

# MULTI MEGAWATT WIND TURBINES FOR OFFSHORE APPLICATION

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## 1. What is offshore application?

### 1.1 Introduction

For a long time offshore wind energy was just a dream. Already in 1929 Honnef proposed the allegedly first offshore wind turbine. Far ahead of its time, the proposition entailed a Multi-Megawatt wind turbine on a floating weathervaning pontoon. Despite some gadgets – a wind turbine with wet feet at a quay side by F.L. Smidth in the 1940's; a wind turbine on an offshore platform by Hütter in 1958; a vertical axis turbine developed by Fokker and GEB Amsterdam on a pontoon; several onboard wind turbines on ships – the real era of offshore wind energy didn't come about until the end of the twentieth century. The term 'gadget' may appear misplaced for wind turbines, but actually the 'small' size of wind turbines was exactly what kept offshore wind energy on the drawing board. It wasn't until the commercially available turbines came closer to the Multi-Megawatt size envisioned by Honnef that the prospect of economically viable offshore wind farms became in close enough range to start with demonstration projects.

The offshore wind turbine that kicked-off current developments is a 220 kW Wind World turbine built off the coast near Nordersund, SE in 1990. The two wind farms with the currently largest capacity of about 160 MW each are built in Denmark, at Horns Rev (2002) and Nysted (2003). At the time of writing, early 2007, about 1,000 MW installed power has been achieved, mainly in the waters surrounding North-West Europe<sup>1</sup> (See Figure 1 and Table 1).

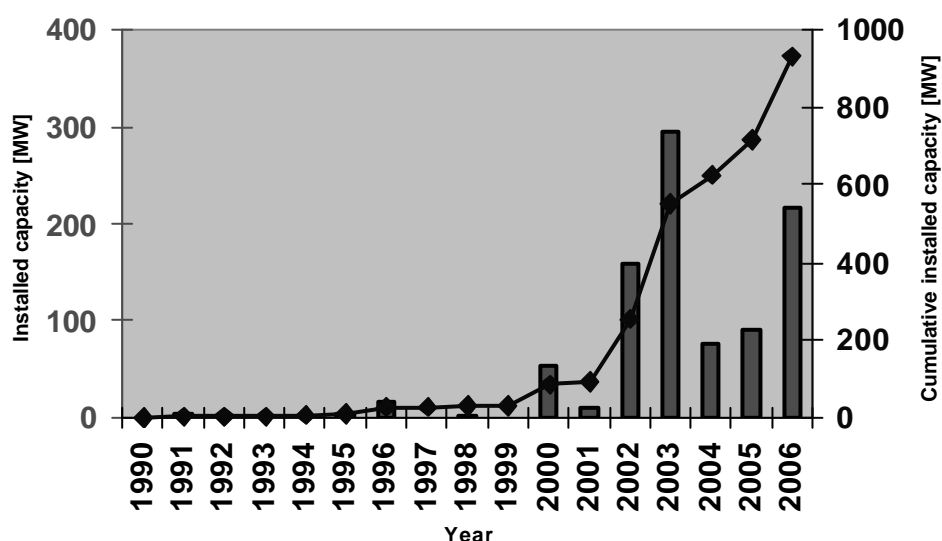


Figure 1 Installed and cumulative capacity of offshore wind farms.

<sup>1</sup> This count includes all wind turbines with a submerged foundation, also at coastal sites and near breakwaters.

Table 1 Installed offshore wind farms up to 2007

Name and country	Turbines	Year	Water depth (m)	Foundation type
Nogersund, Sweden	1 Wind World 220 kW	1990	6	Tripod
Vindeby, Denmark	11 Bonus 450 kW	1991	2-5	GBS
Lely, Netherlands	4 NedWind 500 kW	1994	5-10	Monopile (driven)
Tunø Knob, Denmark	10 Vestas 500 kW	1995	3-5	GBS
Irene Vorrink, Netherlands	28 Nordtank 600 kW	1996	5	Monopile (driven)
Bockstigen, Sweden	5 Wind World 550 kW	1998	5.5-6.5	Monopile (drilled)
Blyth, UK	2 Vestas 2 MW	2000	8.5	Monopile (drilled)
Middel-grunden, Denmark	20 Bonus 2 MW	2000	3-6	GBS
Utgrunden, Sweden	7 Enron Wind 1.4 MW	2000	7-10	Monopile (driven)
Yttre Stengrund, Sweden	5 NEG Micon 2 MW	2001	6-10	Monopile (drilled)
Horns Rev, Denmark	80 Vestas 2 MW	2002	6-12	Monopile (driven)
Samsø, Denmark	10 Bonus 2.3 MW	2003	20	Monopile (driven)
Frederikshavn, Denmark	2 Vestas 3 MW, 1 Bonus 2.3 MW, 1 Nordex 2.3	2003	1	3x Monopile, 1x Suction Bucket
Nysted, Denmark	72 Bonus 2.3 MW	2003	9	GBS
North Hoyle, UK	30 Vestas 2 MW	2003	10-20	Monopile (mixed)
Arklow Bank, Ireland	7 GE Wind 3.6 MW	2003	5-25	Monopile (driven)
Scroby Sands, UK	30 Vestas 2 MW	2004	4-8	Monopile (driven)
Sakata, Japan	5 Vestas 2 MW	2004		
Setana-Cho, Japan	2 Vestas, 600 kW	2004	13	Platform on 4 piles
Emden, Germany	1 Enercon, 4.5 MW	2004	2-3	Piled concrete base
Kentish Flat, UK	30 Vestas, 3 MW	2005	5	Monopile (driven)
Barrow, UK	30 Vestas, 3 MW	2006	21-23	Monopile
Breitling, Germany	1 Nordex, 2.5 MW	2006	2	
Egmond aan Zee, Netherlands	36 Vestas, V90	2006	19-22	Monopile (driven)
Bilbao, Spain	5 Gamesa, 2 MW	2006		
Beatrice, UK	1 REpower, 5 MW	2006	45	Lattice tower

## 1.2 Changed environment

When going offshore several conditions change from the onshore situation. The most significant changes to the environment in which the wind farm is applied are indicated in Table 2.