

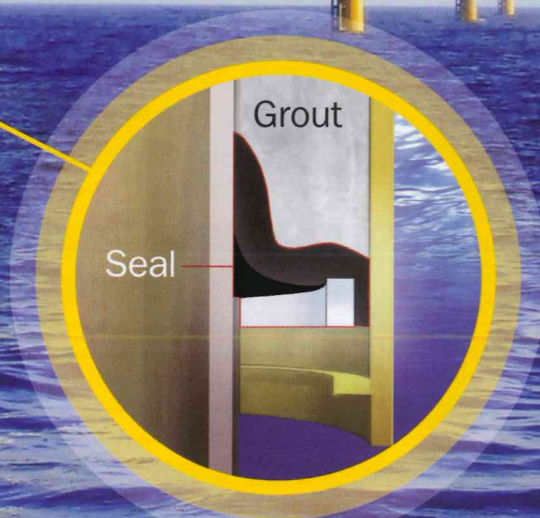
# A solid foundation

One of the most important requirements for offshore wind turbines is a solid foundation. The expected life span of a wind turbine is more than 25 years; the operating environment is harsh and variable. Trelleborg's Grout Seals make sure that you have the perfect seal for a solid and long lasting foundation.



## In short...

Trelleborg has become the world market leader in offshore grout seals, designing and producing them at its manufacturing and development facility in Ridderkerk in the Netherlands.



## The wind energy market offers oceans of opportunity for Trelleborg's grout seals.

A wind turbine normally consists of a foundation in the seabed, a transition piece and the mast with turbine section and blades on top. For the foundation there are different options. At the moment monopile foundations are most common. In this, the monopile is hammered into the seabed and a transition piece slides over the pile. The function of the transition piece is to correct the misalignment of the pile on the seabed and create a stable and rigid base for positioning the mast and turbines. It needs to withstand forces acting on the end of the windmill's turbine blades for the entire life of the wind turbine, which is at least 25 years.

## Making the connection

"The transition piece is usually around 25 meters high, will be clearing the water by around 10 to 15 meters and is pushed about 15 meters over the steel pile in the seabed. The steel pile itself can be 40 to 50 meters long and will generally be around five meters below the water table," says Cees Wien, Sales Manager, Trelleborg Infrastructure.

At the bottom of the transition piece a flexible grout seal is mounted. During installation of the transition piece, the seal slides over the monopile. It seals the annulus between monopile and transition piece, takes the tolerances in the thick steel banded surface and corrects for a small misalignment up to 0.5 degree.

The transition piece is leveled with hydraulic jacks and to create the stable foundation with the pile on the seabed, the annulus is filled with grout. The grout is injected under the water level, just above the seal up to a height of eight to 10 meters. The seal is designed to close a large gap and simultaneously carry a substantial weight of the grout during hardening. After the grout has hardened and become solid, the seal will continue to function for the life of the wind turbine, preventing loss of grout and ensuring a solid foundation.

## Flexibility is key

"The reason for choosing a rubber seal for this specific issue is related to the flexibility of the material," continues Cees. "A rubber seal is able to handle varying gap sizes with minimum and maximum tolerances."

The self activating seal is a full rubber lip seal that initially seals with a tight fit. The sealing properties increase as the pressure becomes higher. The design and choice of material are the key factors in the function and life expectancy of the seal.



Transition piece

## Gwynt y Môr

Gwynt y Môr is one of the largest offshore wind farms in construction in the world and is expected to provide a major boost to the Welsh economy. It is to be built with an installed capacity of 576 megawatts in Liverpool Bay, around 18 kilometers off North Wales, UK, coast in the Irish Sea. Consisting of 160 Siemens 3.6MW turbines, it will be capable of generating enough energy to meet the average annual energy needs of around 400,000 homes. Onshore construction is already well underway and the wind farm is due to be fully operational by the end of 2014.

Bladt Industries and EEW SPC have successfully completed the load-out of the first two foundations. Special to this project is the choice of a combination of a fully operational self-activating lip seal and an inflatable spare seal. Trelleborg has been awarded the contract to supply 160 inflatable grout seals and self-activating lip seals for this prestigious project.

## Wind farm specific

For each wind farm, there are specific design criteria. Based on these criteria, Trelleborg develops a dedicated seal using finite element analysis. Finally, the seals are tested at a scale of one-to-one, normally in the presence of the client, consultants, certifying bodies and the contractor.

"Our grout seals are successfully operating on wind farms globally," says Cees. "We're proud of our work on many installations offshore and how we have helped develop the technology to bring sustainable technology to the world."