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COMMITTEE ON WAYS AND MEANS

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Mr. Chairman and members of the Subcommittee, I appreciate the opportunity to appear before you today to discuss the economics of renewable energy electricity generating technologies that are eligible for the Section 45 production tax credit (PTC).

The Energy Information Administration (EIA) is a statistical and analytical agency within the U.S. 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. We do not take positions on policy issues, but we do produce data, analysis, and forecasts that are meant to assist policy makers in their deliberations. Because we have an element of statutory independence with respect to our data, analyses, and forecasting, our views are strictly those of EIA and should not be construed as representing those of the Department of Energy or the Administration. However, EIA's baseline projections on energy trends are widely used by government agencies, the private sector, and academia for their own energy analyses.

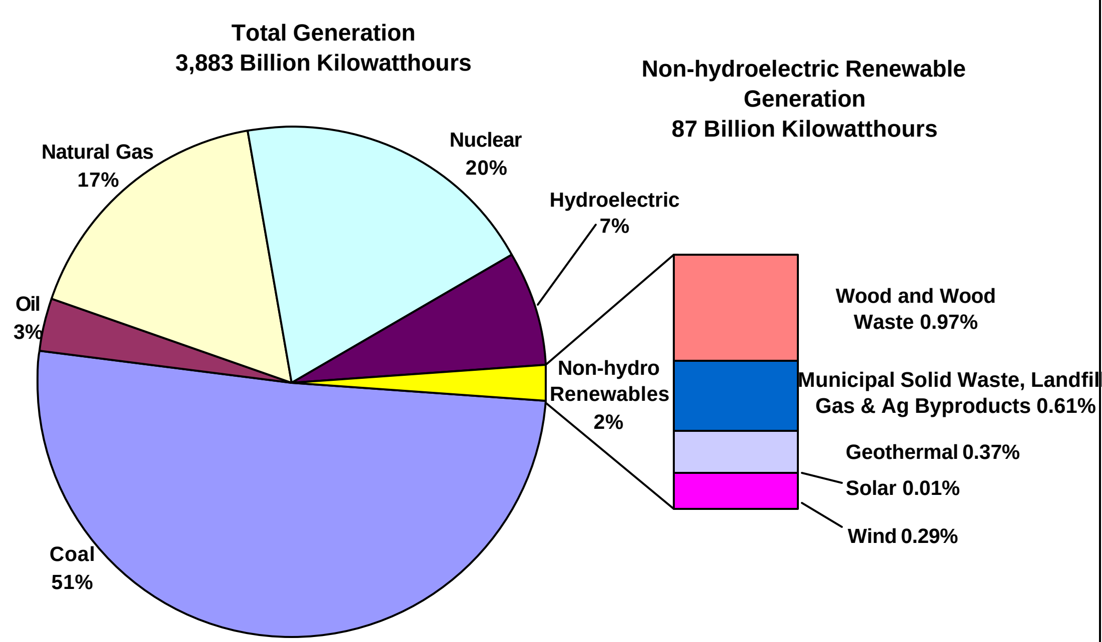
Much of the information I am providing today comes from our *Annual Energy Outlook 2005* (*AEO2005*) which provides projections and analysis of domestic energy consumption, supply, and prices through 2025. The *AEO2005* is based on Federal and State laws and regulations in effect as of late 2004. With respect to electricity generated from renewable energy, *AEO2005* includes the extension and broadening of the PTC through December 31, 2005, that was included in the Working Families Tax Relief Act of 2004 (P.L. 108-311) and the American Jobs Creation Act of 2004 (P.L. 108-357).

The projections in the *AEO2005* are not meant to be exact predictions of the future but represent likely energy futures, given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and subject to many random events that cannot be foreseen, such as weather, political disruptions, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, economic growth, and energy resources may evolve along a different path than expected in the projections. The *AEO2005* includes several alternative cases intended to examine some of these uncertainties.

Renewable Generation Today

In today's market, renewable generation accounts for 9.4 percent of total generation; over three-quarters of it comes from hydroelectric facilities (**Figure 1**). The technologies currently eligible for the PTC account for a small share of total electricity generation. In 2003, the combined generation of geothermal, photovoltaic (see attached Glossary), solar thermal, biomass, municipal solid waste, and wind plants accounted for 2.2 percent of total U.S. electricity generation. Among these renewable sources, biomass generation, mainly from industrial facilities, accounts for over 44 percent of the total, followed by municipal solid waste (26 percent), geothermal (16 percent), wind (13 percent), and the grid-connected solar technologies (1 percent). While their combined generation is projected to more than double by 2025, their share of total generation will remain small, at 3.2 percent.

Figure 1. 2003 Generation by Fuel



Source: Energy Information Administration, Monthly Energy Review, Table 7.2.a, April 2005

Economics of Renewable Generating Technologies

Many factors affect the relative economics of various electricity generating technologies. Such factors include the costs of licensing, permitting, and constructing each plant (often referred to as the overnight construction costs), the time required to build each plant, the costs of financing the construction, the projected cost of the fuel (if any) needed to operate the plant, and other operations and maintenance costs associated with running the plant once it is built. Because the contribution of each of these cost components differs from technology to technology, it is difficult to look at any one factor to determine which technology is best for a given set of circumstances.

One approach that is often used to compare disparate technologies is to estimate their levelized costs. Levelized costs represent the discounted per-kilowatthour costs of building and operating a plant at its typical operating rate (i.e., capacity factor). **Table 1** compares the projected levelized costs to develop the next plant in 2010 for various grid-connected utility-scale renewable technologies to those for pulverized coal, natural gas combined-cycle, and nuclear plants. The values in the table represent the discounted costs of building and operating each technology for 20 years. They include the costs of building the plant, staffing and maintaining the plant, and purchasing the needed fuel each year for 20 years. As shown, pulverized coal plants have the lowest projected levelized costs, followed by geothermal and then natural gas combined-cycle plants. Solar thermal and photovoltaic technologies tend to be much more expensive than other options, while wind and open-loop biomass are in the middle.

Table 1. National Average Levelized Generation Costs for New Plants in 2010

Technology	Levelized Costs (2003 cents per kilowatthour)
Pulverized Coal	4.3
Geothermal	4.4
Natural Gas Combined-Cycle	4.7
Wind	4.8
Open-Loop Biomass	5.1
Nuclear*	6.0
Solar Thermal	12.6
Photovoltaic	21.0

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*The time required to license, permit, and construct a new nuclear plant makes it impossible to bring one on line by 2010. The costs shown are for a plant beginning operation in 2013.
Excludes transmission costs and impact of PTC.
Source: National Energy Modeling System run, aeo2005.d102004a.

When reviewing this table, one might ask why the costs are so different and why we are not seeing greater penetration of geothermal plants. Furthermore, given the costs shown, why has so much natural gas capacity been added in recent years? While pulverized coal plants are expensive to build—typically twice as costly as a natural gas combined-cycle plant—there is an ample supply of fairly low-cost coal and the plants can operate nearly around the clock with annual capacity factors exceeding 80 percent. Because they can be operated so intensively, the recovery of their high construction costs can be spread over a large amount of electricity production, making their per-kilowatthour levelized costs relatively low. In contrast, photovoltaic and solar thermal plants, which are even more expensive to build than coal plants on a per-kilowatt of capacity basis, cannot be operated very intensively. Their potential utilization is limited by the availability of the sun and their annual capacity factors are generally between 25 and 33 percent. Unlike coal plants, the levelized costs for natural gas combined-cycle plants are driven by their fuel costs, rather than their construction costs. If a plant is to be operated intensively—what is referred to as baseload operation—the higher fuel costs for natural gas plants tend to make them less economical than coal plants. On the other hand, if a plant will be operated only occasionally (i.e., peaking operation) or moderately, such as on hot summer days when electricity usage is high, the very low construction costs of natural gas plants make them an attractive option.

For nuclear plants, relatively high construction costs, high operation and maintenance costs, and long planning and construction periods all contribute to their higher levelized costs. For geothermal plants, high construction costs and the site-specific characteristics of the geothermal resource are the key drivers of their levelized costs. At the best sites, their levelized costs can be competitive with new coal plants, but there are only a few sites with costs as attractive as those in Table 1, and they tend to be located in remote areas in the far western region of the country. Once those low cost sites are developed, the remaining sites are much more expensive. The levelized costs for open-loop biomass technologies are most influenced by their high capital costs and the availability of low-cost fuel. When low-cost fuels are available, they can be reasonably competitive, but the supply of such fuels is limited. Because biomass is dispersed and has a much lower energy density per unit of volume than coal, transportation costs generally rule out moving biomass over long distances. The size of plants using biomass can be limited by amount of biomass that can be produced at nearby locations.

For wind, the key levelized cost drivers are the construction costs of the plants and the quality of the wind resource. The wind resource in the country is quite large, but some of the best resources are located in areas where their development is restricted or in relatively remote areas where significant transmission upgrades would be needed to access them.

Two further cautions should be raised about comparing the levelized costs of wind and solar plants to other technologies. Wind and solar technologies are often referred to as intermittent technologies. Unlike the other technologies in the table, their generation is only available when their resources are available. They can not be called upon whenever needed. When the wind is not blowing or the sun is not shining, they cannot generate electricity. As a result, when these technologies are developed, additional capacity may have to be added to back them up and ensure that consumers' electricity needs can be met at all times. The need to add backup capacity for intermittent resources adds system costs that are not reflected in their levelized costs. The levelized costs shown in the table also do not include the costs of transmission investments needed to support the capacity additions. All technologies require some investment to interconnect to the transmission grid, but these costs can be higher for some renewables because of their relatively remote locations and, for the intermittent technologies, the per-kilowatthour transmission costs can be high because of their lower generation.

Impact of the PTC

The availability of the PTC through December 31, 2005, makes the eligible renewable technologies more economically attractive than shown in Table 1. For example, the full 10-year PTC available for wind plants lowers their projected levelized costs by about 2 cents per kilowatthour. The levelized value of the PTC is larger than the nominal value of the PTC because it is an after-tax credit.

For solar technologies, the benefit provided by the PTC does not appear to be large enough to cause a significant change in market penetration. In fact, because their annual output is so limited, the PTC is less valuable to them than the 10-percent investment tax credit for which they are also eligible. For geothermal and biomass technologies, planning and construction periods are so long that it would be impossible for a new plant to be developed in time to take advantage of the current credit. Even for wind technology, only those plants that are well along in their development cycle will be able to enter service in time to qualify for the credit. Short-term extensions of the PTC are likely to have limited impact on qualifying technologies like biomass and geothermal, which have relatively long development periods, even if the credit were large enough to make them economical. Throughout the history of the PTC, its primary impact has been to stimulate the development of wind plants, albeit with the limitations mentioned above.

As stated previously, the *AEO2005* reference case assumes the PTC will expire in December 2005, as provided for in current law. In the *AEO2005*, EIA also has examined the potential impact of a longer-term extension of the current PTC. The only qualifying technology not represented in the extension case was closed-loop biomass. Because of the long establishment times and relative expense of energy crops, it was assumed that no dedicated, closed-loop biomass would be able to take advantage of the extended credit. The PTC extension case is not meant to represent any expectation about future policy decisions regarding the PTC.

In the *AEO2005* PTC extension case, wind power continues to show the largest projected gains, although landfill gas, geothermal, and biomass are also projected to experience some capacity expansion. Installed wind capacity in 2015 is almost 63 gigawatts in the PTC extension case, compared to 9.3 gigawatts in the reference case. In 2015, geothermal capacity in the PTC extension case is 3.2 gigawatts, compared to 2.7 gigawatts in the reference case. Biomass capacity in 2015 is 3.4 gigawatts in the PTC extension case, compared to 2.1 gigawatts in the reference case. In a test case where it is assumed that all of the eligible renewables were given the PTC now available to new wind plants for an extended period, wind and biomass technologies showed the largest growth.

Other Factors Influencing Renewables

Other important factors that could impact the future of PTC-eligible renewable technologies include changes in fossil fuel prices, particularly for natural gas, changes in environmental policies, and changes in other Federal or State policies. The

AEO2005 includes a case where it is assumed that natural gas supply options are more restricted than in the reference case. The key impact of these supply restrictions is higher natural gas prices, making other generating options, including renewables, more economically attractive. In the restricted natural gas supply case, the wellhead price of natural gas in 2025 reaches $6.29 per thousand cubic feet (2003 dollars), 31 percent higher than the $4.79 per thousand cubic feet price in the reference case. These higher natural gas prices cause a shift to increased use of coal and renewables for electricity generation, while natural gas generation is lower. Total additions of renewable capacity in the restricted natural gas supply case are nearly double the level seen in the reference case, and the share of generation accounted for by the renewable technologies eligible for the PTC increases to 4.1 percent, nearly one-third higher than the 3.2-percent share in the reference case. Biomass, wind, and to a lesser degree, geothermal show the greatest increases in response to the higher natural gas prices.

The *AEO2005* also included a case examining the impact of the Environmental Protection Agency's (EPA) proposed Clean Air Interstate Rule (CAIR) which has now been finalized. The CAIR calls for the power sector to significantly reduce its emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x). In the *AEO2005* alternative case, the CAIR was found to have insignificant impacts on renewable generation. Similarly, in a recent analysis prepared in response to a request from Senators James Inhofe and George Voinovich, the potential impact of EPA's proposed Clean Air Mercury Rule (CAMR) together with CAIR was examined. Again, it was found to have only small impacts on renewable generation.

In contrast to these findings, several EIA analyses have shown that renewable generation could be strongly impacted by environmental legislation calling for significant reductions in greenhouse gas emissions. For example, in June 2003, at the request of Senators Inhofe, McCain, and Lieberman, an analysis of S. 139, the Climate Stewardship Act of 2003, was prepared. S. 139 called for a two-phase reduction in greenhouse gas emissions for most sectors of the U.S. economy. The first phase called for reductions to the 2000 greenhouse gas emissions level, while the second phase called for reductions to the 1990 greenhouse gas emissions level. In our analysis, the greenhouse gas cap and trade program called for in S. 139 significantly increases the cost of using fossil fuel technologies that emit greenhouse gases, which encourages increased use of renewables, nuclear, and carbon capture and sequestration technologies. In that analysis, total additions of renewable capacity were more than 10 times the level seen in the *AEO2005* reference case, and the share of generation accounted for by the renewable technologies eligible for the PTC increased to 16.8 percent, more than 5 times the level seen in the reference case. Again, biomass, wind, and geothermal showed the greatest increases in response to the greenhouse gas cap and trade program.

State programs to stimulate renewables, such as power generation standards or mandates, could also influence the impact of Federal PTC changes. In a review of State programs through December 31, 2003, EIA found that the Federal PTC and State renewable programs tend to complement one another. Many of the States have provisions in their renewable programs that limit their funding or the costs they are willing to impose. As a result, the impacts of the State programs likely would be lower without the Federal PTC to reduce the costs of renewables.

Discussions surrounding Federal energy legislation have included proposals for the implementation of a national renewable portfolio standard (RPS) requiring that a certain percentage of all electricity generation or sales come from designated renewable energy sources. EIA has no position on these proposals, but we have prepared several analyses of RPS proposals in recent years in response to requests from Congress. These analyses suggest that such an RPS could stimulate the development of new renewable generating capacity. However, the stated percentage targets in these proposals are often not achieved because provisions that cap the price of tradable renewable credits are triggered. If the PTC and RPS programs were both in effect, such provisions are less likely to come into play as a factor would limit the development of new renewable generating capacity.

This concludes my testimony, Mr. Chairman. I would be glad to answer any questions you and the other Members may have.

Glossary

Closed-loop biomass. A closed-loop process is defined as a process in which power is generated using feedstocks that are grown specifically for the purpose of energy production. Many varieties of energy crops are being considered including hybrid willow, switchgrass, and hybrid poplar.

Combined-cycle. An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more natural gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

Gigawatt. 1,000,000 kilowatts or 1,000 megawatts.

Kilowatt. A unit of electricity generating capacity equal to 1000 watts.

Kilowatthour. The amount of electricity generated by operating a 1-kilowatt generator at full load for 1 hour.

Megawatt. 1,000 kilowatts.

Open-loop biomass. An open-loop process is defined as a process in which power is generated using feedstocks that are a waste stream. Examples of such feedstocks include: agricultural residues (corn stover, wheat straw), forestry residues (logging residues, dead wood), and urban wood waste/mill residues (pallets, construction waste).

Photovoltaic. Direct conversion of sunlight to electricity through use of photo-conversion cells, typically using conducting layers of crystalline silicon cells.

Solar thermal. Conversion of sunlight to electricity by concentrating sunlight to heat water or other medium (like molten salt) for use as a preheater for the boiler fluid of a steam turbine. Sunlight may be concentrated on tubes (trough thermal), points (dish), or tower focal points.