SUMMARY

WWEA
World Wind Energy Association

2012 Small Wind World Report

Presented by:

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President's Foreword

In order to secure energy supply and cope with climate change, GHG emission reduction, biodiversity protection, renewable technologies development, energy conservation, and efficiency improvements have become the world's growing consensus. Among all renewables, wind energy proves to be a relatively matured technology and has tremendous potential in commercialisation and mass production. Today the major application of wind power is electricity generation from large grid-connected wind farms. Until the end of 2011, the total global installed wind capacity reached 239 GW, with an output accounting for 3 % of the total generation capacity in the world.

However, in many countries, especially developing countries, off-grid small wind power is an efficient and key solution to solve problems of power supply in remote regions of electricity shortage. With the expansion of power grid and the reduction of electricity scarce areas, small-scale wind has now been applied in fields such as city road lighting, mobile communication base stations, offshore aquaculture and sea water desalination in several countries. Nonetheless, the industrial scale still remains much smaller compared to that of large-scale wind power and great potential awaits to be exploited.

Following the shift of the energy sector from a centralised energy grid to an ideal distributed network, small wind systems and its hybrid applications are playing an increasingly important role. With the support of the smart grid technology, small wind turbines (SWTs) can now be connected to the power grid from the consumer end and contribute to the stabilisation of the power grid. Small wind application and hybrid technologies have already been put into practice in many countries with good market prospects. Although the unit capacity of SWTs are far less than that of the large turbines, it is just as important for the industry to strengthen its research & development, improve product quality, establish rigorous standards, testing and certification, and lobby for supportive policies to guarantee the long-term growth of the market.

The Small Wind World Report 2012 published by the WWEA provides a comprehensive analysis on the global small wind market based on first hand data. I believe that this report will provide a communication and cooperation platform for the global small wind manufacturers, research institutions and consumers. Here I would like to express my gratitude to Mr. Peter Zhang, the main author, and Mr. Stefan Gsänger, the editor and secretary-general of the WWEA, for their contribution to this publication. My thanks and appreciations also go to the all corporations, associations, research institutions and individuals who have helped in the development and smooth completion of this report.

Dr. HE Dexin
WWEA President

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1.1 Definition of Small Wind

What is small wind? Where does the boundary lie between small wind turbines (SWTs) and megawatt turbines? The definition of small wind is an important matter to be discussed and agreed upon. The word 'small' in the wind industry has been and remains vague and ever-changing. The lack of a credible unanimous definition and casual practice of the industry has created a term that describes wind turbines with a rated capacity from 6 watt to as large as 300 kW.

Small wind was originally defined by its characteristics to produce small amount of electricity for house appliances or to cover various household-based electricity demand. One single 40 inch LED television on the market today consumes approximately 200 W. Assuming that a battery can completely flatten off the fluctuation in supply and demand, it is estimated that an 180 W turbine can sufficiently sustain the television to be turned on for 4 hours per day[1].

Photo 1.1 Small Wind Turbines for Household Application

An average American family uses 11'496 kWh of electricity yearly. Under the same assumptions, a 10 kW turbine is needed to cover the full consumption. In comparison, a European household demands a 4 kW turbine while an average Chinese household requires as small as a 1 kW turbine.

Assuming that small wind is to supply the small consumption of households, the issue of whether a 100 kW turbine may be categorised as small wind needs to be brought onto the debate table.

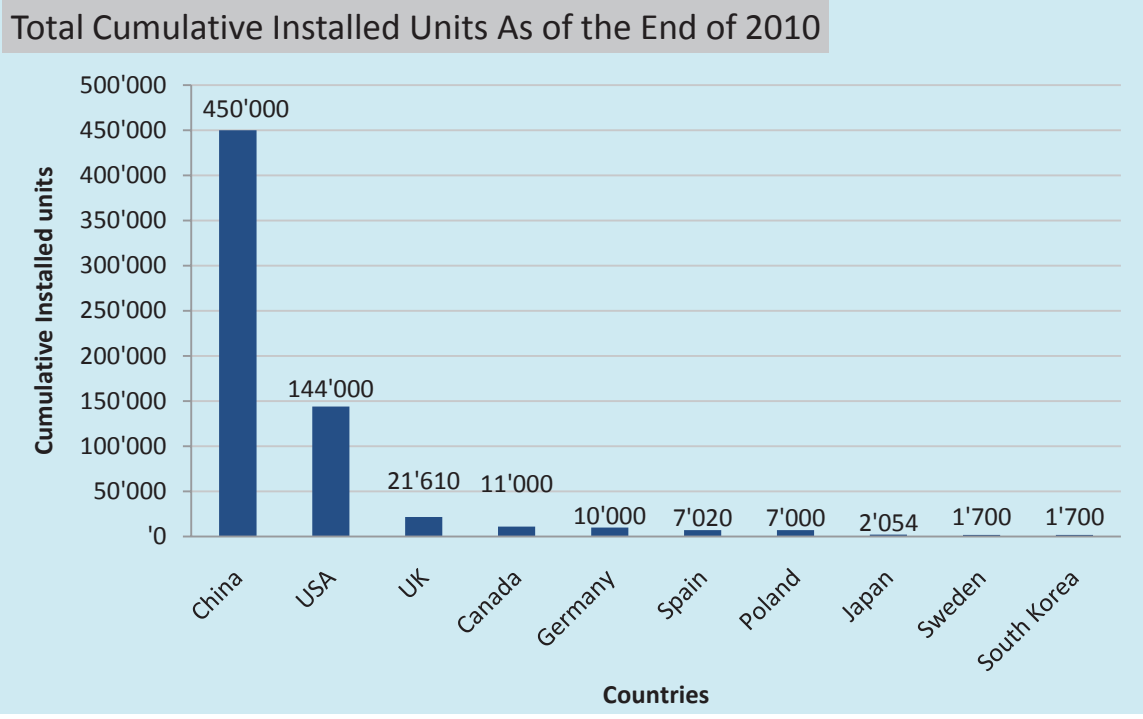
IEC 61400-2 defines SWTs as having a rotor swept area of less than 200 m^2, equating to a rated power of approximately 50 kW generating at a voltage below 1'000 V AC or 1'500 V DC. Currently, in the world today individual countries are setting up their own definition of small wind while conducting market researches, drafting renewable energy laws or offering providing financial aid programs. The discrepancy of the upper capacity limit of small wind ranges between 15 kW to 100 kW for the five largest small wind countries. In the case of the United Kingdom, for example, due to the interest of various parties, the definition of small wind even differs between the national wind energy association, Renewable UK, and its MCS certification body.

[1] The 180 W SWT is assumed to be installed on a site with an average annual wind speed of 5 m/s.

Over the past decades, a growing average size of the small wind capacity has been observed. This pattern is largely caused by the increasing interest in larger grid-connected systems and a comparatively diminishing market of standalone systems. Nevertheless, in order to create a standardised and healthy small wind market share, an agreeable definition of small wind should be agreed upon. This report intends to bring forward the discussion on the definition of small wind and aims to create eventually a unanimous international classification system of small wind accepted by all parties of the industry. For the purpose of generating comparable graphs, figures and charts in this report, 100 kW is chosen as the temporary reference point. The definition, however, requires further discussion until a globally harmonised agreement is reached.

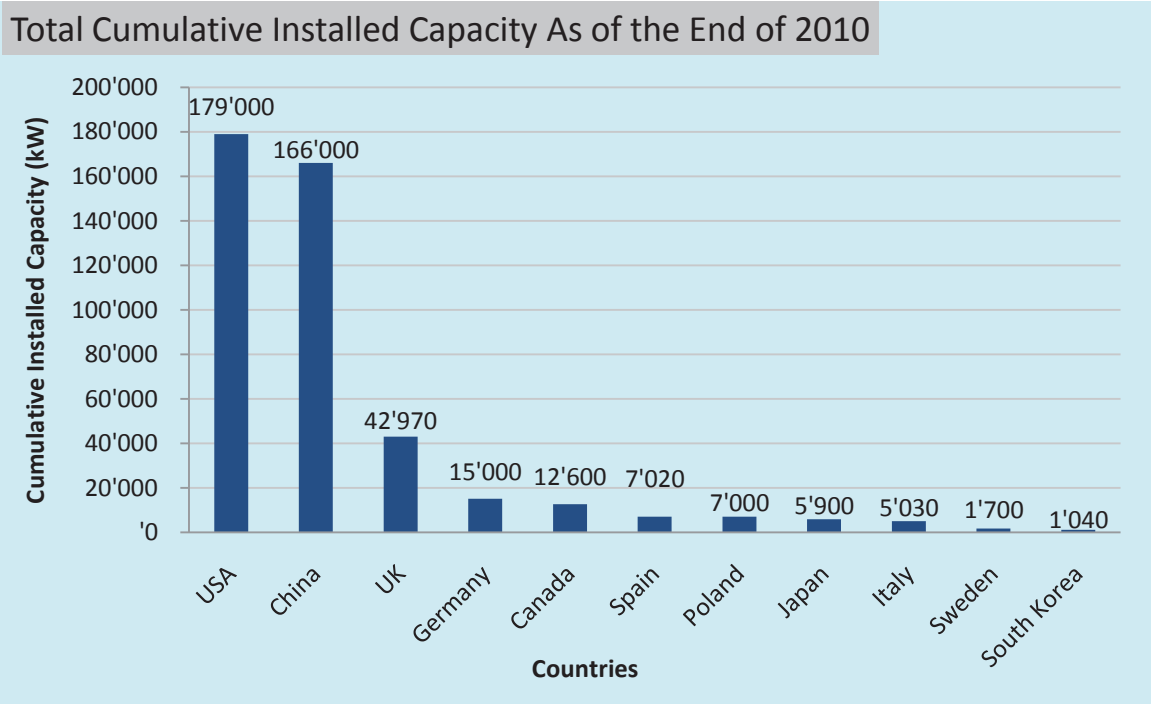
1.2 Summary and Statistics

As of the end of 2009, a cumulative total of 521'102 SWTs were installed, over 60'000 of which were newly installed that year with a sales revenue over 215 million USD. Until the end of 2010, the world total cumulative installed small wind systems reached 656'084 units, demonstrating a 26% growth from 2009 and generating approximately a total of over 382 gigawatt-hour (GWh) in annual energy production worldwide.[1]



[1] Some of the countries only provide rough data that contains uncertainties.

Being the overwhelming leader of the industry, China overshadows all other major markets, the USA and the UK, with its cumulative installed units of over 450'000. REEEP estimates, however, that approximately 250'000 of the 450'000 turbines continue to produce electricity in China and the rest have been retired given that China's first establishment of the small wind market was in the early 1980s.



The total installed capacity around the world has reached 443,3 MW as of the end of 2010. The United States is responsible for approximately 40 % of the installed capacity with a total of 179 MW. The accomplishment of the United States is attributed to the vast market supported by nearly 30 different types of supportive renewable energy policies and financial aid schemes of small wind projects from all levels of government. In comparison with China's average installed size of 0,37 kW as of the end of 2010, the USA and the UK yield 1,24 kW and 2,0 kW per installed small wind turbine, respectively.

Small wind is finding applications increasingly for on-grid power generation. Over the past decade, higher capacity SWTs (capacities between 10 kW and 100 kW) are driving the demand in the western market. In 2009, approximately 34,4 MW of SWTs sold globally were grid-tied, making up 82 % of the total market, leaving 7,6 MW of off-grid systems.

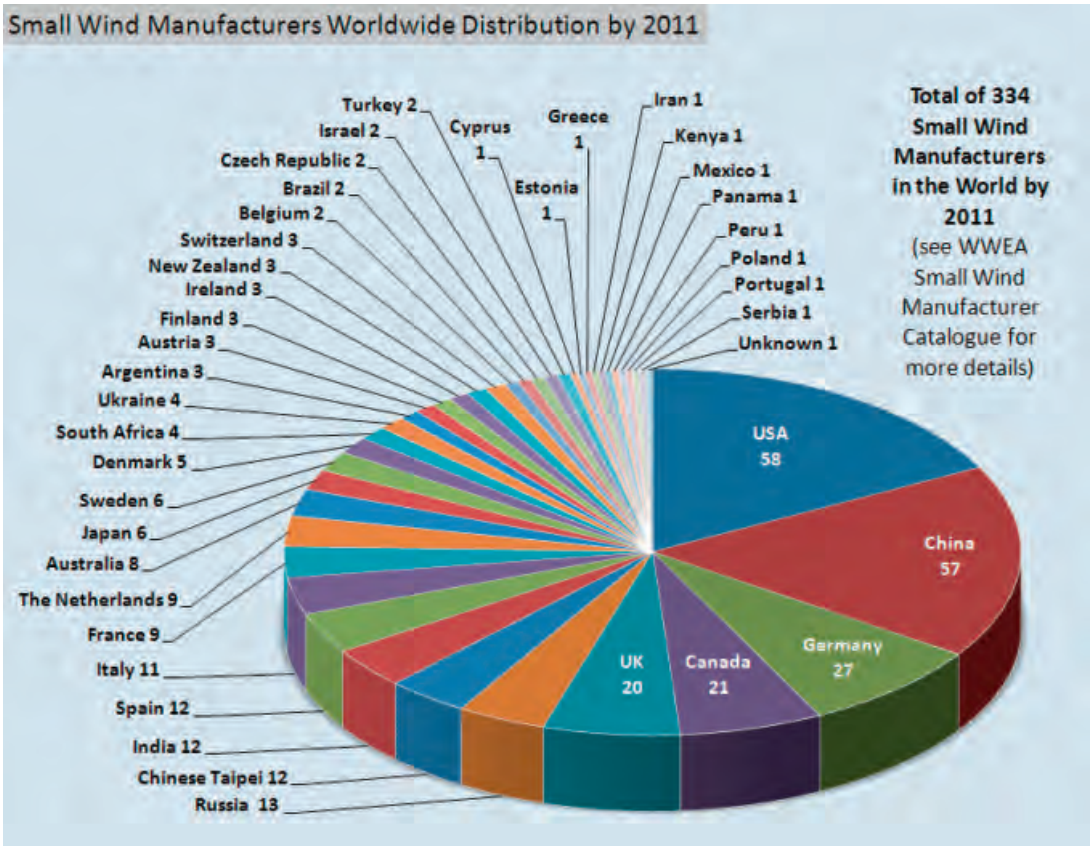
Despite the large demand for SWTs observed in developed Western countries, the market remains fragile today. Sales and production are still dependent on the magnitude of government incentives

in the form of supportive policies or financial aid programmes, and only a handful of countries offer sufficient supportive schemes.

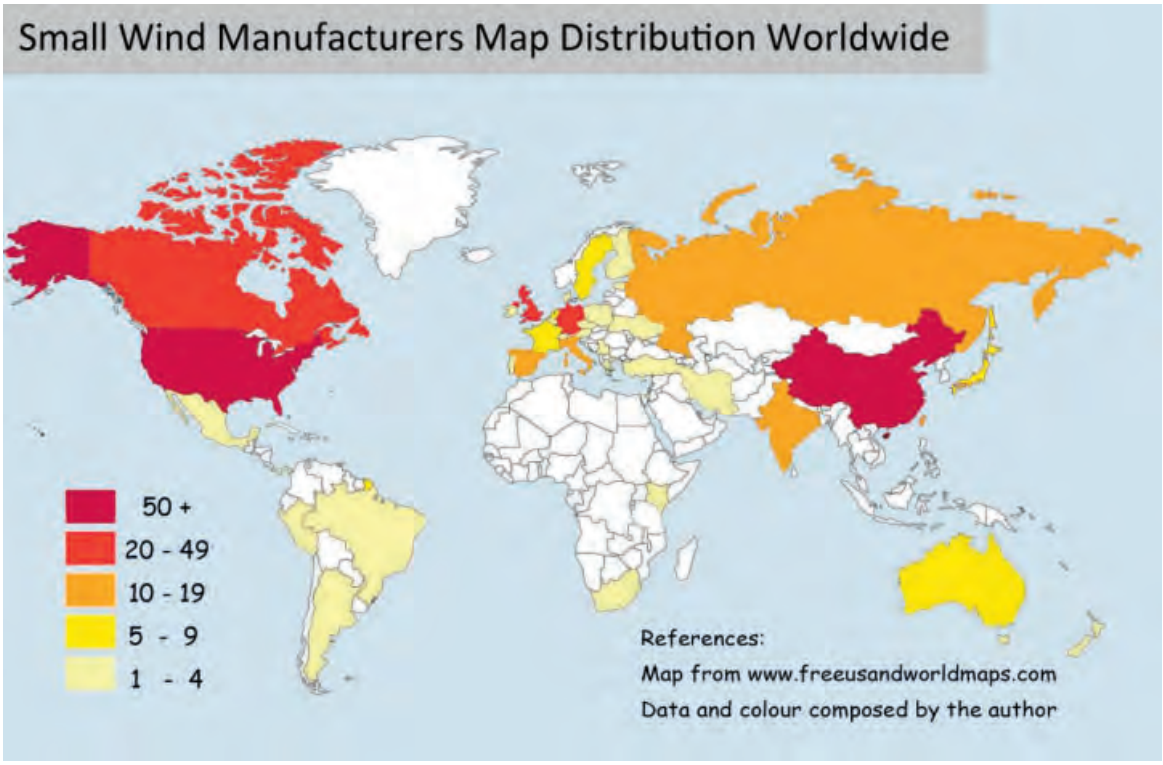
Fully competitive small wind markets are rather found in the developing countries where off-grid and mini-grid applications prevail. Small wind, in areas where electricity grid cannot reach, is often economically feasible without additional political support and poses a true rationale in substituting the existing expensive and environmentally damaging diesel generation.

Although rural residents of countries like the USA, China, and Cuba have been utilising the power generation abilities of wind since the 1960s with small wind turbines, the global industrialisation of small wind energy has demonstrated remarkable growth only in the past decade.

The figure below illustrates that the 5 biggest countries (Canada, China, Germany the UK and the USA) account for over 50 % of the small wind manufacturers. By the end of 2011, there are over 330 small wind manufacturers that have been identified in the world offering complete one-piece commercialised generation systems and an estimate of over 300 additional firms supplying parts, technology, consulting and sales services. A global distribution of small wind manufacturers can be found in the figure below.



The small wind industries in China, the USA, and the UK have emerged as the largest markets, with China as the overwhelming leader in manufacturing and installation. Numerous other countries have entered the market, amounting to approximately 330 identified small wind manufacturers based in over 40 countries, as of the end of 2011.



Based on the world distribution of turbine manufacturers, the development of small wind remains clustered around the developed countries in North America and Europe. Developing countries continue to show relatively slow progress. It is obvious from the map that the tremendous wind resources of Africa, Southeast Asia and South America, where many regions are ideally suited for small wind application, have not yet been cultivated. Due to frequently obsolete and deficient grid systems of the above regions, small wind systems have tremendous potential in supplying off-grid and mini-grid electricity to the local residences.

1.3 Driving Factors

The future of the small wind industry depends on the cost of the technology, the enactment of supportive policies and economic incentives, fossil-fuel prices, investor interest, consumer awareness, certification and quality assurance, permitting processes and regulations, and wind evaluation tools. Financial, wind, and energy experts anticipate high growth rates for the production of SWTs if consumer demand increases.

Costs

Cost remains to be the most influential factor in the dissemination of SWTs. In the USA, the installed cost of a SWT ranges from 3'000 to 6'000 USD per kW and an electricity production cost of approximately 0,15 to 0,20 USD per kWh. In these cases, SWT purchases seem practical only with the presence of economic incentives in grid-connected areas. However, a different trend is observed in China's rural electrification. Many owners of off-grid wind systems name practicality and affordability as the main reasons for their purchase as a way to generate power. In contrast, the installed cost of a SWT in China averages approximately 10'000 CHY (1'580 USD), one-third of the cost in the USA. Production cost, however, demonstrates modest disparity between developed and developing countries as a result of the relatively small amount of maintenance and management work during its lifetime. Average policies and economic incentives play more significant roles in the grid-tied system application than the off-grid systems.

Policies

The SWT market has benefited from the growing global trend of feed-in tariffs (FITs). Over 50 countries in the world have relied on FITs as a mechanism to promote the renewable industry, primarily in wind and solar. Unfortunately, the FITs scheme for small wind has been absent in most countries of the world including the largest market, China, and second largest market, the USA.

Small Wind Feed-in Tariff Pricing Worldwide

Country/ Region	Size Limit	Other Limits	# of Yrs	EUR/ kWh	CAD/ kWh	USD/ kWh	£/ kWh
Chinese Taipei	1-10 kW		N/A	0,182	0,250	0,243	0,155
Canada							
Ontario	< 10 kW	No Domestic content	20	0,098	0,135	0,131	0,085
Nova Scotia	< 10 kW	<200m² swept area	20	0,364	0,499	0,485	0,314
Denmark	< 25 kW		20	0,081	0,111	0,108	0,070
Greece	< 50 kW		20	0,250	0,343	0,333	0,215
Italy	< 200 kW		15	0,220	0,302	0,293	0,189
Israel	< 15 kW		20	0,250	0,343	0,333	0,215
	< 50 kW		20	0,320	0,439	0,427	0,275
Portugal	< 3,68 kW		15	0,432	0,593	0,576	0,371
Slovenia	< 50 kW		15	0,095	0,130	0,127	0,082
Switzerland	< 10 kW		20	0,244	0,335	0,325	0,210
UK	< 1,5 kW	MCS Certified	20	0,421	0,574	0,565	0,362
	1,5-15 kW	MCS Certified	20	0,326	0,444	0,437	0,280
	15-100 kW	MCS Certified	20	0,295	0,401	0,395	0,253
USA							
Hawaii	< 100 kW		20	0,103	0,142	0,138	0,088
Vermont	< 15 kW	0,015 EUR/kWh PTC expire 31.12.2012	20	0,157	0,215	0,209	0,134

Feed-in tariffs, tax credits, and capital subsidies are the major energy policies geared towards SWTs specifically. Additional policies that encourage the use of renewable sources of energy also play an important role in the growth of the SWT industry.

However, some criticise tax credits and capital subsidies as poor public policies because these incentives promote the sales of the hardware, but not the energy generation itself, and hence may not encourage sufficient improvements in efficiency. Nevertheless, government policies demonstrate an administration's testament to the value of a certain technology or method. Aside from government engagement, private equity investors must also remain interested and committed to the industry and fossil fuel prices must continue in their upward trend.

Standards & Certification

The development of standards and certification, already in progress, will serve to promote the sales of better-performing SWTs, and the growth of a healthy and well-established market. As safety and noise have grown important due to the proximity of the technology to users, the internationally accepted IEC 61400-2 (2nd edition, 2006) standard from the International Electrotechnical Commission stipulates specific safety design requirements. In 2009, the American, Canadian, and British Wind Energy Associations (now RenewableUK) coordinated efforts to develop the Small Wind Turbine Performance & Safety Standard, a subset based on IEC61400-2 (SWTs design), IEC61400-12-1 (performance) and IEC61400-11 (acoustics). The derived standards were later adopted by the AWEA and RenewableUK for their certification programs Small Wind Certification Council (SWCC) and Microgeneration Certification Scheme (MCS), respectively. For more detailed information on standards and certification, refer to the respective chapters in section 3 of the full report.

Wind Resource Assessment

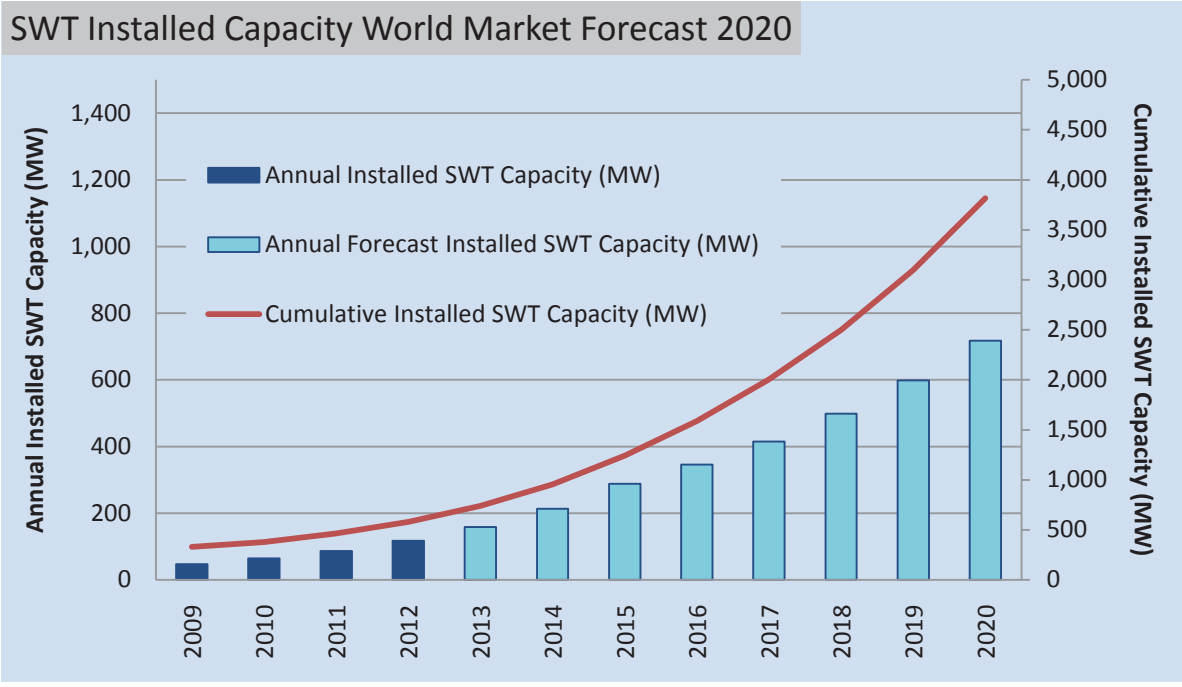
Accurate prediction of the wind speed is essential to calculate the electricity output of a SWT, representing the basis for economic performance. Wind evaluation currently presents challenges for the small wind industry due to the expensive wind measurement tools in urban environments. The shading and turbulence effect of surrounding obstacles produces inconsistent and unpredictable wind patterns below 30 m. Traditional wind resource maps prove inadequate as wind conditions are evaluated at a greater altitude of 50 m while most SWTs do not reach above 30 m. As a result, the vast demand for inexpensive and efficient methods of predicting and collecting local wind data is another key driving factors that requires further innovation and cost reduction in the technology.

1.4 Market Forecast 2020

Political support can be expected to increase the installed capacity of small wind in the upcoming years. In the long term, the global small wind industry may even slowly evolve from a policy-driven model to one that base on the productivity and affordability of the turbine itself. Increasing fossil fuel prices, global warming and the ever-growing electricity demand will be the three long-term drivers of the small wind industry. In order for the small wind technology to mature, however, the

industry must be driven by supportive policies and standards. As small wind technology challenges the traditional means of power generation as well as revolutionising the relationship between utilities and customers, the transition will certainly take time and determination of consumers.

The forecast is based on opinions of industry experts, growth pattern of the large wind industry, and the historical growth trend of the solar PV renewable industry for the past decade that shares many characteristics in common with the small wind industry. In comparison, the global large wind annual installed capacity has seen an average growth of 22 % between 2001 and 2011 and photovoltaic installed capacity experienced an average annual increase of 39 % during the initial period of growth of the solar industry between 2000 and 2010. Accordingly, the small wind industry can be expected to follow similar growth patterns of the large wind and solar industry between until 2020.



Recent trend of the small wind industry has shown an aggressive annual 35 % increase in the global installed capacity for the past years. The rate of growth is anticipated to continue until 2015, reaching an annual installation of 288 MW of SWTs. Within this time frame, individual countries and the international small wind community will be able to establish more rigorous and structured standards and policies to regulate the market and support investments. Based on a conservative assumption, the market could subsequently see a steady compound growth rate of 20 % from 2015 to 2020. The industry is forecasted to reach approximately 750 MW of installed capacity added annually in 2020 and achieves a cumulative installed capacity of 3’817 MW by 2020.