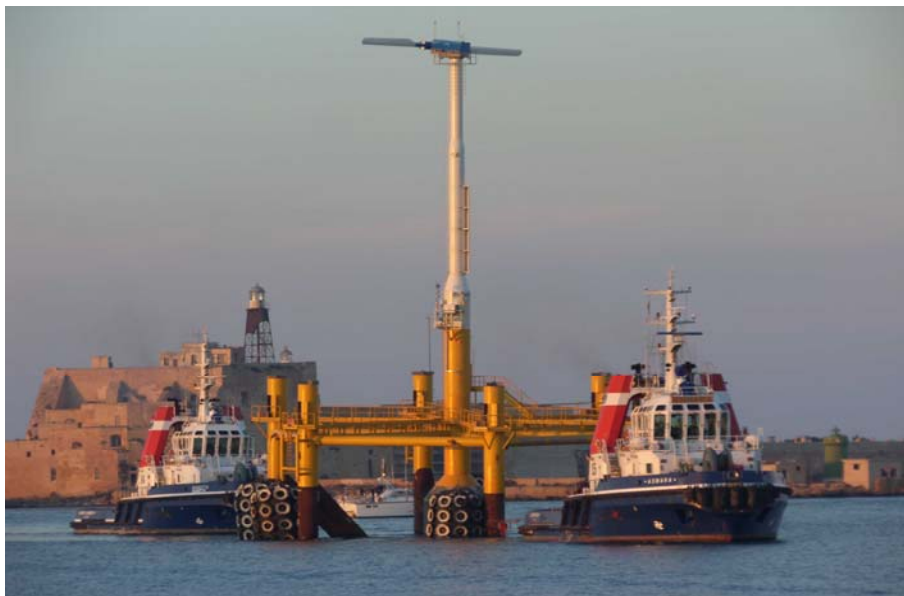




Technical note

Technology concept

Blue H has adapted the concept of submerged tension-legged platforms developed by the oil industry for some of its off-shore rigs, and designed a platform large and stable enough to support a tower and a wind turbine in most foreseeable weather conditions, keeping at the same time the cost of construction, installation, and maintenance at economical levels. As proof of concept Blue H is testing a large scale prototype Submerged Deepwater Platform (SDP) in 108 meters waters at a distance of 10.6 nautical miles from the coast in Southern Italy, the world's first of its kind.



Blue H refers to its short and medium term technological development as Wectop (*Wind Energy Converter on Tension legged Offshore Platform*). In short, Wectop combines this proven marine platform technology (the SDP) together with proven onshore wind energy converter (WEC) technology, which will be fully marinated for sea use. The first commercially operating Wectop, with 2.0 MW rated power, will be installed in the sea in the fall of 2008. Turbine and foundation are certified by RINA.

In parallel to Wectop, Blue H has begun extensive research work in what it calls Project DIWET[®] (*Deepwater Innovative Wind Energy Technology*). The key objective of Project DIWET[®] is to create a custom made fully integrated deepwater wind energy system that is lightweight, but at the same time very reliable, and very easy to service/maintain.

Blue H's SPD consists of a hollow steel body, which provides the buoyancy, which is held "semi-submerged" under water by chains which connect the buoyant body to anchor blocks on the sea bottom. With the buoyant body so held semi-submerged in the water, the necessary uplifting force is created, which keeps the chains constantly tensioned.



Design of the SPD ensures that the uplifting force is always larger than all other forces acting on the platform, such as the weight of the tower and the wind energy converter, the force of the wind and of the waves, thus ensuring the stability of the platform and preventing any dangerous inclination or oscillation. This foundation type is called 'soft-soft' foundation because of its dynamic behaviour; specifically, the soft-soft foundation attenuates horizontal forces by slow movements in the same direction.

One offshore wind energy converter is mounted on top of each SPD. Obviously, the height of the tower, its weight, and the weight of the wind energy converter determine the size of the SPD.

With their goal of ultimately providing power to the grid at prices competitive with all other forms of power, Blue H offshore wind farms must install wind energy converters of the highest power rating to increase the economic feasibility of these projects. Costs of conventional shallow water offshore wind energy foundations increase significantly with water depth. In comparison, the cost of Blue H's SPD is only marginally increased by water depth increases. Therefore, the SPD developed by Blue H provides a cost effective solution for deep water offshore wind energy applications.

The Prototype SPD

The primary purpose of the prototype is to test the assembly, transportation and positioning methods. The secondary purpose is to test performance under actual marine conditions and monitor accurately local wind conditions, information required

to develop an accurate forecast of the future profitability of the first wind farm planned nearby.

The Wind Turbine

Conventional turbines developed for onshore typically:

- Have a rated capacity between 1 MW and 3 MW. Turbines greater than 3 MW in rated capacity are difficult to install onshore, due to transport difficulties with blades alone exceeding 50 meters.
 - *In contrast, wind turbines to be installed offshore can be larger than 3MW as the logistical problems are manageable, thus reducing the cost/MW.*
- Are very heavy, as weight is not a major problem since the tower rests on the ground or is embedded in the ocean floor.
 - *In contrast, on a floating construction, all weight above the water line needs to be counterbalanced by buoyancy generated by the displacement and size of the platform below the water line, so there is a great advantage in using lighter weight wind turbines than those used onshore. Obviously a lighter structure, using overall less steel implies a lower total cost for each unit.*
- Have three blades, which rotate at lower speed than 2-bladers and therefore generate less noise than a 2-bladed turbine, which is an important consideration onshore when wind farms are situated close to residential areas.
 - *In contrast, two blades, which are obviously lighter than three blades, and easier to install and replace, are ideal for offshore use, especially since the background noise made by the faster rotation of the tips, is not a factor at sea.*

To summarize, offshore wind turbines, all of which are currently adaptations of onshore wind turbines made by the same manufacturers, are typically:

- rated at 3 MW* or less
- very heavy (with regards to the overall construction)
- 3-bladed.

*REpower has on test in the North Sea Beatrice field off Scotland, two 5 MW wind turbines fixed into the sea bed at 44 meters depth. These are currently the largest wind turbines in operation in the world, with an overall weight of more than 2,000 tons.

In contrast, Blue H has elected to follow a strategy of ultimately installing deep water wind energy converters (wind turbines) that are:

- 3 MW or more
- as light weight as possible, without compromising the robustness of the unit**
- 2-bladed.

**Blue H is targeting approximately 800 tons for a 5 MW equivalent system