“Global penetration and experience with wind energy and future trends”

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Aims

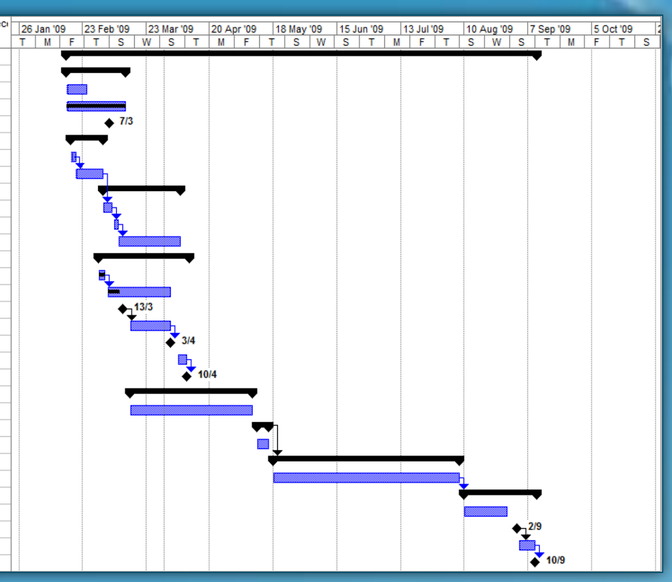
The aim of this project is to comprise an overview of the global experience with wind generation from various utilities and system operators, along with the challenges posed upon the required power system upgrades, the improvement of grid codes or relevant legislation and the necessary operational flexibility.

Objectives

- ✓ Point out the importance of wind energy nowadays
- ✓ Present a brief analysis of a wind energy system’s structure
- ✓ Categorization of collected data into continent groups in order to form a more completed opinion concerning the technologies, dynamics, policy and legislation followed by each country
- ✓ Discussion and evaluation of the findings
- ✓ Reference to future trends and new technologies

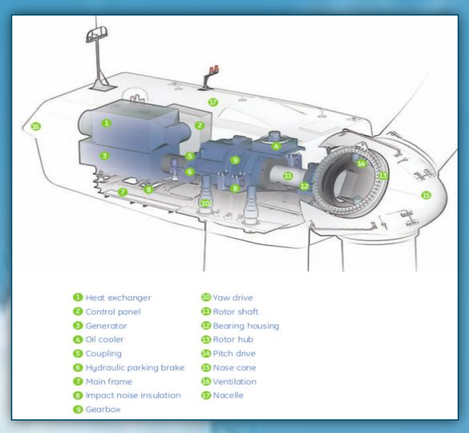
Gantt Chart

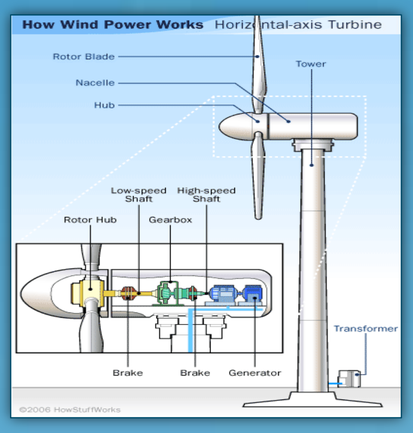
ID	Task Name	Duration	Start	Finish	Predec
1	**Dissertation project**	**150 days?**	**Mon 16/2/09**	**Thu 10/9/09**	
2	**Preliminary study**	**21 days**	**Mon 16/2/09**	**Fri 13/3/09**	
3	Familiarization with objectives	7 days	Mon 16/2/09	Tue 24/2/09	
4	Literature searching	21 days	Mon 16/2/09	Fri 13/3/09	
5	Familiarization with MS Project	0 days	Sat 7/3/09	Sat 7/3/09	
6	**Literature Analysis**	**10 days**	**Wed 18/2/09**	**Tue 3/3/09**	
7	Indexing	2 days	Wed 18/2/09	Thu 19/2/09	
8	First reading process	8 days	Fri 20/2/09	Tue 3/3/09	7
9	**Critical Reading and writing up**	**25 days**	**Wed 4/3/09**	**Mon 6/4/09**	
10	Reorganization	4 days	Wed 4/3/09	Sat 7/3/09	8
11	Evaluation	2 days	Mon 9/3/09	Tue 10/3/09	10
12	Writing up the first draft	19 days	Wed 11/3/09	Mon 6/4/09	11
13	**Critical Analysis and Research Preparation Module**	**31 days?**	**Mon 2/3/09**	**Fri 10/4/09**	
14	Defining aims and objectives	3 days	Mon 2/3/09	Wed 4/3/09	
15	Writing up portfolio	21 days?	Fri 6/3/09	Thu 2/4/09	14
16	Feedback	1 day?	Fri 13/3/09	Fri 13/3/09	
17	Corrections and completing literature review	14 days?	Mon 16/3/09	Thu 2/4/09	16
18	Portfolio Submission	1 day?	Fri 3/4/09	Fri 3/4/09	17
19	Poster Preparation	4 days?	Mon 6/4/09	Thu 9/4/09	
20	Poster Submission	1 day?	Fri 10/4/09	Fri 10/4/09	19
21	**Literature Searching (continue)**	**40 days?**	**Mon 16/3/09**	**Fri 8/5/09**	
22	Searching for implementary material	40 days?	Mon 16/3/09	Fri 8/5/09	
23	**Categorization**	**5 days?**	**Mon 11/5/09**	**Fri 15/5/09**	
24	File creation and evaluation	5 days?	Mon 11/5/09	Fri 15/5/09	
25	**Writing up**	**60 days?**	**Mon 18/5/09**	**Fri 7/8/09**	23
26	Concluding the writing	60 days?	Mon 18/5/09	Fri 7/8/09	
27	**Evaluation of the dissertation**	**24 days?**	**Mon 10/8/09**	**Thu 10/9/09**	26
28	Presentation preparation	15 days?	Mon 10/8/09	Fri 28/8/09	
29	Oral presentation	1 day?	Wed 2/9/09	Wed 2/9/09	
30	Final corrections	5 days?	Thu 3/9/09	Wed 9/9/09	29
31	Hand in dissertation	1 day?	Thu 10/9/09	Thu 10/9/09	30



Methodology

1. Set the main objectives of the project
2. Bibliographic approach of the study. In this context, the inquiry begins by gathering data from books, previous works, relative papers, official organizations and websites, along with the valuable collaboration of private institutes. Primarily, the research focuses on America, then Europe and finally Asia and Australia.
3. Point out the most active countries in ways of wind energy penetration to their energy generation systems.
4. Collection of each country’s current information about wind energy performance, policy and technology used together with innovative systems that lead their way to being incorporated into more energy effective wind turbines
5. Evaluation of gathered data and writing it up
6. Presentation of detail graphs, relative tables and figures in order to show the wind energy profile of each country and thus create a more completed prospect of the current wind energy utilization.
7. Conclude with a reference to which countries are pointed out regarding their wind energy dynamic. Brief analysis of future trends and expectations as well as new technologies that may evolve the systems already in use.

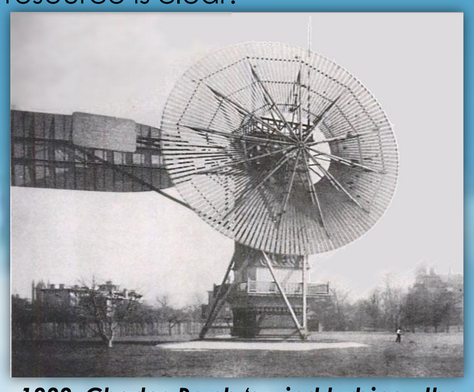




Wind turbine internal and components [1,2]

Background

Although it is considered that wind energy is a relatively new renewable energy resource, it has been in use for centuries. Originally, wind turbines were used for pumping water, grinding grain and other such agricultural activities. The first known windmills were developed in Persia around 500-900 A.D. [6] In the past two decades, technological advancements have made it possible to utilize wind energy for the production of electricity. Given that the fuel source (wind) is inexhaustible and free, the urge to utilize this resource is clear.

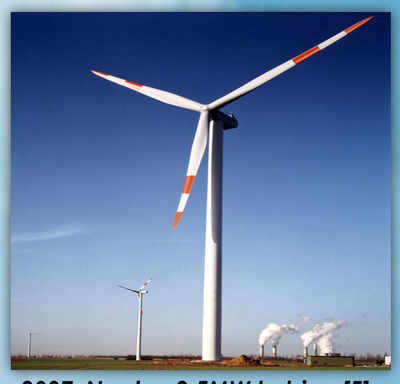


1888, Charles Brush ‘s wind turbine, the first automatically operating wind turbine for electricity generation [3]

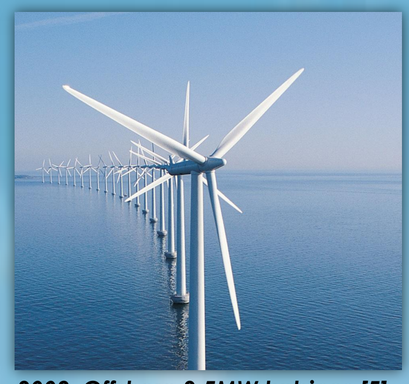
1897, La Cour’s wind turbine, Denmark[3]

1955, Experimental wind turbine, France [4]

1989, German grid-connected 50 kW wind turbine [3]

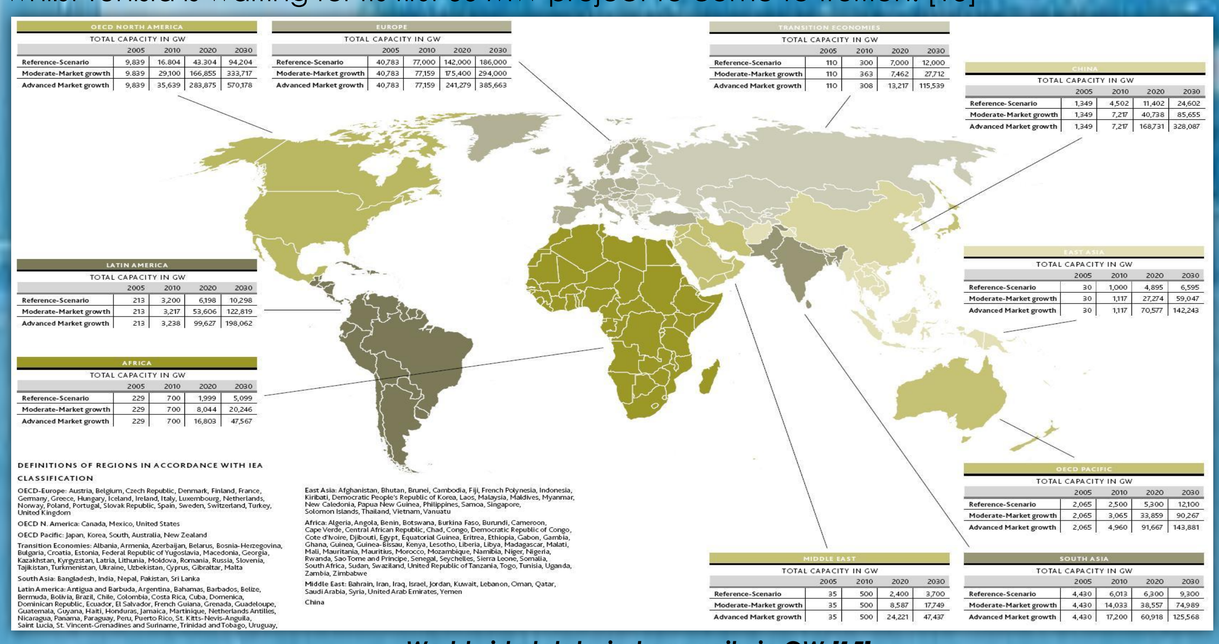


2007, Nordex 2.5MW turbine [5]



2008, Offshore 2.5MW turbines [5]

Furthermore, it is extremely interesting to observe the worldwide penetration of wind generation and future trends. For instance, the North ***American*** Continent has an estimated 10.5 GW of installed wind generation. [6] Currently, ***New Mexico*** has 496 MW of grid-connected (202 MW to the eastern grid and 294 to the western grid) wind generation that has been installed or is under construction. [7] . Modern wind farms began making their appearance in ***Texas*** grid in the mid to late 1990s. The amount of wind generation installed in 2005 was about 8500 MW. [8] In ***Canada***, as of July 2006, there was 1049 MW of installed capacity with approximately 1500 MW of projects that are under construction or have secured power purchase agreements. [9] ***Europe*** has been the leader in utilizing wind energy. Proposals for wind farms continue to grow with projected realistic potential for wind energy in Europe being some 343 TWh/annum. Germany, Spain and Denmark are the leading countries with wind farm installed capacity.[6] In ***Denmark***, wind energy supplies nearly 18% of the national energy needs [6] while the installed capacity is roughly 70% of the nations peak load. In relation to wind power, the western and the eastern parts of Denmark have different degrees of wind power penetration and experience different problems. In 2004, wind generation accounted for about 22% of the electric energy consumption of Western Denmark providing 2,379 MW. [10] At the same period, wind generation of Eastern Denmark accounted for about 12% of the electric energy consumption providing approximately 578 MW. [11] ***Greece***, on the other hand, although has a large wind potential, only 3.2% of the total energy demand of 2008 was met by wind generation. In the Interconnected System 790 MW of wind generators have been installed up to the end of 2008. [12] The installed wind farms capacity is 81 MW and their production accounts for the 10 % of the annual energy demand when the instantaneous power penetration has reached 39%. [13] In ***Ireland***, at the beginning of 2005, 36% of wind generation was connected to the transmission system, while by the end of 2007, this figure was estimated to reach 47.4%.[14] Moving forward to ***Asia, Japan*** has shown a rapid growth recently as far as total installed capacity of wind generation is concerned. At the end of 2007, the total wind power capacity in Japan was 1,538 MW (1,331 turbine units) for an annual net increase of 229 MW. [15] By the end of 2007, ***China***’s total installed capacity of wind power was 6 GW, accounting for only 0.44% of the land usable wind energy. [16] ***Australia*** enjoys one of the best wind resources in the world, resulting in phenomenal capacity factors in many regions with predominantly open farmland. Growth of the country’s installed capacity almost doubled in 2005, with the addition of 328 MW, taking the total to 708 MW. At the same time approximately 6,000 MW of projects are in various stages of pre-construction development. Wind power development in ***Africa*** is concentrated in the north and the south, with relatively low wind speeds experienced in the central belt. In the north, there has been development in Morocco, with 64 MW installed and a national action plan to install 600 MW by 2010, whilst Tunisia is waiting for its first 60 MW project to come to fruition. [15]



Worldwide total wind capacity in GW [15]

Conclusions

Wind energy is rapidly developing into a mainstream power source in many countries of the world, with over 60,000 MW of installed capacity worldwide and an average annual market growth rate of 28%. It could provide as much as 29% of the world’s electricity needs by 2030, given the political will to promote its large scale deployment paired with far-reaching energy efficiency measures. The world cannot afford to stick to the ‘conventional’ energy development path, relying on fossil fuels, nuclear and other outdated technologies from past centuries. Thus, more and more governments are getting aware of the related benefits of wind energy and are creating corresponding frameworks, especially feed-in legislation which guarantees sufficient remuneration and access to the grid also for independent power producers. European pioneer countries like Denmark, Germany and Spain, have started more than a decade ago the implementation of such feed-in tariffs and are still the world leaders in wind technology. Wind can and has to play a leading role in the world’s energy future.

References

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[2] supergrass.ca/blog/images/turbine.png
[3] http://www.windpower.org/en/pictures/brush.htm
[4] http://en.wikipedia.org/wiki/History_of_wind_power
[5] http://www.nordex-online.com/index.php?id=5&L=2
[6] www.awea.org
[7] New Mexico Electricity Transmission Task Force Report, December 29, 2004
[8] ERCOT Transmission services June Report, 7112005
[9] P. Pourbeik, “Wind Farm Integration in British Columbia – Stages 1&2: Planning and Interconnection Criteria”, ABB Report Number: 2005-10988-2.R01.3, March 28, 2005
[10] Annual Report 2004,Eltra(energinet.dk),Fredericia,Denmark,May 2005, p.67
[11] Annual Report 2004, Elkraft System (energinet.dk),Ballerup,Denmark,April 2005,p. 40
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[15] “Global Wind Energy Outlook 2006”, Greenpeace, Global Wind Energy Council, September 2006
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