SUSTAINABLE ENERGY STUDY #20

Renewable Energy Mandate Could Lower US CO2 Emissions 22 Percent - Executive Summary of Analysis of Energy and Economic Impacts of Implementing Both a 25-Percent RPS and a 25-Percent RFS by 2025:

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http://www.eia.doe.gov/oiaf/servicerpt/eeim/execsummary.html

Background

This report responds to a request by Senator James Inhofe for analysis of a "25-by-25" proposal that combines a requirement that a 25-percent share of electricity sales be produced from renewable sources by 2025 with a requirement that a 25-percent share of liquid motor transportation fuel sales also be derived from renewable sources by 2025. The electricity requirement is implemented as a renewable portfolio standard (RPS), while the motor fuel standard is implemented as a renewable fuel standard (RFS).

The RPS establishes a market for renewable energy credits, which will be created by the generation of electricity from qualified renewable generators (e.g., wind, geothermal, biomass, and solar). Electricity retailers must hold RPS credits in proportion to the amount of electricity they sell. Electricity providers can generate their own renewable electricity or trade renewable electricity credits to assure compliance. Similarly, the RFS establishes a market for renewable fuel credits, based on the amount of ethanol or other biofuels sold for motor transportation. Transportation fuel providers must hold RFS credits in proportion to the amount of motor transportation fuels they sell.

This study compares a Policy Case incorporating the 25-by-25 proposal to an updated version of the Reference Case from the Energy Information Administration's (EIA's) Annual Energy Outlook 2007 (AEO2007).[1] Revisions to the Reference Case for this analysis included: expiration of existing ethanol tax credits and tariffs as currently scheduled by law; updates to supply curves for domestic biomass and corn resources; inclusion of offshore wind technology; and updates of the potential for ethanol imports from Brazil.

Analysis Issues

All long-term projections contain considerable uncertainty. This analysis suggests that, to comply with the twin 25-by-25 mandates, it will be necessary for electricity and motor fuel producers to dramatically increase their use of technologies that play a relatively small role in

today's energy markets. For example, the amount of qualifying renewable generation needed to comply with the RPS would require almost a 13-fold increase in non-hydropower renewable generation from 2005 levels by 2025. Similarly, the amount of ethanol and biodiesel needed to comply with the RFS would require more than a 12-fold increase from 2005 levels.

Big changes in the energy system, especially when implemented quickly, come with numerous uncertainties, the impacts of which may not be fully captured in this study. For example, compliance with the twin 25-by-25 mandates would require successful development and rapid deployment of new technologies, such as biomass gasification power plants and cellulosic ethanol plants, that currently are not commercially available. Policy case results are very sensitive to assumptions made regarding the cost and availability of key technologies. Even current technologies, such as wind power, engender significant uncertainties. Once the most economical wind resources are utilized, less attractive resources would have to be developed, with costs that are not well understood.

While a strong push for renewable energy technologies could lead to significant reductions in their costs through breakthroughs or learning, it is also possible that costly hurdles—such as resistance to the siting of new plants, higher than expected transmission interconnection costs, and fuel supply limits—could arise, limiting the development and deployment of renewable energy technologies, and making the proposed mandates much more disruptive and possibly unattainable.

The large increases in bioenergy resources, including corn and other energy crops, that would be needed to comply with the 25-percent RPS and RFS requirements could have significant impacts on agricultural markets and put upward pressure on food and feed prices worldwide. While very rapid improvements in crop yields could limit such pressures, there is considerable uncertainty about the potential for and timing of such improvements. The RFS would also require rapid market penetration of Flex Fuel Vehicles (FFVs) and development of the infrastructure needed to deliver E85 and biodiesel to consumers. As requested, this study assumes that the Senate Bill 23 (S.23) provisions requiring the sale of FFVs and installation of E85 pumps would be put in place.

In addition to technological uncertainties, the Policy Case implies structural changes in the U.S. economy that are not readily apparent from the aggregate impacts on gross domestic product (GDP) or energy prices. Implementation of the proposed RFS policy is likely to involve a major realignment of current capital investment plans and strategies for refiners, automotive manufacturers, and others. For example, substantial capital investment would be needed to put the E85 infrastructure in place to meet the requirements under the RFS policy.

The results of this analysis also suggest that the 25-percent requirement for renewable motor fuel use would significantly increase the use of corn in ethanol production, leading to sharply higher corn prices, substantial changes in domestic feed practices, and large cuts in or elimination of corn exports. The uncertainties inherent in implementing this policy suggest that, while not impossible, it would be very challenging and carry substantial risk.

Key Results

Electricity Sector Impacts

The RPS causes a dramatic shift away from coal and natural gas to renewable fuels, particularly biomass and wind.

Coal-fired electricity generation in the Policy Case is 938 billion kilowatt-hours (28 percent) lower in 2030 than in the Reference Case. Natural-gas-fired generation is 99 billion kilowatt-hours (11 percent) lower in 2030. Generation from nuclear power is 80 billion kilowatt-hours (9 percent) lower in 2030.

In the Policy Case, biomass generation is 495 billion kilowatt-hours (363 percent) higher in 2030 than in the Reference Case, while wind generation is 424 billion kilowatt-hours (824 percent) higher. To reach the generation levels in the Policy Case, biomass and wind capacity grow to more than 10 times their current levels.

To comply with a 25-percent RPS, almost 70 percent of the generating capacity added from 2005 to 2025 would have to be renewable technologies—amounting to more than a 10-fold increase in non-hydroelectric renewable capacity over this period.

The RPS credit price and the growing dependence on higher-cost renewables lead to higher electricity prices and higher consumer electricity bills, particularly in 2025 and beyond.

Average retail electricity prices are 6.2 percent (0.5 cents per kilowatt-hour in 2005 dollars2) higher in the Policy Case than in the Reference Case in 2030. The RPS credit price generally increases through 2025, when the maximum required share for renewable generation is initially imposed. From 2025 to 2030, the RPS credit price is projected to vary between 3.8 and 4.8 cents per kilowatt-hour.

In the Policy Case, annual consumer expenditures on electricity are very close to those in the Reference Case through 2022, as the reduction in fuel prices caused by lower fossil fuel use for electric power generation outweighs the increased capital costs of new renewable generation capacity. After 2023, the net capital investment costs of meeting the RPS and the higher renewable fuel costs outweigh the changes in fossil fuel prices, and electricity expenditures are higher than in the Reference Case. Consumer expenditures for electricity in the Policy Case are $16 billion (3.9 percent) higher in 2030; however, the higher electricity bills are partially offset by lower natural gas bills.

Cumulative (undiscounted) expenditures for electricity for the period 2009-2030 are about $65 billion (about 0.8 percent) higher than in the Reference Case, while cumulative discounted expenditures are $15 billion (0.4 percent) higher.

Liquid Fuels and Transportation Sector Impacts

The RFS mandate results in dramatic increases in biofuels consumption and reduced consumption of petroleum-based fuels.

To meet the RFS requirements in the Policy Case, ethanol production increases more than 4-fold over production in the Reference Case in 2025. In the Policy Case, about 30 billion gallons of ethanol is sold in 2020, 61 billion gallons in 2025, and 66 billion gallons in 2030. In the Reference Case, only 11 billion gallons of ethanol is sold in 2020, 13 billion gallons in 2025, and 16 billion gallons in 2030.

In 2025, the E85 share of the gasoline pool is over 30 percent in the Policy case, compared to less than 1 percent in the Reference Case.3 Such a shift would require massive investment to ensure that vehicles and delivery and refueling infrastructure are in place to meet the needs of the market.
Corn-based ethanol production in the Policy Case increases to about 25.5 billion gallons in 2025 and 2030, almost triple the 9.0 billion gallons produced from corn in the Reference Case in 2025. In the Reference Case, corn-based ethanol production increases to nearly 12 billion gallons in 2030.

Cellulosic ethanol technology is assumed to become commercially available in 2010, but the relatively high capital costs of cellulosic ethanol plants is initially a significant barrier to its adoption. After 2015, with RFS credit prices and corn prices rising in the Policy Case, cellulosic ethanol becomes more economical, and production grows to about 8 billion gallons in 2020, 28 billion gallons in 2025, and more than 31 billion gallons in 2030.

Increased ethanol imports meet part of the high biofuel requirement of the proposed RFS policy. In the Policy Case, ethanol imports grow to 8 billion gallons (137 percent more than in the Reference Case) in 2025 and 9 billion gallons (158 percent more than in the Reference Case) in 2030.

Consumption of petroleum products4 is significantly reduced. Relative to the Reference Case, nonrenewable liquid fuel use is about 2.3 quadrillion Btu (5 percent) lower in 2020, 5.3 quadrillion Btu (11 percent) lower in 2025, and 6.0 quadrillion Btu (12 percent) lower in 2030. The RFS mandate increases transportation energy prices and consumer expenditures for transportation fuels.

The projected retail price of gasoline in the Policy Case increases by about 10 cents per gallon (5 percent) in 2020, 28 cents (1.3 percent) in 2025, and 24 cents (1.1 percent) in 2030 relative to Reference Case prices. Diesel fuel price increases are somewhat greater than those for gasoline, because production of biodiesel is not large enough to affect the price of diesel imports.

Consumer expenditures on liquid transportation fuels increase by $28 billion (about 5.4 percent) in 2020 and about $50 billion (8 percent) in 2030 in the Policy Case relative to the Reference Case.

Cumulative undiscounted transportation energy expenditures by consumers from 2009 to 2030 are about $562 billion higher in the Policy Case than in the Reference Case. Cumulative discounted expenditures over the same period are $193 billion higher in the Policy Case than in the Reference Case.

The RFS credit price, which reflects the payment above market value that is required to bring the marginal gallon of renewable fuel to market in the Policy Case, is $2.18 per gallon in 2025 and falls to $2.02 per gallon in 2030.

Higher prices contribute to a reduction in transportation demand for liquid motor fuels on an energy basis.

Total demand for light-duty vehicle travel is 1.6 percent (62 billion vehicle miles) lower in 2025 and 2.2 percent (93 billion vehicle miles) lower in 2030 in the Policy Case than in the Reference Case.

In the last decade of the projection period, higher fuel prices in the Policy Case cause a shift in consumer preference from light trucks to cars. By 2030, the shift more than makes up for the drop in fuel economy resulting from lower sales of hybrid and diesel vehicles.

On an energy basis, transportation liquids consumption in 2030 decreases by 2.5 percent, from 38.2 quadrillion Btu in the Reference Case to 37.2 quadrillion Btu in the Policy Case.

Other Energy Impacts

Increasing the use of renewable motor fuels leads to higher overall consumption of primary energy, in part because of the significant use of energy in the conversion from biomass to ethanol.

Projected primary energy use from coal, oil, natural gas, and nuclear fuel is reduced substantially. Compared to the Reference Case, total nonrenewable primary energy use is nearly 6.4 percent lower in 2020, 13 percent lower in 2025, and 14.1 percent lower in 2030 in the Policy Case.

   o   The reduction in coal, nuclear fuel, and natural gas energy use is primarily driven by the RPS. In the Policy Case, coal use is 3.0 quadrillion Btu (12 percent) lower in 2020, 5.7 quadrillion Btu (21 percent) lower in 2025, and 7.2 quadrillion Btu (23 percent) lower in 2030 than in the Reference Case. Between 2020 and 2030, the corresponding decrease in natural gas consumption ranges from 15 percent to 26 percent. The reductions in nuclear power are smaller than 10 percent in all years.

   o   The reduction in petroleum consumption and the increase in biofuels consumption of ethanol and biodiesel are driven by the RFS. Relative to the Reference Case, petroleum consumption in the Policy Case is 11.4-percent (2.8 million barrels per day) lower in 2025 and 12.1-percent (3.1 million barrels per day) lower in 2030.

The demand for imported crude oil and petroleum products, excluding ethanol imports, is reduced by approximately 0.8 million barrels per day in 2020, 2.1 million barrels per day in 2025, and 2.4 million barrels per day in 2030. Domestic crude oil production is minimally affected in the Policy Case, but refinery gain is reduced due to reduced refining activity and

natural gas liquids production falls with the reduction in natural gas production resulting primarily from the RPS.

On the basis of energy content, the RFS credit price in the Policy Case is significantly higher ($25.80 per million Btu in 2025 and $23.90 per million Btu in 2030) than the RPS credit price for the electricity sector ($11.20 per million Btu in 2025 and $14.10 per million Btu in 2030). In other words, the difference in cost between renewable transportation fuels (in this case, ethanol) and fuels that are used for motor fuel transportation in the Reference Case is larger than the corresponding cost difference in electricity generation costs.

Greenhouse Gas Emissions Impacts

Total U.S. energy-related carbon dioxide emissions in the Policy Case are 1,138 million metric tons (14 percent) lower in 2030 than in the Reference Case; however, they remain 831 million metric tons (14 percent) above 2005 levels. Carbon dioxide emissions from the U.S. transportation sector are reduced by 370 million metric tons (14 percent) in 2030, while electricity sector emissions are reduced by 724 million metric tons (22 percent).

Biomass and Corn Market Impacts

Biomass consumption for energy uses in the Policy Case rises from less than 30 million tons in 2005 to 571 million tons in 2030, as the power sector and the transportation sector compete for biomass to meet their respective requirements. This level of consumption nearly exhausts the biomass supply represented in the Reference Case, placing upward pressure on biomass prices and raising uncertainty about the ability of the agricultural sector to provide the amounts of biomass that would be required in the Policy Case.

In the Policy Case, the price of biomass rises from approximately $1.70 per million Btu (roughly $30 per ton) in 2005 to about $5.10 per million Btu (over $88 per ton) in 2030.

Approximately 9.2 billion bushels of the total 2025 corn production is used to make ethanol in the Policy Case, up from 3.4 billion bushels in the Reference Case. As a result, less corn is available for food and feed.

Corn prices in the Policy Case increase to about $6.50 per bushel in 2025 (compared with $3.00 per bushel in the Reference Case), then fall to about $6.20 in 2030. Demand for corn-based ethanol remains flat from 2025 to 2030, because of increased cellulosic ethanol production.

Economic Impacts

Achieving the 25-percent renewable fuel target in both the electricity generation and transportation fuel markets leads to higher energy prices, as producers substitute more expensive renewable fuels for less expensive fossil fuels. Higher energy prices reduce economic activity.

Total GDP losses (discounted at a rate of 4 percent) in the Policy Case relative to the Reference Case over the 2009-2030 period are $296 billion (0.12 percent).

Cumulative discounted losses in consumer expenditures in the Policy Case relative to the Reference Case over the 2009-2030 period are $149 billion (0.10 percent).