



TERNA Wind Energy Programme 1997-2009

- Impact Report -

Many developing and emerging countries have substantial unexploited wind energy potential. In many locations, generating electricity from wind energy offers a cost-effective alternative to thermal power stations. It has a lower impact on the environment and climate, reduces dependence on fossil fuel imports and increases security of supply.

The aim of the GTZ Wind Energy Programme TERNA was to enable these positive effects to unfold through the promotion of wind energy in developing and emerging countries. Between 1997 and 2009, TERNA (Technical Expertise for Renewable Energy Application) acting on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) supported ten partner countries in the assessment and utilisation of their wind energy potential and the improvement of energy policy framework conditions. To date, these measures have resulted in the construction of wind farms with an installed capacity of 80 MW at TERNA locations, with a further 1,250 MW at various stages of project development and implementation.

1. Challenges

For many years now, developing and emerging countries have been faced with the challenge of meeting additional energy needs for their social and economic development with obsolete energy supply structures. Overcoming supply bottlenecks through the use of fossil fuels in the form of coal, oil and gas increases dependency on volatile markets and eats into valuable foreign currency reserves. At the same time there is growing pressure on emerging newly

industrialised countries in particular to make a contribution to combating climate change and limit their pollutant emissions.

In the scenario of alternatives, more and more developing and emerging countries are placing their faith in greater use of renewable energy and are formulating specific expansion targets for a 'green energy mix'. Wind power, after having been tested for years in industrialised countries and achieving market maturity, has a prominent role to play here. In many locations excellent wind conditions promise inexpensive power generation when compared with costly imported energy sources such as diesel.

Despite political will and considerable potential, however, market development in these countries was relatively slow to take off. There was a shortage of qualified personnel to establish the foundations for the exploitation of wind energy and to develop projects on their own initiative. The absence of reliable data on wind potential combined with unattractive energy policy framework conditions deterred experienced international investors, who instead focused their attention on the expanding markets in Western countries.

It is only in recent years that appreciable development of the market potential in developing and emerging countries has taken place. The share of global wind generating capacity accounted for by Africa, Asia and Latin America reached about 20 % at the end of 2008, with an installed capacity of 26 GW. This is attributable above all to breathtaking growth in India and China: these two countries alone are

Windfarm in Essaouira, Morocco

Source: KfW-Bildarchiv,
Photographer: G.J. Lopata



responsible for 22 GW. This proves that economic use of wind energy in developing and emerging countries is possible, and also indicates that there is immense potential that is still unexploited.

2. Strategy

GTZ recognised the potential of utilising wind energy in developing and emerging countries at an early stage, and launched a programme for the licensed manufacture and trialling of small wind generating systems as long ago as the late 1980s. Positive experience with technology development and dynamic market trends in the use of grid-connected wind energy in Germany and Denmark characterised the activities of the TERNA Wind Energy Programme from 1997 onwards. Making use of the widely varied competencies of the German wind industry, TERNA pursued the goal of supporting the grid-connected use of wind energy in developing and emerging countries through the provision of advisory services, with reference to the positive experience gained in Germany.

TERNA developed **advisory modules** that could be flexibly adapted to each partner country's need for support and expertise, and to the advancing development of the global wind market. The measures were targeted at two areas: the removal of barriers within the partner countries through the implementation of country projects, and greater involvement of the international wind industry in project and market development in the partner countries (supraregional measures). In accordance with this rationality, **country projects**



were divided into two separate modules, wind farm planning and policy consultancy.

In the field of wind farm planning the pursued aim was to rectify the information deficit by conducting wind measurements and feasibility studies and to significantly reduce both the time needed for project development and the risks involved in the interest of potential investors. Policy consultancy measures were intended to assist the partner country in creating energy policy framework conditions conducive to the use of renewable forms of energy. These included consulting services on issues surrounding the introduction of promotion instruments, the efficient design of licensing procedures and the integration of wind energy into the grid.

Both modules were based on the general principle of building local know-how through close cooperation with the project partner and in the form of training courses, workshops and study tours, thereby enabling the partners to implement and continue the measures independently.

Supraregional measures were targeted at improving knowledge of the framework conditions in developing and emerging countries within the international wind industry and thus promoting investment in partner countries. One way in which this was to be achieved was through the publication of pertinent studies. In addition, it was hoped to bring about a direct exchange of ideas on questions of wind energy use in partner countries through the organisation of joint events. By arranging strategic partnerships with the private sector, TERNA was meant to act as an inde-

Table 1: Overview over TERNA – Country Projects (1997 to 2009)

	Wind measurements	Feasibility studies	Policy advise	Impacts
Asia	Sites	Sites		
Bangladesh	3			0,9 MW in operation
China	1	1	X	framework conditions, TC wind programme
Jordan	2	2		90 MW tendered
Africa				
Ethiopia	9	3		120 MW under construction, framework cond.
Mali	1	1		investors interested
Morocco	3			60 MW in operation, 740 MW planned
Namibia	2	2		investors interested
Senegal	2	ongoing		50 MW study, investors interested
South Africa		grid study	X	techn. + polit. framework conditions
Latin America				
Colombia	1	1		20 MW in operation, 200-400 MW planned

pendent broker between the interests of the German wind industry and the needs of developing and emerging countries.

3. Achievements and Impacts

Over the twelve-year term of the TERNA Wind Energy Programme, the flexibly applicable modules made substantial contributions to the introduction and dissemination of wind energy in ten countries in Asia, Africa and Latin America (see also Table 1).

Wind farm planning and building national professional expertise

Wind measurements and feasibility studies

In the course of wind farm planning, TERNA carried out wind measurements in conjunction with local project partners at 24 locations in nine countries. Feasibility studies were drawn up for those locations where analysis of the wind data revealed sufficient wind energy potential. During the twelve-year term, this applied to eleven locations in seven countries. In addition to technical and economic factors, the feasibility studies also covered social and ecological aspects.

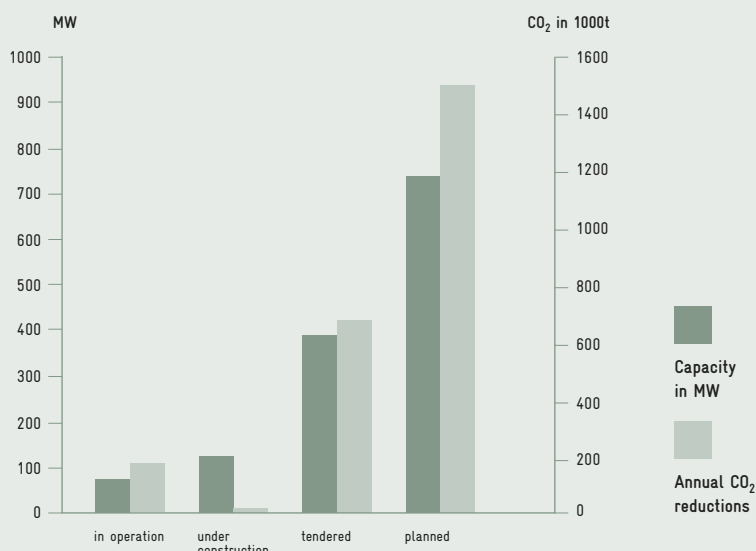
The published results met with great interest in international professional circles. The studies on Ethiopian locations, for example, have been downloaded almost 600 times from the TERNA website www.gtz.de/wind since 2006, while the evaluations of wind measurements in Senegal were downloaded 100 times within six months. This is impressive evidence of the potential of the TERNA wind energy programme to serve as an intermediary and multiplier.

In some cases know-how transfer and training measures led to wind measurements and feasibility studies being conducted by institutions in the partner countries at other locations under their own auspices. This was the case in Ethiopia, for example, where training lasting a total of over 60 days was carried out as part of the study. In Morocco the project partner carried out its own measurements independently at several dozen locations in the follow-up to the TERNA project, partly using the equipment procured in the context of TERNA.

The importance of high-quality studies investigating potential and feasibility is demonstrated by the fact that the interest of investors was aroused at every location for which a feasibility study was produced. This was even true of the study conducted in Mali, which examined the feasibility of a small wind/diesel system for a remote isolated grid.

In several instances, at the project partner's request, TERNA provided support for the preparation of tender documents and negotiation with investors (in Colombia, Ethiopia, Jordan and Senegal, for example), when the level of awareness of GTZ, and its good name, certainly had an impact in the international donor environment.

Figure 1: Existing and planned wind farms at TERNA sites*



Installed and planned wind farms

The work described above has so far led to the construction of wind farms at TERNA locations in three cases. Altogether these have an installed capacity of over 80 MW, and construction of another 120 MW wind farm is about to begin:

- Colombia: the Jepirachi wind farm, with a capacity of 19.5 MW, entered service in La Guajira, Colombia, in April 2004.
- Bangladesh: four small systems with a total output of 0.9 MW were installed at the Muhuri Dam in Feni in 2005.
- Morocco: a wind farm with an output of 60 MW, financed by KfW, was commissioned in Essaouira, Morocco, at the beginning of 2007.
- Ethiopia: following on from the TERNA project, a contract for the construction of a wind farm with a capacity of 120 MW was concluded for the Ashegoda site at the end of 2008; it is scheduled to enter service in 2011.

Tenders have been invited for a further 390 MW (Tarfaya in Morocco and Shawbak in Jordan), and 740 MW are at the planning stage (Laâyoun in Morocco and Jepirachi II in Colombia). As things stand, therefore, currently implemented and planned schemes in the order of over 1,300 MW can be attributed to activities conducted by the TERNA Wind Energy Programme. Given a programme budget of roughly €4 million and an anticipated investment volume in excess of €1 billion, this amounts to an impressive leverage effect.

Impact on the climate is equally impressive. So far the three existing wind farms have achieved CO₂

reductions totalling 339,000 tonnes. In the event of all the schemes being implemented, the annual savings of CO₂ will amount to approximately 2.5 million tonnes, which over a project term of 20 years will add up to almost 50 million tonnes (see figure 1).

Over and above the quantitative results, it is also of significance that TERNA has blazed a trail in a number of countries. Jepirachi, for example, is the first wind farm in Colombia; the wind farms at an advanced stage of project development at TERNA locations in Ethiopia and Jordan will also be the first of their kind in these countries. Even in countries where (as yet) no specific investment projects are planned, TERNA has made a contribution to clarifying the potential for wind energy.

Policy consultancy

In some cases the results of the wind farm planning measures have helped to draw the governments' attention to the positive effects of the utilisation of wind energy, as a result of which they have included this form of energy more closely in their expansion planning and strategy development. Morocco, for example, has set an expansion target of 1 GW for wind energy by 2012. In Ethiopia, too, a national expansion plan for wind energy is being devised. Results such as these, however, are difficult to influence in the course of a project and often do not become apparent until some time after the consultation has taken place.

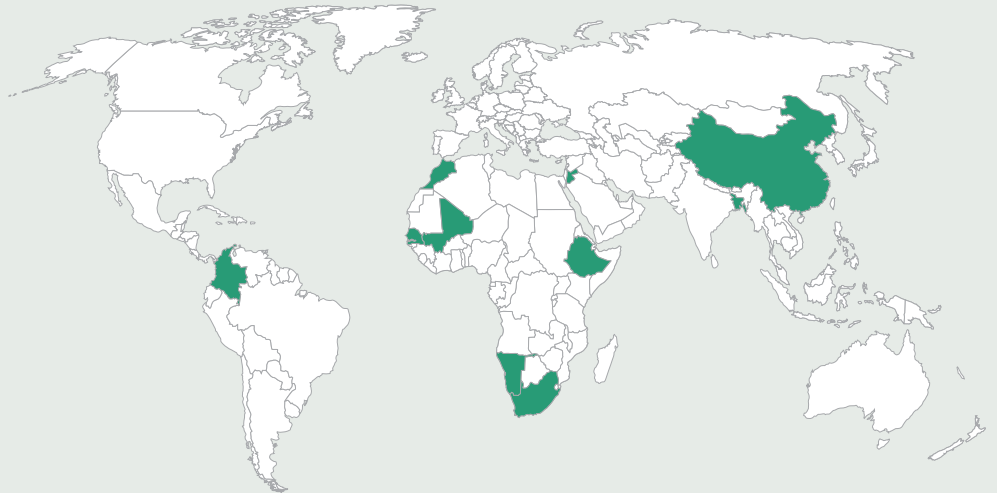
In order to be able to actively steer the sustainable introduction of wind energy and systematically sup-

* MW according to information provided by operator and/or governmental institutions; CO₂ reductions calculated with country-specific emission factors and planned electricity production per year (taken from CDM reports, feasibility studies; in some cases extrapolations)



Wayúu with wind brochure, Colombia
Source: P. Korneffel

Figure 2: TERNA Worldwide



port partner countries in their increasing efforts to make greater use of renewable energy, energy-policy consultancy services were directly included in the project concept to an ever greater extent. In case of China, TERNA helped kick-start the debate on the introduction of appropriate promotion instruments by organising workshops, arranging study tours to Germany and commenting on draft legislation.

The country project in South Africa, which is continuing until the end of 2009 and is described in detail below, pursues the broadest advisory approach of all the TERNA projects. In a regional pilot scheme, the Provincial Government of the Western Cape is receiving support to improve the framework conditions for renewable energies and a grid study is being compiled in collaboration with the national electricity supply company Eskom. Furthermore, extensive training measures on technical, economic and regulatory aspects of the use of wind energy are being conducted for the emerging South African wind industry and state institutions with around 500 participants so far. More or less as a side effect, a study visit focusing on the German Renewable Energy Sources Act (EEG) advanced to become an ideas generator and catalyst for a national feed-in tariff.

As a recognised and neutral international actor, in regard to both wind farm planning measures and policy consultancy, TERNA acted as a mediator between various national institutions. This promoted the coordinated development of wind energy beyond sectoral boundaries.

Supraregional measures

TERNA Country Surveys

Four editions of the TERNA Country Surveys have been published since 1999, each with the aim of providing investment-related information on the framework conditions for renewable energy in developing and emerging countries. After the publication of a further edition in late 2009, reports of 37 different developing and emerging countries will have been published. Since the appearance of the first edition, the series of studies has established itself as a respected publication in the renewable energy sector. The 23 country analyses of 2007 alone were downloaded over 5,000 times from the TERNA website. According to feedback from users in the international wind industry, the studies provided a useful instrument when it came to choosing new target markets; the purpose of the study was thus fulfilled.

In addition, TERNA compiled studies on potential alternative applications of wind energy in developing and emerging countries, such as wind/diesel systems and wind-powered seawater desalination, thereby contributing to concept development in this field.

TERNA autumn event and cooperation with German industry associations

A regular exchange of ideas with the German wind industry was an integral part of TERNAs work from the very beginning. From 1999 onwards, this took the form of the annual TERNA Expert Dialogue, which served as a reciprocal information exchange and networking platform. Following expansion to include delegations from GTZ's partner countries, the conference became established as a renowned dialogue forum where representatives from the world

TERNA Workshop 2008

Source: GTZ



Switchgear Wind Farm Jeprachi, Colombia

Source: Bösl, GTZ

of politics and the private sector come into direct contact with experts and decision-makers from developing countries and emerging economies to exchange experiences and discuss trends in wind energy.

In 2005, this collaboration was transformed into an official cooperation between TERNA, the German WindEnergy Association (BWE) and the Power Systems Association of the German Engineering Federation (VDMA PS). The most visible symbol of this cooperation has been the three-part TERNA Autumn Event, staged on an annual basis since 2007. The TERNA Expert Dialogue, now organised jointly, was supplemented by an official cooperative event known as the Wind Energy and Development Dialogue. The purpose was, and still is, to initiate a dialogue process between representatives from German politics and business on wind energy utilisation in developing countries. Following on from the two conferences, TERNA organised a three-day expert workshop for an average of 50 delegates representing eight partner countries and focusing on grid and system integration of wind energy.

Taking into account registrations for the 2009 Autumn Event to be held in November, the TERNA Expert Dialogue and the Wind Energy and Development Dialogue have been attended each by more than 250 participants from the world of politics and the private sector over the last three years. Representatives of the two associations state that the continuity of the event has made it possible to successfully introduce development-policy issues surrounding the use of wind energy to the German

wind industry. Especially at times when Western markets are saturated and the wind industry is undergoing reorientation, this becomes particularly significant. For this reason, both cooperation and the series of events will be continued by other GTZ programmes after TERNA has come to an end.

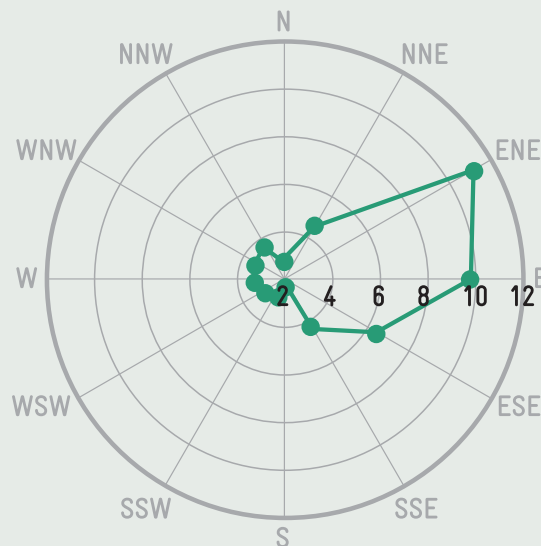
As TERNA constantly had its finger on the pulse of development in partner countries and in the German wind industry, the Wind Energy Programme succeeded in mediating between economic interests of the wind industry and the needs of developing and emerging countries in tapping the potential of wind energy.

4. Summary

Since 1997, the TERNA wind energy programme has developed a flexible methodology for the promotion of wind energy in developing and emerging countries which has proved successful in practical application. This is shown by the number of implemented or planned projects, and by improved framework conditions for renewable energy in partner countries. TERNA has thus been able to make a visible contribution to the dissemination of wind energy in developing and emerging countries. Nonetheless, developments have only just begun – so there is plenty of scope for replication of the approach elaborated here.



Figure 3: Wind Farm Jepírachi – Mean wind speed [m/s]



Annex

Example of wind farm planning: Colombia

In periods of drought, Colombia's dependence on hydropower repeatedly led to shortfalls in electricity supply. With a view to diversifying the energy mix, Colombian utility companies primarily relied on gas-fired power stations. Because of a lack of expertise, an absence of underlying data and low energy prices, the country's excellent wind energy potential remained unused.

With the aim of establishing wind energy as a component part of the capacity expansion, TERNA implemented a project on wind farm planning with the municipal utility of Medellín (Empresas Públicas de Medellín, EPM) in 2001 and 2002. The wind measurements at the La Guajira site, which were accompanied by training measures, revealed an annual average wind velocity of 9.8 m/s. A feasibility study was subsequently compiled, in which it was calculated that the energy yield was more than twice as high as at German locations because of the constant wind speeds. As La Guajira is situated in a protected area for the indigenous Colombian Wayúu population, a social and environmental management plan was devised.

After EPM had decided to build a wind farm on account of the excellent wind potential, TERNA provided assistance with preparation of the tender documents. The German wind turbine manufacturer NORDEX won the competition and erected Colombia's first wind farm (named Jepírachi), with

an installed capacity of 19.5 MW and an investment volume of almost €20 million. After the wind farm was commissioned in April 2004, NORDEX provided one year's training for local personnel on operation and maintenance of the installation.

In accordance with the social and environmental management plan, EPM has so far made investments amounting to half a million euros for the benefit of the Wayúu, who because of their positive experiences are themselves considering erecting a wind energy system to supply their own electricity. On the basis of good results from the first few years of operation, EPM decided to expand the wind farm to a capacity of 200-400 MW, and is currently compiling feasibility studies to that effect.

The package of measures provided and post-project developments make Colombia a role model of what a TERNA project can contribute towards environmentally and socially compatible expansion of wind energy use in developing and emerging countries.

Example of policy consultancy: South Africa

Despite the country's great potential for wind energy, electricity supplies in South Africa are predominantly based on domestic coal resources, which account for more than 90 % of output. At the start of the project, renewable energies were not competitive, because electricity prices were low and the regulatory framework was inadequate. In recent years the Provincial Government of the Western Cape, in par-

left:
**Eskom wind farm
in Klipheuwel,
South Africa**

Source: R. Smit



right:
**Study tour of
South African
delegation**

Source: GTZ



ticular, has proved to be a pioneer in reshaping its energy supplies to become more climate-friendly. Activities by local and international developers of wind projects have also been concentrated in the Western Cape. However, many local companies do not have the necessary expertise to develop wind projects in line with recognised standards.

Against this background, between April 2008 and December 2009 TERNA is supporting the efforts of the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) to establish a framework conducive to the use of wind energy in the province. The measures provided include policy consultancy, technical feasibility analyses and training schemes.

A study visit at the start of the project focused on the German Renewable Energy Sources Act (EEG) and motivated participants from the national regulatory authority to introduce a feed-in tariff for renewable forms of energy according to the German model. The tariff for large systems adopted in May 2009 has considerably improved the economic use of renewable energies and has resulted in a rapid increase in planned wind energy projects, especially in the Western Cape Province.

Policy consultancy measures at provincial level subsequently focused on complementary instruments to

the national feed-in tariff. Among the options proposed in a study, DEA&DP announced that it was further pursuing the idea of setting up an advisory agency for project developers and the introduction of a feed-in tariff for small-scale systems in the province.

The technical feasibility of integrating wind energy into the grid was investigated in cooperation with the national electricity supply company Eskom. The study revealed that the electricity system is excellently suited to accommodating wind-generated electricity. Training courses over a number of days equipped staff at the electricity company with the expertise to conduct grid connection studies for wind farms by themselves.

A total of around 500 people took part in seven events dealing with technical, economic and regulatory aspects of wind energy utilization. In response to the sharp rise in the number of planned wind farms, one of these events was a seminar on international standards for the development of wind projects, with 120 participants.

Even before it officially reached its conclusion, therefore, the country project was able to make a notable contribution to improving frameworks in the province and at the national level.

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