ISSUE 01 • 2012
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energize

energy. efficiency. engineering.

renewables

Green Aspirations

market No Barrier to Growth
software Managing Rough Conditions
certification Modelling Turbulences

Renewable energy consultants

GL Garrad Hassan

EXPERIENCE MATTERS

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To Our Readers

Dr Andrew Garrad

A year ago the Fukushima disaster shook up the world, raising new questions about the feasibility of nuclear power. Renewable energy is moving centre stage.

We are a young, fast-growing industry, but we still have to overcome numerous technical, political and financial challenges before the world can fully rely on us. Always at the forefront of this evolutionary process, energize renewables is acutely aware of the essential questions that must be resolved to take renewable energy to the next level. We are not afraid of bringing up sensitive issues such as "Are tenders creating unsustainably low prices?". A close look at emerging wind energy markets such as Brazil and South Africa highlights the urgency of this topic (page 8). Critical evaluation of current wind field models is the subject of a study on offshore wind turbulence conducted by GL Renewables Certification (summarised on page 30).

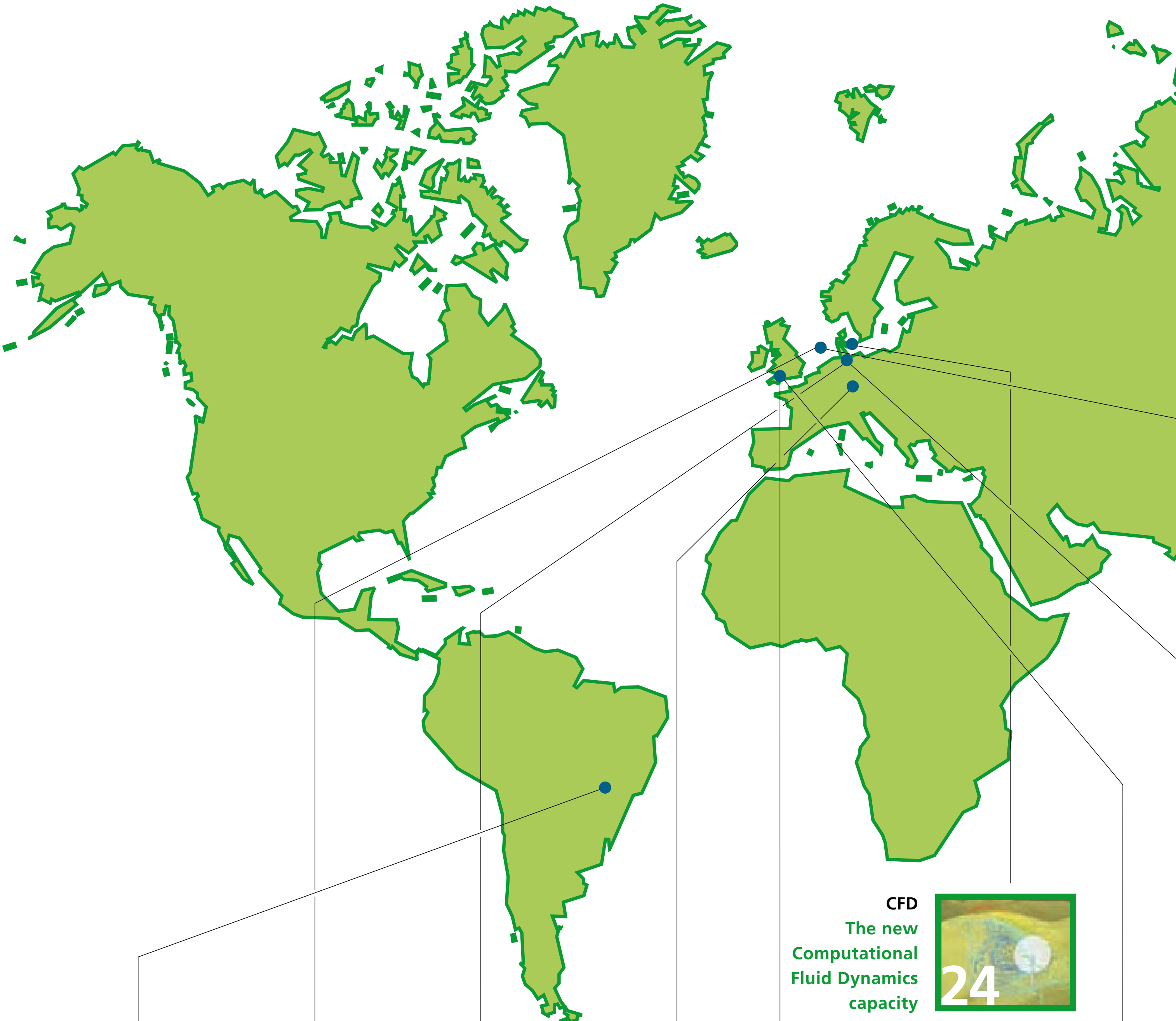
As the market evolves, so does the supply infrastructure. "No Barrier to Growth" (page 10) asks whether the supply chain is still the bottleneck of offshore wind projects. This was one of the topics addressed by the Hamburg Offshore Wind Conference, hosted by GL Garrad Hassan in February 2012. Other items on the agenda included the current role of banks in financing offshore wind parks (page 12), and the targets insurance companies are setting for the offshore wind industry (page 14).

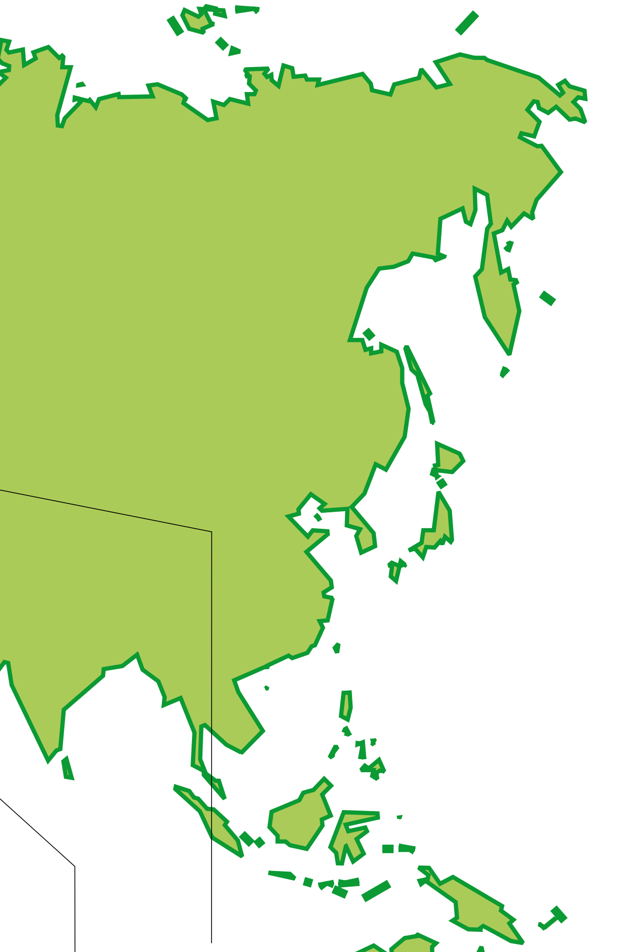
Crucial technical and environmental considerations for planners of wind farms are discussed in "Effective Tools for Pre-Construction Energy Assessment" (page 18), and "Maximising the Potential" (page 22) explains key aspects of monitoring and analysing measurements.

This is a multi-faceted issue indeed, and I believe it clearly shows our industry is heading in the right direction. Renewable energy is a dynamic, fast-growing, inspiring global industry with a bright future. I hope you enjoy reading this issue of *energize*!

Yours sincerely,

Dr Andrew Garrad
President of GL Garrad Hassan





SIMULATION
Turbulence models under scrutiny

DESIGN
How to predict components fatigue life

In Brief:

GL Group's Renewables Business Segment

- **GL GARRAD HASSAN** is one of the world's largest renewable energy consultancies. It offers a unique level of service expertise and global presence across the whole project lifecycle with approximately 950 members of staff in 42 locations, across 24 countries. 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, project 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 farms, improvement in the performance of existing wind farms, measurement projects (wind resource, wind turbine performance and structural behaviour), inspection services, 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 RENEWABLES CERTIFICATION** is a leading certification body primarily focused on the certification of wind farms, wind turbines and their components as well as marine renewable energy. At the forefront of know-how in renewables technology, it is abreast of all the necessary standards and requirements and takes a harmonised approach in ensuring that these are met. Manufacturers, banks and insurers around the world rely on the state-of-the-art service provided by GL Renewables Certification.

  Together, **GL GARRAD HASSAN AND GL RENEWABLES CERTIFICATION** form the Renewables business segment of the GL Group.

- **GL GROUP** is a technical assurance and consulting company for the energy industries and also a leading classification society. GL Group employs almost 6,900 engineers, surveyors, experts and administrative staff. Its global network consists of more than 200 stations in 80 countries.

market

Photo: Dreamstime/Erikdegraaf

With experience gained over almost three decades, GL Garrad Hassan has an unsurpassed technical, political and economic understanding of renewable energy technologies, projects and markets.

Cut-throat Competition: When Will Reality Strike?

In the face of soaring energy needs, emerging markets resort to competitive tendering of power supply contracts. Experts are frowning at the results

As growth in wind deployment in Europe and the US slows, the baton has firmly been passed to emerging markets such as Brazil and South Africa. Surging demand for electricity in these markets sees state-dominated electricity sectors struggling to keep pace. The response has been to attract private capital by awarding contracts through competitive tendering of power purchase agreements (PPAs).

The ambition is remarkable. Brazil plans to install at least two gigawatts of additional capacity per year until 2020, and South Africa's revised integrated resource plan seeks to bring the share of wind to the grid to nine per cent by 2030.If the sole intention of awarding contracts by auction is to foster competition, the Brazilian example must be viewed as a roaring success. Fierce competition between 240 participants in the August 2011 tender round saw 20-year contracts awarded to 44 projects. Prices sank as low as US$ 63/MWh for contracts starting in 2014.

ABSTRACT

- Emerging economies have ambitious goals for their renewable energy future. Bidders are eager to win power generation contracts
- Fierce competition leads to yield and price expectations that may be unsustainable

Discovering the true cost of supplying a good or service through competition is widely used to reduce prices and the desire of governments to secure low-cost energy supplies vital to any economy is laudable. However, the maxim "if something appears too good to be true – it probably is" seems pertinent. Electricity costing US$ 63/MWh from wind farms is lower than has been achieved in almost any other market and gives natural gas a run for its money.

How are these extraordinary prices achievable in Brazil? Indeed, are these prices sustainable at all? The absence from recent tenders of EDP, IPR-GDF, Iberdrola and Petrobras is indicative of the view of some leading regional players.

The cost of delivering wind projects in Brazil does not appear sufficiently favourable to drive prices to the levels observed. However, the onshore wind resource in parts of Brazil compares favourably with any region on earth. Capacity factors of 50 per cent are thought to be achievable by upscaling turbine rotors and the development of new products for the unique conditions.

Placing Low Bids

In a competitive process like that employed in Brazil, a small number of projects with overestimated energy yield can significantly influence the prices of contracts awarded to all projects. Bidders are forced to place uncomfortably low bids to win a contract or risk forfeiting the costs of developing the project and participating in the auction. There

> *The maxim 'if something appears too good to be true it probably is' seems pertinent.*
>
> **OSCAR FITCH-ROY**
> Senior Policy Consultant at GL Garrad Hassan

are no direct parallels with this uncertainty for conventional generation, which can enter into long-term fuel supply contracts to mitigate market risk.

An alternative explanation is that a frenzy of interest in the auction led to "winner's curse", which defies the assumption that all participants are able to make purely rational decisions based on the information available. Empirical studies suggest that in competitive situations players systematically overestimate the value of what is being sold. This might be shown by commitments to generate electricity at unfeasibly low prices. It could be the case that a structural oversupply of global turbine-manufacturing capacity means developers' costs are temporarily low. But this raises questions about the long-term sustainability of the prices once the supply chain rebalances.

POTENTIAL. Brazil plans to install at least 2 GW of additional capacity per year until 2020.

As auction designers strive to accommodate the unique characteristics of wind power the process becomes ever more unwieldy. In South Africa, the challenge of designing a successful auction is seen by the absence of much developmental wind capacity from a recent tender round. An onerous prequalification process muted competition and just 634 MW was contracted. More than 1 GW remains available for a second round in March. Pent-up demand and sufficient time for developers to prepare compliant bids presages an over-subscribed auction and cut-throat pricing here, too.

Two Decades of Progress

Recent history is littered with examples of sub-optimal outcomes from wind-power auctions. The UK's non-fossil fuel obligation tenders saw only a fraction of contracted plants ever completed. Denmark's 2009 offshore wind tender attracted just one participant. Policymakers seeking to unlock the potential of markets like Brazil and South Africa face a dilemma. If administratively set tariffs risk over-rewarding and competitive processes risk unsustainable pricing, how should they respond? Is there a compromise? Means of accommodating the uncertainties inherent in the costs and revenues of wind power should be sought. Mechanisms that allow the tweaking of tariffs as the understanding of costs develops between contract award and project completion would go some way to addressing this information gap.

Important lessons about the role of competition have been learned over two decades of progress. Emerging countries planning to harness the power of markets to reveal prices could do worse than to heed words attributed to Mark Twain: "History may not repeat itself, but it does rhyme." □ **OF**

This article was first published in *Windpower Monthly* magazine.

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Supply Chain. **Following years of uncertainty, new growth perspectives are giving confidence to the offshore wind industry.**

No Barrier to Growth

The long-held assumption that supply chain bottlenecks will limit the growth and economic viability of the offshore wind sector in Europe is no longer valid

The history of the offshore wind sector has been a roller-coaster ride on many levels. Over the last decade, the supply chain for this industry has veered from early optimism and healthy levels of competition through to market withdrawal and scepticism. In fact until recently, it has never had a truly dedicated supply chain, with goods and services being begged and borrowed from parallel industries: most notably onshore wind, oil & gas and coastal engineering. During boom times in these competing sectors, this "entanglement" has dogged the sector with diverted production capacity and resources leading to spiralling costs. In addition, early participants had their fingers burnt by overly optimistic pricing, a poor understanding of the cost-base and inappropriate risk allocation. These factors, combined with a lack of market certainty and the global financial crisis, culminated in the "choking" of the sector in the period 2008–10. A few projects still went ahead, but with eye-watering capital costs and significant programme risks.

ABSTRACT

- The last decade has been challenging for suppliers to the offshore wind industry
- Tough conditions in competing sectors are diverting investor's attention to offshore wind

Decoupling at Last

The announcement of the UK "Round 3" lease awards in early 2010 was a game changer for the supply chain. It provided a clear and significant market (33 gigawatts), over a relatively extended time frame (to 2020). It has since become clear that such a target is a stretch not only for the supply chain but for grid connection and finance. This has led to a more realistic perception of Round 3 as a two-decade endeavour, as underlined by recent government pronouncements which envisage just 18 gigawatts to be in place by 2020. Germany's ambitions for offshore wind are now comparable to the UK's, albeit set in a very different regulatory framework. And despite the waning of political support for the technology in the Netherlands and Sweden, the recent (re-)emergence of French ambition has served to bolster supplier confidence. Ultimately, this needs to be translated into investment in the required facilities and products. We are starting to see this happen with the help of funding and support from governments keen to exploit the jobs potential of the sector.

Commitment from both incumbent and new entrant supply chain players has never been higher. Established wind turbine suppliers see offshore wind as a source of growth to pick up the slack in their orderbooks created from the maturation of key onshore markets, whilst industrial majors from China, Korea and Japan are drooling over the potential to bring their heavy engineering and manufacturing capability to the party. Installation vessel availability remains stretched in the short term, but several new-build offerings are due to hit the market in the next 12–24 months, easing this much-hyped pinch point. High-voltage subsea cables are the clear exception to this general trend, with production capacity stretched for the foreseeable future. The long lead time of new cable factories means that investment decisions need to be made this year to avoid a supply crunch in the middle of the decade. These arguments are supported by the EWEA Report "Wind in our Sails – The coming of Europe's offshore wind energy industry" as authored by the GL Garrad Hassan Strategy & Policy team and launched at the EWEA conference in Amsterdam.

EWEA. The "Wind in our Sails" report is available for download at *ewea.org*

Forecast: Sunny with Showers Later

For the first time we are seeing a trend towards a dedicated supply chain for offshore wind, fuelled by weak conditions in other sectors and an increasing shift towards technology specialisation as designs are better tailored to meet market requirements. Such decoupling goes hand in hand with creating healthy supply chain competition. This will help unlock desperately needed cost reductions. ◻ JP

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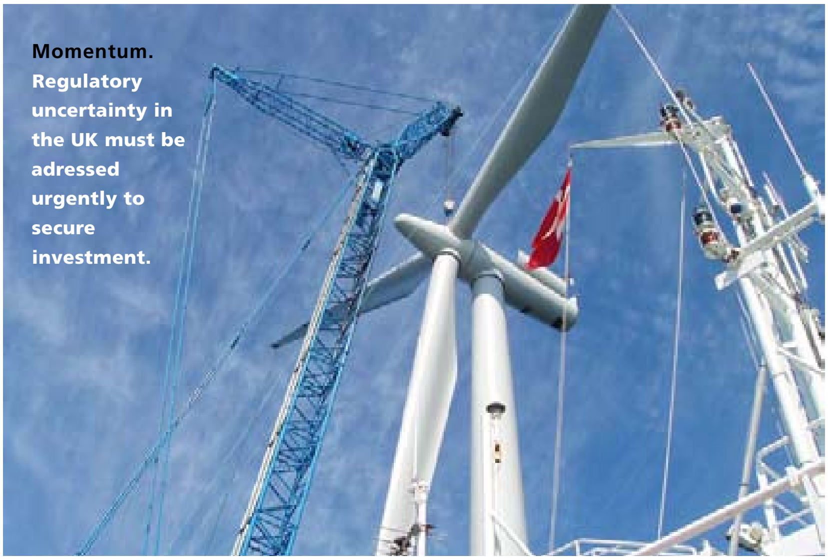
Change the Record!

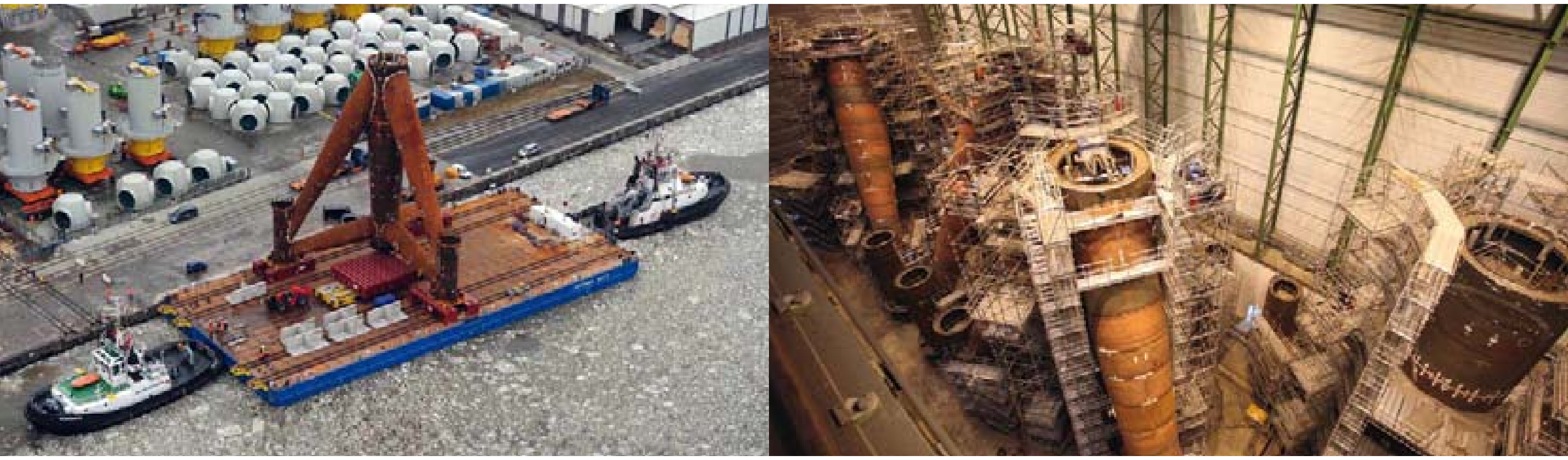
REGULATORY UNCERTAINTY in the UK and other markets has the potential to undermine the confidence of the supply chain to invest and greater clarity is urgently needed to avoid a loss of momentum.

Yet overall the outlook is one of supply meeting demand. The nuclear lobby and other vested interest groups must be challenged if they continue to use perceived supply chain inadequacies as a weapon of choice.



Momentum. Regulatory uncertainty in the UK must be adressed urgently to secure investment.

Photos: Dreamstime/Toft, Seaports of Niedersachsen



Stimulus. Germany's KfW is providing a credit volume of up to five billion euros for projects such as Global Tech I (l.) and Borkum West II (r.).

Banks Back in the Ring

Clear signs of change at the Hamburg Offshore Wind Conference 2012: banks are becoming increasingly open-minded towards offshore wind projects

The investments required for offshore wind energy farms are high – and they are fraught with greater risks than comparable land-based installations. Small wonder that banks have approached new projects only with caution in recent years.

But now the situation has changed. Thanks to the new development framework set in place by the German Government at the beginning of the year, the business model of renewable energy sources has also regained its attractiveness in the offshore sector. Clear indications of this were to be seen at the Hamburg Offshore Wind Conference 2012 organised by GL Garrad Hassan. There is a robust spirit of open-mindedness in the market – despite the risks, which still exist as much as before. The offshore business model is picking up speed again; banks are not only displaying their reservations, but are even signalling their readiness for cooperation.

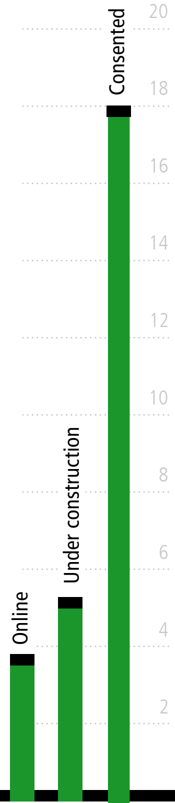
ABSTRACT

- Thanks to state incentives, offshore wind farms are gaining in interest for banks and investors
- Complex contractual structures remain challenging

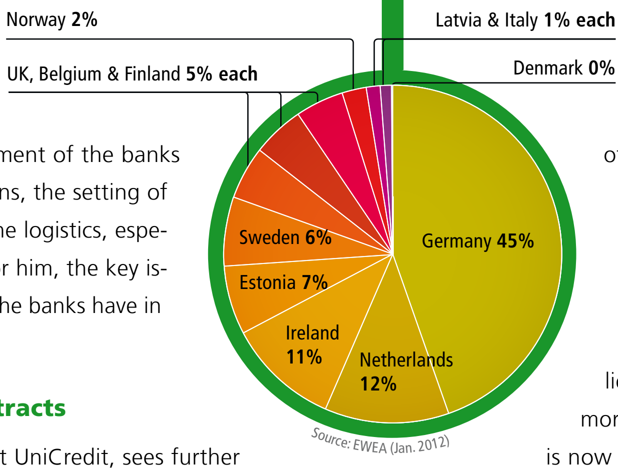
New Money, New Investors

One of the reasons for this reversal in mood is the new Offshore Wind Energy programme of KfW, which is providing a credit volume of up to five billion euros for ten offshore wind farms in the Baltic and North Sea. This has smoothed the waters, since individual banks usually only wish to be involved with tickets of around 50 million euros. For projects in which over a billion euros have to be funded in total, this stake is simply too small. Peter Schäfer, Head of the Renewable Energies Department at KfW, listed the mega-projects which have been launched with the aid of his institute: C-Power II, Borkum West II and Global Tech I, amongst others. A total of 23 banks were involved in these projects: 16 alone with Global Tech I, a joint project by utility companies. For this project, KfW took on the lion's share with 330 million euros through its subsidiary KfW IPEX-Bank. The intention is to realise large projects of this kind more easily in future with the aid of the KfW offshore programme.

One of the financial players that is becoming increasingly active in the German market is Green Giraffe Energy Bankers (GGEB). Based in Paris, the financial advisor holds interests in Borkum West II, Meerwind, Global Tech I and others. Global Tech I alone boasts a funding volume of over a billion euros. Accomplishing the financing of these projects was difficult, says the Managing Director of GGEB, Jérôme Guillet. One thing, however, has been shown: "There is enough money in the market for good projects." One of the main prerequisites for this, however, is early involvement of the banks and their advisors in the discussions, the setting of guarantees and the planning of the logistics, especially of the installation vessels. For him, the key issue is: "How much influence can the banks have in the contract negotiations?"



Offshore market. **Projects online, under construction and consented (in GW) and share of consented offshore capacity (MW).**



Capacity. **German share in consented projects is enormous – and accordingly the financing demand.**

Many Partners, Many Contracts

Eriks Atvars, Managing Director at UniCredit, sees further challenges ahead. He characterised the position by referring to the contracts: "We most appreciate EPC contracts. But these are not available in the offshore market. Why is that?" His answer: "The situation is too complex and there are too many risks for one owner/operator to take on the turn-key construction of a project all by himself." Instead, multi-contracting is predominant in the offshore wind industry, with all the attendant drawbacks – many partners, many different contracts, a web of relationships that is difficult to understand, and time-consuming contract negotiations. As a compromise, Atvars suggested EPCI (Engineering, Procurement, Construction and Installation) contracts.

This viewpoint was shared by Dirk Mous, Vice President Infrastructure & Renewables at NIBC Bank. In the current phase of the industry, the prevailing multi-contracting system means that the partner who should shoulder the financial risks is the one who is best able to. Each risk must be identified, defined and regulated by contract. Dirk Mous also emphasised: "The earlier the banks are included in technical matters and legislatory requirements, the better. It is essential not only to consult financial advisors but also to call upon legal counsel".

At the conference, it became evident that the market of the offshore wind industry is, from the vantage point of the banks, undergoing major change at present. Although the industry is still fairly small in terms of volume, the banking institutions see it as increasingly attractive – with some caveats. Michael Suppan, Vice President at Deutsche Bank, believes that the sector has definitely become more interesting for investors. Offshore wind is now viewed as a promising field. The current trend: "There has been a repricing of risks across the whole spectrum," as Suppan observed. There can be no doubt about it: The market is on the move. ◻ **HS**

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Photos: Global Tech I, Trianel

"No Risk No Fun"

The insurance business is setting clear targets for the offshore wind industry. First things first: The industry needs standard contracts

ABSTRACT

- The risks of offshore wind turbines demand clearly worded insurance contracts
- The industry is working towards a sensible distribution of risk

"You can charter a ship in a minute, because the owner and the charterer know on what conditions they want to finalise. But in offshore wind, you negotiate for six months, discussing clauses up and down. This cannot continue in the long run." With these words, Dr Patrick Wendisch, Managing Partner of Nordwest Assekuranz, zeroed in on one of the prime objectives of his industry. "This new up-and-coming industry should and must arrive at standard contracts and standard clauses."

But the offshore sector is still far from achieving this blissful state, as the example of Munich's municipal utility, Stadtwerke München (SWM), shows. By 2025, the third-largest city in Germany aims to cover the complete energy requirements of all private households as well as industrial and commercial consumers from renewable energy sources. With today's share of renewables in the energy mix standing at 4.7 per cent, this is certainly an ambitious – if not extremely bold – objective. SWM is already participating in three large offshore projects – Global Tech I, Dan Tysk and Gwynt y Môr. The three projects differ considerably, as Dr Thomas Meerpohl, SWM Head of Project Development, stressed during the Offshore Wind Conference of GL Garrad Hassan. There are different partners and there are different contractual provisions, each with a different distribution of risks. What is more, the projects differ to some extent also in terms of the logistics concept, the selected type of turbines, and the foundations. But which concept and what contracts are the best? Nobody knows.

Gaining Experience. **Munich-based SWM is already participating in three large offshore projects.**

Dr Meerpohl sees the positive side – the opportunity to gain a wealth of experience. The time frame may be tight, but the core message is clear enough. All three projects reflect the new strategy of regional energy providers: the municipal utilities want to, and indeed must, produce their energy themselves to a large degree in future. Who would quibble about the few years by which such an important goal might be delayed?

Good Contracts, Bad Weather

Over the past few years, underwriters, corporate law firms and banks have built up expert teams that are exclusively

Installation. One of the worst traps is the danger of confusing ice with bad weather.

focused on projects for offshore wind energy. For example, Hogan Lovells International with a team of a dozen lawyers in Hamburg. One of them is Dr Christian Knütel. He referred to a few of the largest pitfalls to avoid in the offshore wind business. Many partners come from the world of shipping or the onshore industry and, for want of experience in the new sector, tend to underestimate the risks. Unfortunately, it is not possible to insure against any "lack in claim management". His simple advice is therefore that contracts are meant to be read: "You can lose as much money with the bad execution of a good contract as with a bad contract."

One of the worst traps is taking onboard too much bad weather risk, or failing to define this risk precisely. In autumn, the installation ships are not always able to operate, so that one would have to ask: "Who forced the ship into a bad weather period?" As a fundamental rule, he advises against taking on the entire weather hazard, because follow-on risks are associated with it. "What do you do if a vessel needs to be exchanged and the new vessel has a different wind class?" His recommendation: Each contractual partner should bearthe risk he can manage. Regarding insurance clause, he is missing the "knock-for-knock" principle. "Why don't we see that more frequently?"

"Knock-for-knock" is not very popular, however. "Everybody wants to 'pass the hot potatoes' on to somebody else," remarked Dr Patrick Wendisch of the Bremen-based insurance broker Nordwest Assekuranz. "Nobody wants to keep them in his own pocket." The hottest potatoes for him include the weather risk, the manufacturer and subcontractor guarantees, contractual penalties and the logistical costs. "Risk of weather is a special cover – it's very complicated, but in the end we generally find a good solution. The insurance industry is very much in the process of learning its lessons." His advice to all involved: Risks have to be accepted – "No risk, no fun!" □ **HS**

SPECIALISTS. Underwriters, corporate law firms and banks have built up expert teams focused on offshore projects.

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Photos: AlphaVentus, SWM

software

GL Garrad Hassan is acknowledged for its technical rigour. This is reflected in its multiple industry standard software packages which are relied upon by professionals around the world.

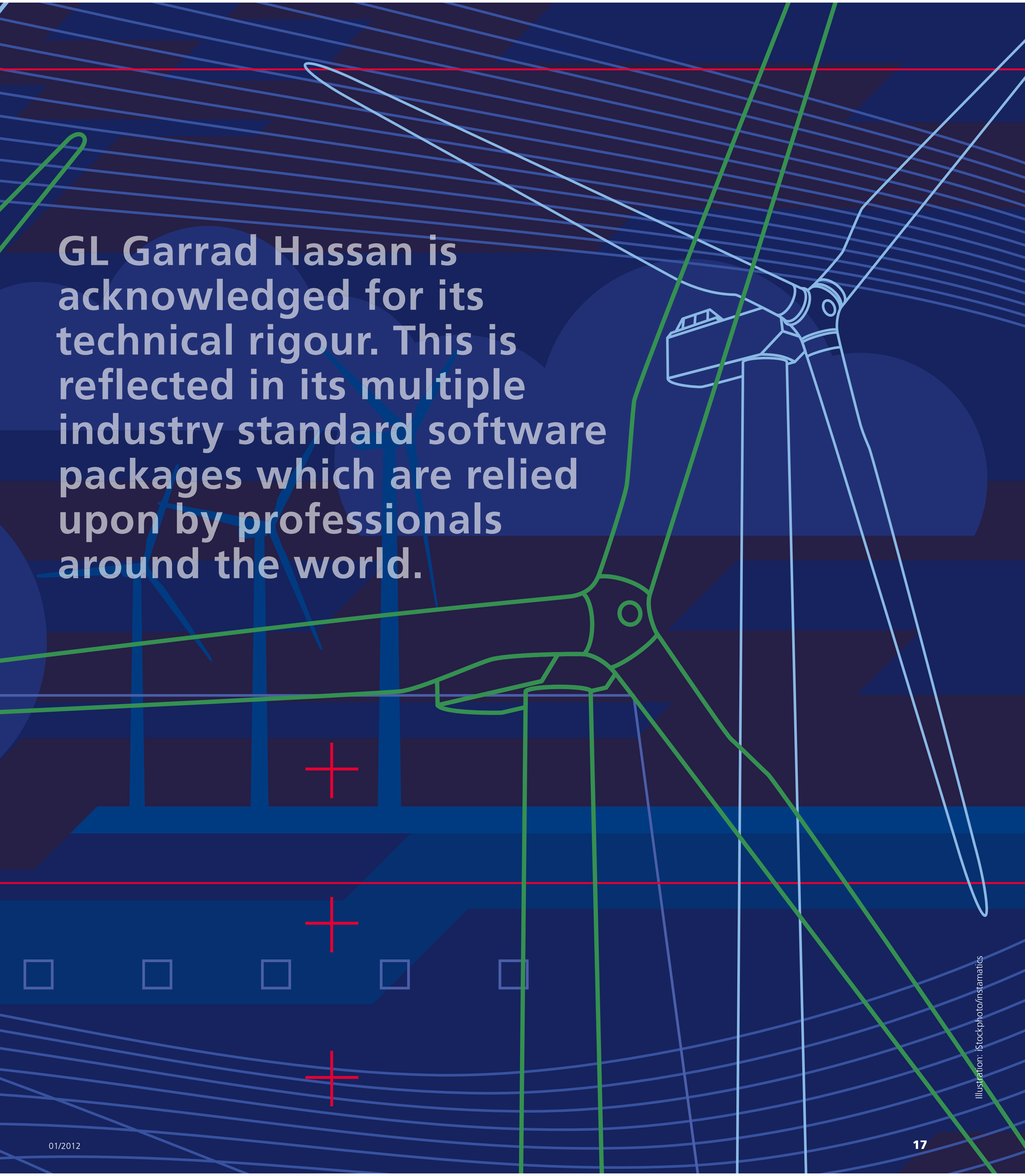


Illustration: iStockphoto/instamatics

Effective Tools for Pre-Construction Energy Assessments

A multitude of interrelated technical and environmental factors must be considered before a wind power project can be planned and implemented. Backed by decades of experience, GL Garrad Hassan's proven software WindFarmer helps planners to manage the complexity

Wind farm design and energy assessment within the wind industry are complex processes that vary greatly depending upon the constraints and challenges of each wind farm site. Stakeholders such as developers, utilities, and financiers must technically evaluate a project to determine its profitability and feasibility in the market. A software package that can model the performance of all types of farms is essential in the wind industry. Some of the key features and models needed in such a wind farm design software package are highlighted here, using the latest WindFarmer software developed by GL Garrad Hassan as a platform for discussion.

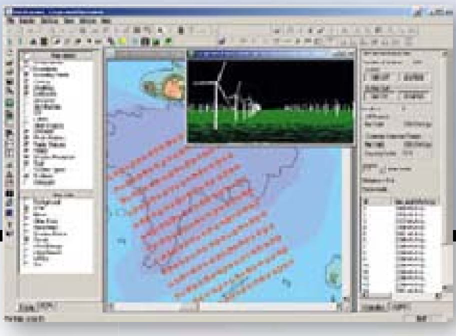
ABSTRACT

- The ability to reliably predict the energy yield of a proposed wind farm is crucial for all stakeholders
- Sophisticated modelling and analytics software is needed to account for all influential factors
- WindFarmer is a proven, highly flexible wind farm design tool

Energy Calculations

Calculated energy production values for a wind farm require several inputs in order to properly evaluate the estimated energy generation of a site. The topography for a wind farm and the boundaries of the site may be loaded into the software as ESRI shape files. The wind flow on the site should be characterised by on-site measurements and extrapolated out to the rest of the site, and the historical air density on the site must be evaluated.

The efficiencies and loss factors specific to the site should be understood, and a turbine layout and power curve must be selected. Once this basic site information



Visualisation. Maps and diagrams help planners understand the specific operating conditions at the proposed site.

has been entered, the type of analysis method chosen to calculate energy is dependent upon the characteristics of the wind farm being assessed.

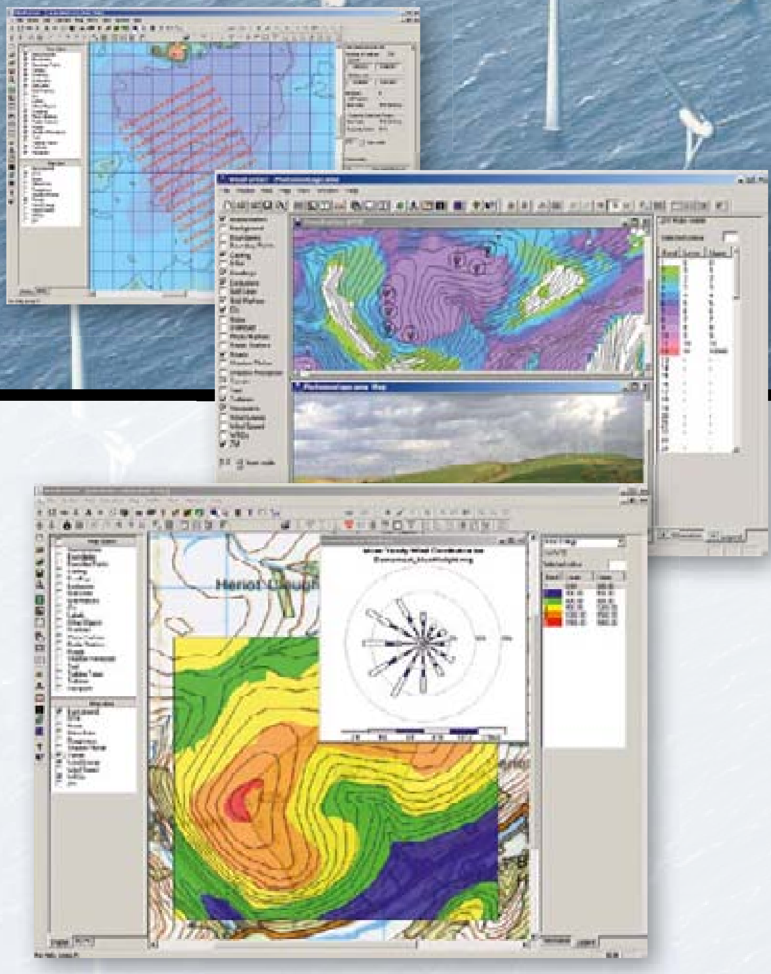
The energy production of a farm is greatly influenced by the wake effects from upwind turbines, and the use of an accurate wake model is key to making an accurate estimate. WindFarmer has several different wake models available to take into account the specific challenges of the broad range of wind farms in development and in operation within the industry.

Wind Farm Wake Modelling

The Eddy Viscosity Wake Model is a CFD model that has been developed, refined, and validated using operational wind farm data for many years and has proven to be a successful wake modelling algorithm in a wide variety of standard situations. WindFarmer also includes several modifications to this base model for wind farms that fall outside of the normal operational envelope of the model. With these adjustments, the exceptional characteristics of regions with such observed wind regimes can be taken into account.

Wind Farm Wakes in Complex Terrain

Environmental parameters such as air density and turbulence levels as well as the development of the wake itself are a function of the underlying topography. Wind- ▷



Complexity Made Simple. WindFarmer structures and correlates the site-specific information to provide reliable information for decision-making.

▷ Farmer makes use of this information to automatically adjust the turbine wake development and energy calculated, based on the turbine's position in the terrain.

Closely Spaced Wind Farm Layouts

The closely spaced wake model allows for wake modelling to be completed on wind farms that are built for uni- or bi-directional wind regimes, as these types of wind farms have their own unique challenges. Such regimes lend themselves to turbine layouts that are positioned closely together in one direction to maximise electricity generation per given area. Turbine wakes in such a layout do not propagate independently and as such, must be modelled differently. WindFarmer's Eddy Viscosity Model for Closely Spaced Turbines effectively models the wakes propagated for this type of wind farm by altering the classic Eddy Viscosity model and allowing velocity deficits caused by the wake effects to be added cumulatively.

Large Wind Farm Model

As the wind industry has developed, the size of wind farms has increased both on- and offshore to include farms that are greater than 100 megawatts in size and many rows deep. The Large Wind Farm Wake Model has been developed to model the increased wakes generated at these large-scale wind farms. The model works by taking into account several characteristics specific to large wind farms, the most important being the alterations to the boundary layer caused by the presence of a large number of turbines

extracting momentum from the atmosphere. As a result, the wind profile varies across the farm, analogous to an increase in surface roughness length. Within WindFarmer, this highly technical and crucial feature is in the form of a check box where the software performs the overall analysis of upstream turbines to derive the added wake losses due to the large wind farm wake effect. The Large Wind Farm Wake Model has been tested and validated with data from offshore and onshore wind farms in operation. Furthermore the speed of the energy yield calculation, typically 10–15 minutes for a 100-turbine array, enables wind farm designers to explore many different layout options within a very reasonable time frame.

Uncertainty Analysis

Once the estimated energy production calculations for a site are completed, the uncertainty associated with these results must be quantified. Uncertainty calculations are essential to quantify and assess the asset's viability and profitability in order to raise project financing. As such, WindFarmer incorporates uncertainty analyses into its results to provide an evaluation of the many sources of uncertainty present within the development process, such as data collection sensors, topographic modelling, and yearly variation of the wind regime on site. These uncertainties are then used to derive the relevant exceedance levels so that stress cases can be run and debt service coverage ratios can be converted into currency for pro forma preparation.

Efficient Wind Farm Design

WAKE. Each wind turbine causes a wake that will affect other turbines located downwind.

Wind farm design software packages offer a range of tools to support the engineer in designing an efficient wind farm layout. These tools include aids for automatic generation of both random and symmetric layouts with high energy yield. Using these advanced tools in the design of a wind farm can help to mitigate project deficiencies found later in the detailed energy assessment. As wind farms become larger and more complex, scientific research is increasing the understanding of how wakes behave within such a complex environment. A software package such as WindFarmer is essential to leverage this knowledge and produce reliable estimates of electrical power production. ☐ **SH**

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Photo: Dreamstime/Visdia

Maximising the Potential

Monitoring and analysis of on-site resource measurements increases the value of the data for assessments. It can be challenging to quickly identify and resolve problems relating to equipment

Photo: iStockphoto/Jeannot Olivet

Measurement. Ensuring accurate and continuous data collection is important.

Since its initial release in spring 2010, the GL Garrad Hassan Online Data Management (ODM) service has continued growing and is currently used by clients in 26 countries worldwide with more than 500 met masts under management. The data collected within each project allows developers of wind farms to maximise the value of their wind resource measurement investment via stable, accurate and continuous data collection and review.

Meet Conditions, Implement Improvements

One of the clients that use this service is Wind Capital Group. The company is developing utility-scale wind farm projects all across the central US and has offices in St. Louis, Missouri, St. Augustine, Florida and Chicago, Illinois. Combining community relationships with experience and vision, Wind Capital Group has developed wind farms – currently operating or under construction – producing nearly 1,000 MW of economically viable, clean, renewable electricity. Its current projects have the potential to produce enough wind energy to power more than 300,000 homes, offsetting more than 1.6 million tonnes of carbon each year.

ABSTRACT

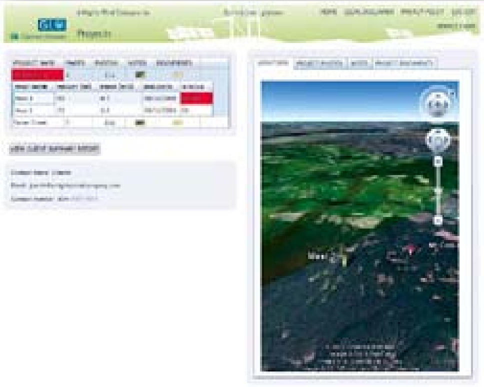
- Online Data Management allows developers to maximise the value of their investment in on-site measurements
- GL Garrad Hassan offers an industry-leading data management service

Working with wind means rapidly changing conditions and equipment pushed to its limits. The ODM service offers a 24/7 fully secure, password protected online access to quality-controlled data for managing and maximising the potential of measurement campaigns. "GL Garrad Hassan's ODM service enables us to turn around internal energy assessments at a much quicker rate since cleaned data is readily available to download," said Rachel Redburn of Wind Capital Group. "We have also noticed that GL Garrad Hassan's energy assessments tend to have a quicker turnaround time because the cleaned data is available to them, as is all the mast documentation."

To further improve the ODM service, GL Garrad Hassan released a new Customer Relationship Management (CRM) component to its service at the end of 2011. The new CRM functionality offers a complete, centralised view of all issues regarding measurement equipment under management, and a full history of all associated electronic communication and support cases. With the new support tool, enquiries can be handled in a timely, transparent and traceable manner, as the full history of communication with the GL Garrad Hassan ODM team is tracked, ensuring a direct and personalised service. Having a comprehensive overview of the status of all the monitoring systems enables ODM users to schedule maintenance and repair programmes to provide maximum value and benefit in the site data.

Access to Summary Statistics

The service is designed to help developers minimise frequent and detailed investigation of on-site resource measurements while maximising the value associated with stable, accurate and continuous data collection. Data are physically located at a secure server farm, fully backed up with multiple levels of redundancy. The service allows access to summary statistics including energy estimates and other critical information pertinent to the early stages of project development. As on-site data measurements are transmitted, received and processed by this automated service, the cleaned data are checked weekly by an experienced analyst and a full set of statistics for all instruments on each mast are presented on the website, alongside a full history of the measurement equipment and issues that



Service. The ODM home page summarises the headline measurement results.

have arisen. Routine data checking ensures that challenges with equipment are quickly identified and resolved, therefore increasing the value of the data for subsequent use in formal, bankable assessments. "The ODM service has proved to be a handy tool for internal analyses as it is nice to be a few clicks away from wind roses, time series plots, and correlations among sensors on a single mast," explained Wind Capital Group's Rachel Redburn.

The quality control of data provided by the ODM service is based on GL Garrad Hassan's years of experience providing energy assessment services. The addition of a new client support tool and enhanced alerting system provides developers and investors with a highly responsive and detailed monitoring service. □ **CE**

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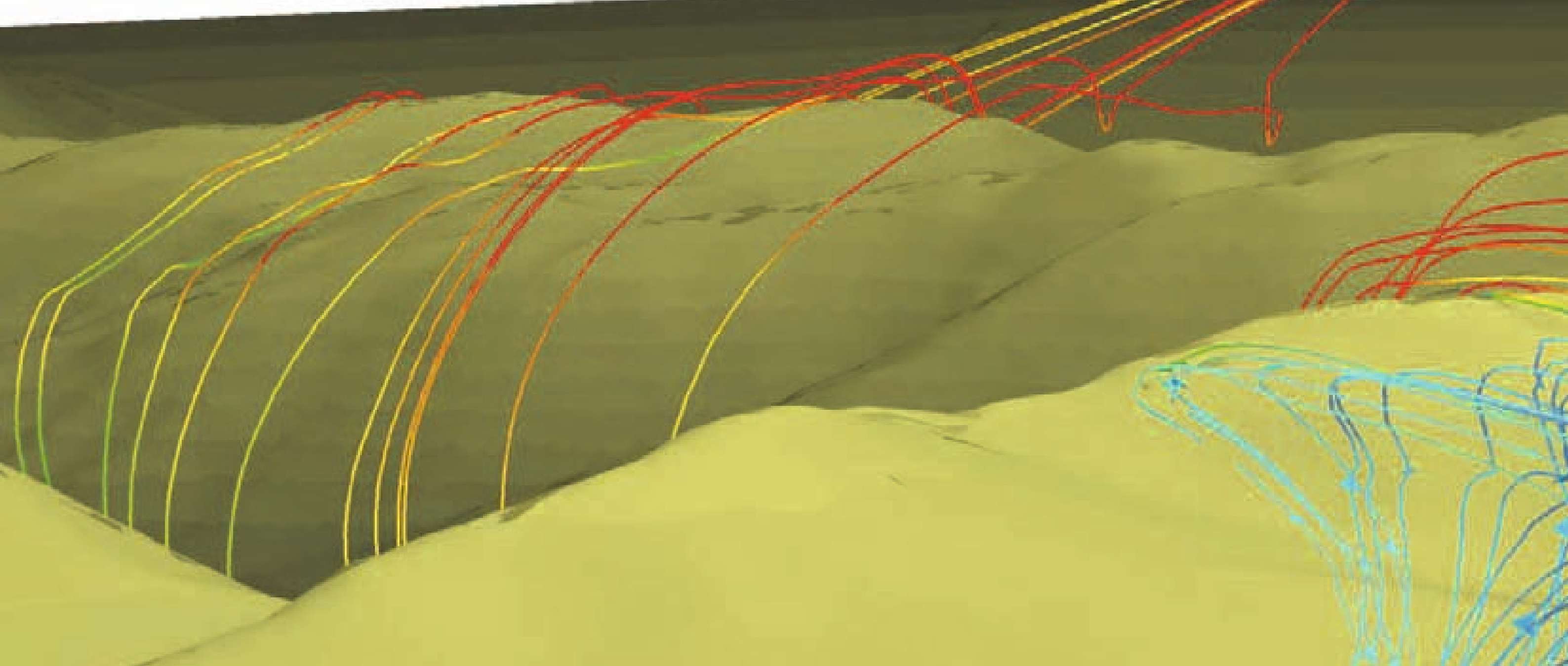
Key Features of the Service

- Instant access to quality-controlled data and monitoring equipment at any time.
- Modern and user-friendly interface, incorporating Google™ Earth.
- Raw and cleaned data can be downloaded for multiple masts and projects.
- PDF summary data reports as downloads.
- Detailed log of all data exclusions, for example from icing, instrument malfunction, as well as full maintenance records stored in one location.
- Broad range of statistics and graphical analyses derived from the data available at a click, including interactive graphical tools for time series, shadow plots and correlations.
- Detailed mounting configuration of current and historic instruments.
- Storage of mast photos and documents, for example calibration certificates and maintenance records.
- Estimated energy and capacity calculations based on selectable project characteristics.
- 24/7 fully secure and password-protected online access (https).
- Robust and secure server infrastructure with multiple levels of redundancy.



Rosa’s Windy Plateau

Sharp ridges, steep slopes and rocky plateaus. Modelling the wind flow in this kind of terrain is no walk in the park. GL Garrad Hassan’s brand-new, state-of-the-art Computational Fluid Dynamics capacity leads such demanding projects to success

“Most definitely not!” exclaimed Rosa, my client, almost laughing. We were planning a visit to the site of a wind farm proposed by Rosa’s employer, a growing developer. Fifteen turbines would be placed on a barren, rocky plateau that rose almost a hundred metres above its surroundings. My job was to predict the turbines’ energy production by modelling the wind flow at their locations, so I had to see the site in person. “We’re not walking up to the top, it’s way too steep,” she said. “Let’s get a helicopter.” I thought, “So steep we need a helicopter?” Well, then, traditional wind flow modelling methods would not be of much use. We would have to bring out non-linear computational fluid dynamics (CFD).

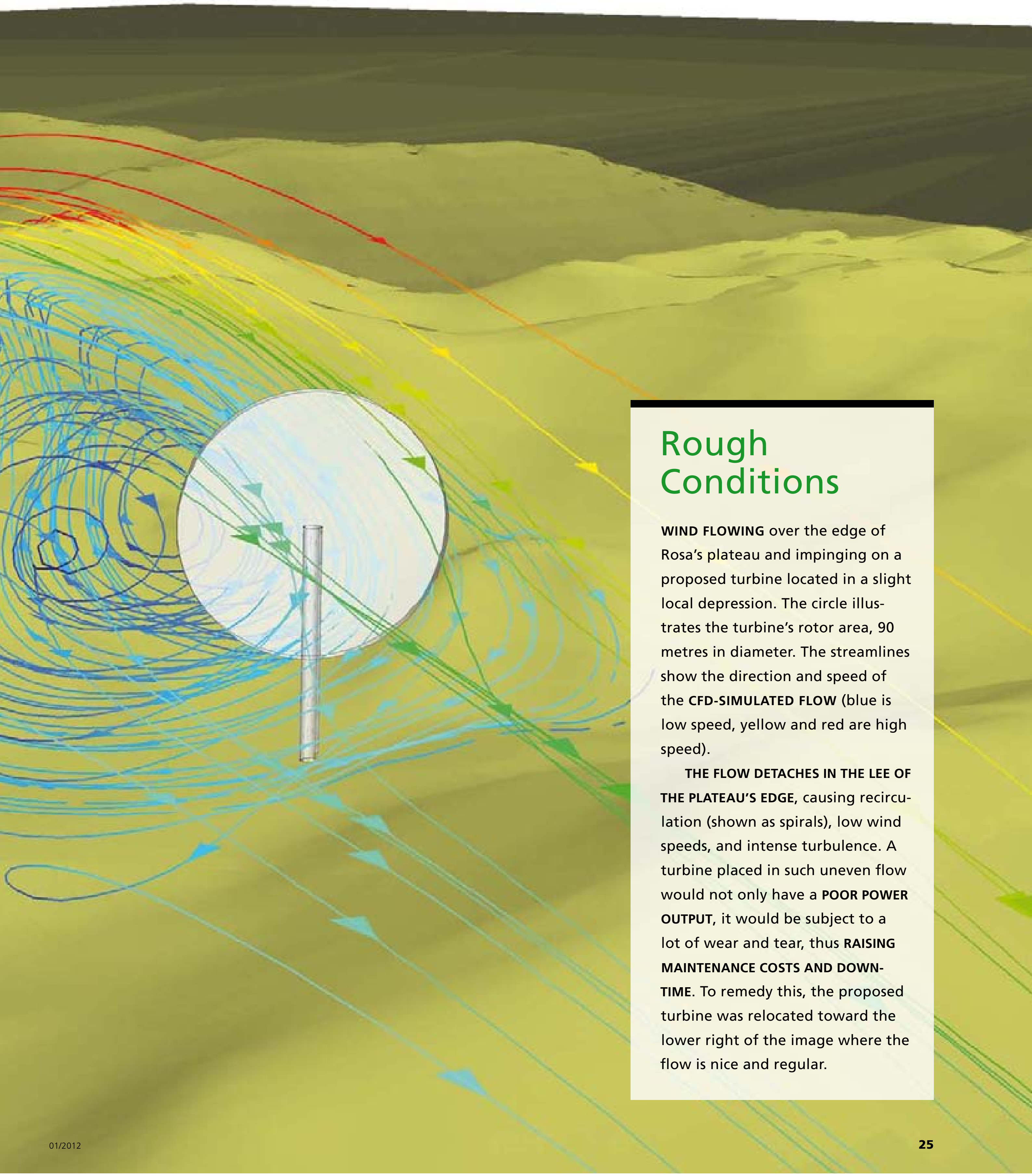
Beyond Tradition

Imagine the wind blowing on a very shallow hill. Standing at the top of the hill, you feel a stronger wind than when standing at the foot of the hill, which is why you would put a wind turbine at the top. Now imagine that you can “pump up” the hill, as you would a balloon. The traditional wind flow models that have been a staple of wind energy assessments since the 1980s are known as “linear” models. They assume that if a hill doubles in height, then the effect that the hill has on the wind flow around it, notably the speed-up experienced at the hilltop, also doubles. This linear scaling actually works fine in simple terrain with shallow slopes.

Now, continue pumping. For a while, everything goes well. But as you pump the hill up further and the slopes become steeper, new things start to happen. ▷

ABSTRACT

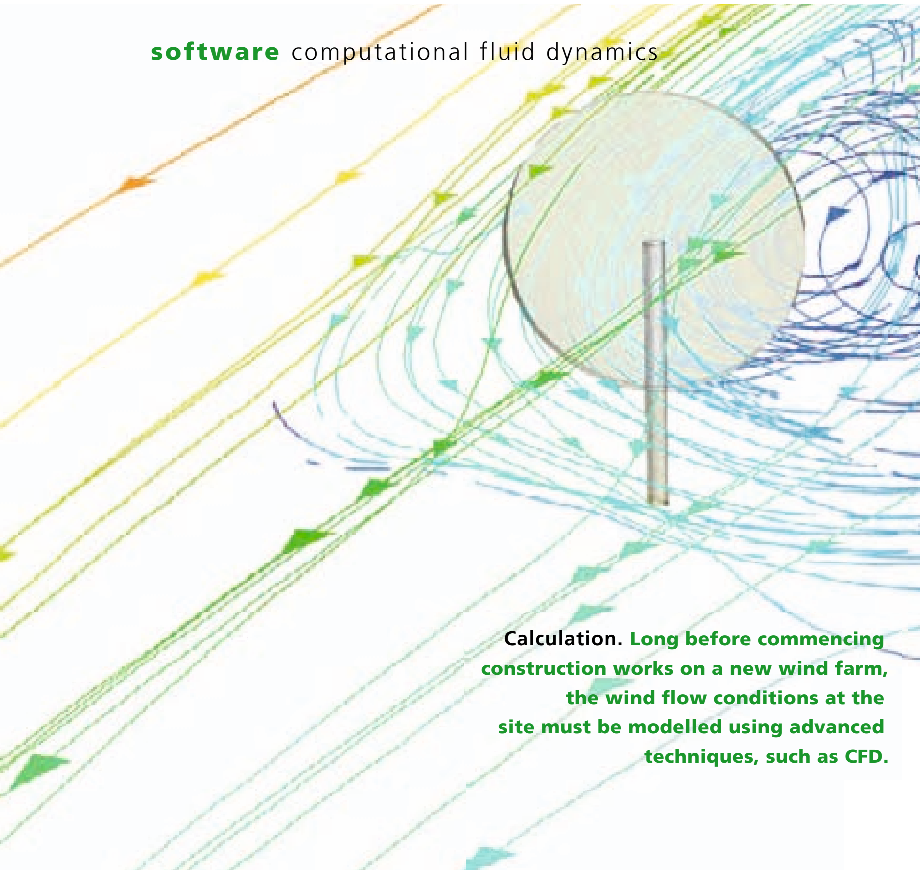
- Traditional linear wind flow models cannot predict wind conditions in complex terrain with sufficient accuracy and detail
- CFD, while requiring massive computing resources, can help avoid costly mistakes when choosing the locations for individual turbines



Rough Conditions

WIND FLOWING over the edge of Rosa's plateau and impinging on a proposed turbine located in a slight local depression. The circle illustrates the turbine's rotor area, 90 metres in diameter. The streamlines show the direction and speed of the **CFD-SIMULATED FLOW** (blue is low speed, yellow and red are high speed).

THE FLOW DETACHES IN THE LEE OF THE PLATEAU'S EDGE, causing recirculation (shown as spirals), low wind speeds, and intense turbulence. A turbine placed in such uneven flow would not only have a **POOR POWER OUTPUT**, it would be subject to a lot of wear and tear, thus **RAISING MAINTENANCE COSTS AND DOWNTIME**. To remedy this, the proposed turbine was relocated toward the lower right of the image where the flow is nice and regular.



Calculation. Long before commencing construction works on a new wind farm, the wind flow conditions at the site must be modelled using advanced techniques, such as CFD.

▷ The speed-up at the top still increases, but not as much. As the slopes pass the 30 per cent mark, the flow behind the hill detaches – the air no longer flows parallel to the ground surface. This massively reduces the wind speed there, while turbulent eddies are shed onto the other hills downwind.

All of these effects have very real impacts on turbines located in complex terrain. But traditional, linear models cannot account for them. This means reduced accuracy and increased uncertainty.

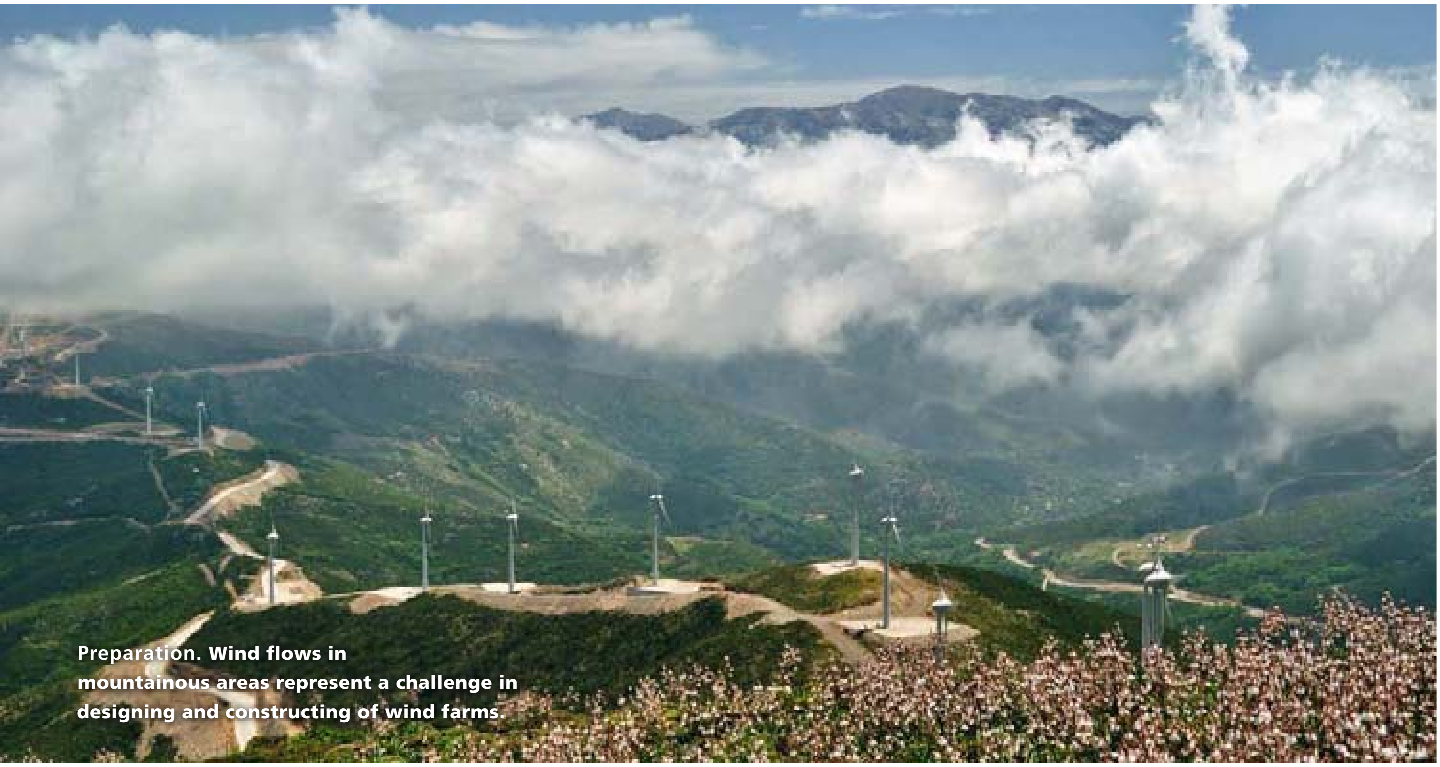
New Tool in the Arsenal

CFD does not make the same assumption of linearity as traditional models do, which in principle makes it better suited to model the wind flow in complex terrain. However, there are two significant trade-offs that have "don't do this at home" written all over them.

CFD is way, way heavier than linear models, computationally speaking, which means that you need a very large and expensive computer in order to get the level of spatial detail needed and to run the model in a reasonable amount of time. The latter is usually done by parallelising the calculation over many processors. In January 2011, GL Garrad Hassan gave a home to a cluster that currently allows the CFD calculations for one wind farm site to be completed within two days.

The more subtle trade-off, however, is the level of care, engineering judgment and expertise needed to do CFD properly. There are many choices to be made at every step when setting up and interpreting the results of a CFD simulation (meshing strategy, boundary conditions, representing different wind directions, etc.). One mistake can lead to inconsistent results, or worse, results that look plausible but are misleading. Unfortunately, awareness of this key difference between CFD and linear models has not yet become universal in the wind industry and some practitioners of CFD may be falling into some of the many traps that exist in CFD.

GL Garrad Hassan has several years of experience in the application of various CFD models to wind farm sites. Since January 2011, GL Garrad Hassan has settled on a commercial, state-of-the-art, multi-purpose engineering physics simulation package as a calculation engine. To ensure consistency and reduce sensitivity to user input to a minimum,



Preparation. Wind flows in mountainous areas represent a challenge in designing and constructing of wind farms.

Photos: Dreamstime/Antikainen/Wojphoto

a method was developed and parameters were set up that can be applied uniformly to a majority of complex-terrain sites, without site-specific tuning.

Validation Exercise

To verify the soundness of this CFD method, it was applied to a dozen complex-terrain sites, each equipped with two or more masts from which quality-assured measurements were available (70 mast pairs in total). This allowed performing cross-predictions between masts using CFD and comparing these wind speed predictions to the actual measurements. Furthermore, a traditional linear model was run for comparison. CFD provided two important benefits when compared to the linear model: the deviation from measurements was generally reduced by one third, and very large deviations were much less frequent. The linear model occasionally resulted in very large errors (up to 20 per cent on the mean wind speed) but this was not observed for CFD. The full results of this validation exercise are documented in a paper presented at EWEA 2012 in Copenhagen. Based on this evidence, CFD methodology can consistently reduce uncertainty in the context of wind resource assessments.

Mistakes Averted

As it turned out, the CFD simulations worked like a charm on Rosa's rocky plateau, providing critical insight into the wind flow patterns there. GL Garrad Hassan was able to determine that two of the fifteen proposed turbine locations would be so severely affected by adverse flow conditions that this would lead to low production levels as well as increased wear and tear, hence high maintenance costs. The planned turbine locations were moved by two hundred metres, where the flow would be more regular and the wind speeds higher. Thanks to advanced flow modelling, the output of the client's project could be substantially improved, and its expected lifetime extended. Now this certainly did please Rosa. □ **JFC**

CFD. Computational fluid dynamics uses powerful computers to analyse and simulate the behaviour of complex liquid or gas flows.

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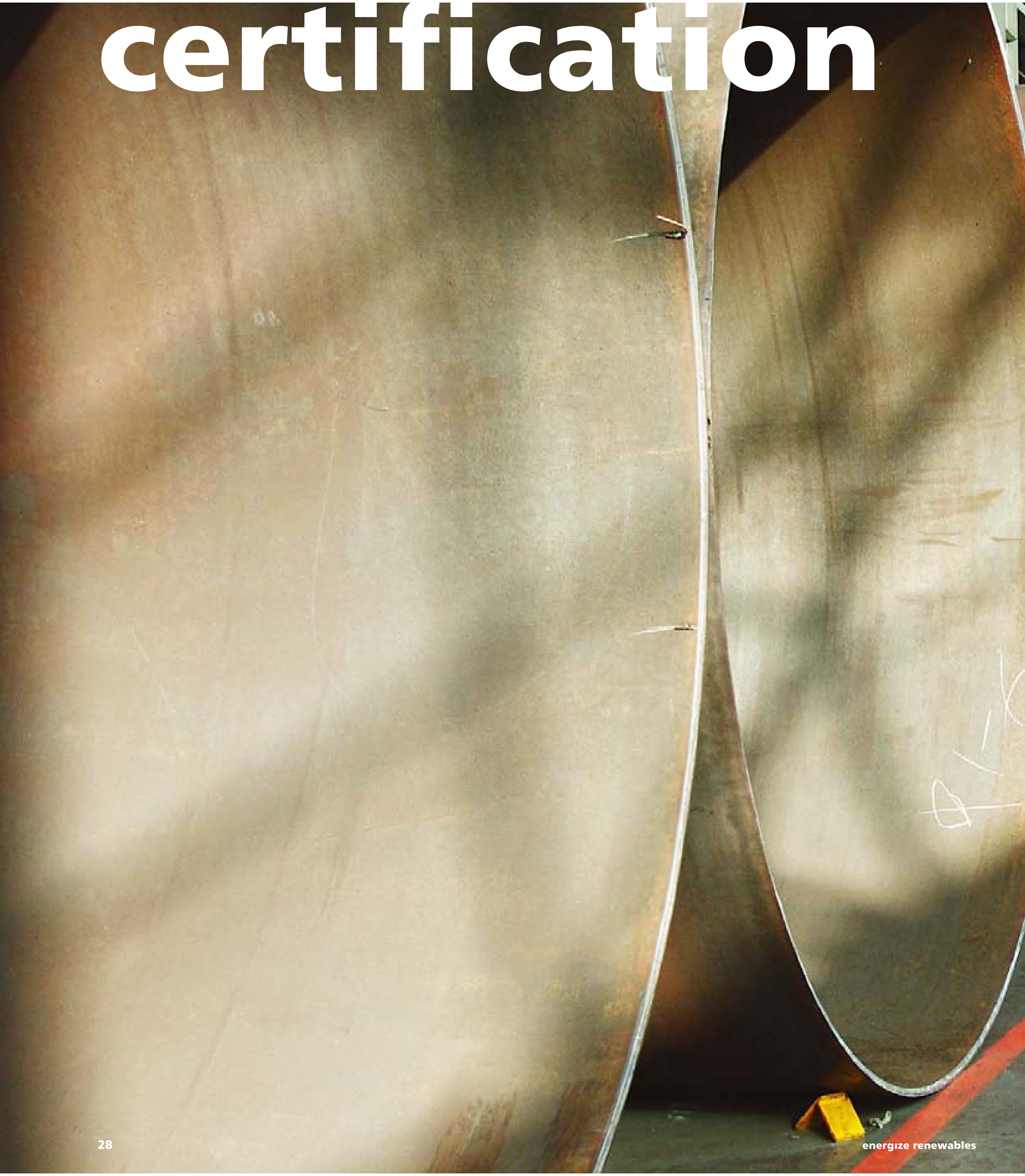
certification



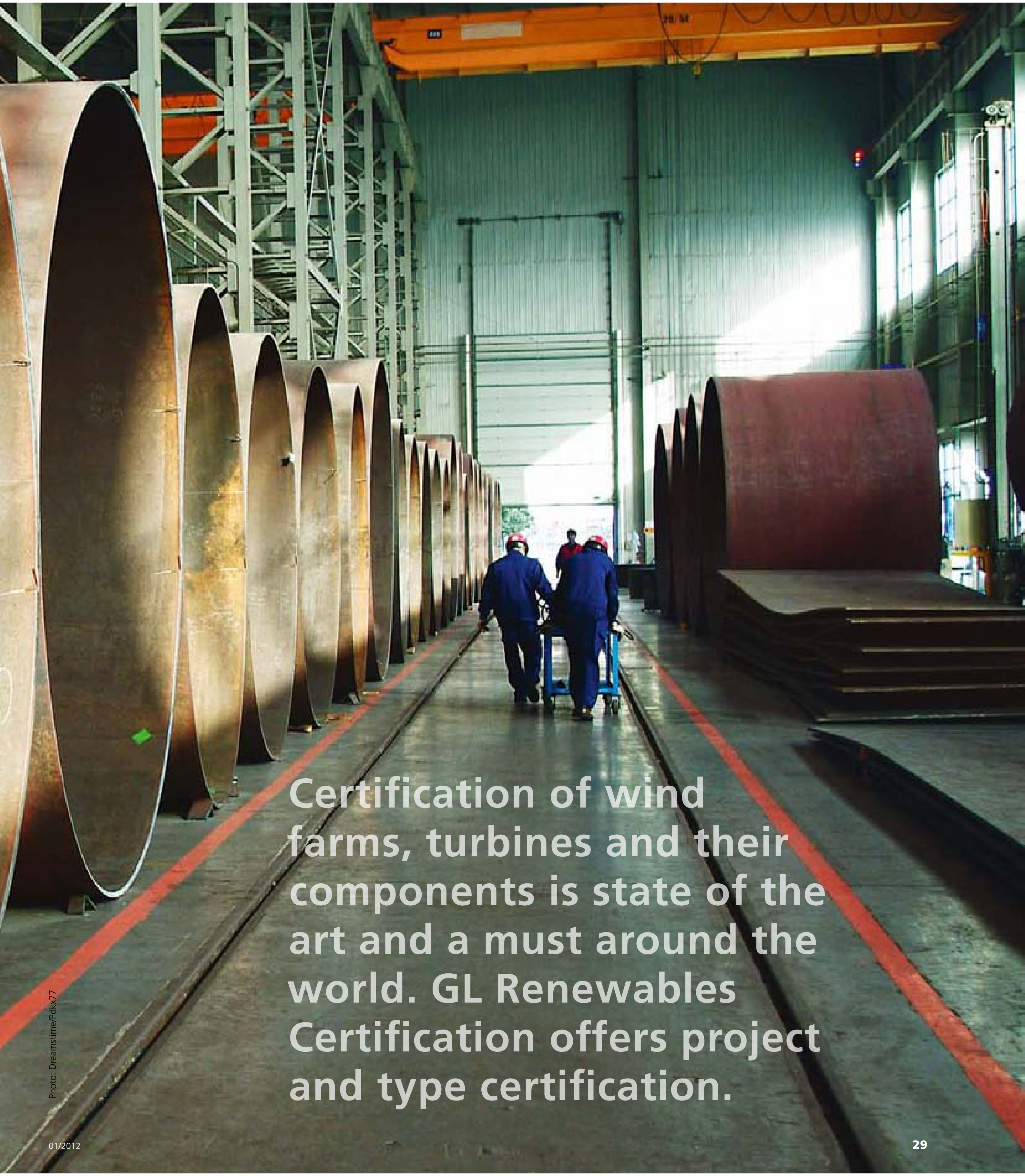


Photo: Dreamstime/Pdkx77

FINO1. **The research platform was erected in the North Sea in 2003, and provides the highest continuous wind measurement in the offshore sector worldwide.**

Photo: Wilhelm Heckmann

Turbulence Models under Scrutiny

Wind turbine designers use a variety of simulation tools to predict the wind loads at the proposed site as accurately as possible. But how can the tools chosen be further improved without reducing safety level?

All simulation tools used in wind turbine design require a simulated wind field as input. To obtain reliable results from a numerical wind turbine model, the wind field model used to analyse turbulences must be realistic. In a recent study on offshore wind turbulence, GL Group experts examined the validity of current wind field models by benchmarking them against wind time measurement series taken at the FINO1 offshore research platform located in the North Sea.

Preliminary investigations had shown that the various models used to describe turbulent wind according to the GL Guideline or the IEC standard can result in significant differences regarding wind turbine loads. The applicability of these models and of deviations in load analyses have been the subject of discussion among design experts. The aim is to reduce margins without compromising safety.

ABSTRACT

- Wind profiles and the distribution of wind speed fluctuations are captured very well by the commonly used models
- The relations between standard deviations of the wind speed components differ from the Kaimal and Mann model

Approximately two years of FINO1 data from three different heights, recorded in samples of 10 minutes with a frequency of 10 Hz, were analysed for the study. From the data pool, only samples with appropriate wind speeds and turbulence intensities were used for analysis.

The statistical properties were calculated and compared with the theoretical values commonly used in standard wind field models. Synthetic wind fields were generated using the wind field generation tool of GL Garrad Hassan's Bladed software. The parameters for the turbulence models were chosen to match the analysed characteristics of the FINO1 data.

Detailed Insight

The study showed that wind profiles as well as the distribution of wind speed fluctuations are captured very well by the commonly used wind field models. These models assume the wind speed fluctuations to be Gaussian distributed. The analysis of conditioned FINO1 data confirmed this assumption on the basis of 10 minutes-time series which did not include meteorological trends on larger time scales.

The analysis of the highly time-resolved FINO1 wind speed measurements with the statistics of increments showed the intermittent characteristics of atmospheric wind fields. This feature is pronounced over a broad range of time scales. Standard wind field models do not reproduce this behaviour of atmospheric wind fields. That means, in comparison with the standard IEC or ESDU models the atmospheric ▷

▷ wind fields show a higher probability of extreme wind speed changes on small time scales. The consequence is a probable underestimation of extreme gusts and their rising time. The intermittency is known to result in additional loads as well as in intermittent power fluctuations.

The relations between the standard deviations of the wind speed components coincide with the ESDU model but differ significantly from the Kaimal and Mann model. However, these results should be compared to other offshore measurements to exclude influences originating from the mast and the measurement devices.

BLADED. GL Garrad Hassan's integrated software package for the design and certification of onshore and offshore turbines.

A Few Surprises

The length scales of turbulence were calculated for the FINO1 data and compared to those given in the relevant standards. Synthetic time series were generated with the calculated properties using Bladed. Some significant differences from the assumptions were found to exist. A load analysis of simulations for some key parameters showed striking differences in the resulting loads. Unfortunately, real-load measurements were not available for comparison. Nevertheless, the ESDU spectrum was found to describe the atmospheric spectral probability densities measured on FINO1 better than the other standard models.

Wake effects in large wind farms aggravate turbulences. Load analyses based on effective turbulence revealed striking differences with respect to the chosen model. Interestingly, the Kaimal spectrum produced higher fatigue loads in this case than the ESDU spectrum. For cases with lower turbulence the study yielded the opposite result. Nevertheless, the Kaimal model showed good agreement with the results of the extreme load simulations for large wind farms.

Future research projects will investigate these important influences on loads of neighbouring wind turbines in greater detail. Further investigation is needed to improve the wind models used in wind turbine load analyses. The Mann model, in particular, will be subject to further investigation.

The GL study, while not a complete review of current wind modelling techniques, provides a good basis for further discussion within the IEC TC 88 committees regarding the continued development of the IEC 61400-1 and IEC 61400-3 standards. □ **TM**

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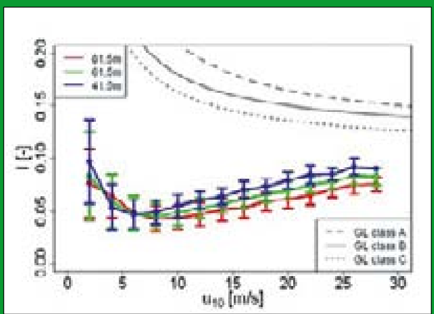


Figure 1. Turbulence intensity of the FINO1 data in the selected wind direction sector.

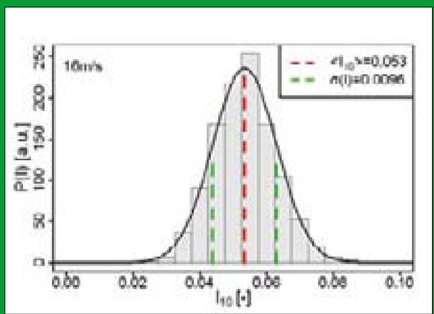


Figure 2. Distribution of turbulence intensities for u10 = 16±1 m/s at 81.5 m height.

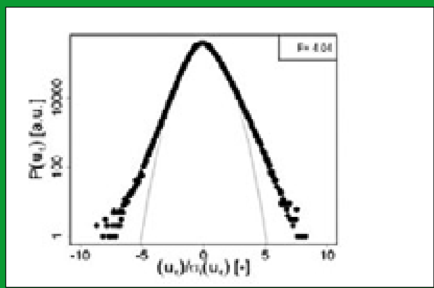


Figure 3. Probability density function of wind velocity increments normalised to a standard deviation of σ=1

Photo: iStockphoto/Teun van den Dries

Loads.
Components, long life, complexity: Everything is huge in a wind turbine.

Will it last?

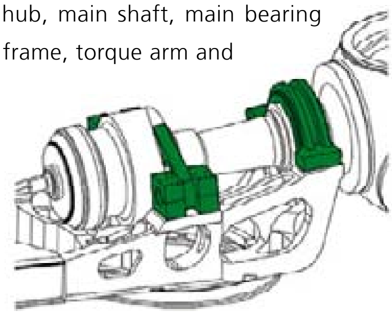
The design lifetime of a wind turbine is very long, and the components in the main load path are huge and expensive. To predict component fatigue life, design engineers rely on sophisticated simulation tools

Modern megawatt-class wind turbines are exposed to high and complex loads. Larger components entail increasing cost and the demand for a sturdy substructure able to carry the deadweight and the aerodynamic loads. At the same time, lightweight and optimised structures are important design objectives to reduce material consumption and cost, and to improve competitiveness.

Considering the large-size components and the long design lifetime, full-component fatigue tests are not common practice in the wind industry. Hence simulation of global loads and component fatigue behaviour is vital. Since failure of large parts can be an economic disaster, simulation accuracy is essential.

Wind Turbine Components

The load-bearing structural components of a wind turbine – in particular, the hub, main shaft, main bearing housings, machine frame, torque arm and planet carrier – are mostly made of large, complex-shaped castings or steel materials. Since wind turbines are often located in remote areas where access for inspection is difficult and repair is costly, their design must be based on reliable safety assumptions, in particular a long crack initiation phase. But more importantly, the prediction of component life prior to crack initiation is what designers of these heavily loaded structural components are most interested in. A current GL study is investigating new ways of improving the accuracy of fatigue resistance predictions.



Gear Box.
Conventional three-point suspension.

Design Loads

The simulation models commonly used to verify the strength of key components typically account for the rotor blades and tower in much detail, whereas the dynamic properties of the drive train, the structural components and other crucial elements are barely considered. Design loads for a wind turbine are thus only available within certain predefined coordinate systems of the wind turbine, e.g. its blade root, hub centre or the tip of the tower. Component loads must be extrapolated ▷

ABSTRACT

- Understanding component fatigue behaviour in wind turbines is crucial and complex
- To optimise design safety and economic efficiency, current models require further refinement

Photo: Dreamstime/lctor

Assembly. **Installation of a rotor hub.**

from these global loads. To obtain the loads a synthetic three-dimensional turbulent wind field is applied to the wind turbine model. This simulation produces load time series of forces, moments, accelerations, pitch and yaw angles, etc. The forces and moments are the appropriate parameters to use in strength verification.

Material Properties

Complex fluctuating loads can cause variations in stress directions, a phenomenon generally referred to as multiaxiality. Regrettably, the multiaxial stress resistance of brittle materials, such as high-strength cast iron, is rarely known outside research centres. Fatigue strength of materials, such as S-N curves for spheroidal graphite cast iron, is experimentally determined on specially prepared laboratory test specimens and usually defined only for uniaxial stress states. The uncertainties involved in quantifying this property are accounted for by using statistical parameters such as probability of failure, scatter, slope and knee of S-N curves, level of confidence and the number of tests.

FATIGUE FAILURE. A three-stage process: The crack initiation phase is followed by the crack growth phase eventually leading to rupture.

The influence of factors such as surface roughness, technical defects, wall thickness, mean stress and notch effects must likewise be accounted for when determining component material strength under fatigue loads caused by uniaxial stress states. These factors cover all related known risks. Careful combination of these factors is necessary to theoretically optimise the load-bearing capacity of the component. An aspect that is commonly disregarded in the determination of material properties is the influence of the manufacturing process. A recent German research project attempts to close this gap using manufacturing simulations and practical experience.

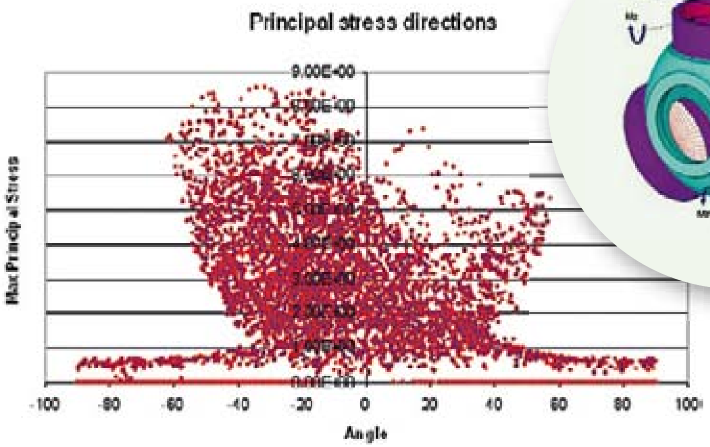
Fatigue Calculation

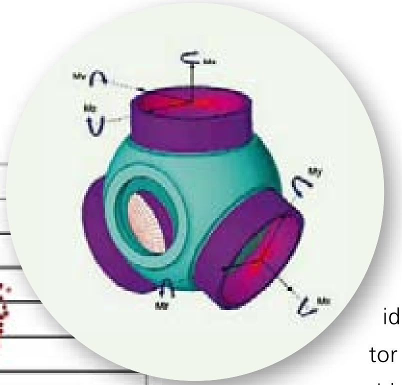
The complex dynamics of wind loads interacting with a turning rotor generate forces and moments that act simultaneously and independently in the three spatial directions. Since it is impossible to identify the most relevant load components in terms of structural component design, all load components must be considered equally. An additional vital factor is the phase relationship.

The analysis distinguishes between stresses under fatigue loading and the representative fatigue property of the material under consideration. The life of a component is a function of both. Various safety and reduction factors are considered in these calculations before damage accumulation is carried out to determine the life and degree of utilisation of a component.

Component Stresses

Due to the complex component geometries and varying load scenarios, the local stress approach in combination with detailed finite element component models and load time series is the generally accepted procedure. Linear superposition and damage accumulation is permissible as long as the material and model behaves linear. Non-linear boundary conditions, however, such as contact surfaces of





Rotor Hub. **An example of multiaxial stress states.**

bearings, require a modified approach. The GL study combines various existing stress analysis data and methods with fatigue loads and finite element models to evaluate multiaxial stresses at various locations of a given wind turbine mainframe.

Evaluating Stress States

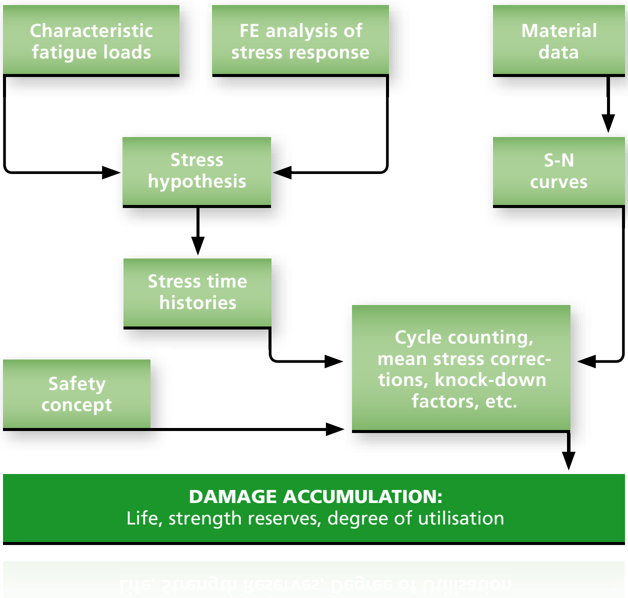
For typical hot spots in classical main frame designs the study concludes that stresses at low wind speeds or in idling situations are mainly caused by the rotor weight, while at higher wind speeds and/or with the blades turned into the wind, high tensile stresses are predominant due to the tilt moment arising from the shear effects of the rotor and the axial thrust. Since the thrust load will increase at higher wind speeds, the mean stress level will step up proportionately. From these and other observations it can be deduced that the stress states causing the largest portion of damage are quasi-uniaxial and show a high mean stress level.

In a second step, different hypotheses were applied to calculate equivalent stresses, and finally damage. The critical plane approach and the modified shear stress criterion proved to be reasonably accurate in predicting fatigue life for both in-phase and out-of-phase loading.

While in the case of the main frame, many locations feature uniaxial stress states similar to the one presented above, the situation is different when analysing the rotor hub of a wind turbine, where multiaxial stress states exist at several points. The influence of these changing principal stress directions needs to be considered in fatigue analyses by applying an appropriate stress hypothesis.

This GL study on material fatigue properties aims to improve fatigue life simulations and refine the existing material models. This should ultimately allow designers to make more efficient use of materials and enhance design competitiveness. ☐ **MR/AM**

Flow Chart. **Fatigue analysis procedure.**



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news in brief

ERG Renew Financing One of the Leading Hotspots

calabria GL Garrad Hassan supported the investors of ERG Renew's Italian wind farm "Fossa del Lupo" ERG Renew and the three banks involved with its due diligence services. The independent engineering consultancy accomplished the assessment of the potential risks that can influence the project financing of the wind farm. The banks are ING Bank, Crédit Agricole CIB and Centrobanca.By identifying potential risks and demonstrating ways of mitigating them, GL Garrad Hassan supported ERG Renew, a wind energy electricity producer, and the banks involved to meet the strict requirements of a project financing. Adding this project to its portfolio, ERG Renew is now one of the leading operators of wind farms in terms of installed capacity in Italy.

The Fossa del Lupo wind farm in Calabria has a total nominal power of 97.5 MW.

Italy. One of the european wind energy hotspots.

GL Renewables Certification Young Professionals Awarded

oldenburg For the second time the "GL Wind Energy Award for Young Professionals" was been presented at the job fair "zukunftsenergien nordwest", this year in Oldenburg, Germany. Following the motto "Innovative ideas for wind energy", GL Renewables Certification awarded the prize to three trendsetting theses in recognition of their new technical approaches to research and development within the wind industry.

Mike Wöbbeking, Vice President GL Renewables Certification, handed over the prizes and highlighted the feasibility, economic benefit and quality of all three papers.

Award. (f.r.) Mike Wöbbeking (GL RC) and the awardees Vera Schorbach (2nd), Julika Wichmann (1st place) and Mareike Strach (3rd).

GL Garrad Hassan Joining Forces

hamburg GL Garrad Hassan has appointed Christoph Thiel as its new Head of Business Development and Sales and Ian Finch as new Business Development Manager.

Mr. Thiel will be responsible for managing global sales and business development for GL Garrad Hassan worldwide. "We are very pleased to have Christoph back at GL Garrad Hassan. His breadth of experience and deep understanding of the market will be extremely valuable in helping us to strengthen GL Garrad Hassan's global presence," said Andrew Garrad, President of GL Garrad Hassan.

Ian Finch will manage sales and business development activities for the GL Group with a special focus on offshore wind. As an experienced sales and business development manager he will work closely with Christoph Thiel and Colin Morgan, who leads the Group's Offshore Wind Practice.

Management I. Christoph Thiel (l.) is new Head of Business Development and Sales. Ian Finch will be responsible for managing sales and BD activities.

Rules for certification and construction. Our latest brochures, rules and guidelines are available on request. Order forms are available on the Internet:
www.gl-group.com > Rules & Guidelines

DIBt Upcoming Changes for German Type Approval

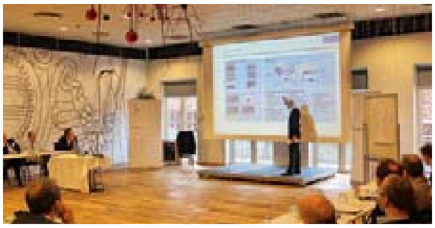
hamburg The Eurocodes will soon replace German national standards for civil structures. In parallel, Deutsches Institut für Bautechnik (DIBt) is working on a revision of its “Guideline for wind turbines”. This guideline forms the basis for approval of towers and foundations of wind turbines according to German building law.

Turbine suppliers should be prepared for this change as it is planned to have a key date rule, i.e. from the day the new edition is published, approval shall be based on it and approvals based on the previous edition are no longer possible. GL RC has been appointed authorised experts for issuing German type approvals on behalf of the Federal state “Freie und Hansestadt Hamburg”. These type approvals facilitate the process of obtaining permits for building wind farms from local authorities in Germany.

Turbine. The revision of the guidelines are expected by mid-year.

Photos: Dreamstime/View7, NASA

DWIA Supply Chain Workshop



Workshop. Dr Lars Landberg (standing) and Lars Falbe-Hansen (at the front table) conduct the SWOT workshop.

horsens The strengths, challenges and opportunities for Danish wind sub-suppliers in a global market were discussed in a workshop led by Lars Falbe-Hansen and Dr Lars Landberg during a meeting of the Danish Wind Industry Association in Horsens, Denmark. The two GL Garrad Hassan experts conducted a SWOT (Strengths, Weaknesses/ Limitations, Opportunities and Threats) workshop addressing challenges and opportunities from Asia.

GL Renewables Certification Strengthen the Presence

hamburg GL Renewables Certification (GL RC) has appointed Rüdiger Urhahn as Vice President Project Management & Sales and Fabio Pollicino as new Head of International Operations.

Mr Urhahn now is responsible for worldwide customer management in the area of certification services. In addition, he was given the task of overseeing all customer projects relating to wind, solar and marine energy. Says Urhahn: “Customer satisfaction and customer focus are paramount to me in my new position.”

In his new role Mr Pollicino will be responsible for further evolving GL RC’s worldwide business, especially in North America, China and India.

The German-Italian joined GL RC in 2002. Most recently he held the position of Head of Group Computer Aided Engineering within GL RC's department of Machinery Components and Electrical Engineering.

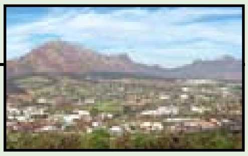
Management II. Rüdiger Urhahn (l.) is the new Vice President Project Management & Sales at GL RC. Fabio Pollicino now heads International Operations.

dates at a glance

Conferences & Fairs

MAY

21. – 23.05.2012
SASEC 2012
Stellenbosch, South Africa



Pioneer. 1st Southern African Solar Energy Conference.

22. – 23.05.2012
PWEA 2012
Warsaw, Poland

Event. The PWEA expects almost 1,000 participants.

28. – 30.05.2012
Wind Power Africa
Cape Town, South Africa

Location. Cape Town International Convention Centre.

JUNE

03. – 06.06.2012
AWEA 2012
Atlanta, USA

Windpower. Georgia World Congress Center.

13. – 14.06.2012
Global Offshore Wind 2012
London, UK

Host. RenewableUK is the organiser.

13. – 15.06.2012
Intersolar 2012
Munich, Germany

Champion. The largest exhibition for the solar industry.

26. – 29.06.2012
Windforce 2012
Bremen, Germany

Innovation. Offshore conference now with a fair.

JULY

9. – 12.07.2012
Intersolar North America
San Francisco, USA

Experts. More than 200 speakers at 30 sessions.

25. – 27.07.2012
Clean Energy Council 2012
Sydney, Australia

Efficiency. Australia's largest event for the renewable energy sector.

IMPRINT

energize renewables, issue no. 01/2012, April 2012 **Frequency** energize renewables is published three times a year **Published by** Germanischer Lloyd SE, Hamburg **Editorial Director** Dr Olaf Mager (OM), Corporate Communications **Managing Editor** Steffi Gößling (SG) **Authors of this issue** Jean-François Corbett (JFC), Caroline Evans (CE), Oscar Fitch-Roy (OF), Sarah Herman (SH), Marcus Klose (MK), Lars Landberg (LL), Tanja Mücke (TM), Ali Muhammad (AM), Joe Phillipps (JP), Milan Ristow (MR), Henning Sietz (HS) **Cover photo** iStockphoto/Pedro Antonio Salaverría Calahorra **Design and production** printprojekt, Schulterblatt 58, 20357 Hamburg, Germany **Layout** Lohrengel Mediendesign **Translations** Andreas Kühner **Prepress** Lohrengel Mediendesign **Printed by** Media Cologne Kommunikationsmedien GmbH, Luxemburger Straße 96, 50354 Hürth, Germany **Reprint** © Germanischer Lloyd SE 2012. Reprinting permitted on explicit request – copy requested. All information is correct to the best of our knowledge. Contributions by external authors do not necessarily reflect the views of the editors or of Germanischer Lloyd **Enquiries to:** Germanischer Lloyd SE, Corporate Communications & Branding, Brooktorkai 18, 20457 Hamburg, Germany, Phone: +49 40 36149-7959, Fax: +49 40 36149-250, E-Mail: pr@gl-group.com

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Training

GL Garrad Hassan

Training Courses – Dates 2012

Wind Farm Design
19 June — Cape Town, South Africa
11 July — Bristol, England

Intro to WindFarmer
20 June — Cape Town, South Africa
12 July — Bristol, England

Weather Basics for Wind Energy
31 May — Hamburg, Germany
14 Sept. — Oslo, Norway

Wind Farm Projects & Investment Risk
13–14 June — Bristol, England
12–13 Sept. — Oslo, Norway

Wind Farm Construction & Operations Procurement
27 June — Bristol, England

Bladed
3–7 Sept. — Bristol, England

Verifying & Optimising Wind Power Performance
19 Sept. — Hamburg, Germany

For more information on these courses, see:
www.gl-garradhassan.com/en/Training.php

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