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Energy and The Future

ENERGY and the future

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Introduction: Energy and The Future

Debate over energy policy in the United States has reached its pinnacle in recent years. Among the key issues that have pushed energy into the spotlight is concern over foreign oil dependence, competition for scarce resources from growing economies, and a mounting scientific and popular consensus that global climate change is a serious challenge of irreversible proportion.

The planet's population is increasing, living longer, and in fast developing economies like China and India—getting wealthier—a combination of forces leading to both greater consumption of energy and increased production of greenhouse gases. Finding clean, alternative energy sources has thus become a critical issue. Yet the country remains dependent on traditional fossil fuels—in 2006 only 9.5% of electricity generated in the United States was from renewable energy sources.[1] With much at stake, policymakers, scientists, and activists believe we are at a crossroads when it comes to making decisions about energy use and policy.

How does Nebraska fit into this global picture? Nebraska enjoys a relatively unique position in terms of energy use and future prospects. As a public power state, the cost of electricity in Nebraska is inexpensive—the state is ranked 46th in retail electricity costs—6.07 cents per kilowatt hour, compared to a national average of 8.9 cents.[2] For many years, residents of the state have enjoyed cheap electricity. However, Nebraskans themselves tend to use a lot of energy. In 2004, the Energy Information Administration ranked Nebraska 18th in the nation in terms of per capita energy consumption.[3] Like a lot of other states, the majority of Nebraska's electricity is generated from traditional fossil fuels. Coal generated 58% of Nebraska's electricity in 2006. The state's two nuclear reactors produced another 35%.[4]

Newer sources of energy have been making headway in Nebraska. As one of the nation's top producers of corn, the corn-based ethanol industry has expanded rapidly in the state with government support, making Nebraska a leading producer and bringing with it high hopes for economic prosperity. As biofuel technology and innovation develop, other forms of biomass may become promising substitutes for traditional gasoline. Wind energy has also gained recent attention within Nebraska, and may become a boon for undeveloped rural areas. Finally, questions remain about the future role of nuclear power in an increasingly energy hungry world. Despite concerns about safety and waste storage, will nuclear power re-emerge as a viable substitute for fossil fuel-produced electricity?

Nebraska's diverse energy potential offers promises and pitfalls. Energy will play a key role in the state's commercial and economic development for years to come. How should Nebraska address these issues?

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[1] Energy Information Administration, U.S. Department of Energy, *Table 8.2a Electricity Net Generation: Total (All Sectors), 1949-2006*, available at http://tonto.eia.doe.gov/ask/Renewables_FAQs.asp#market_share.

[2] Energy Information Administration, U.S. Department of Energy, *Nebraska Electricity Profile, 2006 Edition*, available at http://www.eia.doe.gov/cneaf/electricity/st_profiles/nebraska.html.

[3] Energy Information Administration, U.S. Department of Energy, *Table R2. Energy Consumption by Source and Total Consumption per Capita, Ranked by State, 2004*, available at http://www.eia.doe.gov/emeu/states/sep_sum/plain_html/rank_use_per_cap.html.

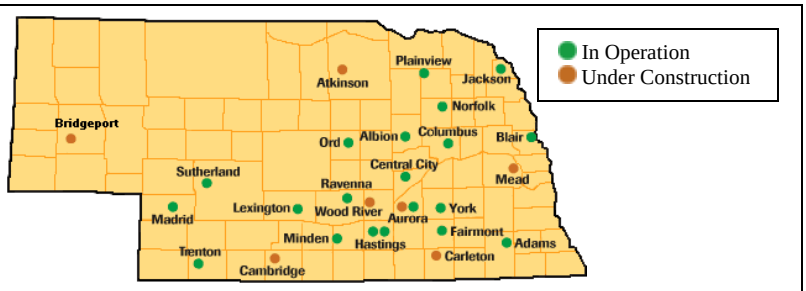
[4] Energy Information Administration, U.S. Department of Energy, *Nebraska Electricity Profile, 2006 Edition*, available at http://www.eia.doe.gov/cneaf/electricity/st_profiles/nebraska.html.

Ethanol

What is it?

Ethanol is an alcohol-based fuel derived from starch crops (corn, sugar cane) and other cellulosic vegetation that is blended with gasoline for use in vehicles.[5] Ethanol is made by fermenting sugars in crops or vegetation, and then distilling it to produce a liquid product. Although ethanol's use as an alternative fuel to gasoline was discovered decades ago, it has only been mass-produced in recent years. In 1990, production of ethanol in the United States was at 900 million gallons. Sixteen years later, in 2006, nearly five billion gallons were produced nationwide.[6] President George W. Bush heralded ethanol and other forms of alternatives to gasoline in his 2007 State of the Union Address, and called for the production of 35 billion gallons of alternative fuels by 2017.[7]

While ethanol can be created from a variety of sources, in the United States it is principally derived from corn. An estimated 18% of the United States' corn crop was used for ethanol production in 2006.[8] Cellulosic ethanol—or ethanol made from cellulosic vegetation—has the potential to significantly change the ethanol industry due to the abundance of potential cellulosic resources that could be used for production.[9] Cellulosic vegetation that could be used for ethanol include woodchips, crop stalks, and switchgrass. However, cellulosic vegetation requires a more complex process to derive sugar from cellulose, making it less cost-efficient to produce at this time. Research is currently underway to create more efficient enzymes capable of breaking down cellulose more quickly.[10]



Nebraska is the second leading producer of ethanol in the country, with nearly 30 plants in operation or under construction. (Source: The Nebraska Ethanol Board)

Status in Nebraska

Nebraska is currently the country's second largest ethanol-producing state. As of October 2007, Nebraska had an annual production capacity of 1,745 million gallons of ethanol, following Iowa at 3,357 million gallons and surpassing Illinois at 1,172 million gallons.[11] There are

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[5] Office of Energy Efficiency and Renewable Energy, United States Department of Energy, *What is Ethanol?* available at http://www.eere.energy.gov/afdc/fuels/ethanol_what_is.html.
[6] Biofuels Journal, *Yearly U.S. Ethanol Production, 1980-2006, in Gallons*, available at http://www.biofuelsjournal.com/articles/Annual_and_Monthly_U_S__Ethanol_Production-25474.html.
[7] President George W. Bush, *State of The Union 2007*, available at http://www.whitehouse.gov/news/releases/2007/01/20070123-2.html.
[8] Ethanol Facts, *Ethanol Basics: What ethanol is and what it does*, available at http://www.ethanolfacts.com/ETHL2007/ebasics.html.
[9] United States Department of Energy, Genomics GTL Program, *How Cellulosic Ethanol is Made*, available at http://genomicsgtl.energy.gov/centers/biorefinerywtitle.pdf.
[10] United States Department of Energy, Genomics GTL Program, *How Cellulosic Ethanol is Made*, http://genomicsgtl.energy.gov/centers/biorefinerywtitle.pdf.
[11] Nebraska Energy Office, *Ethanol Production by State*, available at http://www.neo.ne.gov/statshtml/121.htm.

currently twenty ethanol plants in operation across the state, and another seven under construction.[12]

Infrastructure Issues

As the current ethanol market is largely comprised of corn-based production, infrastructure is currently in place to accommodate moderate growth in the industry by utilizing existing resources for transporting corn products. However, both the expansion of corn-based ethanol and the introduction of cellulosic ethanol production will create a need for new infrastructure in the future.

For further expansion of corn-based ethanol, the greatest need for improvements will be in road and bridge repairs, as most grain is transported by truck. Providing for increased storage and drying capabilities may also be needed as farmers grow more corn. [13] Another challenge facing the corn-based ethanol industry will be its ability to provide fast and efficient transportation of ethanol to refineries outside the midwest. The number of available railroad tanker cars may need to be expanded, and more refineries may need to update their facilities to accept shipments by rail as well.[14] Generally, ethanol and ethanol-blended gasoline cannot currently be transported by pipeline as it can separate in transit and corrode pipes. Until new means can be created, ethanol transport is largely restricted to trucks or rail.[15] At the retail level, the introduction of new blender pumps at gas stations may increase the use of ethanol. These blender pumps have the ability to blend ethanol with gasoline at the gas station pump into a variety of mid-level blends: E10, E20, and E40.[16]

Infrastructure issues such as storage and transport of ethanol and other biofuels have major policy implications. (Source: Team Ethanol)

If the cellulosic ethanol industry grows, it would also present new infrastructure challenges. Currently, there is little infrastructure in place for further expansion of these new markets, mainly because demand for cellulosic ethanol is low. Potentially, some infrastructure for corn-based ethanol could be used for synthesis and transport of cellulosic ethanol, but significant modifications would need to be made. If demand grows for cellulosic ethanol, a suitably large storage and transportation infrastructure would need to be developed to support a viable consumer market.[17]

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[12] Nebraska Ethanol Board, *Nebraska Ethanol Industry: Ethanol Plants in Nebraska*, available at http://www.ne-ethanol.org/industry/ethplants.htm.
[13] Roger Ginder, *Potential Infrastructure Constraints on Current Corn-Based and Future Biomass Based U.S. Ethanol*, July 2007, available at http://www.econ.iastate.edu/research/webpapers/paper_12836_07018.pdf.
[14] Roger Ginder, *Potential Infrastructure Constraints on Current Corn-Based and Future Biomass Based U.S. Ethanol*, July 2007, available at http://www.econ.iastate.edu/research/webpapers/paper_12836_07018.pdf.
[15] Brent D. Yacobucci & Randy Schnepf, Congressional Research Service, *Ethanol and Biofuels: Agriculture, Infrastructure, and Market Constraints Related to Expanded Production*, March 16, 2007, available at http://collinpeterson.house.gov/PDF/ethanol.pdf.
[16] Ethanol Producer Magazine, *South Dakota Gas Companies Install Blender Pumps*, June 2006, available at http://ethanolproducer.com/article.jsp?article_id=2033.
[17] Roger Ginder, *Potential Infrastructure Constraints on Current Corn-Based and Future Biomass Based U.S. Ethanol*, July 2007, available at http://www.econ.iastate.edu/research/webpapers/paper_12836_07018.pdf.

Pros

Supporters of ethanol assert that it is an environmentally friendly alternative to gasoline. They argue that carbon dioxide emissions from gasoline-powered engines are a significant contributor to global warming. Fuel blends of ethanol such as E85 (85% ethanol, 15% gasoline) can significantly decrease carbon dioxide emissions and help reduce smog, and ethanol is biodegradable in soil and water.[18] As opposed to fossil fuels, ethanol is derived from corn and other renewable forms of crops or vegetation that can be grown in the United States, thus reducing reliance on foreign oil sources. As the industry continues to grow, advances in conversion technologies and hybrid source development may make ethanol production a more efficient and environmentally friendly process.[19]

Proponents also argue that Nebraska and other grain belt states benefit from the growing ethanol industry. Around one-quarter of the state's corn harvest is consumed by Nebraska-based ethanol production facilities, which have created an estimated 4,000 jobs in plants and related businesses throughout rural Nebraska.[20] Supporters like to cite examples like the twenty-five million gallon ethanol plant in Plainview, Nebraska, which created nearly 100 new area jobs directly or indirectly, and pays about $128,000 a year to Pierce County in property taxes. Additionally, "distiller's grain"—the by-product of corn ethanol production—can be consumed by cattle in place of feedstock. Supporters also assert that because Nebraska is the number one producer of irrigated corn and number two producer of cattle in the United States, and has ample access to rail transportation, the economic opportunities associated with ethanol production would make sense for the state.[21]

Cons

Critics of ethanol raise questions about the long-term sustainability of the industry. They argue that corn is a relatively expensive grain to produce after the costs of irrigation, fertilizer, herbicides, transportation, and machinery are factored in, and that the aggregated amount of energy it takes to grow corn and convert it to ethanol is too much to justify its production.[22] In this sense, they assert that ethanol is not a truly "renewable" fuel because producing the amount of corn required to increase ethanol production may have negative effects on the natural environment. This might be of particular concern because water is no longer a free-flowing resource in many parts of Nebraska, and water management has become a significant issue for state lawmakers.[23]

In addition to environmental concerns, critics assert that as the cost of corn rises with demand for ethanol, it may increase the cost of food and other crops.[24] They argue that the price

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[18] Renewable Fuels Association, *Ethanol Facts: Environment*, available at http://www.ethanolrfa.org/resource/facts/environment/.
[19] Joe Duggan, *Water drain vs. Economic gain*, Lincoln Journal Star, July 8, 2007, available at http://journalstar.com/special_reports/ethanol/.
[20] Stacie Hamel, *Ethanol also fueling Midlands economy*, Omaha World-Herald, 2W, January 22, 2006; Ethanol Across America, *Issue Brief: Economic Impacts of Ethanol Production*, Spring 2006, available at http://www.ethanolacrossamerica.net/CFDC_EconImpact.pdf.
[21] Bill Hord, *Ethanol is an economic elixir*, Omaha World-Herald, 1A, June 25, 2006.
[22] Tad Patzek et al., *Ethanol from corn: Clean renewable fuel for the future, or drain on our resources and pockets?* Environment, Development and Sustainability, 319-336, 2005.
[23] Joe Duggan, *Water Drain vs. Economic gain*, Lincoln Journal Star, July 8, 2007, available at http://journalstar.com/special_reports/ethanol/.
[24] Nate Jenkins, *Economist: Biofuel May Raise Food Prices*, Lincoln Journal Star, March 27, 2007.

of beef will rise as cattle ranchers raise prices to compensate for the higher cost of corn feed, and that prices in other grains will rise as more farmers switch over to corn production.

For these and other reasons, critics propose that the country as a whole should focus on other forms of alternative energy. Because hydrogen-conversion, nuclear power, and wind-power are arguably better forms of clean energy, they assert that Nebraska should approach ethanol with caution, and not let the state become too dependent on an industry which might lose favor in the future.

Ethanol and Food Prices

Both proponents and opponents of increased ethanol production have expressed concerns about its relationship to higher food prices. However, ethanol's actual impact on food prices may be smaller than many people believe. In a Senate hearing on global food prices, the Chairman of the President's Council of Economic Advisers, Edward Lazear, stated that "[b]ecause corn only represents a small fraction of the IMF Global Food Index, we estimate that the increase in total corn-based ethanol production has pushed up global food prices by about 1.2 percentage points of the 43% increase in global food prices, or about 3% of the increase over the past twelve months."[25] In other words, the impact of corn-based ethanol production on food prices was quite minimal. Costs related to higher food prices were more due to higher crude oil and transportation prices and not corn-based ethanol production. "Rising energy prices are affecting consumers in the United States more than rising food prices," said Lazear, "The bottom line is that ethanol production is a significant contributor to increases in corn prices, but neither U.S. nor worldwide biofuel production can account for much of the rise in food prices."[26] In addition, a study conducted by the Center for Agriculture and Rural Development in Iowa actually concluded that ethanol production has lowered gasoline prices by $0.29 to $0.40 than it would otherwise be.[27]

Legislation

Since the 1990s, Nebraska has used a variety of approaches to incentivize ethanol production in the state. Currently, the Ethanol Production Incentive Cash Fund—authorized by LB 536 in 2001—provides tax credits for qualifying producers of ethanol.[28] Many producers also qualify for other state business tax related incentive programs, like LB 775—the Employment and Investment Growth Act enacted in 1987—which provides tax breaks to entities that meet investment and employment requirements in Nebraska. Like some other states, lawmakers in Nebraska have also attempted to mandate greater use of ethanol. Introduced in 2006, LB 848 would require most gas sold in Nebraska to include 10% ethanol. Although that bill received early support from corn growers and other agriculture interests, further progress on it has been postponed in the legislature.[29]

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[25] *Testimony of Edward P. Lazear,* Chairman, Council of Economic Advisers, available at http://www.whitehouse.gov/cea/lazear20080514.html.

[26] *Testimony of Edward P. Lazear*, Chairman, Council of Economic Advisers, available at http://www.whitehouse.gov/cea/lazear20080514.html.

[27] Xiaodong Du and Dermot J. Hayes, Iowa Center for Agriculture and Rural Development, *The Impact of Ethanol Production on U.S. and Regional Gasoline Prices and on the Profitability of the U.S. Oil Refinery Industry,* available at http://www.card.iastate.edu/publications/DBS/PDFFiles/08wp467.pdf.

[28] Nebraska Department of Revenue, *Nebraska Ethanol Production Incentive Program*, available at http://www.revenue.ne.gov/fuels/eth_prod.htm.

[29] Nebraska State Legislature 2006 Session, Committee Statement: LB 848.

The United States Congress has also pushed initiatives to promote the use of ethanol, and they have set a goal of 2010 to reduce the use of petroleum-based fuel by 30% across the country. Through the Energy Policy Act of 2005, several conditions were put in place to achieve this goal. Specifically, the amount of bio-fuel mixed with gasoline sold in the United States must increase to 7.5 billion gallons by 2012. This act also mandates that federal and state entities use alternative fuels, and any future vehicle purchases must have alternative fuel capabilities. In addition to the ethanol tax credits provided by the state of Nebraska, the federal government will also make a fifty-one cent per gallon ethanol tax credit available to blenders and retailers until 2020.[30]

[30] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.

Biodiesel

What is it?

Biodiesel is a transportation fuel made from fatty acids found in vegetable oils and animal fats. The most common supply of vegetable oil in the United States comes from soy oil, which is extracted by crushing soybeans. However, almost any kind of animal's fat—and even recycled cooking grease—can be utilized to make biodiesel. Biodiesel is created by separating fatty acids into methyl esters and glycerin. Methyl ester is the chemical name for biodiesel, and once separated from the glycerin, it is blended with diesel fuel for use in vehicles. The remaining by-product, glycerin, can be used for a variety of other commercial purposes, such as making soap, skin-care and other personal hygiene products, and in the food industry. Like ethanol, biodiesel technology has been around for decades, and early diesel engines were even run on peanut oil until petroleum was found to be less costly.[31]

Status in Nebraska

Nebraska produced 190 million bushels of soybeans in 2007, making it the nation's fifth largest producer of soybeans that year.[32] Coupled with its first place ranking in cattle production, Nebraska is well-situated to develop its biodiesel production capacity as both soy oil and cattle products are major sources for biodiesel production. However, there are currently only three biodiesel production plants in the state of Nebraska—in Arlington, Beatrice, and Scribner. Arlington was the only plant in operation during 2006, and it produced 400,000 gallons of biodiesel that year. With two additional facilities coming online in 2007, the projected biodiesel production for 2008 is 61.2 million gallons.[33]

Algae can be used as a source to create biodiesel. (Source: New Mexico State University)

Infrastructure Issues

An advantage of biodiesel is that it functions very much like petroleum diesel. Because of the infrastructure already in place to transport and store petroleum diesel, biodiesel can also be transported using the same infrastructure system with few modifications. However, in addition to there being relatively few biodiesel production facilities in the United States, there is also limited infrastructure for storing biodiesel and few compatible fueling stations.[34] The production, storage, and fueling infrastructure may need to expand in order to support increased demand for biodiesel.

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[31] United States Department of Energy, Alternative Fuels & Advanced Vehicles Data Center, *Biodiesel*, available at http://eere.energy.gov/afdc/fuels/biodiesel.html.

[32] Nebraska Department of Agriculture, *Ag Fact Card*, available at http://www.agr.state.ne.us/facts.pdf.

[33] Nebraska Energy Office, *Nebraska's Biodiesel Production*, available at http://www.neo.ne.gov/statshtml/138.htm.

[34] Joint Service Pollution Prevention and Sustainability Technical Library, *Environmental Issues Topic 16: Biodiesel: The Fastest Growing Alternative Fuel in the United States*, February 2006, available at http://p2library.nfesc.navy.mil/issues/emergefeb2006/index.html.

Pros

When biodiesel is added to common diesel fuel, it reduces the amount of carbon monoxide and sulfur dioxide that is released into the atmosphere. Supporters cite statistics indicating that, compared to petroleum diesel, the production and use of biodiesel can reduce carbon dioxide emissions by 78.5 % and that it has a positive energy balance: for every one unit of energy used to produce a gallon of biodiesel, another 3.24 units of energy are gained.[35] A study conducted for the National Biodiesel Board found that the economic benefits from biodiesel production might be significant. The study estimated that the biodiesel industry—including expenditures on goods, services, and the production of both biodiesel and glycerin—adds $4 billion to the GDP annually.[36]

Cons

Critics point out that production costs for biodiesel can vary according to the feedstock used to manufacture it, as well as production scale and other infrastructure considerations. One study estimates that for a plant that can produce 10 million gallons of fuel, it might cost $1.99 per gallon to produce soy biodiesel, and $1.45 per gallon to produce animal fat biodiesel.[37] Critics also cite storage issues and performance in cold conditions as disadvantages. At low temperatures, biodiesel begins to form wax crystals and can eventually gel, making storage and use in winter potentially problematic. Biodiesel mileage per gallon can also be 2.2% less than petroleum-based diesel in some cases. And while more oxygen in biodiesel reduces its carbon dioxide output, it can also increase the amount of nitrogen oxide released into the atmosphere, which can lead to smog.[38]

Legislation

In 2007, the state legislature created Nebraska's first biodiesel production incentives. LB 343 established a production tax incentive for biodiesel production up to 30% of the amount invested in a facility that produces pure biodiesel, as long as 51% is owned by Nebraska individuals or entities.[39] At the federal level, the Energy Policy Act of 2005 extended tax credits for biodiesel producers through 2008. A tax credit of $1.00 per gallon is available for agri-biodiesel and $.50 per gallon for waste-grease.[40]

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[35] National Biodiesel Board, *Benefits of Biodiesel*, available at http://www.biodiesel.org/pdf_files/fuelfactsheets/Benefits%20of%20Biodiesel.Pdf.

[36] John M. Urbanchuk, LECG, LLC, *Economic Contribution of the Biodiesel Industry, Prepared for the National Biodiesel Board with Funding Support from the United Soybean Board*, November 19, 2007.

[37] Nebraska Soybean Association, *Strategically Locating Soybean and Biodiesel Processing Facilities in Nebraska Executive Report*, available at http://agproducts.unl.edu/NSAexec-summary_aug06.pdf.

[38] Anthony Radich, Energy Information Administration, U.S. Department of Energy, *Biodiesel Performance Costs and Use*, available at http://www.eia.doe.gov/oiaf/analysispaper/biodiesel/index.html.

[39] Nebraska State Legislature 2007 Session, LB 343.

[40] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.

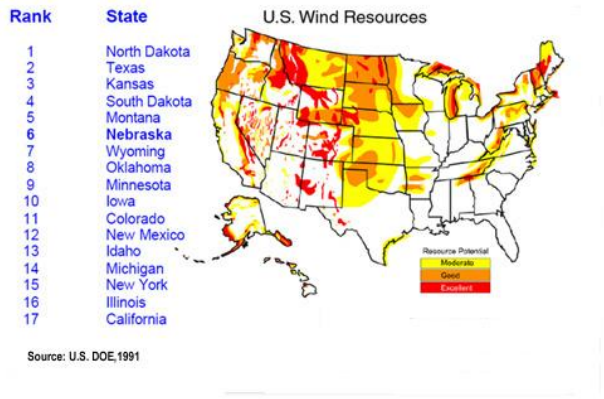
Wind

What is it?

Wind power is a form of solar energy. Wind is created from the sun's uneven heating patterns of the earth, when cooler air moves across land or water to compensate for areas with warmer air.[41] Energy is harnessed from wind through the use of wind turbines, which contain electricity generators connected to utility lines. As wind blows, it turns the generator's turbine blades, creating electricity that can be fed onto the utility lines. The amount of electrical energy generated by a turbine depends on its size and the speed of the wind spinning the turbine. A very small, 10-kilowatt wind turbine powered by 12-mile per hour wind can generate 10,000 kilowatt hours (kWh) of power annually—enough electricity to power an average U.S. household for a year.[42] Much larger turbines grouped together on wind farms can generate millions of watts of power annually.

Status in Nebraska

An early study from 1991 lists Nebraska sixth in the nation for wind energy potential.[43] However, some believe that Nebraska currently lags well behind other states when it comes to harnessing wind power. Nebraska is ranked 21st in installed capacity for wind energy.[44] The first commercial utility-scale turbine operation was developed by Nebraska Public Power District in Springview in 1998, which has since been retired. Currently, there are four large commercial wind energy operations in the state, in Ainsworth, Kimball, Lincoln, and Valley, with a combined potential to generate about 73 megawatts of power. The 36-turbine Ainsworth facility is the largest wind farm in the state, with the capacity to power 19,000 homes annually.[45] Still, Nebraska's total turbine capacity of 73 megawatts trails behind states like Texas, which currently has the largest installed capacity in the country with 2,768 megawatts of power.[46]



Nebraska is ranked sixth in the nation in terms of wind resources. (Source: U.S. Department of Energy)

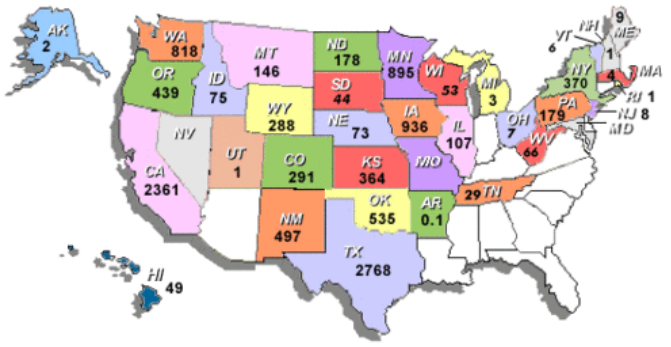
[41] U.S. Department of Energy, Wind & Hydropower Technologies Program, *How Wind Turbines Work*, available at http://www1.eere.energy.gov/windandhydro/wind_how.html.
[42] American Wind Energy Association, *Wind Energy Basics*, available at http://www.awea.org/faq/wwt_basics.html#What%20is%20wind%20energy.
[43] Pacific Northwest Laboratories, *An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States*, Report PNL-7789, 1991, available at http://www.osti.gov/energycitations/basicsearch.jsp.
[44] Nebraska Energy Office, *Installed Wind Energy Capacity Ranked by State*, available at http://www.neo.ne.gov/statshtml/123.htm.
[45] Nebraska Energy Office, *Wind Energy Generation in Nebraska*, available at http://www.neo.ne.gov/statshtml/89.htm.
[46] Nebraska Energy Office, *Installed Wind Energy Capacity Ranked by State*, available at http://www.neo.ne.gov/statshtml/123.htm.

Infrastructure Issues

Nationwide, the development of infrastructure supporting wind energy production has increased in recent years. In 1997, installed wind energy capacity for the United States was less than 500 megawatts of power. In 2007, the projected wind energy capacity for the country was over 3000 megawatts.[47] Still, the main infrastructure challenge facing the wind energy industry is the high cost of installing new transmission lines from windy areas of the country to high-demand electricity markets. According to one estimate, transmission lines can cost between $250,000 to $1 million dollars per mile, depending on the voltage of the lines.[48] Additional issues can complicate the development of new transmission lines, and increase costs. Transmission lines must also be built to accommodate the existence of national parks and wildlife reserves, and be constructed around dense wilderness areas or terrain that is difficult to reach.[49]

Pros

As a form of solar energy, wind power is a natural and potentially unlimited source of electricity. Proponents argue that it does not significantly rely on non-renewable fuels to generate electricity, and does not contribute to the creation of greenhouse gasses. Additionally, some supporters assert that developing commercial wind energy facilities has the potential to facilitate economic development opportunities in rural areas. The U.S. Department of Energy estimates that its plan to produce 5% of the country's electricity through wind energy by 2020 may create 80,000 new jobs and result in $60 billion dollars of investment in rural America.[50] Because commercial turbines only take up a small amount of physical space, individuals can still farm or raise cattle in the same general land-area as a wind operation. Supporters argue that because Nebraska's potential for wind power is high, it could simultaneously serve as a new source for renewable energy and generate income for residents of rural areas, particularly the Sandhills—which is regarded as an especially promising area for wind energy development.



Installed wind energy capacity (in megawatts) in Nebraska trails behind many states. (Source: American Wind Energy Association)

[47] American Wind Energy Association, *Wind Energy Outlook 2007*, Dec. 10, 2007, available at http://www.awea.org/pubs/documents/Outlook_2007.pdf.
[48] George Lauby, *Heineman endorses community-owned wind turbines*, North Platte Bulletin, May 21, 2007.
[49] Energy Information Administration, U.S. Department of Energy, *Background Information and 1990 Baseline Data Initially Published in the Renewable Energy Annual 1995*, available at http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/backgrnd/chap10h.htm.
[50] United States Government Accountability Office, Report to the Ranking Democratic Member, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, *RENEWABLE ENERGY: Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, September 2004, available at http://www.gao.gov/new.items/d04756.pdf.

Cons

Opponents assert that developing Nebraska's wind energy potential may not be cost-justifiable. In addition to the cost of building new commercial turbines, some argue that the state would have to build new transmission lines from western wind power facilities to large population centers like Lincoln, Omaha, and other high-demand urban areas. Developing new lines might require significant funding that may likely have to come from increasing electricity costs to consumers. Currently, the cost of electricity in Nebraska is the fifth lowest in the country, which contributes to the state's livability.[51] The costs of expanding the state's infrastructure might thus fall on consumers across the state through a rise in electricity prices.

Besides geographic issues, another concern is the seasonal variability with which wind turbines produce electricity. The windiest seasons may not align with peak demand times for electricity. Without sufficient storage capabilities, turbine farms may not adequately capture wind energy as efficiently as possible.[52]

Wind turbines near Kimball, NE. (Source: NPPD)

Legislation

State lawmakers have recently enacted legislation to promote greater development of wind energy in Nebraska. In 2007, all 49 of Nebraska's legislators voted for the passage of LB 629, a bill which sets the stage for rural landowners to work with private developers and public power companies to develop wind energy facilities. The bill is based on a Community-Based Energy Development (C-BED) model which has been used successfully in other states. C-BED projects are intended to promote local ownership of wind energy projects and thus keep wind energy profits in the state, particularly in rural areas.[53] Legislators also passed LB 367, which creates state tax exemptions for qualified C-BED projects.[54] Passed in 2006, LB 872 authorized tax credits for renewable energy production generated by "zero-emission" facilities such as wind and solar energy production systems. Tax credits are provided based on production output. For every kilowatt hour of energy generated from zero-emission facilities, producers receive a small credit to reduce their tax liability.[55]

To encourage the development of wind energy projects, the federal government provides several incentives. The Energy Tax Incentive Act of 2005 established Clean Energy Renewable Bonds that would provide financing for state and local governments to receive grants and

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[51] Energy Information Administration, U.S. Department of Energy, *Average Retail Price All Sectors 2007, Current and Historical Monthly Retail Sales, Revenues, and Average Retail Price by State and by Sector (Form EIA-826),* available at http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html.

[52] Energy Information Administration, U.S. Department of Energy, *Background Information and 1990 Baseline Data Initially Published in the Renewable Energy Annual 1995*, available at http://www.eia.doe.gov/cneaf/solar.renewables/renewable.energy.annual/backgrnd/chap10i.htm.

[53] Algis J. Laukitis, *Private ownership of Nebraska's wind energy resources has some lawmakers worried*, Lincoln Journal Star, March 21, 2007.

[54] Nebraska Legislature Research Office, *Session Review, One-Hundredth Legislature, First Session July 2007*, pages 89-92.

[55] Nebraska State Legislature 2006 Session, LB 872.

production incentives for renewable energy production projects.[56] Additionally, the Energy Policy Act of 2005 provides a 2¢ per kilowatt hour tax credit to qualifying wind energy producing entities.[57]

[56] Internal Revenue Service, United States Department of the Treasury, *Internal Revenue Bulleting, Notice 2007-26: Clean Renewable Energy Bonds*, available at http://www.irs.gov/irb/2007-14_IRB/ar17.html.
[57] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.

Solar

What is it?

Solar energy—also known as photovoltaic energy—creates electricity by converting sunlight into electricity using photovoltaic materials, most commonly silicon. The photovoltaic material is comprised of individual solar cells, each of which produce one to two watts of electricity. Solar cells are then combined to create solar panels. Electrons are displaced when sunlight contacts the photovoltaic material and creates an electric current. Electricity produced by solar panels is converted from direct-current electricity to alternate-current electricity before it is transmitted to utility lines. Solar energy can also be stored in batteries for later use.[58]

Status in Nebraska

As of 2005, there was no known large-scale commercial or industrial-level electricity production or consumption from solar power in Nebraska. There are individual homes and small demonstration projects in the state with installed solar energy systems. However, there is little aggregated data available on independent solar energy systems in the state.

Infrastructure Issues

From an infrastructure standpoint, the solar energy industry is still in its infancy. Silicon-based solar panels are widely considered to be quite expensive to manufacture, and many solar industry developers are focusing efforts on concentrating the magnitude with which panels can collect and generate electricity. Infrastructure that could store or transmit solar energy on a wide-scale level is still a ways off.

Pros

Supporters of solar energy point out that it is a completely renewable energy form that utilizes sunlight as its energy source. Every minute of the day, sunlight provides more energy than the earth consumes in a year.[59] This makes solar energy a particularly reliable source of electricity. Proponents also point out that solar power is very environmentally friendly and can be harnessed and stored in batteries to be used whenever needed. Solar panels can be utilized in almost any location, and a solar energy system can be used independently from utility power gridlines.[60] Additionally, solar energy production peaks during the summer months, which is a high-demand time for extra electricity.

Cons

Solar-generated electricity can cost significantly more than electricity derived from fossil fuels or hydropower, primarily because of the high costs of installing a solar energy system. Current solar technology has not advanced to a level where wide-scale production would be possible at a cost-efficient price. The cost to generate photovoltaic energy is $.18-$.23 per

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[58] United States Department of Energy, Energy Efficiency and Renewable Energy, Solar Energy Technologies Program, *Technology*, available at http://www1.eere.energy.gov/solar/pv_basics.html.
[59] Solar Electric Power Association, *A Primer on Solar Photovoltaics and PV Systems*, available at http://www.solarelectricpower.org/index.php?page=basics&subpage=pv&display=facts.
[60] United States Department of Energy, Energy Efficiency and Renewable Energy, Solar Energy Technologies Program, *Technology*, available at http://www1.eere.energy.gov/solar/pv_basics.html.

kilowatt hour[61] versus the average $.07 per kilowatt hour Nebraskans currently pay for household electricity, the majority of which currently comes from coal or nuclear powered plants.[62]

Legislation

New state incentives do exist in Nebraska to produce solar power. However, critics assert that they have minimal impact in encouraging solar energy use. As with wind, in 2006 the state legislature authorized the creation of renewable energy tax credits for solar energy production through LB 872.[63] The Nebraska Department of Energy administers a Dollar and Energy Savings Loan program which makes low interest loans available for residential and commercial energy efficiency improvements. This program can include loans for building or improving a home's solar energy system.[64] The loan program is administered by the state, but is not statutorily-authorized.

Solar panels placed under wind turbines. (Source: Steve Roe)

Additional tax credits and other production incentives are available from the federal government as well. A renewable energy production incentive of up to 1.5¢ per kilowatt hour can be claimed by state and local governments that produce solar and other qualifying forms of renewable energy, although in 2006 the Nebraska Public Power District only received .5¢ per kilowatt hour.[65] Federal law also provides for a 30% tax credit up to $2,000 that citizens can claim for the purchase and installation of residential solar energy systems.[66]

[61] United States Department of Energy, Office of Energy Efficiency and Renewable Energy, *Furthering Energy Independence*, July 2006, available at http://www1.eere.energy.gov/office_eere/pdfs/solar_fs.pdf.
[62] Energy Information Administration, U.S. Department of Energy, *Nebraska Energy Profile, 2006 edition*, *Table 8: Retail Sales, Revenue, and Average Retail Price by Sector, 1990 Through 200*6, available at http://www.eia.doe.gov/cneaf/electricity/st_profiles/nebraska.html.
[63] Nebraska State Legislature 2006 Session, LB 872. Amended through LB 367 of 2007.
[64] Nebraska Energy Office, *Dollar and Energy Savings Loans*, available at http://www.neo.ne.gov/loan/.
[65] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.
[66] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.

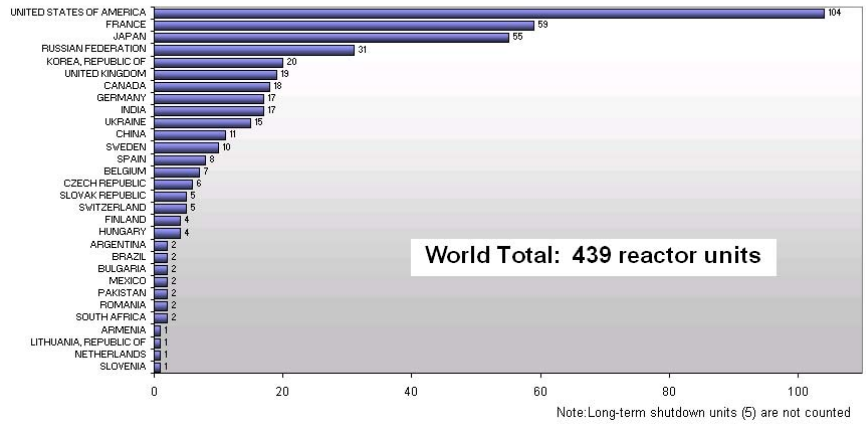
Nuclear

What is it?

Nuclear energy refers to the energy contained within the nucleus of an atom. Uranium is the principal source of fuel used to generate nuclear energy. Small pellets of uranium are placed in metal rods and lowered into a nuclear reactor core. In a process known as nuclear fission, the uranium atoms in the fuel rods are bombarded by neutrons, releasing energy and causing a chain reaction that splits more atoms. The heat generated in the reactor core creates steam or extremely hot water, which is then used to power electricity generating turbines.

After the fission process exhausts the uranium fuel rods, they are removed from the core, and are highly radioactive.[67] Some nations—like France—reprocess spent fuel for subsequent use, which reduces the amount of waste created, albeit at an expensive price. In 1977, the United States ended commercial reprocessing because, although recycled fuel can be re-used in nuclear plants, it can also be used to make nuclear weapons, and thus lead to nuclear terrorism if placed in the wrong hands.[68] Permanent disposal of spent waste remains a high profile issue in the United States.

Currently, there are 439 nuclear power plants in operation world-wide, with a combined power capacity of around 370 gigawatts electric, about 16% of the world's electricity. The United States has 104 operational nuclear reactors, the most in the world, although it only accounts for about 20% of total electricity production in the country.[69]



The United States has the largest number of nuclear reactors in operation.
(Source: International Atomic Energy Association)

Other nations derive a greater portion of their electricity from nuclear power plants. About 78% of France's electricity is generated by nuclear power, followed by Lithuania at 72%, the Slovak Republic at 57%, and Belgium at 54%.

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[67] Energy Information Administration, U.S. Department of Energy, *Introduction to Nuclear Power*, available at http://www.eia.doe.gov/cneaf/nuclear/page/intro.html; U.S. Department of Energy, Office of Civilian Radioactive Waste Management, *Fact Sheet: What are spent nuclear fuel and high-level radioactive waste?* available at http://www.ocrwm.doe.gov/factsheets/doeymp0338.shtml.

[68] Anthony Andrews, *CRS Report for Congress, Nuclear Fuel Reprocessing: U.S. Policy Development*, November 29, 2006, available at http://www.fas.org/sgp/crs/nuke/RS22542.pdf.

[69] International Atomic Energy Association, *Power Reactor Information System: Latest News Related to PRIS and the Status of Nuclear Power Plants*, available at http://www.iaea.org/programmes/a2/; W. Conard Holton, *Power Surge: Renewed Interest in Nuclear Energy*, Environmental Health Perspectives, Vol. 113, No. 11, November 2005.

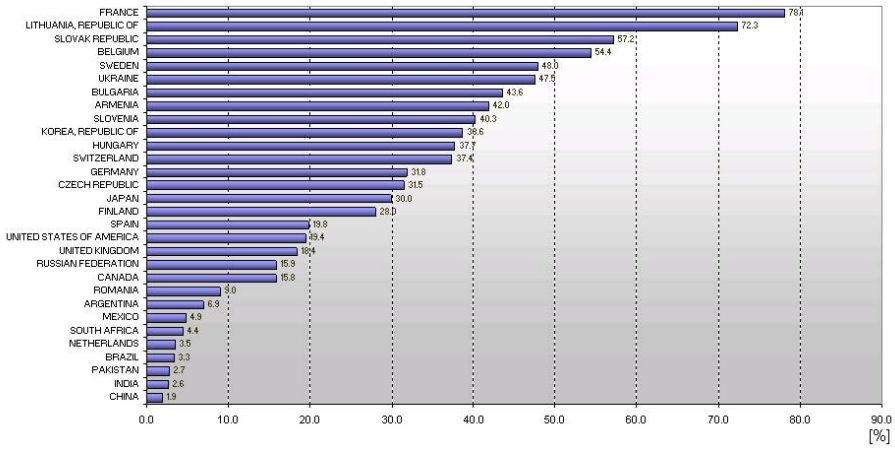
Status in Nebraska

There are two operational nuclear power plants in Nebraska, Cooper Nuclear Station near Brownville, run by Nebraska Public Power District, and Fort Calhoun near Omaha, which is operated by the Omaha Public Power District. In 2006, of the estimated 31.6 million megawatt hours of electricity generated in the state, a little over 9 million megawatt hours were produced by nuclear energy, or about 35%. Nuclear energy was the second leading source of electricity production in the state, followed by coal, which was responsible for about 58% of the state's electricity that year.[70] There is one uranium mine operation in the state—the Crow Butte mine near Crawford in Dawes County, which employs about 75 people.[71]

Throughout the 1990s, Nebraska was involved in a legal dispute over the potential placement of a low-level nuclear waste disposal site in Boyd County pursuant to an interstate compact with Arkansas, Kansas, Louisiana and Oklahoma. A number of utilities sued Nebraska, arguing that the state had acted in bad faith when it delayed and blocked licensing of the waste site.[72] Legal action finally ended in 2004, when a federal court of appeals confirmed a ruling against Nebraska, and the state agreed to pay $140 million in damages.[73]

Infrastructure Issues

Transmission of electricity generated by nuclear reactors is readily available through existing infrastructure. A significant obstacle to expanding the nuclear power industry is that nuclear power plants are quite expensive to build and require public support or subsidies. Construction of new plants can range from $2 to $6 billion.[74] Additionally, the commercial nuclear power industry in the United States is heavily regulated by a variety of state and federal government bureaucracies because of the safety issues involved with production as well as



A number of European nations and Japan derive more electricity from nuclear power than the United States. (Source: International Atomic Energy Association)

[70] Energy Information Administration, U.S. Department of Energy, *Nebraska Electricity Profile, 2006 Edition*, available at http://www.eia.doe.gov/cneaf/electricity/st_profiles/nebraska.html.
[71] Chet Mullin, *Nebraska uranium mine may expand: Rising prices for the nuclear energy fuel spur interest in the Dawes County facility*, Omaha World-Herald, 1A, June 7, 2007.
[72] Scott Bauer, *Nebraska's nuclear-waste fight may head to U.S. Supreme Court*, Associated Press, June 12, 2001.
[73] Entergy Arkansas, Inc. v. Nebraska, 358 F.3d 528 (8th Cir. 2004); *Nebraska helping nuclear waste compact shop around for dump*, Associated Press, May 31, 2005.
[74] Marc Holt, *CRS Issue Brief for Congress, Nuclear Energy Policy*, October 26, 2004, available at http://www.iags.org/CRS_IB88090.pdf.

disposal of spent fuel, making it a relatively slow-growth industry. Permanent storage of nuclear waste is also a significant issue which has yet to be resolved.

Pros

Advocates of nuclear energy point out that it can generate large amounts of electricity without the direct creation of greenhouse gases like carbon dioxide. Supporters thus argue that the United States should re-invigorate nuclear energy production to reduce its current reliance on fossil fuels, match growing energy needs, and help mitigate global warming.[75] One study estimated that human activity accounts for the generation of about 6,500 million tons of carbon equivalent annually. The same study estimated that if 1,000 nuclear plants were operational, under proper conditions those plants would eliminate up to 800-1,800 million tons of carbon equivalent each year if it replaced an equal amount of fossil fuel-based electricity production from coal or natural gas.[76] Although wind and solar power can contribute to a diverse alternative energy portfolio, nuclear energy proponents argue that neither sectors have the infrastructure nor wide-scale production capabilities in place to generate enough energy to replace fossil fuel electricity production.[77] Proponents of nuclear energy also argue that public fears and perceptions of nuclear energy and nuclear energy waste storage are over-exaggerated, and need to be confronted and addressed if the United States is to ever seriously resolve both its rising energy demand and the problem of greenhouse gas emissions.

Cons

Critics of nuclear energy recognize its potential, but are concerned with a variety of issues, the high cost of nuclear plants being one. Safety issues are another concern. The most significant U.S.-based reactor accident occurred at the Three Mile Island plant in Pennsylvania in 1979, when a series of mechanical and electrical mishaps resulted in the partial meltdown of the plant's reactor core, and a subsequent release of radioactive material in the area.[78] Medical research conducted in the years following the accident have not yet shown a strong causal link between the accident and incidence of cancer or other harmful conditions,[79] but many people agree that the accident left a lasting negative impression on the public. The most severe accident in nuclear production history occurred in 1986 at the Chernobyl plant in the Soviet Union, resulting in the evacuation of hundreds of thousands of people, the immediate deaths of about 50 people, and radiation exposure leading to the likely incidence of at least 4,000 cancer cases.[80]

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[75] Peter Schwartz & Spencer Reiss, *Nuclear Now!* Wired, Issue 13.2, February 2005, available at http://www.wired.com/wired/archive/13.02/nuclear.html.

[76] *The Future of Nuclear Power: An Interdisciplinary MIT Study*, 2003, Chapter 1, page 3, available at http://web.mit.edu/nuclearpower/.

[77] Patrick Moore, *Going Nuclear: A Green Makes the Case*, The Washington Post, April 16, 2006, available at http://www.washingtonpost.com/wp-dyn/content/article/2006/04/14/AR2006041401209.html.

[78] United States Nuclear Regulatory Commission, Fact Sheet on the Three Mile Island Accident, available at http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html.

[79] Maureen Hatch et al., *Cancer Rates After the Three Mile Island Nuclear Accident and Proximity of Residence to the Plant*, American Journal of Public Health, Volume 81, Issue 6, June 1991; Evelyn Talbott et a., *Mortality among the Residents of the Three Mile Island Accident Area*: 1979-1992, Environmental Health Perspectives, Vol. 108, No. 6, June 2000.

[80] The Chernobyl Forum 2003–2005: *Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine*, available at http://www.iaea.org/Publications/Booklets/Chernobyl/chernobyl.pdf.

In addition to the outcry generated by the Three Mile Island and Chernobyl accidents, critics of nuclear energy proliferation point to continuing concerns about the proper handling and disposal of high-level radioactive waste generated by nuclear plants. Currently, there is no permanent national repository of spent fuel for the country's nuclear plants, despite decades of federal attempts to secure one. The Department of Energy has designated Yucca Mountain, a federally-owned site 90 miles from Las Vegas, as the location for the repository, but has faced strong opposition from the state of Nevada, and a variety of legal and technical objections. Currently, high-level waste is temporarily stored at nuclear plants and other locations across the country, and critics have expressed worries that temporary holding facilities may be the target of terror attacks or other accidents.[81] The Department of Energy states that high-level radioactive waste is temporarily stored at 121 sites in 39 states.[82] At both of Nebraska's nuclear reactors, waste is stored on-site in temporary pools or in steel-lined concrete containers.[83] Critics of nuclear power argue that it may be irresponsible to expand the industry at a time when the country still cannot find a solution for existing waste.

Legislation

The Unicameral has previously passed legislation related to the transport of hazardous materials including nuclear waste through the state, but has not passed any major legislation directly incentivizing nuclear energy production in Nebraska. On the federal level, the Energy Policy Act of 2005 provides support for the nuclear industry on a variety of levels, including a limited production tax credit for nuclear-produced electricity, financial assistance to help defray the costs of administrative delays for new commercial reactors, support for research, and the extension of a federal plan to indemnify the nuclear industry for liability stemming from accidents.[84] Successful passage of the law was seen as a significant gain for the U.S. nuclear industry.[85]

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[81] Matthew Wald, Energy Department Recommends Yucca Mountain for Nuclear Waste Burial, New York Times, February 15, 2002, available at http://query.nytimes.com/gst/fullpage.html?res=9F03E5DF123FF936A25751C0A9649C8B63&scp=9&sq=yucca+mountain&st=nyt; Shankar Vedantam, Storage of Nuclear Spent Fuel Criticized: Science Academy Study Points to Risk of Attack, Washington Post, March 28, 2005, available at http://www.washingtonpost.com/wp-dyn/articles/A5408-2005Mar27.html; Union of Concerned Scientists, *Nuclear power in a warming world: Assessing the Risks, Addressing the Challenges*, available at http://www.ucsusa.org/global_warming/solutions/nuclearandclimate.html.

[82] U.S. Department of Energy, Office of Civilian Radioactive Waste Management, *Fact Sheet: What are spent nuclear fuel and high-level radioactive waste?* available at http://www.ocrwm.doe.gov/factsheets/doeymp0338.shtml.

[83] Algis J. Laukaitis, *Nebraska seeks spots to store nuclear waste*, Lincoln Journal Star, September 6, 2006.

[84] Energy Policy Act of 2005, P.L. 109-58, 119 Stat. 594.

[85] Michael Grunwald & Juliet Eilperin, *Energy Bill Raises Fears About Pollution, Fraud Critics Point to Perks for Industry*, Washington Post, July 30, 2005, available at http://www.washingtonpost.com/wp-dyn/content/article/2005/07/29/AR2005072901128.html.

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