Wind Energy: An Analysis and Comparison of Wind-Power Development in the United States and Spain

By

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Scott Wilhelmsen for the degree of Baccalaureate of Arts in International Studies in Natural Resources and Baccalaureate of Science in Natural Resources. Presented on May 24, 2007. Title: *Wind Energy: An Analysis and Comparison of Wind-energy in the United States and Spain*.

This essay seeks to analyze the wind-power policies of Spain, the United States and the world in order to better understand the past, present and future potentials of the resource. The growing demand for energy, concerns about global warming, and the need for increased energy security encourage societies to embrace domestic, renewable sources of energy. Thus, governments around the world understand the need to develop clean, domestic, and renewable sources of energy such as wind-power. Consequently the wind-power industry is experiencing a lot of growth thanks to governments that embrace the resource through policy incentives. Currently, wind-power is the fastest growing source of energy in the world, and Spain, the leading producer of wind-power per capita in the world is proving that wind-power can be a viable source of energy. The diverse policies incentives for wind-power of Spain and the United States are analyzed and compared to better understand and predict the past, present and future viability of wind-power in those nations. Overall, the renewable portfolio standards enacted by several US states currently represent the best legislation that the federal government should adopt to encourage further growth in renewable energy in the US.

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I. Introduction

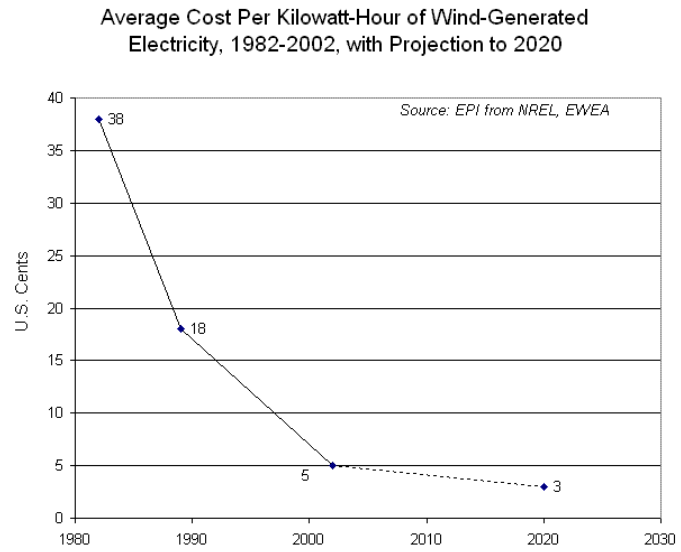
The growing demand for energy, the need for increased energy security and the global warming crisis encourage nations to invest in domestic, renewable sources of energy. Nations more and more are developing domestic, renewable sources of energy to decrease pollution, safeguard the security of their energy supplies and meet the rising demand and price for energy. Wind energy, a type one renewable energy source always exists and will always exist; for example solar, wind, tidal, wave, and geothermal energy will continue to exist no matter how much they are exploited. For countries and companies dedicated to investing in sustainable, renewable energy, wind-power not only proves to be a clean and viable source of energy, but also one that supports regional economic growth and energy independence in the nations that adopt them.

World Wind-Power Trends

Currently, wind-power is in its infancy and developing rapidly all around the globe. Since 1982, the average price for wind-electricity fell from 38 cents per kilowatt-hour (kWh), to 5 cents per kWh in 2002 and is expected to fall to 3 cents by 2020 (Fig, 1.0). Currently, with increasing prices in natural gas and coal, wind power prices are falling below these conventional sources of energy (Brown, 2006). Between 1995 and 2005, wind-generated electricity grew faster than any other energy source at 28.6% (EPI, 2006), (Fig 1.2). In 2005, the global wind markets grew by 40.5%, investing 14 billion dollars in wind-power. Wind-power expanded its capacity by another 25.3% in 2006

(GsÃ¤nger, 2007). Currently, the top five wind-power producers include Germany, followed by Spain, the United Sates, India and Denmark (Fig. 1.1), (GsÃ¤nger, 2007). As wind-power prices fall and other energy sources get more environmentally and economically expensive, wind-power should continue its rise a renewable way to generate electricity in the world.

Fig. 1.0



Source: Brown, 2006

Much of the wind-power growth in the world is enhanced by governments that favor the development of renewable energy in their nations. These governments are using different strategies to encourage wind-power development. In order to get an idea of how well these policies aid the development of wind-power, this paper seeks to analyze the wind-power development strategies of Spain and the United States to see how they work. Furthermore, since Spain has obviously experienced great successes in the industry, this paper also aims to determine what policies and strategies, if any, the US could adopt from the Spanish model to encourage wind-power development.

Fig. 1.1, Top 20 Wind-Power Producers Megawatts (MW)

Country	Added Capacity 2006 MW	Growth Rate 2006 %	Total Capacity 2006 MW	Total Capacity 2005 MW	Rank 2005	Rank 2006
Germany	2,194 MW	11.9%	20,622 MW	18,428 MW	1	1
Spain	1,587 MW	15.85%	11,615 MW	10,028 MW	2	2
USA	2,454 MW	26.8%	11,603 MW	9,149 MW	3	3
India	1,840 MW	41.5%	6,270 MW	4,430 MW	4	4
Denmark	8 MW	.3%	3,136 MW	3,128 MW	5	5
China	1,145 MW	90.9%	2,405 MW	1,260 MW	8	6
Italy	405 MW	23.6%	2,123 MW	1,718 MW	6	7
UK	610 MW	45.1%	1,963 MW	1,353 MW	7	8
Portugal	628 MW	61.4%	1,650 MW	1,022 MW	11	9
France	810 MW	106.9%	1,567 MW	757 MW	13	10
Netherlands	336 MW	27.5%	1,560 MW	1,224 MW	9	11
Canada	768 MW	112.4%	1,451 MW	683 MW	14	12
Japan	354 MW	34.0%	1,394 MW	1,040 MW	10	13
Austria	146 MW	17.8%	965 MW	819 MW	12	14
Australia	238 MW	41.1%	817 MW	579 MW	15	15
Greece	183 MW	31.9%	756 MW	573 MW	16	16
Sweden	54 MW	10.6%	564 MW	510 MW	17	18
Norway	55 MW	20.4%	325 MW	270 MW	19	19
Brazil	208 MW	729.6%	237 MW	29 MW	34	20

Country	Added Capacity 2006 MW	Growth Rate %	Total Capacity 2006 MW	Total Capacity 2005 MW
All others	730	48.4%	2,238 MW	1,508 MW
All Countries	14,900	25.3%	73,904 MW	59,004 MW

Source: GsÃ¤nger, 2007

Fig. II, Turbines in Rio Vista California

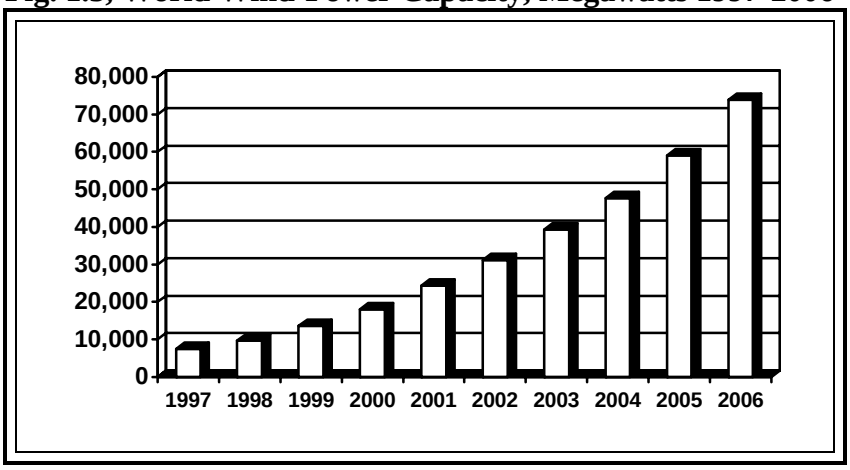
Credit: Jamie Tanaka

Fig. 1.2, Annual Growth in World Energy Sources between 1995 and 2005

Energy Type	Annual Growth Rate
Wind	28.6%
Solar	26.2%
Geothermal	3.1%
Hydro	1.2%
Oil	1.7%
Natural Gas	2.5%
Nuclear Power	1.9%
Coal	2.3%

Source: EPI, 2006

Fig. 1.3, World Wind-Power Capacity, Megawatts 1997-2006



Source: GWEA, 2006

Security Problems of Oil and Gas Supplies Threatens World Economies

Energy dependence on a few oil rich nations, some of which are politically-unstable like Nigeria, Iran, Iraq and Venezuela, create economic risks and uncertainties for the nations that depend on them for energy. Two-thirds of global crude oil reserves are concentrated in five countries bordering the Persian Gulf (Bakhtiar, 2002). Ten years ago, China was not an influential importer of oil. In 1993, China began to import oil to fuel its growing economy. By 2004, China became the second-largest importer of oil, behind the USA (Engdhal, 2004). Furthermore, China oil imports are rising 9% a year and are predicted to rise significantly in the coming decade as China emerges as the world's largest industrial nation. India has also developed a large industrial economy adding to the higher demands and prices of oil and natural gas (Engdhal, 2004). In 1999, Dick Cheney, chairman of Halliburton, the world's largest oil services company spoke to industry insiders about the future of the world's oil supply and demand. "By some estimates," Cheney said, "there will be an average of two percent annual growth in global oil demand over the years ahead, along with, conservatively, a three percent natural decline in production from existing reserves." "By 2010 we will need on the order of an

additional fifty million barrels a day," equivalent to more than six Saudi Arabia's of today's size (Engdhal, 2004).

This dramatic increase in energy demand allows other forms of energy like wind-power to expand significantly (EIA, 2006). Nations that do not develop alternative forms of energy will be more susceptible to the inevitable rise of oil prices. Thus alternative energy sources must be developed to avoid future energy shortages.

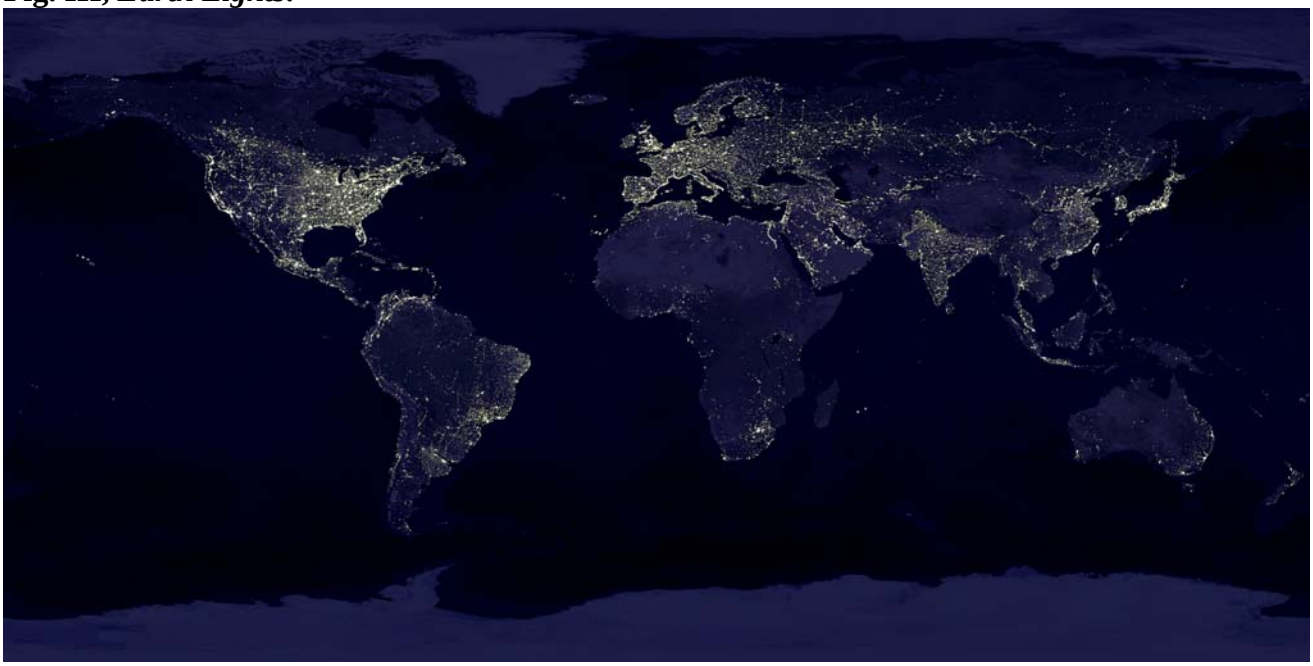
Furthermore, since two-thirds of global oil reserves exist in Persian Gulf Nations, most nations must import much of their supplies of natural gas and oil. As nations import energy supplies, they export currency, adding to national trade deficits. Thus, as nations develop domestic sources of energy, they help lower trade deficits as well as expand regional economies.

Growing Energy Demand, Demands Electrical Expansions

It has been estimated that the world's demand for energy will be 71% higher in 2030, than in 2004 (EIA, 2006). In the EU, electrical demands are expected to rise 51% between 2000 and 2030 (GWEC, 2006). World net electricity consumption is expected to double, from 14.781 billion kilowatt-hours in 2003 to 21.699 billion kilowatt-hours in 2015 and 30.116 billion kilowatt-hours in 2030 (EIA, 2006). About 66% or two thirds of this demand increase will come from China, India and other rapidly developing nations (EIA, 2006). Common sense economics tells us that when demand increases, prices for goods or in this case energy increase, allowing substitute resources like wind-power to emerge. Furthermore, due to concerns of global warming, many nations more and more are looking beyond coal-generated electricity. Altogether, demand for renewable

electricity is increasing allowing the wind-power industry to continue its emergence as a major way to generate electricity.

Fig. III, *Earth Lights*.



Credit: NASA Earth Observatory

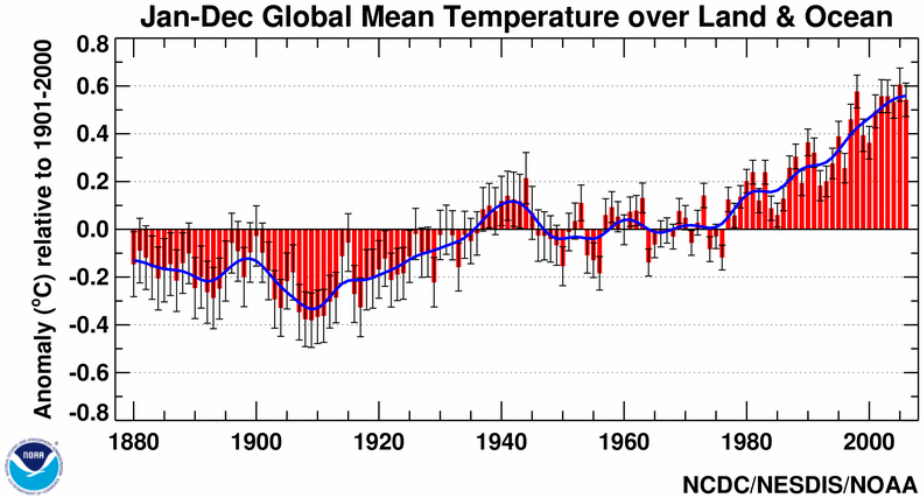
Global Warming Influencing the Future of Energy

Global Warming gives nations another reason to back off fossil fuels like natural gas, coal and oil in order to protect civilization from potentially devastating climate changes. The issue came to light over one hundred years ago when Swedish scientist Svante Arrhenius (1859-1927) first proposed in 1896 that humans could increase the temperature of the earth's atmosphere by burning fossil fuels (Harper, 2004). He discovered that the earth maintains a steady average global temperature thanks to what he called the greenhouse gasses, water vapor, and CO_2, which make up the most important part of the atmosphere's infrared heat-trapping capacities (Christianson, 2005).

In 1957, at the Mauna Loa Observatory and South Pole, scientist Charles Keeling began the measurement of atmospheric CO_2 concentrations using a nondispersive infrared gas analyzer (Scripps institute of Oceanography, 2007). By the 80's it became apparent that CO_2 concentrations were on the rise thanks to Keeling's graph of CO_2 concentrations since 1957, which was later coined the 'Keeling Curve'. The rise in CO_2 concentrations seen on the Keeling Curve couldn't help but be correlated to the anthropogenic release of CO_2 through the burning of fossil fuels. Along with rising CO_2 Levels, the world has been in a warming trend over the past 28 years (Fig 1.4), (NCDC, 2007). Furthermore, thanks to polar ice core samples and sea floor sediment samples, scientists have correlated a rise in CO_2 levels with a rise in global temperature (Fig. 1.5). This triad of data provides some of the most profound evidence for global warming, and the theory of anthropogenic global warming has gained strong consensus among the experts.

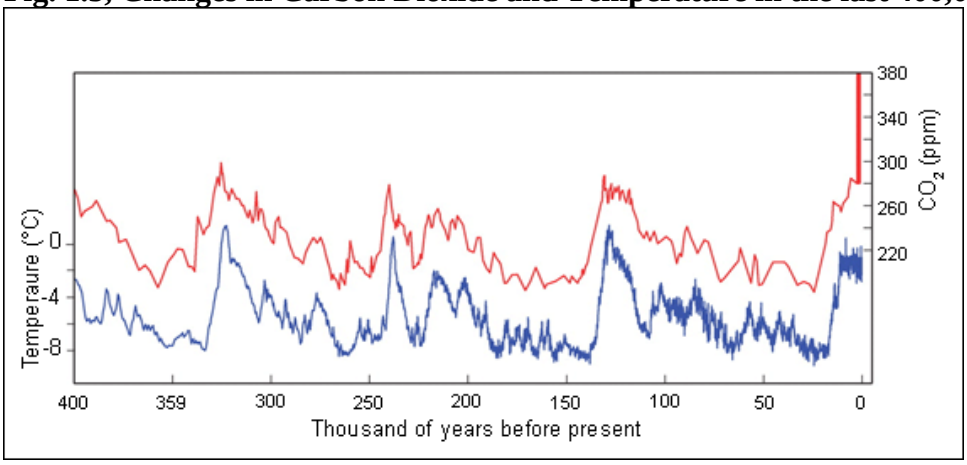
In order to curb the rising CO_2 concentrations, many countries have signed the Kyoto protocol requiring signers to lower their CO_2 emissions 5.2% of 1990 levels by 2012 or face large fines (Harper, 2004). Plus, the European Union Emission Trading Scheme (EUETS) made up of 25 European countries, was created in conjunction with the Kyoto protocol in 1997 and activated in 2005, creating a lucrative market for carbon credits that Kyoto signers can trade (DEFW, 2007). These economic incentives intend to increase the price of using fossil fuels in order to pay for the many external costs of non-renewable energy sources.

Fig. 1.4



Source: EPA, 2006

Fig. 1.5, Changes in Carbon Dioxide and Temperature in the last 400,000 years



Source: EPA, 2006

Why Renewable Energy Policy is Necessary?

- **Competition:** The higher market price of renewable energy plus high research, development and deployment (RD&D) costs makes it less competitive against conventional sources.
- **Externalities:** Fossil fuel-generated electricity pollutes the air, but does not have to pay for the local, regional, and global damage caused by their emissions. Only policies can force the polluting industry to account for the external costs that fossil fuels have on the public.

- **Tragedy of the Commons:** The external costs of fossil fuels accrue to the public and not to the individual consumer. Without regulation, the public will continue to pay the external costs of fossil fuels.

Thus renewable sources of energy should be adopted to prevent global warming, smog, mercury and acid rain-causing pollution. The only way to convert from fossil fuels to renewable is through policy incentives that encourage development in the sector and through on CO_2 and SO_2 emissions regulations.

Conclusion

The economic climate is ideal for developing alternatives forms of energy as demand for energy increases and its supply decreases. Governments worldwide are being influenced by the global warming crisis, forcing them to invest in alternative forms of energy. Also, governments understand the importance of developing domestic sources of energy to lower trade deficits and expand regional economies within their nations. Overall, wind-power is not a fix-all remedy for all the worlds' energy problems, but it is and will continue to grow as an integral component of the solution to the world's energy crisis.

II. Spanish Wind-Power

Spanish Wind-Power Booming

The wind's energy was first captured for non-naval purposes in the Middle East by the Persians in 200 B.C. to grind grains. Eventually, the wind mill made its way to Europe and its use became a popular practice there by the 13^{th} century to pump water and grind grain (Mathews, 2006). By 1890, the Danes had developed the first modern wind

electric generator. Today, Spain is continuing the long tradition of harnessing the wind's power in Europe and has become a world leader in wind-energy.

Spain produces more wind power per capita than any other nation (Fig 2.0) and it is the second-largest wind-energy producer in the world, just behind Germany and the USA right behind Spain (NZWEA, 2004).

Fig. 2.0, Top 30 Wind Power Producers Per Capita

Rank	Country	Population (Million)	Installed in 2004 (MW)	Installed in 2004 (watts/capita)
1	Spain	39.4	2,065	52.4
2	Ireland	3.7	148	40.0
3	Luxembourg	0.4	14	35.0
4	New Zealand	4.0	132	33.5
5	Germany	82.0	2,037	24.8
6	Austria	8.0	192	24.0
7	Portugal	10.0	226	22.6
8	Norway	4.5	59	13.1
9	Netherlands	15.8	197	12.5
10	Australia	19.3	182	9.4
11	Greece	10.5	90	8.6
12	Jamaica	2.7	20	7.4
13	Finland	5.2	30	5.8
14	Sweden	8.9	43	4.8
15	Canada	31.0	124	4.0
16	Italy	57.6	221	3.8
17	UK	59.1	184	3.1
18	Belgium	10.2	28	2.7
19	France	60.8	138	2.3
20	Estonia	1.4	3	2.1
21	Lithuania	3.6	7	1.9
22	Denmark	5.3	9	1.7
23	Japan	127.3	189	1.5
24	USA	285.9	389	1.4
25	Croatia	4.5	6	1.3
26	Czech Republic	10.2	9	0.9

27	**India**	**1,025.1**	**875**	**0.9**
28	**Egypt**	**69.1**	**47**	**0.7**
29	**Slovakia**	**5.4**	**3**	**0.6**
30	**Switzerland**	**7.1**	**3**	**0.4**

Source: NZWEA, 2004

Fig. IV, Wind Farm in Galicia, Spain

Credit: Luis Alvarez

Snapshots of the Spanish Wind-Power Industry:

- Total capacity by end of 2006: **11,615 MW**
- Total capacity target for 2011: **20,000 MW**
- Growth rate 1995–2005: **28%**
- Contribution to the national power supply: **6.5%**
- Peak contribution to Spanish electricity supply: **24%**
- Equivalent number of households supplied: **4 million+**

Economic Growth from Wind-Power in Spain:

- Total jobs in wind industry in 2004: **30,000**
- Jobs projected for 2011: **60,000**

In Spain, the 10,028 megawatts of wind-electricity per year made up 7.78% of their total demand for electricity in 2005, producing more than the US. Plus, a windy day in Spain may produce up to a quarter of their entire electrical needs (Graber, 2006).

Spanish wind-power companies and turbine manufacturers are leaders in the global wind-power market. Wind power is the fastest growing form of energy at 25% worldwide and 15% in the Spanish sector in 2006. Spain has also seen an increase in the demand for energy, which has been increasing 3-4% per year, providing an economic driving force in the energy sector. In 2005, wind-power generation in the country surpassed hydroelectric generation for the first time ever (Panorama Del Sector Eólica, 2006).

Furthermore, as signers of the Kyoto Protocol, the Spanish government and people understand the importance of clean, renewable energy such as wind-power and have passed several policies supporting the development of renewable energy sources. The Spanish government also acknowledges the importance of reducing dependence on foreign sources of energy, to reduce economic vulnerability in the oil market (Graber, 2006). Thus, wind-power in Spain is highly successful thanks to growing energy demands, concern for the environment and need to reduce dependence on foreign oil.

Today, Spain consumes more energy than it produces, and in 2002, the country imported 77% of its energy needs. Energy imports add to trade deficits and puts strain on economies (Spain Country Analysis Brief, 2005). Therefore, the Spanish government wants to become more energy independent to strengthen the economy. As Spain's wind-power sector develops they are becoming less dependent on coal, and natural gas used to produce 52.3% of all electricity produced (Spain Country Analysis, 2005). Spain imports over half the coal it consumes and nearly all of its natural gas and therefore must develop

domestic energy sources like wind-power to become less dependent on foreign fossil fuels that drain their economy and pollute the atmosphere.

Thanks to the developing wind-energy industry, 30,000 jobs have been created. In rural Spain, the industry is transforming once poor, rural economies. Thus, wind energy not only benefits the world's environment and lowers dependency on foreign sources of energy, but also benefits national economies by easing trade deficits and creating jobs.

In the future, the Spanish government plans to double their wind-power capacity to produce a once inconceivable 30% of the nation's electrical needs by 2011, which would reduce carbon dioxide emissions by 77 million tons (Graber, 2005).

One may wonder why Spain, a much smaller, slightly less- technologically advanced nation generates slightly more wind-energy than the USA. There are many factors that have enabled this strong development of wind power in Spain to take place, and the most important are, by far, the wind and renewable energy policies.

Important Wind-Power Policies in Spain

- **1994:** The Special Regime Decree requires electricity generated from renewable resources to be purchased by utilities at a set premium price that is profitable for wind farms for first five years of operation. Plus, all renewable energy generated must be integrated into the grid (Goff, 2006).
- **1997:** The Electricity Sector Law guarantees that renewable resource producer receive 80-90% of what consumers pay (Goff, 2006).
- **1998:** Decree 2818: Producers could now sell their electricity for the variable going rate of conventional electricity, with a fixed bonus added on top, or continue selling power at the set, premium price (Goff, 2006).
- **1998:** Spain Signs Kyoto Protocol (DUP-KI, 2007).
- **1999:** Spain sets goal to generate 9,000 MW of wind-power by 2011 (DUP-KI, 2007).
- **2002:** Spain Ratifies Kyoto Protocol (DUP-KI, 2007).

- **2005:** Spain surpasses 1999 goal in 2005 and set revised goal to generate at least 15% (20,000 Megawatts) of their electricity with wind power by 2011 (Graber, 2006).

Starting in the 1970's, Research and Development and Demonstration (RD&D) subsides from the national budget supported some weak growth in Spain's wind-energy sector. In the early 90's Spain began to implement investment subsides that were also funded by the national budget, and lead to improved growth. The most effective subsidy came in 1994 when the Spanish government implemented premium prices for renewable electricity. This required that all utilities pay a set, higher, price for wind-electricity, which is adjusted each year accordingly. Plus the government requires utilities to purchase all wind-power generated. The policies proved to have an impressive impact and the wind-power industry soared (Goff, 2006).

Furthermore, in 1998, wind-farmers were given an option to choose wind-power premium prices or wind-power bonuses. Wind farmers received bonuses funded by the national government that ensure profitability, and sell their electricity to utilities for the going price of conventional electricity, set by the federal government annually. Therefore, the financial burden of developing wind-power in Spain falls on both the national government and the pocketbooks of consumers (Goff, 2006).

Bolder New Goals for Wind Power in Spain

The goals of the Spanish Government for wind-power are to reduce dependence on foreign sources of energy and to reduce carbon dioxide emissions. These goals are highly politicized, but they boil down to protecting the world's environment, and improving the economy.

In 1999, the Spanish government set a goal of 9,000 megawatts capacity of wind-power by 2011, but realized last year, when they surpassed that goal by 500 MW that they needed to expand the 2011 goal. Therefore, in 2005, Spain set a revised goal of 20,000 MW of installed wind-power capacity by 2011, double the amount produced in 2005 (Graber, 2006).

By 2011, Spain plans to generate 15% of their electricity using wind-power; this means that on windy days, they could be generating as much as 50% of their electricity with the wind (Graber, 2006).

Spain Confronts Challenges with Innovation

To deal with peaks in wind-power, Spain plans to export the surpluses to neighboring nations and already exports about 5% of their electricity (EIA, 2005). As interconnectedness increases, variability in supply will be easier to stabilize. This means that during peak production, electricity will be more easily exported to areas that need it. During low supply, wind-power can be received from other parts of the nation and from neighboring nations such as France and Portugal. Germany and Denmark currently sell wind power to each other as needed so that when the wind is blowing in Denmark and not in Germany, Germany can fill its electrical deficits with Denmark's surplus. Spain wants to join Germany and Denmark in wind-power trading, by connecting to France. Spain already has transmission lines running between France and Spain, but the lines have yet to achieve full capacity (Graber, 2006).

Furthermore, a Spanish farm recently introduced another strategy to deal with the variability of wind-power. Hydrogenics is planning to install a hydrogen station that uses

the excess wind-electricity from a Spanish wind farm to make hydrogen from water by September 2006. This hydrogen can then be used to fuel large internal combustion engines to generate the excess energy back into electricity when needed. One of the best parts about this idea is that the only bi-product of burning Hydrogen is water (Hydrogenics, 2006)

Other challenges for the sector include installing a control center for all the wind farms in the nation, and more detailed meteorological predictions so that utilities can react more accurately to energy needs. Utilities receive hourly information and predictions on wind speeds to better know when to increase or decrease the production of other forms of energy. Improved forecasts would decrease the difference between forecast and real production, improving efficiency (Graber, 2006).

Off-Shore Wind-Turbines Fuel Desalination Plants

For the most part, Spain is an arid country. Thus it seems natural that Spain is also a world leader in desalination technology. Today, Spanish companies make up the largest percentage of competitors on the international market for the design, engineering, construction, and operation of new desalination plants around the world. Currently, Spanish companies are using the wind to power their desalination plants (Graber, 2006).

Fig. V, Wind and solar energy power a desalination plant at the Canary Islands Institute of Technology.

Credit: Technology Review

Fig. VI, An overlook of the test sites and laboratory at the Canary Islands Institute of Technology.

Credit: Technology Review

Spain's Wind Industry Goes Global

Spain is proving to be a world leader in the business of wind-power. The industry is not only at work at home, but also worldwide, developing, supplying and operating wind farms in China, India, USA, Portugal, Italy, France, Australia, Japan and Cuba. In 1997, the wind-power industry in Spain blossomed, which enhanced research and development in the sector. Spain's Gamesa Eólica is the fourth-largest wind turbine manufacturer and wind farm (Graber, 2006). Acción Energia, the most successful wind-power company worldwide operates wind farms, manufactures turbines and develops wind-power facilities (Graber, 2006). It is precisely this vertical integration of

manufacturing, operation, and installation that have made the company so powerful in Spain. The company, Acción Energia, currently does business in Australia, Canada, France and Morocco and plans to expand into China, Ireland, and the United Kingdom. Finally, Spain's Iberdrola represents the world's largest wind farm operator (Graber, 2006).

Fig 2.1, Spanish Companies Leading Global Wind-Power Market:

Company	Specialty	Operating in	Expansion Plans
Acción Energia: Largest Wind-Park Constructor in the World	-Wind-farm operator -Turbine Manufacturer -Wind-power facility developer	Australia, France, Germany, Canada, France, Morocco, Spain, USA	China, Ireland, UK
Gamesa Eólica: fourth-largest turbine manufacturer	-Turbine Manufacturer	China, Egypt, Germany, Ireland, Italy, Japan, Korea, Portugal, Spain, USA	Greece, Taiwan, UK
Iberdrola: Largest wind-farm operator in the world	-Turbine manufacturer -Wind farm operation	Brazil, France, Greece, Italy, Mexico, Portugal, Spain, United Kingdom	Europe, Latin America,

Source: Graber, 2006

Conclusion

Spain's success provides a snapshot of the future potential of world wind-power. Thanks to policies favoring renewable sources of energy, Spain is proving that wind power works. As more and more nations like Spain begin aggressively seeking out alternative, domestic, clean energy sources, wind-power will continue its rise as a viable source of energy for nation's worldwide. As this occurs, governments around the world,

especially the US, should follow in the foot steps of Spain in order to help address the problems non-renewable energy sources cause.

III. Intro to US Wind Power

Currently, wind-power makes up only 1% of US electrical output, but a huge potential for wind-power growth in the US exists (EEI, 2007). The US Department of Energy called the Midwest a "Saudi Arabia of wind." Montana and Texas have the highest amount of wind-power potential in the US, which combined could power the entire United States with electricity (Harper, 2002). It is possible that Texas alone could produce 100% of its electrical needs on less than 4.38% of its land (TSCO, 2007). Plus farmers are integrating crops and livestock with wind-power at the same time. The cost of wind-generated electricity has fallen from 38¢ per kilowatt-hour in the early 1980s to 4¢ to 6¢ today. The wind-power industry currently creates 3.7 jobs per MW of electricity produced which means that around 40,000 wind-power jobs exist in the US (DEED, 2004). Thanks to increasing support from government incentives, innovation, high demands for energy and available wind resources, wind-power is blossoming into a viable energy source in the US.

Wind-power in the US is catching up with other developed nations. In 2006, the USA added another 2,454 MW of wind-electricity to a grand total of 11,603 MW just shy of Spain's total for 2006. The wind-power sector in the USA expanded more than any other nation in 2006 by 28.6% and is expected to install over 3,000 more MW this year (GsÃ¤nger, 2007), (AWEA, 2007).

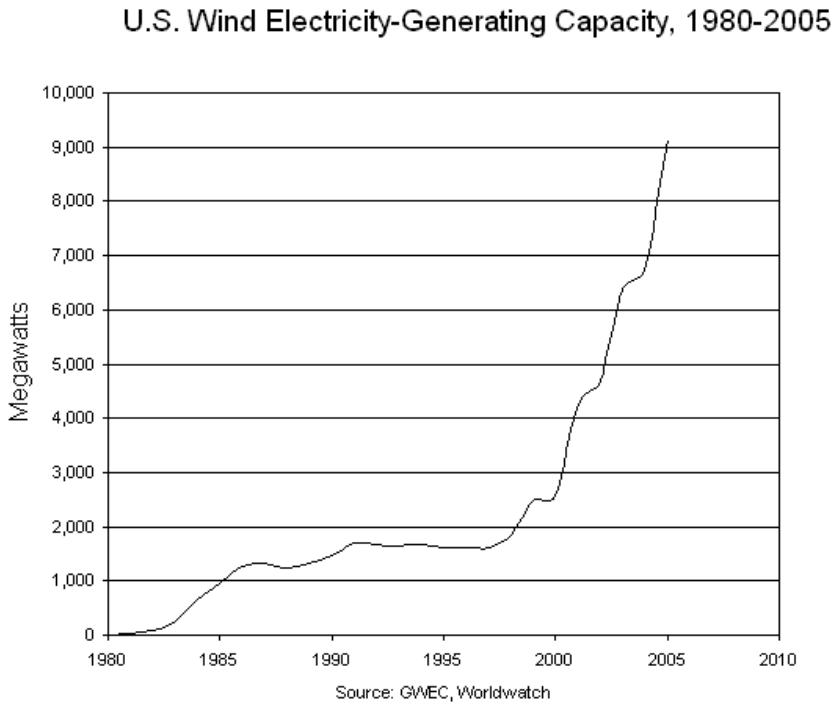
Snapshots of the US Wind-Power Industry:

- Total capacity by end of 2006: **11,603 MW, 31 million Megawatt-hours**
- Growth rate 2005-2006: **26.8%**
- Contribution to the national power supply: **1%**
- Price: **6-4 cents**
- Equivalent number of households supplied: **4,000,000**
- Total jobs in wind industry in 2004: **40,000**

US Renewable Energy Legislation

- **1992 Federal Production Tax Credit:** 1.9¢/kWh for wind, geothermal, closed-loop biomass; 1.0¢/kWh for others. Applies to first 10 years of operation.
- **Section 9006 of the 2002 Farm Bill:** requires the U.S. Department of Agriculture (USDA) to create a program to make direct loans, loan guarantees, and grants to agricultural producers and rural small businesses to purchase renewable-energy systems and make energy-efficiency improvements. Funds were appropriated for FY 2002 through FY 2007. This program is known as the Renewable Energy Systems and Energy Efficiency Improvements Program.
- **DOE's Office of Energy Efficiency and Renewable Energy's Tribal Energy Program:** funding is awarded through a competitive process. This program seeks to promote tribal energy self-sufficiency and fosters employment and economic development on America's tribal lands.
- **Renewable Energy Production Incentive (REPI) 1992:** amended 2005 1.5 cents per kilowatt-hour adjusted for inflation. Available to new renewable energy generation facilities for first 10 years of operation. The following facilities qualify: not-for-profit electrical cooperatives, public utilities, state governments, commonwealths, territories, possessions of the U.S., the District of Columbia, Indian tribal governments, or a political subdivision thereof, or Native Corporations that sell the project's electricity to someone else (DSIFRE, 2007).

Fig. 3.0



Source: EPI, 2006

Renewable Resource Legislation Adopted by US States

For the most part, US renewable energy incentives are minimal and the serious regulations are left up to the State governments. Notice how not much improvement developed in the wind-power sector after the federal 1992 incentives were put in place (Fig. 3.0). About 590,000,000 dollars is expected to subsidize wind energy in 2007. This is approximately what the US spends on the war in Iraq in Just 3 days. But then, in 2000 something happed, begging the question, what initiated the sudden up trend in 2000? To answer that one must look into the state statutes. In 2000, Texas, the leading producer of wind-power enacted the Renewable Portfolio Standard (RPS) policy that

simply requires that all power venders integrate at least 2,280 MW by 2007, increasing to 5,880 MW by 2015. The second leading producer of wind-power, California also has a RPS policy requiring that 20% of the energy be generated through renewable resources by 2017 (EERE, 2007). This new kind of statute ultimately guarantees that so much power will be generated through renewable methods. Plus, the RPS is a market driven policy that allows different forms of renewable electricity to compete because the law keeps the market fair for all types of renewable energy (DSIRE, 2007).

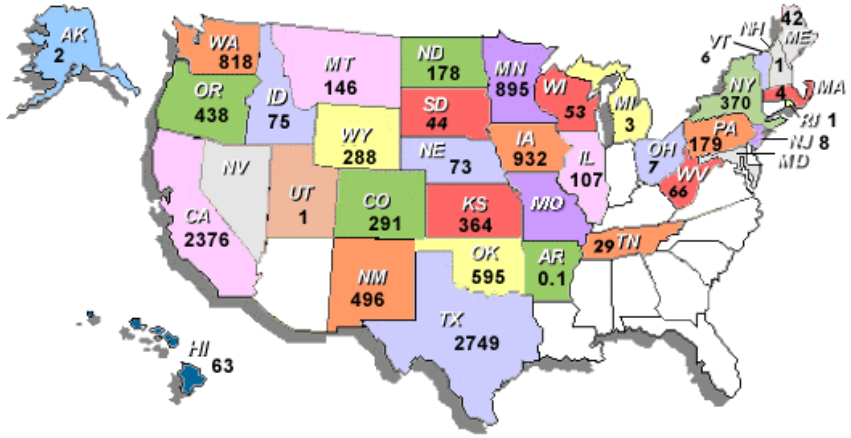
Fig. 3.1, States with Required Renewable Portfolio Standards:

State	Amount	Year
Arizona	15%	2025
California	20%	2017
Colorado	10%	2015
Connecticut	10%	2010
District of Columbia	11%	2022
Delaware	10%	2019
Hawaii	20%	2020
Massachusetts	4%	2009
Maryland	7.5%	2019
Maine	10%	2017
Minnesota	25%	2025
Montana	15%	2015
New Jersey	6.5%	2008
New Mexico	20%	2020
Nevada	20%	2015
New York	24%	2013
Pennsylvania	18%	2020
Rhode Island	15%	2020
Texas	5,880 MW	2015

Washington	15%	2020
Wisconsin	2.2%	2011

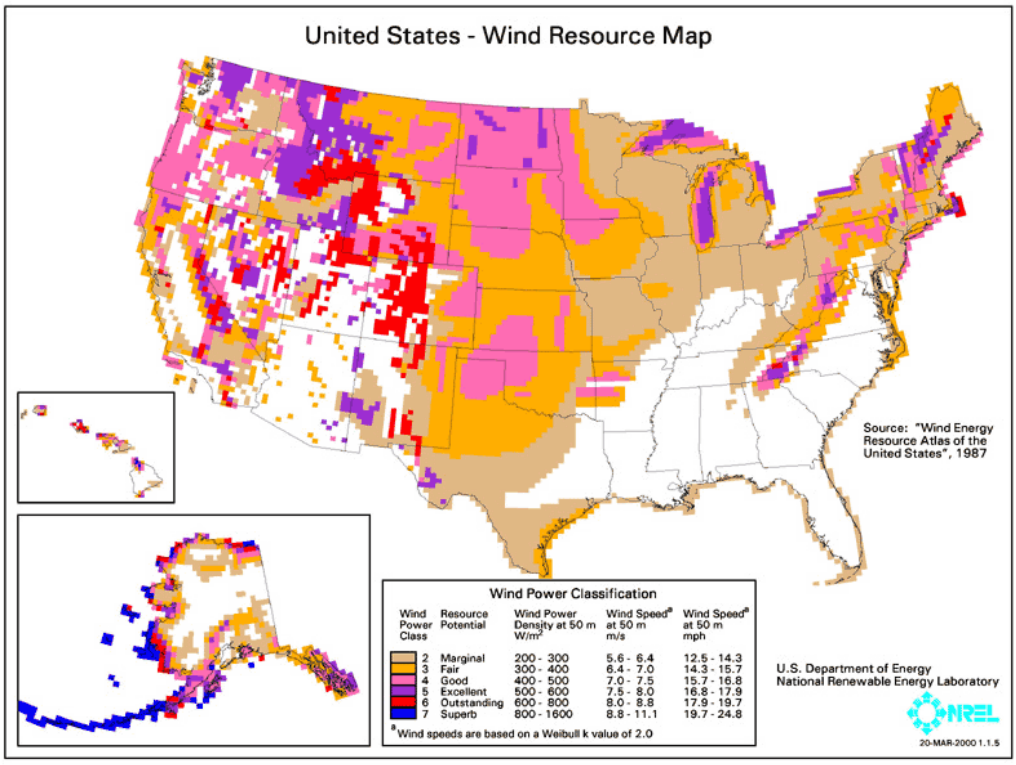
Source: (EERE, 2007)

Fig. 3.2 Wind-Power Capacity by State MW



Source: AWEA, 2007

Fig 3.3



Source: U.S. DOE, 2007

Texas and California are proving that RPS policies for renewable energy work. Texas just nudged ahead to become the leading producer of wind-power after California, which had been the leader since 1981. In Texas, total electrical demands are about 62,710,000 megawatt hours and wind-power makes up 3.6 million megawatt hours in 2006, which calculates out to about 5.7 percent (EIA, 2007). That means the 2,749 MW of wind-power satisfies almost 50 percent of the states renewable portfolio standard. In California, wind-power accounts for about 1.8 percent of the state's electrical output.

How Renewable Portfolio Standard Work

A Renewable Energy Credits (REC) is a currency denomination of RPS policy. A Credit is earned when 1kWh of renewable electricity has been generated. For example, one document may be worth 3,500 kWh. The RPS requires all utilities to demonstrate through credits that they have supported an amount of renewable energy generation equivalent to some percentage of their total annual kWh sales (DSIRE, 2007). For example, if the RPS is set at 10%, and a utility sells 100,000 kWhs in a given year, the generator would need to possess 10,000 Credits by the end of the year. The policy is market driven and Investors and utilities make all decisions about how to comply. Thus, the type of renewable energy to acquire, which technologies to use, what renewable developers to do business with, what price to pay, and which contract terms to agree to are market driven. Utilities decide for themselves whether to generate or purchase their own Credits (DSIRE, 2007). Because the RPS applies equally to all renewable electricity generators, it is competitively-neutral.

How Does Spain Compare to the US?

The RPS policy of several US states and the Special Regime Decree (SRD) of Spain achieve similar outcome through different means. Spain's aggressive 1994 SRD requires electricity generated from renewable resources to be purchased by utilities at a set premium price that is profitable for wind farms for first five years of operation. Plus, all renewable energy generated must be integrated into the grid (Goff, 2006). Overall, Spain has policies that specifically encourage wind-power development. On the other hand, many states with RPS policies are leaving the decision of what type of renewable energy sources to use up to market forces. For example, California, the leading producer of wind-power producer did not begin the RPS until 2003, nine years after Spain's SRD in 1994. By 2020, California will be producing 33% of their electricity with renewable energy. Thus it will be interesting to see which renewable energy industries thrive in states with aggressive RPS. Obviously, wind-power will be more successful in states with high wind-power resources and strong RPS's.

Future of US Wind-Power

By 2020 the US is projected to produce around 200,000 MW of wind-power, creating about 740,000 jobs if the US were to adopt a nation-wide RPS policy that require 15% renewable energy capacity apart from large hydro (NREL, 2004). If the US decides not to adopt such policies then the US is projected to produce around 75,000 MW of wind-power by 2020.

Conclusion:

Overall, wind-power alone will not be a fix-all to the US's and the world's energy problems. Nevertheless, Spain and some US states are proving that wind-power is a very viable source of renewable energy. Nevertheless, in order for wind-power and other renewable energy sources to best begin to replace fossil fuels, the US legislature needs to enact more aggressive, nation-wide policies. A national RPS policy of 15% would greatly encourage growth in the wind-power sector as well as other renewable energy industries. Overall, to help ensure energy security, curb global warming, improve regional economies, and quench the rising demand for energy, a national RPS of 15% should be enacted as soon as possible by the US legislature.

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