

Introduction

For offshore wind energy utilization it is for political and economic reasons absolutely necessary to quantify the energy revenues and costs. However, an evaluation of the economics of wind energy utilization in general and for offshore in particular must be based on extensive and in part highly sensitive data. Therefore, this contribution describes the most important parameters, investment and operating costs on the one side and full-load-hours on the other side, presents values from different sources of experience and clarifies the sensitivity of the economics of wind turbines regarding these influences [1].

The **investment costs** form an important part in the determination of the efficiency of wind energy projects. This includes the costs for the WT and for all utilities that are required for the planning, authorization, design and start-up.

Operating costs are a decisive cost factor and are difficult to estimate at sea. They cover several aspects such as costs for maintenance, maintenance contracts, repairs, insurance, multiservice contracts, leases, management, tax, and electricity purchase. The results show that the long-term average operating costs relative to the electricity produced are about 1-3 €/kWh and are hence of the same order of magnitude as for onshore wind turbines.

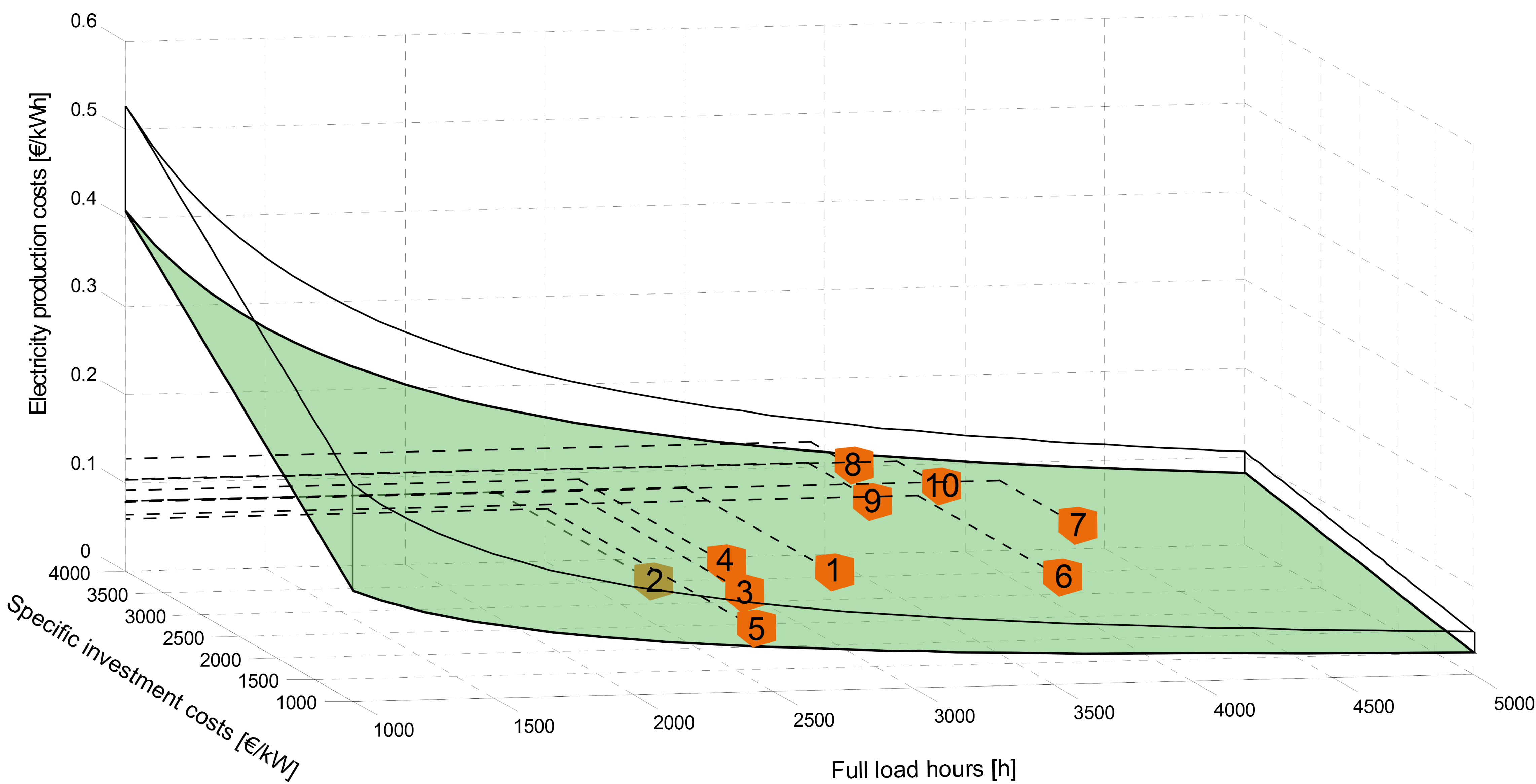
In order to evaluate and compare the performance of wind turbines, the energy generated per year is often normalized to the nominal power of the wind turbine. The so-called equivalent **full-load-hours** depend not only on the performance of the wind turbine but also on the conditions at the site of the wind turbine.

Exemplary Values

Country	No. #	Wind farms	Year constructed	Capacity	Investment cost		O&M	Full load hours	References
				(MW)	(mil. €)	(€/kW)	(€/kW)		
UK	1	North Hoyle	2003	60	120	1992	64,7	3066	[2], [3], [4]
	2	Scroby Sand	2004	60	107	1783	34,2	2343	[5], [6], [7]
	3	Kentish Flats	2005	90	156	1733	36,4	2557	[8], [9]
	4	Barrow	2006	90	181	2011	63,5	2575	[10], [11]
Denmark	5	Middelgrunden	2001	40	49,2	1230	38,6	2500	[12]
	6	Rødsand	2010	207	390	1883	91,2	3800	[13]
	7	Generic				2850	77,5	4080	[13]
Netherlands	8	Prinses Amalia	2007	120	398	3315	147,4	3350	[13]
	9	Generic				3000	90,1	3350	[13]
Germany	10	Alpha Ventus	2010	60	194	3230	122,1	3700	[13]

Electricity Generation Costs

One of the most important and interesting parameters for evaluating offshore wind energy concerns the levelized cost of energy (LCOE). The specific LCOE (in €/kWh) are calculated as the ratio of the relevant annual costs and the amount of electricity generated in that year. The annual total cost is the sum of the individual cost items, whereby the investment costs are assigned to the individual years taking into account the relevant interest rate. The theoretical LCOE under different boundary conditions are shown in the illustration opposite. Hours operating at full load in the range between 1000 and 5000 hours cover sites onshore, at the coast, and offshore. The costs (specific investment costs and operating costs) cover a wide range (1000 to 4000 €/kW and 30 to 150 €/kW) in order to include as many scenarios as possible. The resulting LCOE lie between just under 2,5 €/kWh and up to 50 €/kWh. In addition the LCOE of above offshore wind farms are indicated in the figure based on the values out of the table.



References

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