The Oil Drum: Europe
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Offshore Wind taking off - some background on installation issues

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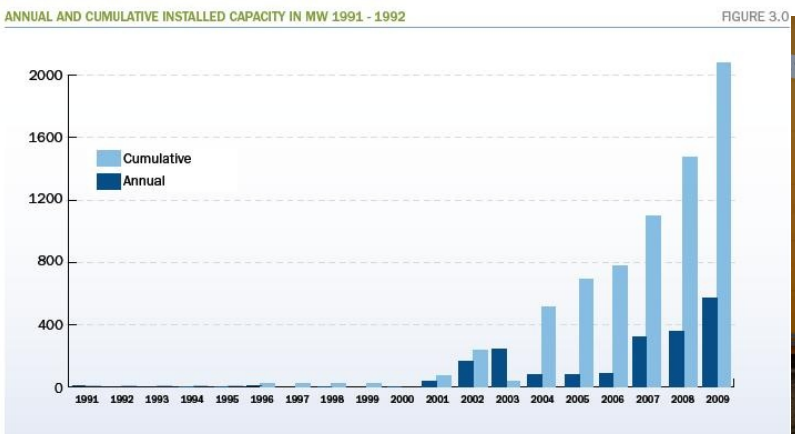
Topic: Alternative energy
Tags: offshore wind [list all tags]

Recent statistics have been published showing that Europe has now installed over 2,000MW of offshore wind capacity, with more than a quarter installed in the past year, and lots more to come in the next few years. I discussed these numbers in more detail here, but wanted to give you here some insights on what these numbers mean on the ground.



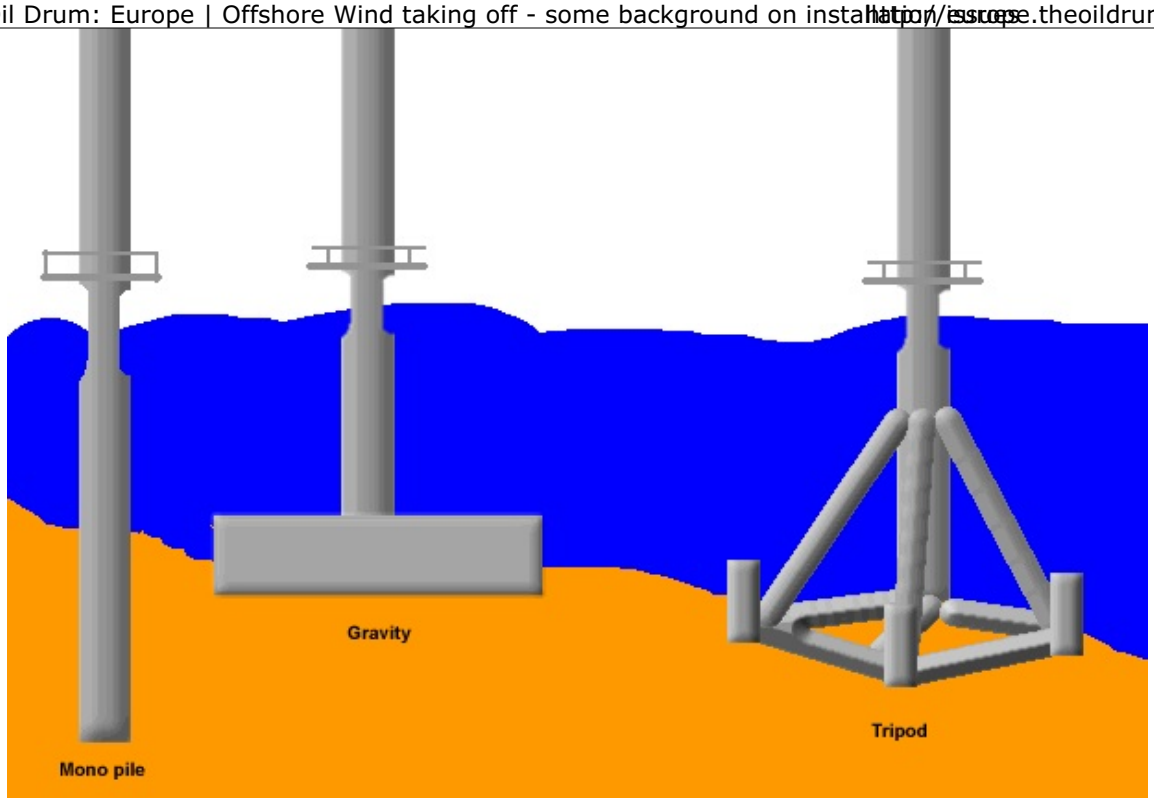
Left: Offshore wind installations. Source: EWEA - The European offshore wind industry key trends and statistics 2009 (PDF))
Right: Transition pieces for the Belwind offshore wind farm, Zeebrugge harbor, 22 January 2010

I recently visited the port site in Zeebrugge, Belgium, where the foundations for the Belwind offshore wind farm (the financing of which I worked on) were stored before their installation. This is a good opportunity to give you a glimpse of the kind of logistics involved, and what kind of problems can happen (and how they are solved), on offshore wind installations.

Follow me below for a tour of a small bit of Europe's fastest growing heavy industry.

Part of the windpower series.

As a quick reminder, there are 3 main types of foundations for offshore turbines: monopiles, gravity-based, and jackets/tripods.



Source: www.offshorewind.net

Here are gravity-based foundations and tripods (you can see more pictures here: The unexpected weight of hope)

Monopiles have typically been used for smaller turbines and lowers depths, as their size (diameter and thickness) needs to increase with the load to be carried and their cost can become an issue. The price of steel will heavily influence the choice between the technologies when several are possible. In this case, with 3MW turbines in 20m depth, monopiles were the most logical choice.

Foundations include two main parts, the foundation itself (the part that's driven into the subsoil) and the transition piece (the part that's affixed on top of the foundation and carries the turbine tower).

two foundations on the ground
with several transition pieces in the background

The transition piece usually includes the boat landing, access platform and j-tubes (the steel tube that protects the electrical cable going to other turbines and/or the transformer station, it is curved near the ground to allow the cable to go from its underground trench to the turbine, thus its name).

On the left, you can see the bottom part of the j-tube,
while the right picture has the more complex set of j-tubes for the transformer station,
which has several cables going to several "strings" of turbines.
Note the anti-corrosion protection on the j-tubes.

It also plays a vital role in that it corrects any flaws in the verticality of the foundation: turbines require the towers to be within one half degree of perfect verticality in order not to have to bear inappropriate loads, and it is not so easy to hammer 50m long steel columns in the sea ground to such precision; the transition piece is designed to be adjusted to provide the perfect position required for the turbine over the water.

Another aspect which requires a lot of precision is the roundness of the foundation and the

transition piece. The two of them must fit together (more on this in a second), and the transition piece needs to be in the exact size for the first part of the turbine tower to be bolted on top of it - tolerances are below a centimeter (the bolts are big ones - a couple centimeters thick, but they need to fit in over the whole diameter of the two parts...) for equipment measured in tens of meters.

The foundations here have a smaller diameter in their top part, in order for the transition piece to be lowered on top of them and around them. The two parts are then grouted together (a special concrete is injected between the two pieces, this is done on site, naturally, and under water).

the narrower top part of the foundation is quite visible on this picture.
Note the steel tubes alongside the transition piece in the foreground;
the j-tubes will be attached to these alongside the foundation part under water.

Some offshore windfarms use a different connection between foundation and transition piece, with the trnasition piece snuggling inside the foundation. One European windfarm has quality issues on the grouting in that configuration, and there are worries that the turbines could slip lower into the foundations (which is not that important) and lose their horizontality (which is a big problem...). with the design here this is less of an issue as the wider diameter below acts as a stop should the grouting fail.

"Ovality" is also an issue for foundations as the transition pieces need to fit on top of them, and it needs to be checked carefully.

oops - ovality

As you can see, the above foundation has a serious problem: it's really not round. In that case, it is not a manufacturing problem: that foundation sank during the transport to site and hit the seabed... The project company, together with the insurance companies, is investigating the best way to deal with this problem: replace it completely, try to improve its roundness by squeezing it back into shape (the giant steel "pinch" for that was being prepared on site when we visited) or, quite possibly, use it as it is (by luck, it is the bottom part which was damaged, ie the part that goes in the sand, so ovality is less of an issue there as long as the vertical penetration in the soil can still be controlled).

The reason the foundation sank is that it was transported to site by floating it - plugs were installed on each end and the foundation could simply be pulled on the water.

the two plugs used to float a foundation,

installed on the next one about to go to site.
One of these is filled with foam, as it needs to be taken off underwater,
when the foundation has been raised vertically,
and the foam makes it float back to the surface to be recovered.

But the design of a plug was found (after a number of trips) to be slightly faulty and water seeped in, leading to the incident. The foundation was recovered, and the design flaw was identified and has now been corrected. Transport of the foundations to the site was of course interrupted during the investigation, but by luck the weather was poor at that time so no work could have been done in that period... The pictures above show the new improved plug system, which includes a more comprehensive set of sensors to warn of any risk of infiltrations...

This is a fairly typical offshore construction incident, in that it was unexpected, hitting a system that had worked fine previously and had not altogether minor consequences. It was a technical problem, to which a technical solution could be found reasonably easily. It had an impact on the schedule, which could be absorbed by the buffers put in place (and indeed in this case did not require more buffers than were required because of bad weather anyway). In terms of financial impact for the project, it will be fairly minor as this can be largely minimized by repairs or covered by insurance. It goes to confirm that the goal cannot be to expect a flawless project, but to have teams which are able to deal with problems as they appear, because they _inevitably_ will appear at some point, and to have a budget and scheduled which include contingencies and are able to withstand such incidents. Resiliency is the key word here...

this is the special piece of equipment used to "grab" foundations
and bring them from their horizontal transport position to the vertical on site.
It was temporarily on site for some repairs/maintenance.

The project is expected to finish installing the foundations and transition pieces in the short future, and move on to the installation of the turbines. These are going to be soon delivered to a harbour site nearby (so, no pictures this time), with completion in the course of this year. The turbines will be erected on their towers on the site inland, and transported as a whole to the site - the erection is expected to attract quite a bit of attention in the area as it will be highly visible.

Editorial Note:
This post was originally published on TOD:Europe on 24 January with a slightly different title.