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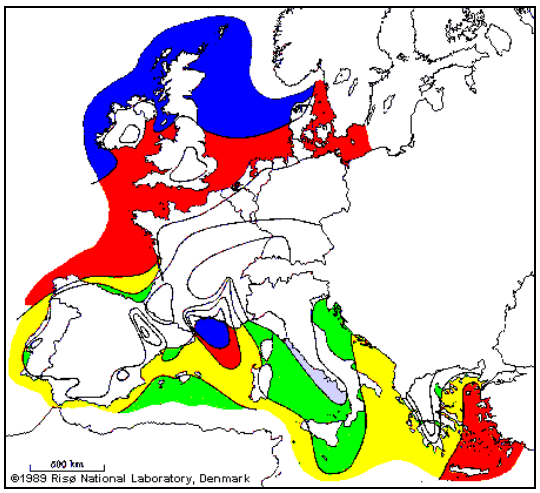
Wind Energy

The answer to reaching the 10% renewable energy target by 2010?

So the target to reach 10% of our energy supply from renewable resources has been set for 2010. The question is does wind have the capability to make a significant contribution to meeting this target? In which I shall now try to answer by looking at the theoretical potential of wind power and what may inhibit it reaching this.

Offshore Wind Turbines

Wind power has got to give the UK the biggest potential for wind energy in the whole of Europe as seen in figure1 in which it shows the coast around the UK to have the highest wind speeds.



Wind resources over open sea (more than 10 km offshore) for five standard heights
(ms^{-1} + Wm^{-2})

10m	25m	50m	100m	200m
> 8.0 > 600	> 8.5 > 700	> 9.0 > 800	> 10.0 > 1100	> 11.0 > 1500
7.0-8.0 350-600	7.5-8.5 450-700	8.0-9.0 600-800	8.5-10.0 650-1100	9.5-11.0 900-1500
6.0-7.0 250-300	6.5-7.5 300-450	7.0-8.0 400-600	7.5-8.5 450-650	8.0-9.5 600-900
4.5-6.0 100-250	5.0-6.5 150-300	5.5-7.0 200-400	6.0-7.5 250-450	6.5-8.0 300-600
< 4.5 < 100	< 5.0 < 150	< 5.5 < 200	< 6.0 < 250	< 6.5 < 300

So why aren't we building more?

It is clear that while our off shore wind speed is so high the onshore wind speed for us is actually mildly higher due to the varying altitudes. So in flatter areas such as Denmark the offshore wind industry has taken off faster than us.

Still the potential for off shore wind power has been estimated to be around 230TWh (828 PJ), which is roughly the current UK electricity supply at the moment. This is taking into general restrictions from shipping, 5km away from land, within 10-50m depth range and other general restrictions from industry requiring the sea. It does not however take into account that you cannot just go building turbines throughout the whole ocean! And to get anywhere near the energy supply we are talking about would involve thousands of turbines being built!

What are the costs?
Engineering costs are higher due to the need to be more robust and survive more harsh conditions. Also grid connection is more difficult and costly. However due to the fact that the only way turbines can be reached is via sea or air there is in fact an overall reduction in costs, as no access roads have to be built.

How quick can we build them?
The build rate of offshore is also significantly slower than that of on land turbines due to the increased technical difficulties. However planning is more easily accepted due to the lack of land ownership and that it has less impact on local communities therefore suffering from fewer objections. As long as the position of off shore wind turbines does not have impact on such activities as bird migration patterns or shipping routes it does not seem to possess any problems for planning.
The average wind farm pays back the energy used to build it within 3-5 months (BWEA, 2004)

What does the future hold ?
Offshore wind farms are developing fast, but is it fast enough?

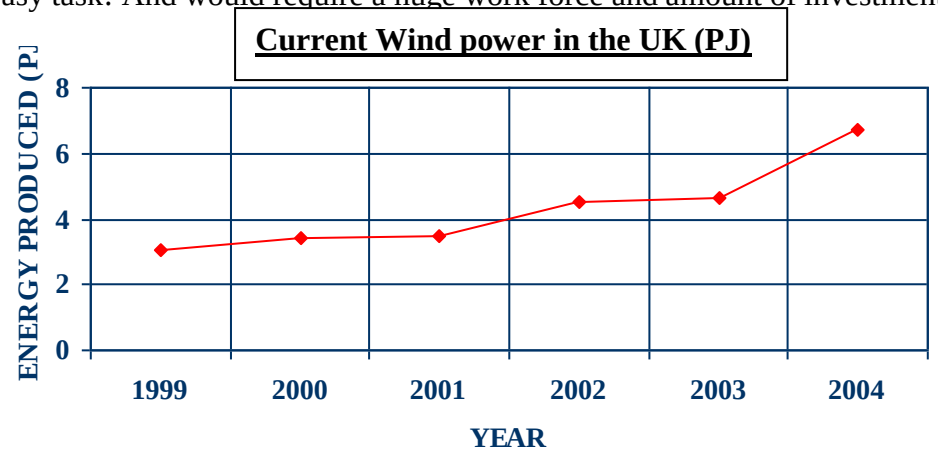
Onshore Wind Turbines

Onshore wind is slightly more advanced already in the UK we currently have 94 separate projects with 1186 turbines at 888.8mw.The wind energy is slightly greater on land.

So why aren't we building more?
The main objection that has led to the slow growth in wind turbines is that from public opinion and the usual NIMBY culture that surrounds these issues. People want to reap the benefits and want to help cut carbon emissions as long as they don't have to change their way of life. There has also been strong opposition from groups such as the countryside lobby who say that wind energy is not green and their main worry is the damage done to the landscape. As long as this is the case planning consent will be difficult. Public view often comes down to aesthetics of turbines while they try to use other possible issues such as noise and danger to bird life to use in their defence.
There are however reports showing that though there is strong opposition to wind turbines it has been showed by BWEA figures that there is a 86% support towards wind energy. It has also been shown by a report that was carried out in an area of Scotland where a wind farm has recently been built that though there was some concern before the wind farm was built of noise, visual impact etc. That after it had been built another survey was carried out finding that peoples perceptions of wind had actually increased and there concerns erased. This case is similar to that of the turbine that was built at Swafham that did meet some opposition when first built. The people were so happy with it that they asked the company to build a further wind turbine to

produce the remaining amount of energy they needed. These are cases showing that there are people who do want turbines built and are willing to go out of their way to get them near them.
There are still those that don't and often these have the greatest voice and influence. A group has actually now been set up to encourage people to do their bit in voicing their encouragement towards wind energy. And hope by doing this that they can outweigh the negative influence of those against and therefore more wind turbine can get the go ahead.
Thus it does give some hope that planning for and construction of wind turbines will be quicker in the future as long as people are willing to accept and stand up for wind.

How quick can we build them?
On land the construction rate would be slightly greater but as with both off and onshore a significant amount of financial backing is required and the initiative for business to develop in this field at the rate the government wants to achieve. For example on government set of figures states that 20% of the UK's electricity could be produced by wind by 2025. This would involve the construction of 100,000 turbines at a power between 500-750 kW. While there were only 999 turbines currently in existence in the UK in 2002 when the paper was written. That would be a build rate of around 4347.8 turbines a year so 11 turbines would have to built each day! Which is no easy task! And would require a huge work force and amount of investment. And



even with the grants provided by the government for offshore development it would be very unachievable at the moment.
A more realistic scenario would at the moment be 1 a day possibly increasing to 2 a day in a couple of years time once the ball has started rolling. And with these scenarios it is possible to look at how I conceivably see the future generation possibilities of wind and to what extent they can contribute to the 10% renewable electricity to be reached by 2010. I will look at three different scenarios one which looks at the build rate being fairly steady one that offers a more optimistic increase in building with the hope of more financial backing and public acceptance and the last will involve using the governments high expectation of how wind energy could develop extremely fast. It may be the case that growth will start off slow then increase as people become more used to the fact they are getting built or that planning and finance make it easier to build quicker.

How much do they cost?
There are not only costs of the construction of wind turbines but on top of that there is the maintenance costs with the construction of roads and tracks to get to the turbines. There would also be extra costs due to the fact that grid would need to be adapted and new terminals set up due to the current facilities not being good enough to cope with the increase. There will also be costs from the storage of electricity due to the fact that the energy supplied from wind is not a constant supply and can vary depending how the wind blows and how many turbines are switched on. This is not all negative as due to the variability in wind power it is also possible to easily switch on and off the turbines depending on how much energy is required and therefore the ability of making some savings is possible.

The Price of electricity-
The price of electricity generated from wind is actually less than that from nuclear or fossil fuels with wind being 3-4 pence per unit, coal at 2.5-4.5 pence per unit and nuclear 4-7 pence per unit. The cost of electricity from wind is also expected to decrease to around 2.7p a unit by 2010 (OXERA, 2004).

One Turbine a Day- I will take this at the moment to be the most realistic growth

that we are going to see. And with the build rate in 2003 at 1 turbine being built every 6 days, then rising to 1 turbine being built every 2.5 days in 2004. It seems that it could be possible that it could fall to around 1 in every 2 days in 2005 and then 1 every 1.5 days in 2006 reaching 1 a day in 2007 and staying steady from then. Due mainly to restrictions of where they could be built and opposition, (only so many people will accept them)
So to estimate energy that could be supplied if the production was one turbine built in a day then I will estimate for an average wind turbine, which can produce 1.5MW (off shore is slightly higher, onshore slightly less) of power for 365 days of the year. There would need to be a load factor incorporated at around 30% (0.3).

So I would calculate for one year that -

1.5 MW * 8760 (hours in a year) * 0.3 (load factor) = 3942MWh

To convert from MWh to PJ I would then –

3942MWh / 10 exp 5 = 3.942 e –3 (MWh to TWh)

3.942 e –3 * 3.6 = 0.0141912 (TWh to PJ)

1.43883 * 365 = 5.179788 PJ of energy a year

Conclusion and Summary tables-

To conclude I would suggest that at a rate of one turbine being built every day it would be possible in an average year to produce 7.17 PJ of energy.

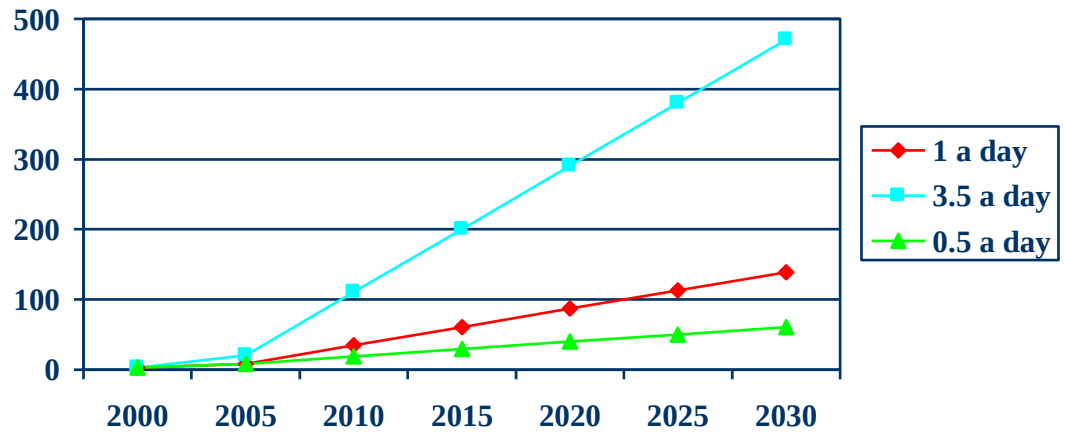
For the other two scenarios of 0.5 turbines built a day and 3.5 turbines a day is summarised in the table and graph below.

From the graph it can be seen that I have made two major assumptions that may need to be looked at further. For example I have assumed that the build rate will be constant where as it has the ability to increase or possibly decrease over time all depending on how much support is given by the public ad the government towards finding new sites. The build rate could theoretically increase from the current rate of one turbine every two days, up to one every day in the first five years to 2010, then again increase up to two a day and then maybe if there was little constraints to three and a half by 2030.

There is also that possibility if suitable sites cannot be found due to lack of public support or lack of government insistence that they are built. The build rate could come to a standstill where the power output could not increase any further. For my scenarios I do not se this as being an particular issue in the first two scenarios and maybe not in the most optimistic due to the fact that by 2030 at three and a half a day there would still only be a total of 7,573 wind turbines in total in the UK.

Summary Table of projections for the potential energy (PJ) production from wind power in the UK.

Yr / Rate	Current	2010	2015	2020	2025	2030
0.5 a day	8.4	18.9	29.4	39.9	50.4	60.9
1 a day	8.4	35.1	62.0	86.9	112.8	138.7
3.5 a day	8.4	101.4	200.4	290.4	380.4	470.4



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