INSTALLING A turbine onto its foundation and completing final assembly can be done in a day, but the full job of constructing a wind farm involves a long list of civil engineering and electrical work. It can take anything from one to three years, and calls for expert project management skills.

Once planning approval and project finance is secured, careful management of a complex series of engineering, logistical and electrical processes is vital.

Whilst turbine suppliers busy themselves with getting the turbine of choice manufactured, pre-assembled and ready for shipping to site, the project developer needs to undertake extensive site preparation before the final build can even be contemplated:

“They build access roads and clear the areas where turbines will be erected,” explains The Canadian Wind Energy Association. “They then prepare the foundations and do the excavating, followed by installing the formworks and pouring concrete.”

Once all components have been received, final assembly and connection to the grid can take place:...(continued opposite).

Online: renewableenergyfocus.com

Part one: Windpower – from conception to reality
http://tinyurl.com/4w57nt4

Part two: A plan to succeed for wind power (planning)
http://tinyurl.com/3ffht9

Part three: Spotlight on due diligence for wind power
http://tinyurl.com/3gfa64v

Part four: Finance for wind farms
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Environmental Impact Assessments (EIA) – what you need to know
http://tinyurl.com/5wbjfbb

Interview with Vestas’ Ditlev Engel
http://tinyurl.com/4ymwxn3
“A crane is used to erect the tower and install the nacelle and rotor with its hub and blades. On the ground, the electrical collection network is installed and connected to the grid through the substation.” The entire construction phase can, for larger projects, take between one to three years depending on the size of the wind farm.

When explained in a nutshell like that, it all sounds pretty straightforward. Of course, in reality is anything but, especially when it comes to offshore wind - which has the same basic construction steps but the work involved is far more complex (see later in the article).

However, while planning concerns and market frameworks are major factors in determining whether a project can proceed or is economically viable, it’s the construction phase where things are most likely to go wrong.

The slightest delay or technical hitch can send investment plans into a dive, and spark off heated battles with insurance firms (most wind policy insurance claims relate to the construction phase, most notably in relation to cable damage).

**The right personnel**

“Contractor experience is key,” says James Green from insurance firm JLT Group, who notes that for offshore wind, insurers are “very hot on anything to do with cables” in particular. He points out that 70% of all claims for renewables relate to cable damage, most of them for offshore projects. Companies need to better check whether they are “using the correct cable laying method for the geological conditions of the seabed, particularly when the cables come onshore”, he suggests.

But it is not just offshore where construction challenges are increasing. All projects, be they on land or at sea, face greater environmental scrutiny during the construction process, while onshore more and more wind farms are being built in extreme climatic conditions (affecting weather windows, logistics, basic ground conditions etc); adopting larger and heavier machines; or simply getting bigger in terms of the number of turbines planned for installation.

With wind technology becoming evermore advanced, projects are more ambitious in overall scope, and a flood of new entrants have entered the market in all parts of the supply chain. Companies like GCube, a specialist underwriter in the renewables sector, admits it has had to do “a lot more technical due diligence and risk assessment on projects, not only from a technology perspective, but also from a method perspective and supply chain perspective”, says the company’s Fraser McLaughlin:

“We won’t even look at the underwriting side until we get comfort that the technology is robust; and that the project management - which is critically important offshore - is robust, the design; and the method statements; and the weather windows; [are all under control].” And he stresses, “we like to sit down and meet the project teams. We like to see the whites of their eyes.”

GCube has invested “a significant amount of money” into what it calls its Knowledge Management System. “The criteria we started using was to build up a database of claims data, which we have from about 10 years, and then geographic data - where the projects are going to be sited. But just as important these days is who is actually building, designing and operating the projects. It’s interesting just how much this all does come down to people.”

During the construction of a wind farm there are a multitude of activities that have to be done simultaneously, while other works depend upon the completion of another part before they can proceed. Having an overall project manager to oversee construction work - to ensure the build is coordinated from start to finish - is vital.
Many project developers would have already appointed a lead contractor under an Engineering, Procurement and Construction (EPC) contract from the outset. This entity would have designed the wind farm, and also overseen the main construction and commissioning activities too.

Increasingly, the turbine supplier is taking full responsibility for overseeing the installation and connection of the actual generators. The Balance of Plant (BOP) – civil engineering, electrics etc., will be done by specialist contractors (often appointed by the EPC contractor).

Clearing the path to site

Transporting turbine components to site is an art in itself, requiring specialist skills, vehicles, and careful route planning.

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Clearing the path to site

Transporting turbine components to site is an art in itself - requiring specialist skills, vehicles, and logistical genius in designing the routes to be travelled from manufacturing facilities to final destination. Much of this is done in the pre-construction phase during general development, site selection, and planning application phases - then would be further refined when it comes to finalising the deals with equipment suppliers:

“Good traffic management is vital to a successful wind farm construction project, particularly in light of the intensity of public highway usage at key periods during the construction phase, and the presence of abnormal loads on the roads,” according to Good Practice During Windfarm Construction, a joint report from Scottish Renewables, Scottish Natural Heritage, the Scottish Environment Protection Agency, and the Forestry Commission Scotland.

Often, due to the inhospitable location of many wind farms, roads/access tracks need to be strengthened or even built from scratch (and the ground made good again) to cope with the heavy loads associated with wind farm development. This forms a key part of the civil engineering/BOP phase.

Indeed, on the engineering side, BOP contractors take responsibility for roads/drainage; crane pads; turbine foundation; meteorological mast foundations; and buildings for electrical switch gear, SCADA equipment, control centres, and maintenance/spare part stores.

On the electrical side, work focuses on the infrastructure requirements necessary for the turbines to feed electricity to the grid - such as point of connection equipment; underground cable networks; and overhead transmission lines.

Electrical BOP operations also involve the installation of electrical switch gear to protect and/or disconnect turbines or other equipment from the system; transformers and switches for individual turbines (where not built into the turbines); grounding and connections for control rooms, maintenance facilities, and any other buildings onsite. And all of this work has to be done while paying heed to environmental legislation. Often, an environmental/ecological consultant or clerk of works will be involved every step of the way.

“We employed specialist environmental consultants to assist us in the creation and implementation of an environmental action plan,” notes Jones Bros, the BOP contractor for GE’s 58.5MW Cefn Croes windfarm in Aberystwyth, Wales (operational since 2005). “Considerable effort was put into measures preventing any damage to peat and marsh habitats where the construction changed any natural drainage routes.”

Jones Bros conducted the construction of the access roads, the turbine bases for the 39 GE 1.5 MW machines, the crane bases and the 33kV cabling for the project (which remains the UK’s largest onshore development to date). The firm was also responsible for the safety of the heavy lifting operations of the tower, turbine and blade erections, and for the complex energy requirements of the 33kV systems.

“We’ve amassed a great deal of experience in managing the complex logistics of working over large expanses in remote areas, and our team understands the special requirements of projects involving the construction of access roads to accommodate abnormal loads, turbine foundations, substation buildings and electrical infrastructure,” the company states.

Scheduling factors

Ensuring timetables are adhered to or reducing installation times has always been vital, but is becoming increasingly important in today’s tough economic climate. For Cefn Croes, John Bros’ on-site batching plant ensured maximum flexibility and saved on countless heavy vehicle journeys: “This entire contract was successfully completed within schedule, despite delays caused by the worst winter in half a century.”

Some companies, like Gamesa – with its Wind Farm Palletisation Project – have standardised procedures to ensure efficient construction and turbine assembly. Each step in the Gamesa process – installing the base, erecting the tower, installing nacelles, assembling blades, control equipment, cabling, and grid connection – is clearly defined, and parts are palletised and delivered to site sequentially in line with the assembly process.

Meantime, the weather plays a major role when it comes to
construction timetables and work conditions for a number of reasons. As well as the simple practical issue of being able to carry out physical work, “it is important to consider the time of year and scheduling of wind farm construction, to minimise impacts on the surrounding environment,” stresses the Good Practice During Windfarm Construction guide. “Careful scheduling and an awareness of the different issues likely to arise at different times of year will be beneficial, particularly in the context of planning for drainage and the impact of flooding events.”

A construction method statement (CMS), covering the construction timetable and seasonal considerations should be clearly outlined and followed, it adds. This should include details about what measures will be put in place to deal with weather-related events (flash floods, peat slide, snow melt, dust etc.) and how construction will be scheduled around key site constraints (such as the breeding bird season); and where scheduling is not practical, what other mitigation will be put in place.

**Offshore wind construction**

When it comes to offshore wind farms, while the basic steps are the same on the surface, the actual construction “is quite different from the development procedure for onshore wind farms”, note the authors of a report for the POWER (Pushing Offshore Windenergy Regions) project – which details the lessons learned from the European offshore wind industry: Further, “the combination of electrical power generation and offshore technology is quite new and challenging.”

The complete installation procedure (starting with manufacturing through to commissioning) for offshore projects, the report says, has 6 key steps and within this, the key construction/BOP works are:

- Site preparation; pre-assembly of parts in harbour; installation of foundation for wind turbines and transformer station;
- Installation of groups of wind turbines (installation of piles, nacelles and blades, inter-array cable laying and testing);
- Installation of electrical infrastructure offshore and onshore (transformer station, cable-to-shore laying and grid connection infrastructure to public energy supply);
- Commissioning of supervisory control and data acquisition system (SCADA), final testing of wind farm, and environmental monitoring of the construction phase.

“To reduce the costs of the construction process, the interfaces between the various project steps, from manufacturing to commissioning, should be kept as smooth as possible,” says the POWER report. “Each interface within

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**REPower wind turbines: reliability as a predictable quantity**

Hamburg, Autumn 2011. Good wind conditions alone are not enough to guarantee high long-term yields from sustainable wind energy. Efficient wind turbines offering high availability are a must. REPower, the Hamburg-based manufacturer of wind turbines, shows how this can be achieved and how an innovative development philosophy can become a mainstay of profitable planning. With around 200 engineers collaborating around the globe, the objective is optimal, constant power performance curves combined with minimal failure.

**Reliability plus efficiency = high yield**

To the development engineers of REPower, innovation doesn’t necessarily mean everything has to be done in a completely different way. The company believes in technological evolution, in progress that is driven by experience. It is constantly refining and optimising its wind turbine design to the last detail. Power performance curves from REPower are guaranteed to 98 per cent – a promise that is backed up by studies undertaken by independent experts like C.T. Garad Hassan. It’s not just the precise power performance curves that make wind turbines from REPower unbeatably predictable and profitable, however. More than anything else, their proven operating reliability and high availability are the cornerstones that lead to consistently high yields, ensuring the wind concepts are right.

**Integral drive train concept: every detail is convincing**

The heart of the innovative REPower technology is a powerful gearbox that makes every component most rigorous. GM- and standardised and protects the efficiency of the turbine’s electrical system. Only two per cent of the electricity generated passes via the partial converter, enabling losses to be minimised. Thanks to the optimal interaction of the gearbox, a double-fed induction generator, and a smaller power electronics system, peak loads. This is doubled at low wind investment; 96.6 per cent of the RE82 turbines from the REPower are still running with the original gearbox. In some cases for as long as eight years. The integrated oil particle sensor further enhances the turbine’s already reliable performance by enabling condition-based maintenance.

**Pitch-back system guarantees rotor blade and wind turbine safety**

When it comes to the design and operating reliability of the rotor blades, REPower engineers leave nothing to chance. The blades undergo extensive testing from the design phase onwards – from tests on the blade section to detailed dynamic load tests of the complete rotor blade, often lasting several months. The patented pitch-back system guarantees the safety of the rotor blades and turbine in daily operation, ensuring that the wind turbine can be shut down in a controlled way in case of failure. The loads acting on the turbine are reduced to a minimum at the critical moment and prolonged downtimes are avoided.

More information: www.repower.de/technology
this chain of project steps is associated with a number of expenses — i.e. for things like documentation hand-off, inspections, insurance; damage assessment; and clarification. To limit these expenses, the process from initial transportation to the harbour to installation of the turbines at sea, could be performed by a single company.

However, “from the various discussions in the framework of this study, an economic advantage could be identified for multi-contractual structures for the procurement of offshore wind farms,” it says. The provider of EPC contracts take on all installation risks, including difficulties caused by bad weather. Covering this risk can push up prices crucial to a successful project.”

Whether an EPC or multi-contractual structure is preferable from an economic point of view is still in question, especially with such a young industry, so further research is needed, concludes POWER.

One company which believes it has the right approach is Dong Energy. Its two Walney offshore wind farms, with a combined capacity of 367.2 MW, ”are setting new benchmarks for the construction of wind farms,” by adopting the multi-contract principle, says the company.

“With some 348 direct supplier contracts, the project organisation (Walney Offshore Windfarms Ltd) has been in full control of all elements streamlining its installation methods to make them faster and more cost-effective, the company has taken “an important step in the continuing drive to reduce the cost of construction of offshore wind farms.”

Meanwhile, “special attention should be paid to cable-laying for grid connection”, the POWER project report continues. The process has so far proved to be more time-consuming than anticipated, with the necessary diver intervention often restricted by strong tidal currents, and as JLT’s Green says, damage to cables during the construction process is also a common problem.

“The weather window for laying the cable and commissioning should be planned long enough in advance, by as much as 20%. “Therefore, the multi-contractual project concept would seem to have clear financial benefits for the developer.”

However, the developer must be able to control and manage the entire procurement, installation and commission process, and deal with weather risks, as well as share the resulting extra costs: “In the multi-contractual approach, the developer must have enough staff with sufficient knowledge during the planning and installation of all main elements of the project, including the reinforcement of the onshore transmission grid,” notes the POWER study.

“The tender process requires technically, highly-detailed invitation and evaluation. The developer must control all interfaces between the different work packages and components, and should have full access to the contractors’ design process and quality control.” It stresses, “an excellent working relationship with the manufacturers is in the installation processes, and the multi-contract principle enables instant mitigation should any delay or faulty deliveries occur,” it says. “The close cooperation with the contractors and suppliers makes it possible to conduct a risk hedging based on the project’s interests and make a total priority of the resources.”

At the same time, “the project [has] optimised the installation time through parallel installation”. Installation of Walney 1 was planned to take one year, whereas half this time was planned for the installation of Walney 2:

“Through parallel installation activity, the focus has been to utilise the favorable weather windows of the summer season,” notes Dong. “And through right planning and logistics, it was possible to install Walney 2 in only 6 months.” As Dong’s ceo, Anders Eldrup, says: through adopting the multi-contract approach and should take the potential for bad weather into account,” stresses the POWER report. As with onshore, weather windows are major factors for all stages of offshore development. Indeed, while “Walney 2 is the world’s fastest ever installation of an offshore wind farm”, to use Eldrup’s words, offshore work on the project has been affected by poor weather too, with array cable installation affected, and the installation of the last blade on the last turbine (which took place in late September) didn’t succeed “until the installation vessel, Kraken, [found a] weather window”.

At the same time, a “common and serious mistake during project planning” is underestimation of onshore harbour logistics. “The efforts to organise harbour logistics should not be underestimated,” it says. “Early planning by experienced project managers is urgently required.”

While the actual basic installation of a turbine onshore (putting the turbine unit on its foundation structure) can be done in a day, getting to that stage once planning approval and project finance is secured, requires careful management of a complex series of engineering, logistical and electrical processes...