NOVEMBER–DECEMBER 2011
RENEWABLE ENERGY WORLD
VOLUME 14 NUMBER 6

RENEWABLE ENERGY WORLD MAGAZINE®

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MANAGE RENEWABLE RISK
Assessing offshore margins

BALANCING ACT
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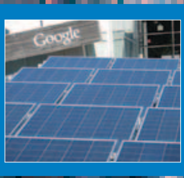

EXECUTIVE DECISION
Maximise value from renewable energy procurement

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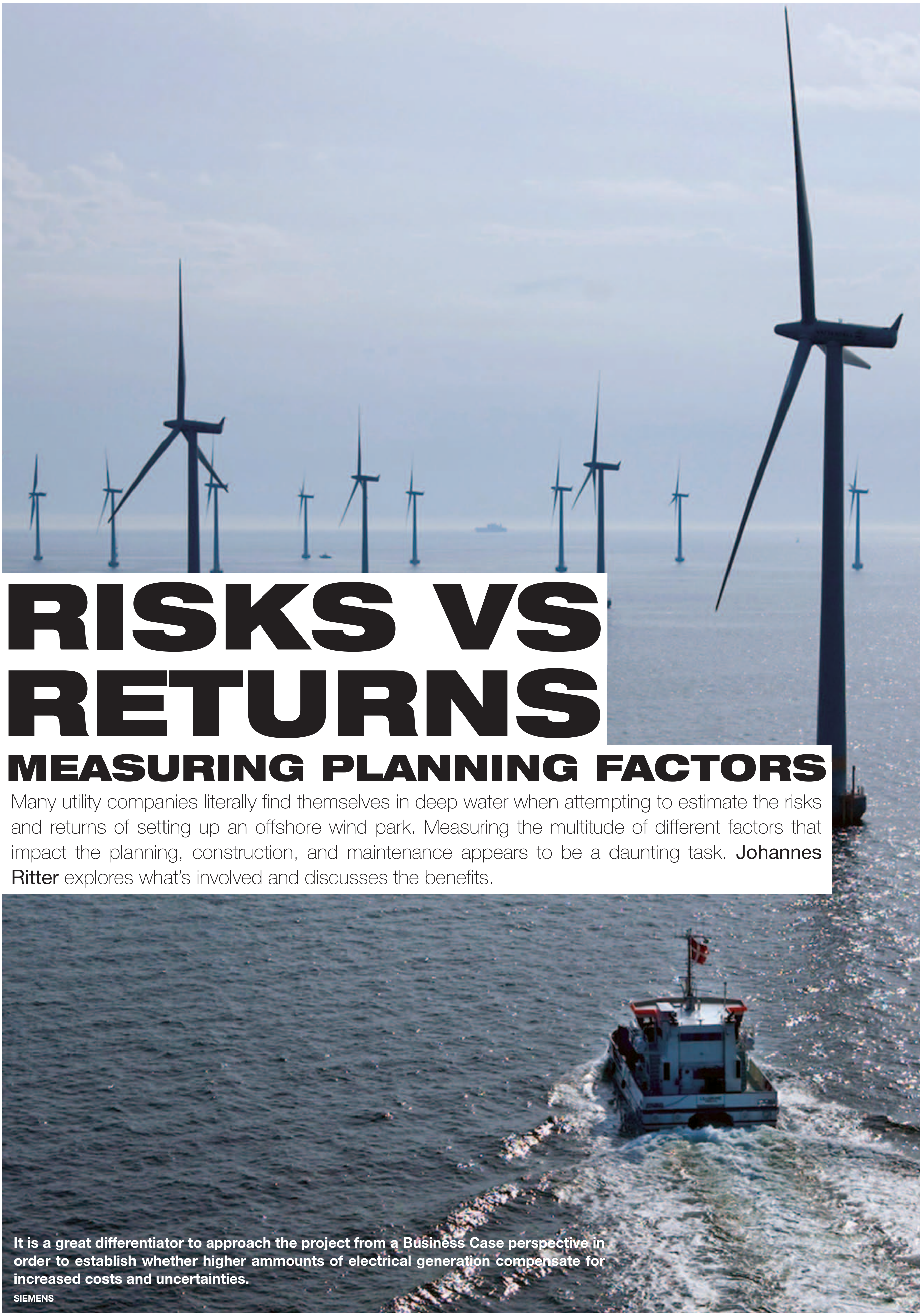


RISKS VS RETURNS

MEASURING PLANNING FACTORS

Many utility companies literally find themselves in deep water when attempting to estimate the risks and returns of setting up an offshore wind park. Measuring the multitude of different factors that impact the planning, construction, and maintenance appears to be a daunting task. **Johannes Ritter** explores what's involved and discusses the benefits.

It is a great differentiator to approach the project from a Business Case perspective in order to establish whether higher ammounts of electrical generation compensate for increased costs and uncertainties.
SIEMENS

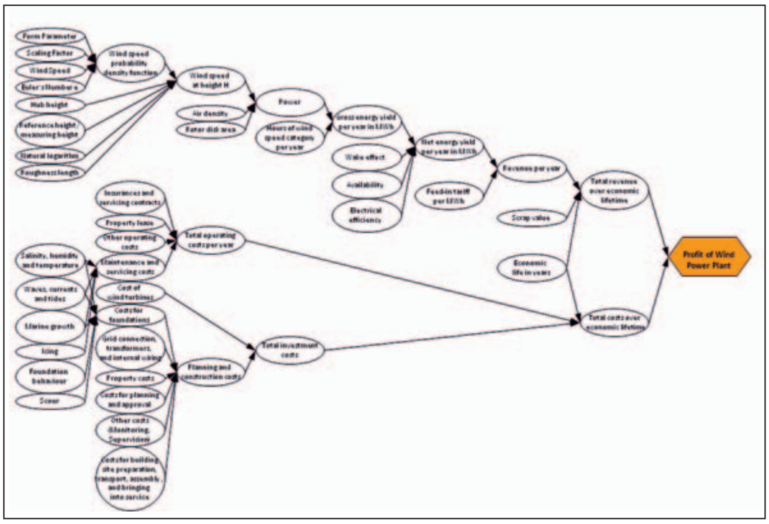
'Give me enough money and I can build anything.' A bold exclamation made by an engineer with years of experience within the offshore wind industry. But in fact this claim has some truth to it. The number one challenge is not of a technical nature but pertains to persuading the investors and project developers with convincing numbers. Whereas the engineer might be interested in technical details, the investors are interested in numbers only, and not in just any numbers, but only those they can trust. The trade off between the technologically possible and the financially feasible is constantly being challenged within the renewable energy industry, but the balance between these two often opposing forces remains. So how does one strike the right chord that will resound with banks, insurance companies, and project sponsors alike? The key lies in recognising that technical and financial figures depend on each other and should be treated as parts within a single system.

Harvesting wind power on the ocean is not a new concept; the first offshore wind parks from the 1990s have long since been made superfluous by newer, more efficient models with an even more suitable placement and a better maintenance programme. Nowadays, engineers around the world are constantly competing to design the largest and most efficient wind mills for use at sea, which has resulted in several innovations within generator, nacelle, and wing tip designs.

With an ever increasing amount of players on the global scene in a time of financial crisis, obtaining the necessary funding for new offshore wind ventures has become still more difficult. This is hardly surprising, seeing as they carry with them far greater investment – and maintenance costs than land based alternatives – not to mention a far greater level of uncertainty that never goes down well with investors in an already shaken global economy. Construction projects of this scale must thus be approved by a variety of gatekeepers before the first stones are even laid, and expert advisors to banks and insurance companies are notoriously hard to impress.

Therefore, it is a great differentiator to approach the project from a Business Case perspective in order to establish whether the higher amounts of electricity generated on the sea within a given project compensate for the increase in costs and uncertainty of that project. At the same time, the Business Case unites the technical part of the venture with the business part, which is an objective that many current approaches fail to achieve.

Only when the wind park project is approached from a broad perspective that combines technology and finance can the true value of the project be calculated. For example, oceanographic survey results are translated into construction costs, environmental impact analyses into offset costs, and wind speed frequency distribution into anticipated electrical output figures. Similarly, operational costs are evaluated, while availability and reliability data concerning wind turbines are fed into the model to predict both maintenance costs and the available uptime of the wind farm. Ultimately, everything is translated into costs and benefits that can be calculated and measured. This way, all the details and consequences of pursuing an investment in a given offshore wind park project are made clear from the outset. When the trade-offs and their repercussions become apparent to both engineer and financial controller, a common understanding arises. Once this is achieved, the project can be efficiently carried out in a spirit of unity, where friction is substituted with common goals.



The Influence map enables a wind farm profit to be determined.
SOLUTION MATRIX

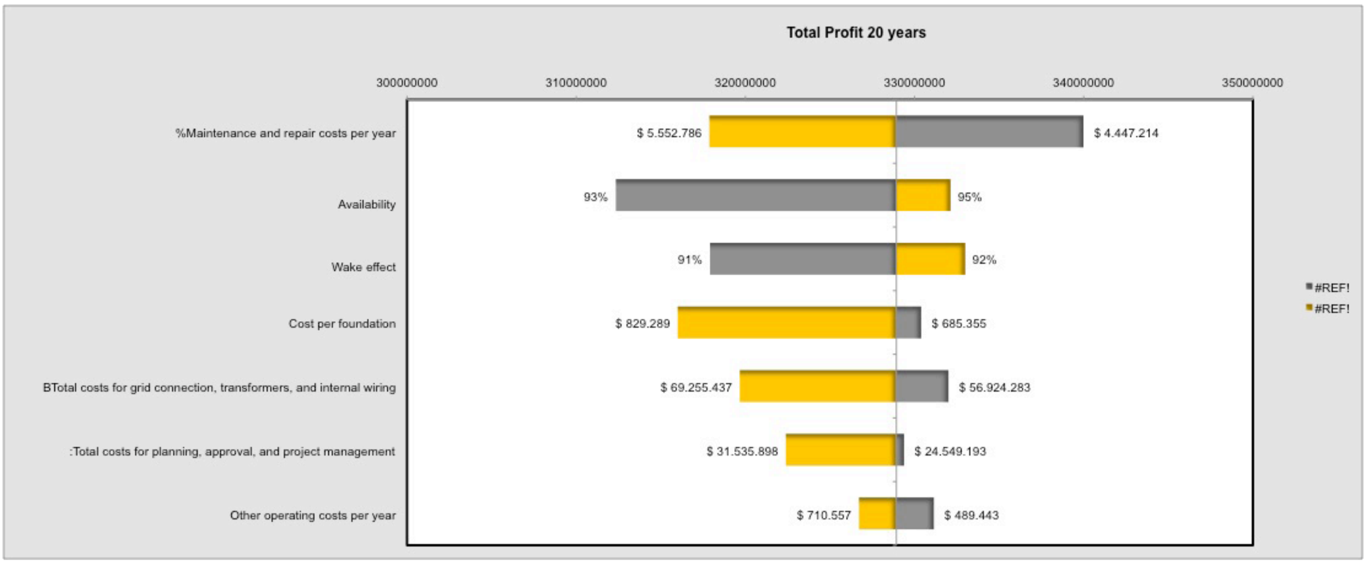
HOW TO CONDUCT A BUSINESS CASE ANALYSIS

The Business Case takes its starting point in the planning and permit phases that hold particular interest due to the sheer size of the initial investment. With a typical 3%–6% of the total project costs relating to simply figuring out where and how to construct the offshore wind park, a strict regimen of cost control and risk evaluation must be adopted. From here, the Business Case moves on to cover the construction and upkeep phases, where different approaches to anything from design to maintenance enter into the equation. Ultimately, the goal is to calculate the lifecycle costs of the project or the total cost of ownership (TCO), broken up into the respective costs relating to acquisition, operation, and scrapping.

Once the various factors, referred to as 'uncertainties' in the Business Case language, are determined by the project team, they are placed into the Influence Map. Some will appear as scientific formulae or constants, whereas others take the immediate shape of dollars and cents. Regardless of their expression, all relevant factors must be included for completeness. Their hierarchy and respective influence on the value, i.e. the ultimate object of the calculation exercise (hexagonal shape) can then be established. The values' unit is always a currency. In this particular case, we aim to determine the profit of the offshore wind power plant. The Business Case then comprises the costs and gains of constructing and maintaining an offshore wind power plant. Given these uncertainties, values, and scenarios, the influence map looks as illustrated above.

DETERMINING PROJECT LIFETIME REVENUE

Given the complexity of the Influence Map it is best readable looking at the upper half first. These uncertainties have impact on the revenue. As can be seen, the uncertainty of various wind speeds (expressed in the wind speed distribution) is broken down into smaller pieces, including form parameter, scaling factor, wind speed, hub height, reference height/measuring height, and roughness length. They are the factors that influence the wind speed at the height h, which combines with the air density and rotor disk area to determine



The Tornado diagram for this example of a wind farm.
SOLUTION MATRIX

the wind power. This uncertainty will then yield a certain amount of gross energy per year, expressed in MWh, and one can compare the trade-offs of different design choices like height and blade type. Deducting further uncertainties such as the wake effect, availability, and electrical efficiency it is possible to arrive at a net energy yield per year in units of MWh. The net energy yield is then multiplied by the feed-in tariff per MWh to establish the revenue per year, to which we add the scrap value and number of operational years for completeness. With the revenue side of the investment well taken care of, we turn our attention to the costs. Once this aspect is in place, reaching the coveted interval of actual project profit becomes a matter of simple deduction.

DETERMINING PROJECT LIFETIME COSTS

The uncertainties concerning cost are on the lower half of the Influence Map. Begin by breaking down the total operating costs per year into smaller, more manageable chunks. One of the uncertainty categories concerns insurance and servicing contracts. Moving on to cover the total investment costs, we take our natural starting point in determining the costs related to the wind turbines and the foundations. The latter is featured in the general planning and construction cost category. It shares the sub-level uncertainty of waves, currents and tides with the maintenance and service cost factor mentioned already, which highlights an important point: Some uncertainties may directly impact more than one type of costs and must be taken into account on each separate basis in order to ensure the overall validity of the Influence Map. Other factors with a potentially adverse effect on the foundation are marine growth and scour, not to mention the behaviour of the foundation itself. The connection to the electrical grid is another cost contributor, involving both transformer acquisition and internal cabling. Siting costs and costs resulting from planning and approval are joined by other plot-related costs (control, supervision) and those for preparing the building site and supplying transport, assembly and other activities required for commissioning the wind park. Adding the total investment costs to the total operating costs per year, we arrive at the total costs over the economic lifetime of the wind park.

EXPERT INTERVIEWS GUARANTEE HIGH DATA QUALITY

In order to ensure a suitable starting point for the numbers part of the Business Case analysis, interviews with experts within relevant areas such as oceanography, environmental impact, and wind speed are carried out. Their aim is to identify all further relevant factors which impact the project and their hierarchy as cost contributors. For instance, the costs of downtime must be reflected in several categories, including consequential damages, contractual penalties, and maintenance. Conversely, a category like maintenance includes various sub-level costs relating to manpower, spare parts, transportation etc. The intervals from the expert interviews thereby form the basis for the financial model.

Establishing the cost side of offshore wind parks is a fairly complex matter that requires a great amount of valid data, to be obtained from interviews with a large number of respondents with special insights – both within the utility and from the offshore wind field overall. The outcome, however, is more than worth the effort if it leads to the right investment decision being made. Data quality is of the essence: if the data fed into a calculation or simulation is incorrect, one can almost be 100% certain that the output will be wrong as well. Asking experts to estimate within a range is superior to demanding specific values, as it is better to be approximately right than precisely wrong.

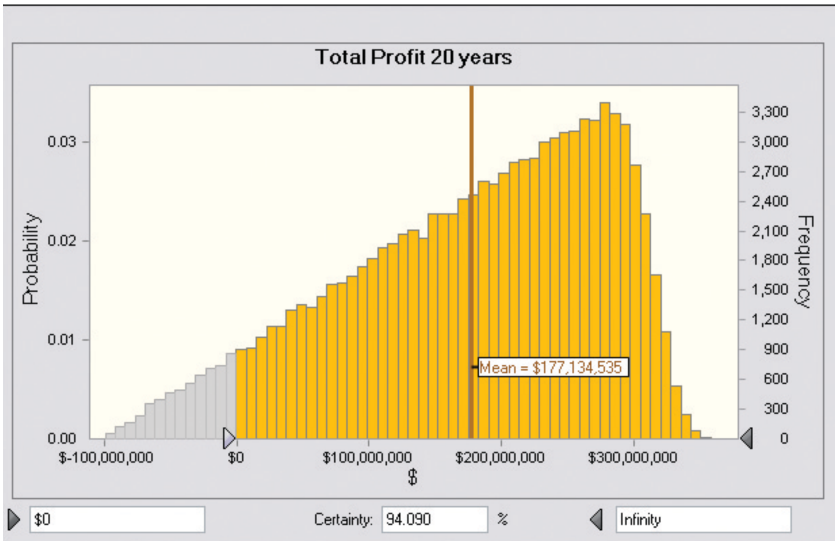
A glance at the diversity of uncertainties in the Influence Map confirms the necessity for involving experts within engineering as well as those knowledgeable within large-scale project finance. Additionally, operation and risk managers may provide sound estimates of other operating costs and costs relating to the maintenance and service of the wind power plant. They may require assistance from the academic field to estimate sub-level uncertainties such as the impact of salinity, humidity and temperature, waves, currents, tides, and icing on the structure. A great deal of this information is already available in written form, however, and requires little more than careful desk research supplemented with a thorough fact checking process.

Filling in these blanks with the suitable intervals and establishing minimum, most likely and maximum figures for each provides us with a selection of numbers that make up the most likely outcome. Using these results, we arrive at the next step: the financial calculations of the Business Case scenario.

FINANCIAL RESULTS: OFFSHORE WIND PARK BUSINESS CASE

Having fed data for the various uncertainties into the financial simulation program, we arrive at the following Probability Distribution Function (PDF) for the 20-year profitability of the offshore wind park, as shown right.

As displayed in the box called 'Certainty', there is a 94% chance of achieving at least a break even on the project (yellow columns) and thereby only 6% chance of a loss. In other words, the specific offshore wind project analysed in this example has a comparably high success rate that only the most risk averse investors would shy away from getting a share in, given the likelihood of a return.



Probability distribution function

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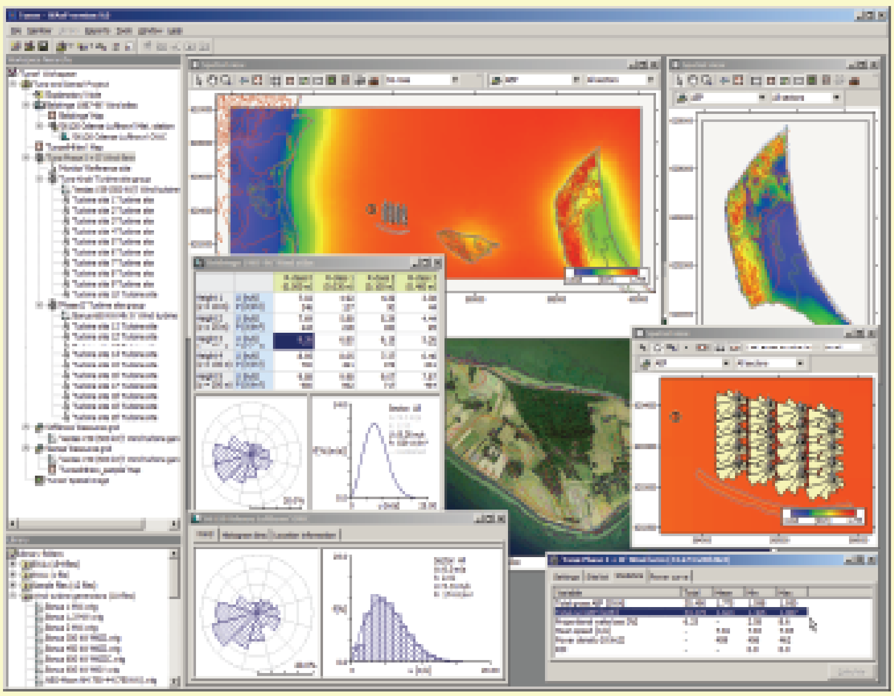
Having established that there is a great likelihood of the project yielding financial gains, developers may then turn their attention to further analysing the probability and impact of the different project uncertainties within the so-called Tornado Diagram – so named after the shape of its rows. In this case the most comprehensive risks with the greatest uncertainties are placed at the top, as shown overleaf on page 28.

It is imperative to devote the most focus to the top-three risks, while keeping the rest in mind. Again, the claim that all investment decisions imply trade-offs shows its validity. The ranking is in its essence an advanced sorting tool that enables us to draw forth the risk areas that are worthy of special attention; that require a higher level of detail and, possibly, the development of area-specific strategies. While arriving at a most likely profit value of US$328 million, we discover that maintenance and repair costs



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will be within the $4.4–$5.5 million range. If a cost-efficient maintenance programme is adopted at the minimum cost of $4.4 million, its impact may be positive enough to ensure a profit of up to $340 million. If the maintenance programme is not able to sufficiently protect the wind park against storms, salinity levels, waves and similar we are looking at a total profit margin of only $318 million. As such, the figures disclose that there lies a great advantage in entering into a maintenance contract with a fixed price from a risk-minimising perspective. Downtime is generally an ill-afforded luxury in the project. With availability being the second-most important risk area, the importance of making preemptive measures is underlined once more. If availability can be kept at 95%, the profits can be as high as $332 million, whereas a drop of 2% to 93% availability carries with it a bottom line of $20 million less – a strong argument in favour of preventive maintenance. As is evident, for a project of this magnitude, even slight adjustments can mean millions of dollars in extra profit or loss. In order to ensure a high availability percentage, a strategy for monitoring and maintenance must be made, in particular with regards to lessening the impact of adverse weather conditions and in case of downtime. The third-most important risk factor stems from the mutual wake effect of the windmills and stresses the need for a proper wind farm layout already from the outset of the project. With a range of $15 million, any planner would be well advised to make the appropriate considerations, yet not all projects benefit from the right coupling of scientific – and financial figures.

Engineers and financial controllers should have no problem finding common ground approaching from a Business Case view.

IN CLOSING: LESSONS LEARNED

As can be seen from this offshore wind park project, adopting a holistic perspective on the various aspects of the project, be they related to engineering or finance, really does pay off in the long run. Not only does attention to the right details and a preventive approach to aspects such as maintenance provide better dividends; they can potentially save life and limbs of maintenance staff by inspiring a pre-emptive strategy that keeps them out of troubled waters. At the same time, knowing when to replace the critical turbine parts and fortify the foundations spares the company of added downtime and consequential damages. With all these potential gains, engineers and financial controllers should have no problem finding common ground and approaching the project planning, execution, and operation phases from a Business Case standpoint. When they unite in mapping out the various uncertainties, and present a comprehensive, prioritised calculation of the risks, uncertainties and return on investment, their project may gain the necessary edge to convince even the most risk-averse investor to give the go-ahead.

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