APPENDIX J – WEATHERIZATION AND INTERGOVERNMENTAL PROGRAM (WIP) INPUTS FOR FY 2008 BENEFITS ESTIMATES

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Program Summary

The Weatherization and Intergovernmental Program (WIP) provides funding and technical assistance to its partners in state and local governments, American Indian tribes, and international agencies to facilitate the adoption of renewable energy and energy efficiency technologies. WIP activities speed the adoption of new technologies and help transfer technologies that are developed by Department of Energy (DOE)-funded research to the private sector.

WIP activities are different from those of most DOE research and development programs that focus on basic science and hardware development. WIP projects are more likely to focus on issues such as economic development in rural areas or how renewable energy and energy efficiency projects can improve air quality. For this reason, it is difficult to characterize the benefits resulting from WIP activities by measuring their energy impact.

In general, WIP activities are characterized by:

- Multiple Technologies
  - WIP facilitates adoption of a range of technologies that are developed by the DOE Office of Energy Efficiency and Renewable Energy (EERE).
- Work Across All Energy Market Sectors
  - WIP sponsors activities in the major energy market sectors—buildings, electric power, industry, and transportation—and works to educate the public, teachers, and students about the benefits of renewable energy and energy efficiency technologies. WIP also helps state and local agencies improve their energy efficiencies by upgrading public facilities.
- Partnerships
  - WIP is involved with a broad range of energy stakeholders that cover the breadth of the U.S. economy. WIP staff members consult regularly with the National Governors' Association, the National Association of State Energy Officials, the National Council of State Legislatures, the National Association of Counties, the U.S. Conference of Mayors, the National Association of State and Community Service Programs, and many others.
- Leverage of Federal Resources
  - Almost every WIP project involves substantial participation and investment by state and local agencies, Indian tribes, and the private sector.

Significant Changes from Previous Analysis

Table J-1 outlines the activities characterized for WIP's FY08 Government Performance and Results Act (GPRA) and identifies any changes from the FY07 GPRA effort. WIP provided characterizations and inputs for these activities to EERE's integrated modeling effort.

Table J-1: Weatherization and Intergovernmental Program Activities

Subprogram	Activity	Inputs changed from FY07?	Reason for Change
State Energy Program	Codes and Standards Energy Audits Rating and Labeling Workshops/Training Incentives Retrofits Loans and Grants Technical Assistance Traffic Signals Procurement Tax Credits Renewable Energy Special Projects: Competitive Grants	Yes	Change in direction
Weatherization Assistance Program Grants	Weatherization Assistance	Yes	Decrease in funding
Intergovernmental Activities	Tribal Energy Activities	Yes	Decrease in funding
	International Renewable Energy Program	Dropped	Decrease in funding
	Renewable Energy Production Incentive	Yes	Change in research

For FY08, the SEP program added three new grant areas to the analysis: Tax Credits, Procurement, and Renewable Energy. Additionally, SEP plans to revamp its Special Projects to focus on competitive grants that promote market transformation. In 2008, the State Energy Program will allocate approximately 78% of its funding to the traditional grant programs, and 22% of its funding to competitive grants. With a projected budget of $45 million, the traditional SEP grants will receive $35 million and the new SEP Market Transformation program will receive $10 million. The SEP Special Projects: Competitive Grants program was developed to strategically realign the SEP program by transforming energy markets at the state level, to promote an integrated portfolio of energy efficiency and renewable energy options, and to strengthen the traditional state energy grant programs.

The GPRA08 inputs for each activity are described in the following sections.

State Energy Program

The State Energy Program provides financial assistance to states, enabling state governments to target their own high-priority energy needs and expand clean energy choices for their citizens and businesses. With these funds and the resources leveraged by them, the State and Territory Energy Offices develop and manage a variety of programs geared to increase energy efficiency, reduce energy use and costs, develop alternative energy and renewable energy sources, promote environmentally conscious economic development, and reduce reliance on imported oil.

The Baseline ("without DOE RD3" case)

SEP provides grants and promotes energy-efficient technologies. Therefore, WIP assumes that no technological improvements beyond those that are in the baseline would occur in the absence of the subprogram.

Target Market Description.

SEP provides grants to the states for them to design and carry out their renewable energy and energy efficiency programs in a way that makes the most sense for their resources and economies. Activities promote technology policies and projects that increase building, transportation, and industrial efficiency, reduce dependence on foreign oil, and increase use of renewable energy.

Baseline Adjustments to the AEO2006 Reference Case

WIP assumed that the *AEO2006* Reference Case adequately captured the technological improvements that would occur in the absence of the program. In the *AEO2006* Commercial Reference Case, shell improvements for new buildings can range up to 22% more efficient than the 1999 building stock; and through 2030, new building shells are assumed to improve by 8%, while existing building stock efficiency is assumed to improve 6% over the 1999 stock efficiency (EIA 2006).

Within the *AEO2006* Residential Reference Case, one of the implicit assumptions is that there will be no radical changes in technology or consumer behavior through 2030. Additional assumptions for the residential reference case include: 1) no new efficiency regulations, beyond what is already in law, nor new government efficiency programs; 2) technologies that have not achieved widespread acceptance already will not achieve significant penetration by 2030; 3) currently available technologies will evolve in both cost and efficiency; and 4) consumers in the future will behave similarly to current consumer behavior (EIA 2006).

Removing Effects of Program Activities

As discussed in the previous paragraphs, WIP assumed that no program-related impacts are included in the *AEO2006* Reference Case; therefore, nothing was removed from the Reference Case to establish the "non-program" baseline.

Other Program-Relevant Adjustments to AEO Reference Case

No other corrections were made to the *AEO2006* Reference Case.

Program Outputs

The State Energy Program (SEP) mission is to provide financial assistance through formula grants to states, enabling state governments to target their own high-priority energy needs and expand clean energy choices for their citizens and businesses.

Assumed Budget Projections

WIP assumed level funding of $45 million throughout the analysis period (2008-2030). Of this, $35 million was assumed to fund formula grants, and $10 million to special projects, which will be geared toward competitive market transformation activities in FY 2008.

Description of Key Activities

The SEP is the only Federally funded, state-based program administered by DOE that provides resources directly to the states. With these funds and the resources leveraged by them, the State and Territory Energy Offices develop and manage a variety of programs designed to increase energy efficiency, reduce energy use and costs, develop alternative energy and renewable energy sources, promote environmentally conscious economic development and reduce reliance on oil produced outside the United States. State energy offices are also instrumental in administering public benefits funds and energy emergency preparedness.

Formula Grants

SEP will provide formula grants to 50 states, the District of Columbia, and territories for energy efficiency/renewable energy programs. These grants will:

- Support implementation of the 2006 SEP Strategic Plan, addressing key goals of market transformation and collaboration with environmental and economic development interests,
- Assist states in strategic planning and analysis,
- Provide technical assistance and training to develop state-level capabilities to form collaborative partnerships and conduct evaluation of the impact of state energy efficiency and renewable energy programs nationwide,
- Provide technical assistance to address emerging regional energy and environmental issues such as transportation and air quality, and
- Support information technology systems for program evaluation and reporting in compliance with E-Gov initiative.

Special Projects: Competitive Grants

Special Projects will focus on market transformation and crosscutting solutions targeted at individual market sectors. They will not be technology-specific independent solicitations. The SEP competitive special project grants will enable states to initiate innovative financially self-sustaining energy planning and program activities. DOE would seek proposals that establish policies that increase available capital for energy efficiency and renewable energy projects and implement strategies that would create a self-sustaining resource base for state programs over the long term, e.g., revolving loan funds, financing risk reduction, performance contracting, etc. SEP will provide tailored technical assistance to states to support state and local actions that further national energy priorities and transform markets for EERE technologies and practices.

Milestones

Award grants to states and territories.

Program Outputs

The State Energy Program will enable state energy offices to tailor energy efficiency programs to state and local needs and to leverage non-Federal resources to supplement Federal assistance. SEP supports state partners in areas such as utility restructuring, implementing newly developed energy efficiency technologies, and urban/regional planning for sustainability. Utilizing a corporate crosscutting approach, EERE will assess the research and development program priorities and provide tailored technical assistance to states to support state and local actions that further national energy priorities.

Table J-2: WAP Outputs, Activities, and Milestones

Outputs	Associated Activities	Associated Milestones
Enable state energy offices to tailor energy efficiency programs to state and local needs and to leverage non-Federal resources to supplement Federal assistance	Key activities 1. Formula Grants 2. Special Projects Competitive Grants	Award grants to states and territories

Translating Program Outputs to Market Outcomes

Table J-3: Linkage of Outputs with Outcomes

Outputs	Associated Ultimate Outcomes
Enable state energy offices to tailor energy efficiency programs to state and local needs and to leverage non-Federal resources to supplement Federal assistance	Achieve an average annual energy savings of 10-12 trillion source Btus (an estimated $60 million-$70 million in annual energy cost savings) with DOE funds.

Key Factors in Shaping Market Adoption of EERE technologies

- Price: The program developed incremental cost data using available cost information for similar projects. Where specific costs were not available, simple payback calculations were used to generate incremental private investment based on on-site fuel costs (EIA 2006) and representative payback periods associated with individual program areas.

Formula Grants

- Codes and Standards: WIP assumed a five-year payback period on investment to develop incremental investment costs, based on previous benefit-cost studies of energy codes[1] (i.e., an annual energy cost savings of $1 implies an initial investment of $5).
- Energy Audits, Workshops/Training, Retrofits, and Technical Assistance: For residential sector prices, WIP used the average cost for Energy Star: Home Performance projects as a guide. For FY05, pilot Home Performance projects were spending between $4,000 and $6,000 in retrofits, so WIP assumed an average of $5,000 of cost to yield 20% energy savings (Energy Design Guide 2003). Commercial-sector prices were based on estimated project costs for the Building Technologies Rebuild America activity, which assumed a cost of $3 per square foot to reduce energy use by 25%.
- Rating and Labeling, Traffic Signals, Procurement, and Tax Credits: WIP assumed a three-year payback period on investment to develop incremental investment costs. The three-year payback comes from a comparative analysis of energy efficiency retrofit payback options. Of the 5,263 buildings sampled, 91% of the implemented energy

[1] See case studies presented on Building Energy Codes Web site for more information: http://www.energycodes.gov/implement/tech_assist_reports.stm.

conservation measures fell below the three-year payback threshold (Anderson and Newell 2002).

- Loans, Grants, and Incentives: For the SEP Loans/Grants activity, WIP assumed that the total amount of funding (DOE plus leveraged) would equal the incremental private investment expenditures. For the SEP Incentives activity, the incremental private investment was assumed by WIP to equal the value of the rebates generated by incentive payments.
- Renewable Energy: A 10-year payback was applied to the Renewable Energy program area, based on a study titled *The Economics of Wind Energy*, which outlines the average payback of a 50 MW wind farm at approximately 10 years (AWEA 2002). Because large wind farms make up the lion's share of the renewable market to date, this metric was chosen as an appropriate metric for the entire renewable energy program.

Special Projects: Competitive Grants

- The building- and industrial-sector payback periods for the market transformation program were set at three years (Anderson and Newell 2002).
- A five-year payback was applied to the transportation-sector analysis, based on the fact that most of the transportation programs are funded by state and local governments, whose investment is less risky and can handle somewhat longer payback.
- A 10-year payback was applied to the clean energy sector, based on a study titled *The Economics of Wind Energy*, which outlines the average payback of a 50 MW wind farm at approximately 10 years (AWEA 2002). Because large wind farms make up the majority of the clean energy sector to date, this metric was chosen as an appropriate metric for the entire clean energy sector.

Final Outcomes (Benefits)

For the FY08 GPRA metrics, the State Energy Program (SEP) was characterized based on the FY08 budget request and the associated leveraged funding. The metrics were derived from *An Evaluation of State Energy Program Accomplishments: 2002 Program Year* (ORNL 2005), where 12 activities (referred to in the report as "project areas") supported by SEP were selected to represent the traditional grant programs. The following activities: Codes and Standards, Energy Audits, Rating and Labeling, Workshops/Training, Incentives, Retrofits, Loans and Grants, Technical Assistance, Traffic Signals, Tax Credits, Procurement, and Renewable Energy account for approximately 94.8% of the total estimated energy savings within ORNL 2005.

For the Special Projects activity, the energy savings metrics were developed for each sector, based on the technical potential calculations developed in Arent et al. (2006).[2] For the FY08 inputs, WIP assumed that the metric for "energy savings per dollar invested" is valid for the SEP inputs using the FY08 funding level expected for the SEP Special Projects program.

More detail about the development of the benefits for each of these activities follows.

[2] Distribution of the full report is limited by DOE. The following report, based on the full report, is publicly available: Arent, D.; Benioff, R.; Mosey, G.; Bird, L.; Brown, J.; Brown, E.; Vimmerstedt, L.; Aabakken, J.; Parks, K.; Lapsa, M.; Davis, S.; Olszewski, M.; Cox, D.; McElhaney, K.; Hadley, S.; Hostick, D.; Nicholls, A.; McDonald, S.; Holloman, B. (2006). Energy Sector Market Analysis. NREL Report No. TP-620-40541

Formula Grants

Codes and Standards. The purpose of the SEP Codes and Standards activity is to encourage the adoption of building codes and standards through training and implementation activities. In ORNL 2005, data were collected on three separate metrics related to building codes: name of new energy-efficiency building code adopted, name of old energy-efficiency building code replaced, and percentage of new construction in state covered by the new code (ORNL 2005). The information provided by each state, on all three metrics combined, was used to calculate energy savings achieved by code activity (ORNL 2005). For consistency, WIP based the estimated savings of the Codes and Standards activities funded by the SEP on the savings estimates produced for the Residential and Commercial Energy Codes projects within the Office of Building Technologies (BT). The program assumed that 50% of the energy savings due to the deployment of codes would result from SEP's Codes and Standards training and implementation activities. A full explanation of the development of these figures can be found in Appendix G of this document.

Energy Audits. The SEP Energy Audits activity provides recipients with specific information needed to improve the energy efficiency of their facility/building through on-site energy audits. Energy-audit savings calculations were based on three indicators: number of audits, square feet retrofit, and reported savings (ORNL 2005). For this effort, WIP converted these three indicators into number of households and square footage of commercial floor space impacted by this activity.

The program assumed a savings per audit of 21.7 MMBtu per household and 0.0167 MMBtu per square foot of commercial floor space (ORNL 2005). The per-unit energy savings estimate for residential retrofits (43.3 million source BTU per project) provides the base for the estimate of savings associated with energy audits in the residential sector (ORNL 2005). An adjustment factor of 0.50 was applied to the retrofit number, based on the conservative assumption that only half of the recommended measures would be installed (ORNL 2005). Based on Tables 1.2.3 and 1.2.4 of the *Buildings Energy Data Book*, approximately 84 MMBtu/HH/yr are used by residential space heating and space cooling, yielding a load reduction attributable to the audits of 26% for residential space heating and cooling. Based on Tables 1.3.3 and 1.3.4 of the *Buildings Energy Data Book*, approximately 121 kBtu/SF/yr are used by commercial space heating, space cooling, and lighting, yielding a load reduction attributable to the audits of 14% for commercial space heating, space cooling, and lighting.

States reported to WIP a total of 581 residential audits, 1,878,809 residential square feet retrofit, and 139,851 MMBtu projected residential source savings. To convert the residential indicators into an estimated number of households, the program assumed that each residential audit represented one household, divided the total residential square feet retrofit by 1,707 (which is the average heated square footage for all residential units in the United States from the *2001 Residential Energy Consumption Survey*), and divided the estimated reported annual savings by the 21.7 MMBtu/HH figure (ORNL 2005). This yields an estimate of approximately 8,100 households impacted by energy audits in any given year.

In the categories of commercial, industrial, and institutional, states reported to the WIP program a total of 35 audits performed, 67,976,934 square feet retrofit, and 17,551,878 MMBtu projected

source savings. To convert the commercial/industrial/institutional indicators into an estimated commercial square footage, the WIP program assumed that each commercial audit represented one building multiplied by 14,500 square feet (which is the average building size taken from the *1999 Commercial Building Energy Consumption Survey*), used the square footage reported, and divided the estimated annual savings by the 0.0167 MMBtu/SF figure (ORNL 2005). This yields an estimate of approximately 1.1 billion square feet impacted by energy audits in any given year, or 1.6% of existing commercial floor space each year.

The WIP program assumed that the number of energy audits performed would be in direct proportion to the funds available for energy audits. The ORNL 2005 figures were based on SEP funding of $46.2 million. Therefore, the figures above were adjusted downward to reflect the $35 million budget request.

Rating and Labeling. The purpose of the Rating and Labeling activity is to establish and promote energy efficiency ratings and equipment labeling. Energy savings in this project area were captured through the energy saved statewide as a result of a state's endorsement of rating and labeling systems for up to 15 different types of energy consuming devices (ORNL 2005). Because the Energy Star program is the largest successful rating and labeling program, and many states use SEP funds to encourage participation in the Energy Star program, savings associated with the program were used to represent the savings achieved by all state rating and labeling efforts (ORNL 2005). Although there are 40 different Energy Star devices, the top 15 were profiled in the ORNL 2005 report. Thus, savings for 25 devices was not included in this analysis. The top 15 Energy Star devices were profiled by capturing the nationwide sales for each device. The energy savings metric was then applied to each device, using the unit savings per device, compared to the energy consumed by an Energy Star device (ORNL 2005). The national savings for each type of energy-consuming device was adjusted downward by multiplying by an "attribution factor" of 0.10, which approximates the proportion of Energy Star purchases made as a result of state encouragement (Feldman and Tannenbaum 2000). **Table J-4** contains the estimated energy savings from rating and labeling.

Table J-4: Estimated Energy Savings from Rating and Labeling (ORNL 2005)

Device	Energy Star savings per unit (MMBtu source)	Number of Energy Star units sold in U.S., 2002	National Savings, 2002 (MMBtu source)	Adjusted national savings (using 0.10 "attribution factors" (MMBtu source)
Office Computer/Monitor	2.938	22,941,000	67,400,658	6,740,066
Home Computer/Monitor	0.853	11,402,000	9,725,906	972,591
Fax Machine	1.801	2,271,000	4,090,071	409,007
Copier	3.033	209,000	633,897	63,390
Multi-function Device	6.540	1,338,000	8,750,520	875,052
Scanner	2.654	6,810,000	18,073,740	1,807,374
Printer	2.085	7,369,000	15,364,365	1,536,437
TV	0.360	10,446,000	3,760,560	376,056
VCR	0.171	12,028,000	2,056,788	205,679
TV/VCR	0.332	4,643,000	1,541,476	154,148
Audio Equipment	0.171	3,687,000	630,477	63,048
Room AC	0.663	2,195,000	1,455,285	145,529
Dishwasher	0.569	2,262,000	1,287,078	128,708
Refrigerator	1.137	1,956,000	2,223,972	222,397
Clothes Washer	2.464	1,224,000	3,015,936	301,594
Total		90,781,000	140,010,729	14,001,076

The WIP program assumed that the savings would be effective for 10 years, and that they were attributable to electricity, based on the conservative life expectancies of major appliances (Demesne 2006).

Workshops/Training. The purpose of this SEP activity is to promote energy efficiency measures through targeted workshops and training sessions. The first item to address in workshops and training is the residential building sector. A residential energy-savings multiplier was developed through the selection of four common energy-conservation measures that could easily be taught in workshops and training sessions (ORNL 2005). Consequently, the WIP program modeled the residential training measures as air infiltration sealing, resetting water heater thermostats, attic insulation, and compact fluorescent lightbulbs (CFLs); and assumed that the average annual savings per household for these four measures was 28.7 source MMBtu, which was derived from the impacts of these measures in four representative cities (Schenectady, New York; Birmingham, Alabama; Moline, Illinois; and Eureka, California) using the *Home Energy Saver* System,[3] a Web-based energy audit system that is driven by the DOE-2 building simulation program (ORNL 2005). The WIP program assumed that 3.4 MMBtu of those savings resulted from CFLs; 5.5 MMBtu resulted from resetting water heater thermostats; and that the rest was attributable to space conditioning (Schweitzer and Eisenberg 2002). Based on the *Building Energy Data Book*, Tables 1.2.4 and 1.2.3, total primary household consumption for 2005 is 191.4 MMBtu/HH: 44.1% (or 84.4 MMBtu) is space conditioning, 12.7% (or 24.3 MMBtu) is water heating, and 11.8% (or 22.6 MMBtu) is lighting. Therefore, the estimated savings resulting from residential workshops and training are 23.4% space conditioning savings, 22.6% water

[3] Accessible at http://hes.lbl.gov/

heating savings, and 15% lighting savings. WIP assumed that 20% of attendees would implement the measures based on the findings from three recent studies (Reed et al. 1999; Peters and McRae 2001; Tools of Change 2004) and that the average attendee would influence 1.75 homes based on U.S Census Bureau residential construction numbers and conservative estimates formulated in the ONRL 2005 report. There were approximately 49,000 residential workshop attendees in 2002 (ORNL 2005), so the program assumed that this number would continue, resulting in residential workshops/training impacting approximately 17,150 existing residential households, or 0.02% of existing residential homes per year.

ORNL 2005 provided an estimate for both commercial and institutional buildings. Because the savings coefficients reported for commercial (156.8 MMBtu/attendee) and institutional (151 MMBtu/attendee) were within 5% of each other, the two were modeled together by the WIP program. The WIP program assumed estimated commercial savings of 5.25% for heating, ventilating, and air conditioning (HVAC) measures and 3.2% for lighting measures based on two reports (McClain et al. 1994; Abraham and MacDonald 1995) that identified the percent energy savings possible from HVAC and lighting retrofits in large and small office buildings (ORNL 2005). The program assumed that HVAC savings equate to both space heating and space cooling. The report used a weighted median number of buildings influenced by each trainee as four buildings per trainee. WIP assumed that 20% of attendees would implement the measures (ORNL 2005). The total number of commercial buildings training attendees in 2002 was 19,000 and institutional building attendees was 25,000 (ORNL 2005). This is equivalent to 176,000 buildings impacted. The program assumed the average square feet per commercial building is 14,500 (CBECS 1999), so commercial and institutional workshops/training impacts about 0.51 billion square feet of existing commercial floor space, or 0.74% of existing commercial floor space per year.

The ORNL 2005 figures were based on SEP funding of $46.2 million. Therefore, the figures above were adjusted downward to reflect the $35 million budget request.

Technical Assistance. The purpose of the Technical Assistance activity is to promote energy efficiency measures by providing technical assistance to building owners. WIP assumed that technical assistance is credited with half the implementation of workshops, and half the savings achieved by workshop attendees (see discussion above for derivation of savings estimates). Because the program assumed that technical assistance savings were half the savings of workshops (ORNL 2005), the estimated savings resulting from residential technical assistance are 11.7% space conditioning savings, 11.3% water heating savings, and 7.5% lighting savings. The program assumed that 10% of attendees would implement the measures (ORNL 2005). This implementation rate is half that of the rate used for workshops and training, based on the assumption that the implementation rate would be substantially lower than workshops and training sessions because technical assistance is less intensive and personal interaction is more limited, providing less detailed instruction, and would therefore be expected to be less motivational. There were approximately 297,350 contacts for residential technical assistance in 2002 (ORNL 2005), so residential technical assistance impacts approximately 29,735 existing residential households, or 0.04% of existing residential homes per year.

WIP assumed that technical assistance commercial building savings would be half the savings of workshops (ORNL 2005), yielding an estimated savings of 2.63% in space conditioning and 1.6% in lighting. The program assumed that HVAC savings equate to both space heating and space cooling. WIP assumed that 10% of attendees would implement the measures (ORNL 2005). The total number of technical assistance contacts in 2002 for commercial buildings was 67,000 (ORNL 2005). The program assumed the average square feet per commercial building is 14,500, from the *1999 Commercial Buildings Energy Consumption Survey*, so commercial and institutional workshops/training impacts about 0.19 billion square feet of existing commercial floorspace, or 0.28% of existing commercial floorspace per year.

WIP assumed that the amount of technical assistance provided would be in direct proportion to the funds available for technical assistance. The ORNL 2005 figures were based on SEP funding of $46.2 million. Therefore, the figures above were adjusted downward to reflect the $35 million budget request.

Retrofits. The purpose of this SEP activity is to provide building owners with retrofit assistance. Energy-savings estimates for retrofits were reported in residential structures, commercial structures, schools, health-care facilities, government buildings, and industrial applications (ORNL 2005). Retrofit calculations were based on two indicators: number of retrofits and square feet retrofit (ORNL 2005). For this effort, WIP converted these two indicators to number of households and square feet of commercial floor space impacted.

The program assumed a savings per retrofit of 43.4 MMBtu per household based on an un-weighted, nationwide average energy savings for the residential sector. This number was based on primary energy savings per house from residential retrofits for four regions of the country, as developed for the Weatherization Assistance Program (Schweitzer and Eisenberg 2002). Based on Tables 1.2.3 and 1.2.4 of the *Buildings Energy Data Book,* approximately 84 MMBtu/HH/yr are used by residential space heating and space cooling, yielding a load reduction of 54% for residential space heating and cooling.

States reported to WIP a total of 683 residential building retrofits and 49.7 million square feet of residential floorspace retrofit. To convert the residential indicators into an estimated number of households, the WIP program assumed that each residential retrofit represented one household and divided the total residential square feet retrofit by the average square feet per household (1,707, which is the average heated square footage for all residential units in the United States from the *2001 Residential Energy Consumption Survey*). This yielded an estimate of approximately 29,800 households impacted by retrofits in any given year, or 0.037% of existing residential single-family buildings in each year.

The program assumed a savings per retrofit of 18.8% per square foot of commercial floor space. This number was based on the average savings in retrofits in commercial buildings reported in two studies (Greely et al. 1990, Coates 1995).

States reported to WIP a total of 18 commercial building retrofits and 119.5 million square feet of commercial floor space retrofit. To convert the indicators into an estimated commercial square footage, the WIP program assumed that each commercial retrofit represented one building

multiplied by the average building size (14,500 square feet, from the *1999 Commercial Buildings Energy Consumption Survey*) and used the square footage reported. This yielded an estimate of approximately 0.119 billion square feet impacted by retrofits in any given year, or 0.18% of existing commercial floor space in each year.

WIP assumed a savings per retrofit of 0.016 MMBtu per square foot of educational floor space (Greely et al. 1990). Based on Tables 1.3.3 and 1.3.7 of the *Buildings Energy Data Book,* approximately 67 kBtu/SF/yr are used by education space heating, space cooling, and lighting, yielding a load reduction of 24% for education building space heating, space cooling, and lighting.

States reported to the program a total of 73 education building retrofits and 68.6 million square feet of education floor space retrofit. To convert the indicators into an estimated commercial square footage, WIP assumed that each education retrofit represented one building multiplied by the average building size (26,400 square feet, from the *1999 Commercial Buildings Energy Consumption Survey*) and used the square footage reported. This yielded an estimate of approximately 0.07 billion square feet impacted by retrofits in any given year, or 0.68% of existing commercial floor space in each year.

WIP assumed a savings per retrofit of 0.041 MMBtu per square foot of health-care floor space (Lew and Wang 1998). Based on Tables 1.3.3 and 1.3.7 of the *Buildings Energy Data Book,* approximately 168 kBtu/SF/yr are used by health-care space heating, space cooling, and lighting, yielding a load reduction of 24% for health-care space heating, space cooling, and lighting.

States reported to WIP a total of one health-care building retrofit and 18.7 million square feet of health-care floor space retrofit. To convert the indicators into an estimated commercial square footage, the WIP program assumed that each health-care retrofit represented one building multiplied by the average building size (23,000 square feet, from the *1999 Commercial Buildings Energy Consumption Survey*) and used the square footage reported. This yielded an estimate of approximately 0.02 billion square feet impacted by retrofits in any given year, or 0.92% of existing commercial floor space in each year.

The ORNL 2005 figures were based on SEP funding of $46.2 million. Therefore, the figures above were adjusted downward to reflect the $35 million budget request.

Loans and Grants. The purpose of this SEP activity is to facilitate energy efficiency loans and grants. WIP found defensible study results on the amount of loans provided and estimated energy savings associated with those loans for the following three programs: Oregon Low-Interest Loan Program, Texas LoanStar Program, and Nebraska Dollar and Energy Savings Loan Program (ORNL 2005). The program also found defensible study results on the amount of grants provided and energy savings associated with those grants for the following five programs: Illinois Energy Efficient Affordable Housing Program, California Grants, Louisiana Institutional Conservation Program, Wisconsin Farm Save Energy Project, and New York State Variable Speed Drive Program (ORNL 2005). The program assumed the estimates of savings per loan/grant by sector as reported in **Table J-5**. Loan/grant funding as a percent of total SEP funding reported for all project areas was 16.2% in 2002 (ORNL 2005). The program assumed that this percentage

would apply to FY08. In 2002, leveraged dollars per SEP dollar for loans/grants was $10.65 (ORNL 2005). Based on the FY 2008 request, WIP assumed that approximately $66.1 million (from both SEP and leveraged funds) would be spent on loan/grant activities. Using the dollar amounts from ORNL 2005's underlying calculations, the percentage of the total rebate package per sector was calculated (see **Table J-5**) to determine the proportion of each sector's savings, yielding a total annual savings of about 1.1 TBtu [(22.9% x $66.1M x 0.0148) + (9.1% x $66.1M x 0.0148) + (3.4% x $66.1M x 0.0178) + (63.3% x $66.1M x 0.0178) + (1.2% x $66.1M x 0.0161)]. The program assumed that the savings would be in effect for 15 years.

Table J-5: Percentage of Total Loan/Grant Amount and Savings per Loan/Grant Dollar by Sector (ORNL 2005)

	Residential	Commercial	Industrial	Institutional	Agriculture
% of loan	22.9%	9.1%	3.4%	63.3%	1.2%
MMBtu/$ loan	0.0148	0.0148	0.0178	0.0178	0.0161

Financial Incentives. The purpose of this SEP activity is to provide financial incentives (or rebates) to encourage the installation of energy-efficient equipment. Defensible study results were cited on rebate payments and the associated energy savings for four programs: Anaheim Public Utilities Energy Efficiency Incentives Program, Pacific Gas and Electric Single Family Homes Energy Efficiency Rebate Program, Pacific Gas and Electric Multifamily Energy Efficiency Rebate Program, and Pacific Gas and Electric Express Efficiency Program (ORNL 2005). These program results provide the basis for assumptions made by sector. WIP assumed the estimates of savings per rebate dollar by sector as reported in **Table J-6**. In 2002, incentive funding of $34.7 million provided for $21.5 million worth of rebates (ORNL 2005). The program, therefore, assumed that each program dollar of funding provides $0.62 in rebates. Incentive funding as a percent of total SEP funding reported for all project areas was 1.3% in 2002 (ORNL 2005). WIP assumed that this percentage would apply to FY08. The program assumed that leveraged dollars per SEP dollar for incentives was $60.87 (ORNL 2005). Based on the FY 2008 request, the WIP program assumed that approximately $28.2 million dollars (from both SEP and leveraged funds) would be spent on incentive activities, equating to about $17.5 million in rebates. Using the dollar amounts from ORNL 2005's underlying calculations, the percentage of the total rebate package per sector was calculated (see **Table J-6**) to determine the proportion of each sector's savings, yielding a total annual savings of about 0.96 TBtu [(78.6% x $17.5M x 0.0281) + (14.9% x $17.5M x 0.1558) + (3.1% x $17.5M x 0.1558) + (2.8% x $17.5M x 0.1558) + (0.5% x $17.5M x 0.1455)]. The program assumed that the savings would be in effect for 15 years.

Table J-6: Percentage of Total Rebate Amount and Savings per Rebate Dollar by Sector (ORNL 2005)

	Residential	Commercial	Industrial	Institutional	Agriculture
% of rebate	78.6%	14.9%	3.1%	2.8%	0.5%
MMBtu/$ rebate	0.0281	0.1558	0.1558	0.1558	0.1455

Traffic Signals. WIP assumed that incandescent bulbs used in traffic signals would be replaced with light-emitting diodes (LEDs) (ORNL 2005). The average traffic light serviced would save 793.9 kWh or 8.64 million source Btu per year, and the total number of traffic signals replaced in 2002 was 94,824 (ORNL 2005). The program calculated the number of replaced traffic signals by developing a number of replaced traffic signals per funding level, and multiplied this by the projected FY08 funding allocation. The program also assumed that the savings would be in effect for 11 years, based on the average life of an LED bulb, which is 100,000 hours (LEDTRONICS).

The ORNL 2005 figures were based on SEP funding of $46.2 million. Therefore, the figures above were adjusted downward to reflect the $35 million budget request.

Tax Credits. The purpose of this SEP activity is to promote the implementation of tax credits within a state. WIP found defensible study results provided by the Oregon Office of Energy (2000), which reported the number of tax credits issued in 2000 (ORNL 2005). The Oregon Office of Energy reported the total monetary value of tax credits given to the following categories: renewable resources, appliances, alternative fuel vehicles, and energy-efficient ducts issued in 2000. They also provided the correlating energy savings reported in electricity, natural gas, and fuel oil savings.

WIP assumed the appliance savings are attributable to electricity, and the alternative fuel vehicles savings are attributable to fuel oil. The energy-efficient ducts allocation came from the *Buildings Energy Data Book,* Table1.1, where 28.6% of the savings was attributed to electricity and 71.4% was attributed to natural gas. For the renewable resources, the WIP program assumed 86.53% of the savings was attributable to electricity and 13.24% of the savings was attributable to natural gas, which correlates to the generic distribution provided by ORNL 2005.

Renewable Energy. WIP developed the renewable energy metric with information provided on six different submetrics within the SEP Alternative Energy program. The first three relate to the number of conventional vehicles converted to alternative fuel vehicles and hybrid vehicle purchases made by state and local governments (ORNL 2005). One of the submetrics was developed through the states' impact on the private sector and relates to the number of refueling stations for alternative fuel vehicles. The last two submetrics relate to the total wind- and solar-powered generation capacity installed as a result of the state energy program (ORNL 2005).

Procurement. WIP developed metrics on the procurement of energy-efficient products made by the SEP, based on information provided in ORNL 2005. ORNL 2005 gathered information on the number of energy-efficient vehicles, office equipment, HVAC equipment, street lights, and "exit" signs purchased by the various state energy programs.

The energy-efficient vehicles metric was developed based on the consumption and use of midsize automobiles and standard pickup trucks vs. the fuel consumption of their energy-efficient counterparts (ORNL 2005). The metric for energy-efficient office products is calculated from the number of Energy Star office products purchased by the state (ORNL 2005). The HVAC metric was developed based on the impact to the commercial sector through the government procurement programs (ORNL 2005). For street lights, the number of high-pressure

sodium (HPS) fixtures that were retrofit in place of the old mercury vapor lamps was calculated (ORNL 2005). The exit signs metric used information on the number of incandescent exit signs that were replaced by compact fluorescent exit signs (ORNL 2005).

WIP assumed the office equipment, street lamps, and exits signs purchases would all reduce electric energy consumption. The HVAC purchase allocations came from the *Buildings Energy Data Book,* Table1.1, where 28.6% of the savings was attributed to electricity and 71.4% was attributed to natural gas. The alternative-fuel vehicles purchases were assumed to offset fuel oil consumption.

Special Projects: Competitive Grants
The Special Projects activity has been modified to accelerate the transformation of energy markets, based on the technical potential of the competitive grants issued in four sectors: Buildings, Clean Energy, Industry, and Transportation. The market penetration and rates for energy savings per dollar invested were developed initially in Arent et al. 2006, and scaled back to represent the proposed FY08 funding level of $10 million. The buildings, clean energy, and transportation sectors were assumed to each receive $2.8 million, with the remaining $1.8 million going to the industrial sector. The aggregate funding level allocations were assumed to be equivalent to those developed in Arent et al. 2006, with small changes to a few individual subprograms, based on recent market trends. A five-year market acceleration rate has been applied to each of the competitive grant programs to reflect the fact that this activity will accelerate the penetration of policies, financing mechanisms, and competitive loan programs, all used to introduce renewable and energy efficiency technologies into the U.S. market at an accelerated rate.

Buildings. Buildings-sector savings were based on estimated impacts for seven potential deployment activities (Arent et al. 2006): Whole Building Retrofit, Building America Deployment (zero net energy homes), 30% Above Code in New Commercial Construction, High Performance Building Deployment (Ultra Low Energy Commercial Building Designs), Increase CFL penetration in homes, Advanced Residential Water Heating, and Commercial Lighting High Efficacy Options. Benefits were estimated using Pacific Northwest National Laboratory's BEAMS tool (PNNL 2004). Penetration rates used in BEAMS were based on generic diffusion curves developed from historic energy-efficient building technology market diffusion (PNNL 2004). Generic scalable curves were developed representing an incremental 1% penetration impact. WIP assumed that it would be responsible for approximately 3% of the incremental change in market penetration, accelerating the practice in the marketplace by one to five years, depending on current efforts by others.

WIP assumed the following performance parameters for each of the potential buildings-related activities:

- Whole-building retrofits (consumer, corporation, institution): 20% load reduction in space conditioning, lighting, and water heating
- Building America deployment: 18% whole-building reduction, increasing to 36% whole-building reduction by 2020 (reaches 50% by 2030); additional 10% of building load met by renewables in 2007, increasing to 30% by 2020 and after (applied to subset of buildings)

- 30% above code: 40% reduction in lighting load, 25% reduction in space conditioning loads
- High Performance Building deployment: 8% whole-building reduction, increasing to 36% whole-building reduction by 2025 (reaches 50% by 2035); additional 10% of building load met by renewables in 2007, increasing to 30% by 2025 on (applied to subset of buildings)
- Increase CFL Penetration in Homes: CFLs at 51 lumens/watt; recessed can CFLs at 37 lumens/watt
- Advanced Residential Water Heating: Electric Heat Pump Water Heater with 2.0 Energy Factor (EF), and Gas Condensing Water Heater with 0.80 EF
- Commercial High-Efficacy Lighting: Super T-8s at 100 lumens/watt.

Clean Energy. The clean energy-sector analysis addressed SEP's impact on renewable technologies in the electric sector, and the potential market acceleration of SEP's actions regarding the following activities: Renewable Portfolio Standards Assistance, Integrated Resource Planning, Renewable Energy Certificates (REC)/Voluntary Markets, and the Utility Voluntary Energy Program. In the Renewable Portfolio Standards Assistance activity, 10% of the savings were attributed to SEP, based on the SEP program providing assistance in meeting RPS targets, and adopting new RPS policies based on the levering capabilities of SEP (Arent et al. 2006). In the Integrated Resource Planning (IRP) activity, the SEP program provides assistance to utilities and public utility commissions by implementing IRP. This would include the facilitation of information sharing and technical assistance by the SEP program. Based on SEP's leveraging actions, 10% of the savings were attributed to SEP (Arent et al. 2006). SEP was assumed to contribute to the REC/Voluntary Markets activity by addressing unresolved issues and barriers, and serving as an information sharing/coordination mechanism for individual states. Again, based on the levering capabilities of SEP, 10% of the savings were attributed to SEP (Arent et al. 2005). Finally, under the Utility Voluntary Renewable Energy Program, the SEP program was assumed to serve as an educator and information facilitator, which could lead to a greater number of voluntary utility renewable energy commitments. Based on SEP's leveraging capabilities, 10% of the savings were attributed to SEP (Arent et al. 2006). A five-year acceleration was then applied to each activity, which assumes the involvement of the SEP would accelerate the acceptance of the technology or practice within the market by five years.

Industry. WIP developed metrics for the industrial sector based on SEP actions relating to large manufacturing plants, medium-sized manufacturing plants, water/wastewater plants, industrial buildings, and establishing an academic cooperative (Arent et al. 2006). The SEP program would provide assistance to large manufacturing plants with best-practices training, plant-wide assessments, and helping companies match projects with appropriate funding partners. SEP would provide assistance to the water/wastewater industry through education and assessment programs centered on improving pumping efficiency. The medium-sized plants would receive assistance from SEP to implement the Industrial Assessment Center activities and investigate manufacturer-financed modifications. SEP would provide assistance to industrial buildings through best-practices training and efficiency assessments. Finally, the academic cooperative would consist of training new engineers on techniques of implementing best practices and energy efficiency assessments. A five-year acceleration was then applied to each activity, which

assumes the involvement of the SEP would accelerate the acceptance of the technology or practice by five years.

Transportation. The transportation-sector analysis focused on the impact of the consumer, corporate, and state/local government impacts on reducing petroleum use in the transportation sector (Arent et al. 2006). Within the consumer program, the savings were aggregated to consumer-focused Energy Star transportation programs, a fuel economy guide program, and a 1 MPG increase in personal vehicle market program. The fuel economy guide program focuses on tools and educational services provided to consumers; and the 1 MPG increase in personal vehicle market is based on the reduction in fuel use associated with the U.S. transportation fleet turnover ratio, and a 1% increase in U.S. fleet fuel economy. The corporate program savings were developed based on aggregate savings associated with the Energy Star voluntary program referenced above, the fleet analysis building from Clean Cities work, and the fleet analysis variation with 15% savings growth (Arent et al. 2006). The fleet analysis building from Clean Cities work savings was developed from data presented at the 2004 Clean Cities Conference, and the efficiency improvements in the transportation sector associated with this program (Arent et al. 2006). The fleet analysis variation with 15% savings growth comes from a second initiative issued within the Clean Cities program to increase petroleum savings by 15% annually at constant funding (Arent et al. 2006). The state and local government program savings were aggregated to the voluntary state adoption of petroleum savings mandates, and an ethanol oxygenation proposed Clean Cities component. The voluntary state adoption of petroleum savings mandates is based on an assumption that one state per year for 25 years will implement a mandate to reduce petroleum use (Arent et al. 2006). The ethanol oxygenation proposed Clean Cities component develops savings based on a Clean Cities analysis regarding a project to encourage states to use ethanol instead of other oxygenates (Arent et al. 2006). The savings for each of these programs was scaled back to the 2008 funding level. A five-year acceleration was then applied to each activity, which assumes the involvement of the SEP would accelerate the acceptance of the technology or practice by five years.

Summary of Inputs

Table J-7 contains the summary of benefits developed for this activity.

Table J-7: State Energy Program (SEP) – Summary of Inputs to Models

	2008	2009	2010	2011	2012	2015	2020	2025	2030
Site Electric									
SEP: Codes	0.7	2.2	4.2	6.6	9.3	18.6	34.6	49.1	62.8
SEP: Energy Audits	3.2	6.3	9.2	12.1	14.8	22.3	32.9	35.4	32.7
SEP: Rating & Labeling	3.7	7.7	12.0	16.3	20.8	35.0	45.9	45.9	45.9
SEP: Workshops/Training	0.4	0.8	1.2	1.5	1.9	2.8	4.2	4.6	4.3
SEP: Loans, Grants, & Incentives	0.7	1.4	2.1	2.9	3.6	6.2	10.5	12.1	12.1
SEP: Retrofits	1.0	2.0	3.0	3.9	4.8	7.2	10.7	11.6	10.9
SEP: Technical Assistance	0.1	0.2	0.3	0.5	0.6	0.9	1.3	1.4	1.3
SEP: Traffic Signals	0.2	0.5	0.7	1.0	1.2	2.0	3.2	3.2	3.2
SEP: Tax Credits	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
SEP: Procurement	0.3	0.7	1.0	1.3	1.6	2.6	4.2	4.9	4.9
SEP: Renewable Energy	0.2	0.3	0.5	0.6	0.8	1.2	2.0	2.8	3.6
SEP: Competitive Grants	4.1	9.4	15.4	21.9	26.0	18.7	12.8	9.4	4.8
Total	*14.6*	*31.5*	*49.6*	*68.6*	*85.4*	*117.5*	*162.4*	*180.5*	*186.6*
Natural Gas									
SEP: Codes	0.3	0.8	1.0	1.3	1.8	3.7	6.0	8.3	11.0
SEP: Energy Audits	2.4	4.7	7.1	9.4	11.7	18.4	29.2	32.7	31.5
SEP: Rating & Labeling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Workshops/Training	0.4	0.8	1.2	1.7	2.1	3.3	5.2	5.9	5.7
SEP: Loans, Grants, & Incentives	0.2	0.4	0.5	0.7	0.9	1.4	2.3	2.7	2.7
SEP: Retrofits	0.9	1.9	2.8	3.8	4.7	7.5	11.9	13.5	13.3
SEP: Technical Assistance	0.1	0.3	0.4	0.6	0.7	1.1	1.8	2.0	2.0
SEP: Traffic Signals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Tax Credits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Procurement	0.1	0.2	0.3	0.4	0.5	0.8	1.3	1.4	1.4
SEP: Renewable Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Competitive Grants	0.1	1.5	3.0	4.5	6.1	8.4	9.0	8.2	8.2
Total	*4.5*	*10.6*	*16.3*	*22.4*	*28.5*	*44.6*	*66.7*	*74.7*	*75.8*
Fuel Oil									
SEP: Codes	0.1	0.3	0.4	0.6	0.8	1.5	2.4	3.3	4.2
SEP: Energy Audits	0.1	0.3	0.4	0.6	0.8	1.2	1.9	2.0	1.9
SEP: Rating & Labeling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Workshops/Training	0.0	0.1	0.1	0.1	0.1	0.2	0.4	0.4	0.4
SEP: Loans, Grants, & Incentives	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.5
SEP: Retrofits	0.1	0.2	0.3	0.3	0.4	0.6	1.0	1.0	1.0
SEP: Technical Assistance	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2
SEP: Traffic Signals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEP: Tax Credits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SEP: Procurement	0.0	0.1	0.1	0.2	0.2	0.4	0.6	0.6	0.6
SEP: Renewable Energy	0.1	0.2	0.2	0.3	0.4	0.6	1.1	1.5	1.9
SEP: Competitive Grants	3.8	6.0	8.9	12.0	15.4	19.4	36.9	48.9	32.0
Total	*4.2*	*7.3*	*10.5*	*14.3*	*18.4*	*24.3*	*44.8*	*58.4*	*42.7*

Weatherization Assistance Program Grants

The U.S. Department of Energy (DOE) Weatherization Assistance Program (WAP) reduces energy costs for low-income households by increasing the energy efficiency of their homes while ensuring their health and safety. DOE provides funding to states, which manage the day-to-day details of the program. Low-income families receive services from a network of more than 900 local weatherization service providers.

The Baseline ("without DOE RD3" case)

WAP provides cost-effective energy efficiency services to low-income households who otherwise could not afford the investment but who would benefit significantly from the cost savings of energy efficiency technologies. Therefore, WIP assumes that no technological improvements would occur in these households in absence of the subprogram.

Target Market Description.

The market includes households that are eligible for Federal assistance, or about 33.8 million households (RECS 2001). Households are categorized as eligible for Federal assistance if the household income is below the Federal maximum standard of 150% of the poverty line or 60% of statewide median income, whichever is higher. Individual states can also set the standard at a lower level than the Federal maximum.[4] Target measures include air sealing; caulking and weather stripping; furnace and boiler tune-up, repair, and replacement; cooling system tune-up and repair; replacement of windows and doors; addition of storm windows and doors; insulation of building shells; and replacement of air conditioners, whole-house fans, evaporative coolers, screening, and window films (Berry et al. 1997). Weatherization *Plus* expands this strategy to include water heating, refrigeration, lighting, and cooling (Weatherization Plus 1999).

Baseline Adjustments to the AEO2006 Reference Case

WIP assumed that the *AEO2006* Reference Case adequately captured the technological improvements that would occur in the absence of the program. Within the *AEO2006* Residential Reference Case, one of the implicit assumptions is that there will be no radical changes in technology or consumer behavior through 2030. Additional assumptions for the residential reference case include: 1) no new efficiency regulations, beyond what is already in law, nor new government efficiency programs; 2) technologies that have not achieved widespread acceptance already will not achieve significant penetration by 2030; 3) currently available technologies will evolve in both cost and efficiency; and 4) consumers in the future will behave similarly to current consumer behavior (EIA 2006).

[4] Eligibility requirements for Weatherization Assistance can be found at http://www.eere.energy.gov/weatherization/apply.html

Removing Effects of Program Activities

As discussed in the previous paragraph, WIP assumed that no program-related impacts are included in the *AEO2006* Reference Case; therefore, nothing was removed from the Reference Case to establish the "non-program" baseline.

Other Program-Relevant Adjustments to AEO Reference Case

No other corrections were made to the *AEO2006* Reference Case.

Program Outputs

In WAP, weatherization services are cost-effective energy efficiency measures for existing residential and multifamily housing with low-income residents. In the early years, WAP focused on low-cost improvements like adding weather stripping to doors and windows to save energy. These measures made up the services provided by weatherization, and are likely responsible for the program's name. For example, DOE's Office of Energy Efficiency and Renewable Energy (EERE) publishes a series of fact sheets about these measures on its Web pages for consumers

Today, WAP includes a wide variety of energy efficiency measures that encompass the building envelope, its heating and cooling systems, its electrical system, and electricity-consuming appliances. In other words, the full range of energy efficiency measures in buildings that apply to all homes and apartment buildings is also included in weatherization technologies.

WAP serves low-income families free of charge and limits according to Federal rules the amount of money that can be spent on any single residence. As a result, only the most cost-effective measures are included in the upgrade of a particular home. This constant pressure for low-cost energy savings has become the trademark of weatherization and distinguishes it from the larger home retrofit industry.

Another distinguishing feature of weatherization is attention to all-around safety check. Many buildings receiving attention are old and need repairs. Weatherization service providers check major energy systems to ensure occupant safety.

Increasingly, weatherization service providers look at the house as a system under the concept of "whole-house weatherization." In recent years, weatherization providers in many states have begun to combine resources from other programs to address other needs of their clients. In recognition that weatherization serves many vital roles in low-income communities, the current multifaceted program is called Weatherization *Plus*.

Assumed Budget Projections

WIP assumed level funding of $144 million throughout the analysis period (2008-2030).

Description of Key Activities

Weatherization Assistance provides technical assistance and formula grants to state and local weatherization agencies throughout the United States. A network of approximately 970 local agencies provide trained crews to perform weatherization services for eligible low-income households in single-family homes, multifamily dwellings, and mobile homes. All homes receive a comprehensive energy audit, which is a computerized assessment of a home's energy use and

an analysis of which energy conservation measures are best for the home and a combination of those energy-saving measures are installed.

Weatherization Assistance
This activity will provide formula grants to states to weatherize low-income homes. Ninety percent of the total WAP funding will be allocated to the states as operating funds for this purpose, i.e., for labor, materials, equipment, administrative systems, etc. Ten percent of the total program funding will be allocated for training and technical assistance, to maintain a high standard of technology application, effectiveness, and results. Most training and technical assistance will be performed at state and local levels.

Training and Technical Assistance
DOE will fund training and technical assistance activities that can be more cost-effectively performed at national/regional levels, to support effective program operations by the network of state and local weatherization agencies. DOE will conduct analysis, measure and document program performance, and promote (e.g., through pilot programs, publications, training programs, workshops, and peer exchange) the application of advanced techniques and collaborative strategies to continually improve program effectiveness.

Milestones

From 2001 to 2011, complete weatherization upgrades for 1.25 million low-income households.

Program Outputs

The overall WAP goal is to reduce the burden of energy prices on the disadvantaged. For FY 2008, WAP will weatherize 55,000 homes with DOE funds, and support the weatherization of approximately 100,000 additional homes with leveraged funds. While the energy impacts of this program can be measured, the additional benefits accruing to low-income families are not adequately represented by an energy-savings metric alone. For example, low-income families pay a higher percentage of their income on energy expenditures and are more likely to be renters with less control over their energy-expenditure options. The net benefits of making more disposable income available for more productive uses is not included in the WAP benefits assessment.

Table J-8: WAP Outputs, Activities, and Milestones

Outputs	Associated Activities	Associated Milestones
Reduce the burden of energy prices for low-income families	Key activities 1. Weatherization Assistance 2. Training and Technical Assistance	Weatherize 54,599 homes annually with DOE funds and support the weatherization of 50,000 additional homes with leveraged funds

Translating Program Outputs to Market Outcomes

Low-income households spend much more of their income on energy bills than do families with median incomes. This percentage of income spent on energy is called the "energy burden," and it is substantial for some weatherization recipients. For example, some elderly recipients who lived on fixed incomes pay as much as 35% of their annual incomes for energy bills.

Many weatherization clients are senior citizens, single parents, or disabled people. DOE guidelines for eligibility give preference to homes where one or more family member has a disability. Some statistics about recipients follow:

- 49% of households receiving weatherization services have one or more family members who have disabilities or are elderly and with special needs.
- 90% of weatherization clients have incomes less than $15,000, and two-thirds earn less than $8,000 per year.

Table J-9: Linkage of Outputs with Outcomes

Outputs	Associated Ultimate Outcomes
Reduce the burden of energy prices for low-income families	Site Btu savings of 15-35%, depending on region and energy usage

Key Factors in Shaping Market Adoption of EERE technologies

- Price: WIP employed the average household weatherization cost of $1,890 (Eisenberg 2001); this estimate does not include training, technical assistance, and administrative costs. Incremental investment beyond this amount for Weatherization *Plus* homes was estimated at an average of $1,400 by the Weatherization Project (Eisenberg 2001). Average costs are based on legislative caps and historical costs for each region. WIP assumed that this amount will be provided by leveraging funds from other organizations. **Table J-10** shows the estimated total costs by region for *Plus* homes.

Table J-10: Estimated Regional Costs for Weatherization *Plus* Homes

Region	Cost per "*Plus*" Household
South	$2,861
Northeast	$3,674
West	$1,814
Midwest	$3,429

Final Outcomes (Benefits)

WAP was characterized based on an estimated level of savings per household, cost to weatherize each household, budget request, leveraged funds, and an assumed life expectancy of 15 years for weatherization measures. The basic assumptions were derived from a spreadsheet provided by the Weatherization Project in September 2001 (Eisenberg 2001). The EERE-integrated models calculate effects such as reductions in carbon emissions and energy intensity.

Table J-11 shows the savings per household used for each region.

Table J-11: Savings Per Household for the Weatherization Assistance Project (Regular and "*Plus*" Programs)

Region	Regular Household Savings (MMBtu/yr)	"*Plus*" Household Savings (MMBtu/yr)
South	22.25	24.23
Northeast	31.20	46.04
West	19.04	20.31
Midwest	31.20	49.21

The figures in the table were calculated based on the 1997 ORNL meta-evaluation report (Berry et al. 1997), the ORNL *Meeting the Challenge* report (Schweitzer and Eisenberg 2000), and special tabulations from the 1997 "Residential Energy Consumption Survey" (Eisenberg 2001b). The regional differences in savings between regular and *Plus* households are due largely to the greater savings potential within colder climate housing. Because WAP measures require a savings-to-investment ratio of 1 or greater, the higher cost of energy combined with the higher energy intensity per household in the Northeast and Midwest provide more cost-effective savings opportunities for additional dollar investments. This tends not to be the case in the Western and Southern regions.

Of the units estimated to be weatherized in FY 2008, WIP assumed that 50% would have the higher savings rates associated with Weatherization *Plus* (Schweitzer and Eisenberg 2000). In Schweitzer and Eisenberg 2003, these savings rates were calculated on a regional basis and multiplied by the expected number of *Plus* households in each region.

To develop energy savings by building type, WIP evaluated historical Weatherization Project data (Berry et al. 1997) concerning the types of households weatherized (see **Table J-12**).

Table J-12: Percent of Weatherized Households by Type

Household Type	% of Weatherized Households
Single-Family	64%
Mobile Home	20%
Multifamily	16%

To develop energy savings by fuel type, WIP used historical data regarding the primary fuels used in households weatherized, as reported in the 1996 meta-evaluation (Berry et al 1997). Because the GPRA metrics are reported for electricity, natural gas, and fuel oil (but not for LPG and kerosene), other fuels were allocated within those types based on similarities of emissions. **Table J-13** shows the allocation approaches used.

Table J-13: Percent of Weatherized Households by Fuel Type

Primary Heating Fuel	% of Weatherized Households	Categorized as
Natural Gas	50.6%	Natural Gas
Liquid Propane Gas	13.2%	
Fuel Oil	16.0%	Fuel Oil
Kerosene	3.2%	
Other (includes wood and coal)	7.5%	
Electricity	9.5%	Electricity

The DOE budget and historical data on regional splits and leveraged funding were used to determine the number of households weatherized in each category (regular or *Plus*) for each of the four regions (South, Northeast, West, and Midwest). The target for FY 2008 funding is to weatherize nearly 55,000 households with DOE funds. This target was segregated into regions based on historical regional splits contained in Eisenberg 2001, which divided the total as shown in **Table J-14.**

Table J-14: Average projection of households by category

Category and Region	% of Total Households
Regular South	10.2%
Regular Northeast	12.1%
Regular West	12.1%
Regular Midwest	15.6%
Plus South	10.2%
Plus Northeast	12.1%
Plus West	12.1%
Plus Midwest	15.6%

Previous benefits estimates for WAP have included benefits that resulted from leveraged funding. For the FY 2008 GPRA analysis, only a portion of leverage-funded household savings was included in the analysis. To calculate an appropriate proportion of leveraged households to which savings should be attributed to DOE, WIP only included savings to leveraged households

where the states indicated that "blended" funding was used in FY 2003 to weatherize households. Blended funding means that funds from other sources are pooled with DOE funds to produce a completely weatherized home (as opposed to "unduplicated," meaning that the state can track production to a specific funding source). Using blended vs. unduplicated data, the number of leveraged households reported in "blended" states represented approximately 30% of the implied total number of households weatherized using leveraged funds,[5] approximately 26,000 out of 89,000 households (U.S. DOE 2004). WIP assumed that 26,000 additional households would be weatherized each year with leveraged funds that could be attributed to DOE

Table J-15 shows the projection for regular and *Plus* households to be weatherized. WIP assumed that the number of households weatherized for each category would be constant from 2012 through 2030.

Table J-15: Projected Regular and *Plus* Households to be Weatherized

	2008	2009	2010	2011	2012-2030
Total Households	81,000	81,000	81,000	81,000	81,000
Regular South	8,281	8,281	8,281	8,281	8,281
Regular Northeast	9,778	9,778	9,778	9,778	9,778
Regular West	9,827	9,827	9,827	9,827	9,827
Regular Midwest	12,614	12,614	12,614	12,614	12,614
Plus South	8,281	8,281	8,281	8,281	8,281
Plus Northeast	9,778	9,778	9,778	9,778	9,778
Plus West	9,827	9,827	9,827	9,827	9,827
Plus Midwest	12,614	12,614	12,614	12,614	12,614

The number of households in each category was multiplied by the estimated savings level for each category. The estimated savings level for each household category was further divided by household type and then by fuel type. WIP assumed that savings from each household weatherized would last for 15 years; i.e., savings from households weatherized in 2008 were included in the annual total savings estimates for 2008 through 2022.

Summary of Inputs

Table J-16 contains the summary of benefits developed for this activity. The chapters on midterm and long-term benefits analysis describe how these inputs are utilized within the NEMS-GPRA08 and MARKAL-GPRA08 models.

[5] Total weatherized households and total DOE weatherized households were reported in the survey; WIP assumed that the difference equaled the number of leveraged households.

Table J-16: Weatherization Assistance Program (WAP) – Summary of Inputs to Models

Year	Average Cost per Household	Annual No. Households Weatherized	Total Households Saving Energy in Year	Energy Savings (site TBtu)	Single Family Household Savings (site TBtu)	Mobile Home Household Savings (site TBtu)	Multi Family Household Savings (site TBtu)
2008	$2,433	81,000	81,000	2.56	1.64	0.51	0.41
2009	$2,447	81,000	162,000	5.12	3.28	1.02	0.82
2010	$2,462	81,000	243,000	7.69	4.92	1.54	1.23
2011	$2,476	81,000	324,000	10.25	6.56	2.05	1.64
2012	$2,476	81,000	405,000	12.81	8.20	2.56	2.05
2013	$2,476	81,000	486,000	15.37	9.84	3.07	2.46
2014	$2,476	81,000	567,000	17.94	11.48	3.59	2.87
2015	$2,476	81,000	648,000	20.50	13.12	4.10	3.28
2016	$2,476	81,000	729,000	23.06	14.76	4.61	3.69
2017	$2,476	81,000	810,000	25.62	16.40	5.12	4.10
2018	$2,476	81,000	891,000	28.18	18.04	5.64	4.51
2019	$2,476	81,000	972,000	30.75	19.68	6.15	4.92
2020	$2,476	81,000	1,053,000	33.31	21.32	6.66	5.33
2021	$2,476	81,000	1,134,000	35.87	22.96	7.17	5.74
2022	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2023	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2024	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2025	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2026	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2027	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2028	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2029	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15
2030	$2,476	81,000	1,215,000	38.43	24.60	7.69	6.15

Tribal Energy Program (TEP)

The Tribal Energy Program offers financial and technical assistance to American Indian tribes to help them create sustainable renewable energy installations on their lands. This program promotes tribal energy self-sufficiency and fosters employment and economic development on America's tribal lands.

The Baseline ("without DOE RD3" case)

The Tribal Energy Program builds partnerships with tribal governments to help assess American Indian energy needs for residential, commercial, and industrial uses. Additionally, it provides technical and financial assistance in energy efficiency and renewable energy project development. Energy projects are competitively awarded on a cost-shared basis for Indian tribes to implement comprehensive energy plans. Therefore, WIP assumes that no technological improvements would occur on tribal lands in absence of the program.

Target Market Description.

In May 2000, the department issued a report, "Energy Consumption and Renewable Energy Development Potential on Indian Lands," which determined that, "Household energy availability

and use on Tribal Lands is significantly below that of non-Indian households. In fact, sizable tribal populations have no access to electricity at all." From FY 1996 through FY 2001, the Renewable Tribal Energy Resources Program funding had been earmarked solely for the benefit of Alaska natives. The TEP attempts to address the needs of those American Indians residing in the lower 48 states, as well as Alaska natives, as reflected in the joint DOE/ Bureau of Land Management's assessment of the renewable resource potential of public lands (DOE/DOI 2003).

Baseline Adjustments to the AEO2006 Reference Case

The *AEO2006* Reference Case includes renewable energy generation and consumption by sector and source; however, the basis for these improvements is not specified by the EIA. For FY08 GPRA, WIP did not suggest the removal of any program-related impacts that might be included in the *AEO2006* Reference Case.

Representation of Program-Relevant Technologies in the AEO Reference Case

There is no documented evidence that the Tribal Energy Program has any measurable effect on the renewable energy portion of the *AEO2006* reference case.

Removing Effects of Program Activities

The *AEO2006* Reference Case includes renewable energy generation and consumption by sector and source; however, the basis for these improvements is not specified by the EIA. For FY08 GPRA, WIP did not suggest the removal of any program-related impacts that might be included in the *AEO2006* Reference Case.

Other Program-Relevant Adjustments to AEO Reference Case

No other changes were made to the *AEO2006* Reference Case.

Program Outputs

The stated goal of the program is to promote tribal energy sufficiency, economic development, and employment on tribal lands through the use of renewable energy and energy efficiency technologies. As such, a measurement of the energy impacts of the TEP does not adequately represent the full scope of the benefits of this program.

The TEP offers financial and technical assistance to tribes through government-to-government partnerships that:

1) Allow tribal leaders to make informed decisions;
2) Bring renewable energy and energy efficiency options to Indian lands;
3) Enhance human capacity through education and training;
4) Improve local tribal economies and the environment; and
5) Make a difference in the quality of life of American Indians.

The program seeks to increase development of renewable energy supply. The assessment of renewable resource potential (DOE/DOI 2003) informed the planning of the Tribal Energy Program. The program will proceed with central-station development of wind resources, followed by biomass resources. Biomass was found to show the most potential for central-station development on tribal lands. Therefore, biomass power would reach parity with wind in terms of capacity additions by 2012 and exceeds wind capacity after 2012.

Assumed Budget Projections

WIP assumed level funding of $2,957,000 throughout the analysis period.

Description of Key Activities

The Tribal Energy Program supports cooperative agreements and builds partnerships with tribal governments to foster information exchange, and technical and financial assistance projects. These activities are intended to promote understanding and acceptance of energy efficiency and renewable energy technologies and to foster stronger public-private partnerships to expand domestic and overseas markets for U.S. manufacturers to these technologies.

The Tribal Energy Program provides financial and technical assistance to tribes for strategic planning, energy options analysis, organizational development, capacity building, feasibility studies, and cost-shared development of sustainable renewable energy on tribal lands. These activities promote tribal energy self-sufficiency and foster employment and economic development on tribal lands.

The DOE policy related to American Indian and Alaska Native tribal governments is designed to ensure an effective implementation of a government-to-government relationship with American Indian and Alaska Native tribal governments. Through the authorities set forth in the Energy Policy Act (EPAct) and subsequent executive orders, DOE is seeking to foster energy self-sufficiency on tribal lands and be responsive to the aforementioned policy.

The Tribal Energy Program supports the development of capacity within the 565-plus Federally recognized Native American tribes and Alaskan Native corporations to meet their energy needs for residential and productive uses; provides, where appropriate, new power supplies for export; and advances the Department's technology performance and integration efforts. Tribal leaders are provided resource assessment services, workshops, training, and energy-plan development assistance toward making decisions regarding the tribes' energy future. Through competitively selected projects, tribes will begin implementing energy plans to assist tribal members in using renewable energy technologies and resources.

Milestones

The Tribal Energy Program goal is to develop 100 MW of renewable electrical capacity on tribal lands by 2012 and electrification of 10,000 currently nonelectrified tribal households (TEP 2004, 2005, 2006).

Program Outputs

The Tribal Energy Program offers assistance for renewable energy feasibility studies and shares the cost of renewable energy projects on tribal lands. The program also offers assistance to tribes for the initial steps toward developing renewable energy and energy efficiency projects, including strategic planning, energy options analysis, human capacity building, and organizational development planning.

Table J-17: Program Outputs, Activities, and Milestones

Outputs	Associated Activities	Associated Milestones
Assistance to tribes for feasibility studies, strategic planning, energy options analysis, human capacity building, and organizational development	Key activities 1. Feasibility studies 2. Strategic planning 3. Energy options analysis	Complete sufficient number of key activities by 2012 to achieve the outcome of 100 MW of new renewable electric capacity
		Complete sufficient number of key activities by 2012 to achieve the outcome of electrifying 10,000 households

Translating Program Outputs to Market Outcomes

In many cases, the DOE funds are leveraged with other sources such as tribal, state, other Federal, and local grants. The basis for this attribution is that, were DOE not leading this activity, these development projects would never occur. WIP did not analyze whether success of this program would eventually lead to the private-sector involvement in developing the new renewables capacity on tribal lands in later years, but such an outcome would be possible under the right pricing conditions.

Table J-18: Linkage of Outputs with Outcomes

Outputs	Associated Ultimate Outcomes
Assistance to tribes for feasibility studies, strategic planning, energy options analysis, human capacity building, and organizational development	Reduction in carbon emissions and oil imports
	Increased comfort of tribal members

Key Factors in Shaping Market Adoption of EERE technologies

- Price: WIP assumed the cost of leased solar arrays and battery storage of electricity to be less than the consumer costs of extending electrical transmission from the nearest electrical utility. For central-station development, WIP assumed the electricity resource produced from renewable resources would cost less than utility-supplied electricity provided to the immediate tribal land with jurisdiction.
- Non-price factors (only those that might affect what gets bought)
    - Key consumer preferences/values: This program seeks to establish electrical service for households currently without electricity on tribal lands. This is not a comparison of alternative electrical services or of using renewable fuels to provide electrical service, but rather a characterization of providing electrical service where none currently exists, using fuels and facilities that are within the control of tribal organizations.
    - Manufacturing factors: Based on program materials and TEP Web site documents (TEP 2004, 2005, 2006), most current activities are focused on development of wind resources. EIA (2000) suggests that biopower provides the greatest potential

for central-station power at competitive prices on tribal lands; therefore, WIP assumed that an even mix of technology will develop, eventually shifting to a majority of biopower development by 2028.

- Community factors: Community development would include electrification strategies for the reservation. Central-station facilities on tribal lands utilizing renewable fuels may generate value streams from off-reservation utility interests.

Final Outcomes (Benefits)

To permit analysis of program success, WIP made several enabling assumptions in consultation with the Tribal Energy Program:

- Achieving the program goal of 100 MW in new electric capacity from renewable energy on tribal lands by 2012 would represent approximately 20% of the total potential capacity, or 500 MW.
- Current development efforts are almost all wind projects. The EIA report suggests that biopower provides the greatest potential for central-station power at competitive prices (EIA 2000). Therefore, we assume that an even mix of technology will develop by 2012, and eventually biopower capacity will exceed wind.
- New biopower plants would operate at a capacity factor of 83%, and wind would operate at a capacity factor of 37%, on average (EIA 2006).
- For solar electrification, materials (EIA 2000) indicate that approximately 25,000 reservation households are without electricity access. The Navajo reservation accounts for the largest percentage of these households, and the EIA report indicates that photovoltaic (PV) rooftop modules may be a feasible way to provide electricity to these and other tribal households in the Southwest. For this analysis, the assumed target was electrification of 10,000 households by 2028.
- WIP assumed a capacity factor of 20% for new PV systems deployed in the Southwest, and the default system was assumed to be 0.6 kW based on an average of currently installed PV units on tribal lands (TEP 2006).

These interim outcomes were provided to the EERE-integrating models for their calculation of final outcomes such as reductions in carbon emissions and energy intensity. The chapters on midterm and long-term benefits analysis describe how these inputs are utilized within the NEMS-GPRA08 and MARKAL-GPRA08 models.

Summary of Inputs

Table J-19: Development of Tribal Renewable Energy Capacity Resulting from FY 2008 Budget Assumptions

Year	Fraction of Potential	MW capacity (cummulative)	Added MW	Share Assumptions		Added MW			Cummulative MW		Capacity factor		Wind	Biomass	Total Service
				Wind Fraction	Biomass Fraction	Wind	Biomass	Total	Wind	Biomass	Wind	Biomass	MWh	MWh	MWh
2008	0.020	10	4	1.00	0.00	4	0	4	10	0	0.370	0.830	32,412	0	32,412
2009	0.037	19	9	0.95	0.05	9	0	9	19	0	0.370	0.830	60,124	3,272	63,396
2010	0.067	34	15	0.95	0.05	14	1	15	33	1	0.440	0.830	126,424	8,725	135,149
2011	0.118	59	25	0.95	0.05	24	1	25	57	2	0.440	0.830	217,966	17,813	235,780
2012	0.200	100	41	0.50	0.50	21	21	41	77	23	0.440	0.830	296,982	166,865	463,846
2013	0.319	160	60	0.50	0.50	30	30	60	107	53	0.440	0.830	412,614	384,989	797,602
2014	0.468	234	74	0.50	0.50	37	37	74	144	90	0.440	0.830	555,226	654,008	1,209,235
2015	0.622	311	77	0.50	0.50	39	39	77	183	128	0.440	0.830	703,621	933,934	1,637,555
2016	0.755	378	67	0.50	0.50	34	34	67	216	162	0.440	0.830	832,743	1,177,506	2,010,249
2017	0.852	426	48	0.50	0.50	24	24	48	240	186	0.440	0.830	925,249	1,352,005	2,277,254
2018	0.900	450	24	0.25	0.75	6	18	24	246	204	0.440	0.830	948,375	1,482,880	2,431,255
2019	0.911	456	6	0.25	0.75	2	5	6	248	208	0.440	0.830	954,157	1,515,598	2,469,755
2020	0.922	461	5	0.25	0.75	1	4	5	249	212	0.460	0.830	1,002,564	1,542,864	2,545,428
2021	0.933	467	6	0.25	0.75	2	5	6	250	217	0.460	0.830	1,008,609	1,575,582	2,584,191
2022	0.944	472	5	0.25	0.75	1	4	5	252	220	0.460	0.830	1,013,646	1,602,848	2,616,494
2023	0.956	478	6	0.25	0.75	2	5	6	253	225	0.460	0.830	1,019,690	1,635,566	2,655,257
2024	0.967	483	5	0.25	0.75	1	4	5	254	229	0.460	0.830	1,024,727	1,662,832	2,687,559
2025	0.978	489	6	0.25	0.75	2	5	6	256	233	0.460	0.830	1,030,772	1,695,551	2,726,322
2026	0.989	494	5	0.25	0.75	1	4	5	257	237	0.460	0.830	1,035,809	1,722,816	2,758,625
2027	1.000	500	6	0.25	0.75	2	5	6	259	241	0.460	0.830	1,041,853	1,755,535	2,797,388

Table J-20: Development of Off-Grid Solar PV Capacity Resulting from FY2008 Budget Assumptions

Year	Cumulative Households	MW Capacity	MWH
2008	110	0.07	125
2009	200	0.13	228
2010	370	0.24	421
2011	670	0.44	763
2021	1,180	0.77	1,344
2013	2,000	1.30	2,278
2014	3,190	2.07	3,633
2015	4,680	3.04	5,330
2016	6,220	4.04	7,083
2017	7,550	4.91	8,598
2018	8,520	5.54	9,703
2019	9,000	5.85	10,249
2020	9,111	5.92	10,376
2021	9,222	5.99	10,502
2022	9,333	6.07	10,629
2023	9,444	6.14	10,755
2024	9,556	6.21	10,882
2025	9,667	6.28	11,008
2026	9,778	6.36	11,135
2027	9,889	6.43	11,261
2028	10,000	6.50	11,388

Renewable Energy Production Incentive

The Renewable Energy Production Incentive (REPI) is part of an integrated strategy in the Energy Policy Act of 1992 to promote increases in the generation and utilization of electricity from renewable energy sources and to further the advances of renewable energy technologies. This program, authorized under section 1212 of the Energy Policy Act of 1992, provides financial incentive payments for electricity produced and sold by new qualifying renewable energy-generation facilities. Eligible electric production facilities are those owned by state and local government entities (such as municipal utilities) and not-for-profit electric cooperatives that started operations between October 1, 1993, and September 30, 2003. Qualifying facilities are eligible for annual incentive payments of 1.5 cents per kilowatt-hour (1993 dollars and indexed for inflation) for the first 10-year period of their operation, subject to the availability of annual appropriations in each Federal fiscal year of operation. Criteria for qualifying facilities and application procedures are contained in the rulemaking for this program. Qualifying facilities must use solar, wind, geothermal (with certain restrictions as contained in the rulemaking), or biomass (except for municipal solid waste combustion) generation technologies.

The Baseline ("without DOE RD3" case)

The Renewable Energy Production Incentive (REPI) Subprogram provides incentive payments to qualified renewable energy facilities. These incentive payments are subject to availability of appropriations and are determined by the type and total quantity of electric energy that is

generated and sold from facilities that apply for the incentive. Therefore, WIP assumes that renewable energy production would neither increase nor decrease in the absence of the program.

Target Market Description.

The market includes qualified renewable energy facilities. A qualified renewable energy facility is a facility that is owned by a not-for-profit electric cooperative, a public utility, a state, commonwealth, territory, or possession of the United States, or District of Columbia, or a political subdivision thereof, an Indian tribal government or a subdivision thereof,[6] or a Native Corporation,[7] and which generates electric energy for sale in, or affecting, interstate commerce using solar, wind, biomass, landfill gas, livestock methane, ocean,[8] or geothermal.

Sixty percent of the funds appropriated for the fiscal year are paid to facilities that use solar, wind, ocean, geothermal, or closed-loop biomass technologies to generate electricity, while 40% of the funds are appropriated to the remaining project types of landfill, livestock methane, and open loop biomass (REPI 2005).

Baseline Adjustments to the AEO2006 Reference Case

The *AEO2006* Reference Case includes renewable energy generation and consumption by sector and source; however, the basis for these improvements is not specified by the EIA. For GPRA08, WIP did not suggest the removal of any program-related impacts that might be included in the *AEO2006* Reference Case.

Representation of Program-Relevant Technologies in the AEO Reference Case

It is observed that REPI has no measurable effect on the renewable energy portion of the *AEO2006* reference case.

Removing Effects of Program Activities

It is observed that REPI has no measurable effect on the renewable energy portion of the *AEO2006* reference case.

Other Program-Relevant Adjustments to AEO Reference Case

No other corrections were made to the *AEO2006* Reference Case.

Program Outputs

REPI was reauthorized by the Energy Policy Act of 2005 until the end of FY2026. A qualified renewable energy facility may receive payments under this section for a 10-year period. Such a period shall begin with the fiscal year in which electricity generated from the facility is first eligible for such payments, or in which the Secretary of Energy determines that all necessary Federal and state authorizations have been obtained for the construction of the facility.

In general, incentive payments made by the secretary under this section to the owner or operator of any qualified renewable energy facility shall be based on the number of kilowatt hours of electricity generated by the facility through the use of solar, wind, biomass, landfill gas, livestock methane, ocean (including tidal, wave, current, and thermal), or geothermal energy during the

[6] New qualified renewable energy facility generator, EPAct 2005.
[7] New qualified renewable energy facility generator, EPAct 2005.
[8] New qualified technology, EPAct 2005. Ocean technologies include production from tidal, wave, current, and thermal energies.

payment period. REPI payments are based on an annual 1.5 cents per kilowatt-hour (kWh) rate (1993 dollars and indexed for inflation).

In past years, not all of the energy generation from qualified facilities received an incentive. They receive a portion of what they are qualified to receive. **Table J-21** identifies the historical electric production and reimbursement for production.

Table J-21: REPI Appropriations Summary

Year of Production (FY)	Year of Payment (FY)	Appropriated Funds	Tier 1 Paid[9]	Tier 1 Unpaid	% Tier 1 Paid	Tier 2 Paid[10]	Tier 2 Unpaid	% Tier 2 Paid
1994	1995	$693,120	$100,725	-	100%	$592,395	-	100%
1995	1996	$2,398,472	$218,604	-	100%	$2,178,217	-	100%
1996	1997	$2,490,893	$195,902	-	100%	$2,294,991	$347,038	87%
1997	1998	$2,853,997	$154,504	-	100%	$2,699,493	$6,519,682	29%
1998	1999	$4,000,000	$122,167	-	100%	$3,877,833	$9,747,420	28%
1999	2000	$1,500,000	$603,182	-	100%	$896,818	$15,664,879	5%
2000	2001	$3,991,000	$1,339,377	-	100%	$2,651,625	$24,755,332	10%
2001	2002	$3,787,000	$1,365,846	-	100%	$2,421,154	$33,679,732	7%
2002	2003	$4,815,033	$1,810,911	-	100%	$3,004,122	$40,211,074	7%
2003	2004	$3,714,911	$3,714,911	$1,091,206	77%	-	$58,145,027	0%
2004	2005	$4,960,000	$4,960,000	$2,205,009	69%	-	$43,393,560	0%

Table J-22 identifies the reimbursed and projected reimbursable amounts of electric energy production from REPI qualified facilities (REPI 2006).

[9] Sixty percent of the funds appropriated for the fiscal year are paid to facilities that use solar, wind, ocean, geothermal, or closed-loop biomass technologies to generate electricity (Tier 1).
[10] Forty percent of the funds are appropriated to the project types of landfill, livestock methane, and open loop biomass (Tier 2).

Table J-22: Historical and Calculated REPI Reimbursed Energy (kWh)

Year	Appropriated Funds	Incentive per kWh	Calculated Electric Production Net kWh
1993		$0.015	
1994	$693,120	$0.015	45,246,571
1995	$2,398,472	$0.016	153,419,858
1996	$2,490,893	$0.016	156,362,717
1997	$2,853,997	$0.016	176,232,769
1998	$4,000,000	$0.016	244,296,795
1999	$1,500,000	$0.017	90,306,430
2000	$3,991,000	$0.017	235,155,041
2001	$3,787,000	$0.017	217,973,477
2002	$4,815,033	$0.018	272,974,795
2003	$3,714,911	$0.018	207,140,568
2004	$4,960,000	$0.018	272,085,553
2005	$4,856,000	$0.019	262,134,103
2006	$4,946,000	$0.019	262,803,036
2007	$4,960,000	$0.019	259,475,467
2008	$4,960,000	$0.019	255,527,899
2009	$4,960,000	$0.020	251,698,645
2010	$4,960,000	$0.020	247,982,464
2011	$4,960,000	$0.020	244,374,421
2012	$4,960,000	$0.021	240,869,863
2013	$4,960,000	$0.021	237,464,401
2014	$4,960,000	$0.021	234,153,891
2015	$4,960,000	$0.023	218,377,141
2016	$4,960,000	$0.023	213,443,498
2017	$4,960,000	$0.023	215,670,928
2018	$4,960,000	$0.024	203,087,254
2019	$4,960,000	$0.025	197,980,282
2020	$4,960,000	$0.026	193,011,129
2021	$4,960,000	$0.026	188,285,313
2022	$4,960,000	$0.027	183,683,294
2023	$4,960,000	$0.028	179,203,700
2024	$4,960,000	$0.028	175,029,995
2025	$4,960,000	$0.029	170,957,846
2026	$4,960,000	$0.030	167,070,870

The REPI goal has been met each year as shown by **Table J-22**. Assuming a constant funding level and a steady GDP estimated inflation rates (OMB), the amount of electricity that is paid as an incentive will decrease. However, the subprogram assumes electricity generation continues to increase based on historical data and other market factors.

Assumed Budget Projections

WIP assumed level funding of $4,960,000 throughout the analysis period.

Description of Key Activities

The REPI Subprogram provides monetary incentives to qualified renewable energy facilities.

Milestones

From 2008 to 2026, applications for the incentive must be received between October 1 and December 31 for production credit for the previous fiscal year.

Program Outputs

The REPI program offers a production incentive. REPI strives to promote increases in generation and utilization of electricity from renewable energy sources and further advances of renewable energy technologies through a production incentive that pays an appropriated amount of money for electricity generated in the previous fiscal year. Because of the goals to diversify the energy market and spur renewable energy, it is difficult to quantify the benefits of this subprogram based on energy savings alone.

Table J-23: Program Outputs, Activities, and Milestones

Outputs	Associated Activities	Associated Milestones
Incentive payments for renewable electricity generated in prior fiscal year.	Key activities 1. Process applications and conduct other activities needed to provide incentive payments.	Incentive payments annually through 2026, the end of the reauthorization period

Translating Program Outputs to Market Outcomes

There was no direct outcome identified that removed REPI from marketplace growth and technology advancement.

Table J-24: Linkage of Outputs with Outcomes

Outputs	Associated Immediate Outcomes and Dates	Associated Interim Outcomes	Associated Ultimate Outcomes
Incentive payments for renewable electricity generated in prior fiscal year	None	Increases in the generation and utilization of electricity from renewable energy sources and further advances of renewable energy technologies.	Environmental and economic benefits and other effects.

Key Factors in Shaping Market Adoption of EERE technologies

- Price: The REPI Subprogram is not cost-sensitive to the renewable energy technologies for which incentives are provided. Because of the constant dollar fund appropriation coupled with the inflation index, fewer projects will be funded in the future. Competition for available funds must be a factor in the future.
- There are no non-price factors identified.

Final Outcomes (Benefits)

Four studies were evaluated to asses the relationship between renewable energy trends and the REPI program. WIP evaluated the observable market applicability, geographical mix of generation resources, economic growth, and green pricing in order to identify increases in the generation and utilization of electricity from renewable energy sources based solely on REPI.

Market applicability research attempted to identify studies, reports, or literature that specifically explained the relationship between decisions to build and operate qualified renewable energy facilities and REPI. While utilities acknowledge REPI as a possible vehicle to decrease costs, their more overwhelming concern is that the uncertainty of REPI's funding and appropriations may reduce its value.

The geographic generation study compared the total electricity generation applied for REPI and EIA's estimate of total U.S. renewable energy generation by region and type of generation (EIA 2005).

The growth and green pricing study attempted to identify any growth and green pricing trends that may be attributable to REPI, resulting in new renewable energy generation. An NREL study was reviewed for a relationship between green pricing and application for REPI, with little correlation found (APPA 2005). Although public utilities' renewable energy production has increased in the past few years, there was no observable evidence that REPI was responsible for this.

After completing the four studies to assess the casual relationship between renewable energy trends and the REPI program, WIP could not attribute an incremental market transformation benefit above and beyond the actual REPI project benefits.

Summary of Inputs

WIP did not provide to the integrated benefits models any energy benefit input resulting from REPI.

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