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Jeremy McBryan

DENMARK ENERGY POLICY: SUCCESS IN ACHIEVING ENERGY INDEPENDENCE AND ESTABLISHING AN INTERNATIONAL WIND ENERGY INDUSTRY

Jeremy McBryan[*]

* Department of Environmental Engineering Sciences, College of Engineering, University of Florida, Gainesville, Florida.

I. BRIEF HISTORY OF DENMARK ENERGY POLICY

A. *Background*

In 1973, Denmark was almost entirely reliant on foreign oil for heat and power generation.[1] Soon after the Yom Kippur War between Syria, Israel and Egypt, the Arab-led oil embargo caused global oil prices to increase significantly in the mid-1970s.[2] Denmark responded "in such a sustained, focused and systematic way that today it is energy independent."[3] Denmark's holistic response included gasoline taxes, carbon dioxide (CO_2) taxes, efficiency standards for buildings and appliances, and the temporary prohibition of driving on Sunday.[4] Since 1980, Denmark's energy consumption has remained relatively flat while the economy has grown by 78%.[5] During this time, Denmark's clean-power industry flourished and is now one of the most successful in the world.[6]

The oil crisis of the 1970s prompted the development of the first of four national energy plans, focusing on protecting Denmark from a similar crisis in the future by improving the security of energy supplies.[7] Fiscal incentives were provided to encourage the exploration of domestic oil and gas supplies, decentralize the heat and power generation system, and reduce the heat and power system's dependence on oil and gas.[8] As a result, coal became the main fuel source for heat and power generation.[9] In the 1980s, public concerns over the use of coal, its relatively large greenhouse gas emissions, and other environmental impacts resulted in updates to Denmark's energy policy.[10] Subsequently, energy policy and environmental policy became inseparable due to concerns of acute environmental damage from

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1. THOMAS L. FRIEDMAN, HOT, FLAT, AND CROWDED: WHY WE NEED A GREEN REVOLUTION – AND HOW IT CAN RENEW AMERICA 18 (2008).

2. Hannah Sentenac, *Denmark Points Way in Alternative Energy Sources*, FoxNews.com, Nov. 28, 2006, http://www.foxnews.com/story/0,2933,203293,00.html.

3. Thomas L. Friedman, *Flush With Energy*, N.Y. TIMES, Aug. 9, 2008, *available at* http://www.nytimes.com/2008/08/10/opinion/10friedman1.html.

4. *Id.*

5. DANISH MINISTRY OF CLIMATE AND ENERGY, THE DANISH EXAMPLE – THE WAY TO AN ENERGY EFFICIENT AND ENERGY FRIENDLY ECONOMY 1 (2009), *available at* http://www.kemin.dk/EN-US/FACTS/DANISHEXAMPLE/Sider/TheDanishExample.aspx.

6. Søren Krohn, *Danish Wind Turbines: An Industrial Success Story* 1 (2002), http://www.windpower.org/media(483,1033).

7. Søren Krohn, *Wind Energy Policy in Denmark Status 2002* (2002), http://www.windpower.org/media(492,1033).

8. *Id.*

9. *See id.*

10. *Id.*

greenhouse gas emissions and their effect on global climate change.[11] Accordingly, the Danish parliament merged the Ministry of Energy with the Ministry of the Environment.[12]

Alternative sources of energy and fuel flexibility have been emphasized throughout Denmark's energy planning and policy development process.[13] All four of the major energy plans encouraged using renewable sources or environmentally desirable fuels such as natural gas, solar power, wind power, and biomass (straw, wood, liquid manure, and household waste).[14] While Denmark introduced nuclear power for the first time in 1976 to satisfy its increasing energy needs,[15] it was removed from Danish energy planning in the 1980s by the Danish parliament.[16] Currently, there are no nuclear power installations in Denmark.[17]

Since 1977, there has been a consistent theme within the Danish parliament and in Danish energy policy to improve energy independence and reduce greenhouse gas emissions.[18] In addition, Danish energy policies have consistently addressed and promoted energy efficiency, decentralized energy systems, private and cooperative ownership of energy systems, sustainable development, and the use of renewable sources of energy (especially wind).[19] Wind energy became a major component of Denmark's energy policy and played a large role in helping to reduce greenhouse gas emissions.[20] Denmark's innovative energy policies and sustained support of renewable energy has helped Denmark become an international leader in renewable energy technology and produced rapid economic growth while maintaining stable levels of energy consumption.[21]

The following sections provide a brief history of Denmark's energy plans. These plans were the foundation of specific policies and actions that ultimately led to achieving energy independence, promoting the use

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11. *Id.*

12. *Id.*

13. Sentenac, *supra* note 2.

14. Co-operatives UK with Dep't of Trade and Indus., CO-OPERATIVE ENERGY: LESSONS FROM DENMARK AND SWEDEN 17 (2004), *available at* http://www.oti.globalwatchonline.com/online_pdfs/36247MR.pdf [hereinafter CO-OPERATIVES UK].

15. Sussanne Blegaa et al., *Alternative Danish Energy Planning*, 5 ENERGY POL'Y 87, 87 (1977).

16. Niels I. Meyer, *Learning from Wind Energy Policy in the EU: Lessons from Denmark, Sweden and Spain*, 17 EUR. ENV'T 347, 349 (2007).

17. Krohn, *supra* note 7, at 3.

18. *Id.* at 1.

19. CO-OPERATIVES UK, *supra* note 14, at 16-17, 21.

20. Krohn, *supra* note 7, at 2.

21. DANISH MINISTRY OF CLIMATE AND ENERGY, *supra* note 5, at 10.

of renewable energy sources, and establishing a successful international wind energy industry.

B. *Danish Energy Plan of 1976*

In the spring of 1976, the Danish government published the Danish Energy Plan of 1976. The plan provided projections of energy consumption for the period 1975-95 and proposed measures to protect Denmark from a future energy supply crisis like that of 1973-74.[22] The plan focused mainly on ensuring the security of energy supplies and provided financial incentives to (1) expand domestic oil and gas exploration, and (2) expand decentralized power generation.[23] The Danish Energy Plan of 1976 also included an energy tax on oil and authorized local authorities to implement energy and heating plans which allowed for greater fuel flexibility.[24] These policies and acts resulted in a significant shift in fuel sources from oil to coal, eventually resulting in public concern regarding greenhouse gas emissions.[25]

To meet the plan's projected increase in demand for electricity, nuclear power (from uranium fuel) was proposed for the first time in Danish energy planning history.[26] Energy experts and the public opposed the plan and called for an alternative energy plan to be developed without nuclear power.[27] After much public and political debate, engineers, scientists, and energy experts from several Danish universities prepared an alternative energy plan that emphasized decentralized energy production, and increased use of energy from renewable sources, specifically solar energy for heating and wind energy for electricity.[28] Additionally, two new non-governmental organizations established in the 1970s, the Organization Against Nuclear Power and the Organization for Renewable Energy, began educating the public about the risks of nuclear power and the benefits of renewable energy.[29]

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22. Blegaa et al., *supra* note 15.
23. Krohn, *supra* note 7, at 1.
24. CO-OPERATIVES UK, *supra* note 14, at 17.
25. *See* Krohn, *supra* note 7, at 1.
26. Blegaa et al., *supra* note 15.
27. *See* Meyer, *supra* note 16.
28. *See* Blegaa et al., *supra* note 15.
29. *See* Meyer, *supra* note 16.

C. *Energy Plan of 1981*

The second official Danish energy plan continued to focus on reducing Denmark's dependence on imported fuels.[30] Additionally, it formally recognized renewables as a potential energy source by providing subsidies and feed-in tariffs to support wind power.[31] The 1981 Energy Plan also considered socioeconomic and environmental impacts during energy policy development.[32] Due to the unresolved nuclear energy issue that began in response to the 1976 Energy Plan, the nuclear versus renewable energy debate continued, and public pressure against nuclear energy remained firm.[33] In response to the official 1981 Energy Plan, Danish energy experts developed an alterative energy plan.[34] Then, in 1985, the Danish parliament eliminated nuclear power as an option for further consideration in future energy supply planning.[35]

D. *Energy 2000*

In 1990, the Danish Ministry of Energy published Energy 2000, a plan that memorialized a renewed focus on renewable energy sources.[36] The plan and its 1993 update, specifically called for increases in the use of biomass fuels (straw, wood, liquid manure, and household waste)[37] and other environmentally desirable alternatives (natural gas, solar power, and wind power), and encouraged the implementation of sustainable development practices within the energy sector.[38] More specifically, Energy 2000 set the following 2005 energy targets: (a) reduce energy consumption by 15%; (b) increase the consumption of natural gas by 170%; (c) increase the consumption of renewable energy by 100%; (d) reduce the consumption of coal by 45%; (e) reduce the consumption of oil by 40%; (f) reduce CO_2 emissions by at least 20%; (g) reduce sulfur dioxide (SO_2) emissions by 60%; (h) reduce nitrous dioxide (NO_2) emissions by 50%.[39] In addition, Energy 2000 set a target

30. CENTRE FOR BIOMASS TECHNOLOGY WITH THE DANISH ENERGY AGENCY, WOOD FOR ENERGY PRODUCTION 6 (Helle Serup, ed., 2d ed. 2002) [hereinafter WOOD FOR ENERGY PRODUCTION], *available at* http://www.videncenter. dk/Groenne%20trae%20haefte/Groen_ Engelsk/Kap_01.pdf

31. *See* CO-OPERATIVES UK, *supra* note 14.

32. WOOD FOR ENERGY PRODUCTION, *supra* note 30.

33. *See* Meyer, *supra* note 16.

34. *See id.*

35. *Id.*

36. *See* CO-OPERATIVES UK, *supra* note 14.

37. *See id.*

38. *See* WOOD FOR ENERGY PRODUCTION, *supra* note 30.

39. *Id.*

of obtaining 10% of electricity from wind turbines by 2005.[40] It was anticipated that the targets of Energy 2000 would be met by increasing energy conservation, implementing taxes on CO_2 emissions, converting to environmentally desirable fuels, and providing subsidies for construction of energy efficient regional heating systems.[41]

E. *Energy 21*

In 1996, the Danish Ministry of Environment and Energy published Energy 21, which again focused on renewable energy sources and officially confirmed Denmark's two overall energy policy goals: (1) to reduce greenhouse gas emissions; and (2) to develop a sustainable energy system.[42] The plan recognized that the management of energy resources was central to the success of Denmark's society and economy.[43] Energy 21 intended to "ensure that the energy sector [was] well-rooted in a democratic, consumer-oriented structure, and . . . robust in relation to market developments. . . . [T]his [was] to be done against a background of the principle of self-sustainability, by securing consumer ownership, and by promoting consumer democracy. . . ."[44] Specifically, Energy 21 established the following targets for reducing fossil fuel energy sources and their resulting emissions: (a) 12-14% of energy will come from renewables by 2005; (b) the percent of energy from renewables will increase by 1% every year after 2005 and achieve 35% by 2030; and (c) CO_2 emissions targets for 2030 are 50% of 1994 levels.[45]

As a result, wind energy became an essential part of Danish energy planning.[46] It was intended to replace coal-fired power generation and thus become a critical component in achieving more than one-third of Denmark's CO_2 emissions reduction target.[47] Long-term planning conducted as part of Energy 21 assumed that 40%-50% of electricity consumption would be generated from wind by 2030.[48]

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40. CO-OPERATIVES UK, *supra* note 14.

41. WOOD FOR ENERGY PRODUCTION, *supra* note 30.

42. *See* Meyer, *supra* note 16.

43. DANISH MINISTRY OF ENVIRONMENT AND ENERGY, ENERGY 21: THE DANISH GOVERNMENT'S ACTION PLAN FOR ENERGY, 1.1: Objectives of Energy Policy (1996), *available at* http://193.88.185.141/ Graphics/publikationer/energipolitik_uk/e21uk/underkap/11.htm.

44. *Id.*

45. DANISH MINISTRY OF ENVIRONMENT AND ENERGY, ENERGY 21 – THE DANISH GOVERNMENT'S ACTION PLAN FOR ENERGY, 1.3 Themes in the National Plan of Action (1996), *available at* http://193.88.185.141/Graphics/publikationer/energipolitik_uk/e21uk/underkap/13.htm.

46. *See* Krohn, *supra* note 7, at 2.

47. *Id.* at 2-3.

48. *Id.* at 2.

Energy 21 was the culmination of several decades of broad political and public consensus on energy policy. Public concern over local and global environmental damage, in conjunction with extensive technical analyses conducted by the Danish Energy Agency, provided a consistent and logical approach to creating adaptable energy policy.[49]

II. SPECIFIC POLICIES AND ACTIONS THAT PROMOTED WIND ENERGY IN DENMARK

Denmark is one of the few countries in the world that has maintained active support of renewable energy development since the 1970s.[50] The energy plans and policies described above provided a framework to advance "energy security, self-sufficiency, and efficiency" objectives by engaging private industries and the public.[51] Furthermore, the specific policies and actions described below that have helped promote the wind energy industry in Denmark have also strengthened its technical capabilities, increased technology exports, reduced greenhouse gas emissions, and helped to establish an international wind energy industry.[52] The following policy factors were critical components of Denmark's success in promoting wind energy infrastructure, achieving energy independence, and establishing a successful international wind energy industry: (a) national energy plans; (b) research, development, and demonstration; (c) economic support systems; (d) energy taxes and green taxation; (e) local ownership; and (f) energy source transition planning.

A. *National Energy Plans*

Denmark's four national energy plans incorporated political, legislative, financial, fiscal, administrative, technological, and educational elements, all of which provided a broad and comprehensive approach to implementing energy solutions.[53] The four energy plans provided a framework for establishing specific policies and actions that promoted wind energy in Denmark and are described below.

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49. *See id.*

50. Judith Lipp, *Lessons for Effective Renewable Electricity Policy from Denmark, Germany and the United Kingdom*, 35 ENERGY POL'Y 5481, 5486 (2007).

51. *See id.* at 5486-87.

52. DANISH MINISTRY OF CLIMATE AND ENERGY, *supra* note 5, at 10.

53. *See* EUROPEAN ENV'T. AGENCY, ENVTL. ISSUE REPORT NO. 27, RENEWABLE ENERGIES: SUCCESS STORIES 68-69 (2001), *available at* http://reports.eea.europa.eu/environmental_issue_report_2001_27/en/Issues_No_27_full_report.pdf.

B. *Research, Development, and Demonstration*

For more than twenty-five years, the Danish government has provided continuous and stable financial support for the research, development, and demonstration of wind energy technologies.[54] This has enabled successful innovation in the fields of meteorology, materials technology, and fluid mechanics.[55] Moreover, it has also established credibility in the wind energy technology market.[56] Denmark has a long history in the wind power sector that began in the 1890s with wind turbine research.[57] For many years, wind power entrepreneurs attempted to promote and develop wind power technology and infrastructure, but many of the firms did not survive.[58] By the 1970s, the Danish government began supporting wind power development at various Danish utilities and through the Danish Academy of Technical Sciences and other government programs.[59]

A significant reason for the diffusion of wind energy technology in Denmark was the creation of a wind turbine test station at the Risø National Laboratory in 1978.[60] Risø became the central Danish authority on wind energy technology and cooperated with turbine manufacturers on a variety of research, development, and demonstration projects.[61] Risø also provided formal approval to manufacturers and producers that were required to receive government subsidies.[62] Eventually, Risø provided certifications that allowed the connection of wind turbines to the electrical grid system.[63] This centralized national certification process provided quality assurance of wind power technologies and prevented inferior wind energy products from being produced, marketed, or sold in Denmark or elsewhere.[64]

A critical aspect of the success of the technology approval and certification process implemented at Risø was the acceptance of innovative and non-standard designs.[65] This was the result of a close

54. *See* Meyer, *supra* note 16, at 350-51.

55. *See* RENEWABLE ENERGY: MARKET AND POLICY TRENDS IN IEA COUNTRIES 230-33 (International Energy Agency & Organisation for Economic Co-operation and Development eds., 2004), *available at* http://www.iea.org/textbase/nppdf/free/2004/renewable1.pdf [hereinafter RENEWABLE ENERGY].

56. *See* Meyer, *supra* note 16, at 350.

57. *Id.* at 349.

58. *Id.*

59. *See id.*

60. RENEWABLE ENERGY, *supra* note 55, at 230.

61. *Id.*

62. *Id.*

63. *Id.*

64. Meyer, *supra* note 16, at 350.

65. *See* Søren Krohn, *Wind Energy Policy in Denmark: 25 Years of Success – What Now?* 3 (2002), http://www.windpower.org/ media(493, 1033).

relationship between researchers and the certification staff, which allowed superior technologies to be integrated into new products.[66] Risø also supported wind energy technology in Denmark by publishing a wind atlas that specifically described Denmark's wind energy resources and provided procedures to estimate how weather, topography, and other land features affect wind speed.[67] It is evident that Denmark's research, development, demonstration and certification programs for wind energy technologies have played a large part in the expansion of wind energy throughout the world.[68]

C. *Economic Support Systems*

To support the proliferation of wind power, Denmark implemented various economic support systems, including feed-in tariffs, economic subsidies, and financial incentives.[69] Economic support systems are needed because "short-sighted commercial investments will often block the introduction of supply systems which are more environmentally benign, have higher supply security and are less costly in the long run."[70] In 1982, the Danish government established a committee charged with promoting energy projects that utilize wind, solar, and biomass energy sources.[71] The following section provides summaries of the economic support systems the Danish government conceived to foster the development of wind energy in Denmark.

1. Feed-in Tariffs

Feed-in tariffs are pricing policies that guarantee fixed prices to producers.[72] A long-term price guarantee provided by a feed-in tariff can create a stable and secure market for investors.[73] The intent of wind energy feed-in tariffs is to provide the financial incentives necessary to encourage wind energy developers to invest in wind energy infrastructure.[74] Feed-in tariffs can enable the diffusion of wind energy technologies over the long term as their planning horizons are typically much longer compared to other existing commercial energy technologies.[75] They typically provide price guarantees for eight to

66. *Id.* at 4.
67. Meyer, *supra* note 16, at 350.
68. *See* Krohn, *supra* note 65.
69. Lipp, *supra* note 50.
70. Meyer, *supra* note 16, at 348.
71. *Id.* at 350.
72. *See* Lipp, *supra* note 50, at 5482.
73. *Id.*
74. *See id.* at 5482-83.
75. *See* Meyer, *supra* note 16, at 348.

fifteen years and can be variable, thus providing a level of support that can be correlated to the advancement and maturity of the supported technology.[76]

In 1993, Denmark established feed-in tariffs, which required utilities to purchase renewable energy at fixed prices, and compensated renewable energy producers for the environmental benefits of generation, allowing their investments to be profitable.[77] Then, in 2001, the feed-in tariff system was changed; now, the price of electricity is market price plus an environmental premium.[78] This fixed environmental premium replaced the previous compensation program for renewable energy producers.[79]

2. Development and Production Subsidies

In addition to feed-in tariffs, the Danish government implemented economic subsidies or financial incentives for the development and production of wind power to support the growth of the wind energy sector.[80] Economic subsidies assisted Danish utilities in the transition from a conventional, large-scale, and centrally-based power generating infrastructure, to a small-scale, decentralized system with intermittent and variable electricity.[81]

Starting in 1979, private individuals and members of cooperatives that installed Risø-certified wind energy equipment were eligible for subsidies of up to 30% of construction and development costs.[82] In 1984, the subsidies were reduced to 15%, and in 1989, they were replaced with production-based incentives.[83] As of 1989, development subsidies totaled approximately 38 million euros,[84] (55.7 million USD) helping to install about 2,500 turbines[85] with 300 megawatts of wind power capacity.[86]

Financial incentives to encourage the production of wind energy include income tax deductions or credits, property tax incentives, sales

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76. Lipp, *supra* note 50, at 5482.

77. *Id.* at 5486.

78. *Id.* at 5487.

79. Meyer, *supra* note 16, at 350-51.

80. Lipp, *supra* note 50.

81. *See* Meyer, *supra* note 16, at 350-51.

82. *Id.* at 350.

83. E. Scott Piscitello & V. Susan Gobach Financial Incentives for Renewable Energy Development: Proceedings of an International Workshop, Feb. 17-21, 1997, Amsterdam, Netherlands 16-17 (1998) (World Bank, Discussion Paper No. 391) [hereinafter Financial Incentives].

84. Meyer, *supra* note 16, at 350.

85. RENEWABLE ENERGY, *supra* note 55, at 231.

86. Meyer, *supra* note 16, at 350.

tax reductions, direct payments, and favorable loan programs. In Denmark, income tax incentives were available for private wind turbine owners and members of private wind energy cooperatives.[87] For example, the initial 450 dollars and the remaining 40% of income raised from selling wind-generated electricity was tax free.[88] These incentives, however, were only available on the first 30,000 kilowatt-hours per year, and cooperative members were required to live in the same municipality as the installed turbine.[89] In addition, private individuals could only connect one turbine to the electrical grid system and the turbine was required to be on the individual's land.[90] Direct wind energy production-based subsidies have continued in Denmark, and laws now require electrical utilities to connect private wind turbines to the electricity distribution grid and to accept and pay for any wind-generated electricity.[91]

D. *Energy Taxes and Green Taxation*

For many years, Danish energy policy included taxes on energy to encourage energy conservation and to help protect the environment.[92] Denmark first introduced a tax on gasoline in 1917, and as of 1980, levied the majority of energy taxes on carbon dioxide, sulfur, electricity, natural gas, gasoline, and various other petroleum products.[93] Starting in 1992, a majority of energy and carbon tax revenues were used to fund projects and programs aimed at increasing Denmark's energy efficiency.[94]

From 1994-98, Denmark implemented a green taxation approach that began to shift the tax burden from income to resource use.[95] For example, taxes on energy (specifically coal and electricity consumption) gradually increased from 1994 to 1998 by an average of 30%.[96] While taxes on coal and electricity increased, income taxes decreased.[97] From 1996 to 2000, the *Green Tax Package 1995* introduced taxes on natural gas and sulfur, increased CO_2 taxes, and called for increases in energy conservation targets for business and industry.[98] As a result, the

87. Financial Incentives, *supra* note 83, at 16.
88. *Id.*
89. *Id.*
90. *Id.*
91. RENEWABLE ENERGY, *supra* note 55, at 231.
92. *Id.* at 239.
93. *Id.*
94. *Id.*
95. *Id.*
96. *Id.*
97. *Id.*
98. *Id.*

effective tax rate on energy products such as gasoline, natural gas, and heating oil in Denmark was roughly 200% in 2002.[99]

The increased energy taxes established by the *Green Tax Package 1995* were largely offset by reductions in labor taxes, subsidies to small and medium-sized companies, and subsidies for energy efficiency programs.[100] Additionally, CO_2 taxes were lower for companies that agreed to implement energy efficiency measures.[101] The Danish Energy Authority (formerly the Danish Energy Agency) developed a suite of qualified energy efficiency solutions that reduced CO_2 or SO_2 emissions, while increasing energy efficiency policies that companies could select and implement.[102] In 1999, the Danish government calculated that the overall tax burden in Denmark had decreased by DKK 335 million (65.9 million USD) and that CO_2 emissions from industry in 2005 would be reduced by 3.8%, equal to 2.3 million tons.[103]

E. *Local Ownership*

Denmark has a long tradition of democratic decision-making, consensus-building, and concern for the welfare of society and the environment.[104] The Danish educational and political system is indicative of the strong liberal democratic culture that exists in the country.[105] These social and political characteristics have provided the framework for a strong local and cooperative ownership movement in Denmark.

The cooperative concept first began in Denmark as a result of cheap agricultural imports in the mid-1800s.[106] This competition forced farmers to work cooperatively to improve their land, and improve their agricultural products.[107] Cooperatives remain a vital part of Danish society in both the food and utility sectors.[108] Local and cooperative ownership has "helped create widespread support for renewable energy, especially wind, because benefits were distributed across a wide group of people."[109]

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99. Krohn, *supra* note 7, at 3.
100. RENEWABLE ENERGY, *supra* note 55, at 174, 239.
101. *See id.* at 239.
102. *Id.* at 240.
103. *Id.*
104. CO-OPERATIVES UK, *supra* note 14, at 16.
105. *Id.*
106. *Id.*
107. *Id.*
108. *Id.*
109. Lipp, *supra* note 50.

In the 1930s, there were an estimated 30,000 windmills in Denmark, with some producing electricity.[110] As modern wind turbines began to appear in the 1970s, local communities became interested in cooperative ownership of their electricity.[111] As the size, expense, and number of wind turbines increased within Denmark, the need for more cooperative members also increased to distribute the costs and benefits of wind technology.

The success of wind energy infrastructure in Denmark can be directly attributed to the high level of social acceptability.[112] This acceptance was due in large part to the high percentage of citizens (80% in the 1990s) that supported wind power and the number of Danish households (150,000 in 2001) that were members of a local wind energy cooperative.[113] Many wind cooperatives began as small grassroots organizations consisting of a few interested individuals and were able to expand due to assistance from the Danish Association of Wind-Power Guilds (a non-profit organization that supports wind power owners and cooperatives).[114] This association helped wind cooperatives lobby government officials, provided cooperative members with relevant legal and tax information, and helped negotiate with manufacturers and utilities.[115] The Danish Association of Wind-Power Guilds has played an important role in expanding wind power cooperatives by changing local attitudes about wind power, providing political influence and technical expertise, and helping to negotiate loans and insurance.[116]

F. *Energy Source Transition Planning*

The Danish government implemented "systematic measures to balance the relationship between conventional (i.e. fossil fuel) energy industries and . . . 'alternative' suppliers" by coordinating with and allocating resources to various sectors of the energy industry for technical research and pilot projects.[117] This helped to ease the transition of wind energy into a complimentary role instead of replacing the conventional energy industry.[118] Subsequently, a grassroots wind energy movement in conjunction with the public's demand for reforms to the monopolized energy market helped create the wind power

110. CO-OPERATIVES UK, *supra* note 14, at 20.
111. *Id.*
112. Meyer, *supra* note 16, at 351.
113. *Id.*
114. CO-OPERATIVES UK, *supra* note 14, at 20-21.
115. *Id.* at 22.
116. *Id.*
117. Lipp, *supra* note 50.
118. *Id.*

technology industry in Denmark.[119] Gradually, wind power enthusiasts and entrepreneurs became organized, influencing the creation of energy policy that continued the transition from conventional energy to wind and other renewable energy sources.[120]

III. ASSESSMENT OF SPECIFIC POLICIES AND ACTIONS THAT PROMOTED WIND ENERGY IN DENMARK

Evaluating the effectiveness of policy is typically performed by assessing whether the intended policy goals or objectives have been achieved.[121] However, many policies do not have specific goals or objectives.[122] In addition, policy outcomes are often affected by a number of dynamic and interdependent factors including resource levels, political commitment, public engagement, and changing goals and objectives.[123] Therefore, policy effectiveness may be best evaluated by qualitatively assessing a few key energy indicators. This approach cannot identify the specific policy or action and its resulting policy outcome; the energy indicators can only provide the cumulative effect of all policies.[124] The following energy indicators were selected to assess the performance of Denmark's energy policies described above: (1) level of renewable energy penetration; (2) contribution to CO_2 reduction; and (3) industry, innovation, and employment effects.[125]

A. *Level of Renewable Energy Penetration*

While Denmark is one of the least populated countries in the world,[126] it is the world leader in installed renewable energy generation on a per capita basis and ranks fifth in the world in installed renewable energy capacity, most of which is wind power.[127] In 2005, 20% of Denmark's electricity was generated from wind sources[128] and as of 2009, over 19% of final energy consumption was from renewable

119. *Id.*
120. *Id.*
121. *Id.* at 5490.
122. *Id.*
123. *See id.*
124. *Id.*
125. *Id.* at 5490-92.
126. U.S. CENSUS BUREAU, *Country Rankings* (2008), http://www.census.gov/ipc/www/idb/ranks.php. Denmark ranks 110th and comprises less than 0.1% of the global population. *Id.*
127. Lipp, *supra* note 50, at 5491.
128. *Id.*

sources.[129] Accordingly, Denmark's 2010 target of 30% electricity from renewable sources will most likely be achieved.[130]

B. *Contribution to CO_2 Reduction*

Denmark's CO_2 reduction target under the Kyoto Protocol (and the European Union burden-sharing agreement) is 30% by 2012.[131] Between 1990 and 2004, Denmark's total CO_2 emissions decreased by only 1.8%,[132] while CO_2 emissions from energy use (after being adjusted for variability in weather condition and variability in international electricity exchange) decreased by 13% from 1990 to 2007.[133] On a related note, total greenhouse gas emissions (also adjusted for weather and electricity exchange with other countries) decreased by 15% from the baseline years (1990 and 1995) to 2006.[134]

C. *Industry, Innovation, and Employment*

Denmark's renewable energy industry and the wind energy industry in particular employs approximately 20,000 people in Denmark and is responsible for creating thousands of wind energy-related jobs around the world.[135] Denmark leads the world in wind turbine production, accounting for more than half of the 40,000 megawatts of wind energy installed around the globe.[136] In 2007, Danish energy technology exports were three times higher than in 1996, and accounted for over 9% of total Danish exports.[137] The success of Denmark's renewable energy technology and industry has prompted similar policy and technology innovations to be implemented in other countries.[138]

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129. DANISH MINISTRY OF CLIMATE AND ENERGY, *supra* note 5, at 2. Final energy consumption is energy consumption by end users, including distribution losses. *Id.* at 2 n.1.

130. Lipp, *supra* note 50, at 5491.

131. *Id.*

132. *Id.*

133. DANISH MINISTRY OF CLIMATE AND ENERGY, *supra* note 5, at 9.

134. *Id.* Under the Kyoto Protocol, 1990 is Denmark's base year for carbon dioxide, methane and nitrous oxide emissions, while 1995 is Denmark's base year for industrial greenhouse gas emissions. *Id.* at 10. Total greenhouse gas emissions include agricultural and landfill emissions (typically methane and nitrous oxide) as well as industrial emissions (typically refrigerants and other gases from electrical facilities) and carbon dioxide from activities that are not related to energy. *Id.* at 9.

135. Lipp, *supra* note 50, at 5492.

136. *Id.*

137. DANISH MINISTRY OF CLIMATE AND ENERGY, *supra* note 5, at 10.

138. Lipp, *supra* note 50, at 5492.

IV. CONCLUSION

The specific policies and actions described above were critical components of Denmark's success in achieving energy independence, promoting the use of renewable energy sources, and establishing a successful international wind energy industry. The success of Denmark's energy policies in promoting wind energy was due in large part to its broad and comprehensive approach which included political, legislative, financial, fiscal, administrative, technological, and educational elements.

Denmark's national energy plans memorialized the country's commitment to wind energy and provided a basis for political motivation and public support to continue to advance legislative, administrative, fiscal, technological, and educational programs in support of wind energy projects. Denmark's continuous financial support of research, development, and demonstration of wind energy technologies resulted in substantial progress in expanding the knowledge and understanding of the science and engineering of wind energy. One critical component was the creation of a central research and technology certification institution, Risø National Laboratory. Risø soon became a world-renowned institution with superior technological expertise and a technology certification center that ensured a continuous and positive evolution of wind energy components and products.

Financial subsidies and other economic programs created a long-term, stable financial environment that helped lure new investors to the wind power industry and facilitated the transition from conventional fossil fuel-based energy systems to renewable energy systems, especially wind energy. Subsidies for private individuals and cooperatives to construct and operate decentralized wind turbines also played a significant role in building public support for wind energy and creating public interest in owning all or part of the renewable energy infrastructure. In addition, energy taxes and incentives to increase energy efficiency and reduce resource use also helped to realign the energy and economic priorities in Denmark. This shift in tax policy was consistent with the values and interests of Denmark residents such as environmental protection and the welfare of society.

Danish energy policy has enabled Denmark to become a leader in the wind energy technology industry, attain substantial reductions in CO_2 and greenhouse gas emissions, and achieve energy independence. The national energy plans and the specific policies and actions that promoted wind energy should be examined by other countries interested in achieving similar energy goals.

If other nations intend to reduce their dependence on energy imports, improve energy efficiency, increase the use of renewable or sustainable

sources of energy, and reduce greenhouse gas emissions, Denmark's energy policies and renewable energy industry (specifically the wind power industry) provides effective energy policy options that can be implemented to achieve various energy and environmental objectives. Since typical planning horizons for renewable energy can be forty to fifty years,[139] any energy policies initiated in the short-term should be the result of long-range national energy planning incorporating the following: (a) clear social and environmental goals and renewable energy targets;[140] (b) stable economic support of the renewable energy industry, including decentralized small-scale producers in the form of development and production subsidies, tax incentives, and long-term renewable energy price guarantees (e.g., feed-in tariffs);[141] (c) a roadmap for transitioning from the current commercial energy supply system, which relies on short-term profits and increasing consumption,[142] to a system that maximizes efficiency and minimizes consumption (e.g., energy taxes and green taxation); and (d) technology and infrastructure improvements to the electrical distribution grid system to allow for decentralized and intermittent energy supplies.[143]

139. Meyer, *supra* note 16, at 348.
140. *See id.* at 358.
141. *See id.* at 359.
142. *See id.*
143. *See id.*