

**Testimony of**  
**Dr. Howard Gruenspecht**  
**Acting Administrator**  
**Energy Information Administration**  
**U.S. Department of Energy**

**before the**  
**Subcommittee on Energy and Environment**  
**Committee on Energy and Commerce**  
**U.S. House of Representatives**

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Mr. Chairman, and members of the Committee, I appreciate the opportunity to appear before you today. My testimony reviews the role of renewable electricity generation in the Energy Information Administration's (EIA) *Annual Energy Outlook 2009 (AEO2009)* projections, provides a brief overview of the renewable resource base, and discusses key findings from earlier EIA analyses of proposals for a Federal renewable portfolio standard.

EIA is the independent statistical and analytical agency within the Department of Energy. We are charged with providing objective, timely, and relevant data, analyses, and projections for the use of the Congress, the Administration, and the public. Although we do not take positions on policy issues, we do produce data and analyses to help inform energy policy deliberations. Because we have an element of statutory independence with respect to this work, our views are strictly those of EIA and should not be construed as representing those of the Department of Energy or the Administration.

### **Renewable Electricity Generation in the *AEO2009* Early Release Reference Case**

The projections in EIA's *AEO2009*, which extend through 2030, are intended to represent an energy future based on given technological and demographic trends, current laws and regulations, and consumer and supply behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and are subject to political disruptions, technological breakthroughs, and other unforeseeable events. In addition, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. The complete *AEO2009*, which EIA will

release in the coming weeks, includes a large number of alternative cases intended to examine these uncertainties.

Projections for electricity sales and generation in the *AEO2009* reference case reflect both market and policy drivers. Projected electricity sales are sensitive to changes in projected electricity prices, which reflect fuel prices, economic growth, and policies that promote energy efficiency, including recently enacted lighting and appliance standards. The projected generation mix reflects fuel prices, the impact of concerns regarding greenhouse gas (GHG) emissions on investment behavior, and the projected growth in sales. Several policy factors play an important role, notably the renewable portfolio standards (RPS) enacted in 27 states and the District of Columbia. *AEO2009* also reflects Federal policies that promote renewable generation sources, including the production tax credit (PTC) for wind through the end of 2009 and for other eligible resources through 2010, as well as investment tax credits for solar photovoltaics (PV) through 2016, reflecting provisions of the Energy Improvement and Extension Act of 2008. The *AEO2009* reference case does not, however, include the further 3-year extension of the PTC and other provisions to promote renewable energy and energy efficiency that were enacted earlier this month as part of the American Recovery and Reinvestment Act of 2009. EIA is currently analyzing the impact of these provisions, which are expected to raise the projected amount of renewables.

Spurred by State renewable incentive programs, tax incentives for renewables, and projected prices for natural gas and other fuels, the *AEO2009* reference case projects that renewable energy sources will play a growing role in electricity generation (**Figures 1 and 2**). In absolute terms, the largest growth in nonhydroelectric renewable generation is projected to come from biomass

and wind power. Between 2007 and 2030, generation from biomass power—both co-firing in existing coal plants and the addition of new plants—increases by more than 500 percent, while generation from wind power increases by more than 300 percent. While solar power is expected to remain a relatively small part of the overall renewable generation mix, it is projected to increase by more than 1600 percent between 2007 and 2030. The growth in solar power is spurred by the State renewable programs and the investment tax credit provisions in the Energy Improvement and Extension Act of 2008 that extended the credit through 2016 and removed the cap on the size of the credit.

Overall, the projected growth in nonhydropower renewable generation in the *AEO2009* reference case constitutes 52 percent of overall projected growth in electricity sales through 2020 and 38 percent of growth in electricity sales through 2030.

Another perspective on projected renewable generation in the *AEO2009* focuses on its share of electricity sales. Share calculations relevant to consideration of any particular RPS proposal must be constructed to reflect its design features. RPS credits available to renewable generators depend on which renewables count and whether there are double or triple credits for some specified renewables, such as distributed PV and wind, or for renewables in specified locations, such as Indian lands, which affect the numerator in the RPS share calculation. Some proposals that EIA has analyzed also allow credits for efficiency programs to count towards meeting the RPS target up to a specified percentage, at the option of State governments. Exclusions from the RPS, another key design feature, affect the denominator of the RPS share calculation. Several past RPS proposals have exempted utilities below a specified sales cutoff value, existing

hydropower and municipal solid waste (MSW) generation, and sales from cooperatives and/or municipal utilities from RPS coverage.

Some sample calculations based on the *AEO2009* illustrate how design features affect RPS share calculations. For example, if existing hydropower and MSW are not eligible for RPS credits, as in many RPS proposals that EIA has analyzed in the recent past, and no electricity sellers are exempted from the RPS, RPS eligible generation projected in the *AEO2009* reference case provides 7 percent of total electricity sales in 2020 and 9 percent of total electricity sales in 2030. The same calculation done in a manner that provides triple RPS credits for distributed wind and solar and provides an exemption from RPS coverage for the same categories of electricity sellers exempted from coverage by the RPS proposal in H.R. 890 shows RPS credits from the same *AEO2009* generation profile equal to 9.6 percent of covered sales in 2020 and 11.6 percent of covered sales in 2030. These sample calculations do not represent the full range of possibilities, since they do not consider the possibility of credits for efficiency or double credits for renewables in certain locations.

The *AEO2009* RPS share, calculated in accordance with the crediting and coverage rules in any specific RPS program design and adjusted for the projected impact of the American Recovery and Reinvestment Act on the energy sector, characterizes the projected starting point for compliance. Some combination of additional generation from RPS-eligible sources, credits for efficiency (if allowed under the RPS program), or RPS credits purchased from the government if a safety valve provision is included in the program and comes into play, would then be required to close the gap between this starting point and the RPS targets.

## Renewable Resources

The National Energy Modeling System (NEMS), used to produce the *AEO2009*, represents the major renewable energy resources with significant mid-term potential to contribute to U.S. electricity markets. These include resources for onshore and offshore wind, biomass, solar, geothermal, landfill gas, and hydroelectricity. EIA represents the total quantity of technically recoverable resources and, where applicable, the increasing cost of exploiting resources that are less accessible or of lower quality.

The wind resources included in NEMS are derived from work done at the National Renewable Energy Laboratory (NREL) to characterize the location, extent, and accessibility of the U.S. wind resource base, as shown in **Figure 3**. Land-based wind resources vary significantly in development cost and economic performance, based on average wind speed, distance from transmission lines and from demand centers, and even the roughness of terrain and access to construction infrastructure and other factors. In addition, some resources may be in aesthetically or environmentally sensitive areas with high mitigation or opportunity costs for development. EIA estimates that wind resources in excess of 15.7 miles per hour annual average wind speed at 50 meters altitude could, in theory, accommodate 3,700 gigawatts of wind capacity, compared to a current installed capacity base of approximately 25 gigawatts. The estimated cost to develop these resources ranges from about \$2,000 per kilowatt to more than \$6,000 per kilowatt, with about 250 gigawatts estimated to be available at a cost of less than \$2,400 per kilowatt. However, much of this resource is concentrated in areas away from the bulk of the U.S. population. In some regions, the available resource is in excess of local demand or grid capacities to absorb the intermittent output of wind generators, while in others the available

resource can serve only a small fraction of load. NEMS allows for the construction of some interregional transmission, but this projected transmission construction adds additional cost to the wind development and may not entirely alleviate the problem.

Offshore wind resources are potentially more productive than onshore resources and are generally located closer to major population centers. While there is significant uncertainty over the cost of exploiting this resource, EIA estimates that it is significantly higher than the cost of onshore development, based on the limited data available from Europe. Like onshore resources, the cost of the offshore resources increases with increasing utilization of the resource, in part influenced by the same factors that increase the cost of onshore resources, such as distance to load centers, environmental or aesthetic concerns, variable terrain/seabed, and also by water depth.

Biomass can be converted to electricity in either dedicated plants or co-fired as a small fuel fraction in existing plants. Some types of biomass may also be suitable for producing liquid fuels such as ethanol. NEMS represents four distinct types of biomass material available to the electric power sector: forestry residues, urban wood waste and mill residues, agricultural residues, and energy crops. As with most renewable resources, availability varies significantly by region. Based largely on recent work from the University of Tennessee, costs are estimated to rise with increasing supply, as shown in **Figure 4**. This reflects the value of some feedstocks to alternative uses, increasing collection and separation costs, and the value of energy crop lands for other uses such as food and feed production. Energy crops are not yet commercially established in the United States, and EIA assumes that their development will take some time. As a result, the supply of agricultural residues and energy crops varies over time in the *AEO2009*

projections. In 2010, total biomass available to electric generators is estimated at 7.6 quadrillion Btu; by 2020, EIA estimates total biomass supply at 10.7 quadrillion Btu, at costs ranging from \$1.60 to more than \$6 per million Btu. By comparison, the United States used approximately 21 quadrillion Btu of coal for electricity generation in 2007 at an average cost of about \$1.80 per million Btu.

Solar resources are found across the entire United States. NEMS represents two types of solar technology: solar thermal power and photovoltaics. Solar thermal power requires direct sunlight and is assumed to be only economically viable in the more arid regions of the Western United States. Photovoltaics can be used throughout the United States. Available sunlight in the United States is several orders of magnitude in excess of plausible electricity demand; therefore, EIA does not represent absolute limits or increasing cost of supply for this resource. However, the resource is constrained by high investment costs, availability of host sites for the more viable distributed applications, and the ability of the grid to accommodate its highly cyclical and intermittent output.

Turning to geothermal energy, EIA considers resources that can be utilized by technology for electricity generation that is available or expected to be available in the near future. EIA uses a site-specific database of known hydrothermal resource areas with well-characterized costs and capacities; this database totals 8.9 gigawatts of total capacity. The United States currently has an installed geothermal capacity base of 2.4 gigawatts. Both the existing capacity and the exploitable resource are located in the Western United States. Future technology that may allow for the exploitation of other types of geothermal resources is not yet at a level of development where EIA can reliably estimate cost or performance and is not included in NEMS.



For hydroelectricity, EIA relies on a site-by-site database of potential new capacity. The database includes about 22 gigawatts of potential new capacity, although much of this is not economically viable because of high capital costs and environmental concerns.

Finally, EIA represents opportunities for new landfill gas capacity based on Environmental Protection Agency estimates of viable landfills in the United States. New opportunities are estimated at about 5 gigawatts, but as with other renewable resources, exploitation costs vary significantly and the entire resource base may not be economic.

EIA does not estimate resources for a variety of pre-commercial renewable technologies including tidal/in-stream hydropower; wave, ocean thermal, enhanced, or engineered geothermal energy; or other solar and wind technologies in early stages of research and development. In most cases this is the result of insufficient data on resource cost and availability and/or technology cost and performance characteristics. With future research and development and changing market and policy conditions, some of these resources may become commercially viable. As technologies approach this point of commercial introduction, improved data should be available to allow their incorporation into EIA projections.

### **Insights from EIA Analyses of Past Proposals for a Federal Renewable Portfolio Standard**

Over the past several years, EIA has produced a number of analyses of Federal RPS proposals. EIA's two most recent RPS studies, issued in June and December 2007 (see [http://www.eia.doe.gov/oiaf/service\\_rpts.htm](http://www.eia.doe.gov/oiaf/service_rpts.htm)), considered two variants of a 15-percent RPS.

Because of changes in energy markets and policies since those analyses were prepared and the role played by the design features of the programs that were modeled, specific results of these analyses may not be directly applied to proposals currently under consideration. Nonetheless, as discussed below, several insights from these prior reports are applicable to many current or future proposals.

### **RPS Accounting Issues**

In general, a higher RPS target—generally measured as renewable generation as a percentage of covered sales—should result in more renewable generation. As illustrated in the sample calculations presented above, however, the actual amount of additional renewable generation that an RPS would be expected to spur is highly dependent on which renewables are eligible for RPS credits, the availability of bonus credits for certain renewables, whether efficiency programs can be counted as a substitute for renewables, and the exclusion of some electricity sales from coverage by the RPS program. All of these factors may cause the “effective” target share of an RPS program to differ from its stated target. For example, the RPS included in H.R. 3221—an energy bill which passed the House of Representatives in August 2007 but which was ultimately not included in the Energy Independence and Security Act of 2007—had a stated RPS target of 15 percent. However, after accounting for exclusion of significant amounts of electricity sales from coverage, the availability of credits for efficiency, and extra credits for renewable generation meeting specified type and/or location criteria, the effective target level for generation by eligible renewables as a share of national sales could be as low as 8 percent.

The actual impact of an RPS on renewable generation may also depend on the design of the market for renewable energy credits. Credits facilitate compliance by allowing covered sellers with poor access to low-cost renewable resources to transparently pay those with better access to over-comply. Most Federal RPS proposals analyzed by EIA limit the credit price, usually by allowing market participants to buy credits from the government at a given price. These government-supplied credits do not represent any actual renewable generation, so once the market price for credits rises to this pre-set credit price ceiling, incremental increases in renewable generation generally stop. Compliance is achieved, but renewable generation does not reach the RPS target.

Program sunset (expiration) dates tend to increase the credit price as the expiration date nears, as credit suppliers have less time available to recover their costs since the credits are worthless after the sunset. For this reason, sunset provisions can increase the likelihood that a credit price cap, if incorporated, will be triggered.

### **Impact of an RPS on Energy Prices and Expenditures**

The impact of a given RPS proposal on energy prices and expenditures depends upon its details, market conditions, and what other policies, including production and investment tax credits and/or limitations on GHG emissions, are in place.

One approach that is often used to compare different generation technologies is to estimate their levelized costs, which represent the discounted per-kilowatthour costs of building and operating a plant at its typical operating rate, i.e., capacity factor. Because the levelized cost of renewable

generation resources tends to be higher than that of equivalent conventional resources (if it was lower, renewable generation would penetrate rapidly without an RPS), there is a tendency for an RPS to increase electricity prices. However, these electricity price impacts can be partially offset if fuel consumption for electricity generation, such as natural gas and coal, is reduced enough to reduce the price of these fuels. The impact of the RPS on natural gas or coal prices and the subsequent feedback to electricity prices largely depend on which of those fuels is favored in the market for new plants. If natural gas is the favored expansion resource, as seems to be the case in the current market, renewable generation may require lower credit prices to be competitive, since the higher operating cost of natural-gas-fired plants is more likely to set the price with which renewables compete.

On a national average basis, EIA's previous RPS analyses found that electricity prices and consumer expenditures on electricity tend to change by relatively small amounts. For example, in EIA's June 2007 study of a 15-percent RPS, EIA found that, with the RPS, residential consumers spent about 0.4 percent more on electricity than in the reference case. However, impacts on specific sellers may vary significantly. Some will be purchasing renewable energy credits and others selling credits, some will have decreases in natural gas or coal prices passed through to customers through cost-of-service regulation, while others will see those reductions reflected in the cost of power purchased in competitive markets.

An RPS can also affect consumer prices and expenditures for natural gas through its impact on natural gas demand for electric power generation. In the June 2007 study, natural gas expenditures were reduced by 0.1 percent, so that combined expenditures on electricity and natural gas increased by 0.2 percent.

## **Impact of an RPS on Emissions of Criteria Pollutants and Carbon Dioxide**

For criteria emissions, such as sulfur dioxide, that are already constrained by a national or regional emissions cap, EIA's past analyses have found that an RPS generally does not result in significant emission reductions. However, the price of an emission allowance under an RPS is often reduced as generation from emitting sources is displaced.

The impact on carbon dioxide emissions, which are not currently constrained by a cap-and-trade system or otherwise regulated at the Federal level, largely depends on the fuels and generators being displaced -- carbon dioxide reductions are significantly larger when coal is displaced than when natural gas is displaced. Certain renewables, such as biomass co-firing at existing plants, directly displace coal use. Other increases in renewable generation will generally displace the marginal (most costly) generation source that would otherwise be used to meet customer load whenever the renewable generation source is available. Due to increasing concerns related to greenhouse gas emissions on investor behavior, the *AEO2009* projections include fewer additions of new coal-fired power plants than earlier *AEO* editions. For this reason, coal is less likely to be the marginal generation source, which tends to reduce the displacement of coal from levels projected in previous RPS analyses.

When compared to analyses EIA has done on policies specifically addressing carbon dioxide emissions, EIA finds that, even when a comparable level of renewable generation is achieved, carbon dioxide emission reductions are seldom similar. With relatively small impacts on electricity prices, an RPS has little impact on overall electricity consumption. Reduced natural

gas consumption in the electric power sector results in reduced natural gas prices, which may then result in natural gas consumption increases in other sectors, and may negate some of the carbon dioxide emission reductions in the electricity sector. Finally, RPS policies do not incentivize carbon dioxide emission reductions from other sources within the electric power sector, such as nuclear or carbon capture and sequestration, or from outside the power sector. While some of these other carbon dioxide reduction opportunities are likely to be more expensive than renewable generation, others may be lower in cost.

### **Regional Impacts of an RPS**

Different parts of the country have access to different types of renewable energy with different cost and performance characteristics. Some parts of the country, such as the Southeast, may initially rely on a significant increase in the co-firing of biomass resources, such as forestry residues, in existing coal plants to comply with the RPS. Other parts of the country, such as the Great Plains or Pacific Northwest, will tend to expand generation using their abundant wind resources. Exploitation of solar resources, when encouraged by specific policy provisions, may depend as much on the retail cost of power as on the quality of solar resource in a given location.

The designs of all of the Federal RPS proposals EIA has examined allow for renewable energy credit trading. Credit trading means that utilities and regions are not limited to locally-available resources in complying with the RPS. However, in its June 2007 analysis of a 15-percent RPS, EIA found that while some interregional trade in credits occurred, most RPS compliance occurred through growth in eligible generation within each region. For example, despite having a relatively poor wind resource, the Southeast was projected to be a net credit “exporter” through

2019 using its biomass resource and after that date met more than 80 percent of its RPS requirement within the region.

### **The RPS, Electricity Transmission, and Intermittency of Certain Renewables**

The need for expansion of the transmission system will depend on the stringency of the RPS proposal and the desire to exploit some of the best renewable resources, which are often located far from existing transmission and major population centers. The more stringent the proposal, the greater the likelihood that markets near the best renewable resources will not be able to absorb the potential increase in renewable generation, requiring additional long-distance transmission capacity to move it to other markets.

Although certain renewables, notably wind and solar power, are inherently intermittent, electricity demand and supply must balance continuously in the absence of cost-effective storage technologies. As reliance on intermittent sources increases, the traditional electricity system paradigm of “generation follows load” becomes harder to sustain. In EIA’s analyses, a lower capacity value is assigned to intermittent renewables than to other generation sources.

Therefore, additional (“back-up”) capacity may be required to meet reliability standards in areas where significant amounts of intermittent renewables are deployed. Greater reliance on intermittent generation could be more easily accommodated with energy storage or if some portion of load could be made to follow changes in generation, such as through smart-grid technologies that allow for automatic or economically-driven time shifting of non-critical loads. For the most part, these technologies are not specifically addressed in previous EIA analyses of

RPS policy, where the projected levels of intermittent generation can be accommodated without their use.

Of course, not all renewable generation is intermittent. For example, electricity generation from biomass, whether involving the co-firing of biomass at low percentages in existing units or the operation of plants designed to be fueled primarily or exclusively with biomass, can be dispatched. The *AEO2009* projections include significant growth in biomass.

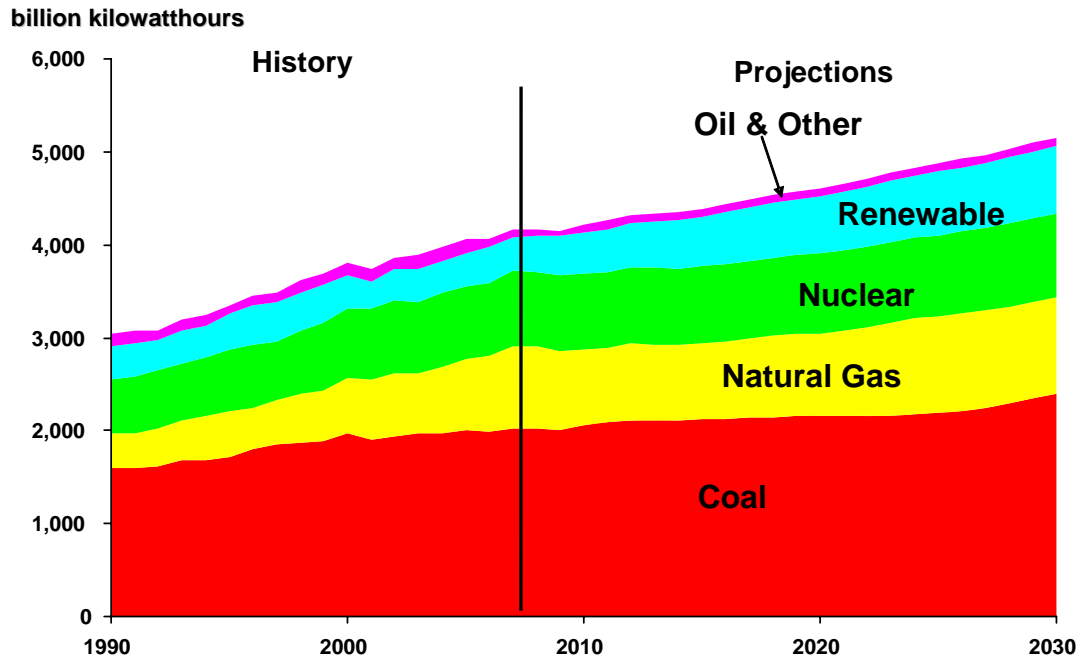
## **Conclusion**

As in the case with many energy issues, the devils (or angels) associated with the design of an RPS are certainly in the details. I know that you, Mr. Chairman, have a long-standing interest in this area. While EIA does not propose, formulate, or advocate energy policies, we are fully prepared to provide the Committee whatever assistance we can, using our extensive data and analytical expertise in this area, as you develop and refine possible legislation.

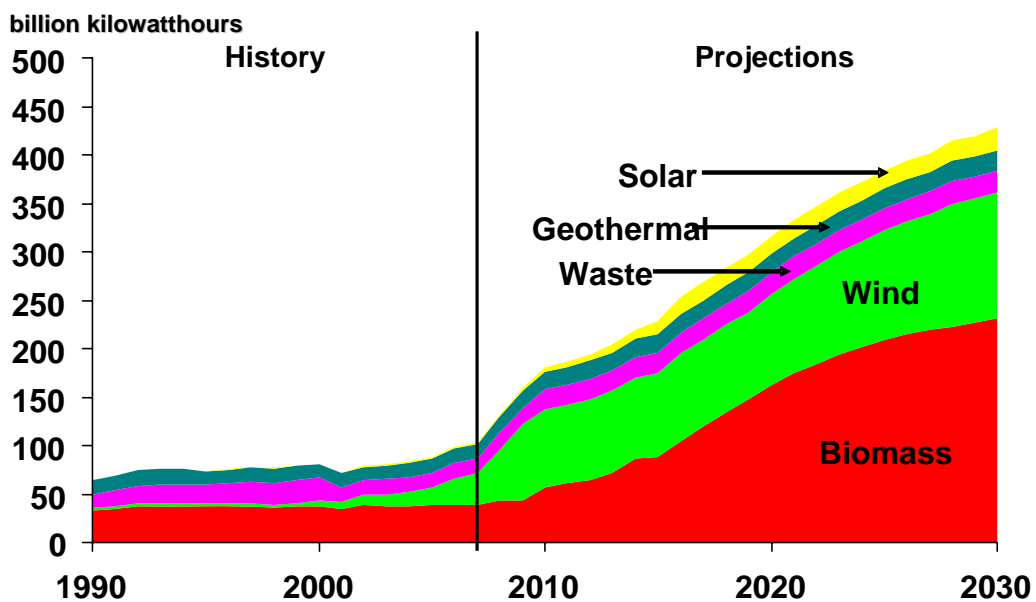
Mr. Chairman and members of the Committee, this concludes my testimony. I would be happy to answer any questions you may have.



**Figure 1. Electricity Generation mix gradually shifts to lower carbon options**

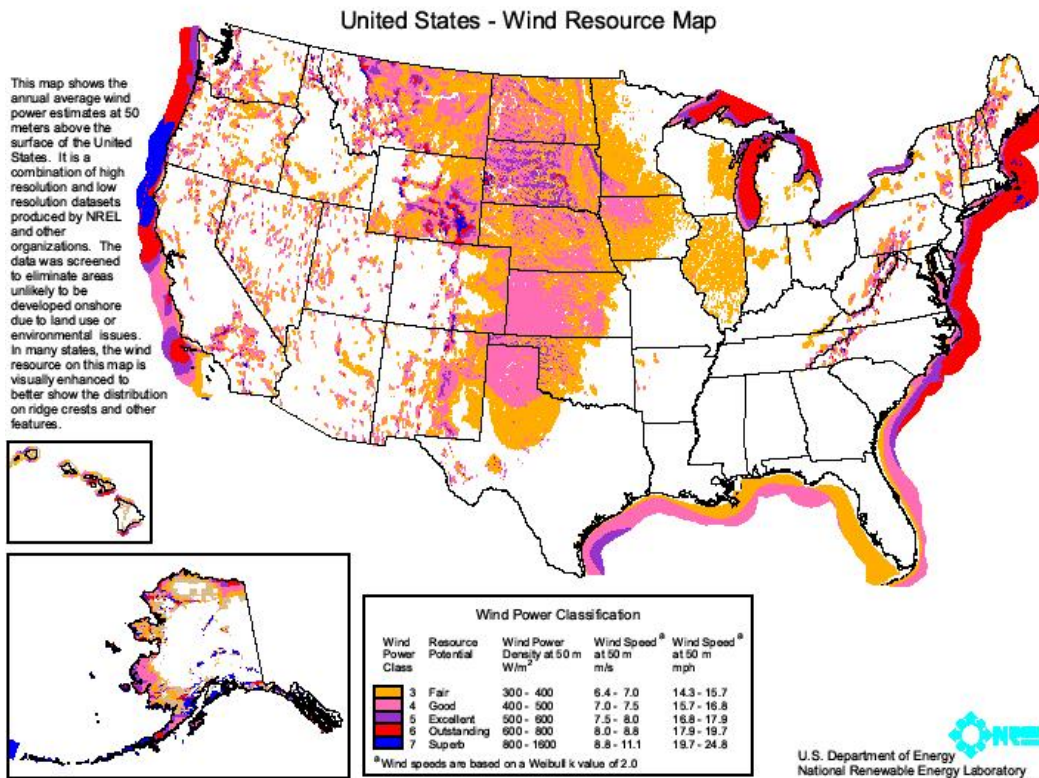


**Figure 2. Nonhydropower renewable power meets 38% of total generation growth between 2007 and 2030**

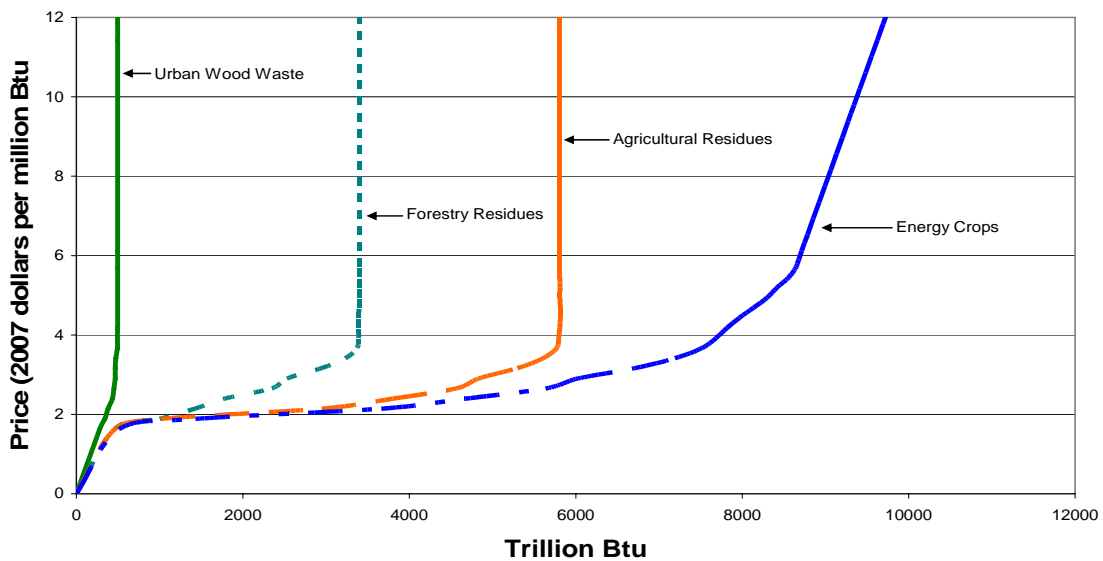


Source: Energy Information Administration, National Energy Modeling System run AEO2009.D112408B.

**Figure 3. Onshore and Offshore Wind Resources**



**Figure 4 – Cumulative Supply of Biomass Feedstock in 2020**



Source: Energy Information Administration, National Energy Modeling System