SR/OIAF/2007-03

Impacts of a 15-Percent Renewable Portfolio Standard

June 2007

Energy Information Administration
Office of Integrated Analysis and Forecasting
U.S. Department of Energy
Washington, DC 20585

Preface and Contacts

The Energy Information Administration (EIA) is the independent statistical and analytical agency within the Department of Energy. EIA provides timely, high-quality energy information and prepares objective, transparent analyses for use of Congress, the Administration, and the public. EIA does not, however, take positions on policy issues. Because of EIA's statutory independence with respect to the content of its energy information program, the analysis presented herein is strictly its own and should not be construed as representing the views of the U.S. Department of Energy or the Administration.

The model projections in this report are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The reference case projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Thus, they provide a policy-neutral starting point that can be used to analyze policy initiatives. EIA does not propose, advocate, or speculate on future legislative and regulatory changes. All laws are assumed to remain as currently enacted; however, the impacts of scheduled regulatory changes, when defined, are reflected.

The Office of Integrated Analysis and Forecasting prepared this report. General questions concerning the report can be directed to John J. Conti (john.conti@eia.doe.gov, 202/586-2222), Director of the Office of Integrated Analysis and Forecasting, and J. Alan Beamon (joseph.beamon@eia.doe.gov, 202/586-2025), Director of its Coal and Electric Power Division. Specific questions about the report can be directed to the following analysts:

Renewable Analysis.....Chris Namovicz (cnamovicz@eia.doe.gov, 202/586-7120)
Robert Smith (robert.smith@eia.doe.gov, 202/586-9413)
Electricity…….Jeffrey Jones (Jeffrey.jones@eia.doe.gov, 202/586-2038)

For ordering information and questions on other energy statistics available from EIA, please contact EIA's National Energy Information Center at:

National Energy Information Center, EI 30
Energy Information Administration
Forrestal Building
Washington, DC 20585

Telephone: 202/586-8800
TTY: 202/586-1181
FAX: 202/586-0727
E-mail: infoctr@eia.doe.gov
World Wide Web Site: http://www.eia.doe.gov/
FTP Site: ftp://ftp.eia.doe.gov/

Contents

Tables

Figures

Executive Summary

This report responds to a request from Senator Jeff Bingaman asking EIA to analyze a renewable portfolio standard (RPS) requiring that 15 percent of U.S. electricity sales be derived from qualifying renewable energy resources. The proposal exempts smaller electricity providers – those with fewer than 4 billion kilowatthours in annual sales – from meeting the requirement, and would not allow current generation from existing hydroelectric and municipal solid waste facilities to meet the requirement. However, retail sellers who generate from existing hydroelectric and municipal solid waste facilities are allowed to exclude this generation from their sales base when calculating their required renewable share. The RPS would allow affected electricity providers to generate their own renewable energy or trade renewable energy credits to assure compliance. Compliance could also be achieved by purchasing credits from the government at an inflation-adjusted rate of 1.9 cents per kilowatthour credit. Generation from distributed generators, represented by end-use photovoltaic installations in this analysis, would earn three credits for every kilowatthour of generation. The RPS requirement runs through 2030 and then sunsets.

Key results include:

- After adjusting for the small electricity provider exemption and the removal of generation from existing hydroelectric and municipal solid waste facilities from the sales base, the target for qualifying renewable generation is equivalent to approximately 12 percent of total electricity sales in 2030.

- Between 2020 and 2030, the projected market value of renewable energy credits is 1.9 cents per kilowatthour, the price at which they can be purchased from the Federal government.

- The RPS leads to a large increase in biomass generation, which grows to almost 320 billion kilowatthours in 2030, triple the level in the reference case. Wind and photovoltaics also show significant increases in generation.

- By 2030, solar installations produce about 8 percent of qualifying renewable generation, but account for approximately 20 percent of the total credits held because of the triple credits awarded to distributed photovoltaics.

- The increased use of renewable sources in the RPS case leads to lower coal generation. Nuclear and natural gas generation are also lowered to a lesser degree.

- Relative to the reference case, retail electricity prices rise by an average of 0.9 percent over the 2005 to 2030 period in the RPS case. Reduced demand for coal and natural gas in the RPS case results in slightly lower prices for these fuels by 2030 when compared to reference case projections.

- Compared with the reference case, end-use sector expenditures for electricity rise while end-use sector expenditures for natural gas fall. From 2005 through 2030, cumulative expenditures for electricity and natural gas by all end-use sectors taken together (all dollars are 2005 dollars, cumulative calculations are discounted at 7 percent) by all end-use sectors are $18 billion (0.3 percent) higher.

- Compared with the reference case, cumulative residential expenditures on electricity from 2005 through 2030 are $7.2 billion (0.4 percent) higher, while cumulative residential expenditures on natural gas are $1.0 billion (0.1 percent) lower.

- Total electricity-sector carbon dioxide emissions are reduced by 222 million metric tons (6.7 percent) in 2030 relative to the reference case. Electricity-sector carbon dioxide emissions are projected to account for 40 percent of total energy-related carbon dioxide emissions in 2030. Over the 2005 to 2030 period, cumulative energy-related carbon dioxide emissions are reduced by 2,925 million metric tons (1.7 percent).

- Projected impacts of an RPS on expenditures for electricity and natural gas in end-use sectors are sensitive to assumptions made regarding the projected generation fuel mix in the reference case. Generally, an RPS proposal has more favorable effects on end-use sector expenditures for electricity and natural gas (i.e. smaller expenditure increases or larger expenditure decreases) as the role of natural gas in the baseline generation mix increases, since a higher natural gas generation baseline results in more displacement of natural gas by an RPS. The *AEO2007* reference case, the baseline for the current analysis, projects considerable additions of new coal-fired generating capacity between 2015 and 2030. To the extent that natural gas plays a larger role in the future generation mix, the RPS proposal considered in this analysis would have more favorable impacts.

1. Background

This service report was prepared by the Energy Information Administration (EIA), in response to a May 9, 2007, request from Senator Jeff Bingaman for an analysis of a Federal renewable portfolio standard (RPS). The request letter and the RPS proposal are provided as appendices A and B to this report. An RPS is a policy that requires covered electricity retailers to supply a specified share of total electricity sales from qualifying renewable energy resources. As of the end of 2006, 23 States and the District of Columbia had enacted an RPS or similar renewable energy requirement. The Federal RPS analyzed here would apply to electricity retailers on a nationwide basis, establishing a target level for the market share of qualifying renewable resources that grows over time until a final target level of 15 percent is reached in 2020.

Proposal Summary

To stimulate an increase in the use of renewable resources to generate electricity, an RPS requires that a specified share of the power sold must come from qualifying renewable facilities. Companies that generate power from qualifying renewable facilities are issued credits that they can hold for their own use or sell to others. To meet the RPS requirement, each covered electricity seller must generate their own qualifying renewable power or purchase renewable energy credits from others. For example, a supplier with 100 billion kilowatthours of retail electricity sales in a year with a 15-percent RPS requirement would have to generate or purchase credits representing a combined total of 15 billion kilowatthours of qualifying renewable power in that year. In a competitive market, the price of renewable energy credits should rise to the level needed to stimulate power plant developers to bring on the amount of qualifying renewable capacity needed to meet the RPS requirement while allowing the market to determine the most economical renewable compliance options to develop.

The RPS program analyzed in this report has the following characteristics:

- The program begins in 2010 with the required renewable share starting at 3.75 percent and growing to 7.5 percent in 2013, 11.25 percent in 2017, and finally to 15 percent in 2020. The program sunsets in 2030.

- Power sellers with retail sales of at least 4 billion kilowatthours (4,000,000 megawatthours) are covered. Entities with retail sales below this level are exempt.

- Generation from existing hydroelectric and municipal solid waste (MSW) facilities are not included in the base electricity sales, but also do not earn compliance credits.

- The amount of qualifying renewable generation required each year is calculated by multiplying the generation base (total electricity retail sales minus existing hydroelectric and MSW generation and sales by or to exempt small retailers) by the required share.

- Qualifying renewable facilities include all new and existing nonhydroelectric renewable generation facilities[1], including co-firing modifications to existing coal plants that are placed in service on or after the enactment date of the legislation. Qualifying fuels include incremental hydropower[2], geothermal, solar, wind, ocean, landfill gas, and certain biomass and municipal solid waste feedstocks.

- Generation from distributed renewable generation resources (customer-sited facilities such as roof-top photovoltaics) earns three credits for every kilowatthour of generation.

- The market value of credits used for compliance is capped at 1.9 cents per kilowatthour[3], adjusted annually for inflation. Power sellers may purchase an unlimited number of compliance credits from the government at this "safety-valve" credit value, allowing them to meet their program obligations without providing additional renewable generation.

Methodology

The projections and quantitative analysis in this report were prepared using the National Energy Modeling System (NEMS). NEMS is a computer-based, energy-economic model of the U.S. energy system. NEMS projects production, imports, conversion, consumption, and prices of energy through 2030, subject to assumptions about macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. Using econometric, heuristic, and linear programming techniques, NEMS consists of 13 submodules that represent the demand (residential, commercial, industrial, and transportation sectors), supply (coal, renewables, oil and natural gas supply, natural gas transmission and distribution, and international oil), and conversion (refinery and electricity sectors) of energy, together with a macroeconomic module that links energy prices to economic activity. An integrating module controls the flow of information among the submodules, from which it receives the supply, price, and quantity demanded for each fuel until convergence is achieved.

The Electricity Market Module (EMM) within NEMS simulates the capacity planning and retirement, operating, and pricing decisions that occur in U.S. electricity markets. It operates at a 13-region level. Based on the cost and performance of 27 different generating technologies, the costs of fuels, and constraints on emissions, the EMM chooses the most economical approach for meeting consumer demand for electricity. As

[1] Average historical generation from facilities in service prior to the enactment date counts toward meeting the target, but does produce tradable credits.
[2] Incremental hydropower is "additional energy generated as the result of efficiency improvements or capacity additions [made on or after the effective date] at a hydroelectric facility that was placed in service before [the effective date]. The effective date refers to the earlier of the date this law is enacted or an applicable State RPS law became effective.
[3] In 2005 dollars shown in the tables and figures in this report, to be consistent with other reported costs and prices, the credit cap is 1.84 cents per kilowatthour.

new technologies penetrate the market in NEMS, their costs are assumed to decline to reflect the expected impact of technological learning. During each year of the analysis period, the EMM evaluates the need for new generating capacity to meet consumer needs reliably or to replace existing electric power plants that are no longer economical. The cost of building new capacity is weighed against the costs of continuing to operate existing plants and consumers' willingness to pay for reliable service.

As shown in Table 1, the target shares for qualifying renewable resources used in NEMS analysis differ from the annual RPS shares specified in the proposal because the NEMS shares are adjusted to account for the exclusion of utilities with sales fewer than 4 billion kilowatthours (4,000,000 megawatthours) and the exclusion of existing hydroelectric and MSW generation from sales when applying the RPS share.

Table 1. Renewable Portfolio Shares Reflecting Adjustments Included in the RPS Proposal

Year	Legislative Target	NEMS Adjusted Share
2010	3.75%	2.79%
2011	3.75%	2.81%
2012	3.75%	2.82%
2013	7.50%	5.67%
2014	7.50%	5.69%
2015	7.50%	5.71%
2016	7.50%	5.74%
2017	11.25%	8.63%
2018	11.25%	8.66%
2019	11.25%	8.70%
2020	15.00%	11.65%
2021	15.00%	11.68%
2022	15.00%	11.72%
2023	15.00%	11.77%
2024	15.00%	11.81%
2025	15.00%	11.85%
2026	15.00%	11.89%
2027	15.00%	11.93%
2028	15.00%	11.98%
2029	15.00%	12.01%
2030	15.00%	12.05%

Source: Energy Information Administration, Office of Integrated Analysis and Forecasting.

More than 20 States currently have some form of renewable energy requirement or target. However, these programs vary substantially from State to State, with significant differences in target levels, qualifying technologies, enforcement mechanisms, and exemptions from compliance. Because of the substantial uncertainty in evaluating the potential effectiveness of the various enforcement mechanisms and because of the

inherent uncertainty associated with the many discretionary aspects of waiver and exemption policies in some States, the reference case of the *Annual Energy Outlook 2007* (*AEO2007*) does not account for renewable generation growth resulting from these programs. As this analysis is based on the *AEO2007* reference case, it also does not account for the potential impact of these State-level programs.

Although State-level RPS programs are not included in the *AEO2007* reference case, EIA has previously analyzed the impact of full compliance with State RPS requirements. Taking account limitations on State budgetary support for such programs, where applicable, that analysis concluded that State-level RPS programs could result in an additional 62 billion kilowatthours of renewable generation by 2030 based on current Federal law and policy, a 30-percent increase over the reference case, or about 10 percent of the total renewable requirement of this proposal.[4] The proposed Federal RPS analyzed in this report would generally allow otherwise qualified generation used to satisfy a State RPS program to also satisfy the Federal requirement. The double-counting and credit transfer provisions of the Federal proposal imply that the State programs would not increase the aggregate national renewable target. However, the existence of additional revenue sources at the State level may somewhat reduce the incremental cost of complying with the Federal target and could affect overall generation-backed compliance levels in the later forecast years.

All cases in this analysis include the 10-percent investment tax credit (ITC) for new geothermal and solar-electric power plants that was permanently extended in the Energy Policy Act of 1992. However, the 30-percent ITC for commercial and residential solar power installations and the production tax credits (PTC) available to various renewable generation sources were both assumed to expire at the end of 2007, as provided for by the law in effect when the *AEO2007* was produced. Both the PTC and the 30–percent ITC have subsequently been extended by law through 2008. The PTC, and to a lesser extent the ITC, support the more rapid deployment of qualifying technologies, so that the recent extension of these credits, and any further extension that may be enacted in the future, would tend to reduce the projected incremental cost of complying with the proposed Federal RPS program. However, any such extensions would also add to future tax expenditures.

[4] See http://www.eia.doe.gov/oiaf/aeo/leg_reg.html.

2. Energy Market Impacts of a 15-Percent RPS

Electricity Sector Generation, Fuel Use, Prices, and Emissions

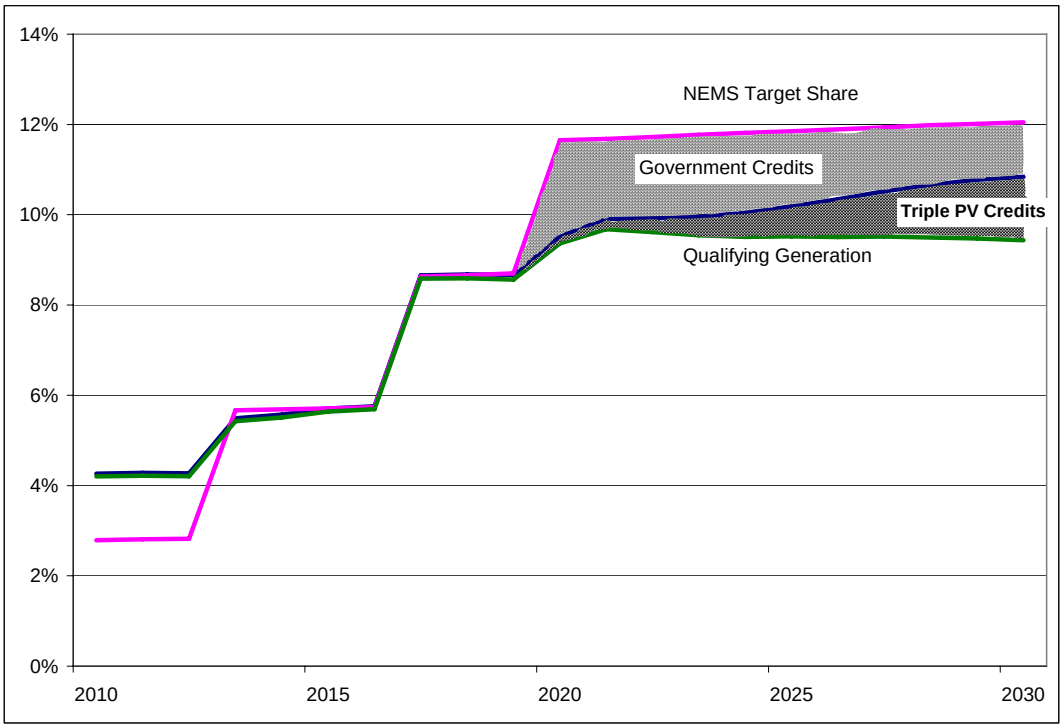
EIA projects that the market value of renewable energy credits will remain below the 1.9 cent per kilowatthour level through 2019, when the RPS proposal requires 11.25 percent of covered sales, equivalent to 8.7 percent of total electricity sales, to be met with qualifying renewable generation (Figure 1).[5], Although the credit price remains below 1 cent per kilowatthour through 2016, when the legislative target is 7.5 percent or below, during the period 2017 to 2019 it rises to the 1.4-to-1.9-cents-per-kilowatthour range.

Once the RPS target increases to the final 15-percent level, equivalent to 11.7 percent of total electricity sales in 2020, EIA projects continued growth in renewable generation, but with some purchase of renewable energy credits from the Federal government to satisfy program requirements. In 2020, actual qualifying generation accounts for 9.4 percent of all sales, with distributed generation credit multipliers and renewable energy credits purchased from the Federal government satisfying the rest of the 11.7-percent share requirement. By 2030, credits purchased from the Federal government account for one percent of sales out of a target equivalent to 12 percent of total electricity sales in that year. During this period, the market value of credits is 1.9 cents per kilowatthour, the price at which they can be purchased from the government.

The renewable energy credit price represents the amount per kilowatthour above the market price of power that is available to qualifying generators. The payment for renewable energy credits provides an incentive for investment in qualifying technologies even if they entail higher costs than other generating technologies. However, as the 2030 sunset date for the RPS program approaches, the period of time over which qualifying generators can anticipate receiving payments for renewable energy credits is shortened, reducing the present value of the anticipated stream of payments for renewable energy credits at any given credit price. As potential investors in qualifying projects seek to compensate for the shortening of their anticipated payment stream, there is upward pressure on credit prices. By 2020, the horizon for credit payments is short enough that investors are unwilling to invest in sufficient amounts of qualifying generation to meet the RPS target unless the credit price were to exceed the 1.9-cent price cap. As a result, electricity sellers subject to the RPS program comply through the purchase of credits from the Federal government at the 1.9 cent per kilowatthour price specified in the proposal and the level of qualified renewable generation falls short of the legislated target (Figure 2). EIA analysis of an alternative RPS requirement with no cost cap and no sunset provision indicates that the same targets as in the proposed program could be met in all years, and the credit price would generally fall below the 1.9-cent-per-kilowatthour cap.

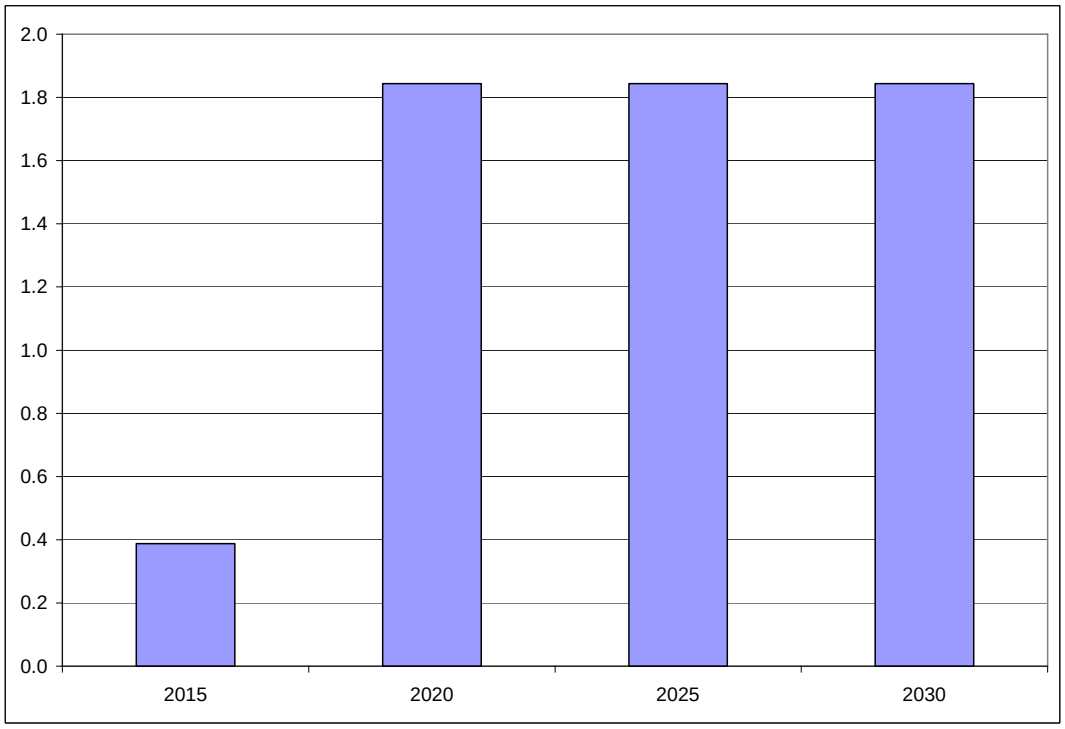
[5] See Table 1 for the correspondence between the proposed RPS targets and the total sales share.

Figure 1. Projected Compliance with the RPS Proposal
(percent qualified generation of total sales)



Source: National Energy Modeling System run BING15I2.D051507B

Figure 2. Renewable Energy Credit Price
(2005 cents per kilowatthour)

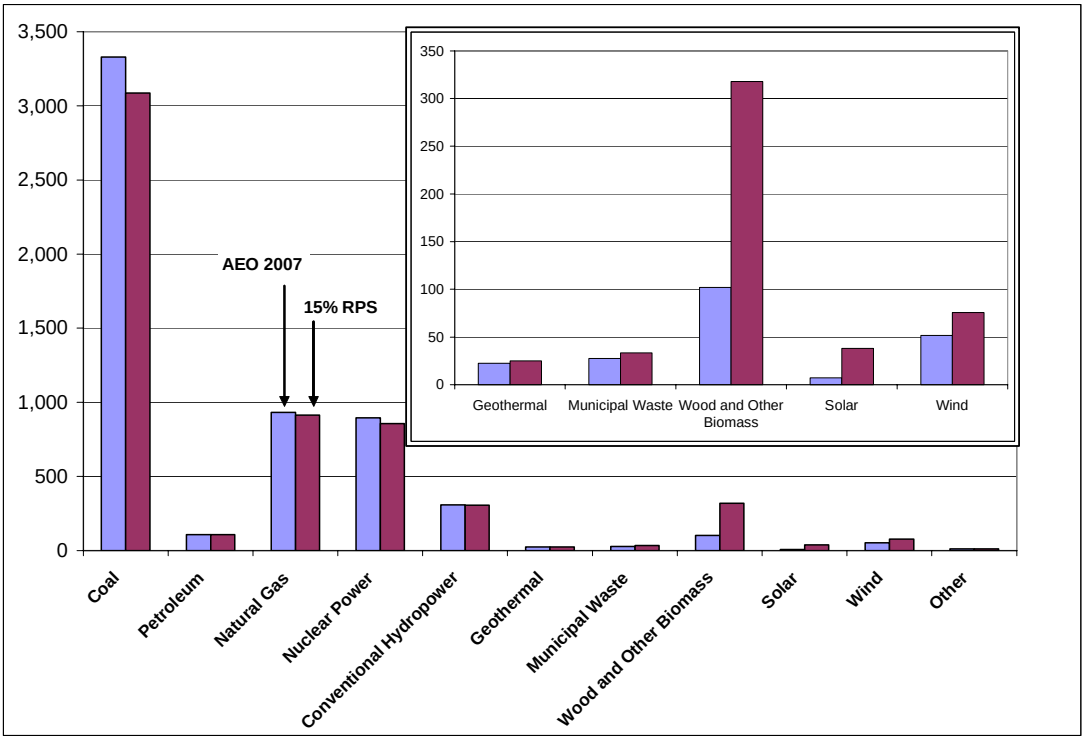


Source: National Energy Modeling System run BING15I2.D051507B

Generation by Fuel

Under the proposed RPS program, generation from renewable resources increases relative to the reference case (Figure 3). Biomass generation, both from dedicated biomass plants and existing coal plants co-firing with biomass fuel, grows the most by 2030, more than tripling from 102 billion kilowatthours in the reference case to 318 billion kilowatthours with the RPS policy (Table 2). Wind generation increases by almost 50 percent by 2030, from 52 billion kilowatthours in the reference case to 76 billion kilowatthours with the RPS.

Figure 3. Generation by Fuel in 2030
(billion kilowatthours)



Source: National Energy Modeling System runs AEO2007.D112106A and BING15I2.D051507B

Although total solar generation does not reach the level of wind or biomass, it has a higher absolute increase than wind and a higher percentage increase than either wind or biomass by 2030, when compared to the reference case. Solar generation, including utility-owned solar thermal and PV and customer-sited PV, increases from 7 billion kilowatthours in 2030 in the reference case to almost 38 billion kilowatthours with the RPS, a five-fold increase. Because customer-sited PV earns 3 credits for every kilowatthour generated, this generation counts as approximately 110 billion kilowatthours for RPS compliance purposes in 2030. This is twice the compliance share accounted for

by wind and about half of the biomass compliance share. Geothermal and landfill gas facilities also show a slight increase in generation compared to the reference case.

The increase in renewable generation stimulated by the RPS primarily displaces coal-fired generation. By 2030, coal generation is 3,086 billion kilowatthours with the RPS compared with 3,330 billion kilowatthours in the reference case, a reduction of about 7 percent. Coal generation is still expected to grow significantly from 2,000 billion kilowatthours in 2005. Nuclear generation is reduced by less than 5 percent, to 856 billion kilowatthours with the RPS from 896 billion kilowatthours in the reference case. As with coal, this still represents significant growth relative to 2005 generation levels. Natural gas generation is about 2 percent less than the 2030 reference case level of 932 billion kilowatthours.

Energy Prices and Expenditures

The shift away from coal to renewable fuels, together with the costs of retail electricity sellers holding RPS credits, affects electricity prices. In 2030, EIA projects the national average electricity price with the RPS to be 2 percent higher than in the reference case, i.e., 8.2 cents per kilowatthour with the RPS compared to 8.1 cents per kilowatthour in the reference case. By 2030, prices for natural gas and coal, two key fuels for the electric power sector, are lower with the RPS than in the reference case.

Cumulative costs to the electric power sector, in the form of capital expenses, maintenance costs, fuel expenditures, the purchase of RPS compliance credits from non-power-sector installations, i.e., residential and commercial owners of PV systems[6], and the purchase of credit allowances from the government are about 0.4 percent ($8.5_ billion higher with the RPS than in the reference case[7], which total $1,963 billion in the reference case through 2030. Cumulative capital and other fixed expenditures decrease by almost $3.6 billion compared to the reference case. Offsetting this is an increase of almost $12 billion in fuel and variable costs, including net impacts of reduced fuel prices, reduced fuel usage, and new purchases of renewable energy credits from the government and end-use sectors.

With slightly higher prices, EIA projects that cumulative consumer electricity expenditures from 2005 through 2030 will increase by 0.5 percent ($21 billion) with the RPS compared to the reference case, despite slightly reduced sales. Reduced demand for natural gas results in lower natural gas prices, and cumulative end-use natural gas expenditures are reduced by 0.2 percent ($3.3 billion) of the reference case total. Net cumulative consumer expenditures for natural gas and electricity are increased by about 0.3 percent ($18 billion) through 2030 compared to the reference case.

[6] The purchase of RPS credits from other power-sector generators is a zero net cost to the industry, as both the seller and the purchaser are within the industry.

[7] Costs accumulated from 2005 through 2030. All dollar values are 2005 dollars, Accumulated costs are discounted to 2005 using a 7-percent discount rate per guidance from OMB Circular A-94.

Table 2. Summary Results

	2005	2015	2015	2030	2030
		Reference	RPS	Reference	RPS
Net Generation by Fuel Type (billion kilowatthours)					
Coal	2,015	2,295	2,240	3,330	3,086
Petroleum	122	103	101	107	108
Natural Gas	752	1018	1008	932	914
Nuclear Power	780	812	809	896	856
Conventional Hydropower	265	306	306	308	306
Geothermal	15	18	20	23	25
Municipal Waste	23	27	32	28	33
Wood and Other Biomass	38	79	138	102	318
Solar	1	3	3	7	38
Wind	15	51	55	52	76
Other	13	8	8	14	12
Total Generation	4,038	4,721	4,719	5,797	5,773
Capacity (gigawatts)					
Coal Steam	311	323	320	450	431
Other Fossil Steam	121	90	91	87	87
Combined Cycle	177	196	194	212	205
Combustion Turbine/Diesel	133	121	120	155	147
Nuclear	100	102	102	113	107
Conventional Hydropower	81	81	81	81	81
Geothermal	2	3	3	3	3
Municipal Waste	4	4	5	4	5
Wood and Other Biomass	7	8	10	11	26
Solar	1	1	1	4	20
Wind	10	18	19	18	25
Other	43	51	51	83	81
Total	988	997	997	1220	1,219
Prices (2005 cents per kilowatthour)					
Credit Price	N/A	-	0.39	-	1.84
Electricity Price	8.10	7.69	7.71	8.05	8.21
Credits (percent of sales)					
Credits Required	N/A	-	5.7	-	12.1
Credits Achieved	N/A	-	5.7	-	10.8
Generation Achieved	2.6	3.9	5.6	3.9	9.4
Power Sector Emissions (million tons per year, except as noted)					
Nitrogen Oxides	3.6	2.2	2.2	2.3	2.2
Sulfur Dioxide	10.2	4.5	4.5	3.6	3.6
Mercury (tons per year)	51.3	24.6	25.3	15.5	15.6
Carbon Dioxide (million metric tons per year)	2,375	2,677	2,624	3,338	3,116

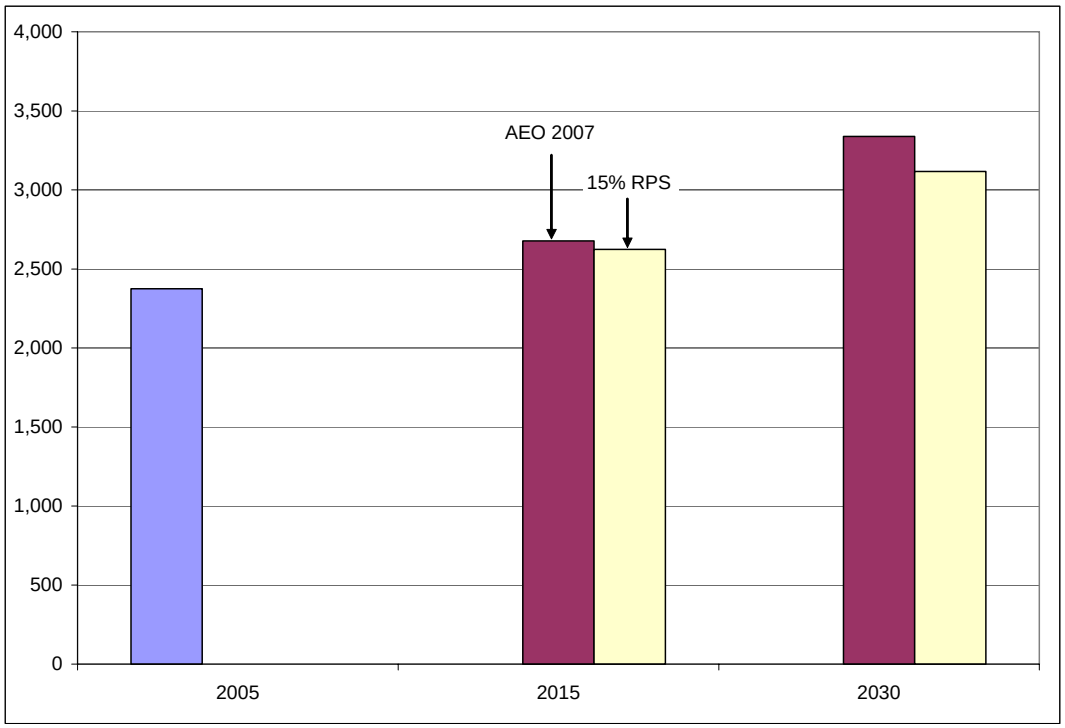
Source: National Energy Modeling System runs AEO2007.D112106A and BING15I2.D051507B

EIA projects that residential customers will spend 0.4 percent ($7.2 billion) more for electricity with the RPS than in the reference case through 2030 and will spend 0.1 percent ($1 billion) less on natural gas, resulting in a net increase of over $6 billion. This represents just over 0.2 percent of total residential expenditures on electricity and natural gas.

Carbon Dioxide Emissions

Although carbon dioxide emissions from the power sector increase in both the reference case and with the RPS policy, the rate of growth is lower with the policy (Figure 4). In the reference case, carbon dioxide emissions are projected to rise to 3,338 million metric tons by 2030, from approximately 2,375 million metric tons in 2005. With the RPS

Figure 4. Electricity Sector Carbon Dioxide Emissions
(million metric tons)



Source: National Energy Modeling System runs AEO2007.D112106A and BING15I2.D051507B

policy, carbon dioxide emissions are projected at almost 3,116 million metric tons in 2030, about 6.7 percent less than the reference case, but still substantially higher than in 2005. Emissions of regulated sulfur, nitrogen, and mercury emissions are not expected to significantly change with this policy because they are limited by existing programs.

Comparison to Other Recent EIA Analyses of Renewable Energy Incentives

The results in this analysis are similar to earlier analyses of RPS proposals prepared by EIA. However, there are some areas where the results differ. The differences generally result from changes in the renewable sales share targeted, the price of government-issued credits that serve as a safety valve, and the fuel mix in the reference cases used for the analyses. A comparison of results from the current study of a 15-percent RPS to a 2005 analysis of a 10-percent RPS proposal, focused on results through 2025, the end-point of the 2005 analysis, shows that the small differences in results reflect changes in both the RPS proposal itself and in the baselines used for the two analyses.

In addition to the lower renewable share target, the 2005 proposal also incorporated a lower price for government- issued credits, 1.5 cents per kilowatthour versus 1.9 cents in the current proposal. The 2005 analysis, based on the reference case from the Annual Energy Outlook 2005, also started from a baseline projection that had a much larger share of natural gas generation than is now expected.

The higher renewable target for qualifying renewable generation combined with the higher cap on the price of government-issued credits, leads to a slightly larger renewable credit and generation shares in 2025 than in the 2005 analysis. The higher renewable credit price and the larger coal generation share expected in the reference case for this analysis also contribute to higher compliance costs. In the AEO 2007 reference case, natural gas was projected to be more expensive than in the AEO 2005 reference case, resulting in a less favorable market for natural gas generation and a more favorable market for coal. For wind generation in particular, which largely competes as a "fuel saver", this resulted in less favorable market conditions, because there would be more times when the wind generation stimulated by the RPS would be displacing relatively low-cost coal instead of higher-cost natural gas. Furthermore, as new wind plants entered service in recent years, EIA has used their output data to update its assessments of new plant performance. As a result, the AEO 2007 analysis reflects somewhat lower plant capacity factors at low wind-speed sites than in the AEO2005 analysis. The combined impact of these baseline model changes is to decrease the overall contribution of wind to meeting RPS goals, and to increase the cost of compliance.

While projected cumulative electricity expenditures through 2025 fell slightly in the 2005 RPS analysis, they rise slightly in the current analysis. Projected cumulative natural gas expenditures through 2025 decline slightly in both analyses, but the reduction is larger in the 2005 analysis in which more power generation fueled by natural gas is displaced.

There is, of course, considerable uncertainty regarding the projected baseline electricity mix. Concerns over growth in greenhouse gas emissions have contributed to increased opposition to many proposals for new coal-fired power plants given that coal is the most carbon-intensive of the fossil fuels. Such opposition, or the actual implementation of future policies to limit greenhouse gas emissions, are not reflected in the *AEO2007* baseline used for the current analysis, which projects considerable additions of new coal-fired generating capacity between 2015 and 2030. To the extent that such additions are

precluded by public sentiment or policy action, natural gas could play a larger role in the generation mix, and so that the RPS proposal considered in this analysis would displace greater amounts of natural gas and less coal. In such a scenario, the projected impacts of the 15-percent RPS proposal considered in this analysis would move towards those identified in the 2005 RPS analysis.

In another recent analysis, EIA examined the impacts of extending the production tax credit (PTC) for new wind power plants. It was found that extending the full 1.9 cent per kilowatthour PTC could have a larger impact on projected wind generation than the RPS with a 1.9 cent cap on the value of renewable energy credits considered in this report, depending on the length of the PTC extension. A 1.9 cent PTC payment per kilowatthour of generation is more valuable to qualifying renewable project developers than the sale of renewable energy credits at 1.9 cents per kilowatthour in an RPS program because the PTC is applied after taxes are calculated, and thus its value is not reduced by the tax rate.

Uncertainty

As with any long-term projections there are considerable uncertainties in these results. Among the key uncertainties are projections of the growth in the demand for electricity, future fuel prices, and the cost and performance of new generating equipment, both renewable and nonrenewable technologies. Future energy and environmental policy is also a key uncertainty.

Since coal and natural gas plants are expected to account for much of the new capacity added over the next 20 years, future coal and natural gas prices are important in determining the credit price needed to make new renewable electricity competitive with other generation options. If coal and natural gas prices turn out to be lower than are projected in this report, the renewable energy credit price needed to make renewables competitive would be larger. Conversely, it would be lower if coal and natural gas prices turn out to be higher than expected.

Projections of the future cost and performance of new generating equipment are always difficult, particularly for technologies that currently have little or no market experience. Nonhydroelectric renewable technologies currently produce about 2 percent of the power generated in the United States. Spurring the market penetration of these technologies with an RPS might allow developers to make reductions in their costs and improve their performance through mass production techniques and learning by doing. These types of improvements are assumed to occur and are incorporated in the NEMS.

However, it could turn out that the current relatively low market shares for these technologies are due to high costs that cannot be easily reduced. In addition, even if renewable technology developers are successful in improving the cost and performance of their technologies, their ability to penetrate the market will depend on the relative costs and performance of nonrenewable technologies. If renewable and nonrenewable technologies improve by similar amounts, the relative advantage that nonrenewable

technologies have today would likely remain. If renewable technology improves at a faster rate than assumed, compliance costs could be less than projected.

For wind, solar, and biomass technologies, the level of development called for with the proposed RPS comes with some uncertainty. For example, developers or grid operators may have to pay to build or upgrade long transmission lines from the remote areas with ample wind resources to the cities with significant demand. In this analysis, costs are assumed to increase as developers turn to more costly sites such as those with higher interconnection costs, higher land costs, or more difficult terrain. However, there is significant uncertainty about the actual cost increases that might occur, and these actual costs may be more or less than projected.

Wind and solar power development may also be constrained by its intermittent nature which leads to the need for backup capacity to ensure that consumers' need for electricity can be met at all times. At regional penetration levels seen for wind in this analysis, NEMS represents many of the most significant costs of accommodating wind intermittency, including costs for additional firm system capacity, potential mismatch between load and wind-production peaks, and lost revenue during periods of excess wind production.

The solar resource development seen in this report would largely occur at the customer site, on the distribution rather than on the transmission system. Such a level of penetration may have minor or significant effects on system cost and reliability, largely depending on localized concentration of installations and the pre-existing condition of local distribution systems.

As with wind, data suggest that there are sufficient biomass resources to fuel the increased biomass generation projected in the RPS case. However, currently there are very few coal plants that co-fire with biomass. To achieve the level of biomass co-firing called for in the RPS case, the infrastructure to reliably gather, process, and deliver the available biomass to coal plants would have to be developed.

Finally, EIA assumes the use of biomass gasification technology for dedicated biomass generation plants. Based on current estimates, these plants trade off somewhat higher capital costs for significantly improved efficiency compared to direct-combustion technology, thus reducing operating costs. However, few commercial biomass gasification operations currently exist, and capital costs for this technology are highly uncertain.

As previously noted, almost half the States have adopted an RPS or similar renewable energy target policy. In addition, a number of States, particularly in the Northeast and Western United States, have taken initial steps to regulate carbon dioxide emissions. At the Federal level, key renewable energy subsidies are scheduled to expire within the next 2 years, and there are a number of proposals in Congress to establish national carbon dioxide emission legislation. The implementation of any combination of these policies would be expected to have a significant impact on renewable generation markets and

could significantly affect the cost of achieving the proposed RPS policy or the allocation of the compliance cost among affected parties.

Interaction with State RPS policy is discussed earlier in this report. If renewable generation is seen as a cost-effective means of reducing carbon dioxide emissions, the cost of new renewable generation might be allocated between the RPS credit price and the cost of achieving the carbon dioxide regulation, reducing the apparent standalone cost of one or both programs, but not reducing total costs. If the renewable generation targets in this proposal exceed the cost-effective renewable mix of future carbon dioxide regulations, then this proposal might increase the cost of carbon dioxide reductions relative to a standalone carbon dioxide policy, while at the same time transferring some of the cost from the carbon dioxide program to the RPS program. The extension of direct or indirect government subsidies for renewable energy, such as the PTC for wind, biomass, and geothermal or the ITC for solar, would likely reduce the apparent cost of RPS compliance by transferring a significant component of that cost to government budgets rather than electricity producers and consumers.

Appendix A. Analysis Request Letter

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510-6150

ENERGY.SENATE.GOV

May 9, 2007

Mr. Guy Caruso
Administrator
Energy Information Administration
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Mr. Caruso:

As you are aware, Congress is considering major energy legislation to increase our energy independence and to reduce the environmental impact of energy production and use. As a part of that legislation, I intend to introduce legislation to require that utilities provide certain percentages of their electricity to consumers from renewable sources. A Renewable Portfolio Standard (RPS), intended to accomplish this goal, has passed the Senate in the last three Congresses. You have provided analysis of my proposals in each of those Congresses. I am requesting that you update that analysis, given changes in the market and changes in the proposal that I am presenting during this Congress. The assumptions of this proposal (see attached) are:

- The facilities subject to the RPS include all electric utilities that sell electricity to retail consumers. Electric utilities with sales less than 4,000 GWh per year are exempt. In addition Hawaii is exempt.
- The base against which the requirement is calculated is defined as all electric utility retail sales in a given calendar year, excluding existing hydropower.
- The definition of new renewable energy is electricity generated at a facility placed in service on or after January 1, 2003, that uses solar, wind, ocean, geothermal, biomass (as defined in the bill), landfill gas, and incremental hydropower.
- The RPS includes a credit system in which one credit will be distributed for each kWh of electricity generated from eligible resources. The cost of credits is capped at 2 cents per kWh, adjusted for inflation.
- The timetable for the RPS is:

2010-2012	3.75%
2013-2016	7.50%
2017-2019	11.75%
2020-2030	15%

I ask that the requested information be made available as soon as possible. I also ask that my staff be briefed prior to the release of information.

If you have any questions regarding this request, or need clarification, please contact Leon Lowery with the Senate Energy and Natural Resources Committee staff at (202) 224-2209. I thank you in advance for your timely attention to this request and for your efforts to ensure that our Nation's energy policy decisions are informed with the best available analysis.

Sincerely,

Jeff Bingaman
Chairman

Renewable Portfolio Standard
Summary of Senator Bingaman's Amendment
110th Congress

The amendment requires sellers of electricity to retail consumers to obtain certain percentages of their electric supply from new renewable energy resources. The percentages range from 3.75 percent during 2010-12, to 7.5 percent during 2013-16, 11.25 percent during 2017-19 and 15 percent during 2020-30. Utilities that sell less than 4,000,000 megawatt hours per year are exempted, as is Hawaii. The provision sunsets on December 31, 2030.

Existing hydropower generators and municipal solid waste generators are excluded from the base amount from which the percentage requirements are calculated.

Qualifying renewables are (including distributed generators) wind, solar, ocean, geothermal, biomass, landfill gas and incremental hydropower.

The Secretary has the authority to establish and design a renewable energy credit trading program. The Secretary may issue credits to generators of renewable energy. Utilities submit credits to the Secretary to certify compliance. Utilities may also make alternative compliance payments to the Secretary at a rate of 2.0 cents per kilowatt hour, adjusted for inflation. Existing renewables can be used for compliance with the requirement, but credits for them may not be traded or sold.

The Secretary is required to charge a civil penalty for failure to meet the required percentage targets of no more than the lesser of 2.0 cents or 200 percent of the average market value of credits per kWh in violation of the requirement. The Secretary may mitigate or waive the penalty for reasons outside the reasonable control of the utility.

The Federal RPS will not affect State programs. To the extent that States require or compliance payments, the Secretary must determine what those payments represent as to compliance with the Federal requirement and allocate credits accordingly. Furthermore, a State Renewable Energy Account will be established. This program will provide grants to States to develop programs designed to promote renewable energy production.

Appendix B. Renewable Portfolio Standard Proposal

SEC. 201. RENEWABLE PORTFOLIO STANDARD.

(a) In General.—Title VI of the Public Utility Regulatory Policies Act of 1978 (16 U.S.C. 2601 et seq.) is amended by adding at the end the following:

"SEC. 610. FEDERAL RENEWABLE PORTFOLIO STANDARD.

"(a) Renewable Energy Requirement.—

"(1) IN GENERAL.—Each electric utility that sells electricity to electric consumers shall obtain a percentage of the base amount of electricity it sells to electric consumers in any calendar year from new renewable energy or existing renewable energy. The percentage obtained in a calendar year shall not be less than the amount specified in the following table: [Modifications made to the table below]2,L0(0,0,0,4,0,17),tp0,p10,10/12,g1,t1,s100n,xls95n

11

"Calendar year:Minimum annual percentage:

2010 through 20123.75

2013 through 20167.50

2017 through 201911.25

2020 through 203015.0

"(2) MEANS OF COMPLIANCE.—An electric utility shall meet the requirements of paragraph (1) by—

"(A) generating electric energy using new renewable energy or existing renewable energy;

"(B) purchasing electric energy generated by new renewable energy or existing renewable energy;

"(C) purchasing renewable energy credits issued under subsection (b); or

"(D) a combination of the foregoing.

"(b) Renewable Energy Credit Trading Program.—

"(1) IN GENERAL.—Not later than January 1, 2007, the Secretary shall establish a renewable energy credit trading program to permit an electric utility that does not generate or purchase enough electric energy from renewable energy to meet its obligations under subsection (a)(1) to satisfy such requirements by purchasing sufficient renewable energy credits.

"(2) ADMINISTRATION.—As part of the program, the Secretary shall—

"(A) issue renewable energy credits to generators of electric energy from new renewable energy;

"(B) sell renewable energy credits to electric utilities at the rate of 1.9 cents per kilowatt-hour (as adjusted for inflation under subsection (g));

"(C) ensure that a kilowatt hour, including the associated renewable energy credit, shall be used only once for purposes of compliance with this section; and

"(D) allow double credits for generation from facilities on Indian land, and triple credits for generation from small renewable distributed generators (meaning those no larger than 1 megawatt).

"(3) DURATION.—Credits under paragraph (2)(A) may only be used for compliance with this section for 3 years from the date issued.

"(4) TRANSFERS.—An electric utility that holds credits in excess of the amount needed to comply with subsection (a) may transfer such credits to another electric utility in the same utility holding company system.

"(5) EASTERN INTERCONNECT.—In the case of a retail electric supplier that is a member of a power pool located in the Eastern Interconnect and that is subject to a State renewable portfolio standard program that provides for compliance primarily through the acquisition of certificates or credits in lieu of the direct acquisition of renewable power, the Secretary shall issue renewable energy credits in an amount that corresponds to the kilowatt-hour obligation represented by the State certificates and credits issued pursuant to the State program to the extent the State certificates and credits are associated with renewable resources eligible under this section.

"(c) Enforcement.—

"(1) CIVIL PENALTIES.—Any electric utility that fails to meet the renewable energy requirements of subsection (a) shall be subject to a civil penalty.

"(2) AMOUNT OF PENALTY.—The amount of the civil penalty shall be determined by multiplying the number of kilowatt-hours of electric energy sold to electric consumers in violation of subsection (a) by the greater of 1.9 cents (adjusted for inflation under subsection (g)) or 200 percent of the average market value of renewable energy credits during the year in which the violation occurred.

"(3) MITIGATION OR WAIVER.—The Secretary may mitigate or waive a civil penalty under this subsection if the electric utility was unable to comply with subsection (a) for reasons outside of the reasonable control of the utility. The Secretary shall reduce the amount of any penalty determined under paragraph (2) by an amount paid by the electric utility to a State for failure to comply with the requirement of a State renewable energy program if the State requirement is greater than the applicable requirement of subsection (a).

"(4) PROCEDURE FOR ASSESSING PENALTY.—The Secretary shall assess a civil penalty under this subsection in accordance with the procedures prescribed by section 333(d) of the Energy Policy and Conservation Act of 1954 (42 U.S.C. 6303).

"(d) State Renewable Energy Account Program.—

"(1) IN GENERAL.—The Secretary shall establish, not later than December 31,

2008, a State renewable energy account program.

"(2) DEPOSITS.—All money collected by the Secretary from the sale of renewable energy credits and the assessment of civil penalties under this section shall be deposited into the renewable energy account established pursuant to this subsection. The State renewable energy account shall be held by the Secretary and shall not be transferred to the Treasury Department.

"(3) USE.—Proceeds deposited in the State renewable energy account shall be used by the Secretary, subject to appropriations, for a program to provide grants to the State agency responsible for developing State energy conservation plans under section 362 of the Energy Policy and Conservation Act (42 U.S.C. 6322) for the purposes of promoting renewable energy production, including programs that promote technologies that reduce the use of electricity at customer sites such as solar water heating.

"(4) ADMINISTRATION.—The Secretary may issue guidelines and criteria for grants awarded under this subsection. State energy offices receiving grants under this section shall maintain such records and evidence of compliance as the Secretary may require.

"(5) PREFERENCE.—In allocating funds under this program, the Secretary shall give preference—

"(A) to States in regions which have a disproportionately small share of economically sustainable renewable energy generation capacity; and

"(B) to State programs to stimulate or enhance innovative renewable energy technologies.

"(e) Rules.—The Secretary shall issue rules implementing this section not later than 1 year after the date of enactment of this section.

"(f) Exemptions.—This section shall not apply in any calendar year to an electric utility—

"(1) that sold less than 4,000,000 megawatt-hours of electric energy to electric consumers during the preceding calendar year; or

"(2) in Hawaii.

"(g) Inflation Adjustment.—Not later than December 31 of each year beginning in 2008, the Secretary shall adjust for inflation the price of a renewable energy credit under subsection (b)(2)(B) and the amount of the civil penalty per kilowatt-hour under subsection (c)(2).

"(h) State Programs.—Nothing in this section shall diminish any authority of a State or political subdivision thereof to adopt or enforce any law or regulation respecting renewable energy, but, except as provided in subsection (c)(3), no such law or regulation shall relieve any person of any requirement otherwise applicable under this section. The Secretary, in consultation with States having such renewable energy programs, shall, to the maximum extent practicable, facilitate coordination between the Federal program and State programs.

"(i) Recovery of Costs.—

"(1) IN GENERAL.—The Commission shall issue and enforce such regulations as are necessary to ensure that an electric utility recovers all prudently incurred costs associated with compliance with this section.

"(2) APPLICABLE LAW.—A regulation under paragraph (1) shall be enforceable in accordance with the provisions of law applicable to enforcement of regulations under the Federal Power Act (16 U.S.C. 791a et seq.).

"(j) Definitions.—In this section:

"(1) BASE AMOUNT OF ELECTRICITY.—The term 'base amount of electricity' means the total amount of electricity sold by an electric utility to electric consumers in a calendar year, excluding—

"(A) electricity generated by a hydroelectric facility (including a pumped storage facility but excluding incremental hydropower); and

"(B) electricity generated through the incineration of municipal solid waste.

"(2) DISTRIBUTED GENERATION FACILITY.—The term 'distributed generation facility' means a facility at a customer site.

"(3) EXISTING RENEWABLE ENERGY.—The term 'existing renewable energy' means, except as provided in paragraph (7)(B), electric energy generated at a facility (including a distributed generation facility) placed in service prior to January 1, 2003, from solar, wind, or geothermal energy, ocean energy, biomass (as defined in section 203(a) of the Energy Policy Act of 2005), or landfill gas.

"(4) GEOTHERMAL ENERGY.—The term 'geothermal energy' means energy derived from a geothermal deposit (within the meaning of section 613(e)(2) of the Internal Revenue Code of 1986).

"(5) INCREMENTAL GEOTHERMAL PRODUCTION.—

"(A) IN GENERAL.—The term 'incremental geothermal production' means for any year the excess of—

"(i) the total kilowatt hours of electricity produced from a facility (including a distributed generation facility) using geothermal energy; over

"(ii) the average annual kilowatt hours produced at such facility for 5 of the previous 7 calendar years before the date of enactment of this section after eliminating the highest and the lowest kilowatt hour production years in such 7-year period.

"(B) SPECIAL RULE.—A facility described in subparagraph (A) that was placed in service at least 7 years before the date of enactment of this section shall commencing with the year in which such date of enactment occurs, reduce the amount calculated under subparagraph (A)(ii) each year, on a cumulative basis, by the average percentage decrease in the annual kilowatt hour production for the 7-year period described in subparagraph (A)(ii) with such cumulative sum not to exceed 30 percent.

"(6) INCREMENTAL HYDROPOWER.—The term 'incremental hydropower' means additional energy generated as a result of efficiency improvements or capacity additions made on or after the date of enactment of this section or the effective date of an existing applicable State renewable portfolio standard program at a hydroelectric facility that was placed in service before that date. The term does not include additional energy generated as a result of operational changes not directly associated with efficiency improvements or capacity additions. Efficiency improvements and capacity additions shall be measured on the basis of the same water flow information used to determine a historic average annual generation baseline for the hydroelectric facility and certified by the Secretary or the Federal Energy Regulatory Commission.

"(7) NEW RENEWABLE ENERGY.—The term 'new renewable energy' means—

"(A) electric energy generated at a facility (including a distributed generation facility) placed in service on or after January 1, 2003, from—

"(i) solar, wind, or geothermal energy or ocean energy;

"(ii) biomass (as defined in section 203(b) of the Energy Policy Act of 2005 (42 U.S.C. 15852(b));

"(iii) landfill gas; or

"(iv) incremental hydropower; and

"(B) for electric energy generated at a facility (including a distributed generation facility) placed in service prior to the date of enactment of this section—

"(i) the additional energy above the average generation in the 3 years preceding the date of enactment of this section at the facility from—

"(I) solar or wind energy or ocean energy;

"(II) biomass (as defined in section 203(b) of the Energy Policy Act of 2005 (42 U.S.C. 15852(b));

"(III) landfill gas; or

"(IV) incremental hydropower.

"(ii) incremental geothermal production.

"(8) OCEAN ENERGY.—The term 'ocean energy' includes current, wave, tidal, and thermal energy.

"(k) Sunset.—This section expires on December 31, 2030.".

(b) Table of Contents Amendment.—The table of contents of the Public Utility Regulatory Policies Act of 1978 (16 U.S.C. prec. 2601) is amended by adding at the end of the items relating to title VI the following:

"Sec.610.Federal renewable portfolio standard.".