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Hydrocarbone Energy Offshore versus Wind Energy Offshore

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Introduction

The evolution of the hydrocarbon energy industry and the wind energy industry seem to have similarities in their evolution.

Both have started onshore and extended their activities offshore.

In this context it may be relevant to look at the development of the petroleum offshore industry which is now well developed and in a maturity stage, and discuss if some aspects may be relevant for the wind energy industry offshore.
In that respect, the differences as well as the similarities are of interest, since they may suggest ways to follow or to deviate from.

In this short overview of the two industries, it is not the intention to describe each in detail, but to give general ideas on methods which may be used to further develop the wind energy industry based on experience gained from the offshore industry.

Synopsis of hydrocarbon offshore industry development

The first technology developed to extract hydrocarbons from the soil was developed on land. The planned functions were, in addition to drilling, cleaning and conditioning of the crude oil such that the product could be safely transported and delivered to a refinery plant.

In this stage of the development, the surface of the installation was not restricted.

When oil reservoirs where found underwater, the industry started to move offshore.

The first installations were in very shallow water. Thus it was not difficult to move from onshore to the new locations. To create facilities similar to those “onshore” did not involve large costs or particular technical challenges.

When the water depth increased, the cost of facilities increased dramatically. It became also necessary to modify the technology, or develop new technology such that the space needed was reduced.

In addition, other challenges became more critical and costly: safety, danger for environment, installation of equipment, transportation of personnel, transport of the products to shore, reliability of production and last but not least maintenance.

Those challenges have been solved, an infrastructure has been established, and investments have been made to allow the industry to grow.
For example large semi-submersible crane vessels have been built to install, perform modifications and removal of platforms and equipment. Special types of separators have been developed to save space.

In addition, theoretical studies and research based on experience have been carried out by the authorities and the industry in many countries to develop safe engineering standards for offshore installations.

The most recent developments have been for very large water depths, and for installations placed on floating structures or on the sea bottom.

New technologies are being developed to answer to a new challenge: reducing the cost of production to an acceptable level as water depth increases and environmental conditions worsen.

Wind energy industry status

The idea of using the wind for power started onshore, with mills for grinding corn, and pumps. But also it started early at sea - with sailing boats.

Going offshore is therefore not as new as it might seem for the wind energy industry.

The standard way of extracting electrical energy from the wind has involved windmills. In a simplified description, the process consists of a propeller activating a turbine which produces the end product electricity. Then the electricity is

sent through the net to the consumer.

The motivation to move wind power installations offshore is not necessary primarily dictated by the resources available, but also for political and social reasons.

This is a major difference from the offshore industry. While the cost increase for a hydrocarbon installation offshore is compensated by better accessibility to resources, the increase in cost for wind power generation has no direct compensation.

Therefore the cost increase due to transferring windmills offshore will have a comparatively large impact on the commercialization of generated power in the market.

The search for effective solutions will be even more important than for the hydrocarbon industry.

In the last decade, the first windmills have been installed offshore, in large parks and in relatively shallow water. As for the offshore hydrocarbon industry, the technology is basically similar to that used onshore.

Now the industry is preparing to take a step further: deeper water depths and rougher weather conditions.

Windmills in deeper water depths

The development of new offshore windmills is pr. day basically based on the same technology as used onshore.

To make the installation more cost effective, the power of the turbine is increased, and, as a consequence, also the size and weight. Also the propeller increases in size and weight, with a diameter in the range of 100-150 m.

If the installation is to be in the North Sea, where the wave height can be 25 to 30 m, the axis of the turbine will be placed at about 80 m to 130 m above sea level to avoid impact on the propeller. The highest point of the installation will be 200 m above sea level.

As for offshore hydrocarbon installations, it is expected that the development of such an installation has to address a number of issues.

- **Safety**

The installation shall be safe. In the offshore industry, structural collapse or failure of equipment may have dramatic consequences both for the environment and for the personnel on board. Therefore, recognized standards and safety requirements established by the authorities are quite stringent.

The windmill represents a different case. They are unmanned, and collapse or failure have consequences only for the owners' economy, and are minimal for the environment.
Existing standards and rules for windmill concepts need to be addressed, and risk and consequence analyses must be done to determine acceptable safety levels.

Safety includes ship and aircraft traffic. Navigation lights have to be installed. Power for these is essential at all times, even when the windmill is not in function. This requires an additional system in the concept of the installation.

- **Installation**

Installation of offshore platforms is achieved with large semi-submersible vessels. Those vessels are expensive, with day rates of several hundred thousand Euro. To avoid those extra costs, new vessels adapted to the size and the shape of the windmill may be needed to be built. This also implies new long term investment in the windmill industry, as was done for the offshore hydrocarbon industry.

- **Transport**

The electricity produced has to be transported to the shore. In case of several installations, these may have to be connected. New installations will in any case require electrical connections, transformers, etc., The "marinization" of such electrical equipment must be done with care and tested in realistic conditions.

- **Environmental conditions**

The environmental conditions offshore are very different to those onshore. Equipment and processes used in the hydrocarbon industry have been adapted to particular requirements to achieve optimal functionality. The trend has been to make things smaller and lighter.

So far in the wind energy industry, the tendency has been to make larger and heavier despite increase in efficiency.
The wind characteristics offshore, and especially at large heights, are anticipated to be significantly different to those experienced onshore.

Those remarks do not mean that the current developments are wrong, but there is a difference. This may be explained by the nature of the exploited resource.

- **Cascade effect**

This effect is a characteristic of the offshore industry, and may be described as follows: the introduction of a system generates the necessity of new ones.

As an example it is decided that personnel shall be able to live on the installation. Then it should be possible to eat, to rest, to have the minimum of accommodation: i.e. a form of shelter with kitchen, beds and other facilities shall be provided. Personnel may be injured, so evacuation should be possible, in which case access ladders must be appropriate, or wide stairs may be required. Or evacuation by helicopter may be preferred. In the last case due to the propeller a platform shall be planned at a safe distance, but in case of bad weather the

helicopter have to land, etc… etc…

Therefore the definition of the minimum functions and the safety level has to be settled and documented through a risk and consequence analysis.

- **Maintenace**

Maintenance of the installation must also be planned. This includes the inspection of the support structure but also maintenance and possible repair of the propeller blade, rotor, etc.

Personnel need to have access by boat or helicopter, and this requires additional equipments on the installation.

Access to different parts of the structure shall be provided. For example to reach the rotor at 100 m above sea level, it is essential to install a ladder, stair or elevator.

In case of major problems of the rotor it may be necessary to remove it. Lifting several hundred tonnes at a height of 100 m above sea level requires a special vessel with a high day rate. One such intervention may be enough to jeopardize the economy of the project, i.e. the windmill with the use for this kind of repair.

Conclusive remarks

The question this presentation introduces is: “What may be learned from the offshore hydrocarbon industry?”

One of the obvious answers is that the installation of structures offshore is rather complex. Many issues have to be planned and investigated. Some aspects such as maintenance, personnel intervention, and installation are crucial for the economy of the project. The choice of the technology can be critical for the success or failure of these issues.

The offshore industry is well established, and regulated by rules and standards. These are based on high safety levels due to the serious consequences for environment and personnel in case of mishap.

The offshore windmill is a completely different matter. Direct use of the offshore rule will lead to unnecessarily high costs.

The offshore hydrocarbon industry has developed to achieve compatibility between the environment and the purpose of the activity (getting oil and gas onshore). Today the technology used is significantly different to that first used onshore.

This leads to a final question: Are we using the right technology?