Alliance for Rural Electrification
POSITION PAPER 2012

THE POTENTIAL OF SMALL AND MEDIUM WIND ENERGY IN DEVELOPING COUNTRIES

A guide for energy sector decision-makers

Alliance for Rural Electrification
Shining a Light for Progress

Introduction

Even if small-scale wind power is not necessarily the first solution that comes to mind when thinking about rural electrification, small and medium wind technologies offer excellent solutions for this purpose.

Small and medium wind turbines (SMWT) are not only environmentally friendly, they also offer a very advantageous cost-competitive solution for off-grid applications in rural areas. Small wind can also be combined easily in hybrid systems with solar or diesel, creating even more possibilities. The price of conventional energy sources, especially fossil fuels, is constantly rising, whereas the costs of small wind are showing a gradual decline, emphasising the attractiveness of these technologies.

Market overview: small wind manufacturing

Today there are about 250 companies in 26 countries manufacturing small wind turbines. More than a third of these, and the largest, are based in the U.S., but the U.K. and the Netherlands are also home to other big manufacturers. The global market for small wind technologies is forecasted to more than double on a business-as-usual scenario between 2010 and 2015, reaching USD 634 million. The installed capacity could increase threefold in the same period . Much of this growth will take place in developing and emerging markets.

Installation and consumption

The concentration of SMWT producers in developed countries, along with the fact that the technology remains relatively unknown, could be one of the reasons for the lack of focus on small and medium wind as an off-grid application in developing and emerging markets. Nevertheless, the potential for these applications in unelectrified areas is proven by several decades of experience and a number of completed projects. These applications should be more widely acknowledged as a credible alternative for energy access – at both global and local levels. The success of SMWT in China, for example, demonstrates this potential. The country started using SMWT for rural electrification projects in the early 1980s, and reportedly had 400,000 systems installed by the end of 2010.

Technical description of small and medium wind turbines

Turbines with a diameter of less than 15m and a power output below 50kW are classified as small. However, most small wind turbines have a diameter of around 7m or less and a power output ranging between 1kW and 10kW. For very small installations, such as a remote household, wind turbines can have a diameter smaller than 2m and an output of 1kW or less. Medium size wind turbines have a rotor diameter of 15-30m, and a maximum output of 50-250kW.

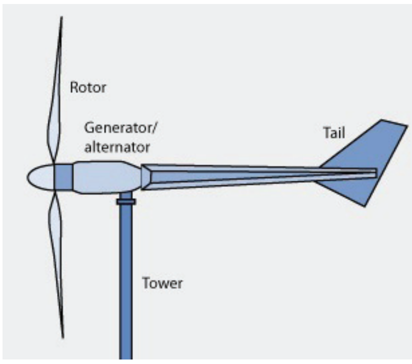

Figure 1. Basic parts of a small wind turbine.
Source: ARE, 2011

The turbines can be designed in a number of different ways, integrating one to three blades, a horizontal or vertical axis and so forth. In general, the commonly used horizontal wind turbines are more efficient than vertical ones and are more reliable due to better rotor balance. The turbines are always placed on a pole, preferably higher than 15m, to avoid ground turbulence. For this purpose, tilt-up poles/towers are very popular in developing countries since they are easy to install and offer good accessibility for maintenance and repair.

[1] *Pike Research, 2011*
[2] *REN21, 2009*

The majority of small-scale wind turbines are built on freestanding poles or towers. However, building-mounted turbines are another option. Such turbines are directly installed on a building, usually on the rooftop. Both vertical and horizontal axis turbines can be building-mounted, but they might be subject to more turbulence.

Most small wind turbines have a permanent magnet generator and do not require a gearbox. This type of generator produces alternating current (AC), which must be rectified to direct current (DC) by means of a simple bridge rectifier. Similar to solar photovoltaic (PV) systems, the DC-voltage allows the use of these turbines for battery charging. For in-battery charging systems, a charge controller is added to prevent the battery from overcharging. In grid-connected systems, an inverter is used to control the SMWT and for supplying electricity to grid voltage and grid frequency. A dump load is required to protect the inverter from overvoltage and to prevent the turbine from overspeeding.

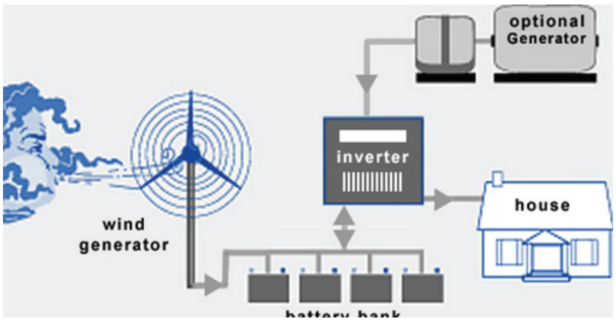

Figure 2. Off-grid small wind system.
Source: Wholesale Solar, 2011

In most cases, medium size wind turbines do have a gear box, and use an induction generator. These turbines are better suited for feeding into a mini-grid rather than charging batteries directly.

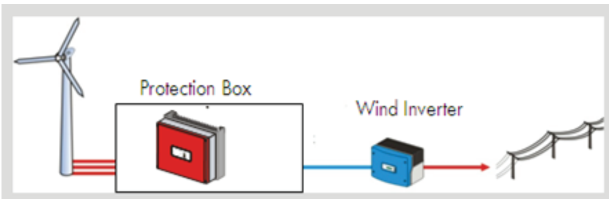

Figure 3. Small wind turbine with protection box and standard wind inverter to feed in public grids or mini-grid. Source: SMA Solar Technology

Hybrid systems

Small wind power can be combined with other energy sources within a hybrid system. This combination makes it possible to optimise the usage of available resources. For example, wind is relatively more available in colder months and solar resources during the warmer months of the year. Therefore, a more proportional year-long solution can be designed, avoiding dependency on just one source with limited availability at a certain day, time or season.

For situations when there are no or not enough renewable sources available, and the battery capacity is limited, a diesel generator is often used as an additional power supply. This can be done in two ways. In smaller systems the diesel generator will recharge the batteries when they are drained too much. Adding the diesel will help in optimising the system. Second, in mid-size system the diesel generator will form the base grid on which the turbines feed-in.

In a context of rising diesel prices, the injection of renewable energy sources, and in particular from small and medium wind turbines, in existing diesel-based systems supplying a mini-grid offer an excellent alternative that lowers energy bills for remote communities and local businesses. This approach is already used in various places around the world, and should be promoted more, as it greatly reduces energy costs for the end-users and decreases the energy costs burden for governments (fewer subsidies on diesel).

Operation and maintenance

SMWT require a certain degree of maintenance. Generally it involves some greasing; visual and audio inspection; and checking of guy-wires and bolts/screws once or twice a year. Heavy maintenance, such as the refurbishment of rotor blades and changing guyed wires, might be required, but only a couple of years after the installation. Experience shows that good performance needs regular maintenance.

A significant challenge for the long-term operation of SMWT is the repairs and the availability of spare parts. Faults need to be identified correctly, and require qualified/trained personnel to fix them. The right spare parts must also be ordered, shipped and paid for. To help with these issues, more and more installations in rural areas are equipped with remote control systems to monitor the performance and possible failure at an early stage.

Most of the competent SMWT dealers or manufacturers offer some guidance with planning, installation and maintenance. This type of scheme, involving the project developers, should be made compulsory over a certain period to guarantee a suitable O&M process. It is also crucial to assure proper installation in the first place, since most of the technical failures arise because of not setting up the turbines properly and not providing the required technical standards.

Importance of site location and developing countries' resource potential

As SMWT need wind to produce electricity, a proper setting and location, determined subsequent to a wind resource assessment, are key requirements for successful SMWT projects. If the data for the targeted site is unavailable, wind measurements are necessary prior to installation. Ideally, this type of wind mapping should be carried out over a long period (one year) to integrate the different seasonal variations.

Access to reliable data on wind speed, especially in developing countries, remains one of the main challenges in the sector, since such estimates are not yet available globally.

In general, average wind speed over 5m/sec is strong enough to ensure economically sound operations. At this speed, a decent SMWT produces 350kWh per square meter rotor surface annually (see Figure 3). For example, an SMWT rated at 5kW with a rotor diameter of 5m (20m2 rotor swept area) generates around 6,000 kWh per annum. At an average of 6m/sec wind speed, the same turbine will generate up to 8,500kWh per annum.

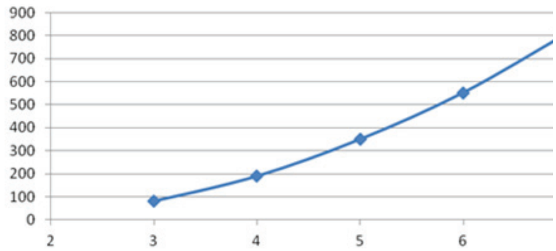

Figure 3. Annual power output for m² rotor surface [kWh/ (m/s)].
Source: Balthasar Klimbie, WES, 2011

While feasibility studies and regional or local wind resource measurements are still required to foster the development of new wind projects in developing countries, the few existing evaluations point to many regions with a strong potential.

Countries like Morocco, Egypt, Kenya, Ethiopia and Madagascar have already been noted as very suitable regions for small wind, but many additional places around the world (especially above a certain altitude and/or on the coast) would also present an ideal setting (see Figure 4). In these favourable regions, SMWT should become a mainstream option and be massively integrated in the local energy mix, since with such conditions small wind is competitive with any other energy source. Even in regions typically considered as having fewer wind resources, there can be specific areas with particularly good wind availability.

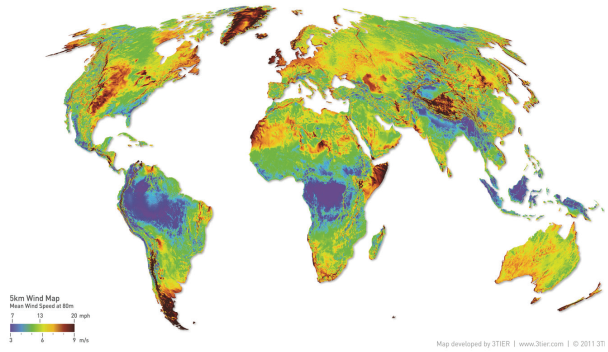

Figure 4. Global mean wind speed at 80m.
Source: 3TIER, 2011

Another important factor to be taken into account is that the siting a wind turbine is of utmost importance in ensuring its reliability and appropriate performance. Wind turbines should be sited away from any major obstructions (such as trees, houses), with a clear exposure to the prevailing wind. Ideally, a wind turbine should be set up on a smooth hill top, where the air flow in general is reasonably smooth and free from excessive turbulence, which may cause damage and shorten the working life of a turbine. Alternatively, a wind turbine should be set on a tower as high as possible, since wind speed increases with height. See more in Figure 5.

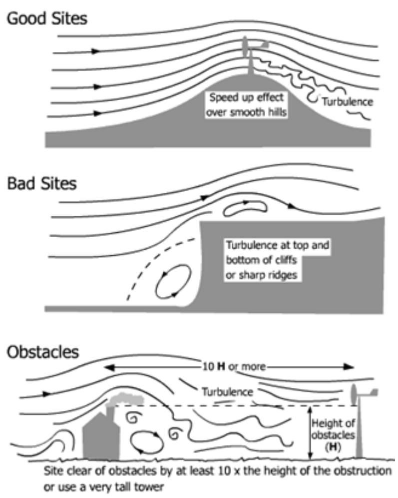

Figure 5. Wind flow over hills and obstacles.
Source: RenewableUK, 2012

Small wind costs and financing

Prices of SMWT depend on the type of the turbine and its size. The costs of a small wind turbine vary as much as from EUR 2,500 to EUR 7,500 per kilowatt installed. For example, a complete SMWT battery charging system of 5kW (turbine, pole, and electronics) will cost around EUR 8,000 to EUR 12,000 (uninstalled). Adding batteries and a standalone inverter, as well as the installation

Technology	Typical Characteristics	Typical Energy Costs (U.S. cents/kWh)
Mini-hydro	Plant capacity: 100-1,000 kW	5-12
Micro-hydro	Plant capacity: 1-100 kW	7-30
Pico-hydro	Plant capacity: 0.1-1 kW	20-40
Biogas digester	Digester size: 6-8 cubic meters	n/a
Biomass gasifier	Size: 20-5,000 kW 8-12	
Small wind turbine	Turbine size: 3-100 kW	15-25
Household wind turbine	Turbine size: 0.1-3 kW	15-35
Village-scale mini-grid	System size: 10-1,000 kW	25-100
Solar home system	System size: 20-100 watts	40-60

Table 1. Status of renewable technologies, characteristics and costs. Source: REN21, 2010

cost, would include another 20-40% in the overall costs. It is important to make the cost calculations and breakdown before starting a project in order to determine electricity prices compared to alternatives, such as diesel or kerosene.

The costs also vary significantly in different parts of the world, based on production expenses. For example, a similar turbine could cost about USD 3,000 in the U.S., USD 1,500 in China and more than USD 5,000 in Taiwan.

With prices comprised between 15 and 35 USD cents per kWh over the lifetime of the system, small wind is, in these conditions, cheaper than small scale PV, and even cheaper than some small scale hydro solutions. In remote rural areas, it is common to find very high diesel prices (integrating the cost of the diesel itself, as well as of the transportation) and an inefficient genset that generates a kWh at a cost between EUR 1-3.

In such cases, small wind represents an ideal solution.

System size/type	Fixed cost (per site & per kWh)	Marginal cost (€/kW)	Annual maintenance cost
2009			
1.5-15 kW	€11,790	€2,360	€260
15-50 kW	€3,540	€3,540	€87
50-250 kW	€3,540	€3,540	€87
2015			
1.5-15 kW	€11,790	€1,425	€260
15-50 kW	€2,882	€2,882	€72
50-250 kW	€2,882	€2,882	€72
2020			
1.5-15 kW	€11,790	€1,340	€260
15-50 kW	€2,594	€2,594	€65
50-250 kW	€2,594	€2,594	€65

Table 2. Evolution of grid-connected small wind prices. Source: BWEA & Poyry, 2009

If these costs can seem relatively high compared to other off-grid renewable energy technologies, limiting this comparison to investment costs would be a mistake. SMWT do not fall under the same investment category as other small scale alternative energy technologies, such as standalone PV systems, and usually do not meet the same type of needs. However, when it comes to costs over the lifetime of a project, the comparison starts looking different and often more to the advantage of the small wind turbines. Under favourable conditions, small and medium wind generation prices are significantly lower than those of conventional energy sources (diesel, kerosene, etc.) and can be even lower than the price of some other renewable alternatives (see Table 1).

Moreover, thanks to market growth in the developed countries involved in SMWT manufacturing, economies of scale are being generated, contributing to declining small-scale wind costs. Technical improvements are also adding to this trend. This decrease, which is expected to accelerate in the forthcoming years, should have a positive impact on developing and emerging countries as the technologies will become even more affordable (see Table 2).

In Europe or other mature markets, private clients pay cash for their SMWT or use credit schemes. In contrast, many 'development' projects in remote areas of developing countries are often at least partly financed by an external organisation due to the high initial investment required. But even in these developing and emerging economies, it is possible to find SMWT paid in cash, largely for projects built by private stakeholders such as mobile phone operators for telecom towers, which require a substantial amount of power. In these cases, if the natural conditions are favourable and wind measurements have been carried out correctly, it is not rare to have a high return on investment, with full cost recovery only after a couple of years. At the same time, the payback period can vary greatly depending on factors such as the technology chosen, location, available financing options and other incentives.

the multiplication of poor quality products, especially in developing countries where the controls are usually less strict, a situation that will ultimately backfire on the industry in the same way as immature and poorly maintained PV systems have long ruined the image of this technology.

In order to improve the level of quality and market visibility, several certification systems have been developed. Certified turbines are safe and have a predictable power output. Respect for these standards and quality controls should therefore be imposed

Component	International standards and explanation
Turbine	IEC 61400-2: Design and safety requirements IEC 61400-11: Procedure for acoustic emission measurement techniques IEC 61400-12: Power performance measurements Other known and respected standards are designed by Microgeneration Certification Scheme (MCS) (UK, overall certification including factory inspection) and AWEA (American Wind Energy Association).

Table 3. International standards for small wind turbines. Source: ARE, 2011

Besides a grant oriented/supported approach, a well-designed small wind or hybrid project could also be profitable and sustainable without any subsidy. In this case, however, access to capital through loans or other types of financial instruments is compulsory, along with a long term off-take agreement (with a private user, the local utility or a community) to help the project developers to support their investment. This is not to say that support from donors to accelerate the dissemination of suitable cost-competitive technology is not required. International organisations and other development agencies have an important role to play in supporting their development in order to accelerate access to energy and economic growth.

The importance of quality in developing markets

Small and medium wind is still a relatively young market and, as with every technology, it is confronted with some difficulties when it comes to securing and imposing reliable and sustainable technologies worldwide. In recent years, small and medium wind systems have become safer and more reliable. However, it is important to work on common quality standards and compliance mechanisms, both for technologies and their installation process. This is necessary to avoid

in every new programme or project to ensure the sustainable functioning of a small wind system. Moreover, the success of the turbine's performance also depends very much on ensuring an appropriate siting. For this reason, quality and safety regulation during the installation process are equally important. Thorough attention has to be paid to siting the turbine in order to ensure its reliability and best possible performance. By imposing such standards, the likelihood of the project's success can be substantially enhanced. It is generally acknowledged that recognised standards lead to increased quality of a given product and its performance.

Conclusions

Why choose small and medium wind?

- Cost competitiveness and quick cost break-even in favourable natural conditions.

- Easy to integrate in (existing) mini-grids fed with diesel. Hybrid wind-diesel systems provide higher quality, lower costs, and are a more reliable and sustainable solution than diesel-only systems.

- Allow, in combination with such applications as solar to develop a 'whole-year-round' solution.

- The perfect solution not only to generate enough power for feeding and developing small businesses, but also to increase the synergies with growing sectors like telecommunications.

- Contrary to most other sources of energy supply, wind energy is not subject to theft and is less vulnerable to vandalism.

What can you do to accelerate small and medium wind development?

- Develop knowledge of this technology. Education and training are the key to everything. Information is available, contact us.

- Encourage local communities and small businesses to use alternative sources of energy. This will increase the reliability of their electricity supply and decrease their electricity bills.

- Feasibility studies and assessment of wind speed data are missing. This type of study is an easy way to discover new business opportunities and favourable locations.

- Integrate, impose and control quality standards and certifications for every new installation. This will ensure the installation of products that will generate reliable electricity over a longer time span.

Remember: a system that is cheaper today will not be so after only a few years, when it will have to be partially or entirely replaced.

- Encourage the development of joint ventures and partnership agreements with expert companies. This will ensure proper installation, operation and maintenance AND will generate local employment.

- Subsidies, whether on investment or on the production, can have a tremendous impact on accelerating the development of small wind, increasing energy and generating economic activities. The subsidies supporting diesel could easily be transferred (at least partially) to clean, sustainable and cost-competitive energy technologies.

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Case study 1

Wind Energy Solutions (WES)
Wind turbine installation in Nusa Penida Islands, Indonesia

Company description

Wind Energy Solutions, a Dutch-based manufacturer of small and midsize wind turbines (50-250 kW), was established in 1983, when wind energy just started becoming a part of the modern electricity generation system. Since then, it has installed over 1,000 units globally – initially mainly in the Netherlands targeting local farmers, but later also in developing countries, such as India, Indonesia and several African countries, providing electricity to small communities, islands, businesses and schools.

The challenge

The Nusa Penida Islands lie southeast of Bali, Indonesia. Both small islands are not connected to the main grid, and the power was supplied by diesel gensets. Due to the remote location, diesel had to be imported by boats, which added to the cost and made it expensive for the local people. Alternative energy solutions were welcome to save on the diesel costs, and due to the favourable wind regime on the islands, wind energy was seen as particularly suitable. The electricity on the island is mainly used by local households and small industry. In order to implement the project successfully, support from local government institutions was necessary. Ensuring this support required a great deal of effort.

Advantages of wind energy solutions

The favourable location of the islands makes wind turbines a very suitable solution for alternative energy. Prior to the project start, wind measurements were carried out for four months to ensure suitability.

Since the specific energy needs required a significant amount of generated electricity to be fed into the grid, it was decided to install a mid-size system. Due to limited technical capabilities (for example, a crane could not be transported to the islands in order to install large-size turbines), the system was implemented with 80 kW wind turbines, the biggest that could be installed in the particular circumstances.

Project implementation

The wind turbines were installed in a hybrid modus on the already existing diesel grid. Five 80kW turbines were installed, providing a total of 400kW wind energy. The project implementation took approximately a year, mainly due to the organisational struggles related to the initial lack of support from the local authorities. The O&M activities of the system are carried out by PLN, the national utility of Indonesia. PLN owns the turbines, and is responsible for their maintenance. A two-week long training course was provided to the PLN representatives by the WES technicians.

Project costs and financing

The five turbines, purchased by PLN, cost EUR 800,000. Electricity generation costs are around EUR 0.19 per kWh. Electricity is produced by the PLN and sold to the end customers. In order to keep the prices low, the government at the time subsidised the diesel costs – generation with diesel gensets cost about EUR 0.45 per kWh. Without the subsidy, the return on investment can be achieved in about five years.

Project outcome

The project allows for savings of about EUR 250,000 on diesel annually. One of the main lessons learned is the important influence government support for diesel technologies has on renewable energy solutions. It is more difficult to operate in an environment where subsidies are provided to diesel rather than renewables.

WES80 built without a crane
Source : WES

Case study 2

Beijing Bergey Windpower Company Ltd.
Dongao Island wind-PV-diesel smart mini-grid project for rural electrification, China

Company description

Beijing Bergey Windpower is a China-based company that began its operations in 2000. It manufactures small wind turbines and designs and develops renewable energy power systems. It is actively involved in rural electrification projects. Beijing Bergey Windpower is a subsidiary of Bergey Windpower Company in the U.S., the world's leading supplier of small wind turbines.

The challenge

The main objective of the project was to electrify the local residents and tourist facilities on the Dongao Island. There are 600 local residents and a growing number of tourists, increasing by 30% annually, that affect the growing energy demand. Currently, the total power consumption on the island is 1 million kWh. The local government and businesses have initiated the development of green power generation in order to protect the environment. There is no industry on the island except fishing, so, the main application of generated electricity is for the daily life of local residents and tourists. This particular project is a pilot case, but there are thousands of islands in China with similar conditions. Among the major challenges faced during the project implementation was the small size of island, which means accordingly that there was limited land availability for the installation of wind turbines and a solar panel, and the direct threats imposed to gensets, which so far had been the main energy source on the island. The introduction of a renewable energy smart mini-grid meant that this solution can be replaced by an alternative solution.

Advantages of wind energy solutions

Dongao Island is 30km away from the coast. It has excellent wind resources and limited space for a solar panel. Diesel fuel prices are increasing, transportation costs also add to the high operational costs. Therefore, small wind solutions provide a viable alternative. The South China Sea, where the island is located, is a particularly windy area. The experience and knowledge of the local residents on the island helped to estimate the necessary resource availability and the site's suitability for the installation.

Project implementation

The new smart mini-grid power system was installed as a wind-PV-diesel hybrid. It did away completely with the need to use diesel gensets. The system combines 50kW of wind (10kW x 5), 200kW of solar energy and 750kW of diesel genset. A battery bank worth 2000kWh was created. Project planning and design started in 2009, and the first power service was provided in December 2010. At the moment, the project developer – China Singyes Solar Technologies Holdings Limited, a local independent power producer (IPP) – takes care of the operational and maintenance issues, but it might become a business model afterwards when these tasks are contracted to local entrepreneurs, for example.

Project costs and financing

The total investment reached around USD 5 million, most of it related to the equipment – a solar panel, batteries and wind turbines. The generating costs per kWh are USD 0.47 per kWh. The residents pay USD 0.28, and the rest is subsidised by the local government. To ensure long-term profitability, this model might be re-discussed in the future.

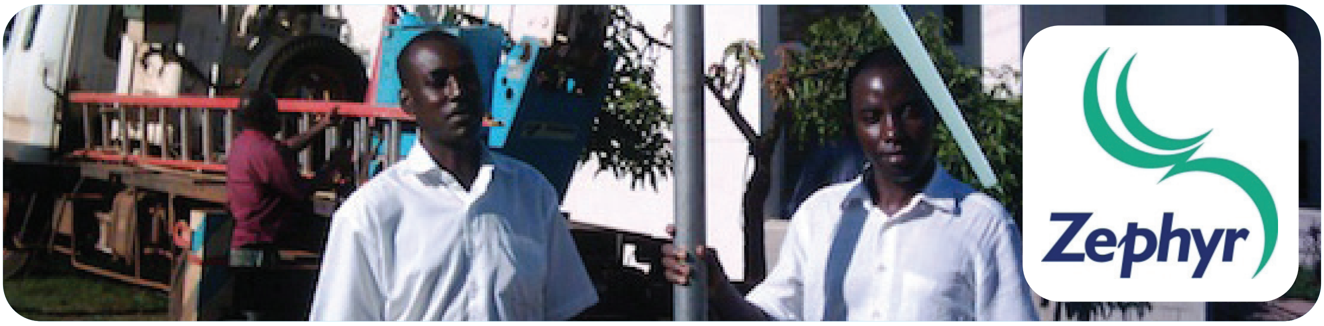
Project outcome

The project provides cleaner energy solutions to local households. In addition, five new resorts will be developed on the island, attracting new visitors and thereby generating additional benefits for the local community. It is not only the tourism industry that benefits from the access to clean energy; the telecom sector uses it too to power its operations. The project has a significantly positive impact on the environment – CO_2 emissions will be reduced by 1,500t, SO_2 emissions by 45t, and dust by 308t annually. Since this is a pilot project, based on its success and the experiences learned, a similar approach might be expanded elsewhere in China, on islands in particular.

Windpower installation in China
Source : Bergey Windpower

Case study 3

Zephyr Corporation
GSM Cell Site, Namibia



Company description

Zephyr Corporation, a Japanese company established in 1997, designs, manufactures and sells small wind turbines and other renewable energy solutions. Represented in more than 40 countries worldwide, in recent years it has built up solid experience, specifically in developing countries. Most of the activities are concentrated on Asia, with a particular focus on Indonesia and Vietnam, but recently also on Africa and the Middle East.

The challenge

The particular GSM cell site, used by a local mobile operator, was powered by a diesel-PV hybrid system, so the project was implemented in order to add a small wind turbine to it. The already installed solar panels did not perform well during certain periods of the year; they did not provide optimal efficiency due to seasonal variations. The arising need to restore and top up batteries was effectively met by wind power. Together with PV, wind and other renewable energy sources can reduce diesel consumption to zero.

Due to negative past experience with similar projects in that specific area, it was crucial to prove the reliability and high performance of the small wind turbine.

Advantages of wind energy solutions

The location had good availability of wind resources. The already used solar powers did not provide the optimal solution so a hybrid system was implemented as the best solution. Moreover, the possibility to use an existing telecom tower to install the turbine enabled to cut the initial costs.

Project implementation

Wind speed measurements were estimated prior to the project implementation and a tower load analysis was carried out. A small wind turbine of 1kW was installed – Airdolphin Pro (Z-1000-48, 48VDC), and the battery bank was charged through a hybrid controller.

The installation and after-service was done in partnership with a local company active in Namibia and South Africa.

Project costs and financing

The project was funded by the mobile operator MTC. The installation corresponded to most of the investment. Prior to the project, the estimated electricity generating costs per kWh were approximately USD 2-3, based on diesel fuel costs and transportation, genset maintenance and labour fees. The small wind turbine immediately reduced the frequency of maintenance visits required to the remote site location, which resulted in lower costs. In addition, the turbine was installed on an existing telecom tower, which allowed to cut costs. As a result, the operator was able to save considerably, and the expected payback time is between one to four years.

Project outcome

The solution employed in Namibia is a typical telecom site solution that can be deployed in other sites in various countries that are dependent on diesel solutions. The particular hybrid system is a cost-saving and green business model that can be replicated elsewhere. If sufficient wind resources are available, small wind is a cost-saving and reliable solution in these locations. ■

Small wind turbine weighing only 20kg
Source : Zephyr Corporation

Case study 4

The Wind Factory B.V.
Installation of a wind-diesel hybrid system in Ilakaka, Madagascar

Company description

The Wind Factory has over 20 years experience in engineering, installation, operation & maintenance of on- and off-grid wind systems. Together with The Sun Factory, it offers wind, solar or hybrid solution.
The focus is on decentralised small and medium-sized wind turbine systems, hundreds of which are installed worldwide. The Wind Factory is particularly active in several African countries, carrying out complete village electrification even.

The challenge

The project site in Ilakaka is a rural village with several thousand inhabitants and is a typical example of an isolated grid in Madagascar. The energy is sourced by expensive inefficient diesel power and distributed by a local IPP. Energy demand is constantly rising due to increasing local business activities.

Advantages of wind energy solutions

The average wind speed on the hills near Ilakaka has enough potential to source energy, especially during the late afternoon and evening, when consumption is at its peak. The existing diesel generator runs almost 24/7 so adding a hybrid wind turbine of a similar power in parallel would instantly lower diesel consumption.

Project implementation

The old inefficient diesel generator was replaced by a modern 100kVA generator and combined with a WES18 80kW hybrid wind turbine. The wind turbine has two blades with a rotor diameter of 18m on a tower of 30m with an integrated telecom antenna for local provider. The hybrid controller of the wind turbine has a remote control and can achieve a unique 100% wind penetration. Yearly production of the wind turbine is about 160,000kWh at 6m/s average wind speed. The Malagasy colleagues were trained in the Netherlands for one month on installing and maintaining the wind turbines. At the moment, more than 40 off-grid wind turbines are installed and maintained by them in Madagascar – IPP's, telecom and private businesses.

Project costs and financing

The project was financed by The Wind Factory International in conjunction with its branch in Madagascar and the local IPP, supported by a Private Partnership Program of the Dutch Government. Improvement of the local grid and counters was partly financed by ADER, the Agency for Rural Electrification in Madagascar.

Project outcome

Over 400 grid connections provide energy to about 2,500 people and over 200 businesses.

Diesel consumption is expected to fall by 40,000l annually, saving over 100Mt CO_2. Simultaneously, the local grid has been improved and new kWh-counters have been installed. As the biggest wind turbine built in Madagascar, this project has already given confidence to local government and private businesses that wind energy is not exclusively for developed countries and main grids.

The Wind Factory
installation in Madagascar
Source : The Wind Factory

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