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China

A New Era Dawning

Whether in Inner Mongolia, on the subtropical island of Hainan or off the coast of Shanghai: wind energy is booming in all regions of China. A glimpse behind the scenes.

For several months now, technician Dai Wei has been working at the so-called Olympic Wind Farm, situated at Guanting Reservoir northwest of Beijing. Erected last winter in a frosty minus 20 degrees Celsius, the wind farm is the visible “green

conscience” of this year’s Olympic Games. Since then, 33 wind turbines manufactured by the Chinese industry leader Goldwind have been in operation, each with a rated output of 1.5 megawatts. With a small service team, 23-year-old Wei

ensures that everything runs smoothly at the Olympic Wind Farm. This was not always the case, however. “Some of the converters turned out to be faulty, and we had to exchange them,” he explains on the way to the site. The route passes by cherry ▶

Photo: © Jan Oelker



A prototype of Mingyang's 1.5-MW-turbine on the island of Xinliao Dao in the south of China.



plantations and fertile farmland. On the bumpy dirt road, Wei's vehicle throws up a lot of dust. A farmer and his wife trundle along on their donkey cart; they wave a hello and the wind technician politely returns the greeting. "The farmers do not harbour any hostile feelings towards the turbines. They were informed at an early stage about the project, and even had their say in the location of the individual turbines," says Wei. After the Olympic Games, when the wind farm is handed over to the operator, the City of Beijing, he and the team will leave. "Then we'll go off to the next project,"

he explains in the late evening, as the sun dips behind the bare mountain slopes. "And that can be anywhere in China: in the tropical south, on the Russian border in the northwest or thousands of kilometers away from here in Gansu Province, south of Mongolia."

A change of scene: a few hundred kilometers farther westward, northeast of Hohhot we are in the provincial capital of Inner Mongolia. The carousel table never stops turning. New dishes appear continuously from the cookhouse as if by magic. Delicious lamb, pork, fish and vegetable spe-

cialities are served. Tsingtao beer flows liberally, while smaller glasses are filled up with high-octane liquor. Again and again, the phrase "Gan bei" is heard; this famous or perhaps notorious Chinese toast is a call to empty your glass in one go. Without this ritual, business in China would be unthinkable, and the wind energy sector is no exception.

Market newcomer in the wind business

The next morning, the skies hang grey over the barren landscape in Qahar Youji Zhongqi. Snow has fallen overnight. On the little-used main road, trucks loaded with coal roar past. The erection team of the company CSIC is joined by German engineer Holger Struve from the Rendsburg engineering office "aerodyn" on the journey to the wind farm upon the Hui Teng Xi Le plateau, which lies on an altitude of 2,000 meters and has served the Chinese wind industry as a test site for many years.

"We're pressed for time," admits Youchuan Tao, chief engineer of the wind section at the shipbuilding giant CSIC, when they arrive at the base of the 2 MW prototype developed by aerodyn. The expectations, resting on the new business unit within the conglomerate, boasting more than 300,000 employees, are very high indeed. "We are the newcomers in the wind segment. It is clear that we have to improve quite a lot regarding the design, the assembly of the

A section of a Nordex tower is delivered to the Hongsipu wind park near Mongolia.





The Shiren wind farm near Shangyi in Hebei province.

components and deliveries from subcontractors,” says Tao. “Above all, we have to speak to our suppliers about the quality – it simply must get better,” he adds.

CSIC intends already to commence series production of the 2 MW unit in September. A new production hall for this purpose was completed in record time in Chongqing, a metropolis of many millions in the centre of China. An order for twelve wind turbines has already been received; the aim is to produce up to 200 units in the course of next year.

And CSIC is only one of the many wind energy newcomers amongst the Chinese manufacturers. Frequently, it is the subsidiaries of major Chinese industrial or energy groups that have entered the fray. A good example here is Guodian United Power Technology Co. Ltd., a young offshoot of the energy supply utility Guodian – one of the “Big Five” Chinese power station operators – which has also been manufacturing wind turbines of late.

However, the ability of the Chinese market to absorb new players is enormous. In 2006, the Chinese government announced the target of generating 30,000 megawatts through wind energy by 2020. Today, it is already clear that this goal will be reached in only a few years. Since the hunger for energy in the Middle Kingdom will remain unbounded over the medium term, insiders believe it is quite possible that 100,000

megawatts of wind energy capacity could be installed by 2020.

As a result, companies such as Goldwind, Sinovel, Nordex China, Mingyang, CSIC, Guodian and many others are faced with work of an Olympic nature, not only in this year. “Despite the priority for renewable energies as prescribed by law since 2006, the grid connection of wind farms still remains a complicated matter in some cases,” comments Goldwind manager Wang Jin at the newly occupied premises of Goldwind Science & Creation Windpower Equipment Co. Ltd. southeast of Beijing. Every month, 30 turbines of the gearless 1.5 megawatt plant – precisely the type running at the Olympic Wind Farm – are assembled at the production facilities there. An outsized poster on the wall proclaims grandly: “Preserving white clouds and blue sky for human beings and reserving more resources for the future”. This slogan will continue to apply to the orange-garbed employees long after the Olympic spectacle has ended. ■



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Chinese Wind Experts

The Chinese wind energy market is developing fast: in 2007 alone, 3,400 MW of wind turbine capacity have been installed. This lists China as number three behind the USA and Spain. At present there are over 30 wind turbine manufacturers in China. Certification of wind turbines is not yet mandatory in China, but this will happen in the future. GL Industrial Services in Shanghai will tackle this market potential with inspection services to material, components as well as wind turbine types and wind park projects. A certification working procedure for composite material has already been established. Further ideas are under development. Wu Qiang John and Zhu Guo Alex offer inspections and certification services for components such as rotor blades or machinery components. Wu Qiang John joined Germanischer Lloyd in April 2008. He has completed an MBA in Germany and previously worked for Vestas. Civil engineer Zhu Guo Alex studied at Shanghai Tongji University and completed his master's degree on “Finite element analysis for wind turbines” in Germany. ■



Wu Qiang John (left) and Zhu Guo Alex



Bolting of a SUPERBOLT®.

Bolting

Tight Connections

Bolted connections are quintessential in wind turbine engineering. The tower, the rotor, the gearbox and the generator all have to withstand the severest weather conditions. But nuts and bolts aren't all the same.

A 50-year gust happens only once every fifty years. With a bit of luck, a wind turbine with its average 20-year life expectancy may just escape the challenge. In theory, that is. But then – it might not. Once such a gust hits the turbine, there mustn't be any yielding or bursting under the impact. This is why wind turbines are designed from the drafting board stage for that maximum blast. Experts use sophisticated computer software to calculate all conceivable load conditions, or they test components in the lab, if necessary all the way to their fracture. Bolted joints – a wind turbine has thousands of them – play a key role in the load bearing capacity of the entire unit. Over the years, bolted connections must withstand enormous loads.

Centrifugal, gyroscopic and weight forces

Bolted connections are separable joints holding two or several parts together by applying pressure. They are exposed to numerous influences: from freezing cold

to sizzling heat, from rain to snow and ice. Then there are various mechanical forces, such as centrifugal, gyroscopic and weight forces. "What makes matters more complicated," says GL expert Fabio Pollicino, "is the fact that wind doesn't simply approach the turbine in a uniform manner, like a wall of wind."

In fact, winds blow with various strengths and at different heights, causing different concurrent loads. A rotor blade passing through the highest point of its trajectory may be facing entirely different loads and wind directions than a blade passing through the lowest position. Of course, the aim of the engineer is to convert as many of these loads as possible into electric energy. But such loads always have to be transferred via the structure. Because of this, the foot of a wind turbine tower has to withstand the comparatively greatest loads. Large turbines of the multi-megawatt class have more than one hundred

M36 and even bigger sized bolts anchored in the foot of the tower to join the power plant, anything up to 120 m tall, firmly to the foundation.

The spring principle

The bolt type used most frequently is the metric hexagonal head bolt. The nut accounts for the required preloading force. Nuts are usually tightened using hydraulic tools. During the tightening process, the bolt stretches somewhat. In so doing, it acts like a spring, compressing the materials it clamps together. This is why bolt torque is of pivotal importance. The bolted connection will be unable to perform as expected unless the prestress is applied exactly as calculated. But influencing factors such as the lubrication condition can lead to error. Using clean, precisely lubricated hardware is therefore essential.

But even perfect lubrication cannot prevent some variation of the torque, and thus, the prestressing of the bolt. "In

typical bolted joints, a variation range of roughly 20 per cent is not unheard of," says Pollicino. "Being able to fine-tune the preloading precisely increases the security of the joining," he adds. Recently, Germanischer Lloyd examined an advanced piece of technology for preloading bolts with greater precision, called the "SUPERBOLT®".

The supernut

The special nut developed by Swiss company P&S Vorspannsysteme AG might more aptly be called a "preloading device". Installed into the face of the nut are many small screws in a circular arrangement. They all push against a pressure plate, jointly applying the same physical force as one large screw – with one important difference: it is much easier to tighten many small screws than one big one. Such preloading devices have been in use in the industry for quite some time, keeping the shafts of large presses or cranes in position, for example. Recently the SUPERBOLT® technology was certified by GL for wind power applications as well. "Obtaining this certification was a first step. In the near future we intend to have the 'tightening factor' aspect type approved too," says Reto Rieder, head of the P&S engineering department.

Bolts equipped with piezo elements manufactured by Intellifast GmbH offer another possibility for measuring the forces acting on bolted connections. These devices can be used to monitor bolt length by ultrasound, possible even during operation. They can detect the overstressing of a bolt

Close-up of a SUPERBOLT®-equipped connection.



beyond its yield strength, for example. "This technology enables a comparatively exact measuring of the bolts' pre-load and is therefore ideally suited for condition monitoring systems too," Pollicino explains.

Section by section

Let us take a look at an example of a wind turbine tower. Towers are manufactured in sections to facilitate transport. These sections are bolted together at the destination site. In most cases, the cylindrical, rolled-steel sections have welded L-type flanges at each end. These flanges feature drilled bolt holes. As the tower sections are assembled on top of each other, the bolts are fastened. Even during the manufacturing stage, certain tolerances occur with respect to flange flatness. During transport the section may be further deformed. Quite frequently these gigantic steel parts arrive at the construction site with their original manufactured precision compromised to some extent. Technicians must add thin steel shims between flanges to correct for the resulting alignment errors. This avoids wasting the strength of the bolts on merely holding the structure together, preserving it instead for resisting wind loads.

Once the wind turbine has been installed, it is ready to face the wind. Given the cylindrical cross section of the tower, the bolted joints arranged in a circular pattern are never loaded evenly. "The external force sometimes exceeds the prestress," says Pollicino. The bolts located on the wind-facing side of the tower are stretched while the bolts on the opposite side are relieved. The tower sections tilt away from the wind, rocking the flanges and creating a virtual "gap" on the windward side. Of course, there isn't a real gap that you could see through, but the bolts are stressed longitudinally to the extreme. Depending on the type, bolts can have different strength properties. If the yield point is exceeded, the bolt suffers a lasting, plastic deformation, compromising the design strength of the bolted connection.

So the goal is to avoid reaching the yield point. To accomplish this, engineers call for properly dimensioned bolts and tightening torque values to provide the necessary preload. To make sure the technicians assembling the turbine use the right hardware, the GL engineers use simulation software to verify if they have chosen a bolt size big enough to withstand even the strongest gusts. "These calculations take into account the full range of wind and equipment-related parameters," Pollicino explains.

THE SCIENCE OF NUTS AND BOLTS

Nuts and bolts are standardised. They are assigned one of several strength categories. Their key properties are minimum tensile strength and yield strength. The value is embossed onto the bolt head, such as 8.8 or 10.9. The first number multiplied by 100 indicates the minimum tensile strength (eg. 10.9 \triangleq 10x100). One tenth of the second number multiplied by the first result indicates the minimum yield strength (e.g. 10.9 \triangleq 0.9x1000), both in Newtons per square millimetre (N/mm²). In addition, there are differences in the way bolts are manufactured. The biggest screw used in a wind turbine is an M64.

The most interesting bolted connection, according to Pollicino, is the one joining the rotor blade to the hub. The rotor blades, being made of fibre composites, must for instance be fitted with steel threaded inserts that will receive the mounting bolts. These inserts are bonded into the blade root. An excessive bolt torque may damage the rotor blade. The bearing between the rotor blade and hub makes it even more difficult due to possible deformation.

One billion load changes

The sheer number of load changes affecting a wind turbine during its lifetime is stunning. A comparison with an automobile reveals a different world: An average wind turbine operates for approximately 170,000 hours during its lifecycle. A typical passenger car has to survive no more than 5,000 operating hours. The number of load changes the structure of a wind turbine has to withstand is similarly gargantuan: roughly one billion, compared to about 100,000 in the case of a car. But load changes aren't all the same. "Greater alternating loads have more dramatic effects," Pollicino points out. To illustrate this, he uses the example of a piece of wire: the more often you bend it backwards and forwards, the sooner it will break. The same principle applies to a wind turbine tower – except that you would have to bend it several million times to make it break. ■

FOR FURTHER INFORMATION

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What is Crucial to Certifying Types and Projects?

Abstract

Certification of wind farms, wind turbines and their components is state-of-the-art and a must in most places around the world. Furthermore certification to harmonized requirements is an active support of export. The benefit of Type and Project Certification for manufacturers, operators, banks and insurances is described, making use of the different certification processes as well as guidelines. The modules to obtain Type and Project Certificates are shown in detail according to the Guideline for the Certification of Wind Turbines, Edition 2003 with Supplement 2004 [2]. Type Certification comprises Design Assessment, Implementation of the design-related requirements in Production and Erection, Evaluation of Quality Management and Prototype Testing. Project Certification is based on Type Certification and covers the aspects of Site Assessment, Site Specific Design Assessment, Surveillance during Production, Transport and Erection as well as Commissioning and Periodic Monitoring. Each individual module concludes with a Statement of Compliance. Certificates are issued upon the successful completion of the relevant modules leading to safe, reliable and successful projects and wind turbines.

1 Introduction

Certification of wind turbines has a thirty-year history. It has been applied differently in scope, requirements and depth in e.g. Denmark, Germany and India, each on the basis of their own rules. These countries are still leading in the development and application of certification rules, but during recent years a number of other countries such as China, USA and Japan as well as operators, manufacturers and many banks have realised the necessity of a thorough evaluation and certification of wind turbines and wind farms. In general, the importance of expertise, assessment and certification of wind energy systems with respect to technical integrity and safety requirements becomes more apparent in view of the demonstration of functionality and structural reliability. In particular, Project Certification gives the possibility to assess the technical integrity of the wind

turbine subject to site specific demands (e.g. cold climate or wake effects in wind park configuration) to ensure reliability of the wind turbines on site. Minimising risks and building up confidence for investors, insurance agents, operators and authorities are the main aspects of a third party assessment within the Project Certification.

2 Certification

According to the international standard ISO/IEC 17000, certification is the confirmation of compliance of a product or a service with defined requirements (e.g. guidelines, codes or standards). International standards and guidelines are used to carry out Type Certification and Project Certification in the wind energy branch.

It is common practice to perform Type Certification (see chapter 4) for the complete wind turbine and Project Certification (see chapter 5) for the complete wind farm. Furthermore, components can be certified in order to provide market access to sub-suppliers.

3 Guidelines

In 1986, GL Wind created a first comprehensive certification procedure for international Type Certification and Project

Certification, which in its roots still applies today, but enhanced at regular intervals in order to cover the practical aspects and the experiences and developments in the field.

International standardisation efforts on wind energy systems certification procedures started in 1995 within IEC and resulted in the first issue of IEC WT01 [1] published by the IEC in April 2001. The certification procedure according to [1] as well as the procedure according to GL [2,3] have been introduced internationally and are the most important guidelines for certification of onshore and offshore wind turbines and wind farms.

4 Type Certification

Type Certification applies in general to the generic design of a wind turbine. To attain a Type Certificate, the modules as shown in figure 1 have to be carried out.

For each module, a Statement of Compliance will attest the conformity with the guidelines. The Type Certificate will list these statements and finalise the certification of the wind turbine type. Examples for both documents are shown in figure 2. A re-certification to renew the certificate is

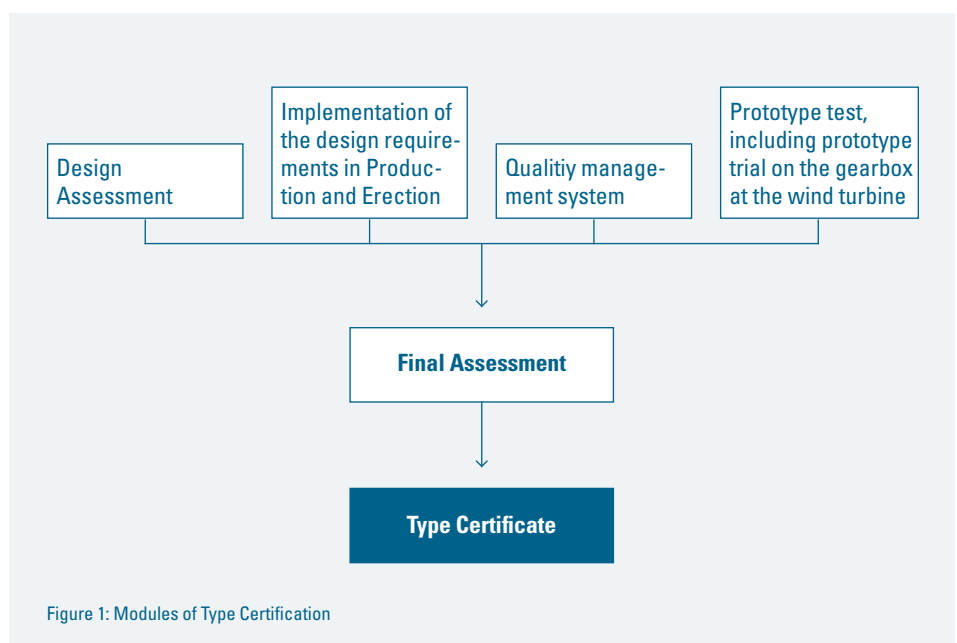




Figure 2: Examples of Statement of Compliance (left) and Type Certificate (right)

possible at any time. Furthermore alternative components can be included step by step.

4.1 Design Assessment

Design Assessment according to [2] can be divided into three parts: A-, B- and C-Design Assessment. The C-Design Assessment can be used to erect the prototype of a wind turbine. Within the C-Design Assessment, a plausibility check of the design documentation for the prototype will be performed.

A- and B-Design Assessments consist of a complete examination of the design analyses with all required material and component tests. They will be completed with the commission witnessing of one of the first wind energy systems of the assessed type. Compared to an A-Design Assessment, the B-Design Assessment may contain still outstanding items, provided that these are not safety-relevant. Furthermore, the validity period is limited to one year. This period can be used to fulfil all requirements for the A-Design Assessment which contains no outstanding items and does not expire

unless the design is modified. According to [2] the following documents in the form of specifications, calculations, drawings, descriptions and / or parts lists are to be assessed:

- control and safety concept
- load case definitions / load assumptions
- safety system
- rotor blades and blade test reports
- mechanical structures including nacelle housing and spinner
- machinery components (including prototype test of the gearbox on an adequate test bench)
- electrical installations, including lightning protection
- tower and foundation (optional)
- manuals for erection, commissioning, operation and maintenance
- other optional items like personnel safety, fire protection or condition monitoring system.

The load case definitions and the load assumptions / load calculations can optionally be performed according to the International Standards IEC 61 400 – 1, 2nd edition

[4] or IEC 61 400 – 1, 3rd edition [5] instead of the GL Wind Guideline [2]. If this is done, all requirements specified in the IEC standard will be used for design and certification. Topics not specified in the IEC standard will be dealt with according to the GL Wind Guideline [2].

4.2 Implementation of the design-related requirements in Production and Erection (IPE)

IPE shall ensure that the requirements in the technical documentation of the components are observed and implemented in production and erection of the wind turbine. This will be shown by the manufacturer of the components and the manufacturer of the wind energy system to the certification body.

4.3 Quality Management system of the manufacturer and designer

It will be shown that the manufacturer and designer meet the requirements of ISO 9001 with regard to the design and manufacturing process. In general the QM system is certified by an accredited certification body. ▶

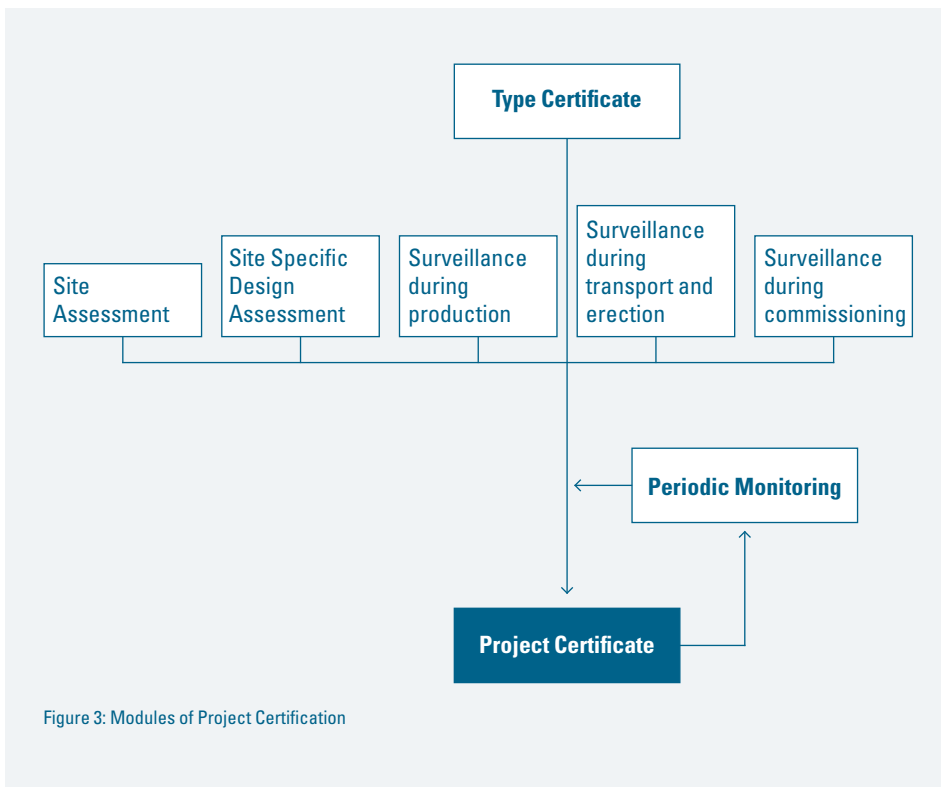


Figure 3: Modules of Project Certification

4.4 Prototype Testing

Within the scope of Prototype Testing, measurements of the power curve, noise emission and electrical properties as well as a test of wind turbine behaviour and load measurements are carried out by an accredited testing laboratory. Furthermore, the prototype of the gearbox is to be tested on the installation. All resulting test reports will be checked for plausibility of the measured results and compared to the assumptions in the design documentation.

5 Project Certification

Project Certification covers the aspects of assessing site conditions and suitability of the wind turbine for a given site. The individual modules are given in figure 3.

Upon successful assessment of the different modules shown in figure 3, the Project Certificate as shown in figure 4 will be issued, remaining valid as long as the Periodic Monitoring is carried out at the required intervals.

5.1 Site Assessment

Within the Site Assessment, the site conditions will be checked and compared to the parameters used for the generic design assessment of the wind turbine (part of the Type Certification). The documentation of the following conditions will be assessed:

- Wind conditions
- Soil conditions
- Electrical conditions
- Other environmental conditions (temperatures, earthquake, lightning, snow and ice formation...)

The Site Assessment will be concluded with a Statement of Compliance. In case conditions at the site are not covered by design parameters, a design assessment shall be performed applying the site-specific conditions. The generic Design Assessment will be enhanced to a Site Specific Design Assessment (see chapter 5.2).

5.2 Site Specific Design Assessment

The Site Specific Design Assessment extends the Design Assessment as part of the Type Certification to the site specific conditions. Due to the following reasons a Site Specific Design Assessment has to be performed:

- Site conditions are not covered by design parameters, or
- Design of the wind turbine to be installed deviates from the design assessed as part of the Type Certification (e.g. tower developed for the wind farm only)

5.3 Manufacturing Surveillance

Before manufacturing surveillance may begin, certain Quality Management (QM)

requirements shall be met by the manufacturer. As a rule, the QM system should be certified to comply with ISO 9001; otherwise the QM measures can be assessed by the certification body. The extent of the surveillance during production depends on the level of the QM measures: in general, actions and approvals like inspections and testing of materials and components, scrutiny of QM records (test certificates, reports), and, for example, inspections of corrosion protection.

5.4 Transport and Installation Surveillance

At the wind farm site, the important steps during installation shall be monitored. Prior to this monitoring, the transportation of the components from the manufacturer's works to the relevant site will be supported. Before starting, an installation manual shall be prepared containing all actions in consideration of the special circumstances of the site. Furthermore, a site plan showing the locations of the wind turbines shall be prepared, together with plans of the electrical installation, showing how the plant will be connected to the public mains supply.

5.5 Commissioning Surveillance

Commissioning surveillance deals with the transition of the finalised installation to



Figure 4: Example of Project Certificate

the operating wind turbine. Surveillance of commissioning is to be performed for the wind turbines of the wind farm and shall finally confirm that the wind turbines are ready to operate and are in compliance with the assumptions during the thorough assessment. Commissioning will be performed according to the previously approved procedures for all components related to operation and safety.

5.6 Periodic Monitoring

Periodic Monitoring is necessary to maintain the validity of the Project Certificate and is carried out in regular intervals, e.g. two years. Periodic Monitoring shall be carried out by authorized persons and shall contain at least the main components (e.g. rotor blades, gearbox, tower), the electrical installation, the hydraulic and pneumatic system and the safety and control system.

6 The Certification Body

GL is an internationally operating certification body for wind turbines and ocean energy converters and market leader in this field. GL carries out examinations, certifications and expertises and is actively involved in the development of national and international standards. GL offers the complete range of services for the certification of wind energy systems, wind farms and

ocean energy converters, plus inspections as well as any kind of expertise reporting. Certification is amongst others carried out on the basis of the GL Guideline for the Certification of Wind Turbines (Edition 2003 with Supplement 2004) [2], as shown in figure 5, and the Guideline for the Certification of Offshore Wind Turbines (Edition 2005) [3]. Both guidelines are regularly supplemented with technical information which is available on GL's homepage (www.gl-group.com/glwind). Furthermore, GL is accredited to carry out certification in accordance with all relevant national and international standards in the fields of wind and ocean energy.

7 Conclusion

The rapid growth of the wind energy industry and the growing size of wind farms enforce financing banks and insurance companies as well as authorities to require reliability and safety assessments of these projects. The assessments are carried out within the certification of the types of components, turbines and the wind farms, onshore and offshore. Within the framework of the certification of wind turbines, reliability, safety, strength and fatigue are evaluated in order to guarantee safe operation. Minimising risk and the building up of confidence for investors, insurance agents, operators and authorities are the main aspects of a third party assessment within the certification process.

8 References

- [1] IEC WT 01: "IEC System for Conformity Testing and Certification of Wind Turbines, Rules and Procedures", 2001-04
- [2] Germanischer Lloyd, Hamburg, Germany: "Guideline for the Certification of Wind Turbines", Edition 2003 with Supplement 2004
- [3] Germanischer Lloyd, Hamburg, Germany: "Guideline for the Certification of Offshore Wind Turbines", Edition 2005
- [4] IEC 61 400 -1 "Wind turbine generator systems – Part 1: Safety requirements", second edition February 1999
- [5] IEC 61 400 -1 "Wind turbine generator systems – Part 1: Design requirements", third edition August 2005



Figure 5: GL-Guideline [2]

Fire Protection Systems

Technical Note

Experts in the wind energy sector, and especially the insurance industry, have a truly burning interest in active fire protection measures. But how can fires on wind turbines be extinguished or, even better, prevented entirely?

The first units belonging to the German offshore wind farm "alpha ventus" in the North Sea are due to be installed by the end of the year. In the years to come, twelve plants will generate enough electricity for 50,000 households. Any failure of one of these plants, e.g. through fire, would lead to considerable expense.

At the "Husum Wind" trade fair in September 2008, Germanischer Lloyd will be presenting its Technical Note for Fire Protection Systems. This document allows manufacturers, owners, operators, investors and underwriters to minimize risk and to initiate corrective measures in good time. It addresses the topic of fire protection systems and the corresponding requirements for manufacturers. Safety concepts and tests, condition monitoring and regular inspections are also examined. The Technical Note sets out uniform requirements regarding effective and reliable fire protection systems for wind turbines and the certification of such systems. In addition, methods for the certification of fire protection systems are presented.

We will be happy to send you a copy of the new Technical Note for Fire Protection Systems. Please contact:

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Power in Small Packages

Wind turbines do not only come in the multi-megawatt format. At some locations, small installations offering a rated output of only a few kilowatts represent a useful supplement to power from the electrical grid. In remote areas, they are often the only possibility for generating electricity



This small wind turbine supplies an isolated house in the US with electricity.

It's lonely out in the wilds. The wind howls, bends trees, lashes your face. Here, in Alaska, real wilderness is still to be had: huts without running water, without heating, without power sockets. But even the toughest biologist finds it difficult to get by without at least some electricity. The computer and measuring instruments need to be powered. In order that the lonesome researcher can operate his equipment, there is a small wind turbine spinning outside the hut. Five kilowatts of output – just enough energy for the bare essentials. And if the wind should happen to drop, batteries can bridge the gap for a maximum of 48 hours. But luckily it is almost never calm here.

Power for fridges and mobile phone networks

Such small wind turbines (SWTs), with a rotor diameter up to approximately 15 meters are becoming increasingly popular – not only for powering the research stations at remote locations. In emerging and developing countries, these cost-effective

and low-maintenance miniturbines supply energy for transmission stations, water pumps and cellular networks. For these regions, small wind turbines are often superior to other island solutions, such as diesel generators or photovoltaic plants: they need neither fuel nor sunshine. Even in densely populated areas, more and more small wind turbines are to be seen sprouting in gardens and on roofs. This is the case in wind-blessed Scotland, where the windmills use the energy for the fridges and TV sets in their houses. The excess electricity is fed into the national grid – with the “net metering” method, the electricity meter in the house simply runs backwards and the owner is able to reduce his power bill.

About a hundred suppliers are offering these little power plants, which range in cost between several hundred and several thousand Euros. As a result, the quality also differs greatly. Some manufacturers are even of the opinion that they can break

Betz' law, a formula defining the maximum possible energy to be harvested from the wind.

From spiral vanes to the Savonius rotor

Construction kits are available which use the generator from a car and are driven by ordinary propellers. There are also specially water-protected and corrosion-proof models for use on yachts. The small units follow all of the well-known concepts: from spiral vane types through mantle turbines up to Savonius rotors. However, as is the case with their bigger brothers, the horizontal-axis concept with three blades has gained widespread acceptance so far. And, just like the XL versions, most of the little turbines use a gearbox to step up the shaft rotations to the required generator speed.

The reasons for erecting a small wind turbine vary considerably. On the American continent, the demand is for private houses off the beaten track, whereas in Europe, it is often universities or companies who wish to demonstrate their ecological awareness with a wind harvester. And the number of SWT enthusiasts is growing.

Dwarves in the landscape

Gearbox or not, garden or company – the mighty midgets are highly in demand. “It's a booming market,” says Fabio Pollicino of Germanischer Lloyd. But they are by no means a recent appearance; the first pioneers set up their installations over 30 years ago. On the global market, the lead is being taken by Southwest Windpower from USA with some 90,000 units sold. Up

FACTS AND FIGURES

Small wind turbines (SWT) are characterized by a swept rotor area smaller than 200 m². Their generators provide voltages of up to AC 1000 V (or DC 1500 V). Their towers are typically no higher than 20 meters. The safety of small wind turbines is predominantly assessed according to IEC 61400-2:2006.

until now, there have been no uniform rules or guidelines for the tiny turbines. "As one of the market leaders in the 'small wind turbine' sector, we recognize the significance and necessity of standardizing our plants. They have to meet the safety requirements of the certifiers and other agencies," says Frank Greco, CEO of Southwest Windpower.

In view of the low prices for personal-size wind turbines, it is no wonder that hardly any of the units have been officially tested. A process that is common practice for large turbines has still to be implemented for the little units. "To date, there is just about no certification for small wind turbines," Pollicino points out. Just about none? To be more precise, Southwest Windpower is the first manufacturer to be certified – by GL, in accord with present standards. The market leader manufactures various turbines in series, from minipropellers for sailboats up to free-standing units on a 20 meter lattice tower. For instance, the Skystream 3.7 is especially designed for the residential market. With a peak output of 2.6 kilowatts, it will deliver about 400 kilowatt-hours per month at a site offering average wind conditions. The turbine weighs 77 kilograms and is equipped with a gearless drive. Thanks to the permanently excited generator and converter, it delivers grid-compatible voltages for a wide range of wind speeds. "We are proud to offer our Skystream 3.7 – certified in cooperation with Germanischer Lloyd – on the European market. Southwest Windpower is

A Skystream 3.7 in Utah, USA.



Handing over of the Type Certificate for Grid Connection Compatibility for the Southwest Windpower Skystream 3.7 small wind turbine in Hamburg: Mike Wöbbeking (GL), Eric Seidel (SWWP), Fabio Pollicino (GL) (f.i.t.r)

paving the way for other developers by helping to set stringent standards for the engineering, design and manufacture of small wind turbines," says Frank Greco of Southwest Windpower.

How robust are the rotor blades?

To allow the erection and operation of installations like the Skystream 3.7, Germanischer Lloyd and others produce expert appraisals and carry out type approvals. For this, GL engineers like Fabio Pollicino take a close look at the construction and design of the plants. What does the generator grid connection look like? How robust are the rotor blades of glass-fibre composite material? Have the bolted connections been chosen correctly and are they also suitable for use at sea? What about the electronics? Has the cabling been dimensioned adequately, so that it is not likely to heat up unduly or even burn out in the event of a storm? To be able to answer all these questions, GL maintains a test centre in cooperation with several partners. WINDTEST Kaiser-Wilhelm-Koog, on the North Sea coast, enjoys an excellent reputation worldwide for the testing of wind turbines. Even the dinosaur of all wind turbines, GROWIAN, which in its time was the largest wind turbine in the world with a rotor diameter of 100 meters, has put through its paces here.

But the test field is not only suitable for testing giant turbines. Even for the little units, expertise on the blade loads, drive train and tower i.a. are needed. Everything is done to the very highest standards: WINDTEST works on the basis of an ac-

creditation based on ISO 17025. Skystream 3.7 also had to prove its mettle here. "The Skystream 3.7 has passed the duration test successfully," says Pollicino. For this, the entire turbine had to run perfectly for about 2500 working hours. But why go to so much trouble for a small turbine? "The manufacturers want to set themselves apart from their competitors by means of a technically independent assessment. The intention is to get more selling points," Fabio Pollicino explains. In the US market, SWTs only receive subsidies if they are properly certified. In Germany, only units with Type Approval may be erected.

Pointing the customer in the right direction

In fact, many buyers, financiers, authorities and insurers will also be keeping a watchful eye on small wind turbines in future, to see whether the technology has matured. By giving the customer an orientation aid, the safety standard "IEC 61400-2" of the International Electrotechnical Commission will surely make an important contribution. And yet a lot of the action in constructing small turbines is still taking place in garages, with the motto, "if it turns at all, that's great!" The era of the homebuilt "coffee grinders" could end soon when the market is penetrated by small wind turbines that are professionally built. ■

i FOR FURTHER INFORMATION

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New Lecturer

Christian Nath, Global Business Manager at Germanischer Lloyd, is the new lecturer for the "Renewable Energy Finance" course at the Frankfurt School of Finance & Management. Targeted at bank and law firm employees as well as project developers, this course of further education will begin for the first time on 12 September in Hamburg. The curriculum was designed in close cooperation with representatives of financial institutes, insurance companies, law practices, the Federal Financial Supervisory Authority (BaFin) as well as companies operating in the field of renewable energies. ■

Christian Nath



Helimax: Wind Energy Strategic Network (WESNet)

Wind resource assessment; Harvesting of wind energy; Wind energy in electrical power systems and Techno-economic models and optimization. These topics are on the agenda of the new strategic wind energy research and development network that has recently been created with the financial support of the Natural Sciences and Engineering Research Council (NSERC). With financing over 5 years, this network brings together 16 Canadian universities, federal (including NRCan and EC) and provincial (including Hydro-Québec and Manitoba Hydro) agencies, institutional partners of the wind sector (including CanWEA and the CORUS Centre) as well as Helimax as representative of the private sector. This research network's objective is to affirm and reinforce Canadian wind energy expertise on the international level. The Network will help train 153 students and ensure the transfer of know-how and technological advances to the wind industry. ■

Lecture

High Technical Demand

Regulations for the Grid Connection of Wind Power

Grid codes for wind turbines differ from one country to another. Manufacturers of wind turbines are constantly challenged to adapt the design of their installations to be in line with the latest requirements of the network operators. "Wind energy plants shall be configured in such a way that they are conforming to the

regulations", stated Tobias Gehlhaar from Germanischer Lloyd in his presentation at the 7th International Workshop on Large Scale Integration of Wind Power in May in Madrid, Spain. "This must be taken into account in new developments and satisfied by means of innovative solutions".

For the verification and evaluation of a turbine, test procedures have been developed. Wind energy plants should be certified in order to be accepted for grid connection by the system operators. This approach has to be uniform in order to be comparable for different turbine types and countries, Gehlhaar emphasized. In his presentation, Gehlhaar gave an overview on the highest demands given in a purposive selection of regulations. ■

DATES

9–13 September 2008

HUSUM WindEnergy
Husum, Germany

Press Conference:

· "Technical Note for Fire Protection Systems"
GL and GDV
10. September 2008, 10 a.m., Booth 1C18, Hall 1

Lectures:

· "Design Accompanying Assessment"
Axel Dombrowski
10. September 2008, 3.15–5.15 p.m.
RLE Experts Forum "Advance by Technology Transfer", Hall 1, Meetingroom 1

· "Grid Surveillance" (in German)
Germanischer Lloyd AG/ WINDTEST
12. September 2008, 10:00–11:00 a.m., Room 3

29–31 October 2008

4th Global Wind Energy Conference, GWEC,
Beijing, China

Lecture:

· "The latest News for Certification of Wind Turbines and Wind Farms – Onshore and Offshore"
Mike Wöbbeking

26–27 November 2008

DEWEK
Bremen, Germany

Lecture:

· "Efficient Modelling of the Drive Train Dynamics in Wind Turbines"
Markus Kochmann and Milan Ristow
26. November 2008, 2:30 p.m.

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