity-building measures and expansion of the energy infrastructure. The measures supported by the GEF within this programme are focussed on renewable energy sources.

15 Dalelo, Aklilu, Rural Electrification in Ethiopia: Opportunities and Bottlenecks, Addis Ababa University, Department of Geography and Environmental Education, 2002.

16 The National Meteorological Services Agency (NMSA) is responsible for generating and archiving climate data. This also includes measuring wind data and solar irradiation, although the older data from the NMSA is often not particularly precise.

17 This is expected to be available at www.swera.unep.net from May 2007.

During the first stage of the project ten locations were identified, where wind measurements were taken at a height of ten meters. The measurements began in January 2005 at the following locations: Mesobo-Harena, Ashegoda, Maymekden, Gondar (Bilagig), Harar (Ghiorgis Meda), Nazret (Sire Ababune), Debre Berhan (Beryu Meda), Sululta (Gorodima), Bahir Dar Substation and Nefas Meewcha (for the results of the measurements at seven locations, see chart below).

Monthly Wind Speed in m/s

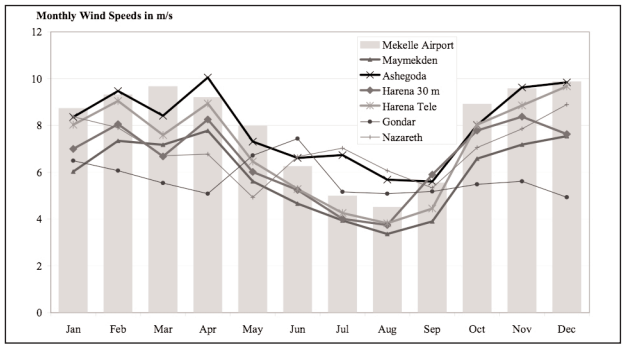

Abb. 1: Average monthly wind speeds in m/s at selected locations – measurements taken as part of the GTZ TERNA wind energy programme in 2005[18]

Further measurements were taken at four selected locations (Mesobo-Harena, Ashegoda, Nazareth and Gondar) over a period of 12 months at a height of 40 metres, with results ranging between 6.9 m/s in Harena and 9.4 m/s in Nazareth. On this basis, GTZ arranged for feasibility studies to be drawn up for Ashegoda and Harena in the course of 2006. Work at Gondar was deferred for the time being on account of the very small space available.

Ashegoda

The site at Ashegoda is situated at 2,400 metres above sea level in the northern highlands of Ethiopia. Measurements at a height of 40 metres revealed an average wind speed of 8.11 m/s. Given a hub height of 57 to 60 metres and an installed capacity of 68.8 to 73.1 MW, it is expected to be possible to generate between 197.4 and 240.0 GWh of electricity per year, depending on the type of turbine used. With an anticipated capacity factor of 31.0 to 37.7 %, the figure is very good considering the thin air at altitude. The connection to the grid is to be provided through a 230 kV line. The calculated production costs have been quoted as being approximately 6 US cents/kWh. Compared with the other forms of energy available as alternatives, the cost is roughly twice as high as hydropower and half the cost of power from diesel generators. The GTZ study recommends that the project be implemented.

Mesobo-Harena and Nazareth

Another feasibility study was conducted in Mesobo-Harena. This location is also in the north of the country, at an altitude of 2,320 to 2,430 metres. In this case the connection to the grid can be provided through a 132 kV line. The results of the study are somewhat poorer than those from Ashegoda. Wind measurements at a height of 40 metres showed a speed of 6.88 m/s. The potential annual yield for this site is given as 85.1 to 99.1 GWh with an installed capacity of 48.8 to 51 MW, depending on the type of turbine. The anticipated capacity factor is between 19.9 and 23.4 %. Accordingly, the production costs for a kilowatt hour have been estimated at between 8.73 and 10.54 US cents. On the basis of these results, the GTZ study is putting forward a guarded recommendation to build the wind farm. It does however advise searching for alternative, more productive locations. EEPCo is currently conducting a third feasibility study itself in Nazareth, with support from GTZ.

18 Source: GTZ, TERNA Wind Energy Programme – Ethiopia, 2006.

EEPCo is presently looking for assistance from international donor organisations to finance the two wind farms it envisages building. The feasibility studies have been made available to all relevant financing institutions.

Biomass

So far biomass has played no part in grid-coupled electricity generation in Ethiopia. Four sugar works have generated electricity for their own use since the 1950s. Since 1998, Finchaa Sugar Factory (FSF) has had the largest and most modern plant, with a capacity of 7 MW. The surplus capacity of 3.6 MW could be fed into the grid. FSF and EEPCo have issued declarations of intent to that effect. All in all the sugar works could make as much as 30 MW available for supply to the grid. To date, however, no such project has been implemented.

Solar energy

Photovoltaics (PV) and solar thermal energy have had only a minor role to play in Ethiopia up to now. The average daily insolation rate across the country is 5.26 kWh/m^2. It varies through the year, from 4.55 kWh/m^2 during the rainy season in July to 5.55 kWh/m^2 in February and March. Geographical differences range between 4.25 kWh/m^2 in the Gambella region in the west of the country and 6.25 kWh/m^2 in the Tigray region in the north.[19]

Photovoltaics

Installed capacity in the photovoltaics sector is estimated at 1.2 MW$_p$. The majority of this is to be found in installations for telecommunications purposes. As well as this, some non-governmental organisations and international organisations are working with solar home systems (SHS) to electrify households, schools and other public facilities.

The Stiftung Solarenergie (Solar Energy Foundation) has equipped two villages in Ethiopia with solar panels since 2005. In 2006 the Foundation helped to set up the Solar Competence Center in Addis Ababa, which has the aim of advancing the spread of renewable energy.[20]

A US$ 4.93 million World Bank programme, with financial assistance from GEF resources, aimed at promoting renewable energy within the framework of the Energy Access Project also covers the installation of several hundred PV systems with a total capacity of some 400 kW$_p$. The programme was launched in 2003 and is set to run until 2008, and is also meant to help establish lasting distribution structures for photovoltaic systems.

Solar thermal energy

Until now solar thermal energy has only been used in exceptional cases in hotels and a few non-governmental institutions for heating water. In rural areas, in particular, the population is thought to have insufficient purchasing power to buy such technology. No support is provided.

Geothermal energy

The geothermal energy potential in Ethiopia is estimated at approximately 700 MW. The resources are located in the region of the African Rift Valley. Temperatures of between 50°C and 300°C were measured there at depths of 1,300 to 2,500 metres. The first, and so far only geothermal electricity generating plant is situated in Aluto-Langano and has a capacity of 7.3 MW. It was in operation from 1999 onwards, connected to the EEPCo grid, but since 2002 it has had to be shut down due to a lack of technical maintenance. Apart from this pilot project, geothermal energy has not been used to generate electricity. The German Federal Institute for Geosciences and Natural Resources (BGR) is currently carrying out a project in cooperation with the Ethiopian Geological Survey to investigate geothermal resources in the Afar region.

19 A solar atlas is available online at swera.unep.net.

20 The Stiftung Sonnenenergie is involved in development-policy projects in various African countries targeted at promoting the use of renewable energy. The priority partner country is Ethiopia (www.stiftung-solarenergie.de).

11.6 Rural Electrification

Degree of electrification

One striking characteristic of the Ethiopian energy market is the extremely low degree of electrification, which in rural areas is only about 1 %. The 15 % of the population of Ethiopia who presently have access to electricity are almost entirely restricted to the country's urban centres.[21]

In rural areas, almost all energy provision is based on traditional biomass. Wood is by far the most important fuel, at about 82 %. Apart from wood, dung (9.4 %) and plant residues (8.4 %) are also used. Negative side effects of this form of energy use are large-scale deforestation, declining biodiversity, poor water quality and soil erosion. Heavy dependence on biomass also leads to supply problems, especially in connection with periods of drought.

Diesel generators are commonly used for local electricity supply beyond the reach of the ICS network belonging to EEPCo.

With a view to social and economic development in rural areas, the Government of Ethiopia is pressing ahead with various rural electrification measures in cooperation with international donor organisations. The programmes are an integral part of the Agricultural Development-Led Industrialization Strategy (ADLI) formulated by the Ethiopian Government. Apart from large-scale hydropower, however, renewable energy has only a minor role to play in this.

Sustainable Development and Poverty Reduction Programme (SDPRP)

In July 2002 the Government of Ethiopia presented a programme aimed at reducing poverty in the country, the Sustainable Development and Poverty Reduction Programme (SDPRP), with the Ministry of Finance and Economic Development (MoFED) in overall charge. This programme expressly emphasises the importance of the expansion of rural energy supplies for the development of the country.

Rural Electrification Strategy

Also in 2002, the Ministry of Infrastructure published a strategy paper on rural electrification. This quotes objectives of expanding the power grid, setting up off-grid systems, making use of renewable energy sources and establishing an institutional framework.

The activities of the Rural Electrification Fund (REF) originate from the Rural Electrification Strategy. Within the framework of the World Bank's Energy Access Project, funds amounting to US $ 15 million are available to the REF. The Rural Electrification Board (REB) announced the promotion of specific projects for the first time in 2006. Of the 31 projects submitted by cooperatives, local authorities and private companies, 15 were approved. In 14 of the 15 selected projects it is planned to use diesel generators. Renewable energy plays very little part at all. For the time being it is planned to continue the project until 2009.

Universal Electrification Access Programme (UEAP)

In February 2006 EEPCo, on behalf of the government, launched the Universal Electrification Access Programme (UEAP), the most comprehensive programme to date targeted at the ambitious expansion of electricity provision. The programme is integrated into the government's five-year strategy for the electricity sector for the period up to 2010.

21 15 % of Ethiopians are counted as belonging to the urban population. There are about 1,000 places classed as 'urban', each with more than 2,000 households. The other 85 % of the population live in village-type structures in the country.

Year	2002	2003	2004	2005	2006
Number of towns with new access to power grid/year	23	66	74	32	227
Total number of towns with access to power grid	492	558	632	664	891

Tab. 4: Number of towns connected to the power grid, new connections and total; Ethiopia; 2002-2006[22]

Under the UEAP, 7,542 towns, villages and public institutions are to be given access to the electricity grid. By 2010 the proportion of the population with a connection to the EEPCo power system is supposed to rise to 50%. The cost of achieving all the objectives envisaged in the context of the UEAP is estimated at US$ 1.3 billion.

By 2009 it is intended that a further 200 rural settlements will be connected to the national power grid. The cost of the investment required for this project phase amounts to some US$ 177 million. A proportion of this (US$ 100 million) was promised by the World Bank as part of the Ethiopian Electricity Access (Rural) Expansion Project in mid-2006, while the other US$ 77 million will be raised by the Ethiopian state.

The World Bank is currently leaving open the possibility of further financial assistance. Although the state-owned utility company EEPCo has proved its potential in realising ambitious goals in recent years, doubts still remain as to the economic feasibility of the set targets. This applies in particular to electricity prices, which are too low given the large-scale expansion of the grid.

The African Development Bank (AfDB) is assisting the Ethiopian electrification programme with a loan of US$ 131 million. The loan was approved in December 2006. The project was launched at the beginning of 2007 and is supposed to run for 48 months. Among other things it is planned to build a 280 km-long high voltage line and several thousand kilometres of low voltage lines. Altogether 235 towns and villages with almost 2 million inhabitants in the Akesta-Alem Ketema and Nekemte-Gendo regions are to be connected to the electricity grid.

Exchange rate (End of January 2007):
1 Ethiopian birr (ETB) = 0.08 euro (EUR)
1 US dollar (USD) = 8.77 ETB

22 Source: World Bank, Electricity Access Expansion, Project Information Document, October 2006.

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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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