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GL Garrad Hassan www.gl-garradhassan.com

energize renewables

energy. efficiency. engineering.

Wuthering Heights

pooled forces Garrad Hassan Joins GL Group

risk assessment The Way to Safe Wind Farms

wind turbine Power Characteristic Is Key Factor

Renewable Energy

GL Garrad Hassan

GL Garrad Hassan is the world's largest renewable energy consultancy. Dedicated to serving the renewables industry it offers independent technical and engineering services, products, and training to the wind, wave, tidal and solar sectors. Although the GL Garrad Hassan name is new, the company has a rich heritage. It was created by the integration of specialist companies that, united under a single brand, form the renewable energy consulting division of the GL Group.

www.gl-garradhassan.com

To Our Readers

Andrew Garrad

Recent statistics continue to show that wind is the world's fastest-growing source of power generation with an average annual growth of 29 per cent over the last ten years. And the future prospects of the global wind industry are even more encouraging. Offshore wind installations, for example, are now being planned and constructed with over 100 turbines as standard.

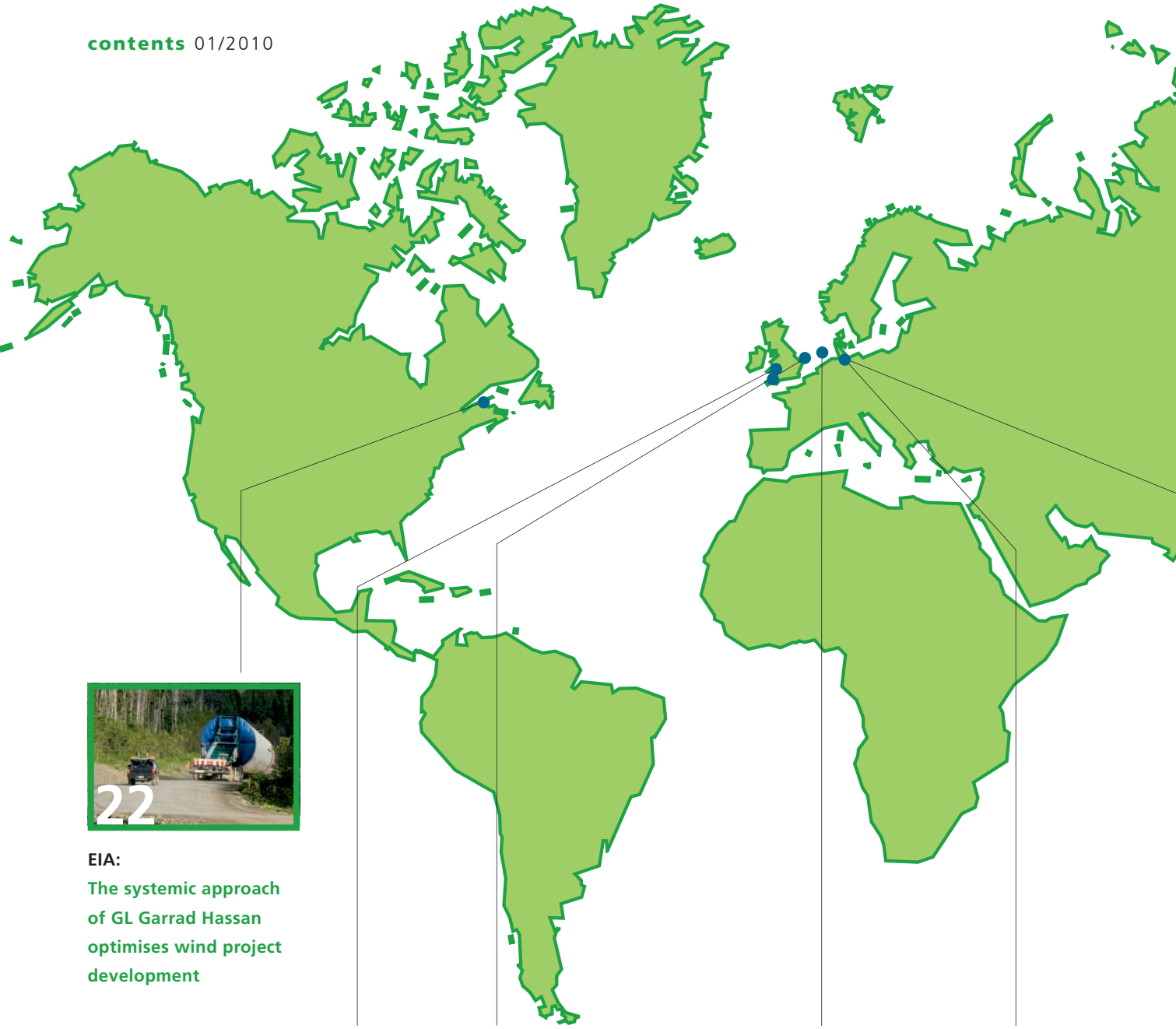
Looking at technical assurance and consulting, the demands from manufacturers, operators, financiers and insurers have risen sharply: The investment costs going into wind projects are measured in billions, and the owners and operators of the biggest wind farms are now large-scale utility companies.

These projects call for a premier supplier of engineering consultancy, certification and project management services to the renewable energy industries. **Garrad Hassan, GL** and **Noble Denton** are pooling their expertise to address all key questions in renewables whether in the optimisation of wind farm designs, improvements in the performance of existing wind farms, measurements, inspection or certification of turbines. Dealing with huge offshore wind farms requires experienced and sophisticated project management services as well as in-depth operational knowledge in the transportation, installation and project execution. The combined renewables business will operate under the name of **GL Garrad Hassan**.

Our new magazine *energize renewables* marks this development by offering news, projects and case studies in renewables. *energize renewables* will provide detailed and comprehensive coverage of best practices and offers an insight into the spectrum of our services in the wind, solar, wave and tidal energy industries.

Yours sincerely,

Andrew Garrad
President of GL Garrad Hassan



EIA:
The systemic approach of GL Garrad Hassan optimises wind project development

WIND FARM:
The power characteristic is a key factor in engineering a wind turbine

MERGER:
GL and GH ready to serve the renewables sector as one enterprise

FINANCING:
Concepts that may encourage banks to finance offshore wind farms

INTERVIEW:
Member of GL's Executive Board Pekka Paasivaara talks about the company's strategy

RISK ASSESSMENT:
Manufacturers of wind turbines have to ensure safe and profitable operation

STANDARDS:
GL presents revised guidelines for wind turbine certification

In Brief:
GL Garrad Hassan – Part of the GL Group

- GL Garrad Hassan is the **WORLD'S LARGEST** renewable energy consultancy. It offers a **UNIQUE LEVEL OF SERVICE EXPERTISE** and global presence across the whole project lifecycle.
- With 650 staff in 35 locations, across 20 countries GL Garrad Hassan is a **GLOBAL PLAYER IN RENEWABLES.**
- Its technical scope covers all relevant aspects of onshore wind, offshore wind, marine renewables, and solar energy. It addresses the requirements of manufacturers, operators, investors, projects developers, authorities, and the supply industry **WITH REGARD TO ALL TECHNICAL ASPECTS OF RENEWABLE ENERGY APPLICATIONS.**
- Given the current focus on wind energy, GL Garrad Hassan is able to provide **A COMPREHENSIVE SET OF SERVICES** including the optimal design of wind parks, improvement in the performance of existing wind farms, measurement projects (wind resource, wind turbine performance and structural behaviour), inspection and certification of turbines all as well as a large array of software products and turbine design services. In addition, GL Garrad Hassan **HAS GAINED SUBSTANTIAL EXPERIENCE** in tidal and wave power generation and is involved in various solar projects.

GL Garrad Hassan is the renewables business segment of Germanischer Lloyd (GL). GL is a technical assurance and consulting company **FOR THE ENERGY INDUSTRIES AND ALSO A LEADING CLASSIFICATION SOCIETY.** GL employs almost 6,900 engineers, surveyors, experts and administrative staff. Its **GLOBAL NETWORK** consists of more than 200 stations in 80 countries. Customers of GL Garrad Hassan enjoy the benefits from established industrial techniques to renewables, the application of existing computational techniques, the adaptation of maritime techniques to marine renewables and a large engineering capability within GL.

GL Garrad Hassan

Optimising wind farms: GL Garrad Hassan takes a close look from the pre-development phase through to operations. From strategic consulting to wind resource assessment, due diligence reviews to performance optimisation, GL Garrad Hassan offers its services to project leaders, financing institutions and insurers of renewable energy.

consulting & engineering

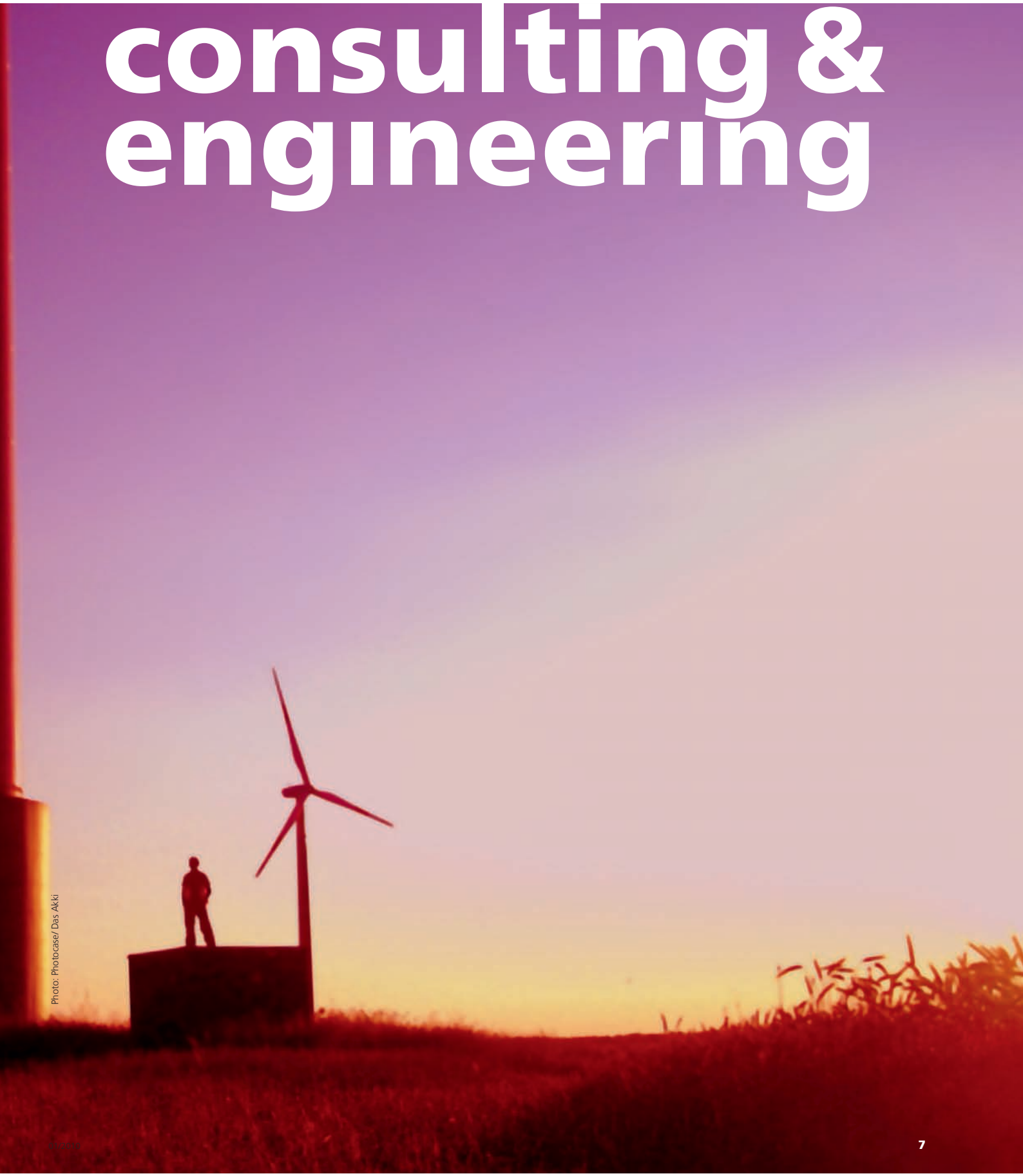


Photo: Photocase/ Das Akki

"We Want to Be the World's Number One"

Germanischer Lloyd (GL) is rapidly expanding its activities in the renewable energy sector. The British company Noble Denton, Canadian company Helimax, as well as the German company WINDTEST Kaiser-Wilhelm-Koog, all fitted in with its growth strategy and were summarily snapped up by GL Group.
And the latest coup: The Garrad Hassan Group – one of the world's most highly renowned consultancies in the field of renewable energies – has joined GL Group. *energize* spoke with Pekka Paasivaara, Member of GL's Executive Board, about the company's strategy

ENERGIZE: There are lots of consultancies – why did you specifically choose Garrad Hassan?

PEKKA PAASIVAARA: The GL Group has repositioned itself strategically in the last year. We were led by the question of how we wanted to position ourselves in the renewable energy market. We came to the conclusion that we would have to build up a very wide ranging service spectrum alongside our already active turbine and project certification.

Our customers need comprehensive advice on all phases of wind farm development – from the first studies right through to the inauguration. We made it our aim to build up a one-stop shop, i.e. offer comprehensive consultancy services from one provider. We already knew Garrad Hassan and that we would complement one another marvellously. At the end of July we thus agreed to become one.

ENERGIZE: How do you do something like that – surely you didn't just phone up Garrad Hassan and ask if they wanted to become part of GL?

PAASIVAARA: It was a long process. It was important that we were both convinced that we really fitted together. Not just in terms of technical competence but also in terms of the business culture and employee mindsets – a very important prerequisite.

ENERGIZE: Garrad Hassan and the GL wind section are about the same size, with 300 employees each. How do you plan to bring together the two companies?

PAASIVAARA: Our business culture and the way we view the market are very similar. In this I mean our opinions of how we wish to position ourselves and what sort of services we wish to offer. ▷

ABSTRACT

- GL is looking at all forms of renewable energy in the future. Wind and solar will play a leading role in the years to come.
- GL offers consultancy and certification services for all components of on- and offshore wind turbines.

Photo: iStockphoto

ENERGIZE: Consultancy and certification from one company? Does that fit together? As a customer I want to have an impartial certifier.

PAASIVAARA: You're right, the special role of certification requires an impartial body. It is for precisely this reason that we are going to keep our certification activities separate from our other activities in the field of renewable energies.

ENERGIZE: How are you going to get this across to your customers?

PAASIVAARA: There is a sort of "Wall of China" between the technical services and the certification department. The certification unit is managed separately with different personnel, different systems technology and different process management. We believe that we can hold up the integrity of the certification unit in this way. We have obviously also spoken with our customers about this. They have said that it is alright, GL may do consulting and certification at the same time. GL was already doing this before the takeover of Garrad Hassan, by the way.

ENERGIZE: Garrad Hassan has recently expanded its expertise to include solar power, with the focus on Concentrated Solar Power **(CSP)**. This is new territory for GL – what are you going to do with the solar section of Garrad Hassan?

CSP. Concentrated Solar Power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam.

PAASIVAARA: We have renamed the Wind Power section at GL to GL Garrad Hassan". We will thus no longer just look at wind power, but at all forms of renewable energy in the future. We see a lot of potential in Concentrated Solar Power. Apart from solar power, we are involved in many research projects looking at energy generation from the seas, for example wave and tidal power plants. But if you consider the achievable medium-term yields, then solar and wind power will certainly play a leading role for years to come.

ENERGIZE: Have customer structures changed at all in the last few years?

PAASIVAARA: In wind power, large companies are operating with large investment volumes. With further sinking production costs, wind power will become an increasingly attractive energy technology. This is bringing in the large energy suppliers and infrastructure companies around the world, whether it be EDF, E.ON, Iberdrola, Florida Light or Vattenfall. These are our customers.

ENERGIZE: Are you shifting your regional focus points?

PAASIVAARA: At the moment we have a regional balance in the onshore wind power sector. The USA, Europe and India plus China each have around one third of the world market. China is also growing very strongly this year and we can see that China will take the lead in terms of installed capacity by next year at the latest. It's a different situation in the offshore sector. Europe will continue to play a very strong role here. Although there are big offshore plans in China and the USA, implementation is going to take several years.

ENERGIZE: What components of an offshore turbine does your certification business cover?

PAASIVAARA: Our certification service covers all components of a wind power system, such as the turbine and foundation structures. In the last few years we have strengthened our competences. We are bringing in our services for measurement, engineering and environmental analysis, from Garrad Hassan comes expertise in software solutions, and Noble Denton is bringing in over 100 years of experience in the offshore field, e.g. know-how in un-

We will no longer just look at wind power, but at all forms of renewable energy in the future.

Vision.
Pekka Paasivaara, Member of the GL Executive Board.

derwater structures and offshore installations. With these we are able to offer convincing concepts for the whole project management of an offshore wind farm. We carry out a feasibility study with all the required measurements, analyse the turbine power, check the machines' economic viability and thus the validity of the financial models, carry out the environmental impact assessments and take on the implementation management. That last point can have a pretty varied scope, starting with an owner's engineer, who keeps an eye on all the work going on, right up to the complete management of all operative steps.

ENERGIZE: What does this cost in relationship to the investment as a whole?

PAASIVAARA: This can vary a lot, because the investors can book their desired scope of services. This may come to 0.1 per cent of the investment volume, or also up to 7 per cent if a complete management is booked.

ENERGIZE: Doesn't the flood of certifications make a wind farm unnecessarily expensive? Damage isn't prevented by this, after all, as many examples have shown.

PAASIVAARA: The certification of wind farms, wind turbines and their components reflects the current technical state of affairs and is compulsory for most locations around the world. As far as the total costs of an offshore wind farm are concerned, the cost of a type or project certification is marginal. But it means a big increase in security for investors, insurers, operators and authorities.

ENERGIZE: What will the wind power business of GL Garrad Hassan look like in five year's time?

PAASIVAARA: We aim to be the world's leading technical consultant: the best partner for developers, investors and project owners. ☐ JI

Pooled Forces

The renewables sector continues to grow, offering a host of opportunities for GL Garrad Hassan is now ready to serve the market as one integrated technical services and consulting enterprise

ABSTRACT

- GL Garrad Hassan supports all present and future forms of renewable energy. Wind, water and solar energy will play key roles in the years to come.
- GL offers consulting and certification services for all components of on- and offshore wind turbines.

The world's oceans hold an almost inexhaustible supply of energy. However, harnessing that energy poses enormous technical challenges. A project worth eight million British pounds will produce tools capable of accurately estimating the energy yield of major wave and tidal stream energy has been approved by the Energy Technologies Institute (ETI).

PerAWaT, a project led by GL Garrad Hassan, and including EDF Energy, E.ON, the University of Edinburgh, Oxford University, Queen's University Belfast and the University of Manchester will develop a series of models to predict the performance of wave and tidal stream generator arrays. ETI Chief Executive Dr David Clarke said: "Although the UK has huge marine potential, investment is being held back by uncertainty about the overall costs involved and the potential returns on investment in wave and tidal technologies."

The PerAWaT marine energy project demonstrates that "renewables" denotes more than just wind energy. In particular since Germanischer Lloyd, an enterprise that originated as a provider of technical services to the shipbuilding and shipping industries, and Garrad Hassan (GH) pooled their forces, the new enterprise faces the challenge.

Growing Demand

Last year the two companies announced the successful completion of their merger negotiations in Hamburg. Under the name GL Garrad Hassan they now jointly form a leading independent, global provider of consulting, engineering, turbine design, certification, measurement, project management, strategic advice and inspection services as well as software products for the renewable energies sector.

Their joint technical services portfolio covers the entire life cycle of wind, solar, marine and other renewable energy projects, both onshore and offshore, including the areas of safety, integrity, reliability and performance management.

"The merger of Garrad Hassan and GL is a reflection of growing customer demand for a one-stop service provider who offers solutions for challenges in technology, environmental matters and asset performance on a worldwide scale," said Pekka Paasivaara, Member of the GL Executive Board. "Together we will offer a unique level of service expertise and global presence across the whole project lifecycle."

The new renewables business segment GL Garrad Hassan employs over 600 highly qualified engineers, technical experts and supporting staff working at 34 locations around the world. The merger follows GL's acquisitions of Canadian wind energy consulting and engineering company Helimax, as well as WINDTEST, a German specialist in the field of measurements for wind turbines and wind farms. In addition, the offshore wind power expertise of Noble Denton, particularly in wind project management, was added to the GL Group in April 2009.

GL has thus positioned itself as a full-service consultant with an expanding range of services, such as optimization of wind farm designs, performance enhancement of existing wind farms, measurement projects (covering wind resources, wind turbine performance and structural behaviour), as well as inspection and certification of turbines.

Garrad Hassan contribute their comprehensive engineering and consulting expertise, along with a large array of software products and turbine design services. The merger puts GL Garrad Hassan at the forefront in the drive to develop a greener and more sustainable energy mix for the world.

Photo: Dreamstime

New Project

DUDGEON OFFSHORE WIND LTD have appointed GL Garrad Hassan to provide continued technical support as it pushes ahead with Dudgeon's 560MW Round 2 project, in parallel with a planning approval process, in order to chase a 2013 commercial operation date. The Dudgeon site, which is positioned north of Cromer off the coast of Norfolk, has the potential to cover the annual electricity demands of 400,000 UK homes.

GL GARRAD HASSAN'S MULTI-DISCIPLINARY OFFSHORE TEAM is utilizing its many years of experience in supporting project developers, owners and investors to provide Dudgeon with advice related to the wind turbine and support structure procurement process as well as assessment of wind resource and site conditions.

Successful Combination

"GH is delighted to be merging with GL. We have considered many potential partners but we have chosen GL because we share the same values of independence and technical rigour. Both companies have been working together for 25 years and hence know this combination will be successful. It brings benefits to our clients and employees alike. We are now able to provide an even more comprehensive service offering with access to more engineers, and this will enable us to enter developing markets," explained Andrew Garrad, former CEO of Garrad Hassan, who will be President of the new, combined renewables business. □ SG

PERAWAT.
"Performance Assessment of Wave and Tidal Array Systems" is a project to predict wave and tidal energy.

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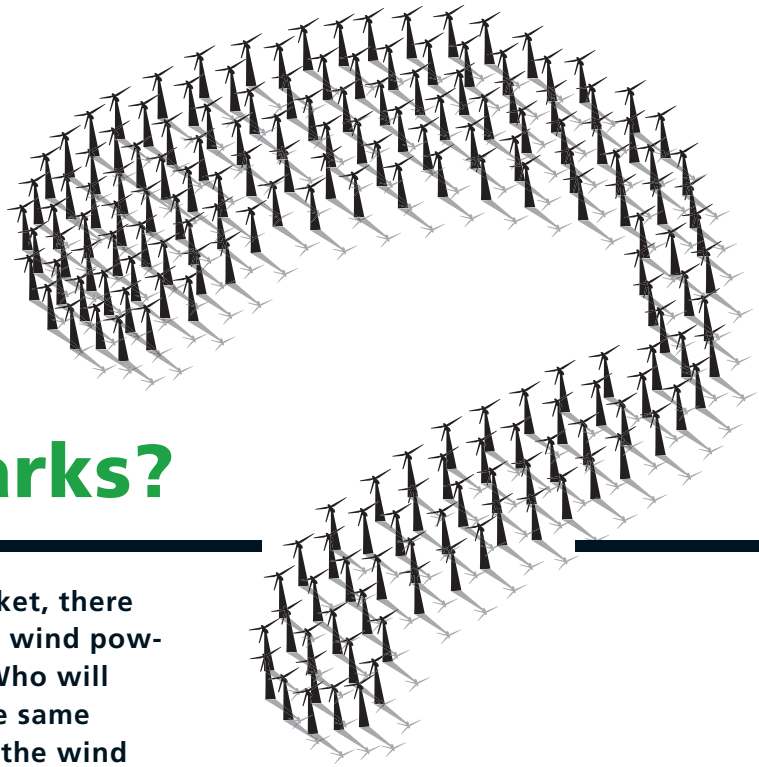

Too Many Question Marks?

Quite contrary to the onshore market, there are several challenges for offshore wind power that have yet to be overcome. Who will finance which component? Will the same company assume liability for both the wind turbine and the foundation? Which method of erecting turbines is most efficient?

ABSTRACT

- Banks are often reluctant to finance offshore wind farms. They prefer general contractor agreements.
- GL Garrad Hassan offers a full range of consultancy and certification services covering all components of on- and offshore wind turbines.
- Wind experts are proposing entirely new concepts that may encourage banks to finance new projects.

20-20-20 – The European Union has ambitious goals. Energy consumption and greenhouse gas emissions are to decrease by 20 per cent, whereas the percentage of electricity produced from renewables is supposed to increase by 20 per cent. And all this by 2020. There is thus no getting round the topic of offshore wind technology. Though 21 out of 40 farms planned have been approved in Germany alone, one can hardly speak of a stampede for offshore wind. Of the 70,000-some MW that might be installed in European waters this decade according to EWEA estimates, only 600 MW have been connected to the grid to date. Unresolved questions regarding financing, system technology and liability are the main drags. "More new ideas is what we need," demands Wilhelm Heckmann, engineer with GL Garrad Hassan.

When it comes to financing, banks politely hold back. One reason is that general contractor agreements are the exception rather than the rule. Instead of having one company in charge, each manufacturer is liable for its own components. "Banks prefer general/EPC contractor agreements," explains Jochen Gassert of GL Garrad Hassan. "The more in-

Offshore.
Jack-up barges transporting the wind turbine components.

terfaces you have, the more difficult it is to find the person responsible in the event of a problem."

Technical Expertise

But there are ways to overcome this dilemma. GL Garrad Hassan offers technical due-diligence checks to assess the feasibility and soundness of projects. Using a special financial model, GL Garrad Hassan can calculate the expected yields as well as the maintenance and service costs. "From the banks' point of view, that would be the ideal approach," emphasises Jochen Gassert.

Danish energy company Dong Energy prefers multi-contracting, assembling wind farm components from multiple suppliers in-house and distributing the risk among the manufacturers. This does, however, call for a high level of technical expertise.

"Currently there are hardly any tools for accurate cost estimates," says Jochen Gassert. Making realistic predictions is virtually impossible. The basic parameters of wind projects, such as foundation soil conditions, distances, harbour infrastructure and available installation vessels, are too diverse. "Longer waiting times, smaller installation windows. The further you go out, the more expensive it gets," says Wilhelm Heckmann.

Heated Debate

Moreover, there is the weather, fluctuating feed-in tariffs (outside of Germany) and uncertainties regarding the technical reliability of wind turbines. "Though GL Garrad Hassan offers a standard model, there are always some variables," says Jochen Gassert. These include aerodynamic and electrical losses, and grid availability. In particular, a large question mark hangs above the installation method at sea. While there is plenty of theoretical knowledge, practical experience with offshore systems in deep water is scarce.

It is thus hardly surprising that a heated debate has erupted regarding the vessel types that should be used to transport the components to the wind farm site and install them. Should the turbine parts be hauled in by transport vessels and then assembled by special installation craft? Or would it be more expedient to use special vessels capable of loading the components in the port and subsequently – equipped with pile-driving machinery and a crane – erecting the wind turbines, as well? Then there is the maintenance debate, waged with almost sectarian fervour: Should engineers and spare parts be present on site or not? For the GL specialists, the answer is clear: "Special vessels. We need to have personnel constantly on site at the wind farm," says Jochen Gassert. Wilhelm Heckmann specifies: "A service **JACK-UP BARGE** is the most cost-efficient solution."

JACK-UP BARGE. A barge capable of lowering three or four supporting legs to the seafloor to raise itself up.

Will all these question marks disappear soon? Perhaps. Some experts even go as far as claiming that installation vessels could soon be operating 300 days a year. Meanwhile, wind experts are presenting entirely new concepts. One such proposal envisages wind turbines being assembled and tested directly in the harbour. If everything goes according to plan, the entire wind turbine would then be transported to its site and erected in a matter of hours. If the associated assembly methods prove successful and the wind turbines demonstrate their seaworthiness, the banks will probably show more interest, as well. □ **DH**

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Photo: Alpha Ventus / Matthias Ibeler

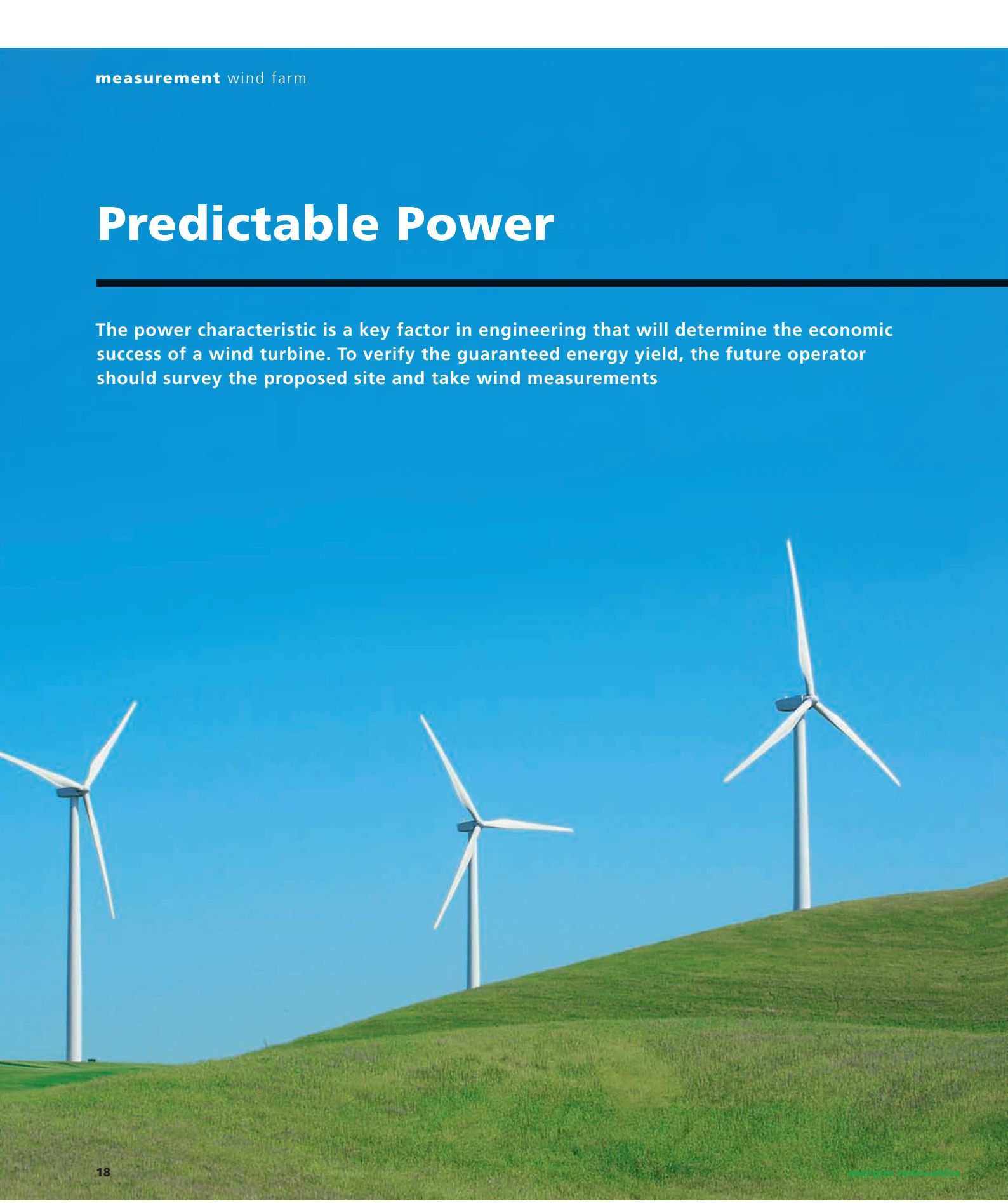
The success is measurable: GL Garrad Hassan offers an unquestionable level of know-how in the field of wind projects and the full range of turbine measurement services. The combined expertise is clearly recognised among developers, lenders and turbine manufacturers throughout the world.

measurement

Photo: KfW/ Rüdiger Nehmzow

Predictable Power

The power characteristic is a key factor in engineering that will determine the economic success of a wind turbine. To verify the guaranteed energy yield, the future operator should survey the proposed site and take wind measurements



Wind conditions, turbine types, infrastructure, efficiency: Before a prospective wind farm project is ready to enter the actual planning stage, a number of essential assessment criteria must be evaluated to determine the feasibility of the project. At this point, it is not necessary to conduct a full-scale, detailed analysis, which would involve significant effort and time. Instead, assessing certain key criteria summarily will provide meaningful and entirely adequate information. The results of this preliminary assessment form a solid basis for deciding whether the project should proceed. Once the actual planning process has been initiated, an extensive, in-depth study of all relevant aspects of the project will follow.

Focus on the Power Characteristic

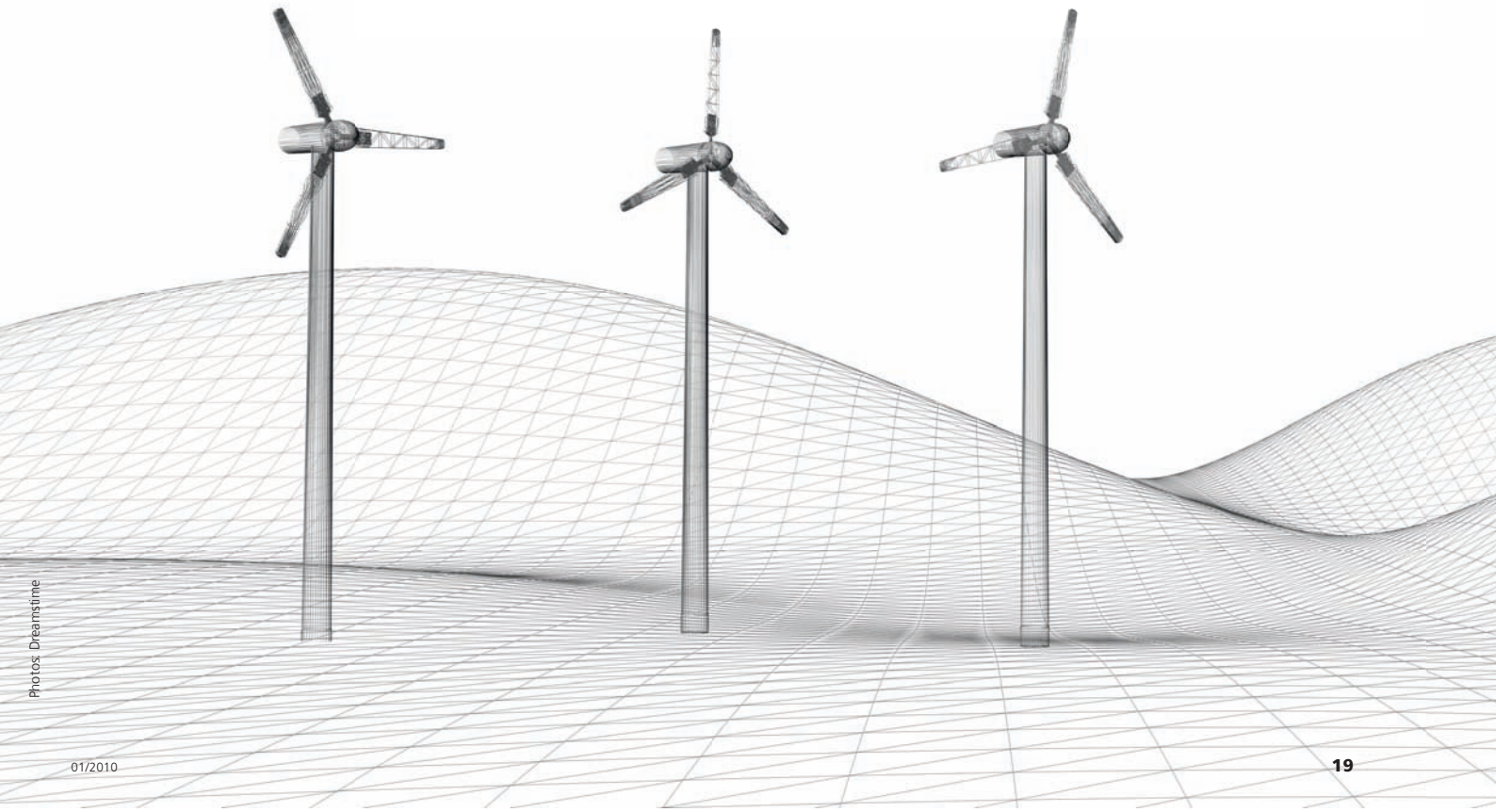
One key aspect in determining the technical requirements for a prospective wind turbine and in assessing its long-term economic feasibility is the power characteristic, or power curve, of the envisioned system. The power characteristic reveals the power yield to be expected under specific wind speed conditions. It serves as an indicator of the output behaviour of any specific wind turbine type. It allows planners to compare various machine types and select the type best suited for the given site in terms of annual power output. The annual power yield can be calculated by convoluting the power curve by the wind speed distribution at the site.

Ignoring the power characteristic, on the other hand, may have severe consequences for the operator's liquidity since deviations in the operating behaviour will directly affect the financial feasibility of the power plant.

To mitigate this risk, purchasing agreements usually contain a clause guaranteeing that the manufacturer will compensate the operator for any damages caused by deviations of the power characteristic ▷

ABSTRACT

- Comparing the power characteristics of various wind turbine types helps ensure the best possible energy yield at the given site.
- Each site must be assessed as early as possible to find suitable conditions for measuring.
- An AEP procedure is recommended for comparing the measured and the guaranteed power characteristics.



Photos: Dreamstime

▷ from the type specification. Typically, such clauses cite "95 per cent of Annual Energy Production (AEP)", referring to the relevant technical directives.

Produce Evidence

In wording such warranty clauses, operators should make sure the contract provides for an appropriate method of verifying conformance with the power characteristic once the power plant is in operation. Without a contractually-agreed form of evidence, the guarantee will be essentially worthless.

The only way to prove non-conformance once the wind farm is in operation is to take measurements on single turbines located at the perimeter of the site. The directives set clear, tight limits for **AMBIENT CONDITIONS** at the site under study, in particular regarding existing obstacles in the path of the wind (i.e. buildings, trees, turbines) as well as elevations and uneven terrain.

AMBIENT CONDITIONS. The "ambience" of a turbine is determined by its rotor diameter. For a large unit, this can be a circle around the tower up to six kilometres in diameter.

It is therefore essential to assess the measuring conditions at the site as early as possible so as to ensure the validity of the warranty clause. In the event that the standard conditions as defined by the directives cannot be met due to the particular situation at the site, the guarantee clause in the contract should be adapted to reflect the actual conditions. Options include:

- **perform a site calibration pursuant to the IEC directive prior to constructing the power plant;**
- **negotiate site-specific deviations from FGW TR 2 and /or IEC 61400-12-1;**
- **agree on one specific wind turbine that can be measured as stipulated in the directives, to be used as a reference unit for the entire site covered by the contract;**
- **take measurements based on the current draft version of IEC 61400-12-2 (refer to "nacelle anemometry").**

State explicitly in the guarantee clause that the power characteristic of the entire wind farm should be used as a reference (wind farm power characteristic dependent on the wind direction, in analogy to the draft version of IEC 61400-12-3), rather than relying on the power characteristic of individual turbines.

Measure the Power Characteristic

Both the site itself and the surroundings of a wind turbine play a critical role in determining power characteristics. In flat terrain free of obstacles, it can be assumed that the wind speed measured on a measuring tower will be equivalent to the wind speed at the centre of the rotor area (hub). This basic assumption does not apply in complex terrain,

The Initial Assessment

The following questions should be answered to assess the basic aspects of a planned wind farm project:

WIND RESOURCES
What are the wind conditions at the site?

PLANNING AND TECHNICAL CRITERIA
What basic questions should be addressed?

TURBINE TYPE
What wind turbine type would best match the site (wind situation, power characteristic, structural stability, etc.)?

Photo: Gamesa Eólica

Operating. **The power characteristic serves as an indicator of the output behaviour of any specific wind turbine type.**

however, which is why the site under investigation must be calibrated prior to building the wind farm. This is done by determining wind-speed-dependent correction factors using two measuring towers. The resulting factors will then be added to the wind speed readings associated with the actual power measurements.

When choosing a suitable site for a measuring tower, every attempt should be made to avoid the lee side of obstacles and adjacent wind turbines, apart from purely practical considerations, such as property ownership or the existence of firm ground conditions to support the tower base. This will ensure that the free geometric sector available for evaluation will be as large as possible. This sector must be oriented towards the prevailing direction of the wind. Following these rules will help minimise the measuring time, and thereby, the associated costs.

Select the Criterion

IEC 61400-12-1 offers the user two criteria for establishing a complete set of data. The first criterion involves measuring up to 1.5 times the wind speed at 85 per cent of the nominal power output. For a unit with a rated speed of 12 m/sec, this would be around 17 m/sec.

Since this criterion may not be practicable for follow-up measurements, the AEP criterion was defined as an alternative. It stipulates that the data set is considered complete when the AEP, based on the readings, reaches a minimum of 95 per cent of the AEP extrapolated up to the cut-out speed. This is usually easy to achieve for lower to medium wind speeds, since the contribution of high winds to the overall frequency distribution – and thereby, to the extrapolation – is minimal. It makes sense to continue taking measurements until the AEP criterion has been met up to the site-specific medium wind speed. This should be defined in advance by mutual agreement.

To allow the measured power characteristic to be compared to the guaranteed characteristic it is advisable to agree on a suitable method of comparison, if possible based on the AEP comparison. The directives leave some room for interpretation. Contracts should therefore contain appropriate stipulations to provide a definitive reference framework. □ **IE,CT***

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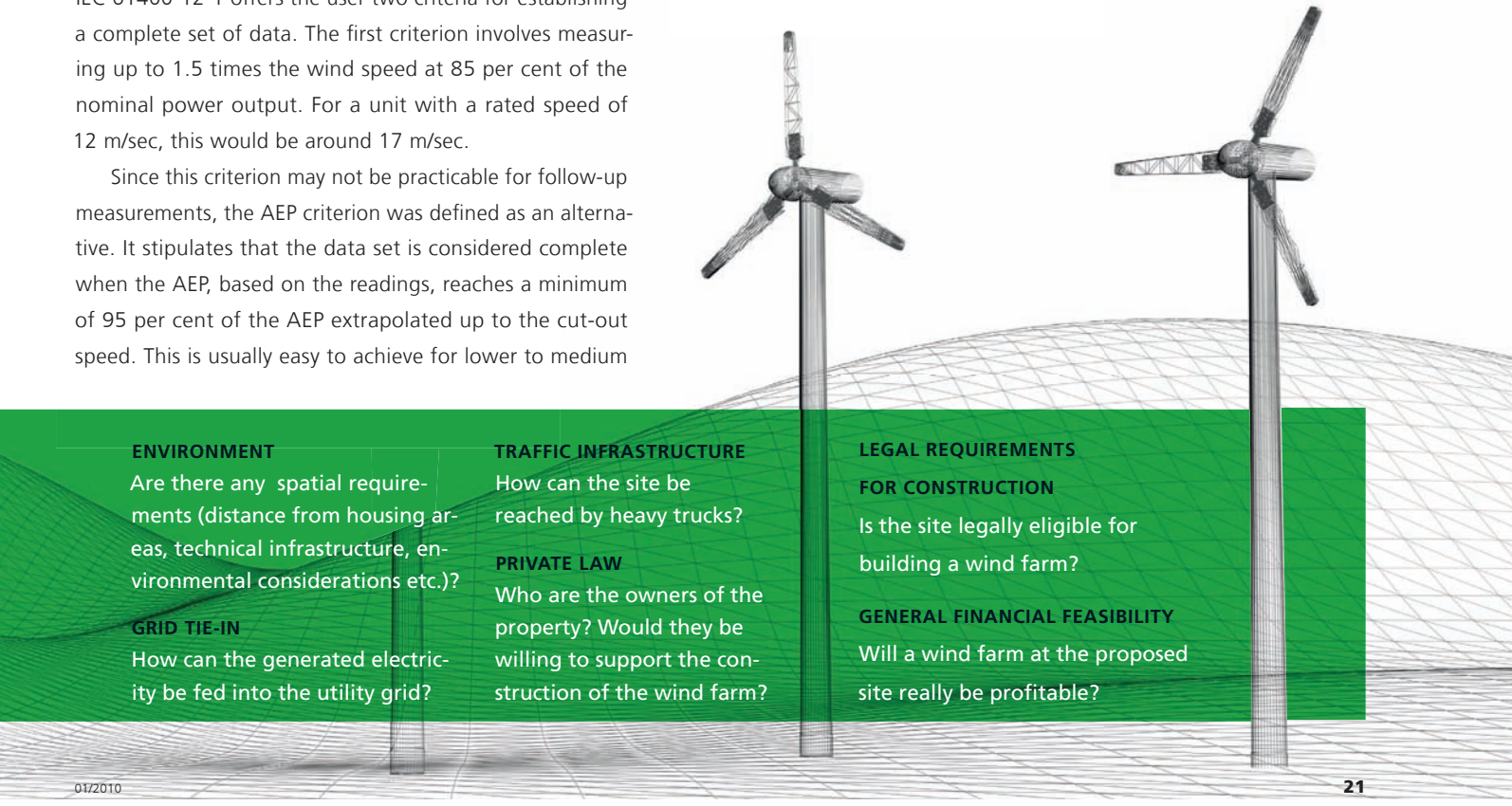


ENVIRONMENT
Are there any spatial requirements (distance from housing areas, technical infrastructure, environmental considerations etc.)?

GRID TIE-IN
How can the generated electricity be fed into the utility grid?

TRAFFIC INFRASTRUCTURE
How can the site be reached by heavy trucks?

PRIVATE LAW
Who are the owners of the property? Would they be willing to support the construction of the wind farm?

LEGAL REQUIREMENTS FOR CONSTRUCTION
Is the site legally eligible for building a wind farm?

GENERAL FINANCIAL FEASIBILITY
Will a wind farm at the proposed site really be profitable?

One-Stop-Shop Support

Badly sited or designed wind projects can have adverse social and environmental implications. GL helps clients to address these issues early in the project development phase and ensure that a project is compliant with regulatory requirements

ABSTRACT

- GL Garrad Hassan offers environmental service ensuring the highest energy yield and lowest social and environmental impacts.
- The Systemic Approach benefits the clients of GL Garrad Hassan by focusing on cost efficiency and risk management.

Environmental pollution and the emission of carbon dioxide (CO_2) due to the use of fossil fuels represent a threat to the environment, sustainable economic growth and health. Electricity generated by a wind turbine is produced without CO_2 emissions; it also does not pollute the air or water with harmful gases and materials. Indeed, wind turbines cause virtually no emissions during their operation and very little during their manufacture, installation, maintenance and decommissioning.

While this is the case, a wind energy project can potentially affect their immediate surroundings if they are not sited properly. In order to prevent environmental impacts due to the installation of wind turbines and to obtain the development consent an Environmental Impact Assessment (EIA) has to be completed. Typically such a study will include detailed investigations of the natural and human environment, evaluate the potential effects of the wind project on the environmental and the local community, and proposed mitigation measures to reduce or eliminate any residual impacts. If taken on early in the development phase, certain elements of an EIA such as constraints analysis and site screenings – which can quickly identify social or environmental critical issues – will assure the developer of a reduction of development risks.

EIAs are also as essential and required for on- and offshore projects. However the potential impacts of on- and offshore wind farms are distinct given the different site conditions and environmental surroundings.

Systemic Approach

GL Garrad Hassan offers an environmental service ensuring the highest energy yield is achieved while minimizing social and environmental impact and ensuring the regulatory compliance of a renewable energy project. How is this achieved? Through a systemic approach tried and tested in Canada by GL Garrad Hassan, an approach that integrates engineering, environmental sciences and the Geographic Information Systems (GIS) and enables all specialists to work together and create an optimised project. In essence, GL Garrad Hassan's main advantages are the following:

CUTTING-EDGE METHOD ENSURES HIGHEST ENERGY YIELD

GL Garrad Hassan understands the interaction between environmental factors, turbine siting, and energy yield.

EFFICIENCY IN PROJECT DESIGN

By combining engineering with environmental sciences and GIS, GL Garrad Hassan ensures that a project is developed in a cost-efficient manner. Additionally, ▷

Photo: Innergex Renewable Energy

Risks. **The impact of wind farms on the scenery, even in uninhabited areas have to be considered in the project's development.**

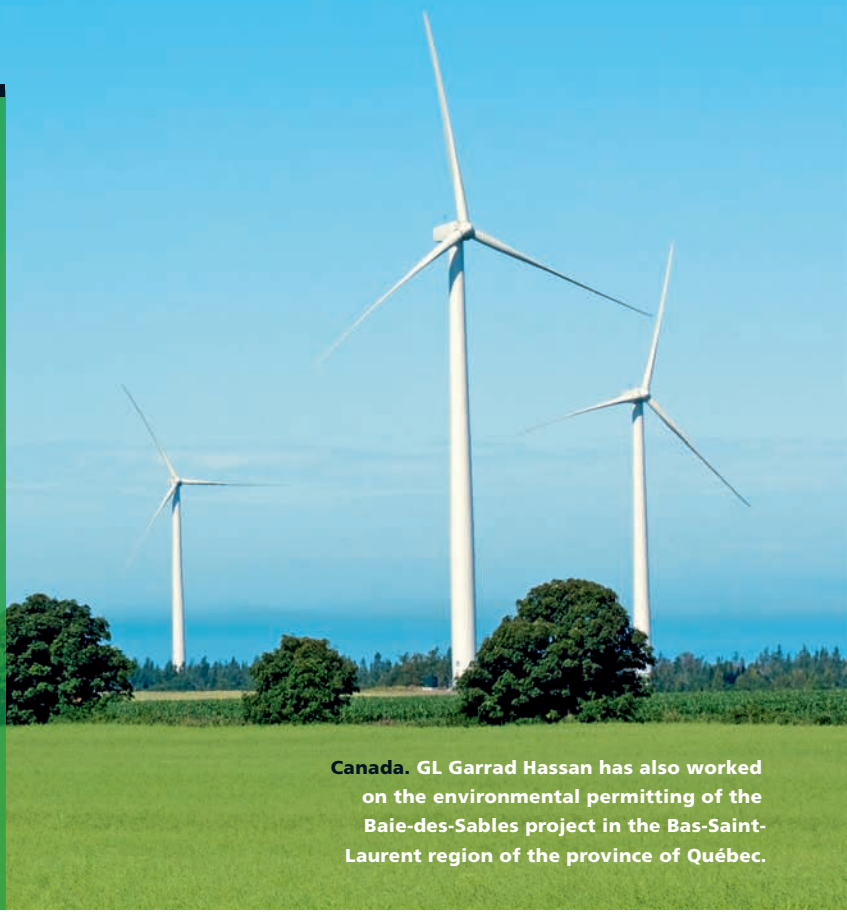
Environmental Services Include:

- Full environmental permitting management
- Constraints analysis and site screenings
- Identification of stakeholder issues and means to obtain community acceptance
- Public consultations/hearings and organization of presentations
- Photomontages and zones of visual impact assessments
- Noise emission and shadow effect measurements
- Interference with communication systems
- Navigation risk assessment
- Ice throw risk analysis
- Baseline monitoring of avian fauna, bats, terrestrial fauna
- Habitat assessments
- Environmental impact assessments
- Environmental monitoring during construction and operation

Case Study: St. Joseph Wind Farm

TYPE OF PROJECT	Environmental Assessment
CLIENT	Pattern Energy Group/ Bowark Energy
PROVINCE	Manitoba
YEAR	2008 – 2010

Complete Environmental Assessment and fatal flaw analysis according to both the Manitoba provincial requirements and the federal requirements. Furthermore, Helimax headed a multi-disciplinary team made up of internal resources and local subcontractors, and as such was responsible directly or indirectly for the overall budget management and all components of the environmental permitting process. The project will begin construction in summer 2010 and GL Garrad Hassan is managing the construction and post-construction environmental monitoring program.



Canada. GL Garrad Hassan has also worked on the environmental permitting of the Baie-des-Sables project in the Bas-Saint-Laurent region of the province of Québec.

Photo: Innergex Renewable Energy

▷ GL's EIA team includes local specialists that understand the local issues on a site-specific basis. These specific specialists are added to the team when required.

□ EXPERIENCE

Former Helimax, now part of GL Garrad Hassan, has successfully completed EIAs for more than 3,500 MW of wind power projects. It has established itself as the Canadian leader in applying wind engineering expertise throughout the EIA of wind farms. With its knowledge and experience, GL Garrad Hassan can become the leading expert for EIAs of wind farms in Europe. □ **MT**

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A Successful Approach

CREATING AN OPTIMISED PROJECT DESIGN

ENVIRONMENTAL/SOCIAL FEATURES

- □ Protected areas
- □ Watercourses, wetlands, water bodies
- □ Sensitive wildlife areas/sites
- □ Heritage/Archaeological sites
- □ Roads, trails, houses, settlements
- □ Communication towers, microwave links
- □ Permissible noise levels
- □ Lot lines
- □ Recreational areas

PATRICK HENN. **GL's Section Head of Environment and Permitting.**

Persuasive Benefits

Maximise energy, minimise environmental and social impacts: a systemic approach optimises wind project development

ENERGIZE: How would you describe your systemic approach?

PATRICK HENN: The systemic approach is basically a project development strategy that integrates engineering, environmental sciences and GIS to ensure that a project's design is optimised, i.e. that it maximises energy while minimises environmental and social impact.

ENERGIZE: Why is the systemic approach successful in Canada?

HENN: We quickly realised a few years back that wind project development was done without considering environmental constraints, social acceptance, local zoning, etc. This generated frustration amongst developers in that – further down the development path – site constraints were reducing the amount of land available for development or, in some cases eliminated a site altogether. The systemic approach proposes looking at siting issues early in the process to reduce the risk of surprises down the line. Additionally, integrating the environmental permitting process with the engineering of a project ensures that all elements are considered in parallel, thus creating an optimised project.

ENERGIZE: How do your clients benefit?

HENN: Generally speaking, the systemic approach has two main benefits: Cost efficiency, as the whole project design is done "under one roof" and risk management, as our approach quickly identifies "showstoppers" or critical issues that might impact a project's design.

ENERGIZE: How many EIAs have you conducted since you started the environmental service?

HENN: We have conducted EIAs for more than 3,500 MW of wind projects. Furthermore, if you consider the partial services such as constraints analyses, noise impact assessments, visual assessments, electromagnetic interference studies, etc, we have probably carried out such studies for more than 10,000 MW of projects.

ENERGIZE: How many EIA experts can you provide?

HENN: Our team is growing and currently includes approximately 20 in-house experts, such as environmental assessment managers, land planners, noise specialists and GIS staff. We also have a very extensive network of local specialists to address specific issues like avian fauna, bats, archaeology, etc.

ENERGIZE: Do you think the systemic approach will also be successful in Europe?

HENN: I can't see why not! Environmental and social issues are present in any jurisdiction and virtually all projects need to comply to a certain level of environmental regulation. The approach ensures these items are taken into account efficiently in the development phase of a project.

- Land uses
- Land owner restrictions
- Visual consideration

ENGINEERING

- Turbine selection
- Turbine layout
- Proximity to transmission lines
- Site complexity assessment
- Preliminary roads layouts, electrical network

METEOROLOGY

- Mesoscale
- Met towers

certification

Certification of wind farms, turbines and their components is state-of-the-art and a must around the world. Certification to harmonised requirements actively supports exports. GL Renewables Certification offers project and type certifications – also in other fields of renewable-energy exploitation for manufacturers, banks and insurers of wind turbines and components.

Photo: iStockphoto

The Way to Safe Wind Projects

To avoid liability issues, manufacturers of wind turbines should take CE Conformity Assessment very seriously. A standardised risk assessment process and GL's certification offering help ensure safe and profitable operation

ABSTRACT

- The EC Machinery Directives require the manufacturer to perform a risk assessment identifying all hazards associated with the machine and estimating the resulting risks.
- Consistent risk assessment as an integral part of the design process is a core element of any sound safety strategy.

Driven by the dynamic wind energy market in Europe, the issue of CE marking has moved into focus. Market supervisory authorities no longer turn a blind eye to the safety aspects of wind turbines. Incorporating safety criteria into the turbine design process is therefore imperative. Not only is it a moral obligation to protect the health and well-being of people, it also makes perfect economic sense for, manufacturers and operators to take CE marking and safety requirements quite seriously. Shutdowns and a damaged reputation for the manufacturer are typical consequences of an accident caused by an illegally CE-marked wind turbine. The German Equipment and Product Safety Act, incorporating the Product Safety Directive into federal law, stipulates a fine of up to € 30,000 for an illegally applied CE mark. Other European countries impose similar penalties.

A Passport for All of Europe

To guarantee the free movement of goods across the single European market, more than 20 product guidelines have been issued since 1987 based on Article 95 of the EC Treaty. Limited to "essential requirements" that are general in nature and primarily focus on health protection, these guidelines are compulsory for any product put into circulation. The requirements are specified by harmonised standards and a risk assessment process, which must describe all risks associated with the machine in sufficient detail, along with the measures implemented to guard against them. Due to its importance for machine safety, this assessment is the key element of the overall CE conformity assessment process. Upon its completion in accordance with the applicable EC guideline(s), an EC declaration of conformity is issued and the CE mark is granted, both of which jointly constitute a "passport" that allows the machine to be sold and put into service anywhere in the single European market.

A Risk Assessment How-to

Every wind turbine is subject to the terms of Machinery Directive which requires the manufacturer to perform a risk assessment identifying all hazards associated with the machine and estimating the resulting risks. The manufacturer must then design and construct the wind turbine to minimise these risks. Further guidance can be found in the harmonised basic standards (type-A standards) such as EN ISO 14121-1, which describes an iterative risk assessment process as shown in the flow chart, and EN ISO 12100-1, which details the identification of hazards, specific risks to account for in the design process, design guidelines, a strategy for risk minimization, and criteria for acceptable residual risks. The risk assessment process is subdivided into five steps (see insert).

Photo: Vestas

Hazards.
Manufacturers and operators should take safety requirements quite seriously.

Any residual risks that cannot be completely eliminated by appropriate technical means must be stated in the operating manual and identified by warning signs on the wind turbine.

Multitude of Standards

With its Guideline for the Certification of Wind Turbines, Germanischer Lloyd underscores the great importance of wind turbine safety. The comprehensive GL certification process verifies compliance with a multitude of standards, including harmonised EU standards such as EN 61400-1 and EN 61400-2. Furthermore, Germanischer Lloyd requires a systematic consideration of possible faults, "and measures for limiting negative consequences". This ensures that hazards associated with a wind turbine are identified and minimised by applying state-of-the-art technology. This systematic fault analysis is largely equivalent to the risk assessment approach described above.

EN ISO 13489-1. The familiar control categories of EN 954-1 have been replaced by the performance levels of EN ISO 13849-1.

Technical protective means, or machine control elements incorporating such measures, are referred to as safety-related parts of the controls. Their operation and assessment is described in the harmonised standard **EN ISO 13849-1**. The objective is to ensure that the safety of the control functions and their behaviour in the event of a fault achieve the degree of risk reduction determined by the risk assessment. To that end EN ISO 13849-1 defines five performance levels for implementing the controls. In the certification process, Germanischer Lloyd will check the respective performance levels established by the manufacturer and their implementation in the turbine design. In this respect GL certification and CE marking are congruent.

The Manufacturer's Responsibility

The manufacturer of a wind turbine must ensure that the machine is designed and manufactured according to the essential requirements of the applicable EC guidelines. ▷

Risk Assessment Process

BOUNDARY DEFINITION

Define the limits of the machine (EN ISO 12100-1): □ Space limits: clearance, working space, etc. □ Use limits: intended use □ Time limits: probable lifetime assuming proper use

HAZARD IDENTIFICATION

□ All conceivable hazards □ Interaction between the machine & its environment □ Possible malfunctions □ Proper use □ Requirements for personnel

RISK ESTIMATION

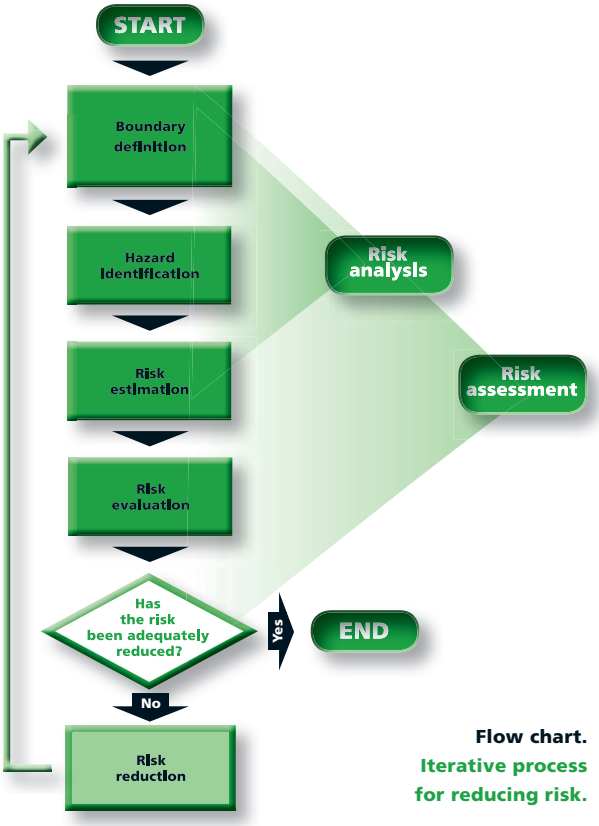
EN ISO 14121-1 lists four risk elements to be determined for each identified hazard, establishing the probability of its occurrence and the severity of potential harm.

RISK EVALUATION

The decision whether the residual risk is acceptable or whether risk reduction measures are necessary requires experienced specialists. EN ISO 12100-1 and others provide relevant guidance.

RISK REDUCTION

The Machinery Directive provides three guiding principles to reduce residual risk: hazard elimination, technical protective measures, and user information.



Flow chart. Iterative process for reducing risk.

▷ The manufacturer bears the responsibility for the assessment process and the conformity of the wind turbine. The principle of full liability regardless of negligence or fault relieves claimants of the need to prove the manufacturer's negligence, requiring only evidence of the causal connection between the turbine fault and the harm suffered. The manufacturer may not be exculpated purely on the assertion of having done "everything in his power" to place a safe turbine on the market, or of having complied with all the standards. Therefore the best way to guard against liability claims is to optimise product safety. A manufacturer who implements a rigorous safety strategy can protect himself effectively against accidents and their legal consequences.

Consistent risk assessment as an integral part of the design process is a core element of any sound safety strategy. Risk assessment is teamwork, involving experts from a variety of disciplines to scrutinise many different aspects. Independent, experienced experts with in-depth knowledge of safety standards are the best option. They will examine the safety aspects from an external perspective, providing the turbine manufacturer with a neutral "third opinion" and valuable additional insight. By combination of GL certification and CE marking the far-reaching consequences of nonconformity and illegal CE marking can thus be avoided. Ultimately, it is in the hands of manufacturers to live up to their responsibility and initiate the appropriate measures. □ **HB**

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Leading Certification Body

GL presented upcoming guidelines for certification of wind turbines. The 2010 edition will describe how to obtain type and project certification.

Date and place were well chosen. China Wind Power 2009 was the meeting place of the most important companies working in wind energy. There, in Beijing Germanischer Lloyd presented the latest development of the 2010 edition of GL Guideline for the certification of wind turbines. "Certification of wind turbines is a must in most places around the world and thus a strong support for export", said GL expert Mike Wöbbeking. "It is important for manufacturers of wind turbines and components as well as banks and insurers involved to know the different certification processes and guidelines." The new edition will cover small wind turbines and latest information on several prominent wind energy markets.

In the revised GL's guidelines, the procedures to obtain type and project certificates will be described. Type certification comprises design assessment, implementation of the design requirements in production and erection, evaluation of quality management and prototype testing. And on the basis of type certification, project certification is carried out that covers site design conditions, site-specific design assessment, surveillance during production, transport and erection as well as witnessing of commissioning and periodic monitoring.

ABSTRACT

- The new GL Guidelines for the certification of wind turbines will effect future development.
- The Edition 2010 is to substitute the current Edition 2003 plus Supplement 2004.

Relevant Standards

The most important part of the Type Certification is the assessment of the design documentation. In addition, the implementation of the design requirements in production and erection shall be observed. Therefore, the manufacturers of wind turbines and components will be evaluated all the way in terms of their quality management. In addition Prototype Testing will be made to guarantee the product quality and to verify the performance of the safety and control systems of the turbines. The measurements shall be based on the relevant standards and has to be performed according to ISO 17025.

Photo: Suzlon

Onshore. Wind Park in Weihai.

GL has actively been involved in the development of national and international standards and is an international leading certification body for wind turbines. Its certification services for wind energy products and projects are provided on the basis of the GL Guideline for the Certification of Wind Turbines. "It will have effect on future wind turbine developments worldwide," pointed out Mr. Woebbeking.

Also available and operational in the market is the GL Guideline for the Certification of Offshore Wind Turbines (Edition 2005). □ **SG**

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news in brief

Mitsubishi Power Systems Wind turbine – GL issues Statement of Compliance

hamburg Mitsubishi Power Systems Europe received a Statement of Compliance from GL Renewables Certification for the A-Design Assessment of their wind turbine MWT 95/2.4 (50 Hz). The Statement of Compliance means new opportunities. "Due to the long-lasting relationship between Mitsubishi Power Systems Europe and GL, we are delighted we were chosen by them to verify the design assessment of the newly developed wind turbine. Another milestone in our cooperation," said Christian Nath, Vice President GL Renewables Certification.

The statement was issued according to the International Standard IEC 61400-1 "Wind turbine generator systems – Part 1: Safety requirements", 2nd edition, and the "Guideline for the Certification of Wind Turbines", Edition 2003 with Supplement 2004, GL.

Certificate. **GL's Vice President Christian Nath (third from l.) handed over the Statement of Compliance to Masaaki Shibata, Mitsubishi Power Systems Europe (fourth from l.).**

Envision A-Design Assessments

beijing GL has signed a contract on wind turbine certification with Chinese Envision Energy Co., Ltd. Services including A-design assessments of six turbine variants before the end of 2010. The agreement comprises certification for an onshore wind turbine of 1.5 MW (EN 15-77 and EN 15-88) for both 50-Hz- and 60-Hz markets and is the logical continuation of the d-Design assessment issued last year.

One year ago at the same venue, the D-design assessment certificate was handed over to Envision Energy. This plausibility check of the 1.5-MW wind turbine formed the first step of certification for Envision Energy and in the cooperative work of both companies. Now the contract was signed at the joint booth of Garrad Hassan and GL at the Wind Power China in Beijing. The contract will commence immediately.

Applied Bolting Technology No Special Tools Required

chicago Applied Bolting Technology (AB) received certificate number 73638 from Germanischer Lloyd. GL certify that Applied Bolting's M32, M36 and M48 Squirter® Direct Tension Indicators (DTIs) control bolt tension to ±10% with a confidence factor of 97.7%. GL states that this is the first visual bolt tension indicating system that doesn't require special tools.

Squirter® Direct Tension Indicators are compressible washers, made with special slots stamped into their bottom surface. When the DTI bumps are sufficiently compressed, indicating that the bolt has achieved a certain tension, an orange silicone squirts out from the perimeter of the DTI.

Photo: ABT

The Squirter® has been hailed by construction and bolting professionals as an amazingly simple and yet revolutionary product which enables someone tightening a bolt to see just when they should stop tightening – not too soon, and not too late. Tens of millions have been supplied to structural bolting applications worldwide, and now are available for wind power.

Bolt. **Squirter® DTI in Wind Tower Flange.**

Notes on Engineering Details. Load assumptions, safety system & protective and monitoring devices, rotor blades and machinery components, support structure, electrical installations and project certification:
Various Notes on Engineering Details are now available as in PDF form on the GL Group website www.gl-group.com.

Photo: Marcus Dewanger

Pioneer. Peter Quell (REpower Systems, 2nd from l.) received the certificate from Dr Uwe Jönck (GL, 2nd from r.).

REpower First unit certificate for MM series

hamburg REpower Systems AG has received the first unit certificate from GL Renewables Certification for new turbines in its turbine portfolio. The certificate is the first ever that has been issued for a wind turbine (generation unit) with a double-fed generator system. It confirms once again that the technical system implemented by the company meets the high requirements of the grid system in Germany.

The measurements required for the certification were conducted on a REpower MM82 with a rated power of 2.05 megawatts, located at the Dollerup wind farm near Flensburg. "The unit certification for the wind turbine REpower MM82 is one of the first which has been issued by us under the new ordinance SDLWindV," says Dr Uwe Jönck, Department Machinery Components and Safety with GL Renewables Certification. In order to obtain certification, simulation models for the characteristics of the wind turbine on the grid needed to be further developed and then validated by comprehensive tests in real operation.

Sewind GL Certifies 3.6 MW Offshore Wind Turbine

shanghai China's power giants are all rushing for wind power exploration. Although China's output of wind energy is 1.1 per cent per year, only 0.3 per cent of that energy is being utilised as electricity. China has to improve its power grid increasingly to reach the goal of having 8 per cent electricity provided via wind energy by 2020. Shanghai Electric Wind Power Equipment Co. Ltd. (Sewind) and GL signed a contract for type certification of their 3.6-MW offshore wind turbine.

"Certified technologies will provide a competitive advantage to Sewind and will strengthen its position when entering the offshore market," said Andreas Anders, Business Development Manager GL Renewables Certification.

GL has actively been involved in the development of national and international standards and is an international leading certification body for wind turbines.

Sewind is part of Shanghai Electric Power Generation Group which is one of the strongest industry groups for power generation equipment manufacturing in China.

Photo: Sewind

Goal. In 2020, China's electricity provided by wind turbines is expected to rise up to 8 per cent.

Photo: Suzlon

Callback. 417 sets of S88-V2 blades around the world have been replaced.

Suzlon Blade Retrofit Programme Completed

pune Wind turbine manufacturer Suzlon Energy Limited (SEL) announced the completion of its worldwide programme to reinforce all V2-type Suzlon blades on its S88 2.1-MW turbines. Instances of blade cracks were first discovered in late 2007 on some Suzlon S88-wind turbines in the U.S. Suzlon responded immediately, launching a detailed root cause analysis and designing a retrofitting solution for its 417 sets of S88-V2 blades around the world – a commitment of approx. 100 million US dollars, already provided for in the financial year 2008–09. Prior to implementation, the solution was extensively tested.

Suzlon also introduced the next generation, S88-V3, which is consistently exceeding performance standards at windfarms around the world. One of Suzlon's S88-turbines produces enough energy to power approximately 500 average American homes.

Christian Nath, Vice President GL Renewables Certification, reported: "We used 3-D loading and design analysis software to verify the modified blade design, going beyond the requirements of IEC 61400-23."

dates at a glance

Conferences & Fairs

APRIL

20. – 23.04.2010

EWEC

Warsaw, Poland

MAY

05. – 06.05.2010

HOW

Hamburg, Germany

23. – 26.05.2010

WINDPOWER 2010

Dallas/Texas, USA

JUNE/JULY

07. – 09.06.2010

Offshore Wind China

Shanghai, China

27.06. – 02.07.2010

2010 Intl Conference

Yokohama, Japan

29.06. – 30.06.2010

BWEA Offshore Wind

Liverpool, UK

SEPTEMBER

18. – 22.09.2010

Husum WindEnergy

Husum, Germany

Lisewo. The installed capacity is 10.8 MW.

Hamburg. Regular meeting point of the wind industry.

Dallas. Worldwide largest annual wind conference.

Shanghai. Premier offshore wind power event in Asia.

Yokohama. Port city on Tokyo Bay.

Liverpool. Ninth annual conference and exhibition.

Husum. Visitors at the leading wind energy trade fair.

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GL Garrad Hassan

Wind Farm Design
5 May Bristol, England
13 May Athens, Greece
27 May Dallas, TX, USA
2 June Oldenburg, Germany
30 August Rio de Janeiro, Brasil

Introduction to GH WindFarmer
6 May Bristol, England
14 May Athens, Greece
28 May Dallas, TX, USA
3 June Oldenburg, Germany

GH Bladed Training
10–14 May Bristol, England

Introduction to Wave and Tidal Energy Conversion
18 May Aberdeen, Scotland

Financing Your Wind Farm
9 June London, England

Wind Farm Development
22–23 June Bristol, England

For information on all our international training courses, please visit **www.gl-garradhassan.com/training** or contact Mr Andrew Brown at **training@garradhassan.com**

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