ELSEVIER

Energy Policy 35 (2007) 5399–5402

ENERGY POLICY

www.elsevier.com/locate/enpol

Viewpoint

How the next US president should slow global warming

Elizabeth Lokey

University of Colorado, USA

Received 28 March 2007; accepted 31 May 2007
Available online 23 July 2007

Abstract

This paper addresses the energy technologies and policies that the next US president should immediately implement to slow global warming. Increased reliance on renewable energy through deployment of a National Renewable Portfolio Standard will help meet increased electrical demand in a sustainable way. Carbon regulation through an internationally fungible cap and trade system will help make renewables more cost competitive with conventional energy. Mandating National Energy Efficiency Portfolio Standards will also help decrease electrical demand and reduce the need for large investments in new generation. Within the transportation sector, plug-in hybrid and electric vehicles should be rapidly deployed to shift this sector's liquid fuel requirements to the electrical grid.

Keywords: Global warming; Renewable energy; Energy efficiency

1. Introduction

The next president of the United States should recognize global warming as the most pressing environmental challenge facing this generation and rally citizens around a coherent energy policy that will help mitigate global warming through long- and short-term federal policy initiatives during the first 100 days in office. In the spirit of the Apollo and Manhattan projects, the president needs to convince the American public that tackling global warming will not be cheap, but its costs will pale in comparison to the damage that would result from a changing coastline, the spread of tropical diseases in the US, and a host of other associated warming threats. The president should explain that the legislation proposed will minimize governmental spending and instead rely on market-based policies to shift the economy away from a dependence on fossil fuels. Unlike past efforts at energy policy, like the Energy Policy Act of 2005, which have lacked focus and allocated sums of money to disparate interests from the oil and gas industries to hydrogen research, the president's plan will make bold steps toward a sustainable energy future that slows global warming by addressing the electric, end-user, and transportation sectors.

2. The electric sector: increased renewables

The president should first address the electrical sector, which accounts for 40% of all greenhouse gas (GHG) emissions (US Department of Energy, Energy Information Agency, 2005). Some types of renewable energy like wind, geothermal, and hydro are already cost competitive with traditional coal and natural gas-based electricity; other forms of renewables that are well-sited and close to being cost-competitive should receive subsidies (Komor, 2004). Currently, 27 states have Renewable Portfolio Standards or Goals, which mandate that utilities derive a portion of their electricity from renewable energy sources (Database of State Incentives for Renewables and Efficiency, 2006). The president should implement a National Renewable Portfolio Standard of at least 20% by 2025, which would decrease overall US emissions by 17.7%, and invest in research and development for improved energy storage of variable resources like solar and wind energy through highly efficient and environmentally benign compressed air energy storage and pumped hydro (Taylor and VanDoren, 2002). States with poor renewable energy sources would be

E-mail address: lokey@colorado.edu

0301-4215/$ - see front matter
doi:10.1016/j.enpol.2007.05.019

eligible for federal subsidies that should decrease the premium of renewable energy over conventional energy. Given the ample solar resources in the Southwest, biomass in the Southeast, geothermal sites in the Northwest, and wind in the West, the US has a plethora of untapped sites for renewable energy generation (Flavin et al., 2006).

Any price differential between renewable energy and conventional energy could be leveled as conventional energy is made to be more expensive through deployment of a national cap-and-trade system for carbon emissions. The next president should ratify the Kyoto Protocol and implement a domestic cap-and-trade system for GHGs that is fungible with the European Trading Scheme. By integrating this trading system into the global marketplace and recognizing international projects that absorb or avoid the emission of carbon as valid allowances, the market will determine the most cost-effective carbon reductions. Adopting carbon emission targets and allocating a limited number of tradable carbon emission allowances to utilities as proposed by the McCain–Lieberman Climate Stewardship Act would help make renewable energy cost competitive with energy derived from fossil fuels (Natural Resources Defense Council, 2005). If the number of allowances given did not satisfy the load-serving entity's emissions, the utility could purchase carbon allowances from another power supplier, replace inefficient equipment, invest in carbon offset projects, utilize carbon scrubbers, or replace its fossil fuel generation with renewables to fulfill its carbon obligations. Later these caps could be applied to airlines, industrial factories, and vehicle owners. Joining the international effort to slow warming will provide a positive example for other large emitters like Australia who have not ratified the Protocol and allow the US to help shape the effort to slow warming in the years after 2012 when the Kyoto Protocol expires.

Since coal and natural gas-based power plants will continue operating until they can be phased out, the carbon released from these fossil fuels could be mitigated by using improved pollution controls. Mercury and sulfur and nitrogen oxides pollution from power plants can be almost completely eliminated with new scrubbers. And, carbon emissions can be reduced by 82% on sunny days and 50% on cloudy days by feeding the stack emissions to algae (Vunjak-Novakovic et al., 2005).

3. Industrial, residential, and commercial sectors: Energy Efficiency Portfolio Standards

In addition to this shift in the electrical and transport sectors, the president should implement energy efficiency standards that help industrial, residential, and commercial energy customers save money and avoid carbon emissions by using less energy to power buildings and factories. Fully exploiting energy efficiency measures could negate the need for new base load electricity as these measures significantly reduce overall energy demand throughout the day and night. This reduced demand will slow the recent momentum for new nuclear facilities, which can fill base load energy demand without emitting carbon, but should not be pursued because of the unresolved problems with nuclear waste storage, proliferation threats, and a limited supply of uranium (Finch, 2002). Power companies could be compensated for their loss in revenues as a result of efficiency measures by either decoupling the company's profits from its sales like power providers in California have done successfully or allowing utilities to charge customers for their lost revenues.[1]

On a per kilowatt-hour (kWh) basis, energy efficiency is cheaper than generation; energy efficiency measures cost an average of 2.9 cents per kWh to implement while conventional electricity derived from coal costs a minimum of 3–4 cents per kWh to generate (Rogers et al., 2004). For each dollar that the federal government invests in energy efficiency standards, $165 is returned to the American public in the form of energy savings (Koomey et al., 1999). Retrofitting an incandescent lighting system with a compact fluorescent one as Wal-Mart currently advocates can decrease energy needs up to 75% (Geller, 2006; Fetterman, 2006). Also, since energy efficiency measures avoid line losses and charges associated with transmission and distribution, they are preferable to the new generation. Improvements in insulation and better design practices like orienting windows to face the South and using strategic overhangs that block summer sun rays can decrease emissions from natural gas and oil, which are used for heating, and reduce electrical usage to run air conditioners.[2] To promote more energy efficiency, the president should follow the lead of several states by implementing a National Energy Efficiency Portfolio Standard that specifies a minimum efficiency of appliances sold and new buildings constructed (Database of State Incentives for Renewables and Efficiency, 2006). Additionally, energy users whose needs per square foot for heat and electricity exceed the national average should be required to pay a carbon tax for each kWh or British thermal unit of natural gas used in excess of the average.

4. The transport sector: transition from liquid fuels

The president's policies toward the transportation sector, which accounts for 32% of GHG emissions (US Department of Energy, Energy Information Agency, 2005), should decrease GHG emissions and reliance on foreign oil by shifting current liquid fuel requirements to the electrical grid. Using the aforementioned reformed electrical grid that relies more on renewable energy, demand side management, and carbon pollution controls to power plug-in hybrid and electric vehicles could decrease overall

[1]Call #8: Decoupling and Other Mechanisms to Address Utility Disincentives for Implementing Energy Efficiency. Environmental Protection Agency, State Energy Efficiency and Renewable Energy Technical Forum, May 19, 2005.

[2]Building Green From Principle to Practice. Natural Resources Defense Council, http://www.nrdc.org/buildinggreen/approach/default.asp.

emissions and reduce US reliance on foreign oil. Eliminating the military infrastructure used to guard oil trade routes and secure our petroleum imports would free up an estimated $132.7 billion annually of taxpayer dollars that could be funneled into this effort (ThinkEquity Partners, 2006).

Since Toyota and General Motors already have plug-in hybrid prototype vehicles (Bullis, 2006) and the current electrical grid could support 84% of the US fleet if all vehicles were converted, plug-ins are a plausible short-term transportation solution (World Business Council for Sustainable Development, 2006). The grid currently supports the largest requirements at any given time, which usually occurs in the middle of hot summer days when appliances and air conditioners are running at full capacity. Therefore, at night, when most people do not use much electricity, the grid has approximately 50% excess capacity. If plug-in hybrid vehicles were charged at night, then this excess capacity could be exploited. Switches that allow vehicles to charge only during these "off-peak" times would ensure that an additional burden was not placed on the electrical grid during the day.

Plug-in hybrids, just like hybrids on the market today, would undoubtedly cost more than internal combustion engine vehicles with comparable performance (US Department of Energy, Office of Energy Efficiency and Renewable Energy). However, this cost differential could be paid for in part by utility companies since plug-in and electric vehicles could be docked during the day at stations that allow the electrical grid to use the car's battery as storage. When the grid experiences high demand, the energy stored in car batteries could be utilized to supplement current needs. In this way, these vehicles could absorb excess wind or solar energy placed on the grid at random times and provide electricity that could be dispatched when needed (Kemption et al., 2001). Plug-in hybrids would be more economical to fuel since it costs only an average of 2.7 cents per mile to charge the battery as opposed to 11.5 cents per mile to fuel a gas-powered car.[3] Adding a carbon tax to the price of gasoline so that US prices at least double and are similar to those in Western Europe would make these fuel savings even more important and help shift the market to favor plug-in hybrids (AA Roadwatch.ie, 2007).

Plug-in hybrids do still rely in part on gasoline and emit some tailpipe emissions; therefore, long-term transportation solutions also must be sought. The liquid fuel requirement of plug-in hybrids could most likely be eliminated in the near future as electric vehicles are further refined. Currently, drivers want to be able to travel about 300 miles before refueling or recharging. This range is not yet possible for a battery-powered vehicle because the battery storage would cause the car to be prohibitively heavy. However, as light-weight, energy-dense batteries are refined, this type of travel may soon be possible in a vehicle that has no liquid fuel. A company called Tesla Motors has developed an electric car that can outperform some sports vehicles by using a lithium-ion battery (Berdichevsky et al., 2007; Lerner, 2007). Further refining of high energy density batteries could also allow for faster recharging so that electric vehicle drivers could "power-up" at retrofit gas stations in a matter of minutes. Or, batteries could be designed for easy removal, and drivers could swap depleted batteries with charged ones at gas stations.

Although plug-in hybrid and electric vehicles are the most technically feasible and economically viable short-term alternative to petroleum, many Americans believe that ethanol or hydrogen could supply future US transport needs. These beliefs are popular because of the recent attention these alternatives have been given by President George W. Bush in the 2003 and 2005 State of the Union Addresses and the $5.78 billion (ethanol) and $4.06 billion (hydrogen) authorized to be spent on them in the Energy Policy Act of 2005.[4] The next president should redirect these research dollars into the aforementioned transportation programs because neither hydrogen nor ethanol will provide viable alternatives to petroleum in the short term.

Switching to ethanol seems to be an easy transition because the US has an infrastructure that currently supports liquid fuels. However, the pipeline system of the US could not be utilized to transport this new fuel since it was designed for non-corrosive materials that do not mix with water. Ethanol would have to be transported by glass-lined or stainless steel pipes or trucks (Whims, 2002). The fossil fuel inputs to grow, harvest, refine, and transport the inputs for ethanol mean that it is far from being a carbon-neutral (Patzek, 2004). A lifecycle analysis of the embodied energy in ethanol production from corn shows that the process requires 29% more fossil energy than the fuel produces (Pimental, 2003). Furthermore, in order to provide enough ethanol to support just one-third of US vehicles, more cropland than is currently used to feed all US citizens would be needed (Pimental and Patzek, 2005). Brazil is able to serve half of its country's needs with ethanol because of its lower fuel demand and climate which supports sugarcane, a feedstock with an energy content eight times that of corn (Brown, 2006). Cellulosic ethanol made from fibrous material like corn husks has the potential to yield up to three times as much energy as corn, but the processes and enzymes necessary to break down cellulosic material are currently expensive and the problem of how to transport high-volume, low-density crop residue from fields to a biorefinery in an economical way remains unsolved. (Kaylen et al., 2000; Lynd, 1996).

[3] Electrical efficiency of PHEV is .3 kWh/mile (Unpublished National Renewable Energy Laboratory PHEV report by Paul Denholm). At an average electricity price of 9 cents per kWh (Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, Energy Information Agency, 2005), the cost per mile is 2.7 cents. At $3 per gallon of gasoline, a vehicle with a fuel efficiency of 26 miles per gallon costs 11.5 cents per mile to drive.

[4] Cost Analysis of the Energy Policy Act of 2005, by title, Taxpayers for Common Sense, http://www.taxpayer.net/energy/2005EnergyBillCostAnalysis.htm.

Hydrogen has also been touted as the next transportation fuel. However, myriad challenges with respect to proton exchange membrane fuel cell durability and how the hydrogen is isolated from other atoms, stored, and transported lead many experts to the conclusion that "it is unlikely that hydrogen will ever become an important energy carrier in a sustainable energy economy" (Bossel, 1835).

5. Conclusion

In summary, the next president should address the nation with a sense of urgency about global warming, presenting this challenge as an opportunity for new technological innovation, and take aggressive steps to support

1) National Renewable Energy Portfolio Standards of at least 20% by 2025,
2) Ratification of the Kyoto Protocol and implementation of a globally integrated cap-and-trade system for carbon emissions from power plants and eventually other polluting industries,
3) National Energy Efficiency Portfolio Standards that mandate minimum efficiency standards for appliances, new buildings, and a carbon tax for existing inefficient buildings, and.
4) Rapid research, development, and deployment of plug-in hybrids and continued research on electric vehicles.

If these policies are implemented through policy instruments like a market-based cap-and-trade system for carbon, American taxpayers should not have to pay more, but instead will only see their taxes allocated to different, more attainable and sustainable energy alternatives. These bold initiatives from the US will involve the global community as they provide an excellent example for developing countries to follow and prompt innovation in other developed countries.

References

AA Roadwatch.ie, 2007. Latest European Petrol Prices: Price Comparisons—Surveyed in April, April 16, 2007 〈http://www.aaroadwatch.ie/eupetrolprices/〉.

Berdichevsky, G., Kelty, K., Straubel, J.B., Toomre, E., 2007. The Tesla Roadster Battery System. Tesla Motors Inc., August 16, 2006.

Bossel, U., 1835. Does a hydrogen economy make sense. Proceedings of the IEEE 94 (10).

Brown, L., 2006. How food and fuel compete for land. The Globalist February 1.

Bullis, K., 2006. GM's Plug-in Hybrid, Technology Review. MIT Press, Cambridge, MA.

Database of State Incentives for Renewables and Efficiency, 2006. Summary Tables. December 26, 2006 〈http://www.dsireusa.org/〉.

DSIRE: Database of State Incentives for Renewables and Efficiency, Arizona Incentives for Energy Efficiency, 2006. NC State University.

Fetterman, M., 2006. Wal-Mart grows 'green' strategies. USA Today, September 9, 2006.

Finch, W.I., 2002. Uranium—Fuel for Nuclear Energy 2002. US Geological Survey, Bulletin 2179-A.

Flavin, C., et al., 2006. American Energy: The Renewable Path to Energy Security. Worldwatch Institute and Center for American Progress, September 2006.

Geller, H., 2006. Compact Florescent Lighting, American Council for an Energy Efficient Economy 〈http://www.aceee.org/press/op-eds/op-ed1.htm〉.

Kaylen, M., Van Dyke, D.L., Song-Choi, Y., et al., 2000. Economic feasibility of producing ethanol from lignocellulosic feedstocks. Bioresource Technology 72 (1), 19.

Kemption, W., Tomic, J., Letendre, S., Brooks, A., Lipman, T., 2001. Vehicle to Grid Power: Battery, Hybrid, and Fuel Cell Vehicles as Resources for Distributed Power Generation in California. UC Davis, June 1, 2001.

Komor, P., 2004. Renewable Energy Policy. iUniverse, Inc., Lincoln, NE, p. 7.

Koomey, J.G., Mahler, S.A., Webber, C.A., McMahon, J.E., 1999. Projected regional impacts of appliance efficiency standards for the US residential sector. Energy 24 (1), 69.

Lerner, P., 2007. Can 6,831 laptop batteries change the World? Popular Science, May.

Lynd, L.R., 1996. Overview and evaluation of fuel ethanol from cellulosic biomass: technology, economics, the environment, and policy. Annual Review of Science and the Environment 21, 403.

Natural Resources Defense Council, April 2005. A Responsible Energy Plan for America, 2005. available at 〈www.nrdc.org〉.

Patzek, T., 2004. Thermodynamics of the corn–ethanol biofuel cycle. Critical Reviews in Plant Sciences 23 (6), 519–567.

Pimental, D., 2003. Ethanol fuels: energy balance, economics, and environmental impacts are negative. Natural Resources Research 12 (2).

Pimental, D., Patzek, T.W., 2005. Ethanol production using corn, switchgrass, and wood; biodiesel production using soybean and sunflower. Natural Resources Research 14 (1).

Rogers, C., Messenger, M., Bender, C., 2004. Funding and Savings for Energy Efficiency Programs 2000–2004. California Energy Commission 〈http://www.fypower.org/pdf/CEC%20_Trends2000-04.pdf〉.

Taylor, J., VanDoren, P., 2002. Evaluating the Case for Renewable Energy: Is Government Support Warranted? Policy Analysis, No. 422, January 10, 2002, The Cato Institute, available at 〈www.cato.org〉.

ThinkEquity Partners, 2006. GreenTech Newsletter: Renewable Subsidies, 12/22/06, p. 6.

US Department of Energy, Energy Information Agency, 2005. Emissions of Greenhouse Gases in the United States, 2004. Report 0573, released December 2005.

US Department of Energy, Office of Energy Efficiency and Renewable Energy. Hybrid Electric Vehicles: HEV Cost Calculator 〈http://www.eere.energy.gov/cleancities/hev/cost_calc.html〉.

Vunjak-Novakovic, D., Kim, Y., Wu, X., Berzin, I., Merchuk, J.C., 2005. Air-lift bioreactors for algal growth on flue gas: mathematical modeling and pilot-plant studies. Industrial and Engineering Chemistry Research 44, 6154–6163.

Whims, J., 2002. Pipeline Considerations for Ethanol. Department of Agricultural Economics, Kansas State University, August 2002.

World Business Council for Sustainable Development, 2006. Mileage from megawatts: enough grid capacity to charge plug-in vehicles. GreenBiz Magazine, December 12, 2006.