

Policies to Promote Non-hydro Renewable Energy in the United States and Selected Countries

February 2005

Energy Information Administration
Office of Coal, Nuclear, Electric and Alternate Fuels
United States Department of Energy
Washington, DC 20585

This report is available on the Web at:
<http://www.eia.doe.gov/fuelrenewable.html>

This report was prepared by the Energy Information Administration, the independent statistical and analytical agency within the United States Department of Energy. The information contained herein should be attributed to the Energy Information Administration and should not be construed as advocating or reflecting any policy of the Department of Energy or any other organization.

Contacts

This report was prepared by the staff of the Renewable Information Team, Coal, Nuclear, and Renewables Division, Office of Coal, Nuclear, Electric and Alternate Fuels. General information regarding this publication may be obtained from Fred Mayes, Team Leader (202/287-1750, e-mail fred.mayes@eia.doe.gov). Questions about the preparation and content of the report should be directed to Mark Gielecki, Economist (202/287-1729, e-mail mark.gielecki@eia.doe.gov) or Janice Poling, Presidential Management Fellow (202/586-3823, e-mail janice.poling@eia.doe.gov).

Table of Contents

1. Introduction	4
2. Non-hydro Renewable Energy Policy in the United States	6
2.1 Background	6
2.2 Federal Non-hydro Renewable Energy Policies	6
2.2.1 Regulatory Measures and Financial Incentives	6
2.2.2 Research and Development	7
2.3 California	8
2.3.1 Background	9
2.3.2 History of Non-hydro Renewable Energy Policies in California	9
3. Non-hydro Renewable Energy Policy in Selected Foreign Countries	11
3.1 Germany	11
3.1.1 Background	11
3.1.2 Research, Development, and Demonstration (1974-present)	12
3.1.3 Electricity Feed-In Law (1991) and Renewable Energy Law (2000)	13
3.2 Denmark	14
3.2.1 Background	14
3.2.2 Investment Subsidy (1979-1989)	16
3.2.3 Production Subsidy and other Direct Support Mechanisms (1981 and 1992)	17
3.2.4 Domestic Market Support (1990-2000)	17
3.3 The Netherlands	18
3.3.1 Background	18
3.3.2 Investment Subsidies (1986 and 1991)	19
3.3.3 Windplan	20
3.3.4 Demand-Pull Ecotax System	21
3.4 Japan	21
3.4.1 Background	21
3.4.2 Policies	23
3.5 Comparison of Policies to Promote Non-hydro Renewable Energy	25
4. Conclusion	26
4.1 Political Commitment	26
4.2 Public Opposition	27
4.3 Structure of Policies	27
References	28

Figures

Figure 1. United States Electricity Generation, 2003	6
Figure 2. Wind Capacity & Major US and State Policies, 1980-2003	8
Figure 3. California Electricity Generation, 2003	9
Figure 4. German Electricity Generation, 2002	11
Figure 5. Germany's Non-hydro Renewable Energy Policies and Growth, 1980-2002	12
Figure 6. Danish Electricity Generation, 2002	15
Figure 7. Denmark's Non-hydro Renewable Energy Policies and Growth, 1979-2002	16
Figure 8. Dutch Electricity Generation, 2002	19
Figure 9. The Netherlands' Non-hydro Renewable Energy Policies and Growth, 1980-2002	20
Figure 10. Japanese Electricity Generation, 2002	22
Figure 11. Japan's Non-hydro Renewable Energy Policies and Growth, 1974-2002, with Installed PV Capacity 1992-2002	22

Tables

Table 1. Net Maximum Electric Capacity (GW) December 31, 2002	4
Table 2. Summary Comparison of Countries' Non-hydro Renewable Energy Policies and Incentives	25

1. Introduction

Since the energy crises of the 1970s, many countries have become interested in developing renewable energy technologies for electricity generation. At first, many countries pursued this strategy as a way to reduce dependence on imports of fossil fuels. However, with an increased awareness of environmental issues in the 1980s and 1990s, many countries have continued their renewables strategies as a means of protecting the environment. This article examines policies designed to encourage the development of non-hydro renewable energy in four countries—Germany, Denmark, the Netherlands, and Japan—and compares the policies enacted in each of these countries to policies that were used in the United States between 1970 and 2003. For each country, policy development is analyzed in the context of historical non-hydro renewable generation data to try to determine which types of policies most effectively increase non-hydro renewable generation. Since this paper uses data to examine the effectiveness of policies, more recent policies (e.g., renewable portfolio standards) will not be analyzed closely, as there is not yet enough data to determine their ultimate effect on non-hydro renewable generation.¹

Clearly, many conditions differ among these countries—even in regions within countries—such as natural resource endowments, political and economic systems, and cultural traditions. All of these factors can lead to differences in energy costs and prices. Natural resource endowments are important because they can impact the energy choices countries make. For example, Denmark has virtually no hydro potential, Japan has little fossil energy, and Germany has a relative abundance of coal resources. Additionally, the countries examined in this report tend to have higher electricity prices than the United States, potentially reducing the relative cost of policies to promote non-hydro renewables.²

Another point worth noting is that the differences among countries mentioned above affect policy choices and may make some policies not applicable in certain countries. Finally, a major policy that will directly affect the energy choices of all the countries analyzed here except the United States is the Kyoto Protocol. With Russia’s ratification in November 2004, this international agreement to reduce emissions of greenhouse gases of its industrialized country signatories, compared to 1990 levels, entered into force in February 2005.³

In this report, generating capacity values from various sources are used in the country discussions to provide specialized information on specific issues. For comparability Table 1 below shows country generating capacities according to the International Energy Agency as of yearend 2002.

Table 1. Net Maximum Electric Capacity (GW) December 31, 2002⁴

	Fossil-Fired	Nuclear	Hydro	Non-hydro Renewables
United States.....	758	105	96	20
Germany	81	23	10	12
Denmark.....	10	0	0.01	3
Netherlands.....	20	0.45	0.04	1
Japan	173	46	46	1

GW = Gigawatts

Source: International Energy Agency, Electricity Information 2004, OECD/IEA, 2004.

Each country was chosen because its experience with renewable energy and renewable energy policy is exceptional in some way. For instance, 21 percent of the electricity generated in Denmark was from wind power during 2003. No other country in the world has integrated such a large percentage of non-hydro renewables into its electric grid. Examining the history of renewables development, and in particular, the development of the wind industry in Denmark, is useful because Denmark’s policies succeeded in increasing both the capacity and market share of renewable energy.

Germany, a country much larger than Denmark and the country with the largest economy in Europe in 2003, has the most installed wind capacity in the world, increasing from 12 gigawatts (GW) in 2002 to more than 14.5 GW in 2003.⁵ In high-wind

¹ We would like to acknowledge a few people whose assistance was instrumental in the writing of this paper. Janet Sawin, of the World Resources Institute, allowed us to draw extensively from the appendixes of her Ph.D. dissertation for the details of renewable energy policies in Denmark, Germany, and California. Bruce Bawks, of EIA’s Office of Energy Markets and End Use, referred us to the following Japan experts, who provided information on Japan’s renewable energy policies: Hiroki Kudo, Group Manager, Environment and Energy Conservation Group, The Institute of Energy Economics, Japan; Kaoru Yamaguchi, Ph.D., Group Manager, New & Renewable Energy Group, The Institute of Energy Economics, Japan; Naoki Matsuo, Ph.D., Chair, Senior Research Fellow, Advisory Services on Climate Strategy. Tineke de Vries, Environmental Business Liaison, Royal Embassy of the Netherlands, assisted us with identifying relevant renewable energy policies in the Netherlands.

² International Energy Agency, *Energy Prices and Taxes, Quarterly Statistics, Third Quarter 2004*, Tables 19 and 20. Paris.

³ BBC News, February 2005, “Kyoto Protocol Comes into Force,” <http://news.bbc.co.uk/2/hi/science/nature/4267245.stm>, accessed February 23, 2005.

⁴ This report contains information on both renewable electric capacity and generation. Capacity is measured in watts and refers to the maximum amount of electricity produced at any given moment. Generation is measured in watthours and refers to the cumulative amount of electricity produced over a given time period.

⁵ Central Intelligence Agency, *The World Factbook 2004*, “Germany,” <http://www.cia.gov/cia/publications/factbook/geos/gm.html#top>,

areas of Germany, wind-generated electricity makes up about 20 percent of all electricity on the grid, although overall, Germany gets about 5 percent of its electricity from renewables.

The Netherlands generated about 8 percent of its electricity from non-hydro renewables in 2002, and that percentage has increased significantly throughout the 1990s.⁶ The Netherlands also imports renewable electricity from neighboring countries. The Netherlands has used a more voluntary approach towards developing renewables than Germany and Denmark and has still achieved remarkable results, particularly with cogeneration of waste and biomass.

Japan is the world's fourth largest energy consumer and second largest energy importer. Japan also implemented an aggressive, successful solar photovoltaics (PV) program beginning in the 1990s.

This article will first briefly describe U.S. Federal legislation that encouraged the growth of renewable energy. Next, the report examines California, where Federal and State legislation combined to install nearly all the U.S. wind capacity as of the early 1990s. Having established an understanding of Federal and California renewable energy policies, the report then compares the policies of the other countries to similar laws enacted in the United States. Finally, some conclusions are drawn about why similar policies had dramatically different results in different countries.

Except for the United States and California, for which 2003 data are available, the electricity generation data presented in this article are for the year 2002, the most recent year for which all data, in particular, detailed renewables data, are available.

accessed April 26, 2004.

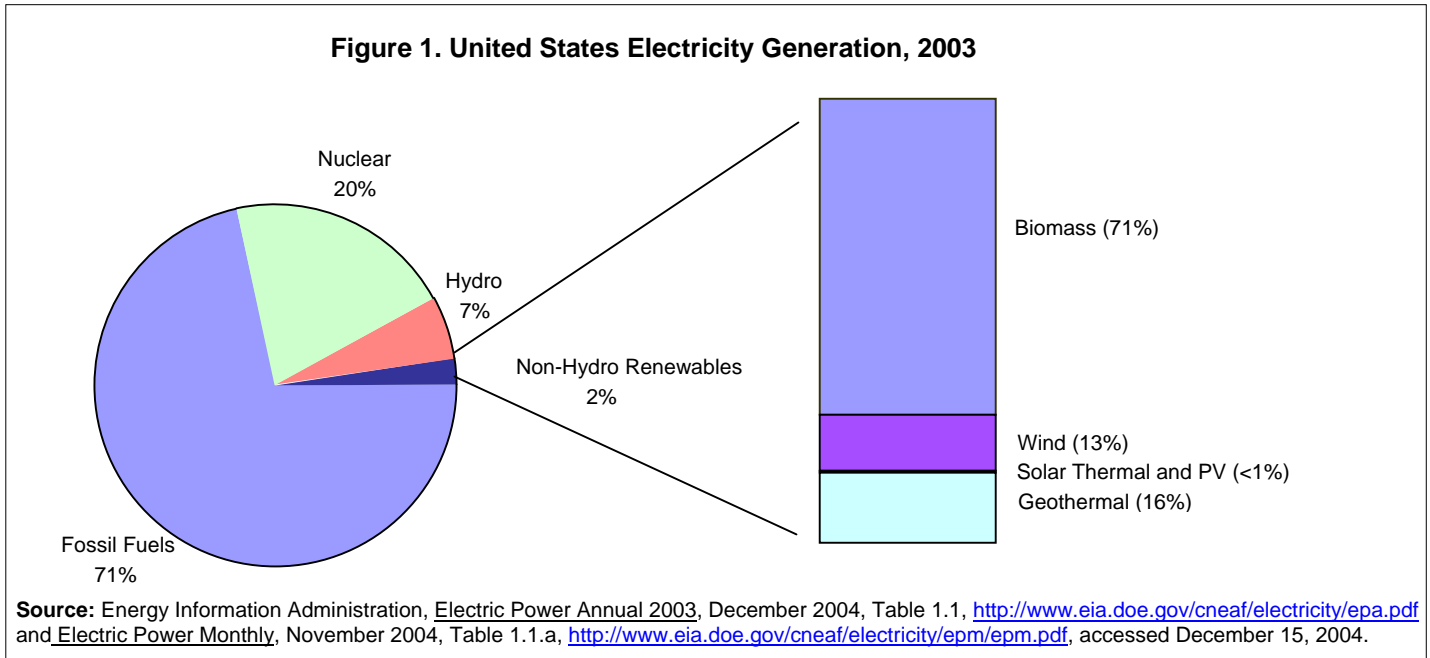
⁶ Energy Information Administration, International Energy Annual 2003. Various Tables. Accessed December 2004.

2. Non-hydro Renewable Energy Policy in the United States

2.1 Background

The United States has the largest economy in the world, with a population of 290 million in an area about two and a half times the size of Western Europe.⁷ In 2003, the United States generated 3,883 billion kilowatthours (kWh) of electricity.⁸ About 71 percent of United States electricity was generated from fossil fuels, about 20 percent from nuclear power, another 7 percent from hydroelectric facilities, and the remaining 2 percent from other renewables (Figure 1). Biomass (71 percent) was the predominant non-hydro renewable fuel for electricity generation in 2003, followed by geothermal and wind. Solar thermal and photovoltaics together accounted for less than 1 percent of U.S. non-hydro renewable generation.

In the United States, energy policies are the product of both individual State and Federal policies. California is featured because it has been among the most active States in encouraging renewable energy.⁹



2.2 Federal Non-hydro Renewable Energy Policies

Federal policies used to promote renewable energy have included financial incentives, regulatory measures, and research and development (R&D) programs.

2.2.1 Regulatory Measures and Financial Incentives

In response to energy security concerns of the mid-1970s, the United States passed the National Energy Act of 1978 (NEA), which sought to decrease the Nation's dependence on foreign oil and increase domestic energy conservation and efficiency.¹⁰ The Public Utility Regulatory Policies Act (PURPA) of 1978, part of the NEA with a stated purpose of improving energy conservation and energy efficiency in the utilities sector, also had major impacts on the development of renewable electricity.¹¹

PURPA opened the door to competition in the electricity supply of the United States by requiring utilities to buy electricity from qualifying facilities (QFs), which are defined as nonutility facilities that produce electric power using cogeneration technology or renewable power plants with capacities of less than 80 MW. Utilities are required to purchase power from qualifying facilities at the utilities' "avoided cost." The interpretation of "avoided cost" was left up to individual States. This resulted in a number of

⁷ Central Intelligence Agency, *The World Factbook 2004*, "United States," <http://www.cia.gov/cia/publications/factbook/geos/us.html>, accessed May 19, 2004.

⁸ Energy Information Administration, *Electric Power Annual*, 2003, December 2004, Table 1.1, <http://www.eia.doe.gov/cneaf/electricity/epa.pdf>, accessed December 15, 2004.

⁹ Database of State Incentives for Renewable Energy, "Summary Tables Overview," <http://www.dsireusa.org/summarytables/index.cfm?&CurrentPageID=7>, accessed May 19, 2004.

¹⁰ Gielecki, Mark; Mayes, Fred; and Lawrence Prete, "Incentives, Mandates, and Government Programs for Promoting Renewable Energy," February 2001, Energy Information Administration, http://www.eia.doe.gov/cneaf/solar/renewables/rea_issues/incent.html, accessed May 19, 2004.

¹¹ U.S. Government Printing Office. *Compilation of Selected Energy-Related Legislation: Electricity*. Washington, DC, 1991. Page 115.

different regimes, some of which, as in California and New York, were particularly favorable to renewables. California based its avoided cost calculations on forecasts of natural gas and oil prices, which were higher than prices actually turned out to be, resulting in favorable investment conditions for renewable power.¹² However, in 1995, the Federal Energy Regulatory Commission (FERC) took responsibility for interpreting “avoided cost,” directly linking it with the costs a utility would incur either generating the power directly or purchasing it from another supplier. This interpretation resulted in lower avoided costs than the interpretations of some states, including California.¹³

The United States has also used financial incentives to try to spur the growth of renewable energy. The 1978 Energy Tax Act (ETA), part of the NEA, included a 30-percent investment tax credit for residential consumers for solar and wind energy equipment and a 10-percent investment tax credit for business consumers for the installation of solar, wind, geothermal, and ocean thermal technologies. Although the level of these tax credits changed over time until their expiration in 1985, the fundamental policies were developed with the passage of the ETA.¹⁴

The most important law promoting renewable energy in the 1990s was the Energy Policy Act (EPACT) of 1992. EPACT established a 10-year 1.5 cents per kWh inflation-adjusted¹⁵ production tax credit (PTC) for tax-paying privately and investor-owned wind projects and closed-loop biomass plants brought online between 1994 and 1999. The incentive expired in 1999, but has since been renewed twice, in 1999 and 2001, before its expiration at the end of 2003. Late in 2004, it was extended again through 2005. This latest extension increased the number of renewable technologies that are covered by the incentive.

Figure 2 illustrates the relationship between wind capacity in the United States and the PTC. Although the graph depicts total installed capacity in the United States, nearly all the windpower capacity was in California until the 1990s. EPACT also created a Renewable Energy Production Incentive (REPI) for electricity generated from biomass, geothermal, wind, and solar from tax-exempt publicly owned utilities and rural cooperatives. Unlike the PTC, the funding available through REPI is subject to annual congressional appropriations, thereby making the availability and level of the credit uncertain.

While EPACT significantly improved the economics of windpower, another U.S. policy, implemented thus far at a State level, has been more beneficial to the installation of solar photovoltaic generation. This policy is net metering, which allows small producers of renewable energy from selected sources to sell their power back to the grid.¹⁶ The buyback rate is determined by law and is frequently equal to the retail electricity rates, or sometimes slightly less than retail rates.¹⁷ Net metering programs are designed for small electricity customers (residential or small commercial) who produce their own power to bank power on the grid in times of surplus and draw down from the grid in times of need. As of September 2004, net metering was available in 32 States and the District of Columbia.¹⁸ Most States set size limits on systems for net metering eligibility with many States having capacity limits around 25 kilowatts (kW), though limits vary from 10 kW in New Mexico to 1,000 kW in California.¹⁹

2.2.2 Research and Development²⁰

Government investments in energy RDD&D (research, development, demonstration, and deployment) are intended to accelerate the development and introduction of technologies and practices that provide social benefits, such as increased energy security, reduced energy costs, or reduced pollution associated with energy use. The focus in the Department of Energy’s (DOE) renewable energy programs is on technologies that would be developed more slowly or not at all if they depended only on current private-sector incentives and interests. Consequently, these investments serve as a support program for nascent industries because, when successful, R&D reduces the capital and/or operating costs of new products or processes.

The DOE renewable energy programs are implemented in several ways: through direct funding of R&D at national laboratories, through grants and cooperative agreements with universities, and through various forms of financial and technical assistance to industry partners. In general, the industry partnerships, a prominent part of renewables R&D funding since the mid-1980s, are cost-shared; that is, the industry partner provides a portion of the funding or other resources needed for the work. The cost-

¹² Gielecki, Mark; Mayes, Fred; and Lawrence Prete, “Incentives, Mandates, and Government Programs for Promoting Renewable Energy,” February 2001, Energy Information Administration, http://www.eia.doe.gov/cneaf/solar/renewables/rea_issues/incent.html, accessed November 19, 2004.

¹³ In 1995, FERC defined avoided costs as, “...the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase from the qualifying facility or qualifying facilities, such utility would generate itself or purchase from another source.” FERC, “18 CFR Part 292 Regulations Under Sections 201 and 210 of the Public Utility Regulatory Policies Act of 1978 With Regard to Small Power Production and Cogeneration,” accessed November 19, 2004.

¹⁴ For more information on how these incentives changed over time, please see: Gielecki, Mark; Mayes, Fred; and Lawrence Prete, “Incentives, Mandates, and Government Programs for Promoting Renewable Energy,” February 2001, Energy Information Administration, http://www.eia.doe.gov/cneaf/solar/renewables/rea_issues/incent.html, accessed November 19, 2004.

¹⁵ Due to the inflation-adjustment provision, the 2005 renewal of the PTC allows for 1.8 cents per kWh.

¹⁶ Some States limit eligibility to photovoltaic systems while others permit all small renewable facilities to participate.

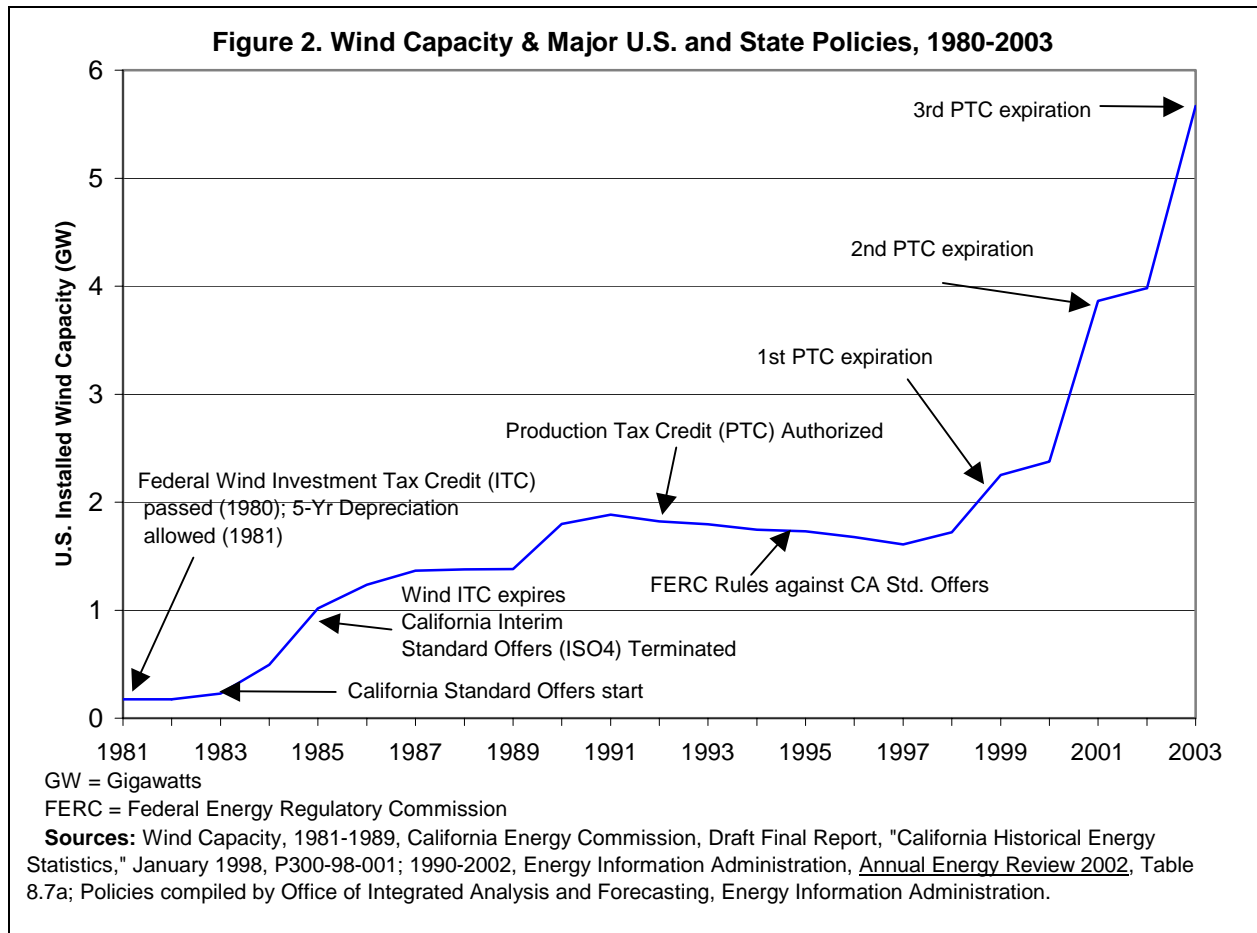
¹⁷ DSIRE, “Net Metering Rules,” <http://www.dsireusa.org/library/includes/seeallincentivetype.cfm?type=Net¤tpageid=7&back=regtab>, accessed June 8, 2004.

¹⁸ DSIRE, “Rules Regulations and Policies,” <http://www.dsireusa.org/summarytables/reg1.cfm?&CurrentPageID=7>, accessed June 8, 2004.

¹⁹ DSIRE, “Net Metering Programs,” http://www.dsireusa.org/library/docs/NetMetering_Map.doc, accessed January 12, 2005.

²⁰ This section is adapted from information provided by Sam Baldwin, Peggy Podolak, and Randy Steer, of the Office Energy Efficiency and Renewable Energy, U.S. Department of Energy.

sharing can be in the form of direct financial contributions towards the costs of the R&D, or it may be "in kind," meaning that a value is ascribed to some facility or equipment that the industry provides for the effort, or, in the case of the government, the industry partners' use of DOE's national laboratories. The degree of cost-sharing is negotiated and depends on many factors, such as the technology's technical risk (the higher the risk, the greater the government's share) and nearness to commercial readiness, the degree to which the government believes that industry has incentives to do the work on their own, and the size of the industry partner. (Small businesses are sometimes provided a higher share of costs than large businesses, at least in early stages of technology development.) Although national laboratories negotiate licensing fees or royalties when they license a technology they have developed to industry, the renewable energy R&D program itself has not required any repayment or royalties from industry partners when jointly-funded R&D leads to commercial success. In partnering programs, DOE also works with the ultimate product consumer to determine desired product characteristics and feeds this information back to its partners.



2.3 California

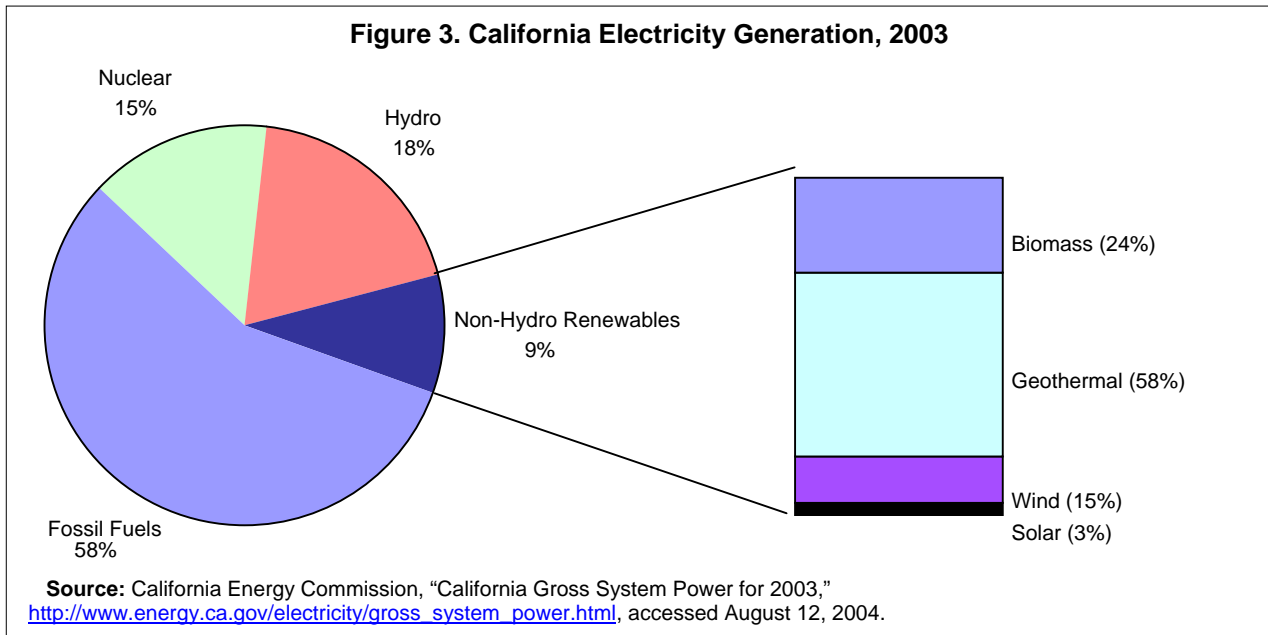
Until the early 1990s, nearly all growth in non-hydro renewable capacity in the United States took place in California. In more recent years, other States have begun pursuing policies to increase non-hydro renewable generation, particularly States are developing Renewable Portfolio Standards (RPS). However, most of these initiatives are still relatively new and their impact on non-hydro renewable generation is still unclear. For a review of current State RPS policies, renewables mandates and targets, see "State Renewable Energy Requirements and Goals: Status Through 2003."²¹ A comprehensive overview of State renewable energy incentives is provided in the Database of State Incentives for Renewable Energy.²² Because this paper examines historical trends in non-hydro renewable generation, it is instructive to examine California's policies that, along with Federal statutes, encouraged the development of non-hydro renewable energy there. Needless to say, the Federal laws described above—particularly PURPA and EPACT—have had a significant influence on the development of renewable energy in California. However, many laws enacted at the State level have also significantly affected the development of renewables in California.

²¹ Energy Information Administration, <http://www.eia.doe.gov/oiaf/analysispaper/rps/index.html>, accessed January 5, 2005.

²² Database of State Incentives for Renewable Energy, <http://www.dsireusa.org>, accessed January 5, 2005.

2.3.1 Background

California is the most populous state in the United States, with about 35 million people spread out over 150,000 square miles. California produced 277 billion kWh of electricity in 2003 and imported 22 percent of its electricity needs.²³ Of the electricity generated within the State, 58 percent was generated from fossil-fuel sources, 15 percent from nuclear power plants, 18 percent from large- and small-scale hydropower plants, and about 9 percent from other renewables (Figure 3). Most of the non-hydro renewable power was generated by geothermal energy, with smaller amounts from biomass, wind energy, and solar.²⁴



2.3.2 History of Non-hydro Renewable Energy Policies in California

Early Activity

California began providing tax incentives for installing renewable technologies—particularly solar energy devices—in 1976 with a 10-percent investment tax credit.²⁵ Two years later, the amount of this investment credit was increased to 55 percent. The investment credit was consistently extended (though the periodic extensions did create uncertainty in the market) through 1986 for wind energy projects and into the 1990s for other renewable projects.²⁶ This State incentive was in addition to Federal incentives for the construction and use of renewable energy technologies that were offered between 1978 and 1985. In 1978, California started the Wind Energy Program with a target of having 500 MW of wind capacity installed by the mid-1980s.²⁷ Although the Federal government was also funding R&D for wind energy technologies at this time, the California Energy Commission (CEC) wanted to explore a wider range of designs than were eligible for the Federal program. As such, it funded several turbine projects to determine the efficacy of different designs.²⁸

Market Development

In the early 1980s, California moved from funding strict R&D projects for wind energy to focusing on demonstration projects for wind turbines. These demonstration projects resulted in design improvements that helped to bring costs down for wind energy developers. Throughout this period, the focus was on relatively small machines compared to the multi-megawatt R&D efforts at the Federal level.²⁹

²³ California Energy Commission, http://www.energy.ca.gov/electricity/gross_system_power.html, accessed August 12, 2004.

²⁴ California Energy Commission, "California Gross System Power for 2003," http://energy.ca.gov/electricity/gross_system_power.html, accessed August 12, 2004.

²⁵ For a comprehensive list of current renewable energy incentives in California, see, <http://dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=CA>, accessed June 2, 2004.

²⁶ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University. September 2001, Chapter 5.

²⁷ Ibid, Appendix 5.

²⁸ Dodge, Darrell M, "Illustrated History of Wind Power Development," <http://telosnet.com/wind/recent.html>, accessed August 12, 2004.

²⁹ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University. September 2001, Chapter 5.

In 1982, California's Public Utilities Commission (CPUC) articulated California's interpretation of the term "avoided cost" as used in PURPA. The interpretation was based on long-term avoided costs partially derived from forecasts of natural gas and oil prices. The price reverted to the actual avoided cost after the first 10 years. However, actual avoided cost turned out to be much less than contract costs because oil prices had fallen significantly during the mid-1980s. Thus, after the initial 10-year period, the price that wind producers were receiving dropped dramatically in what is sometimes called the "11-year cliff."³⁰ In 1982, the CPUC created the "Standard Offer" contracts (Numbers 1-3) to secure renewable electricity generation. The contracts were 10-year power purchase agreements for a price of 6.9 cents per kWh. The contracts were based on the notion that there should be no difference in electricity rates regardless of whether the electricity was generated by a utility or by a qualifying facility.³¹

The next year, CPUC authorized Interim Standard Offer Number 4 contracts (ISO4), which were granted for periods of 15-30 years, with prices guaranteed for the first 10 years. The majority of California's wind energy capacity was installed through this program, starting in late 1983. Wind energy projects began reaching the "11-year cliff" in 1992. The "cliff" reduced the profitability of California wind developments after their first 10 years of operation.

Nonetheless, by 1985, mostly via ISO4, California had installed 1,000 MW of wind capacity.³² By 1990, this had increased to 1,799 MW of wind capacity, which was more than half the world's total at that time.³³

In 1996, California established net metering laws for residential customers who installed solar energy or small-scale wind energy systems of up to 1 MW.³⁴ Eligibility was extended to biogas digesters in 2002 under a pilot program. Utilities are only required to enroll customers in net metering up to one-half of a percent of peak electricity demand, a provision which limits the financial burden of net metering on the utilities.³⁵ Finally, the buyback rate for net metering in California is equal to the retail electricity price, and State law prohibits the utilities from charging net metering consumers interconnection fees.³⁶

To further support the installation of smaller-scale renewable energy projects, California instituted the Emerging Renewables Buydown Program in 1998. The program helps residents and small commercial establishments pay for the initial investment in renewable technology. Buydown rates vary between \$2,000 and \$3,600 per kW, depending on the size of the system and the type of technology used.³⁷

In 1999, California began offering a 1.5 cents per kWh customer credit for purchasing renewable electricity. The rebate was reduced to 1 cent per kWh in 2000, with a ceiling of \$1000 per year.³⁸ This incentive is similar to the demand-pull incentive (Ecotax exemption) used in the Netherlands, described in the next chapter, though it has not been as successful in increasing the demand for non-hydro renewable electricity.

In 2002, California introduced an RPS requiring utilities to purchase 20 percent of electricity from renewable generators by 2017. All non-hydro renewable sources are eligible, as well as small-scale hydropower and municipal solid waste if it is not combusted. To reach 20 percent, utilities are expected to increase the proportion of power they get from renewable generators by at least 1 percent each year through 2017.³⁹ The CEC estimates that by 2017 California will need to generate 30,610 billion kWh of non-hydro renewable generation in addition to the approximately 2,500 billion kWh of non-hydro renewable generation in 2003 to meet the RPS requirement.⁴⁰

³⁰ Chapman, Jamie; Wiese, Steven; DeMeo, Edgar; and Adam Serchuk, November 1998, "Expanding Wind Power: Can Americans Afford It?" Renewable Energy Policy Project Research Report, No. 6, http://solstice.crest.org/repp_pubs/pdf/chapman.pdf, accessed May 18, 2004.

³¹ California Public Utilities Commission. 1993, "California's Electric Services Industry: Perspectives on the Past, Strategies for the Future," http://www.ucei.berkeley.edu/Restructuring_Archive/Yellow_book.pdf, accessed May 18, 2004.

³² Energy Information Administration, "Wind Power Milestones," <http://www.eia.doe.gov/cneaf/solar/renewables/renewable.energy.annual/backgrnd/chap10l.htm>, accessed May 17, 2004.

³³ Energy Information Administration, Annual Energy Review 2003, DOE/EIA 0384(2003) September 2004.

³⁴ DSIRE, "Net Metering Rules—California," http://www.dsireusa.org/library/includes/incentivesearch.cfm?Incentive_Code=CA02R&Search=TableType&type=Net&CurrentPageID=7, accessed June 8, 2004.

³⁵ Ibid, accessed June 8, 2004.

³⁶ Ibid, accessed June 8, 2004.

³⁷ California Consumer Energy Center, "Current Rebate Levels—Emerging Renewables Program Rebates," http://www.consumerenergycenter.org/erprebate/2004-01-08_curmnt_rebate.html, accessed June 8, 2004.

³⁸ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 5.

³⁹ Database of State Incentives for Renewable Energy, "California Incentives for Renewable Energy," <http://www.dsireusa.org/library/includes/map.cfm?State=CA&CurrentPageId=1>, accessed May 18, 2004.

⁴⁰ California Energy Commission, Renewable Resources Development Report, http://www.energy.ca.gov/reports/2003-11-24_500-03-080F.pdf, accessed January 7, 2005.

3. Non-hydro Renewable Energy Policy in Selected Foreign Countries

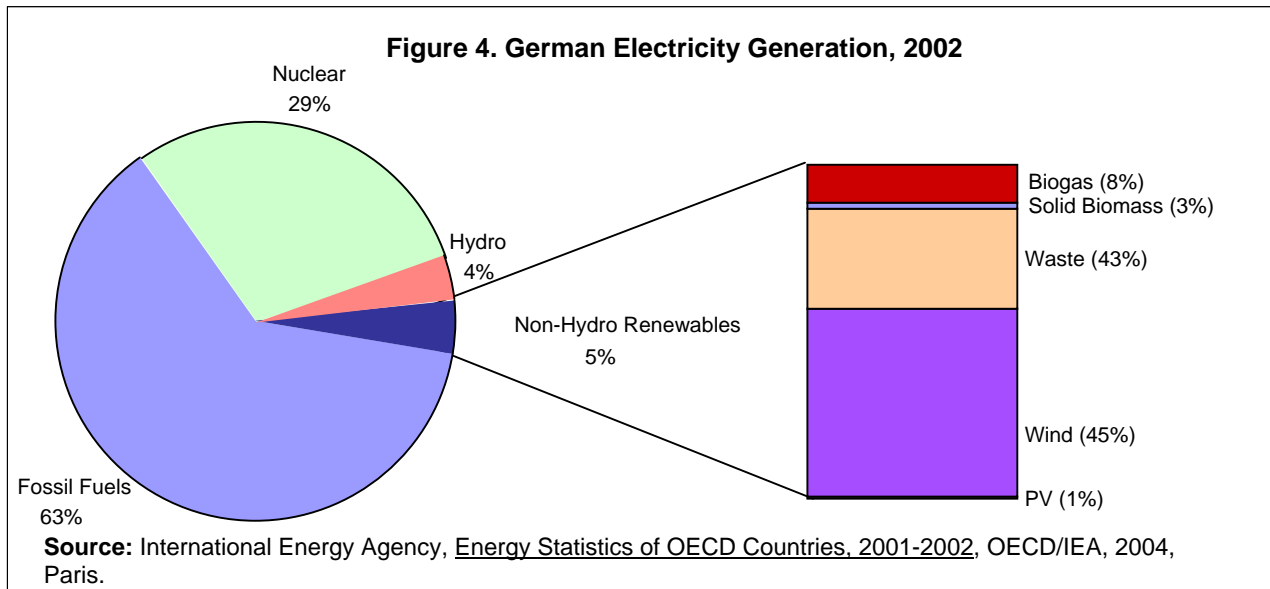
This chapter presents the renewable energy policies of four countries: Germany, Denmark, the Netherlands, and Japan, and compares them to similar policies in the United States.

3.1 Germany

3.1.1 Background

Germany⁴¹ has a population of 82 million in a land area slightly smaller than that of Montana.⁴² Although Germany's economy and electrical grid are smaller than those of the United States, it is one of the largest economies in the world. Non-hydro renewable power generation in Germany decreased over the period 1980 through 1987, declining from 5.2 billion kWh in 1980 to 3.8 billion kWh in 1987. After 1987, however, non-hydro renewable generation has consistently increased each year, regaining 1980 levels in 1991. Installed non-hydro renewable electricity generation capacity in Germany was very small until the early 1990s, when installation of wind turbines and solar panels began to increase. Between 1987 and 1997, German non-hydro renewable generation grew at about 10 percent per year to nearly 10 billion kWh. During this time, non-hydro renewable generation's installed capacity grew by a factor of 20, from less than 100 MW in 1987 to more than 2,000 MW in 1997.⁴³ Germany also has the most installed wind capacity in the world, with more than 14,500 MW at the end of 2003.⁴⁴

In 2002, Germany generated 72 billion kilowatt-hours of electricity, of which about 63 percent was from fossil fuels.⁴⁵ (See Figure 4.) Germany generated about 29 percent of its electricity from nuclear power, about 4 percent from hydropower, and about 5 percent from non-hydro renewable sources.⁴⁶ The contribution of renewables has increased since 2001, mainly due to windpower. Over 3,200 MW of wind capacity were added in 2002, followed by another 2,645 MW in 2003, bringing total installed capacity to 14,609 MW.⁴⁷



Germany became interested in spurring the growth of renewable energy in the 1970s during the energy crisis brought on by the high cost of imported oil. Germany used a variety of policies to reduce oil imports, including subsidizing domestic coal, increasing the import quota on coal, expanding nuclear generation, and increasing research and development for new energy

⁴¹ Throughout this section, "Germany" refers only to West Germany for dates before 1990, and to unified Germany for all dates thereafter.

⁴² Central Intelligence Agency, *The World Factbook 2004*, "Germany," <http://www.cia.gov/cia/publications/factbook/geos/gm.html#top>, accessed April 26, 2004.

⁴³ Capacity growth figures are based on data from IEA, 2003, *IEA Wind 2002 Annual Report*, Chapter 8: Germany, These figures differ from non-hydro renewable capacity data as listed by EIA, which can be found at <http://www.eia.doe.gov/pub/international/iealf/table64g.xls>.

⁴⁴ EWEA, "Wind Power Installed in Europe by End of 2003," http://www.ewea.org/documents/europe_windata_jan20041.pdf, accessed April 26, 2004.

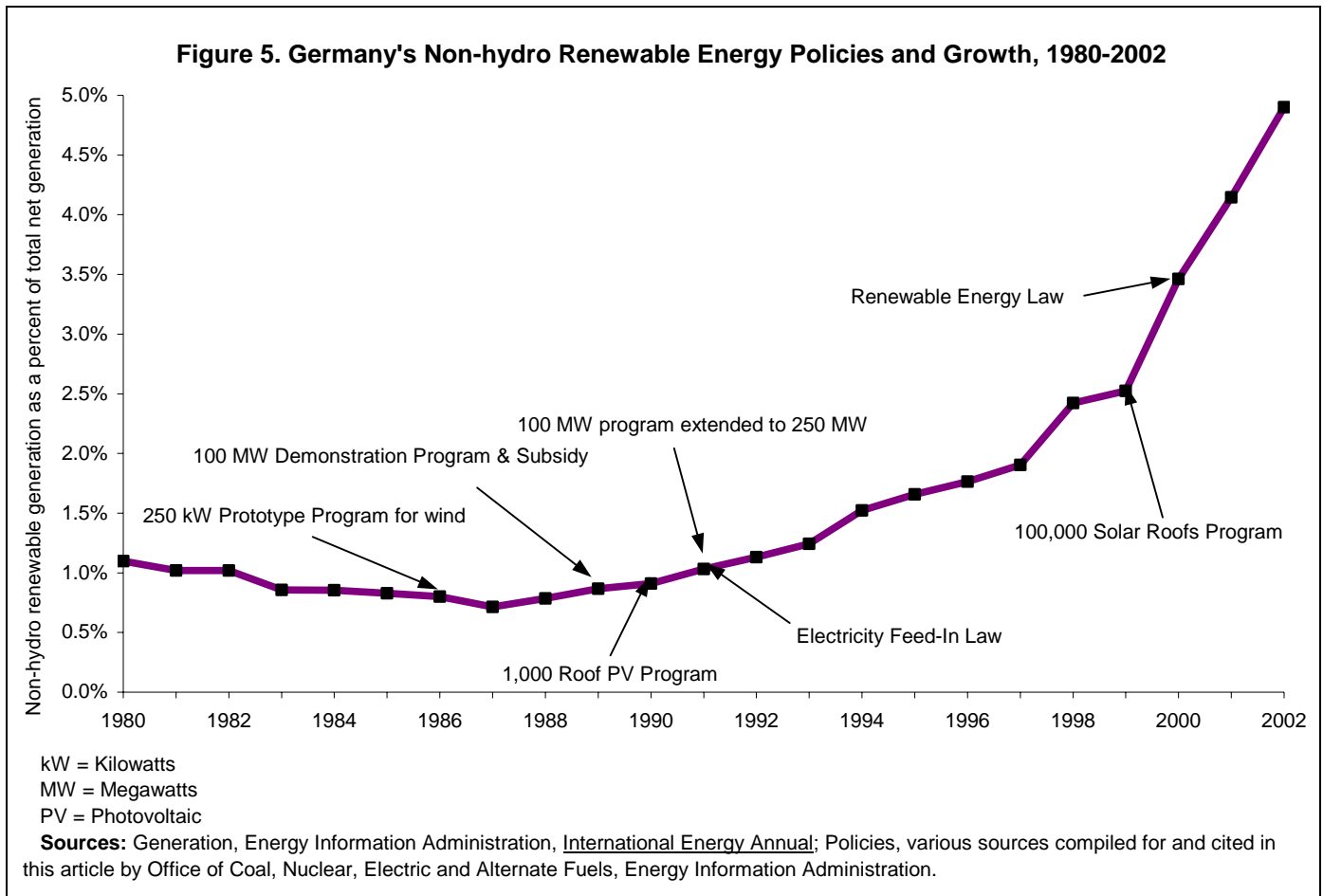
⁴⁵ International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

⁴⁶ Ibid.

⁴⁷ American Wind Energy Association, March 2004, "Global Wind Energy Market Report," <http://www.awea.org/pubs/documents/globalmarket2004.pdf>, accessed April 28, 2004.

technologies (mainly renewables).⁴⁸ (See Figure 5.) Although the development of renewable-generated power was initially driven by a desire to reduce dependence on foreign oil, current renewable energy policies are developed with the goal of reducing air pollution and carbon dioxide emissions. More recently, the German government announced its intentions to phase out nuclear power over the next 2 decades, a move that will probably continue to drive demand for renewable energy in the future.⁴⁹ Since 1998, the Green Party has been part of the ruling coalition in Germany and has had a major role in affecting the country's energy and environmental policies.⁵⁰

Germany and the United States enacted similar policies to promote the growth of renewable energy. However, Germany has surpassed U.S. installed wind capacity, despite the smaller size of the German grid. This section examines the similarities and differences between the United States and German approaches to renewable energy.



3.1.2 Research, Development, and Demonstration (1974-present)

Wind

Germany invests significant resources into the development of renewable energy. As in the United States, early R&D into wind turbines was completely government-funded and conducted by companies in the aerospace industry. From 1975 through 2000, Germany spent about \$215 million (1995 dollars) on R&D of wind turbine technology. Funding levels for wind R&D varied from year to year, peaking at more than \$28 million (1995 dollars) in 1980 and 1981 before declining and leveling off in the early 1990s at about \$6 million (1995 dollars) per year.⁵¹ While funding levels for wind R&D were higher in the United States,

⁴⁸ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 7A.

⁴⁹ International Energy Agency, 2002, *Energy Policies of IEA Countries: Germany*, Paris: OECD.

⁵⁰ Energy Information Administration website: <http://www.eia.doe.gov/emeu/cabs/germe.html#ENVIRO>, accessed June 23, 2004.

⁵¹ Ibid. Appendix 7b.

year-to-year R&D expenditures followed a similar path in the two countries, peaking in FY 1981, declining and leveling off over the next decade, and then increasing beginning in FY 1992.⁵²

Germany began the 250-kW Prototype Program for wind turbines in 1986. The program subsidized the first five turbines of a company after the prototype was constructed and tested.⁵³ Although more than 50 commercial wind turbines were installed under that program, costs remained too high for market conditions in Germany at the time. This was followed, in 1989, by the 100-MW Demonstration Program, which provided a subsidy of 0.08 Deutsche Marks (DM) per kWh (4.3 cents U.S.) for wind-generated electricity by turbines accepted into the program.⁵⁴ Participants could choose either this production subsidy, or a 60-percent capital investment grant for the cost of the facility.⁵⁵ Due to its popularity, this program was expanded in 1991 to the 250-MW Wind Program.⁵⁶ By mid-year 1991, more than 2,300 applications for a proposed capacity of 520 MW had been received, and by 1998 more than 350 MW of wind-generated electricity had come onto the national grid.⁵⁷ These latter programs, with their focus on large turbines, mirrored the wind energy efforts in the United States. Therefore, the wind R&D programs in the two countries were very similar in their funding patterns and their focus.

Photovoltaic

In 1990, the German government began the “1,000 Roof” program, which sought to move some of the government’s renewable energy focus away from R&D and towards demonstration projects.⁵⁸ Between 1991 and 1994, this program installed about 5.25 MW of PV panels and successfully field-tested the grid installation of more than 2,000 PV systems.⁵⁹ After 1994, many Federal States and municipalities became involved in advancing the development of PV panel systems. State and local incentive programs contributed to the installation of an additional 6 MW of solar photovoltaic capacity by 1999.⁶⁰

To further promote the development of PV power, Germany passed the 100,000 Solar Roofs Program in 1999. The program provides low-interest loans for PV systems. In combination with the Renewable Energy Law that was passed in 2000, the 100,000 Solar Roofs Program increased PV capacity from less than 50 MW installed in 1997 to about 400 MW installed by year-end 2003.⁶¹

3.1.3 Electricity Feed-In Law (1991) and Renewable Energy Law (2000)

Germany’s Electricity Feed-In Law, enacted in 1991, changed the market conditions for renewable electricity producers by obligating utilities to buy renewable electricity and by dictating the price that renewable electricity producers would receive for their power. Utilities were required to buy renewable power at 90 percent of the retail rate for electricity. This law did two important things for renewable electricity producers in Germany. First, it created a market for renewable electricity. Second, it guaranteed producers of renewable electricity a sustainable price high enough to cover their long-term costs. Both of these factors combined to make renewable electric generating capacity a better investment.

In many ways, PURPA is similar to Germany’s Feed-In Law. They both require utilities to purchase electricity from nonutility renewable producers, and they both define (if loosely, in the United States) the price at which the transaction will take place. A difference, however, is that in the United States, calculations of “avoided cost” tended to be lower and closer to market wholesale electricity rates than the higher fixed-price German utilities are required to pay to renewable electricity producers.⁶² This means that in Germany, where the price paid to producers of renewable energy was higher, new renewable technologies

⁵² Energy Information Administration website, Department of Energy Historical R&D Budget Fiscal Years 1978-1999: http://www.eia.doe.gov/cneaf/solar/renewables/rea_issues/reatabp1.html, accessed June 23, 2004.

⁵³ Sawin, Janet, “The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000,” PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 7A.

⁵⁴ Ibid. Conversion from DM to US currency based on historical exchange rates averaged over 1989 as found at FX History, <http://www.oanda.com/convert/fxhistory>, accessed April 22, 2004.

⁵⁵ Office of Technology Assessment, September 1995, *Renewing Our Energy Future*, OTA-ETI-614, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/year_f.html, accessed April 22, 2004.

⁵⁶ Gipe, Paul, 1999, “Latest Data from Germany’s 250 MW Measurement Program 1999,” Appeared in *WindStats* 12(4), <http://www.wind-works.org/articles/German250MW.html>. Accessed April 27, 2004.

⁵⁷ Office of Technology Assessment, September 1995, *Renewing Our Energy Future*, OTA-ETI-614, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/year_f.html, accessed April 22, 2004, Gipe, Paul, 1999, “Latest Data from Germany’s 250 MW Measurement Program 1999,” Appeared in *WindStats* 12(4), <http://www.wind-works.org/articles/German250MW.html>. Accessed April 27, 2004.

⁵⁸ Office of Technology Assessment, September 1995, *Renewing Our Energy Future*, OTA-ETI-614, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/year_f.html, accessed April 22, 2004.

⁵⁹ Weiss, Ingrid and Peter Sprau, 2002, “100,000 roofs and 99 Pfennig—Germany’s PV financing schemes and the market,” *Renewable Energy World* Jan-Feb 2002, http://www.jxj.com/magsandj/rew/2002_01/weiss.html, accessed April 27, 2004.

⁶⁰ Ibid., accessed April 27, 2004.

⁶¹ Stein, Christof, Presented March 8, 2004 at Photovoltaic Workshop in Rome, “The Experience of Germany on Photovoltaic Incentives,” Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, <http://www.elettronet.it/browse.asp?goto=455&livello=2&IdDocumento=21545&IdRevisione=28941>, accessed April 27, 2004.

⁶² Sawin, Janet, “The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000,” PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Chapter 8.

became competitive earlier. Additionally, while the buyback rate for renewable power in Germany was linked to future *retail* prices, in California, buyback rates for the first 10 years were linked to projections of future oil and natural gas prices. After 10 years, buyback rates reverted to actual costs, which were much lower, thereby decreasing the rates (premiums) paid to renewable power producers.

Another major difference between Germany's Feed-In Law and the U.S. PURPA is that the main purpose of the Feed-In Law was to promote the use of renewable resources, while the main purpose of PURPA was to promote energy efficiency. In the United States, before FERC interpreted the meaning of "avoided cost" in 1995, PURPA also promoted the development of renewables in States with favorable "avoided cost" calculations (like California). However, after FERC's interpretation of "avoided cost," the law became less favorable to renewable producers, but was still useful in its original purpose of promoting efficient nonutility electricity generation.

Since the U.S. net metering programs⁶³ obligate utilities to purchase renewable power, they can be compared to Germany's Feed-In Law. Although net metering allows consumers to sell excess electricity back to the grid, the policy is not analogous to Germany's energy policies, which obligate utilities to purchase renewable power from private producers, regardless of their size. The German law encourages much larger contributions to the grid from private renewable energy producers.

In 2000, Germany passed the Renewable Energy Law, which set specific prices that independent renewable power producers could receive for each type of renewable energy source, although for a limited amount of time. For instance, in 2000, a new wind turbine project would be paid 0.178 DM per kWh (U.S. 11 cents per kWh) for the first 5 years and then the rate would begin to fall. The decreasing nature of the prices is reflective of Germany's expectation that these projects would become increasingly cost-competitive. The buyback tariff rate for PV systems was €0.51 per kWh (U.S. 45 cents per kWh) and was set to decrease by 5 percent annually.^{64,65} Finally, this law also dictates that the costs of grid connection for renewables projects are the responsibility of the utility, which can pass on the costs to consumers.⁶⁶ This new law, while still dictating the buyback rates paid by utilities, can more precisely target each renewable energy technology with a buyback rate designed to further its growth. Since each technology's cost of generation differs, the support necessary to make it competitive in the market varies.

It is clear that while the German Feed-In Law had a significant positive effect on the development of renewable electricity generation in Germany, PURPA did not have a similar effect throughout the United States. While some States, including California, did manage to install new renewable electric generation capacity, PURPA was a necessary measure but not a sufficient incentive for investors to develop new renewable energy projects.⁶⁷

One reason that PURPA did not have a similar effect as Germany's Feed-In Law could be timing. The wind industry was significantly more developed, both in terms of technology and in terms of costs, in 1991 when Germany passed its Feed-In Law than in 1978 when PURPA was passed. Given that, subsequent development of wind turbines in the United States was undertaken with the relatively inefficient machines of the early 1980s, while post-Feed-In-Law wind turbines in Germany were both cheaper and more advanced. If the timing of PURPA versus Germany's Feed-In Law was the only consideration, one would have expected the U.S. market to begin to grow as technological advances in turbine designs brought costs down. However, even with the advances in turbine technology, PURPA did not begin to create the kind of market growth associated with the Feed-In Law in Germany until additional incentives (in the form of the U.S. Production Tax Credit, among others) were added in 1992.

3.2 Denmark

3.2.1 Background

Denmark is a small country compared with the United States, with a population of just 5.3 million spread over a land area about twice the size of Massachusetts (16,000 square miles).⁶⁸ Although it is interconnected with the larger European electric system, its own electric grid is small relative to that of the United States. Denmark generates about 18 percent of its electricity from renewable sources—the largest percentage in the world.

⁶³ Database for State Incentives for Renewable Energy, <http://www.dsireusa.org/glossary/glossary.cfm?&CurrentPageID=8#net>, accessed April 26, 2004.

⁶⁴ €denotes the symbol for the Euro, the basic unit of currency among participating European Union countries.

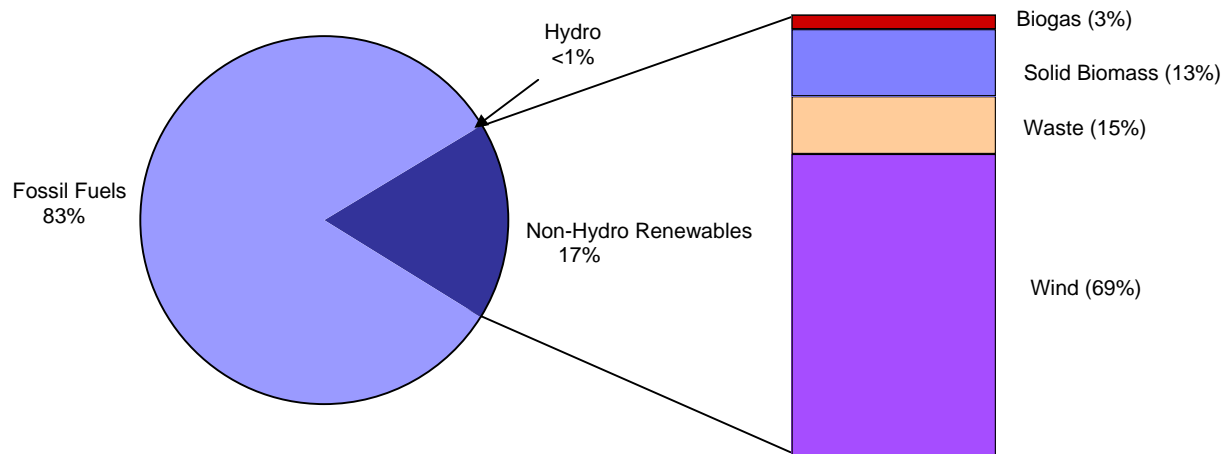
⁶⁵ Weiss, Ingrid and Peter Sprau. 2002. "100,000 roofs and 99 Pfennig—Germany's PV financing schemes and the market." *Renewable Energy World* Jan-Feb 2002, http://www.jxj.com/magsandj/rew/2002_01/weiss.html, accessed April 27, 2004.

⁶⁶ Sawin, Janet. "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000." PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University. September 2001. Appendix 7A.

⁶⁷ See discussion on California's Standard Offer Contracts in section 2.3.2 for more information about additional state-incentives that supplemented PURPA.

⁶⁸ Central Intelligence Agency, *The World Factbook 2004*, "Denmark," <http://www.cia.gov/cia/publications/factbook/geos/da.html#top>, accessed on April 19, 2004.

Figure 6. Danish Electricity Generation, 2002



Source: International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

In 2002, Denmark generated 39 billion kilowatt-hours of electricity, of which 83 percent was from fossil fuels.⁶⁹ (See Figure 6.) Denmark has less than 10 MW of hydropower capacity, so the remaining 17 percent is from other renewable energy sources, primarily wind.⁷⁰

Denmark began pursuing renewables as a source of energy in the mid-1970s as a response to high prices for oil imports. The program began with funding for research and development, but turned more toward developing the industry when, in 1979, the government began offering an investment subsidy for up to 30 percent of the cost of wind turbines, biogas digesters, and solar panels.⁷¹ Although reducing Denmark's dependence on foreign oil is still relevant, this has taken a back seat to measures enacted by Denmark to protect the environment. Particularly important has been the goal of reducing carbon dioxide emissions to comply with Denmark's commitments to the European Union (EU).

Since the 1970s, the Danish government has been consistent in passing and funding its renewable energy policies, thereby fostering an environment of relative certainty for developers. Two factors drive this consistency in policymaking. First, Danes have an environmental consensus that has led them to develop energy in what they consider to be a more sustainable manner. Second, the wind industry in Denmark developed with a system of cooperative ownership of turbines, which gives farmers and nearby landowners an interest in projects. Individuals or local cooperatives own about two-thirds of land-based wind turbines in Denmark.⁷² Cooperatives have reduced local opposition and generated a voting public with a stake in the wind industry.

Denmark pursued five main policies (in bold in Figure 7)⁷³ to encourage the development of renewable energy between 1975 and 2000. In addition to these policies, Denmark also made more general energy policy decisions, such as the 1985 decision not to pursue nuclear power, that have also had implications for the development of renewable energy in Denmark. This section will examine each policy and compare its provisions to similar policies in the United States.

⁶⁹ International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

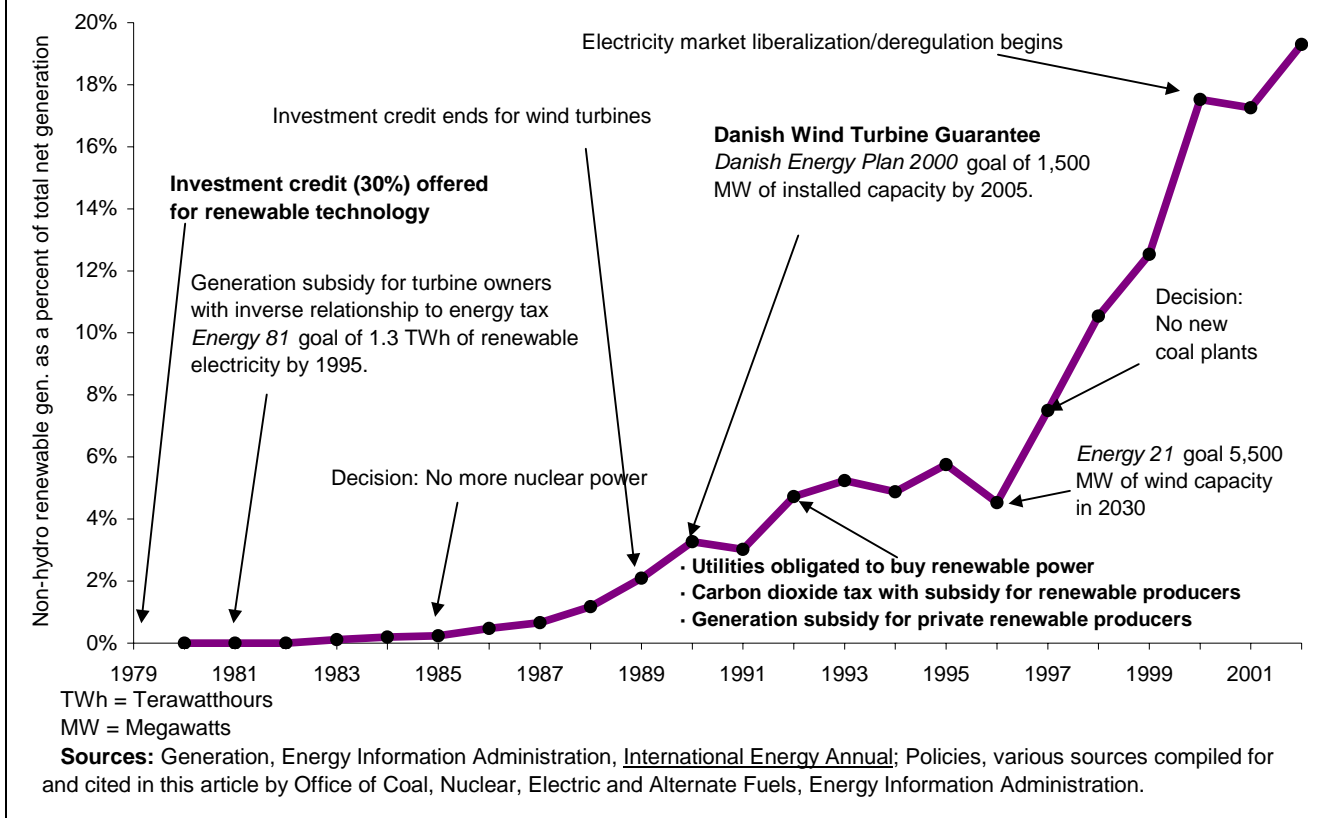
⁷⁰ Ibid.

⁷¹ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 6.

⁷² Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley & Sons, Inc: New York.

⁷³ Please note that the fluctuations in the graph between 1990 and 1996 are a reflection of dramatic swings in total net electric generation, not variability in non-hydro renewable generation, which consistently increased between 1990 and 1996.

Figure 7. Denmark's Non-hydro Renewable Energy Policies and Growth, 1979-2002



3.2.2 Investment Subsidy (1979-1989)

Denmark's investment subsidy allowed individuals to be reimbursed for capital costs of wind turbines, solar panels, and biogas digesters. The subsidy was available from 1979 to 1989 and declined gradually over that period from 30 percent to 10 percent.⁷⁴ In 1978, the United States enacted the Energy Tax Act of 1978, which provided a 10-percent tax credit for investment in wind, solar, geothermal, and ocean thermal technologies. This investment tax credit (ITC) changed over time, though the basic provisions remained the same. The U.S. ITC contributed to the California wind energy construction boom in the early 1980s, as favorable interpretation of PURPA's "avoided costs" combined with multiple Federal investment incentives to make wind energy a profitable investment. However, the nature of the ITC, while encouraging wind development, did not stimulate the development of the most efficient machines, and many wind turbines stood idle after construction was completed.

Another major difference between Denmark's investment subsidy and the U.S. ITC is that Denmark used a direct subsidy reimbursing a fixed percentage of the investment. Denmark's direct investment subsidy was successful in building its wind industry, while the United States' use of a tax credit did not result in new wind capacity, except in California. With a properly calibrated investment subsidy, investors develop renewable energy projects to promote renewable energy rather than to save money on taxes—a major factor in the level of commitment to the efficiency of wind turbine operation.⁷⁵ An example of tax credits that promote inefficient renewable projects is the combined Federal/California tax credit on wind projects in the early 1980s. The combined tax credit of nearly 50 percent of project cost caused many turbines to be erected that operated at very low capacity factors. As soon as the California contract price (Standard Offer 4) expired in the early 1990s, these projects shut down. Essentially, there were insufficient quality requirements for receipt of the ITC, or, the investment credits were set too high. That is, there was insufficient incentive to generate electricity.⁷⁶

⁷⁴ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 6.

⁷⁵ Ibid. Chapter 8.

⁷⁶ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Chapter 8.

3.2.3 Production Subsidy and other Direct Support Mechanisms (1981 and 1992)

In Denmark, the first production subsidy was introduced in 1981. It was designed to offset the energy tax for wind energy producers. In 1992, a flurry of legislation was passed which significantly benefited the wind industry. First, utilities became obligated to purchase renewable energy from private producers at a fixed price of between 70 percent and 85 percent of the retail price of electricity (a price higher than the wholesale price of privately-generated fossil fuel-fired electricity). Second, the 1981 energy tax was replaced by a carbon dioxide (CO₂)-based tax system and the original subsidy became a CO₂-related subsidy for all renewable energy technologies. The subsidy amounted to 0.10 Danish Kroner (DKK) per kWh (about 1.6 cents per kWh in 1992 or 1.2 cents per kWh in 2000) for both private producers and utilities. The net effect of this system is to increase the cost of CO₂-emitting generation, thereby reducing the relative cost of non-emitting renewable generation. Third, an additional production incentive was enacted for private producers of wind-generated electricity in 1992. This production incentive was an additional payment of 0.17 DKK per kWh (about 2.8 cents per kWh in 1992 or 2.1 cents per kWh in 2000). Thus, between the CO₂-related subsidy and the production incentive, private wind energy producers could expect 0.27 DKK per kWh (4.4 cents per kWh in 1992 or 3.3 cents per kWh in 2000) in addition to the guaranteed price paid by utilities.⁷⁷

Although in 1992 these three policies were enacted separately, it is impossible to attribute growth in wind capacity in Denmark to any individual policy. Taken together, however, their passage in 1992 probably strongly contributed to the 30-percent annual growth in wind capacity in Denmark between 1996 and 2001. Denmark's basic guaranteed pricing and utility purchase obligations are very similar to those enacted in Germany, but the additional incentives for renewable energy producers in Denmark help to make renewable technologies more economic.

The U.S. PTC/REPI system enacted under EPACT in 1992 differs from Denmark's production subsidy in a number of crucial ways. First, the PTC has had to be renewed by Congress periodically. The original law applied to facilities constructed between 1994 and 1999. After a brief expiration period, the PTC was renewed in 1999 for 2 years, and again in 2001 for 2 years, but the uncertainty about the future of the PTC is a major factor inhibiting consistent development. However, once a qualifying plant is built, the tax credit is certain for the next 10 years, even if eligibility for new plants expires. The REPI is subject to annual congressional appropriation, which has limited its effectiveness because public utilities cannot rely on revenue from REPI for financing renewables projects even for those plants that have already been built.⁷⁸

The REPI and the PTC have certainly succeeded in increasing the installed capacity of wind turbines in the United States, from less than 2,000 MW in 1994 when the program started, to more than 5,500 MW in 2003. However, the uncertain nature of the PTC has created a boom-and-bust cycle for wind development in the United States, as large amounts of capacity are built in the year prior to the expiration of the PTC, and virtually no capacity is built when the PTC is not available. By contrast, Denmark's production subsidy remained the same from 1992 through 2000 enabling more consistent growth, and some would argue, a stronger domestic wind industry. Some changes are expected in Denmark's subsidy regime with the new green-certificate trading program that began in 2003.

An additional difference between the U.S. PTC and Denmark's generation subsidy is that while Denmark's production subsidy is a direct payment, the U.S. PTC is a tax credit. Assuming the value of the direct subsidy (after taxes) and the tax credit are the same, the tax credit scheme will favor larger, more diverse businesses if the value of the tax credit is greater than the tax liability on eligible generation. For instance, if a wind operator gets paid 3 cents per kWh for the electricity produced, pays taxes at a 33-percent rate (1 cent), and is eligible for a 1.8-cent-per-kWh tax credit, the amount of the tax credit exceeds the operator's tax liability by 0.8 cents per kWh. But if the company is more diverse and is taxed on additional income from other sources, then the company is in a position to take advantage of the full tax credit.⁷⁹ In this way, the U.S. PTC puts smaller companies at a disadvantage. Denmark's generation subsidy did not have the same effect of favoring larger, more diverse companies. In fact, most wind turbines in Denmark are owned by small cooperatives. Also, contributing to local ownership were very favorable feed-in tariffs (rate paid for electricity going into the grid) and the availability of flexible financing terms provided by Danish banks.⁸⁰

3.2.4 Domestic Market Support (1990-2000)

In 1990, the Danish Wind Turbine Guarantee established government-guaranteed long term financing of large wind projects that used Danish-made turbines. The program significantly reduced the financial risk of building large wind projects with Danish

⁷⁷ Ibid. Appendix 6.

⁷⁸ Bird, L.; Parsons, B.; Gagliano, T.; Brown, M.; Wiser, R.; Bolinger M., July 2003, "Technical Report: Policies and Market Factors Driving Wind Power Development in the United States," National Renewable Energy Laboratory, NREL/TP-620-34599.

⁷⁹ Namovicz, Chris, Office Integrated Analysis and Forecasting, Energy Information Administration, May 13, 2004, Personal Communication.

⁸⁰ Cohen, Joseph M. and Wind, Thomas A., February 2001, "Distributed Wind Power Assessment," National Wind Coordinating Committee, http://www.nationalwind.org/pubs/distributed/distributed_wind.pdf, accessed November 19, 2004

turbines and thereby encouraged local manufacturing of wind turbines and turbine components.⁸¹ Danish companies manufactured almost all of the wind turbine capacity installed in Denmark.⁸²

In 1994, the government issued a directive to municipalities requiring them to plan for future wind turbine siting, although the directive did not create installation quotas for municipalities.⁸³ At the same time, the Danish government sought to reduce the public's resistance to wind turbines by subsidizing the removal of older, inefficient, or loud turbines with new machines. Finally, in 1994 and again in 1996, Parliament reduced the restrictions on which individuals can be in a wind turbine cooperative. The restrictions were originally designed to encourage many individuals to buy small shares in wind cooperatives in their neighborhoods. The loosening of the regulations reflected investors' desires to own more shares in cooperatives throughout Denmark. By 1996, Danish adults could own shares in wind cooperatives of up to 30,000 kWh.

After a slight decrease in non-hydro renewable capacity between 1990 and 1991, modest steady growth in both non-hydro renewable capacity and generation continued until 1996. Generation increased from 1 billion kWh in 1991 to 2.3 billion kWh in 1996 with a corresponding increase in capacity from 343 MW to 619 MW.⁸⁴ After 1996, however, the industry grew much more rapidly—at more than 30 percent per year—until at least 2002. During this period of rapid growth, no major new policies came into force, and the growth is probably due to the industry taking advantage of the incentives initiated in the early 1990s.

In the late-1990s, Denmark revealed a new energy strategy called *Energy 21*, which affirmed the 1996 targets for both carbon dioxide and wind generation capacity, but also set targets on a longer planning horizon for 2030. By 2030, Denmark wants 5,500 MW of wind generation capacity with 4,000 MW being offshore. This target corresponds to 50 percent of total Danish electricity demand in 2030. As of year-end 2003, wind energy supplied 21 percent of the Danish electricity demand.

Since 2000, Denmark has begun to turn away from guaranteed pricing and has introduced tradable green electricity certificates. Their new goal is to create a market for green power via these certificates, though the policy has not been in place long enough to evaluate the efficacy of the scheme.

The dominance of Danish turbine manufacturers continues. In 2002, the two largest manufacturers of wind turbines worldwide were Vestas and NEG Micron, both Danish companies. Together they accounted for 36 percent of the new installations globally in 2002 and had a total accumulated installed capacity of 12,131 MW.⁸⁵ Early data indicate that the two Danish companies combined for 32 percent of new installations globally in 2003.⁸⁶ Vestas and NEG Micron announced a merger in late-2003 and will continue to be major players in the world wind turbine market.⁸⁷ Another important factor in the development of the Danish wind industry was the consistent domestic market for wind turbines throughout the 1980s and 1990s.⁸⁸ Taken together, all this information suggests the policies pursued by Denmark nurtured the Danish wind industry and created companies with the ability to be dominant players in the world turbine market.

Although this program seems successful for Denmark, replication elsewhere might be difficult. The program was initially promulgated in 1990, prior to the formation of the EU. The EU determined that the Danish Wind Turbine Guarantee program created unfair competition and the scheme is no longer available within the EU.⁸⁹

3.3 The Netherlands

3.3.1 Background

The Netherlands is a small, low-lying country in northern Europe with a population of 16 million in an area about twice the size of New Jersey.⁹⁰ The Netherlands generated about 96 billion kWh of electricity in 2002, about 88 percent of which came from fossil fuel sources, with nuclear accounting for about 4 percent and non-hydro renewables accounting for about 8 percent.⁹¹ (See

⁸¹ Office of Technology Assessment, September 1995, *Renewing Our Energy Future*, OTA-ETI-614, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/year_f.html, accessed April 22, 2004.

⁸² Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Chapter 8.

⁸³ Auken, Svend, Winter/Spring 2002, "ISSUES AND POLICY: Answers in the Wind: How Denmark Became a World Pioneer in Wind Power," *Fletcher Forum on World Affairs*, 26(149).

⁸⁴ Energy Information Administration, <http://www.eia.doe.gov>. Accessed April 20, 2004.

⁸⁵ BTM Consult ApS, March 2003, *International Wind Energy Development World Market Update 2002 with Forecast 2003-2007*, Ringkøbing, Denmark.

⁸⁶ BTM Consult ApS, March 2004 Press Release, *International Wind Energy Development World Market Update 2003 with Forecast 2004-2008*, Ringkøbing, Denmark, <http://www.btm.dk/documents/pressrelease.pdf>, accessed April 22, 2004.

⁸⁷ Møller, Torgny, January 2004, "Danish wind giants head for merger," *Windpower Monthly*, 20(1).

⁸⁸ Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley & Sons, Inc: New York, P57.

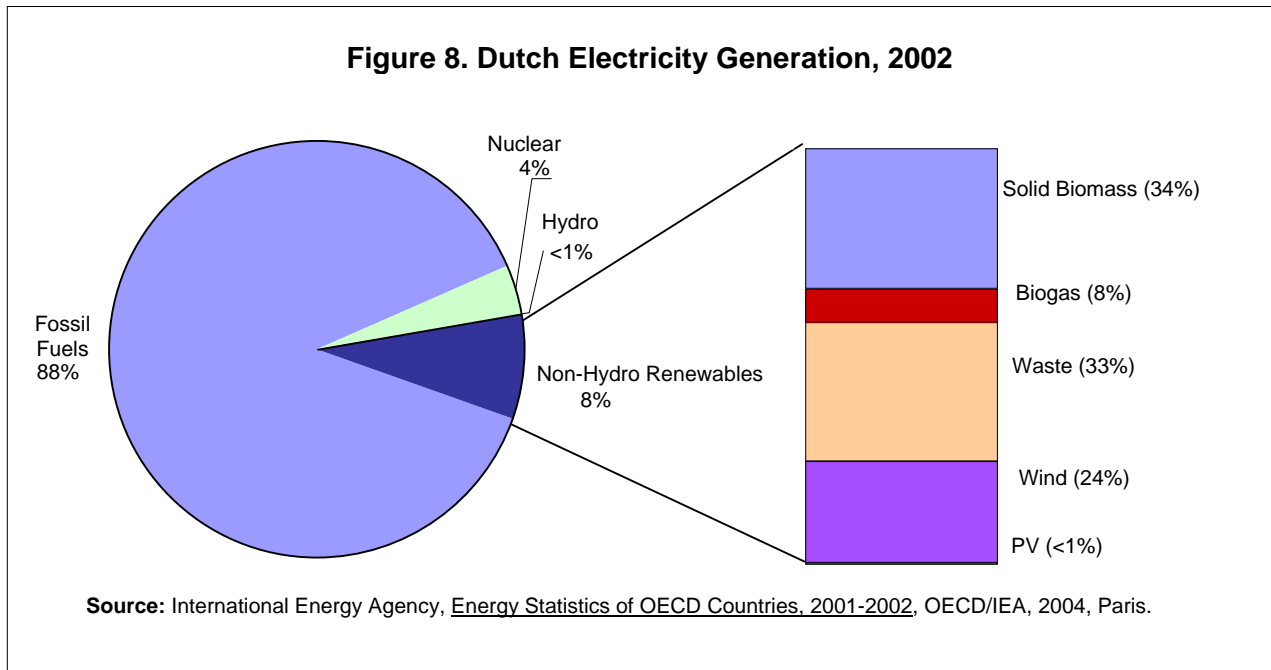
⁸⁹ Office of Technology Assessment, September 1995, *Renewing Our Energy Future*, OTA-ETI-614, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/year_f.html, accessed April 22, 2004.

⁹⁰ Central Intelligence Agency, *The World Factbook 2004*, "The Netherlands," <http://www.cia.gov/cia/publications/factbook/geos/da.html#top>, accessed May 3, 2004.

⁹¹ International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

Figure 8.) The Netherlands gets a greater percentage of its non-hydro renewable electricity from biomass and waste incineration than any other country in the EU.⁹² Wind accounts for about 24 percent of non-hydro renewable energy, and solar photovoltaics for less than one percent.

The Dutch began encouraging the development of renewable electric generating capacity in the 1970s as a response to the oil crises. In the early 1980s, concern over environmental issues such as ozone and local air pollution continued to advance the renewables sector. In the late 1980s, the Dutch government became concerned about climate change, particularly important for the Netherlands given its low elevation.



Research into wind energy began in 1976 with the start of the National Wind Energy Research Program (NWER). A national solar energy research program began in 1978 with funding for solar thermal energy; funding for solar photovoltaics began in the 1980s. Biomass and waste also figure prominently in the country's renewable energy mix. The biomass industry benefits from subsidies to the agricultural sector and from its role in reducing sulfur dioxide (SO₂) and CO₂ emissions. Also, the country has significant quantities of wood waste, straw, and verge grass available. Bioenergy research programs began in 1990. These included research into co-combustion (co-firing), gasification, pyrolysis, waste-to-energy, landfill gas technology and utilization, biogas wastewater treatment, digestion of green waste, bioethanol production and energy crops.

In 1981, the NWER was superseded by a second wind energy R&D program, which conducted demonstration projects as well as basic research.⁹³ The focus of both these programs was large-scale wind turbines and wind farms, similar to the early focus of R&D efforts in the United States and Germany.

A striking feature of Dutch renewable energy policy has been its use of national planning to guide industry and business. The Dutch developed three national plans between 1980 and 1997, and these plans have included energy efficiency standards for buildings, increased use of combined heat and power, and accelerated development of renewable energy. The most recent plans have also included targets for addressing climate change, and the 1997 Action Programme for Renewable Energy sets targets of meeting 5 percent and 10 percent of the nation's total energy demand with renewable sources in 2010 and 2020, respectively. The use of national plans has provided a context within which industry, business, and government can work to achieve broad policy goals.⁹⁴

3.3.2 Investment Subsidies (1986 and 1991)

The Netherlands progressed from basic R&D to demonstration projects relatively quickly between the late 1970s and 1981. As in the United States and Germany, the early focus of the R&D program in the Netherlands was on large-scale turbine technology. The first major programs to support the development of the wind industry were the investment subsidies offered under the Integrated Programme for Wind Energy (IPW) begun in 1986 and the Application of Wind Energy in the Netherlands

⁹² International Energy Agency, *Renewables Information, 2003*, OECD: Paris.

⁹³ Wolsink, Maarten, 1996, "Dutch Wind Power Policy: Stagnating Implementation of Renewables," *Energy Policy* 24(12): 1079-1088.

⁹⁴ Moore, Curtis and Jack Ihle, 1999, "Renewable Energy Policy Outside the United States," Renewable Energy Policy Project, http://solstice.crest.org/repp_pubs/articles/issuebr14/, accessed May 3, 2004.

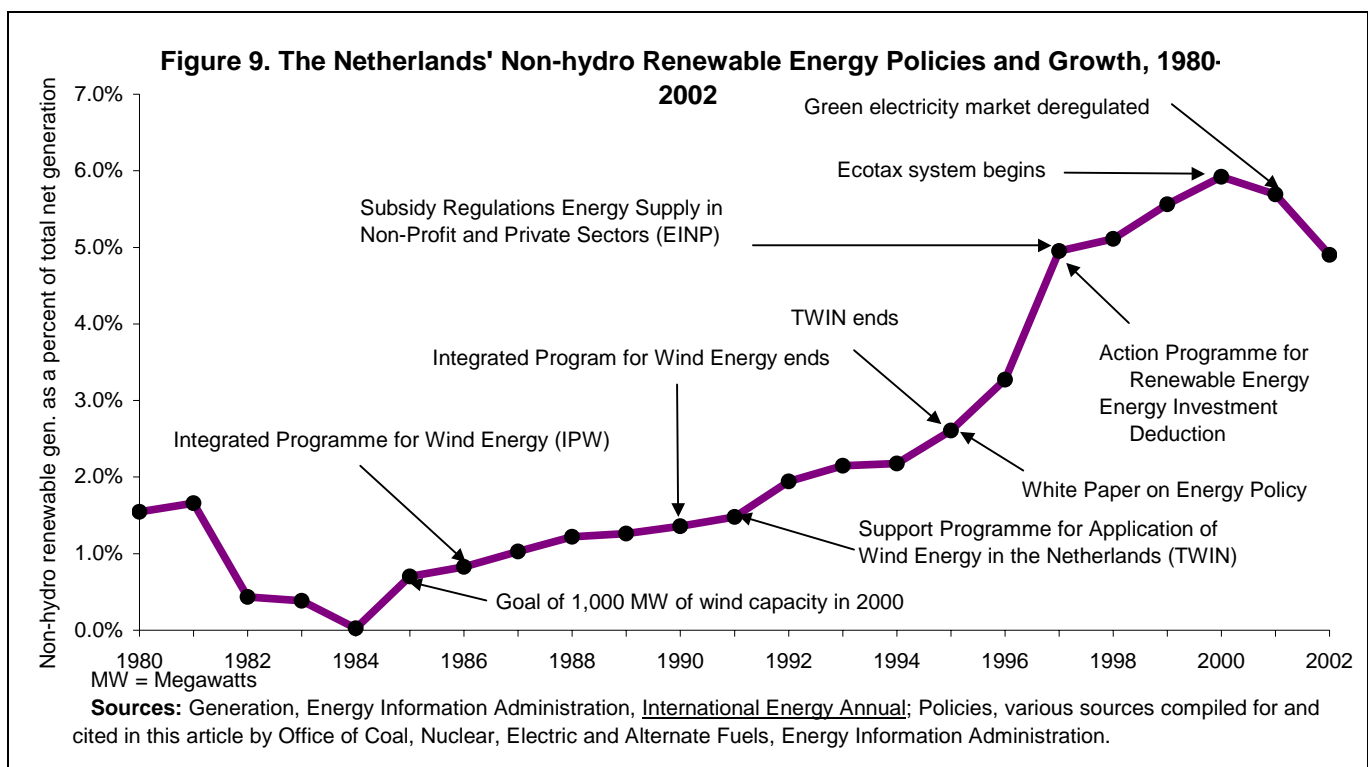
(TWIN) program begun in 1991 (Figure 9). These programs were similar, each offering two kinds of subsidies. The first subsidy, covering 35-40 percent of the cost of the turbines is similar to investment subsidies offered in the United States (1980s) and Denmark (1979-1989).⁹⁵

The second subsidy, offered for turbines that met stringent noise requirements, was designed to encourage turbine manufacturers to develop turbines that would be more acceptable to the public. The second subsidy also tried to reduce siting difficulties by offering incentives to site wind projects in unpopulated areas. Denmark has a different kind of program that is also trying to reduce public opposition to wind turbines. Denmark's program subsidizes the investment required to replace old wind turbines with newer, more efficient models. Between 1986 and 1990, the installed non-hydro renewable capacity in the Netherlands increased sixteen-fold from 3MW to 48MW.⁹⁶ Although the United States has invested money in R&D to make wind turbines more efficient, the government has not promoted policies that would reduce public opposition to wind turbines in local areas.

3.3.3 Windplan

The Netherlands, like the United States, relied on voluntary programs as much as possible. One example of a voluntary program in the Netherlands was the utilities' creation of Environmental Action Plans (MAPs), which specified how utilities would reduce CO₂ emissions in the mid-1990s. One part of the MAPs, Windplan, is similar to the German 100MW wind program begun in 1989. However, while the mandatory program in Germany was successful in installing more than 300 MW of wind capacity, the plan in the Netherlands did not even install 100 MW. This is partly due to the voluntary nature of Windplan, but was also related to the turbine specifications that Dutch utilities demanded manufacturers meet to participate in Windplan. The specifications were awkward and difficult to produce, and the turbines themselves were less efficient than other models. This both undermined Windplan and reduced the ability of Dutch wind turbine manufacturers to compete in the world market.⁹⁷

Another barrier to the installation of wind capacity in the Netherlands has been the planning period and the number of permits required. Whereas in Denmark and Germany, the national government could persuade local authorities to install windpower, in



the Netherlands the planning and siting processes lie entirely within the purview of municipalities. For their part, the municipalities require numerous environmental and building permits and encourage consensus-based decision making, which

⁹⁵ Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley & Sons, Inc: New York.

⁹⁶ Energy Information Administration, <http://www.eia.doe.gov/pub/international/iealf/table64g.xls>, accessed May 3, 2004.

⁹⁷ Johnson, Anna; and Staffan Jacobsson, "The Emergence of a Growth Industry: A Competitive Analysis of the German, Dutch and Swedish Wind Turbine Industries." Paper presented at the Winter 2002 Danish Research Unit for Industrial Dynamics Conference, Aalborg, Denmark, January 17-19, 2002, <http://www.druid.dk/conferences/winter2002/gallery/jacobsson.pdf>, accessed April 26, 2004.

increases planning time and often kills projects altogether.⁹⁸ The multi-layered permitting processes in the United States are more similar to those of the Netherlands than those of Denmark and Germany. In the United States, local municipalities have zoning control, power producers are regulated by the States and, if a facility is to be located on Federal lands, there are Federal permitting issues as well.

3.3.4 Demand-Pull Ecotax System

The Netherlands' more recent ecotax system is unlike policies used in the United States. It pursues a demand-pull approach to encouraging consumers to buy renewable energy. In contrast, the United States favors supply-push systems such as R&D (Federal) and renewable portfolio standards (numerous States). The Dutch ecotax system, also called the regulatory energy tax, has two components. First, producers of green power receive a production subsidy. Additionally, households are exempt from the ecotax for all green power purchases. In some areas of the Netherlands, these two incentives combine to make green power cheaper than fossil alternatives, while in other areas, fossil-generated power is still more economic.⁹⁹

As a response to these measures, the demand for green electricity from small consumers (such as households) has increased from a few thousand households in 1998 to about 1 million households in July 2002.¹⁰⁰ Demand for renewable energy has outstripped supply, however, and the Netherlands has been importing green electricity since 2000.¹⁰¹ In 2001, the Netherlands introduced a system of green certificates to authenticate imported renewable electricity.

3.4 Japan

3.4.1 Background

Japan is an island nation of about 127 million people living in a land area slightly smaller than California.¹⁰² Japan generated 1,097 billion kWh of electricity in 2002, of which 71 percent was generated from fossil fuels, 21 percent from nuclear power plants, 6 percent from hydropower and 2 percent from non-hydro renewables.¹⁰³ (See Figure 10.) Waste and biomass dominated electricity production from non-hydro renewables, though Japan also got electricity from geothermal, solar, and wind sources as well.

As with Germany, Denmark, and the Netherlands, Japan became interested in renewable energy during the energy crises of the 1970s. In 1973, Japan used oil to supply 76 percent of its energy needs. This dependence had declined to 68 percent by the late-1980s.¹⁰⁴ Japan's reaction to the energy crisis was to work towards securing stable oil supplies, promote the development of nuclear power and renewable energy sources, and encourage energy conservation.¹⁰⁵

In 1997, Japan hosted the Third Conference of the Parties to the United Nations Framework Convention on Climate Change. During this meeting, the Conference negotiated the Kyoto Protocol, the implementation mechanism of the Climate Change Convention. Japan ratified the Protocol and has agreed to reduce its CO₂ emissions to 6 percent less than 1990 levels by 2012. While Japan's initial interest in renewable energy was fueled by energy supply and security concerns, environmental considerations, including climate change, have continued to drive policies in recent years.

⁹⁸ Reiche, Danyel and Mischa Bechberger, 2004, "Policy Differences in the Promotion of Renewable Energies in the EU Member States," *Energy Policy* 32:843-849, Junginger, M.; Agterbosch, S.; Faaij, A.; and W., Turkenburg, 2004, "Renewable Electricity in the Netherlands," *Energy Policy* 32:1053-1073.

⁹⁹ Ibid.

¹⁰⁰ Junginger, M.; Agterbosch, S.; Faaij, A.; and Turkenburg W., 2004, "Renewable Electricity in the Netherlands," *Energy Policy* 32:1053-1073.

¹⁰¹ Reijnders, L., 2002, "Imports as a major complication: liberalization of the green electricity market in the Netherlands," *Energy Policy* 30:723-726.

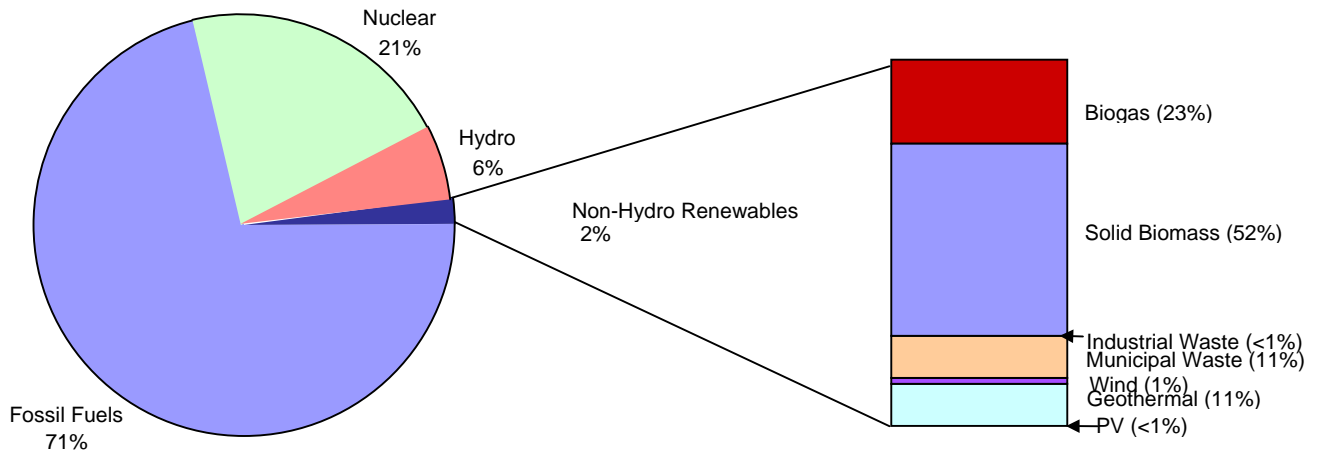
¹⁰² Central Intelligence Agency, *The World Factbook 2004*, "Japan," <http://www.cia.gov/cia/publications/factbook/geos/ja.html#top>, accessed June 9, 2004.

¹⁰³ International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

¹⁰⁴ Kamata, Yoshiro, August/September 1989, "The Energy Situation and Energy Policy in Japan," *Revue de L'energie*, 40: 692-702.

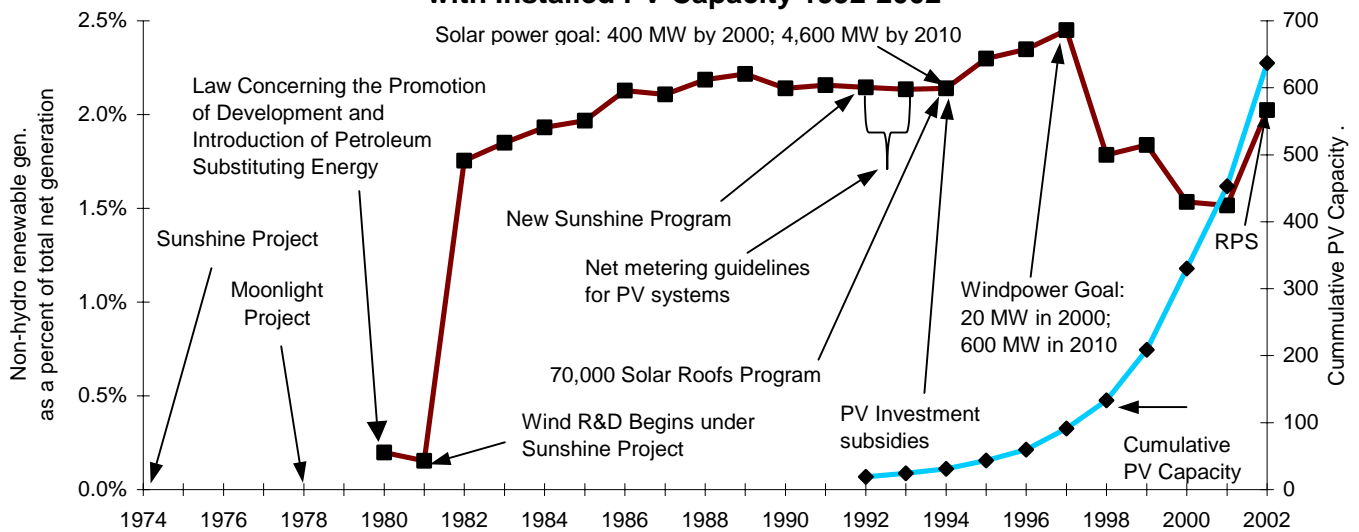
¹⁰⁵ Ibid.

Figure 10. Japanese Electricity Generation, 2002



Source: International Energy Agency, *Energy Statistics of OECD Countries, 2001-2002*, OECD/IEA, 2004, Paris.

Figure 11. Japan's Non-hydro Renewable Energy Policies & Growth, 1974-2002, with Installed PV Capacity 1992-2002



PV = Photovoltaics
 MW = Megawatts
 R&D = Research and Development
 RPS = Renewable Portfolio Standard

Sources: Generation, Energy Information Administration, *International Energy Annual: Policies*, various sources compiled for and cited in this article by Office of Coal, Nuclear, Electric and Alternative Fuels, Energy Information Administration. Installed PV Capacity, *International Energy Annual, IEA PV Technology Status and Prospects Annual Report 2002*, Paris, France.

3.4.2 Policies

Japan's support of renewable energy began in 1974 with the Sunshine Project (Figure 11), a program meant to develop alternative energy resources (including solar, geothermal, coal gasification/liquefaction, and hydrogen) through R&D efforts.¹⁰⁶ Solar energy efforts focused initially on solar thermal applications rather than photovoltaics, but after 1980, Japan began to fund more R&D for PV.¹⁰⁷ The Moonlight Project, targeting R&D for technologies promoting energy efficiency began in 1978. Together these two projects oversaw R&D programs that did basic and applied research undertaken cooperatively by government, industry, and academia.¹⁰⁸

In 1980, Japan passed the Law Concerning the Promotion of Development and Introduction of Petroleum Substituting Energy, which charged the government with adopting guidelines for the use of alternative energy sources and technologies and fiscal measures to encourage their development.¹⁰⁹ The law also created the New Energy Industrial Technology Development Organization (NEDO) which was established to promote the development of new, non-petroleum sources of energy.¹¹⁰

In 1981, NEDO began conducting wind R&D under the auspices of the Sunshine Project. Between 1981 and 1986, the R&D program successfully developed a 100 kW pilot wind plant and conducted research on materials, reliability, control properties, power generation, and the potential impacts of wind-generated electricity on power grids. In 1986, the focus of R&D shifted to larger, MW-sized machines. The 1990s were characterized by a series of demonstration projects and further research, particularly into interconnection and grid stability issues.¹¹¹ In the mid-1990s, the Ministry of International Trade and Industry (MITI) articulated a goal of 20 MW of installed wind capacity by 2000, and 600 MW by 2010.¹¹² By the end of 2003, windpower capacity in Japan was just over 500 MW.¹¹³

In 1992, the government introduced the New Sunshine Program to further support alternative sources of electricity. This program combined the R&D efforts of the Moonlight Project and the original Sunshine project together into one program. To encourage the development of grid-connected, distributed generation, the government passed laws in 1992 and 1993 that established the basic rules of net metering, setting the buy-back price of electricity equal to the retail selling price of electricity.¹¹⁴

In May 2002, Japan instituted an RPS, the "Law on Special Measures for the Utilization of New Energy, etc." This law, passed to ensure energy security and curb global warming, promotes the use of solar, wind, biomass, geothermal, and small hydro (less than 1,000 kW). This measure allows power companies to meet their obligations by producing power from new generation sources, purchasing allowable generation from others, or trading with other power companies via a renewable energy certificate trading system. Eight-year goals are to be re-evaluated and set every 4 years.¹¹⁵

Photovoltaic

Japan's success throughout the 1990s in encouraging the development of a market for photovoltaic technology is remarkable. In 1992, the country had an installed PV capacity of less than 19 MW. By the end of 2002, installed capacity increased to 635 MW.¹¹⁶ The growth in PV was driven by four actions on the part of the Japanese government, all taken between 1992 and 1994. First, the government provided net metering guidelines to dictate how distributed PV generation would be hooked up to the national electricity grid. Second, the government set an ambitious goal for the development of 4,600 MW of PV by 2010. Third, the government introduced subsidies to support the installation of PV technology. Finally, the government established the 70,000 Solar Roofs Program to encourage residential use of PV and to inform people about the benefits of using PV technology.

The government subsidies for PV began in 1994, with a program called the Residential Monitoring Photovoltaic Power Generating Systems, which provided subsidies for installation of PV systems if the installer collected data about user needs and

¹⁰⁶ Kurokawa, Kosuke, 1996, "An Overview of System Technology in Japan," *Renewable Energy*, 8:480-484.

¹⁰⁷ Watanabe, Chihiro, 1995, "Identification of the Role of Renewable Energy: A View from Japan's Challenge: The New Sunshine Program," *Renewable Energy*, 6:237-274.

¹⁰⁸ Tatsuta, M., 1996, "New Sunrise Project and New Trend of PV R&D Program in Japan," *Renewable Energy*, 8:40-43.

¹⁰⁹ Fukasaku, Yukiko, 1995, "Energy and Environment Policy Integration: The Case of Energy Conservation Policies and Technologies in Japan," *Energy Policy*, 23(12):1063-1076.

¹¹⁰ Kamata, Yoshiro, August/September 1989, "The Energy Situation and Energy Policy in Japan," *Revue de L'energie*, 40: 692-702.

¹¹¹ Ushiyama, Izumi, 1999, "Wind Energy Activities in Japan," *Renewable Energy*, 16:811-816.

¹¹² Ushiyama, Izumi, 1999, "Renewable Energy Strategy in Japan," *Renewable Energy*, 16:1174-1179.

¹¹³ International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 12: Japan.

¹¹⁴ Kurokawa, Kosuke, 1996, "An Overview of System Technology in Japan," *Renewable Energy*, 8:480-484, International Energy Agency, 2003, *IEA Photovoltaic Power Systems Programme Annual Report*, "Japan: PV technology status and prospects," <http://www.oja-services.nl/iea-pvps/ar02/index.htm>.

¹¹⁵ "Development Trends in and Promotional Measures for Renewable Energy, Part 1," (Draft Translation) The Institute of Energy Economics, Japan, Summer 2004

¹¹⁶ International Energy Agency, 2003, *IEA Photovoltaic Power Systems Programme Annual Report*, "Japan: PV technology status and prospects," <http://www.oja-services.nl/iea-pvps/ar02/index.htm>, accessed May 27, 2004.

efficiency.¹¹⁷ This program was renewed in 1997 and renamed the Residential PV System Dissemination Programme. The goal of both these programs was to reduce the cost of installing PV systems by subsidizing the installation costs of residential systems.¹¹⁸ The subsidies were available for homeowners installing their own PV systems, for suppliers of ready-built houses, and for public organizations to introduce systems into public buildings.¹¹⁹ Finally, there was also a subsidy for connecting PV systems to low voltage lines on the power grid. Over the course of the program, the subsidies decreased as the economics of PV systems became more favorable. Between 1994 and 2000, PV systems were installed in more than 50,000 houses.¹²⁰

The net metering guidelines in Japan are similar to those in California and many other states. However, while Japan chooses to subsidize grid connection for PV systems, California's net metering laws make connection the responsibility of the utilities. Both California and Japan offer subsidies for the initial investment/installation costs of PV systems, a factor which has made the systems more economically favorable.

¹¹⁷ Kuwano, Yukinori, 1998, "Progress of Photovoltaic System for Houses and Buildings in Japan," *Renewable Energy*, 15:535-540.

¹¹⁸ International Energy Agency, 2003, *IEA Photovoltaic Power Systems Programme Annual Report*, "Japan: PV technology status and prospects," <http://www.oja-services.nl/iea-pvps/ar02/index.htm>, accessed May 27, 2004.

¹¹⁹ Ibid.

¹²⁰ Ibid.

3.5 Comparison of Policies to Promote Non-hydro Renewable Energy

Table 2 provides a summary comparison of the non-hydro renewable energy policies and incentives discussed in this chapter to similar policies in the United States, which were discussed in Chapter 2.

Table 2. Summary Comparison of Countries' Non-hydro Renewable Energy Policies and Incentives

Country	Provisions	United States Analogy	Differences
Germany Research and Development (1974-Present)	Early R&D conducted by firms in the aerospace industry and was focused on large turbines (larger than 1MW), which were perceived as having the best chance of becoming marketable.	R&D program also initially contracted with companies from the aerospace industry and focused on large-scale turbine technology	
Germany Electricity Feed-In Law (1991) & Renewable Energy Law (2000)	<ul style="list-style-type: none"> Obligated utilities to buy power from renewables producers Purchase price for power was 90% of the retail rate 	PURPA <ul style="list-style-type: none"> Required utilities to buy power from renewables producers Purchase price for power was at utilities "avoided cost," which was defined by the states 	<ul style="list-style-type: none"> German renewable energy producers received higher rates than United States producers Germany linked rates to retail prices while California rates were linked to (high) projections of "avoided cost"
Denmark Investment Subsidy (1979-1989)	<ul style="list-style-type: none"> 30% capital grant to individuals who installed wind turbines, solar panels or biogas digesters Wind turbines designs had to be approved by Riso Test Station to be eligible 	1978 Energy Tax Act <ul style="list-style-type: none"> 10% tax credit for business investments in wind, solar, geothermal, and ocean thermal Extended to 1985 and then again to 1988 	<ul style="list-style-type: none"> Denmark's incentive is a grant but the United States incentive is a tax credit No approvals required for any technologies that received tax credits under the United States Program
Denmark Production Subsidy & other support mechanisms (1981 & 1992)	<ul style="list-style-type: none"> Production subsidy offsets energy tax (later CO₂ tax) for wind energy producers Additional production incentive for private renewable energy producers Law obligated utilities to buy power from renewables producers Law set utilities' purchase price for power at 85% of the retail rate 	PURPA <ul style="list-style-type: none"> Required utilities to buy power from renewables producers Purchase price for power was at utilities "avoided cost," which was defined by the states PTC (from 1992 EPACT) <ul style="list-style-type: none"> Production incentive for private energy producers Must be renewed periodically by Congress 	<ul style="list-style-type: none"> Danish renewable energy producers received higher rates from utilities than United States producers under PURPA The Danish production incentive was higher than the United States PTC Denmark's production incentive is a grant but the United States incentive is a tax credit Denmark's production incentive is not subject to periodic renewals.
Denmark Domestic Market Support (1990)	<ul style="list-style-type: none"> Government-guaranteed long term financing of large wind projects that used Danish-made turbines Program designed to protect/help the Danish wind industry 	NONE	
Netherlands IPW (1986) & TWIN (1991)	<ul style="list-style-type: none"> Investment subsidies for wind energy covering 35-40% of capital costs Additional subsidies for turbines with low noise ratings or those located in remote areas (to reduce public opposition) 	1978 Energy Tax Act <ul style="list-style-type: none"> 10% tax credit for business investments in wind, solar, geothermal, and ocean thermal Extended to 1985 and again to 1988 	<ul style="list-style-type: none"> The Dutch incentive is a grant but the United States incentive is a tax credit No United States analogy to second type of subsidy offered by the Netherlands.
Netherlands Voluntary Programs (utilities)	<ul style="list-style-type: none"> Joint agreement between utilities to install 250 MW of wind (unsuccessful in actually installing wind capacity). 	•PVUSA (PV for Utility Scale Applications) (1986) TEAM-UP (1994)	•PVUSA and TEAM-UP include Federal support; the latter was a DOE – utility industry cost-sharing partnership.
Netherlands Demand-pull Ecotax system (2000)	<ul style="list-style-type: none"> Exempt renewable energy from ecotax to encourage consumers to choose green power (has resulted in need to import green electricity to meet market demand). 	•California's 1999 customer credit (rebate) for purchases of renewable electricity.	•California's credit is a ¢/kWh rebate while the Netherlands' policy is a tax exemption.
Japan Net metering	<ul style="list-style-type: none"> Sets parameters for connecting small, distributed PV and wind systems to the grid 	• Similar to policies enacted in 32 States and the District of Columbia	
Japan 70,000 Solar Roofs with investment subsidies (1994) RPS (2002)	<ul style="list-style-type: none"> Encourage the use of PV systems in residences Educate consumers about PV technology 1.35% of total electricity to be generated by renewables by 2010 	Million Solar Roofs Initiative (1997) <ul style="list-style-type: none"> Seeks to install a million solar PV or solar thermals systems by 2010 No financing offered at Federal level RPS Laws enacted in various states 	•No Federal RPS

Source: Various sources compiled for and cited in this article by Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration.

4. Conclusion

In general, policies to promote non-hydro renewable energy in Germany, Denmark, and Japan have tended to be coordinated and consistent. In the United States, many policies are enacted at the State level and may not be synchronized with Federal policies, which themselves are subject to periodic reauthorization and/or appropriations legislation. In addition, both the Netherlands and the United States have complex multi-layered permitting processes that can slow the development of new renewable energy facilities.

Although the United States enacted laws similar to successful legislation in other countries, Denmark and Germany have both increased the market penetration of non-hydro renewables to an extent not yet seen in the United States. Some of the differences in outcomes for the installation of non-hydro renewable energy are related to varying resource endowments, political and economic systems, cultural traditions, and electricity prices, but three other factors may also be important. At a general level, Denmark and Germany both displayed an extraordinary level of political commitment to renewable energy that was both consistent and well funded. Additionally, Denmark's use of cooperative ownership structures helped overcome some public and political opposition to wind turbine technology. Finally, Denmark, Japan, and Germany enacted policies expressly for the purpose of promoting renewable energy—something the United States did not do until 1992 with the passage of EPACT. The following discussion will examine each of these points in detail.

4.1 Political Commitment

One outward manifestation of the political commitment displayed in Denmark was the setting of ambitious goals for renewable energy—but, more importantly, the government enacted policies to enable industry to meet the goals. For instance, Denmark's first renewable energy goal, set in 1981 when the government began subsidizing production from wind turbines, called for the production of 1.3 billion kWh of electricity from renewables by 1995, a goal that was met by 1993. In 1990, the Danish government again set a renewable energy goal, this time of installing 1,500 MW of capacity by 2005, a goal met in 1998.¹²¹ The 1990 goal, articulated in the *Danish Energy Plan 2000*, was supported by generation subsidies, CO₂-related subsidies, and guaranteed pricing policies introduced in Denmark in 1992. The structure of these subsidies further confirms Denmark's commitment to renewable energy as the subsidies are guaranteed over the long-term and do not need to be regularly reviewed by the government. Finally, in its *Energy 21* policy unveiled in 1996, Denmark set a goal of 5,500 MW of renewable capacity by 2030¹²² and had achieved more than 3,100 MW by the end of 2003. The consistency with which Denmark has met its goals ahead of schedule gave confidence to wind industry developers and financiers that the government was committed to encouraging the development of renewable energy.

Germany set few goals expressly for developing renewable energy but did begin setting CO₂-related goals in 1990 and generally articulated a commitment to renewable energy as a way of reaching CO₂ reduction targets. This text from a Cabinet Decision on November 7, 1990 illustrates this commitment: "The Federal Government reaffirms its call for the longer-term economic potential of renewable energy sources to be tapped as rapidly as possible in light of the contribution they could make to CO₂ reduction...the Federal Government will continue to work towards making it easier for renewable energy sources to gain a foothold in the market."¹²³ Germany followed up this CO₂ goal with the 1991 Feed-In Law, which was successful in significantly increasing the installed renewable capacity in Germany.

In contrast to Denmark, the Netherlands set a number of goals related to renewable energy and enacted policies to assist in promoting renewable energy, but still consistently failed to meet their targets. In 1985, the Netherlands set a goal of installing 1,000 MW of windpower by 2000, a target that was reiterated in 1991 when the TWIN program was enacted. The Netherlands had not yet met this goal at year-end 2003. Although the Netherlands had investment subsidy programs to support their goals, few projects got built, possibly because of the complex permitting system in the Netherlands.¹²⁴ Additionally, the utility-run Windplan program in the mid-1990s was enacted without government regulation. Had the plan been mandatory rather than voluntary, it might have encouraged the installation of more wind capacity. Finally, while incentives in the Netherlands may

¹²¹ Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 6. Also, International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 6: Denmark.

¹²² Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001, Appendix 6.

¹²³ Ibid. Appendix 7, as cited in Deutsche Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU, German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety), *Environmental Policy: The Federal Government's Decision of 29 September 1994 on Reducing Emissions of CO₂, and Emissions of other Greenhouse Gases, in the Federal Republic of Germany*, Bonn: BMU, November 1994.

¹²⁴ Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley & Sons, Inc: New York.

make renewables look like profitable investments, regulations in the Netherlands can change very quickly and without periods of adjustment for business and industry, a factor that serves to make investors more wary of risking capital.¹²⁵

Japan's political commitment to renewables and to PV, in particular, has been strong and consistent over time. R&D into "new energy" sources began in the late-1970s and continues to this day. In the early 1990s when the government's focus switched from strict R&D to market support mechanisms, the government both set ambitious goals for the development of solar power and enacted policies to support the goals.

Overall, based on these three examples, the country that displayed the most success in meeting its goals, Denmark, gets a high percentage of its electricity from renewable sources, and Germany, a country that has displayed its political commitment in other ways, has the highest installed wind capacity in the world. Japan's success at installing PV capacity in the 1990s is also likely related to the government's political commitment to both R&D and market support mechanisms. The Netherlands also gets a high percentage of its electricity from renewable sources, but its ability to achieve its windpower goals may have been hampered by political and regulatory inconsistency.

4.2 Public Opposition

Although many people support the idea of renewable technologies, having large renewable energy projects installed nearby can still generate significant local opposition. Some types of projects will naturally cause more opposition than others. For example, there is little organized public opposition to small-scale PV systems for residences and/or commercial establishments. In fact, even larger-sized PV systems are frequently not targets for protests because many such structures are erected as building-integrated photovoltaic systems (BIPV), which make the structures more aesthetically pleasing.

For other renewable technologies, however, public opposition can hamper the development of projects. The design of such projects can often influence the level of public support the project can garner. For instance, with wind projects, public opinion studies have shown that smaller numbers of turbines are more acceptable than hundreds or thousands of turbines.¹²⁶ In addition to aesthetics, there is some opposition to wind projects because of noise concerns and birds killed by the turbine blades.

Countries have dealt with the issue of public opposition in very different ways. In Denmark, the use of cooperatives to involve ordinary citizens in the development of windpower created a voting constituency invested in the technology that helped propel the government towards wind- and renewable-friendly policies. Additionally, more than any other country discussed, Denmark created and protected an internationally competitive wind industry that now provides thousands of jobs to Danish people—another constituency invested in windpower. Finally, Denmark's national government required local communities to include potential sites for wind turbines in their local plans, a move which helped to put the issue on the table for many communities, ultimately simplifying siting issues.

In the United States, some projects have run into significant opposition, while others have moved forward easily. However, there are no major regulations, such as those in Denmark, which simplify the permitting process for wind turbines. Local municipalities have control over siting and permitting of new construction, while States regulate power producers. The situation is similar in the Netherlands, where a complex permitting process can delay or even prevent the installation of wind capacity.

4.3 Structure of Policies

A final distinction between policies enacted in Denmark, the Netherlands, Germany, Japan, and the United States has been the structure of the policies. The manner in which each country views renewable energy affects the way its policies are structured. The EU and Japan treat renewable energy as a strategic interest, creating numerous inter-related policies designed specifically to encourage the development of renewables. In Denmark and Germany, the stated purpose of the Feed-In-type laws enacted to support the development of wind power was to encourage the growth of renewable energy. PURPA, the U.S. counterpart to these policies, was less narrowly focused on renewables, as its original stated purpose was to encourage energy conservation and efficiency in the electric utilities sector.¹²⁷

A second element to a policy's structure is its method of implementation. Until the late-1990s, the Netherlands used mostly voluntary programs, while Germany and Denmark dictated the price that utilities were required to pay for renewable energy. Germany and Denmark also used a variety of financial incentives in addition to this command-and-control approach. The United States also turned to financial incentives with the PTC and REPI in 1992. Since 2000, Germany, Denmark, and the Netherlands have all been moving towards a more market-based system with both the Netherlands and Denmark beginning the use of green certificate trading in electricity markets. The method of implementation is crucial for how policy is enacted—voluntary programs, which cannot be enforced, are more difficult to implement, but some command-and-control methods impose high costs on utilities or consumers that hamper market development.

¹²⁵ Reiche, Danyel and Mischa Bechberger, 2004, "Policy Differences in the Promotion of Renewable Energies in the EU Member States," *Energy Policy* 32:843-849.

¹²⁶ Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley and Sons, Inc.: New York.

¹²⁷ U.S. Government Printing Office. *Compilation of Selected Energy-Related Legislation: Electricity*. Washington, DC, 1991. Page 115.

References

- American Wind Energy Association, March 2004, "Global Wind Energy Market Report," <http://awea.org/pubs/documents/globalmarket2004.pdf>, accessed April 28, 2004.
- Auken, Svend, Winter/Spring 2002, "ISSUES AND POLICY: Answers in the Wind: How Denmark Became a World Pioneer in Wind Power," *Fletcher Forum on World Affairs*, 26(149).
- BBC News, February 2005, "Kyoto Protocol Comes into Force," <http://news.bbc.co.uk/2/hi/science/nature/4267245.stm>, accessed February 23, 2005.
- Bird, L.; Parsons, B.; Gagliano, T.; Brown, M.; Wiser, R.; Bolinger M., July 2003, "Technical Report: Policies and Market Factors Driving Wind Power Development in the United States," National Renewable Energy Laboratory, NREL/TP-620-34599.
- BTM Consult ApS, March 2003, *International Wind Energy Development World Market Update 2002 with Forecast 2003-2007*, Ringkøbing, Denmark.
- BTM Consult ApS, March 2004 Press Release, *International Wind Energy Development World Market Update 2003 with Forecast 2004-2008*, Ringkøbing, Denmark, <http://www.btm.dk/>, accessed April 19, 2004.
- California Consumer Energy Center, "Current Rebate Levels—Emerging Renewables Program Rebates," http://www.consumerenergycenter.org/erprebate/2004-01-08_currnt_rebate.html, accessed May 18, 2004.
- California Energy Commission, "More Information about the Emerging Renewables Program," http://www.energy.ca.gov/renewables/emerging_renewables/more_info.html, accessed May 18, 2004.
- California Energy Commission, *Renewable Resources Development Report*, http://www.energy.ca.gov/reports/2003-11-24_500-03-080F.pdf, accessed January 7, 2005.
- California Public Utilities Commission, 1993, "California's Electric Services Industry: Perspectives on the Past, Strategies for the Future," http://ucei.berkeley.edu/Restructuring_Archive/Yellow_book.pdf, accessed May 18, 2004.
- Chapman, Jamie; Wiese, Steven; DeMeo, Edgar; and Adam Serchuk, November 1998, "Expanding Wind Power: Can Americans Afford It?" *Renewable Energy Policy Project Research Report*, No. 6, http://solstice.crest.org/repp_pubs/pdf/chapman.pdf, accessed May 18, 2004.
- Central Intelligence Agency, *The World Factbook 2004*, "Denmark," <http://www.cia.gov/cia/publications/factbook/geos/da.html#top>, accessed April 19, 2004.
- Central Intelligence Agency, *The World Factbook 2004*, "Germany," <http://www.cia.gov/cia/publications/factbook/geos/gm.html#top>, accessed April 26, 2004.
- Central Intelligence Agency, *The World Factbook 2004*, "Japan," <http://www.cia.gov/cia/publications/factbook/geos/ja.html#top>, accessed May 3, 2004.
- Central Intelligence Agency, *The World Factbook 2004*, "The Netherlands," <http://www.cia.gov/cia/publications/factbook/geos/nl.html#top>, accessed May 3, 2004.
- Central Intelligence Agency, *The World Factbook 2004*, "United States," <http://www.cia.gov/cia/publications/factbook/geos/us.html>, accessed May 19, 2004.
- Danish Wind Energy Association, "Energy Policy in Denmark," <http://www.windpower.org/en/articles/energypo.htm>, accessed April 20, 2004.
- Database for State Incentives for Renewable Energy, <http://www.dsireusa.org/glossary/glossary.cfm?&CurrentPageID=8#net>, accessed January 5, 2005.
- Database of State Incentives for Renewable Energy, "California Incentives for Renewable Energy," <http://www.dsireusa.org/library/includes/map.cfm?State=CA&CurrentPageId=1>, accessed May 18, 2004.
- "Development Trends in and Promotional Measures for Renewable Energy, Part 1," (Draft Translation) The Institute of Energy Economics, Japan, Summer 2004.

Energy Information Administration, <http://www.eia.doe.gov/pub/international/iea2002/table63.xls>, accessed May 3, 2004.

Energy Information Administration, <http://www.eia.doe.gov/pub/international/iealf/table64g.xls>, accessed May 3, 2004.

Energy Information Administration, "State Renewable Energy Requirements and Goals: Status Through 2003," <http://www.eia.doe.gov/oiaf/analysispaper/rps/index.html>, accessed January 5, 2005.

Energy Information Administration, "Wind Power Milestones," <http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/backgrnd/chap10l.htm>, accessed May 17, 2004.

Energy Research Centre of the Netherlands, "Renewable Electricity Policies in Europe Fact Sheets, The Netherlands: Policy Instruments," <http://www.renewable-energy-policy.info/relec/netherlands/policy/investment.html>, accessed May 5, 2004.

European Commission, "Biomass Electricity—Netherlands," The ATLAS project, http://europa.eu.int/comm/energy_transport/atlas/html/bioeneth.html, accessed May 5, 2004.

European Wind Energy Association, 2004, "Wind Power Installed in Europe by End of 2003," http://www.ewea.org/documents/europe_windata_jan20041.pdf, accessed April 26, 2004.

Fukasaku, Yukiko, 1995, "Energy and Environment Policy Integration: The Case of Energy Conservation Policies and Technologies in Japan," *Energy Policy*, 23(12):1063-1076.

FX History, <http://www.oanda.com/convert/fxhistory>, accessed April 22, 2004.

Gielecki, Mark; Mayes, Fred, and Lawrence Prete, "Incentives, Mandates, and Government Programs for Promoting Renewable Energy," February 2001, Energy Information Administration, http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/incent.html, accessed May 19, 2004.

Gipe, Paul, 1995, *Wind Energy Comes of Age*, John Wiley & Sons, Inc: New York.

Gipe, Paul, 1999, "Latest Data from Germany's 250 MW Measurement Program 1999," Appeared in *WindStats* 12(4), <http://www.wind-works.org/articles/German250MW.html>, accessed April 27, 2004.

International Energy Agency, 2003, *Energy Balances for OECD Countries*, IEA: Paris.

International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 6: Denmark.

International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 8: Germany.

International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 12: Japan.

International Energy Agency, 2003, *IEA Wind 2002 Annual Report*, Chapter 14: The Netherlands.

International Energy Agency, 2003, *IEA Photovoltaic Power Systems Programme Annual Report*, "Japan: PV technology status and prospects," <http://www.oja-services.nl/iea-pvps/ar02/index.htm>, accessed May 27, 2004.

International Energy Agency, 2002, *Energy Policies of IEA Countries: Germany*, Paris: OECD.

Johnson, Anna; and Staffan Jacobsson, "The Emergence of a Growth Industry: A Comparative Analysis of the German, Dutch and Swedish Wind Turbine Industries," Paper presented at the Winter 2002 Danish Research Unit for Industrial Dynamics Conference, Aalborg, Denmark, January 17-19, 2002, <http://www.druid.dk/conferences/winter2002/gallery/jacobsson.pdf>, accessed April 26, 2004.

Junginger, M.; Agterbosch, S.; Faaij, A.; and W. Turkenburg, 2004, "Renewable Electricity in the Netherlands," *Energy Policy* 32:1053-1073.

Kamata, Yoshiro, August/September 1989, "The Energy Situation and Energy Policy in Japan," *Revue de L'énergie*, 40: 692-702.

Kurokawa, Kosuke, 1996, "An Overview of System Technology in Japan," *Renewable Energy*, 8:480-484.

Kuwano, Yukinori, 1998, "Progress of Photovoltaic System for Houses and Buildings in Japan," *Renewable Energy*, 15:535-540.

Moller, Torgny, January 2004, "Danish wind giants head for merger," *Windpower Monthly*, 20(1).

- Moore, Curtis and Jack Ihle, 1999, "Renewable Energy Policy Outside the United States," Renewable Energy Policy Project, http://solstice.crest.org/repp_pubs/articles/issuebr14/, accessed April 19, 2004.
- Namovicz, Chris, Office of Integrated Analysis and Forecasting, Energy Information Administration, May 13, 2004, Personal Communication.
- Reiche, Danyel and Mischa Bechberger, 2004, "Policy Differences in the Promotion of Renewable Energies in the EU Member States," Energy Policy 32:843-849.
- Reijnders, L., 2002, "Imports as a major complication: liberalization of the green electricity market in the Netherlands," Energy Policy 30:723-726.
- Sawin, Janet, "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Windpower in the United States, California, Denmark and Germany, 1970-2000," PhD Dissertation, Fletcher School of Law and Diplomacy, Tufts University, September 2001.
- Stein, Christof, Presented March 8, 2004 at Photovoltaic Workshop in Rome, "The Experience of Germany on Photovoltaic Incentives," Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, <http://www.elettronet.it/browse.asp?goto=455&livello=2&IdDocumento=21545&IdRevisione=28941>, accessed April 27, 2004.
- Tatsuta, M., 1996, "New Sunrise Project and New Trend of PV R&D Program in Japan," Renewable Energy, 8:40-43.
- Ushiyama, Izumi, 1999, "Renewable Energy Strategy in Japan," Renewable Energy, 16:1174-1179.
- Ushiyama, Izumi, 1999, "Wind Energy Activities in Japan," Renewable Energy, 16:811-816.
- U.S. Government Printing Office, 1991, Compilation of Selected Energy-Related Legislation: Electricity. Washington, DC.
- Watanabe, Chihiro, 1995, "Identification of the Role of Renewable Energy: A View from Japan's Challenge: The New Sunshine Program," Renewable Energy, 6:237-274.
- Weiss, Ingrid and Peter Sprau, 2002, "100,000 roofs and 99 Pfennig—Germany's PV financing schemes and the market," Renewable Energy World Jan-Feb 2002, http://www.jxj.com/magsandj/rew/2002_01/weiss.html, accessed April 27, 2004.
- Wolsink, Maarten, 1996, "Dutch Wind Power Policy: Stagnating Implementation of Renewables," Energy Policy 24(12): 1079-1088.