Renewable Energies
WIND

International Master in Sustainable Development and CR

2011-2012

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www.eoi.es

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Technical description: technology options, learning curve and grid integration.

Wind Energy

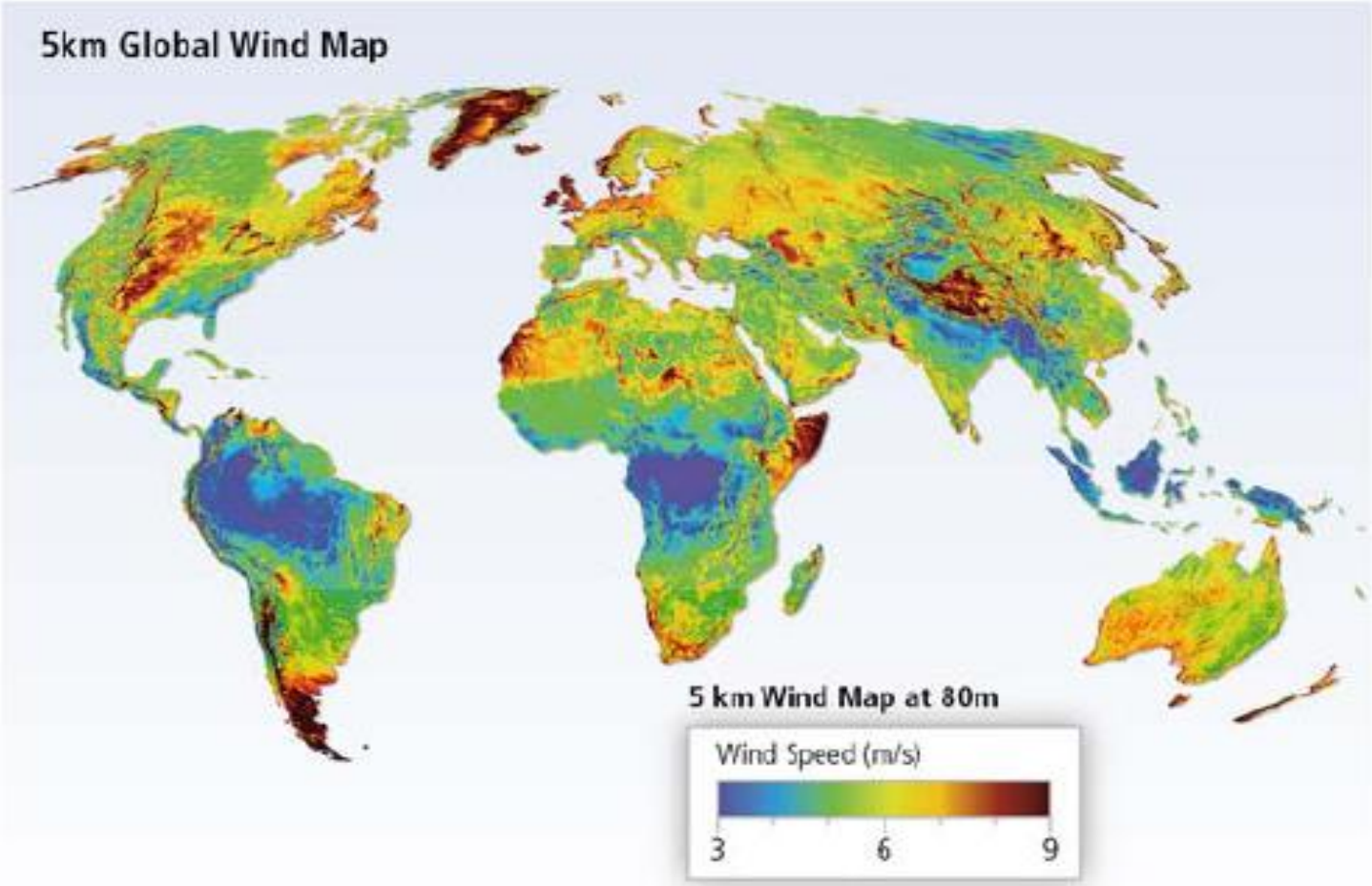
http://www.youtube.com/watch?v=6IjUkNmUcHc

• Wind energy has been used for millennia in a wide range of applications. The use of wind energy to generate electricity on a commercial scale, however, became viable only in the 1970s as a result of technical advances and government support.

• A number of different wind energy technologies are available across a range of applications, but the primary use of wind energy of relevance to climate change mitigation is to generate electricity from larger, grid-connected wind turbines, deployed either on land (‘onshore’) or in sea- or freshwater (‘offshore’).

Wind Energy

Global Wind Map showing World Wind Speeds

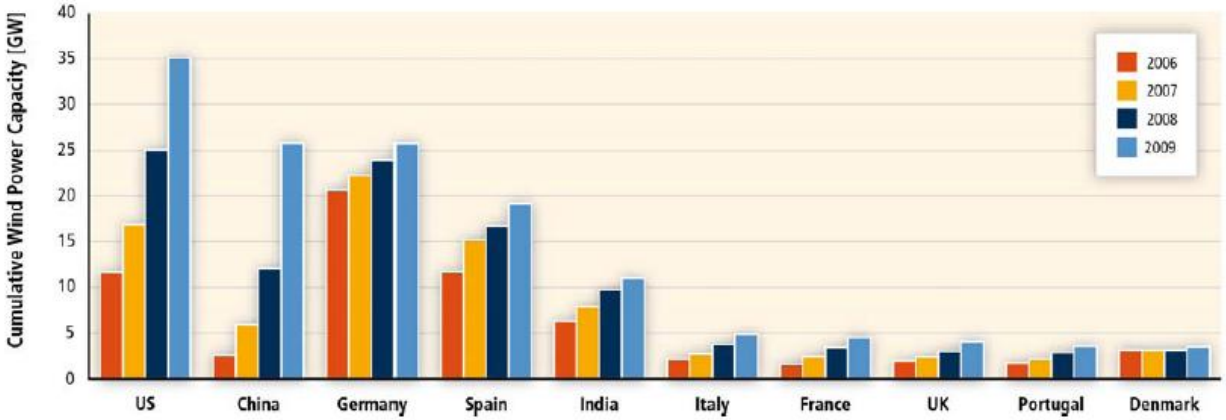


Wind Energy

•The countries with the highest total installed wind power capacity by the end of 2009 were the USA (35 GW), China (26 GW), Germany (26 GW), Spain (19 GW) and India (11 GW).

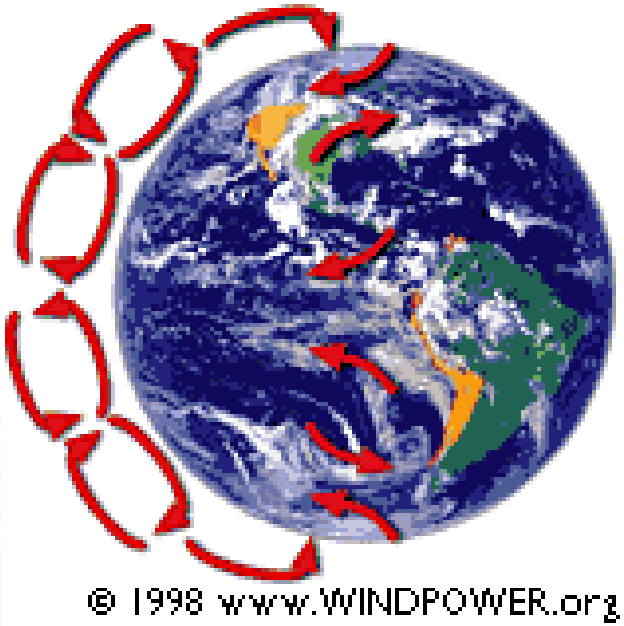
• After its initial start in the USA in the 1980s, wind energy growth centred on countries in the EU and India during the 1990s and the early 2000s.

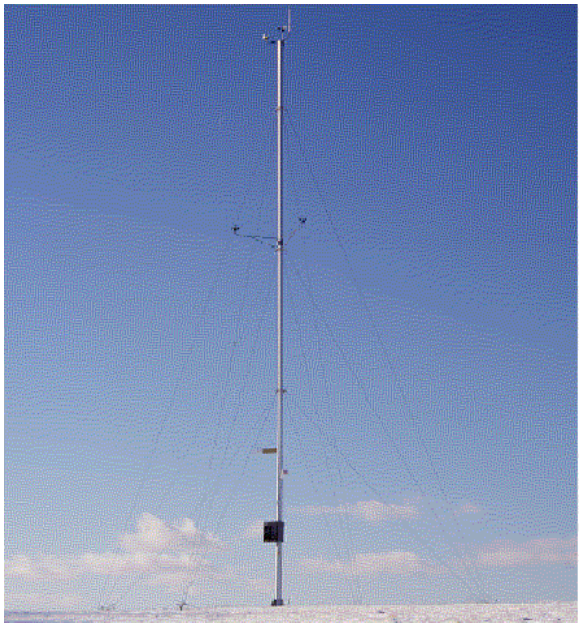
• In the late 2000s, however, the USA and then China became the locations for the greatest annual capacity additions



Wind Energy-how to measure the wind speed and direction

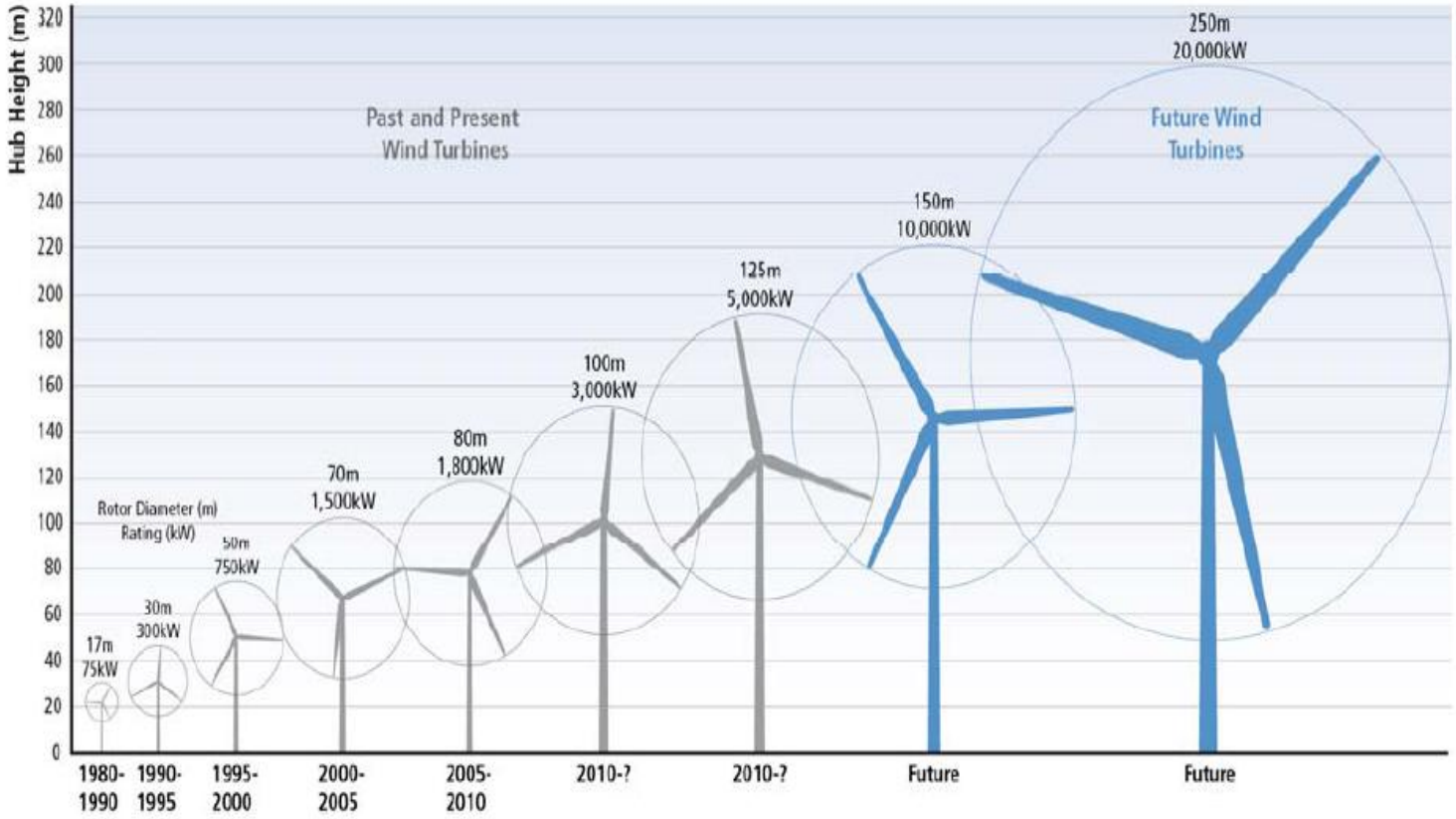
Renewable Energies



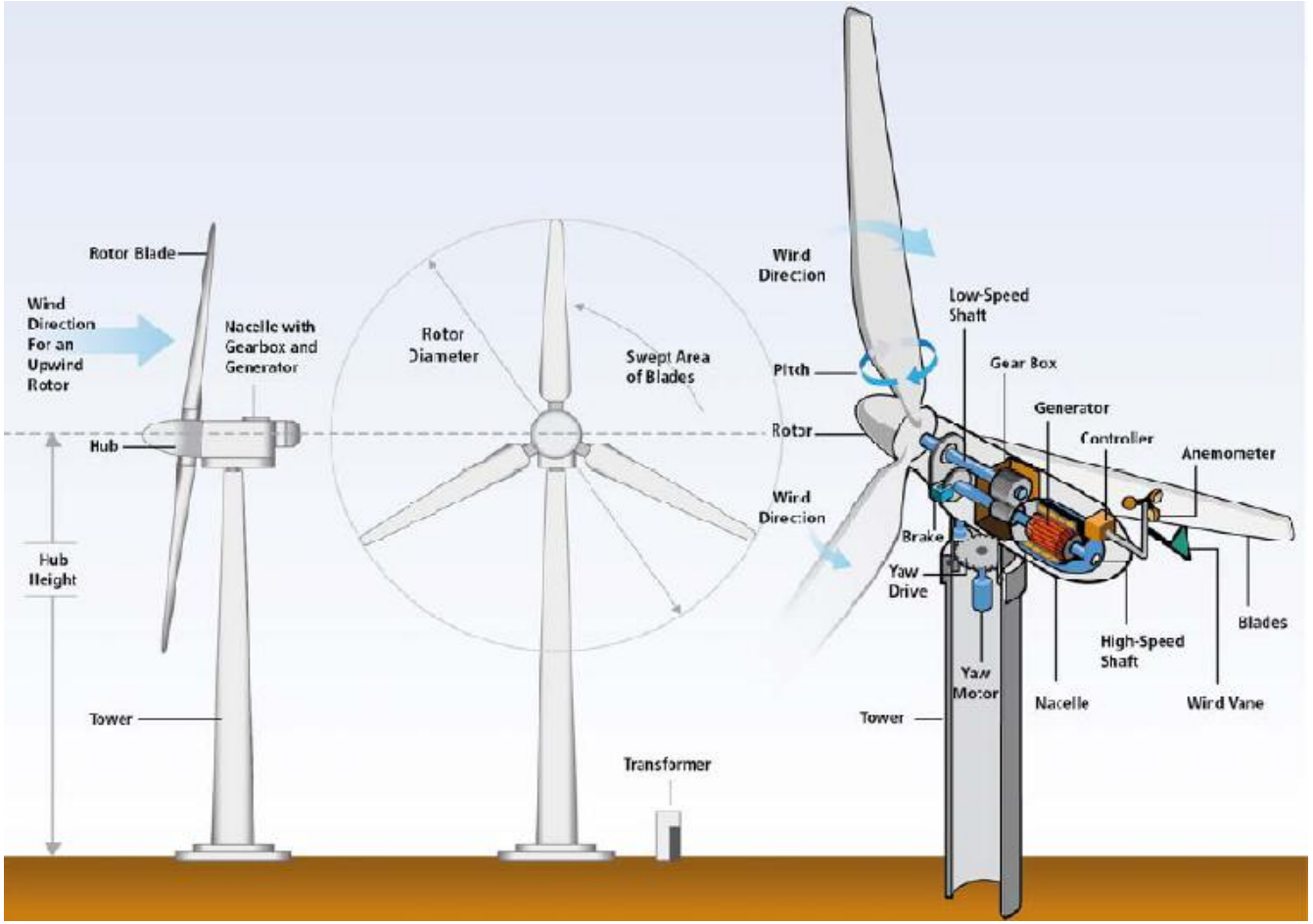


Wind Energy-turbines

http://www.youtube.com/watch?v=tsZITSeQFR0&feature=relmfu



Wind Energy-components



Wind Energy-Grid integration

- Lower levels of predictability.

- Very low marginal operating cost, other generators are then dispatched to meet demand minus any available wind energy wholesale electricity prices will tend to decline when wind power output is high.

- Solutions: Mass-market demand response, energy storage, large-scale deployment of electric vehicles and battery charging.

Regulatory framework: incentives, market, purchase agreements.

Wind Energy

• Depending on the country, the development of new wind farms can be incentivated through different mechanisms.

• Among these, we can find feed-in-tariffs, power purchase agreements and obligation from the distribution companies to buy the wind production.

• At the early stages of wind development, premiums and incentives were high enough to guarantee a profitability to the investors based on the high investment costs.

• Nowadays, technology maturity and investment costs reduction can allow lower premiums and incentives to make the investment profitable.

Offshore wind farms

- Currently under big development, mainly in the UK and the Netherlands.

- **http://rwe-videoarchiv.com/player/standalone/player.php?logo=2&clip=31509608&titel=Rhyll Flats Offshore wind farm&h=380&b=640**

Offshore wind farms

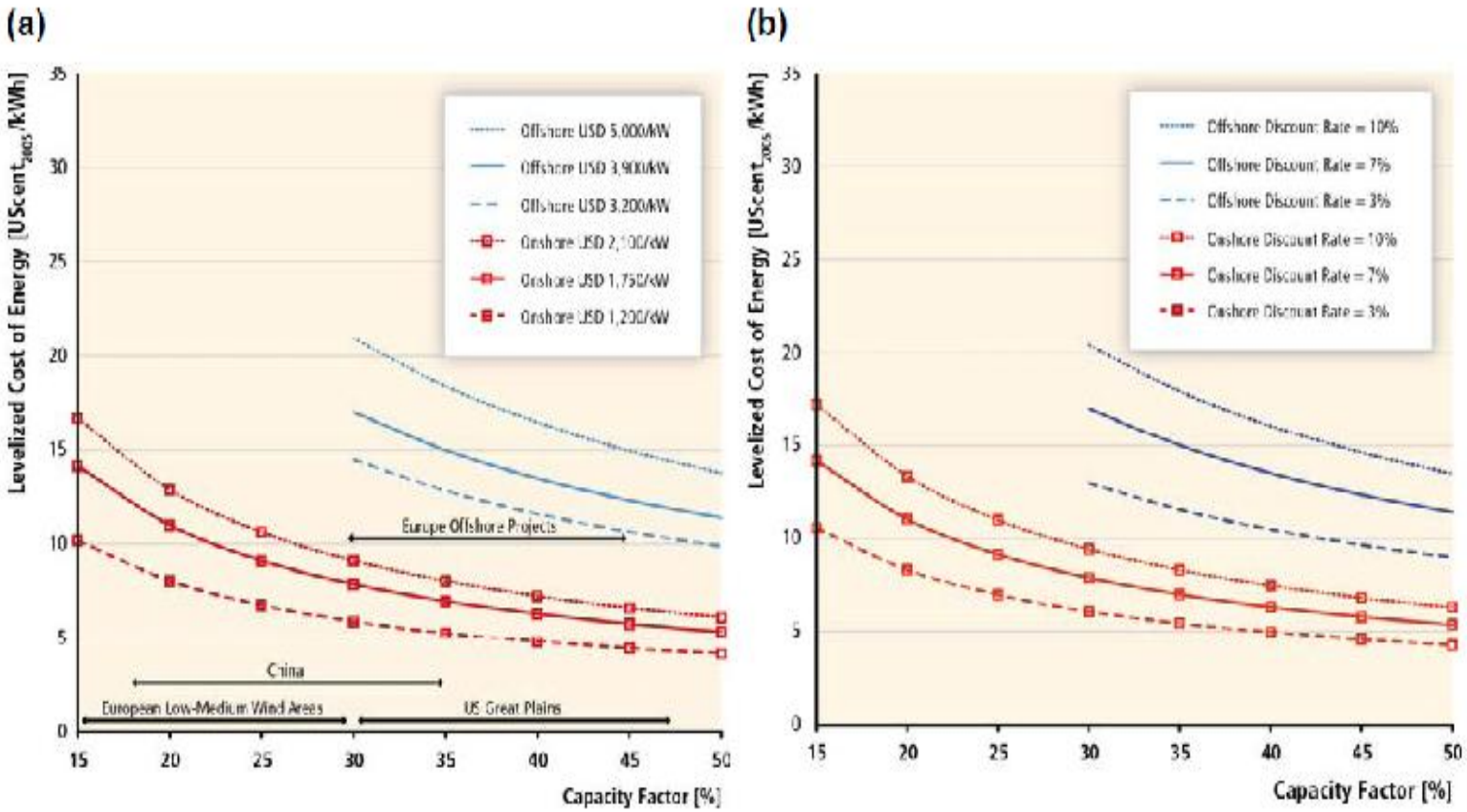
• Offshore wind energy technology is less mature than onshore, with higher investment costs, lower power plant availabilities and higher O&M costs.

•The primary motivation to develop offshore wind energy is to provide access to additional wind resources in areas where onshore wind energy development is constrained by limited technical potential and/or by planning and sitting conflicts with other land uses.

• Other motivations include the higher-quality wind resources located at sea; the ability to use even larger wind turbines and the potential to thereby gain additional economies of scale; the ability to build larger power plants than onshore, gaining plant-level economies of scale; and a potential reduction in the need for new transmission infrastructure.

http://www.youtube.com/watch?v=Bw53_Fn35zU

Wind Energy



Economic valuation: basic modeling assumptions, capex, opex and IRR.

Wind farm economic valuation model

VALUATION MODEL

WIND FARM

MACRO ASSUMPTIONS	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflation (CPI - Spain)	2,33%	1,75%	2,25%	2,50%	2,50%	2,50%	2,50%		
Inflation (PPI - Spain)	3,00%	1,00%	1,25%	1,50%	1,75%	1,75%	2,00%		
Inflation (Labour costs)	2,25%	1,75%	3,75%	3,50%	3,25%	3,25%	3,00%		
Corporate tax	30,0%	30,0%	30,0%	30,0%	30,0%	30,0%	30,0%		
Pool price Forecast	37,45	45,39	47,13	49,41	58,71	68,01	77,31	78,50	79,99
Escalation Poolprice year 2031 ongoing	1,5%								

WIND FARM	
Hurdle rate	10,5%

First year of operation

Wind Farm Lifetime	2010	2011	2012	2013	2014	2015	2016	2017	2018
	0,00%	0,00%	100,00%	100,00%	100,00%	100,0%	100%	100%	100%
					2032	2033			
					0,0%	0,0%			

WTG Model a	ECO74
Hub height	60
Rotor diameter	74

First year after 20 years of operation

Wind farm economic valuation model

VALUATION MODEL

WIND FARM

MACRO ASSUMPTIONS	2010	2011	2012	2013	2014	2015	2016	2017
Data for TAX calculation								
Distance between WTG	5							
Side #1 WTG pad	35							
Side #2 WTG pad	45							
Roadtrack Width	10							
Real Estate Tax % (IBI-BICE)	1,3%							
Tax % (IAE)	32,0%							
Numbers of turbines (a)	13							
MW/Turbine	1,7							
Numbers of turbines (b)								
MW/Turbine								
TOTAL Installed Capacity	21,7							
Operating hours (P50 value)	2443							
Capex (€m/MW)	1,82							
Turbine								
Civil works								
Electrical works								
Connection works								
Development expenses								
Engineering+h&s								
Opex (€/MW)								
Opex (€/MWh)								

	Municipality variable fee	
2200	<2200 NEH	0
2400	2200 - 2400	1000
2600	2401 - 2600	2200
2800	2601 - 2800	3500
3000	> 2800	4500

43,96	45,06	46,18
17,99	18,44	18,90

Environmental impact

Environmental Impact

•The construction and operation of wind power plants impacts wildlife through bird and bat collisions:

• Modifications of habitat and ecosystem, with the nature and magnitude of those impacts being site- and species-specific.

• Wind turbines are unavoidably visible in the landscape.