CATALOGUE

of SMALL WIND TURBINES

** under 50 kW*

8th Edition

2016

series
OPEN KNOWLEDGE

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* *under 50 kW*

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2016

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With special thanks to the Chinese Wind Energy Association for their contribution to the 2016 edition and continued partnership in promoting small wind energy.

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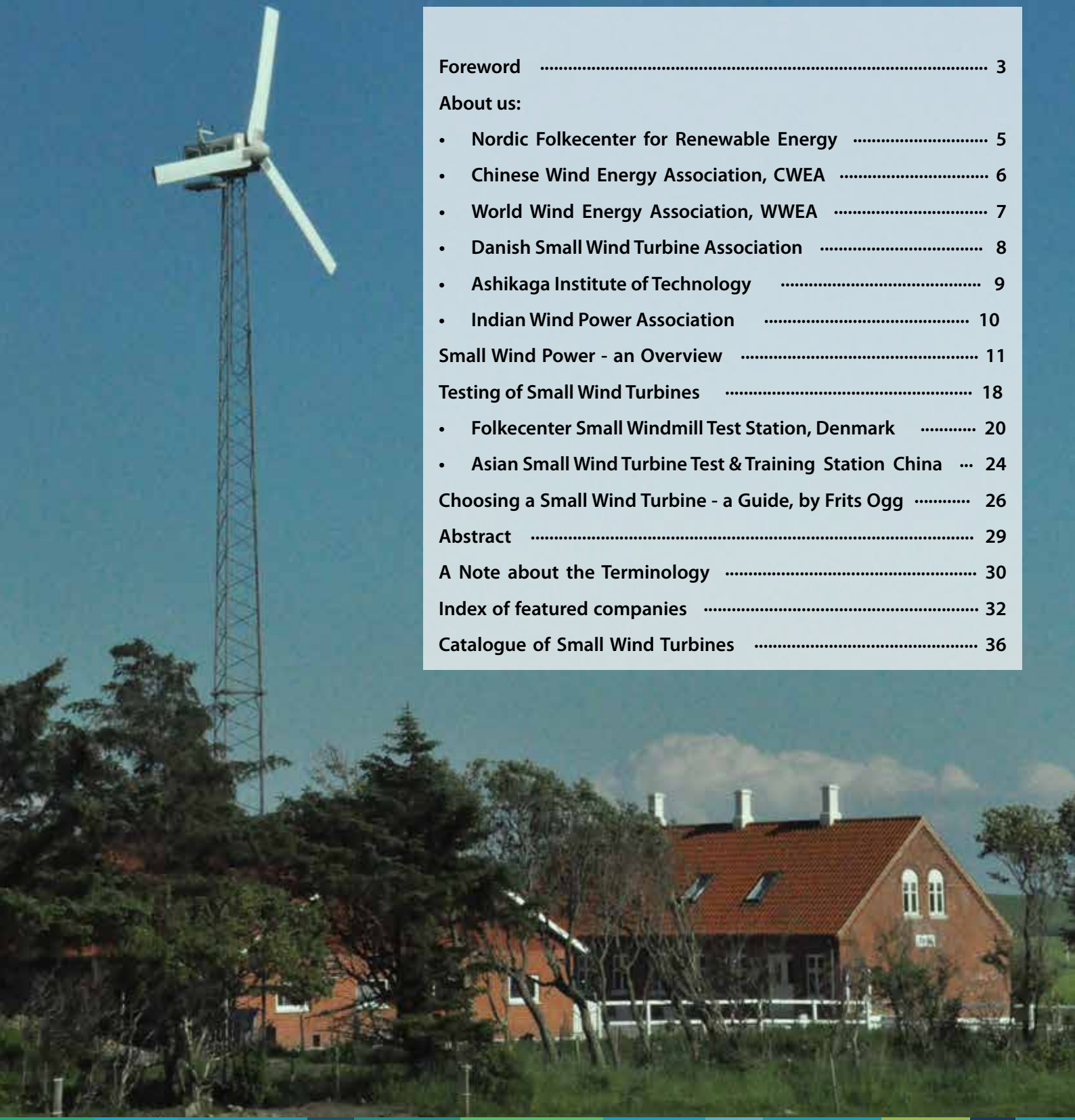



MiEV

Foreword

We have the pleasure to present the 8th edition of the "Catalogue of Small Wind Turbines". The 2016 catalogue has been developed by the Chinese Wind Energy Association, CWEA, and the Nordic Folkecenter for Renewable Energy in cooperation with the World Wind Energy Association, WWEA, the Danish Small Wind Turbine Association, the Ashikaga Institute of Technology and the Indian Wind Power Association.

The catalogue presents manufacturers of small windmills of up to 50 kW. There are small windmills from 28 countries coming from 104 companies that market 302 types of wind turbines.

Since the relaunch of the catalogue in 2014 in a new form, where we added content matter, changed layout and editorial team, the catalogue has been developing - and in this year's edition we cooperate with more associations; the World Wind Energy Association presents its newest overview on the small wind industry and exclusively for us, Frits Ogg wrote a guide "How to choose a small wind turbine".

Like in previous editions, not all small wind turbines are represented in the catalogue, also not all data for each model is complete. We make every effort to present detailed and well documented information about every manufacturer and type. For this purpose, we try to contact every known supplier and ask to fill out a questionnaire. But if no response is provided, we in general do not include the product in the catalogue unless we have sufficiently detailed and reliable information from other sources.

We warmly encourage manufacturers of small wind turbines from all over the world and others to contact us at info@folkecenter.dk with details and printable pictures for the next edition. New entries and additions are most welcome to make the catalogue even more representative for the small windmill world community.

Preben Maegaard
Director emeritus, Nordic Folkecenter for Renewable Energy
Founding President, World Wind Energy Association

June 2016

Nordic Folkecenter for Renewable Energy

The Nordic Folkecenter for Renewable Energy is an independent, non-profit institution, managed by a board of 11 members representing trades, local authorities, energy organisations, sciences and concerned citizens. Folkecenter is member of various international networks including partners in all parts of the world.

Since its foundation in 1984, Folkecenter provides research, development of technology, training and information for the manufacture, industrial innovation and implementation of renewable energy technologies and energy savings in Denmark and throughout the world. Folkecenter's goal is to achieve measurable increases in the utilization of renewable energy technologies and thereby significant reductions in environmental pollution associated with energy use in Denmark and elsewhere.

Folkecenter's mission:

INFORM, INSPIRE & INVOLVE

Folkecenter provides information within sustainable energy solutions in Denmark and elsewhere to local citizens, small and medium companies, political decision makers focused on decentralized solutions, trainees and wider public. Folkecenter serves as consultant to manufacturers, local consumer groups, and initiators within renewable energy. Creative thinkers at the Folkecenter have always been challenging political, technological and economical *status quo* of renewable energy to come up with innovative solutions, serving as inspiration for other organisations and individuals. It is the aim of Folkecenter to involve local communities for the development of decentralized energy solutions for a future ecological society.

TEST & DEMONSTRATE

Folkecenter contributes to development and implementation of efficient renewable energy systems: hybrid autonomous systems with integration of solar, wind and biomass; CO_2-neutral transportation with electricity, hydrogen and plant oil. Folkecenter's facilities are equipped for testing of small-scale wind power, photovoltaic systems and wave energy systems. Folkecenter's advantage is hands-on experience on site and demonstration of practical and experimental examples of integration of several renewable energy solutions, solar and passive housing, water recycling systems.

TRANSFER TECHOLOGY

Since many years Folkecenter has been transferring technology and sustainable solutions to many other countries. It is crucial to share the knowledge in order to achieve more balanced energy systems based on the use of renewable energy mix. Among others, Folkecenter supports technology transfer to Sri Lanka, Mali, Burkina Faso and Uganda.

Small Wind Power

SMALL WIND WORLD MARKET: BACK ON THE TRACK AGAIN

SMALL WIND WORLD MARKET STABILIZES AFTER A DIFFICULT 2013

The world market for small wind has stabilized after the fall in 2013 both in terms of units and capacity installed. The two biggest markets, China and USA, have seen a similar growth in terms of new units as in 2013, 10% and 1% respectively. The highest growth was seen in the UK with a 19% growth in terms of units compared with only 2% in 2013. As of the end of 2014, a cumulative total of at least 945 000 small wind turbines were installed all over the world. This is an increase of 8.3% (7.4% in 2013) compared with the previous year, when 872 000 units were registered.

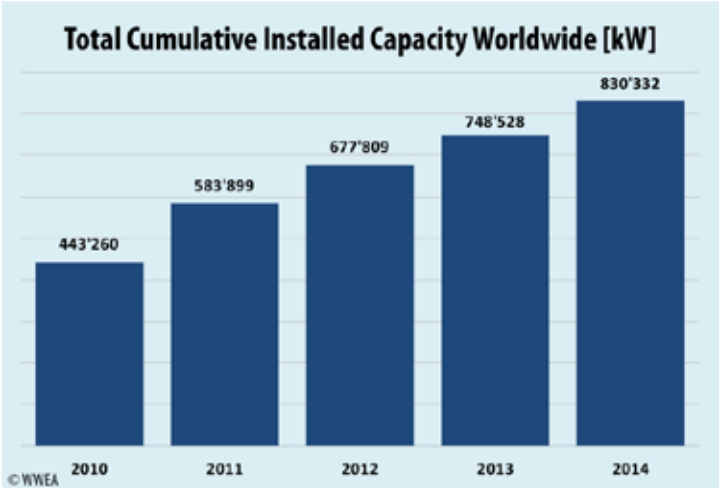
The numbers presented here are based on available figures and even exclude major markets such as India. WWEA therefore estimates an actual total number of more than one million units to be installed worldwide.

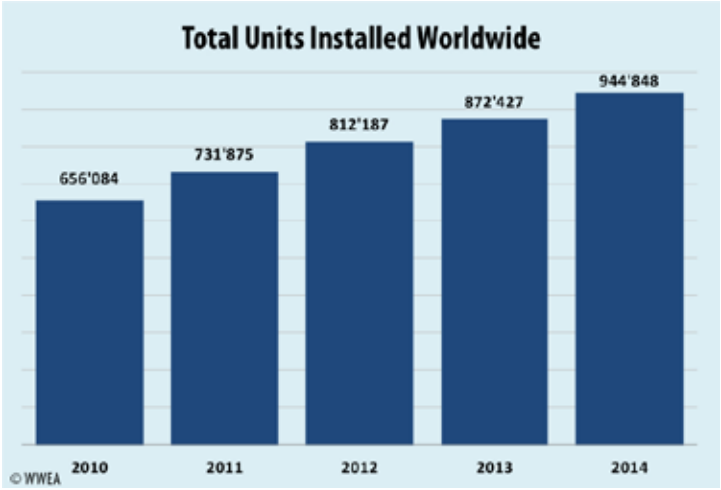
China continues to lead by far the market in terms of installed units. 64 000 units were added in 2014, 9000 more than in 2013, reaching 689 000 units installed by the end of 2014. The Chinese market represents 72% of the world market in terms of total installed units. According to estimations, around half of the turbines continue to produce electricity in China given that this market started already in the early 1980s.

In the USA, the number of units installed in a year felt to 1600 units in 2014, down after 2700 units in 2013. With a total cumulative units installed of 159 300, USA is the second largest market, clearly behind China, but well ahead of a number of medium-sized small wind markets.

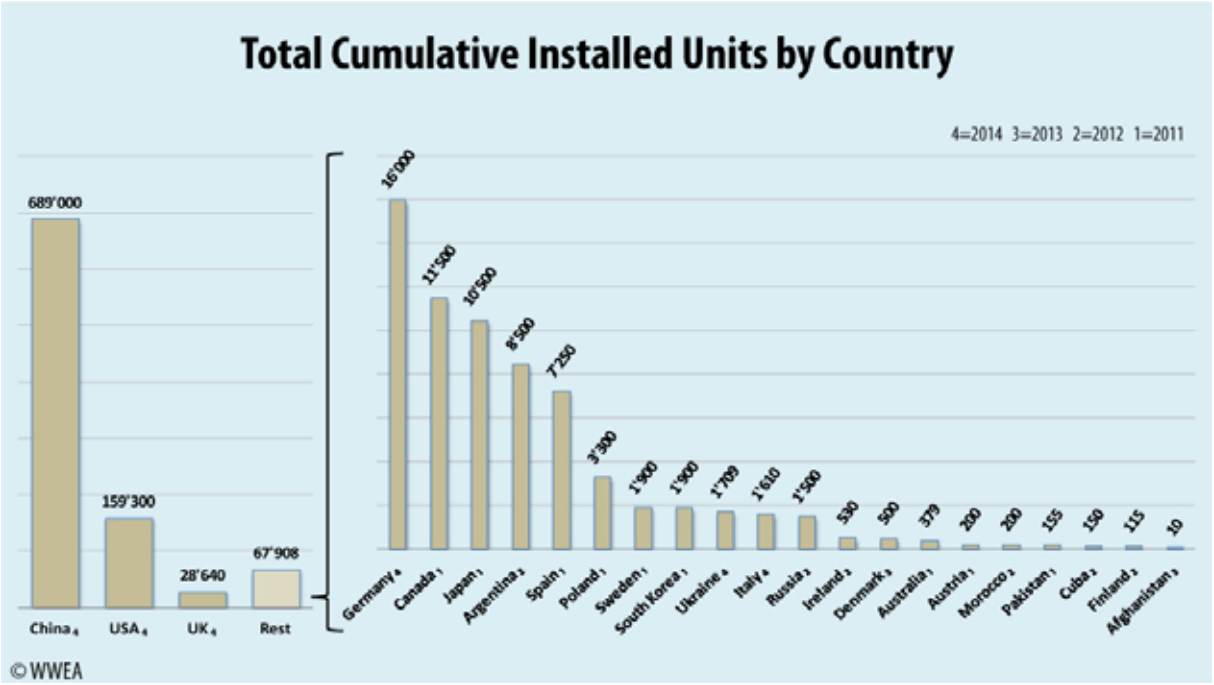
The small wind market in the UK saw an increase in the number of installations in 2014 despite the unfortunate changes in the Feed-In scheme introduced in the UK in November 2012. 2237 SWTs were installed in 2014, a substancial increase compared with only 500 units installed during 2013, but still far from the numbers reached in 2012. An interesting fact is that for every turbine installed in the UK, one is also exported overseas, 2614 units were exported to markets like continental Europe, the USA, and Asia[1].

The booming market of the recent years, Italy, grew by 71% reaching 1610 units by the end of 2014. Germany, Canada, Japan and Argentina are all medium-sized markets with total number of small wind turbines between 8500 and 16 000 units.





[1] *2015, Small and Medium Wind UK Market Report, RenewableUK*



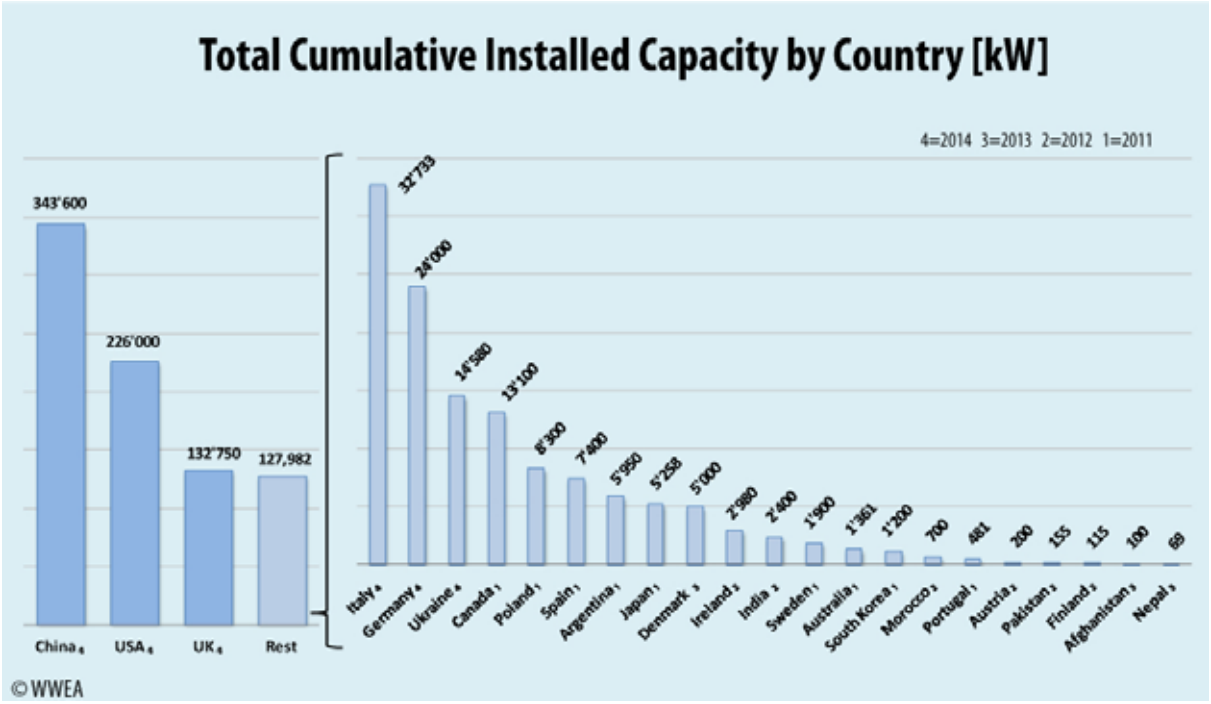
STRONG RECOVERY IN GLOBAL SMALL WIND CAPACITY

The recorded small wind capacity installed worldwide has reached more than 830 MW as of the end of 2014. This represents a growth of 10,9% compared with 2013, when 749 MW were registered. The previous year's growth rates, 10,4% in 2013 and 16,1% in 2012, demonstrate a strong recovery of the world market for SWT.

In terms of installed capacity, China accounts for 41% of the global capacity, the USA for 30% and UK for 15%. The USA small wind market grew only by 3,7 MW in 2014, a 34% decline in new capacity compared with 2013 and 80% declined compared with 2012.

The small wind market accounted for $20 million in investment, $16 million less than in 2013[2].

In the UK and Italy, the over-20 kW segment exploded during 2014. In the UK, installed capacity in the range 15-100 kW grew by 75,6%; in Italy, the range 20-60 kW grew by 85,4%. The rest of the segments remained very stable in the UK and saw small growth in Italy. In both countries, the structure of the Feed-in tariff was the impulse for the small wind sector. However, the structure of the feed-in tariff benefited larger turbines over the smaller machines.



[2] *2014 Distributed Wind Market Report, U.S. Department of Energy*

Testing of small wind turbines

Folkecenter Small Windmill Test Station, Denmark

TESTING AT THE FOLKECENTER SMALL WINDMILL TEST STATION

Since its foundation in 1983, the Nordic Folkecenter for Renewable Energy has been dedicated to provide research, development, testing and implementation of renewable energy systems. Practical examples of small scale windmills are constantly being tested, measured or demonstrated for national and international clients at the Folkecenter Small Windmill Test Station.

The test site has platforms and foundations of different types for testing of electricity windmills of up to 40 kW and mechanical wind pumps. The test station is equipped with data loggers, wind measurement masts, towers for installation of wind turbines and water wells where the performance of small windmills for electricity and water pumping can be measured by international standards.

The importance of the Folkecenter's test station relies on good wind resources and the center's years of experience within testing. The test center aims to support the manufacturers to control quality of components and systems by testing on site before going to the market or during the approval and certification the windmills by a third party.

Vertical or horizontal windmills that are still at the prototype stage, can be put to the test during the last phases of development. By doing this, the companies can modify the design according to real data given by the test station. A windmill tested at the Folkecenter can go through various tests from the prototype stage.

1. INITIAL OPERATION OF PROTOTYPE:

Estimation of Vibrations, Noise and Performing

For the small wind turbine market, it is important to test the prototypes in a real life scenario to see what the actual performance of such turbine would be during its operational life. By prototype testing and monitoring of the windmill vital information such as the performance and noise, the behavior of a new small wind turbine design will be available for the manufacturer that is actively involved in the testing process.

A prototype often has never before been in operation. The initial will prove whether the calculated performance can be verified under real wind conditions. With wind speeds at Folkecenter Small Windmill Test Station that can go up to 30 m/s and beyond, the ability of the prototype to survive wind extremes is crucial. Loads and noise of the windmill will be verified as part of the initial testing.

Being so, the manufacturer can make the necessary basic modifications before proceeding to the next step.

2. TRIMMING:

Adjustments, Optimization of Components and Operation

After the first phase of testing, the manufacturer can see if the prototype lived up to its expectations. Adjustments and optimization can be made of various components to obtain the best possible performance of the actual design of the wind turbine. The trimming will typically include various blade angles and software adjustments.

3. TESTING OF COMPONENTS:

Load Test of Tower, Blades and Protection against Runaway

Besides power and noise, security is an important matter for any kind of windmill, small or big. It is important to test the safety of the windmill. Household wind turbines are especially likely to be close to the residence of the owner.

As part of the certification a range of full-scale structural static and fatigue tests are conducted. At the Folkecenter test station static tests of tower, foundation and blades are made according to the requirements of the Danish approval procedure.
All turbines, big and small, need to have a reliable overspeed protection system. Runaway can lead to critical loss of control over the turbine and its components and cause accidents. As the Folkecenter Small Windmill Test Station is located in a region where wind speeds over 20 m/s occur during most winter periods, real life high wind tests are part of the testing process.

4. POWER CURVE

Measurements for Documentation

Once the small wind turbine's design has been optimized and its components have been tested for safety, it is time for the measurements and documentation during a specified period of time. In this way a real and authentic power curve can be made in accordance to international standards by an independent body.

5. FINAL REPORT

The final report will include the measurements and an assessment of the windmill and its components. By this stage, the windmill should be ready for certification by a third party for sale in national and international markets.

In conclusion, since the small wind turbine market is making its way into mainstream renewable energy, it is important for the industry to develop reliable products for on-grid and off-grid customers to allow the governments to enact supportive policies and economic incentives for a clean and fossil-fuel future.

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How to choose a small wind turbine?

Small wind turbines provide electricity. However, wind turbines are not suitable for every place. There are many factors one must consider when choosing a wind turbine system. Even small wind turbines require an amount of space for installation and sufficient wind for the wind turbine to function. What matters?

TEXT: **Frits Ogg**

1. PERMISSIONS
No permit, no wind turbine. Regulations differ from country to country so you have to search for your national or regional regulations. The national wind association can help you with this.

2. WIND RESOURCES
Is the wind resource at your site good enough to justify your investment in a small wind turbine system is a key question. Monitoring by a wind resource measurement system at a site provides the best picture of the available resource but it has a cost. Wind measurement systems are available; whether this expense is justified depends on the nature of the proposed small wind turbine system and its costs. The measurement equipment must be installed high enough to avoid turbulence created by trees, buildings, and other obstructions. The most useful readings are those taken at hub height at the supposed place of the wind turbine generator. You can also measure with two wind-loggers. One on the preferred location at hub height at least for one year. The other at alternative locations for some time to see if there are better places, with the fixed wind-logger as a reference. You may consider hiring an experienced small wind site assessor who can determine the wind resource and/or where the turbine should be located on your property.

3. LOCATION
The positioning of your small wind turbine is very important because it will determine the actual performance of the turbine. You can have varied wind resources within the same property. In addition to measuring or finding the annual wind speeds, you need to know the prevailing directions of the wind at your site. You need to consider existing obstacles such as trees and buildings, and you need to plan for future obstructions such as new buildings or trees that have not reached their full height. Your turbine needs to be sited upwind of buildings and trees, and it needs to be 10m above all obstacles within a 100m horizontal radius.
You also need enough room to raise and lower the tower for maintenance, and if your tower is guyed, you must allow room for the guy wires.

4. ENERGY USE YOU WANT TO MEET
You need to know how much electricity you use per year. Depending on the average wind speed and your demand, a wind turbine for a home rated in the range of 2 to 15 kW would be required to make a significant contribution to the demand. Without storage or grid coupling with feed-in tariff a wind turbine should deliver about 50-60% of your energy consumption.

5. HORIZONTAL OR VERTICAL AXIS?
There are basically two types of turbines to choose from, vertical axis and horizontal axis wind turbines. Horizontal axis wind turbines dominate the majority of the wind industry. Horizontal axis means the rotating axis of the wind turbine is horizontal, or parallel to the ground. In recreational and residential wind applications, vertical axis

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Abstract

This catalogue contains information about wind turbines that are manufactured and distributed worldwide. The information is a basic representation of the turbines, please be aware that there are many factors and regional variables that prevent an accurate comparison between different models. Rated wind speeds are different for all models so please keep this in mind when comparing the rated outputs. Prices as well are not comparable as they may or may not include the tower, cables, shipping, taxes, etc.

This data is subject to change since many of these machines are constantly undergoing testing and development. As of June 2016 this information is accurate to the best of our knowledge, however we can not guarantee that all information in the following pages is up to date. For more information about a wind turbine contact the company listed or find a distributor in your area.

The companies listed are primarily manufacturers, however, if information is only available from a distributor their company information accompanies that of the turbine even though it is produced elsewhere. This catalogue is not a promotion of any of these companies or products. Information comes from the companies listed, not from direct knowledge or testing of these machines.

All information and photos included in the following pages are credited to the manufacturers/distributors. Many thanks to all those people who provided this information, their help is very much appreciated. If any of these pages are to be reproduced please reference this publication as the source.

This catalogue is the eighth edition with revisions planned for the future. If you have information about wind turbines that are not described here, or corrections to existing pages please contact the Nordic Folkecenter for Renewable Energy.

A note about the terminology

(in order of appearance in the following specification charts)

Model ..... The name of a specific wind turbine, used to distinguish it from others.

Orientation ..... The relation of the rotor of a Horizontal Axis Wind Turbine (HAWT) to the tower,
- Upwind of the tower; the rotor faces the wind and is yawed, in most cases by a tail vain.
- Downwind of the tower; the machine is yawed, in most cases by the blades themselves.

A Vertical Axis Wind Turbine (VAWT) is omni-directional and is not classified as upwind or downwind.

Rated Output (W/kW) ..... The power produced by a wind turbine in watts at its rated wind speed. Please keep in mind that the rated wind speed is not a standard, the average used in the small wind industry is 11 m/s, but rated wind speed can range anywhere from 6 m/s all the way to 20 m/s. The power available in the wind increases eight times with every doubling of the wind, so the same turbine at 12 m/s will produce approximately eight times as much as it would at 6 m/s. Different turbines are rated at different wind speeds. Another indicator, possibly more appropriate, of a turbine's size is its rotor diameter and/or swept area, i.e. the physical size of the machine.

Peak Output (W/kW) ..... Maximum power output of a wind turbine.

Output Voltage (V) ..... In the context of this catalogue this term refers to any or all of the following: the voltage produced directly from the turbine, or the voltage once it has been inverted/rectified for the purpose of charging batteries or connection to a utility network.

Generator Type ..... The type of generator or alternator that is used to convert mechanical energy to electrical energy.

Stand Alone ..... The wind turbine is intended for use in remote applications where the excess electricity is stored in batteries.

Grid Connection ..... The wind turbine is designed to be connected to the utility grid.

Direct Heating ..... A heating system that stores energy generated from the wind as hot water which can be used for space heating and hot water use.

Pumping ..... These wind turbines/mills pump water either mechanically or in combination with an electrical pump.

Controller Type ..... The system that monitors the condition of the wind turbine and its environment. Depending on these conditions, the controller can adjust the operation of the machine to prevent damage or to optimize performance.

Overspeed Protection ..... Mechanism or device for limiting the maximum speed of the rotor to prevent the rotor from self-destruction. This can generally be called governing and some examples include;
- Furling: the rotor swings out of the wind either sideways or up to lessen the size of the swept area exposed to the wind,
- Stall regulation: the blades of a fixed pitch wind turbine can be designed to stall in high wind speeds (stall = less lift and more drag),
- Pitch control: the speed is controlled by varying the angle of the blade to its direction of travel.

Blade Material ..... The materials used in construction of the blades.

Much of the above terminology is referenced from the "1997 Glossary of Wind Energy Terms" by Paul Gipe and Bill Canter.

COUNTRY	COMPANY	RATED OUTPUT (W; kW)	PAGE
Argentina	INVAP Ingenieria	4.2 kW	36
Australia	RESA Renewable Energy Solutions	5 /20 kW	37
	SOMA Power	400 W; 1 kW	38
Austria	Silent Future Tec	4.2 /8 kW	39
	STEP Energysystems	15 kW	40
Brazil	Enersud Indústria e Soluções Energéticas	250 /380 W; 1 /6 kW	41
	Alternate Power	300 W	42
	Endurance Wind Power	5.2 /35 /50 kW	43
	Wenvor Technologies	30 kW	44
China	Anhui Hummer Dynamo	400 /600 /500 W; 1 /2 kW	45
	First Wind Turbine Manufacturing	450 /750 W; 1 /2 /3 /5 /10 /20 kW	46
	Guangzhou HY Energy Technology	400 /600 W; 1 /1.5 /3 kW	47
	Hohhot Boyang Renewable Energy	500 W; 1 /5 /10 kW	48
	Hopeful Wind Energy Technology	300 /600 W; 1 /1.5 /5 kW	49
	Ningbo Windpower	200 /300 /400 /600 W; 1 /2 /3 /5 kW	50
	Osiris Energy	10 kW	51
	Qingdao Anhua New Energy	20 /30 kW	52
	Qingdao Windwings Wind Turbine	600 W; 1 /2 /3 /5 /10 kW	53
	Shandong Huyae Wind Power	50 kW	54
	Shanghai Forevoo Windpower Technology	300 /500 W; 1 /2 /5 /10 /20 /30 /50 kW	55
	Shanghai Ghrepower Green Energy	1 /2 /5 /10 /30 /50 kW	56
	Shenzen Typmar Wind Energy	300 /600 W; 1 /3 kW	57
	Urban Green Energy	200 W; 1 /3.2 kW	58
	Yuequing Zohnhan Windpower	750 W; 1.5 /2 /3 /5 /10 kW	59
Denmark	KVA Diesel	10 kW	60
	Solid Wind Power	24.5 kW	61
	Thy WindPower	6 /10 kW	62
	Viking Wind	25 kW (10 /20 /25 kW)	63
England	Eclectic Energy	400 /400 W	64
	Ecotricity Group	5 /11 /15 kW	65
	FuturEnergy	1 /10 kW	66
	VWT Power (Quiet Revolution)	4.2 kW	67
	Leading Edge Turbines	12 /28 /85 /160 W	68
	Marlec Engineering	25 /90 /90 /140 /340 /500 W	69
Estonia	my!WIND	5 kW	70
Finland	FinnWind Oy	3.6 /4 kW	71
	Oy Windside Production	135 /500 W; 1 /20 kW	72
Germany	AeroCraft	120 /240 /750 W; 1 kW	73
	Braun Windturbinen	2.5 /3.6 /6.5 /9.5 kW	74
	EasyWind	6 /7.5 kW	75
	FuSystems SkyWind	1 kW	76
	Kessler Energy	10 kW	77

Solid Wind Power
(Denmark)

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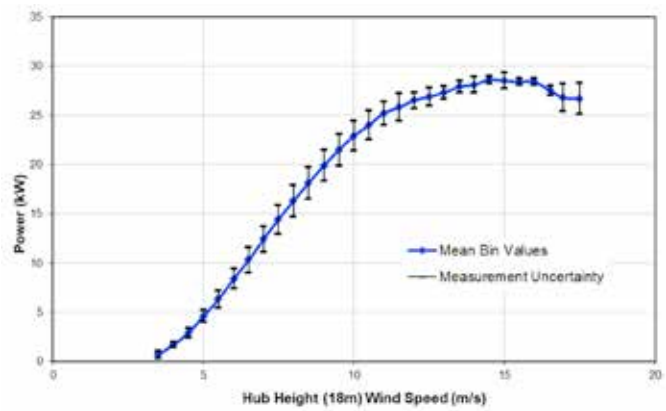
Contact: Morten S. Kristiansen

Established 2013
Distribution: Domestic, international
Direct from factory

Model	**SWP – 25 -14TG20**
Orientation	Horizontal axis with upwind rotor
Rated Output	24.5 kW
Peak Output	28.6 kW
Output Voltage (V)	230 V
Generator Type	Asynchronous induction
Applications	Grid Connection
Controller Type	Orbital A/S TMC3
Overspeed Protection	Stall/ Tip Brakes, Electromagnetic fail-safe braking
Blade Material	Fiberglass
Number of Blades	3
Rotor Diameter (m)	14
Swept Area (m2)	154
Windspeed (m/s)	
Rated	12,5
Cut-in	3
Cut-out	25
Governing	
Survival	
Head Weight (kg)	1929 (Nacelle + Rotor)
Tower Type	Tubular Steel Tower
Tower Height (m)	18m, total height 25m
Product Life (years)	20
Warranty (years)	
Units sold	Total 301 units; of this 10 kW 211 units; 25 kW 90 units.
On the market since	2013
Price	Contact Solid Wind Power for more Information
Certificate	ISO/IEC 17025



THY WindPower (Denmark)

Oddesundvej 183
Visby
7755 Bedsted

www.thymoellen.dk
Tel: +45 53574088
E-mail: lp@thyml.dk
Contact: Leif Pinholt

Established 1986
Distribution: Domestic, Direct from factory

THYmøllen

Model	TWP 40 - 6 kW	TWP 40-10 kW
Orientation	Upwind	Upwind
Rated Output	6 kW	10 kW
Peak Output	6.6 kW	11 kW
Output Voltage (V)	3 x 400	3 x 400
Generator Type	Asynchronous	Asyncronous
Applications	Grid Connection	Grid Connection
Controller Type	PLC	PLC
Overspeed Protection	Blade tip brakes	Blade tip brakes
Blade Material	Wood / Glassfiber	Glassfiber
Number of Blades	3	3
Rotor Diameter (m)	7,13	7,13
Swept Area (m2)	40	40
Windspeed (m/s)		
Rated	10 m/sec.	10 m/sec
Cut-in	3,5	3,5
Cut-out	25	25
Governing		
Survival	plus 60 m/sec	plus 60 m/sec.
Head Weight (kg)	900	1000
Tower Type	Lattice and tubular	Lattice and tubular
Tower Height (m)	21 m	21 m
Product Life (years)	25 to 30	25 to 30
Warranty (years)	2	2
Units sold	207	200
On the market since	6	3
Price	Contact THY WindPower	
Certificate		

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