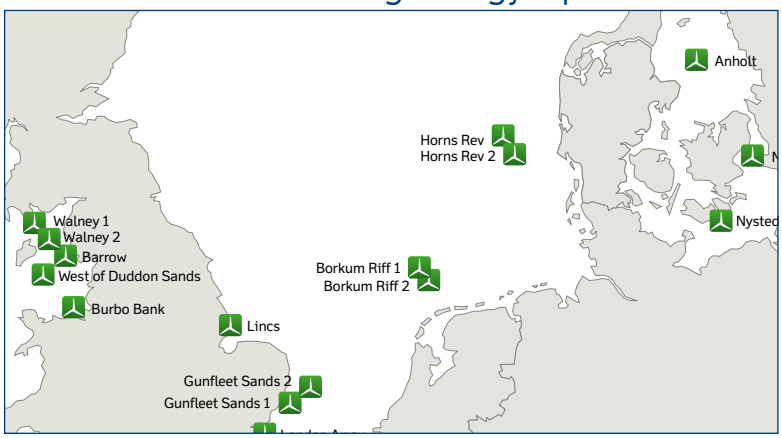
The winds of change

With worldwide capacity for offshore wind power set to grow exponentially, many technical challenges still exist for developers. **James Webb** presents a case study of one such project

From its humble origins some 20 years ago, the offshore wind power industry has developed into an important form of electricity production. Strong growth is forecast: worldwide operational capacity is expected to rise from 3.16 gigawatts (GW) as of late 2010 to 75 GW worldwide by 2020 – a 23-fold increase. Currently, Europe is at the forefront of this sector, although the United States and especially China are expected to emerge as other major players beyond 2015, according to a BTM Consult report.

While there are many technical complexities facing offshore wind farm development, an understanding of the windstorm risk to wind turbines had not been adequately addressed until recently. Danish firm Dong Energy, a world leader in offshore wind farm development took up this challenge, with the aim of quantifying European windstorm risk to its portfolio of offshore wind farms in the North, Baltic and Irish Seas.

Wind turbine sites: Dong Energy's portfolio



Source: Dong Energy

A key problem was the lack of reliable historical loss data to help accurately determine the vulnerability of offshore wind turbines to high wind speeds. Currently, the majority of the world's wind turbines are located onshore, and these facilities account for most of the damage caused by wind. However, there have been few incidents of windstorm damage to wind farms offshore – where higher wind speeds are generally experienced – and where waves and sub-surface currents pose additional hazards.

The difficulty of basing vulnerabilities on historical experience is compounded by the fact that the design of wind turbine components onshore and offshore has advanced over recent decades. This includes the design of the blades, supporting towers and generator units.

As well as the need to quantify windstorm risk to its offshore portfolio, executives at Dong Energy also wanted to share this knowledge with their investors, insurers and other business partners. This promised to satisfy stakeholder concerns about the degree of risk, and to align perspectives on appropriate levels of insurance cover. Fundamentally, it offered to facilitate effective financial support.

With these aims in mind, Dong Energy collaborated with catastrophe risk modelling firm Eqecat, and parent company, ABS

Eurowind: The Eqecat way

Eqecat's Eurowind model methodology aims to provide a realistic representation of winter storm risk over Europe. The hazard component is based primarily on recorded historical wind speeds gathered from onshore measurement stations across Europe. This data is regarded as reliable because of typically small levels of error of the measurement devices.

This hazard module is then enhanced with numerical atmosphere-ocean general circulation model (AOGCM) output. This hybrid approach improves the nature of the event set of thousands of probabilistic storms used in an analysis. For Dong Energy's wind farm analysis, it also helped to supplement the limited available empirical offshore wind speed data. The wind hazard was further refined by using friction factors specific to sea conditions.

The wind hazard within each storm footprint in the event set was modelled for each wind farm, with damage correlation between wind farms considered as a function of event footprints. The combined load of wind, waves and underwater currents on these structures was applied in the analysis using wind speed as an index parameter.

Damage was calculated from the hazard using the vulnerability functions developed with Dong Energy. The natural variability in both hazard intensity and vulnerability was combined in the analysis to produce probabilistic damage results (annual and return period results) that fully reflect uncertainty.

Consulting, a provider of risk analytics and risk engineering services to the wind power industry.

Eqecat conducted a risk analysis of Dong Energy's portfolio of 16 offshore wind farms. The portfolio consists of wind farms in operation, as well as those planned or under construction. One of these new developments, in which Dong Energy is a major partner, is the London Array, a vast complex of 175 turbines in the outer Thames Estuary in the UK, which is expected to become the world's largest offshore wind farm.

The analysis project, the first of its kind in the offshore wind farm industry, encompassed a review of the wind turbine design for Dong Energy's portfolio, a review of wind, wave and underwater current hazards to which offshore turbines are subjected.
It also covered workshops between Eqecat and Dong Energy's technical staff to develop vulnerability functions and a portfolio risk analysis using Eqecat's European windstorm model, Eurowind incorporating the analytically derived vulnerabilities.

Vulnerability functions were developed for specific components: blades, towers and foundations, and benefited from Dong Energy's in-house engineering analysis and information on design base criteria. For the towers and foundations, vulnerability functions were also developed for waves and underwater currents produced by the wind hazard.

The analysis was applied to "at risk" values relating to the cost of in-situ repair to, or replacement of, damaged wind turbine components. Cost estimates were derived for a diverse range of factors that can contribute to losses, including manpower, support vessels, jack-up rigs, the removal of debris, obtaining replacement parts, refurbishment and delays owing to the weather.

The key results of this analysis were probabilistic risk metrics at various return periods for each wind farm and for all wind farms combined.

To share this information, Dong Energy recently held a presentation in Copenhagen hosted by Ole Petersen, director of group insurance at Dong Energy and CEO of the company's insurance captive.

Together with Eqecat, analysis results were presented to a receptive audience of financiers, insurers, reinsurers and insurance brokers.

In any industry, setting rational expectations about risk among major stakeholders is a critical condition for effective risk management. This need is particularly the case in young intensive growth sectors, such as offshore power generation, where history offers scant information on natural catastrophe damage. To inform a shared view of risk and to help sustain development, robust probabilistic analytics can play a useful role.

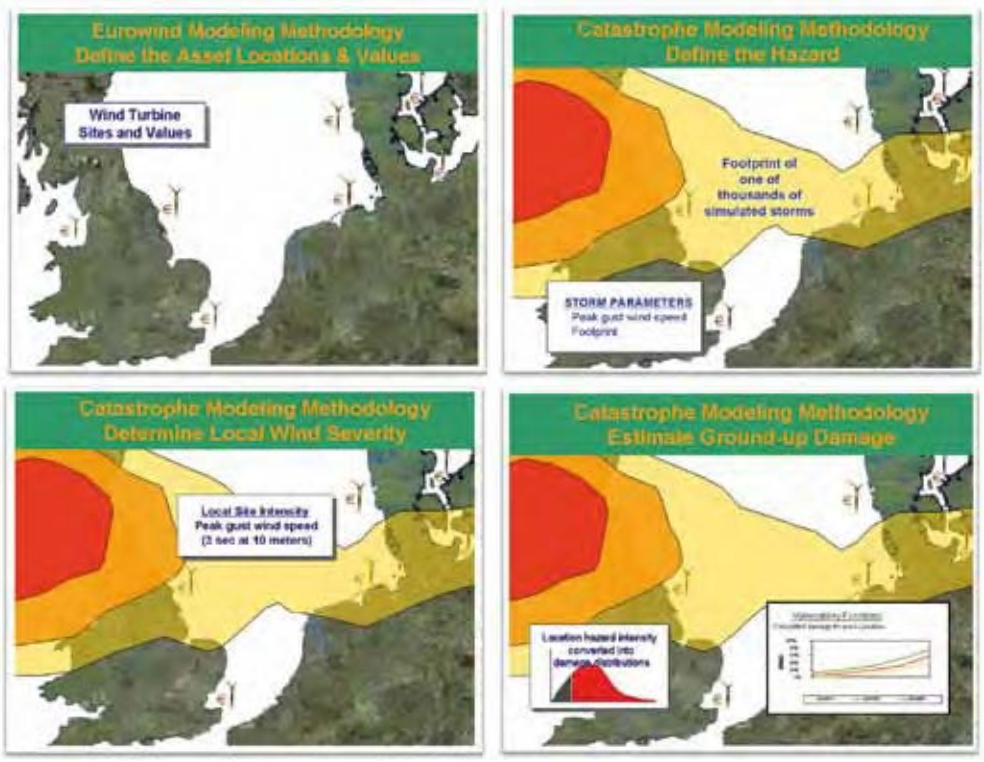
James Webb is product marketing leader, Europe and offshore energy, at risk modelling firm Eqecat

Wind power and Dong Energy

Globally, on- and offshore wind power is beginning to play an increasingly important role in the production of electricity. This is being driven by several factors such as: increasing power demands from developing economies; the pressure to reduce carbon emissions; and the need to secure energy against a backdrop of uncertain supply from conventional sources. Renewed concerns over the safety of nuclear power following the recent Great Tohoku offshore earthquake arguably enhances further the positive prospects for wind power.

Wind power is the most rapidly growing renewable energy technology and Dong Energy illustrates this growth trend well. Currently, it accounts for 14 percent of the company's power generation, with the rest provided by conventional fuel sources. By 2020, the firm aims to reverse this ratio so that wind power will be its dominant source of electricity generation. The majority of DONG Energy's wind capacity comes from offshore wind farms in Denmark, although capacity is increasing from facilities located in UK waters.

Eqecat Eurowind portfolio analysis



Source: Eqecat