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Potential for Renewable Energy Development: Alternatives to AEO2001

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Preface

The U.S. Department of Energy's Energy Information Administration (EIA) has developed a comprehensive computer model of the domestic energy economy that it employs to forecast possible scenarios of energy development within the U.S. including production, imports, conversion, consumption and price. This model, called the National Energy Modeling System (NEMS) incorporates economic, regulatory, resource, technological and environmental data on all aspects of energy development and consumption in the United States. The results of Reference Case simulations using NEMS are published in the *Annual Energy Outlook* (AEO). Planners and decision-makers in both the public and private sectors refer to forecasts produced by NEMS for analysis of policy initiatives.

The reference case projections of the AEO assume continuing market changes and improvement in energy technologies as derived from past trends. Under these conditions, renewable energy technologies have typically not achieved significant market share during the AEO forecast period. This report explores some of the assumptions used in NEMS regarding renewable electric-generation technologies to determine how modifying these assumptions might influence the projected growth of these technologies.

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List of Acronyms

AEO	Annual Energy Outlook
COE	Cost of Energy
CHP	Combined Heat and Power
DOE	U.S. Department of Energy
EIA	Energy Information Administration
GPRA	Government Performance and Results Act
LFG	Landfill Gas
MSW	Municipal Solid Waste
NEMS	National Energy Modeling System
OPT	Office of Power Technologies
PERI	Princeton Energy Resources International
PTC	Production Tax Credit
PV	Photovoltaic
RETC	1997 Renewable Energy Technology Characteristics
RPS	Renewable Portfolio Standards

Executive Summary

Levelized cost of energy assumptions for renewable energy technologies significantly influence forecast projections of U.S. grid-connected power generation and associated carbon emissions. Assumptions that are based on cost alone ignore the potential of other factors, such as direct access and green marketing, to drive capacity expansion. In recent years, deregulation has enabled consumers in many states to purchase electricity from renewable sources, even if it is not the least-cost option. Capacity expansion decisions in the National Energy Modeling System (NEMS) are primarily determined by factors directly affecting the cost of energy. NEMS is a commonly referenced computer model of the U.S. energy-economy that is used by the U.S. Department of Energy to produce the *Annual Energy Outlook* and its projections through 2020. In NEMS, renewable energy technologies fail to capture a significant share of the electricity market, even by the end of the forecast period.

This study explores the potential impact of green marketing-supported electric-generator capacity additions and alternative cost of energy assumptions for renewable energy technologies on the overall cost and development of renewable grid-connected power generation in a modified version of NEMS. The expectation is that policies and programs designed to increase market share will leverage economies of scale and learning by doing that will in turn help reduce the cost of these technologies, making them more cost-competitive in the long run with currently established technologies.

Seven simulations were conducted using a modified version of the Energy Information Administration's National Energy Modeling System (NEMS-GPRA)[1] (Table ES-1). Results are compared to the *Annual Energy Outlook 2001* (AEO2001) Reference Case for six renewable energy technologies. For each of these scenarios, the renewable energy technologies considered were geothermal, biomass, solar thermal, solar photovoltaic, wind and municipal solid waste (excluded in the levelized cost scenarios).

In the first scenario (FX), technical fixes were applied to the wind and intermittent technologies to improve their treatment by the model. The second case (RA) augmented the forced capacity additions for each technology. This case was designed to represent the probable outcome of a green pricing market in which construction of renewable generation is increased to serve consumer demand for clean power. Input capacity additions were supplied by Princeton Energy Resources International (PERI) based on their green market analysis for the U.S. Department of Energy's Office of Power Technologies (DOE/OPT, 2001b). The third scenario (TC) modified the levelized cost of energy for each technology. This case represents the competitive outcome of more aggressive projections of technological progress for renewable energy technologies. The alternative costs of energy assumptions were based on the *1997 Renewable Energy Technology Characterizations* (RETC).[2] For all of the above technologies, with the exception of biomass, the

[1] For clarity, the modified version of NEMS as used for this analysis is referred to as NEMS-GPRA, to denote the Government Performance and Results Act (GPRA) focus of this study.

[2] The RETC is the result of a joint project of EPRI and the DOE/OPT that assesses the current capabilities and future potential of renewable electric generation technologies. It includes projections of future performance and costs,

forecast in the RETC results in a reduced levelized cost of renewable energy than predicted in the AEO2001 Reference Case. A fourth scenario (HP) augmented industrial as well as commercial sector combined heat and power (CHP) capacities. A doubled natural gas price case (NG) is explored as a sensitivity case on the model to identify the potential benefits to renewables. The sixth scenario (WN) looks at the enhancement of lower wind speed technologies under a proposed $40 million wind research budget. Finally, a combination of these six scenarios (AL) was run in which the code fixes, green pricing additions, cost of energy modifications, CHP adjustments, high gas price, and enhanced lower wind speed technologies were implemented.

Table ES- 1. NEMS-GPRA Analysis Scenarios

Case #	Abb.	Title	Description
Case 0		NEMS-GPRA reference case	Replication of AEO2001
Case 1	FX	Technical fixes	Adjustments to wind and intermittent technologies
Case 2	RA	Renewable additions	Forced capacity additions for six renewable technologies based on green pricing forecasts by PERI
Case 3	TC	Technology characterization	Modified cost of energy parameters based on RETC for five renewable technologies
Case 4	HP	Combined heat and power	Adjustments to increase natural gas and biomass CHP in the industrial and commercial sectors
Case 5	NG	High natural gas price	Apply a carbon tax to natural gas prices to individual sectors to produce a doubled effect by 2020
Case 6	WN	Wind cost sensitivity	Modify cost of energy parameters for wind to match $40 million wind research budget cost projection
Case 7	AL	Scenario combination	Cases 1 through 6 combined

Results from each of the scenarios, as summarized in Table ES-2, demonstrate a substantial increase in renewable electric power capacity and generation as well as a significant reduction in carbon emissions for each of the scenarios. The total installed capacity in 2020 of non-hydro renewable electricity generators is shown in Figure ES-1. Generally, the AL case produced the most dramatic results, although individual technologies were affected differently in each case. Wind development received the greatest boost from the modifications to NEMS-GPRA.

For all technologies, the Case 7 AL resulted in an increase in generation that was greater than any of the individual scenarios, but less than their sum. Wind, which has a comparatively low cost of energy in the RETC, experienced an increase in generation in the AL case over 20 times

including levelized energy cost estimates, based on the assumption of continued developmental support and successful resolution of unresolved issues.

that of the reference case by 2020. Geothermal was up 2.5 times and solar thermal up 2.8 times over the reference case by 2020 in the AL Case 7. In the TC case, the forecast for photovoltaic, with its relatively high cost of energy, did not change in the TC case 3, but generation did increase by 93% in 2020 in both the RA and AL cases. The projection for MSW, a 5.6% increase by 2020, for the RA and 13.3% increase in 2020 under the AL case is likely due to the high natural gas influence.

In each scenario, carbon emissions decreased in comparison to the reference case every year between 2001 and 2020. By 2020, electricity sector emissions were only slightly lower in the FX case, down 4 Mt/a (0.2%) in RA, 28 Mt/a (1.4%) in TC, 4 Mt/a (0.2%) in HP, 9 Mt/a (0.4%) in NG, 33 Mt/a (1.6%) in WN, and 62 Mt/a (3.0%) in the combined scenario.

Table ES- 2. Capacity, Generation, Carbon, and CHP Changes for 2020 (and 2010), Cases 1-7

	Renewable Capacity (GW)	Renewable Generation (TWh)	Carbon Emissions (Mt)
Case 1 (FX)	0.5 (0.6)	1.5 (2.4)	0 (1.0)
Case 2 (RA)	7.2 (3.4)	25.1 (11.6)	-4 (-3)
Case 3 (TC)	50.5 (15.9)	199.8 (74.4)	-28 (-14)
Case 4 (HP)	0.0 (0.0)	0.0 (0.4)	-4 (-5)
Case 5 (NG)	1.7 (0.3)	4.5 (4.8)	-9 (-16)
Case 6 (WN)	62.9 (18.7)	261.9 (81.4)	-33 (-12)
Case 7 (AL)	76.2 (24.5)	309.1 (108.3)	-62 (-36)

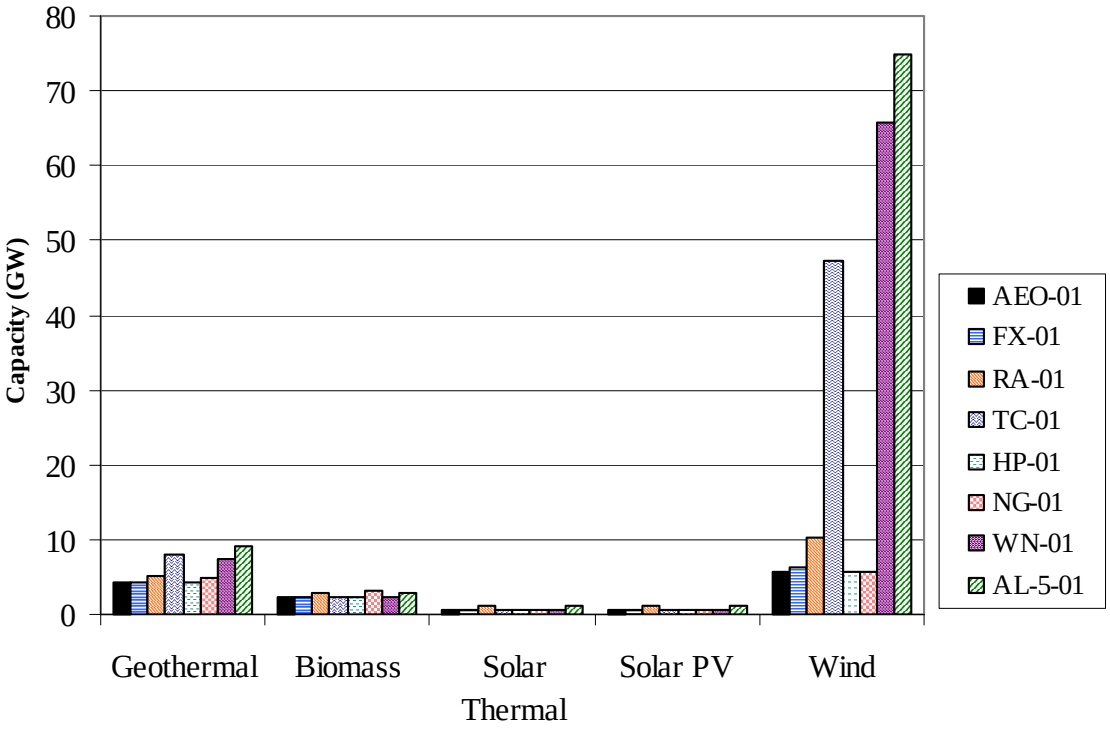

Figure ES- 1. Total Non-Hydro Renewable Capacity in 2020 by Technology

1. Introduction

Forecasts of the potential market for renewables are highly dependent on assumptions regarding future technology and policy developments. Technological optimism will govern projections of the economic competitiveness of renewable technologies by influencing factors that are included in a technology's levelized cost of energy equation. Policy mechanisms exist or may be created to help increase market share for various nascent technologies, based on externalities that the electricity market, in its current state, fails to internalize. Features of renewable technologies that argue for policies to encourage their continued growth and development include: they are well suited for decentralized generation; they have the potential to supply an abundant domestic source of power; they can provide non-polluting, carbon neutral energy. This study explores the potential impact of technology and policy advancements that enhance the economic competitiveness of renewable technologies.

In the National Energy Modeling System (NEMS), as with many models, levelized cost of energy assumptions for renewable energy technologies significantly influence forecast projections of U.S. grid-connected power generation and associated carbon emissions. The NEMS Reference Case assumes that only state renewable portfolio standards (RPS) programs that are currently legislated will support capacity additions for renewables outside of these technologies becoming a least-cost option. The possibility of direct access for consumers and green marketing of renewables under deregulation is not modeled explicitly. Instead, factors affecting cost of energy function as the primary driver of capacity expansion decisions. In the resulting forecasts, which extend through 2020 for the *Annual Energy Outlook 2001* (AEO2001), renewable energy technologies fail to capture a significant share of the electricity market.

This study explores the effect of seven scenarios on overall cost and development of renewable grid-connected power generation in a modified version of the Energy Information Administration's National Energy Modeling System (NEMS). The impacts of these alternative forecasts are compared to the AEO2001 Reference Case for installed capacity, generation and carbon emissions for six renewable energy technologies. For each of these scenarios, the renewable energy technologies considered were geothermal, biomass, solar thermal, solar photovoltaic (PV), wind and municipal solid waste (excluded in the levelized cost scenarios).

Table 1 summarizes the eight cases that were executed for this analysis. These scenarios include a reference case (Case 0); a technical fix case (Case 1); a renewable capacity additions case based on green marketing projections (Case 2); a technology optimism case based on alternative cost of energy assumptions for renewables (Case 3); a combined heat and power case for the industrial and commercial sectors (Case 4); a high natural gas price scenario (Case 5); a wind sensitivity case based on enhancements to lower wind speeds under a proposed $40 million wind research budget (Case 6); and a combined scenario with all of these changes incorporated (Case 7).

The first scenario incorporates changes to wind policy and modifications to the level of allowable intermittent technologies. The second case, which augments the forced capacity additions for each technology, represents the probable outcome of a green pricing market in which construction of renewable generation is increased to serve consumer demand for clean

power. The third scenario, modifies the levelized cost of energy for each technology, representing the competitive outcome of more aggressive projections of technological progress for renewable energy technologies. The fourth scenario increases the AEO2001 assumptions regarding the potential for combined heat and power (CHP) in industrial applications with some treatment of commercial CHP capabilities. The fifth case doubles price of natural gas to observe its potential benefits to renewable technologies. A sixth case looks at how the low wind speed technologies would benefit under varying wind research budgets with a focus on the $40 million funding scenario. Finally, a combination of these six scenarios is executed in which the code fixes, green pricing additions, cost of energy modifications, CHP adjustments, high natural gas price, and wind enhancements were implemented.

Table 1. NEMS-GPRA Analysis Cases

Case #	Abb.	Title	Description
Case 0		NEMS-GPRA reference case	Replication of AEO2001
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Case 3	TC	Technology characterization	Modified cost of energy parameters based on RETC for five renewable technologies
Case 4	HP	Combined heat and power	Adjustments to increase generation and capacity for industrial biomass and natural gas and natural gas commercial CHP
Case 5	NG	High natural gas price	Apply a carbon tax to natural gas prices to individual sectors
Case 6	WN	Wind cost sensitivity	Modify cost of energy parameters for wind to match $40 million wind research budget cost projection
Case 7	AL	Scenario combination	Cases 1 though 6 combined

2. Methodology

Berkeley Lab has developed a derivation of the EIA version of NEMS that permits the manipulation of key economic drivers of renewable energy development. For clarity, this modified version of NEMS is referred to as NEMS-GPRA. With NEMS-GPRA it is possible to test the effects of changes in energy cost and forced capacity assumptions for renewables compared to the Reference Case projections published in AEO2001. The sensitivity of the model is such that, for some technologies, relatively small differences in forecast cost of energy parameters can significantly affect electricity generation and carbon emissions projections.

The changes for the FX Case 1 enhance the capabilities of intermittent technologies and promote the growth of wind. The forced capacity additions in the RA Case 2 were derived as part of a green marketing analysis conducted by Princeton Energy Resources International (PERI) for DOE's Office of Power Technologies (2001b). The alternative costs of energy assumptions in the TC case were based on the *1997 Renewable Energy Technology Characterizations* (RETC).[3] The HP source code and input changes were supplied by PERI based on work for DOE/OPT (2001a). The high natural gas prices in the NG case simulate the effects of doubled gas prices by 2020. The WN case was derived by PERI to determine how a $40 million budget for the wind program would impact the forecast for renewables, especially wind. The AL case determines the effectiveness of integrating the various case changes.

The modifications for each scenario are outlined in the following seven sections. The reference Case 0 is the NEMS-GPRA version of the AEO2001 Reference Case. This case contains no code or data changes. Any deviations from the results published in AEO2001 and those reported here for Case 0 are a result of compiler and processor differences between EIA and Berkeley Lab platforms. This case serves as baseline against which all other cases are compared.

2.1 Case 1: Technical Fixes (FX)

Modifications to the reference case were implemented to improve its treatment of renewable energy technologies. FX Case 1 incorporates changes to wind and intermittent technologies as follows:

- Wind
  - extend the production tax credit to wind plants built by 2006 - update last year of generation subsidy variable ("UPIRGSYL") in *ecpdat* input file to 2006 from 2001 and increase the magnitude of the subsidy to adjust for the fact that the credit is a deduction from tax owed (after-tax). Therefore, its value before tax (as it is treated in the model, like a negative O&M cost) should be the credit/(1-tax rate).

[3] The RETC is the result of a joint project of EPRI and the Department of Energy's Office of Utility Technologies that characterizes the current state of the most competitive renewable energy technologies and projects the cost of energy for these technologies 30 years into the future, based on the assumption of continued developmental support and successful resolution of unresolved issues.

- Intermittent technologies
  - increase the upper limit of intermittent renewable technologies (solar thermal, solar PV, and wind) - raise the allowable penetration to 50% of generation in a region from 10% in the *ecpdat* input file.

The impact of these changes is to improve the market responsiveness of these technologies and prevent low ceilings on potential capacity from masking the results of the scenarios tested in this analysis.

2.2 Case 2: Renewable Additions (RA)

The RA Case 2 is intended to represent a possible green pricing scenario, where new market opportunities not currently incorporated in NEMS may significantly impact the growth of renewable electricity generation. In this case, regional renewable capacity additions were forced in NEMS-GPRA to reflect the green pricing market. Otherwise all assumptions were kept as close as possible to the reference case.

Table 2. Green Pricing Renewable Capacity Additions, Cases 2 and 7

All Renewables[1] (MW)	2005	2009	2013	2018	Cumulative
Geothermal	113.7	147.5	254.1	178.8	**694.1**
LFG	68.5	69.4	70.0	63.8	**271.7**
Direct-Fired Biomass	46.8	43.1	76.1	46.9	**212.9**
Biomass Gasification	81.3	79.1	118.2	59.9	**338.4**
Solar Thermal	38.6	170.2	259.2	140.7	**608.7**
Concentrator PV	12.7	39.4	96.4	93.0	**241.5**
Central Station PV	0.0	91.1	185.9	136.3	**413.3**
Wind class 4	1,318.7	1,098.9	1,553.9	490.7	**4,462.1**
Total	**1,680.2**	**1,738.6**	**2,613.8**	**1,210.0**	**7,242.6**

[1]Although presented as national totals, additions were made regionally, according to the 29 August 2001 PERI spreadsheet

source: Princeton Energy Resources International, spreadsheet from Jim McVeigh 29 August 2001

Table 2 shows the RA and AL planned capacity addition assumptions. These data, based on regional estimates by PERI, were included in the NEMS-GPRA plant data file as planned additions. Each new capacity addition was made by creating a contrived power station with the RETC operating characteristics for that particular renewable technology. New plants for each technology, except biomass and geothermal, were added to the *pltf860* input file. Biomass and geothermal additions were made in a separate input file, called *wfloors*, due to difficulties in implementing them via the *pltf860* file.

Plant sizes were based on PERI (2001b), which reported values as five-year increments (2003, 2008, 2013, and 2018). For all renewables, values were partitioned into annual increments by Berkeley Lab and implemented accordingly. Characteristics of the power stations were revised accordingly each year an addition was made. Solar thermal trough assumptions were used in

2005 and power tower plant assumptions were used for subsequent additions. Solar PV assumptions were those of thin film for all years additions were made. All of the wind capacity additions were from class 4. MSW additions were made as landfill gas (LFG) plants. Generally, these parameters were the lowest cost options in each of the years, with the exception of wind, for which the amount of class 6 resource available in later years was assumed to be limited.

NEMS-GPRA treats the country as comprising 15 Electricity Supply Regions, 13 of which cover the contiguous U.S. (Figure 1). In the regional breakdown of NEMS-GPRA, regions 14 and 15 are combined and reported together with region 13. The forced capacity additions for this case were actually added regionally, according to PERI's projections, but are reported in Table 2 as national totals.

The accuracy of the forced additions was verified by the reported cumulative planned additions, which NEMS-GPRA tallies in a table comparable to Table A17 of AEO2001. The difference in total planned additions in 2020 between the AEO2001 and RA forecasts is 7.2 GW, as expected. The difference in all the intermediate years' totals also agree, indicating that the forced builds were correctly implemented.

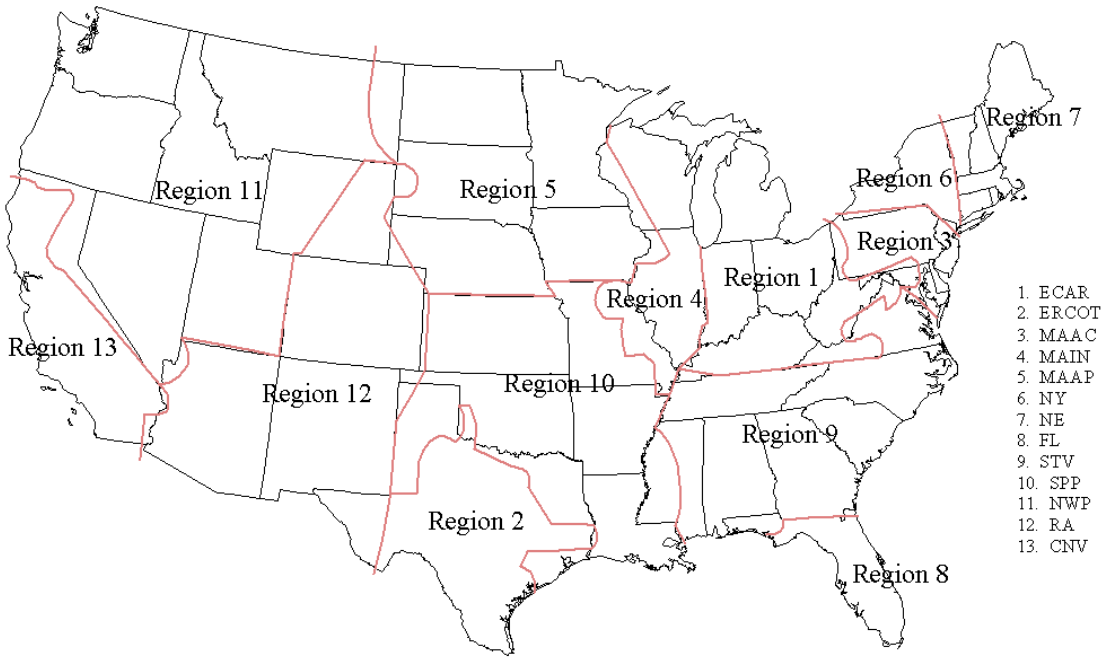

Figure 1. NEMS Electricity Supply Regions

adapted from The National Energy Modeling System: An Overview, *Energy Information Administration*

2.3 Case 3: Technology Characterization (TC)

The levelized costs implemented in the TC and AL cases are reported in Table 3 and Figure 2 and compared to the levelized costs embedded in AEO2001. These numbers were originally derived from the RETC[4] and then implemented in NEMS-GPRA, and have an effect similar to that of the AEO2001 "High Renewables" Case. Reported here are the actual levelized costs that are outputted by NEMS-GPRA. The reported costs vary slightly from the values published in RETC because of variation inherent in the method by which they are added to the model, as described below.

Table 3. Levelized Costs of Energy (1999 ¢/kWh) in Case 0 and Case 3

	Geothermal		Biomass		Solar Thermal		Solar PV		Wind	
Year	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3
2001	4.93	4.24	5.41	5.82	15.94	14.67	25.69	24.77	6.15	2.26
2005	4.62	4.03	5.12	5.29	14.65	11.96	17.23	15.47	5.40	3.42
2010	4.94	5.02	5.01	5.55	15.48	10.04	15.69	12.83	5.30	3.48
2015	4.89	4.78	4.77	5.39	14.64	8.53	14.42	10.48	4.74	3.54
2020	5.03	5.13	4.91	5.29	14.11	7.91	14.27	9.05	4.39	3.51

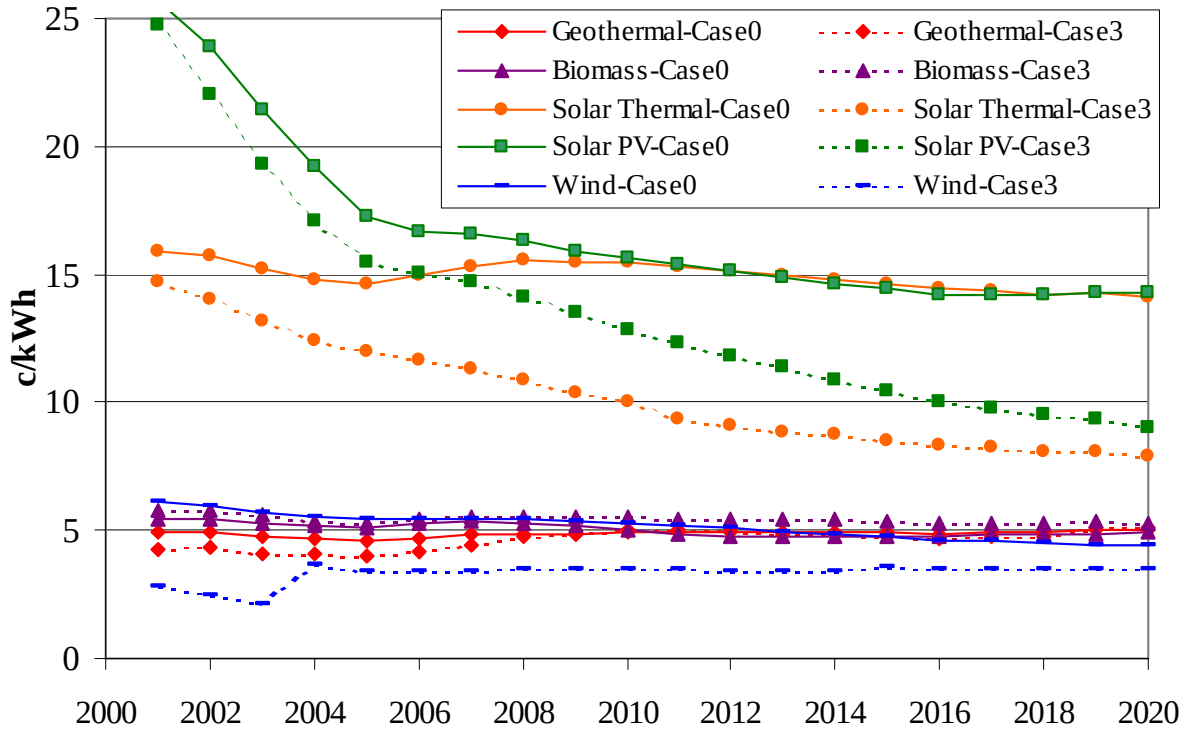

Figure 2. Comparison of Case 0 and Case 3 Levelized Cost of Energy (1999 ¢/kWh)

[4]Values were taken from Chapter 7, *Table 1. Levelized Cost of Energy for GenCo Ownership*, page 7-3.

The RETC levelized costs were incorporated in NEMS-GPRA by overwriting the capital and fixed O&M costs directly. The capital costs and fixed O&M costs for each technology (solar PV, wind, solar thermal, geothermal and biomass) in NEMS-GPRA Case 3 reflects the RETC forecast. These costs are overwritten in the *ecpdat* input file. The levelized costs that result from lowered capital and fixed O&M costs for Case 3 (as output by NEMS-GPRA) are reported in appendix Table 2TC, as compared to the levelized costs embedded in Case 0. Differences between the RETC and NEMS-GPRA levelized costs of energy are due to the way NEMS models the overwritten cost changes and how they affect other variables that contribute to the levelized cost calculation. As well, differences in the assumed fixed charge factor also account for some of the discrepancy.

For wind, targeting the RETC levelized cost required the injection of negative adders to the variable O&M costs (called variable O&M benefits, or *vombens*) used by NEMS. These vombens compensate for the differences in levelized costs between RETC and AEO2001. Because NEMS-GPRA includes the vombens directly in the calculation of levelized cost, they function as a straightforward means by which to adjust the levelized cost of energy (COE) used by NEMS-GPRA in its electricity sector production cost and capacity expansion calculations. Specifically, the vombens were calculated (in 1999$) as the difference between the TC levelized cost and that reported by NEMS-GPRA. The wind vombens were then converted to 1987$ and were added in the *udat.f* file as a source code manipulation. The use of vombens for wind was required because the *ecpdat* overwrites resulted in a 0.5 ¢/kWh discrepancy by 2020. Through the additional use of vombens, the levelized cost was less than 0.2 ¢/kWh off from the RETC target, resulting in an approximate doubling in wind capacity.

The modifications made to NEMS-GPRA for this simulation, that allow for the implementation of the RETC COE, involved:

- modifying the *ecpdat* input file to:
  - overwrite overnight capital costs and fixed O&M costs for wind, biomass, solar thermal, and solar PV
  - set the project contingency factor ("UPLRPC") = 1.00 for solar thermal and biomass
  - eliminate learning by doing for all renewables
  - extend the wind production tax credit to 2006 as described in Case 1 and adjust the magnitude of the subsidy to account for the pre-tax nature of the credit
  - increase the generation limit of intermittent technologies to 50% from the default 10%
- calculating vombens based on output from the EMMREPT intermediate file (in 1999$)
- modifying the *udat.f* source file with the vombens for wind (in 1987$)
- geothermal capital costs and fixed O&M costs were made separately as code changes to *renew.f*
- modifying the *westech* input file so that wind capacity factors equal RETC assumptions
- modifying the *solarin* input file so that solar thermal capacity factors match RETC assumptions

Despite the fact that NEMS-GPRA treats the wind resource as three distinct classes, each with its own capacity factor, wind COE is reported in the EMMREPT as having a single levelized cost. This situation makes calculating the levelized cost vombens for wind problematic since the cost

of wind energy varies by wind class. To circumvent the problem, a single COE for wind was calculated as a mix of class 4 and class 6 wind conditions. Under the assumption that the most robust wind resources are most cost competitive and will be developed first, the COE was weighted with an emphasis on class 6 early on, with class 4 representing a greater share of development by 2020. The exact method used to calculate the cost of energy is described in Table 3.

Due to significant changes made to the default coding of the Geothermal Energy Submodule, manipulating the COE through overwrites in the *ecpdat* file or through vombens could not be done. The restructuring of this submodule prevented costs from being overwritten without the loss of information regarding the potential at various sites. Instead, code changes were applied to this case to lower the individual geothermal the various component site costs. This modification is made as a one adjustment to the exploration capital cost by 15%, field capital cost by 15%, and plant capital cost by 25% in the *renew.f* code.

The net effects of overwriting the capital costs and fixed O&M costs as well as the vomben introduction (difference in COE from Case 0) are reported in Table 3. With the exception of the biomass technology, RETC forecasts lower costs of energy than in the reference case.

2.4 Case 4: Combined Heat and Power (HP)

The HP Case 4 incorporates the benefits of additional CHP in industrial as well as commercial sector applications. Capacity additions match those specified by PERI (2001a), as shown in Table 4. The industrial CHP target was 21 GW in 2020 over the 2001 baseline. Approximately 87% (18.2 GW) of this additional industrial CHP was natural gas, with the remaining 13% (2.8 GW) from biomass.

The industrial natural gas CHP additions are introduced using the *icogenwk1* input file. The investment tax credit (ITC) is increased to 15% from the default value of zero, and the capital cost multiplier is reduced from 100% to 75% for years 2001–2010. In addition, the system 3 heat rate was changed from 12,375 Btu/kWh to 13,123 Btu/kWh. The overall efficiency for systems 6 and 7 were increased to 0.78 from 0.74 and 0.72, respectively.

The biomass CHP additions were made via code changes in the *ind.f* module. Resource availability increased by roughly matching the proportions specified by PERI. Each of the four regions is a grouping of the nine census divisions in NEMS-GPRA.

To enhance the commercial CHP, three changes were implemented in this case. The technology capital costs for fuel cells, gas turbines, and micro turbines were reduced gradually to about 10% less than the AEO2001 reference case by 2020. The efficiency improvements were sped up so that the default 2020 improvements are reached ten years earlier, in 2010. The market acceptance parameters were increased from 30% to 50% for maximum potential penetration, and from 60% to 90% for rate of acceptance.

Table 4. CHP Additions Relative to Year 2001, Cases 4 and 7

	2006	2010	2015	2020
HP Case				
Industrial Sector - Natural Gas				
Cumulative Additional Installed CHP Capacity (GW)	6.2	10.7	14.3	18.2
Industrial Sector - Biomass				
Cumulative Additional Installed CHP Capacity (GW)	0.7	1.5	2.1	2.8
Total				
Cumulative Additional Installed CHP Capacity (GW)	**6.9**	**12.2**	**16.4**	**21.0**

source: National Renewable Energy Laboratory (NREL), fax from Larry Goldstein 4 October 2001

2.5 Case 5: High Natural Gas Price (NG)

The high natural gas price case is achieved by imposing a carbon tax to natural gas in the *PRICE_ADJUST* subroutine of the Emissions Policy Module (*epm.f*). The amount of carbon tax on natural gas use in each sector - residential, commercial, industrial and transportation, as well as in electricity generation are adjusted by applying estimated scalars to the variable *ETAXENDU* and *ETAXELEC*. The adjustment is done on natural gas while petroleum products and coal are left unchanged. The carbon tax is imposed in such a way that the resultant gas price ramps up gradually towards a doubling effect by 2020.

2.6 Case 6: Wind Sensitivity (WN)

Using the 2001 version of NEMS, three different budget scenarios for wind were initially assessed to determine the extent of wind penetration given various levels of research funding that enhance lower wind speed technologies. The three scenarios represent a $20 million, $40 million, and $60 million budgets to the DOE wind program. With the exception of the $20 million budget, which hinders the advancement of class 4 wind technology, each scenario is modeled to determine the extent to which research programs are able to enhance the class 4 wind technology over time. For the purposes of this report, scenario 2 or the $40 million budget is the focus for Case 6 as well as for any corresponding AL runs. Brief results are presented for the other two scenarios in the results section.

The baseline for this analysis is a combination TC-FX case. Each of the three budget scenarios is modeled by lowering the forecasted levelized costs and increasing the capacity factors through 2020 in addition to the TC and FX assumptions. In order to represent the enhancement of the low wind speed technology (class 4 wind), the levelized cost over time is lowered to simulate increased penetration of class 4 wind. In 2001, class 6 wind accounts for 100% of the wind resource mix, but by 2010 35% of the mix is class 4 with class 6 taking up the remainder. In 2015, the wind classes are split 50%-50%, and by 2020 70% of wind is class 4 with 30% class 6.

Vombens are added to each scenario as well as to the baseline to more closely match the wind technology targets of each budget and enable comparison with the earlier analysis. Without the

vombens, the baseline amount of additional installed wind capacity is almost half what it would be with the vombens in place. This illustrates the extremely sensitive nature of wind costs on capacity growth.

2.7 Case 7: Scenario Combination (AL)

The AL scenario implements the FX technical fixes, RA green pricing hardwired capacity additions, RETC-projected renewables cost trajectories, the HP industrial and commercial CHP adjustments, the high natural gas price NG case, and the wind sensitivity WN changes exactly as they were implemented for the individual cases described above.

3. Results

For all cases, results are reported in Appendix 1, 2, and 3 for electric generator installed capacity, electric generation and carbon emissions, respectively. These values are given as national totals from 2001 through 2020 for each of the renewable technologies under study, and are compared to the reference case values to show the net impact of the modified assumptions. Table 5 provides a summary of the overall changes in capacity, generation and carbon emissions for each of the scenarios.

Table 5. Capacity, Generation, Carbon, and CHP Changes for 2020 (and 2010), Cases 1-7

	Renewable Capacity (GW)	Renewable Generation (TWh)	Carbon Emissions (Mt)
Case 1 (FX)	0.5 (0.6)	1.5 (2.4)	0 (1.0)
Case 2 (RA)	7.2 (3.4)	25.1 (11.6)	-4 (-3)
Case 3 (TC)	50.5 (15.9)	199.8 (74.4)	-28 (-14)
Case 4 (HP)	0.0 (0.0)	0.0 (0.4)	-4 (-5)
Case 5 (NG)	1.7 (0.3)	4.5 (4.8)	-9 (-16)
Case 6 (WN)	62.9 (18.7)	261.9 (81.4)	-33 (-12)
Case 7 (AL)	76.2 (24.5)	309.1 (108.3)	-62 (-36)

3.1 FX Case 1

Appendix Tables 1FX (electric generator capacity), 2FX (electricity generation), and 3FX (carbon emissions) compare the results of Case 1 and Case 0. Technical fixes for wind and intermittent technologies result in a 1.5% increase in electric generation from renewable technologies, corresponding to 1.5 TWh more in 2020. Total installed capacity for the same year increases by 0.5 GW or 2.9%.

This effect is almost entirely due to the extension of the wind production tax credit by five years to 2006. As well, an adjustment is made to the magnitude of this subsidy to correct for the fact that the credit is a deduction from tax-owed (after-tax). Thus, the subsidy before tax is the credit/(1-tax rate). Solar thermal and PV show no effect from the changes implemented. This is because the levelized costs of solar energy are too high throughout the forecast period (above 10 ¢/kWh) for it to be competitive.

Not surprisingly, the net carbon emissions effect of the FX case is minimal.

3.2 RA Case 2

Appendix Tables 1RA, 2RA, and 3RA show the equivalent tables for the RA Case 2. Forced capacity additions are implemented into NEMS-GPRA as shown in Table 2. In this scenario, all

renewables benefit in the majority of years from the forced additions. The increase is fairly steady, starting in 2002 and ramping over the forecast period.

Overall, this case resulted in a 26% increase in renewable electric generation in 2020, up from 97.8 TWh to 122.8 TWh. Approximately 51% of this increase in 2020 is from wind, contributing an additional 12.7 TWh, with roughly 22% from geothermal, a 5.5 TWh increase from 25.8 TWh. For biomass, the 0.6 GW of forced builds is estimated to result in a 1.3 TWh increase by 2020. Because biomass is reported as a sum from both dedicated plants and cofiring, this amount is masked in the output tables by fluctuations in the biomass cofiring. Solar thermal generation increases by roughly 10% of the total renewable generation increase, a 2.4 TWh increase from 1.4 TWh. Installed generating capacity increases 7.2 GW by 2020 for all renewable technologies, with 63% of this increase from wind additions. For all technologies except PV, generation increases proportionally more than capacity, reflecting improving technology.

In the RA Case 2, annual carbon savings reach 4.0 Mt by 2020, a 0.2% reduction from total U.S. carbon emissions.

3.3 TC Case 3

The TC Case 3 can be interpreted as the competitive outcome if renewables cost trajectories are close to those reported in the RETC, while all other AEO2001 assumptions are left unchanged.

Appendix Tables 1TC, 2TC, and 3TC represent the results from adjusting the levelized costs of each technology to reflect the RETC forecast. Overall, electric generation from renewables increases by 204% in 2020 with 1325% and 105% increases in wind and geothermal generation, respectively. Notably, wind power experiences the most significant boost from the RETC cost projections. Wind generation increases by 174 TWh from just over 13 TWh in 2020. The increase in capacity over the reference case starts early, when the cost of energy reaches around 3¢/kWh. Wind also shows the greatest capacity effect, resulting in over 47 GW more capacity in 2020, a 816% increase. Based on these capacity and generation results, it can be determined that the capacity factor of wind generation increases from about 26% to 42%. Geothermal increases its installed generating capacity by 78% in 2020 relative to the reference case, up from 4.41 GW to 7.85 GW in the final forecast year.

In contrast, despite a dramatic reduction in the levelized cost of energy, PV and solar thermal show no change as a result of lowering its costs of energy. With PV and solar thermal costs forecasted by 2020 to be 9.1 ¢/kWh and 7.9 ¢/kWh, respectively, the cost of these technologies are likely still too high to compete with other technologies at the wholesale level.

With biomass, installed capacity does not change throughout the forecast period. Biomass cost of energy also remains relatively high, starting at 5.8¢/kWh and never dropping below 5.3¢/kWh.

The TC Case 3 scenario includes a significant reduction in carbon emissions as a result of enhanced renewables use. By 2020, electricity sector emissions are reduced by 28 Mt/a, which translates to a reduction of 1.4% of total U.S. carbon emissions.

3.4 HP Case 4

Appendix Tables 1HP, 2HP, and 3HP present the results from the HP Case 4 run of increasing the industrial natural gas and biomass CHP as well as some changes to commercial natural gas CHP. With a total increase of 21 GW by 2020 relative to the 2001 baseline, carbon emissions are reduced 4 Mt in the final forecast year. A significant share of the 7.4 Mt of carbon saved in the power sector is offset by an increase of 2.6 Mt in the industrial sector due to gas use on-site. Net carbon emissions savings are still realized in this case due to the increased biomass CHP usage. Renewable capacity or generation is not affected throughout the forecast period. Appendix Table 4 illustrates how the increased fuel consumption from industrial natural gas CHP outweighs the reduction from electric generation.

3.5 NG Case 5

Appendix Tables 1NG, 2NG, and 3NG show the NG case results. Simulation of a doubled natural gas fuel price in the residential, commercial, industrial, transportation, and electricity sectors by 2020 resulted in an overall carbon reduction of 9 Mt by 2020. The appearance of a large (45.5 Mt in 2020) carbon savings from doubled natural gas prices is largely offset by increased electricity sector emissions from fuel switching from natural gas to coal. As a result of high natural gas prices, renewables capacity increases by a total of 1.7 GW in 2020, with 0.5 GW from geothermal, 0.4 GW from MSW and biomass capacity increasing by 0.7 GW.

below summarizes the resulting natural gas prices by sector from imposing a carbon tax on natural gas use. In general, the prices were approximately doubled in 2020, about 60-65% above AEO2001 prices in 2015 and approximately 35% above in 2010.

Table 6. Natural Gas Prices by Sector (1999$/Mbtu)

1999$/MBtu	2000	2005	2010	2015	2020
Residential	7.19	6.63	8.68	10.52	12.35
Commercial	5.70	5.31	7.37	9.00	10.64
Industrial	4.00	3.17	4.46	5.50	6.48
Transportation	7.94	6.80	9.49	11.75	13.87

3.6 WN Case 6

Table 7 summarizes the results from runs experimenting with three wind budget scenarios that favor various levels of low wind speed class 4 enhancement. A combination of Cases 1 and 3, TC-FX, serve as the baseline. The TC-FX run results in 12.5 GW more wind in 2010 and 47.2 GW by 2020. Under scenario 1, the cost of wind energy in 2020 is actually higher than the baseline, 3.38 ¢/kWh in 2020 relative to RETC's 3.02 ¢/kWh. However, with the lowered CF relative to the baseline it is difficult to make any direct conclusions about the results. The wind capacity increases under this case are about the same as the baseline, with 45.9 GW more wind in 2020 1.3 GW less than the TC-FX baseline in this last forecast year. Scenario 2 represents a 2.50 ¢/kWh wind cost in 2020 about 0.5 ¢/kWh lower than the baseline, which results in nearly 13 GW more wind capacity by 2020 compared to the TC-FX baseline. Under this $40 million

budget scenario, an additional 5 Mt of carbon emissions are reduced under this scenario by 2020 as a result of this reduced wind cost projection over the TC-FX baseline. Scenario 3 represents the $60 million wind program budget in which the class 4 technology is able to make the greatest advances, lowering the cost of the wind mix to 2.4 ¢/kWh by 2020. This results in 24.6 GW more wind capacity over the TC-FX baseline and a nearly 70% increase in wind generation with carbon emissions reductions 10 Mt more than the baseline in 2020.

Table 7. Summary of Case 6 Wind Budget Scenario Results

Year 2020 Results	GPRA01 TCFX baseline	Scenario 1 ($20 million)	Scenario 2 ($40 million)	Scenario 3 ($60 million)
COE (c/kWh)	3.02	3.38	2.50	2.37
CF Class 4	0.38	0.32	0.45	0.46
LBL COE (c/kWh)	3.05	3.42	2.43	2.49
Capacity (GW)	47.2	45.9	59.9	71.8
Generation (TWh)	173.6	168.4	238.1	292.7
Carbon Emissions (Mt)	-28.0	-24.0	-33.0	-38.0

Tables 1WN, 2WN, and 3WN show the WN case results for wind scenario 2. Any AL runs involving WN include the results from analyzing the $40 million budget scenario, which is seen as the most widely accepted budget of the three.

3.7 AL Case 7

The effects of the combined modifications to NEMS-GPRA are shown in Appendix Tables 1AL, 2AL and 3AL. Figure 3 compares the total capacity of each renewable technology in 2020 for each of the six simulations and the reference case. As this figure illustrates, the combined effects of all assumptions are larger than any applied separately, yet less than their sum. Clearly, wind is highly sensitive to the imposed changes, especially through lowered cost of energy. Geothermal also exhibits some response to lowered site costs with biomass, solar thermal, and solar PV showing very little stimulus to the proposed changes. A comparison of total renewable capacity additions under each scenario is presented by year in Figure 4.

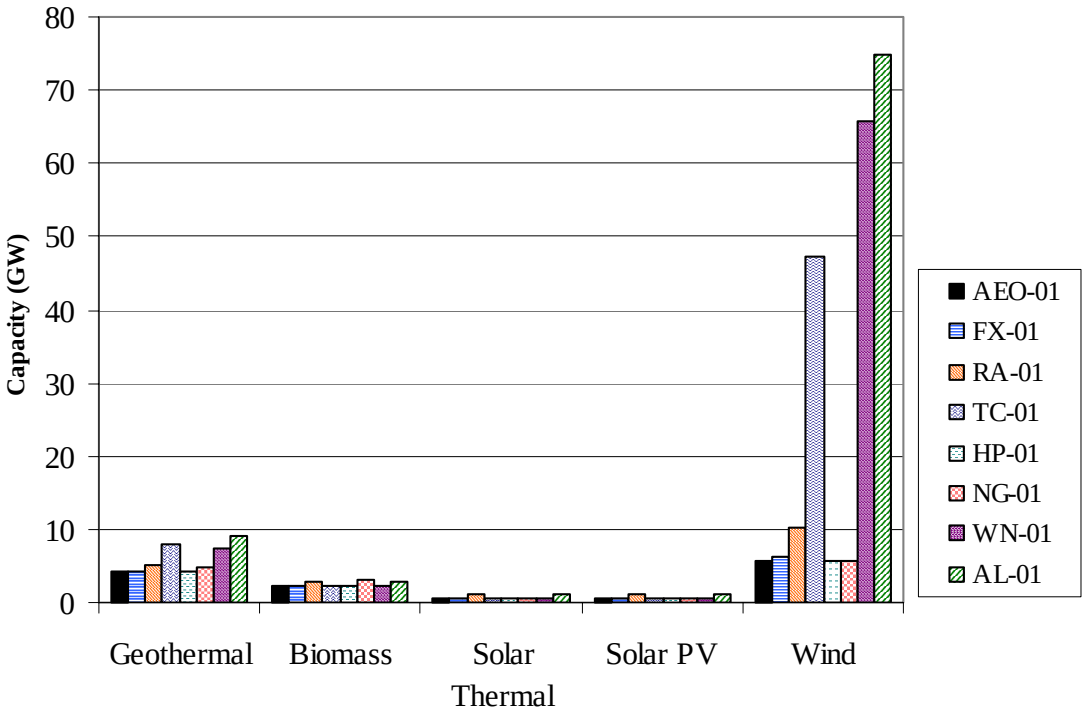

Figure 3. Total Non-Hydro Renewable Capacity in 2020 by Technology

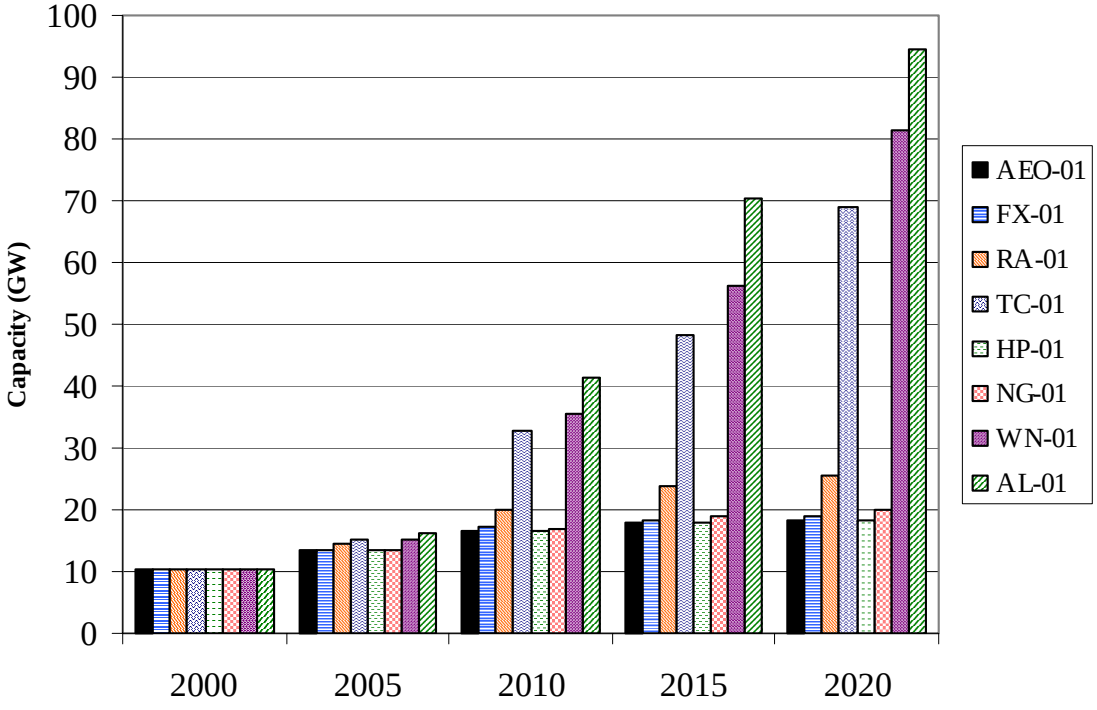

Figure 4. Total Non-Hydro Renewable Energy Capacity

As in the AL Case 7, wind benefits most from the assumptions in place for the scenario and is up even from the WN Case 6. Wind generation increases over 21 times that of the reference case by 2020 in AL Case 7. Solar thermal and PV also show increases, with generation in 2020 up nearly 2.8 times and 1.9 times, respectively. Generation from geothermal more than doubles during the forecast period. Biomass shows a significant decrease in generation over the reference case, due to the presence of biomass cofiring in the reported results.

As expected from the above results, AL also reports the greatest carbon savings. Total emissions are reduced by 62 Mt/a by 2020, which is 8% of the electricity sector or 3% of total energy-related emissions.

4. Conclusions

FX Case 1 technical fixes, RA Case 2 forced capacity additions, TC Case 3 levelized cost modifications, HP Case 4 CHP adjustments, NG Case 5 high natural gas prices, WN Case 6 wind cost sensitivity, and the AL Case 7 combined scenarios were implemented into NEMS-GPRA. The scenarios were designed to simulate the potential benefits to renewable energy technologies of (1) a more competitive marketplace that includes direct access for customers and green marketing-induced capacity additions, (2) more aggressive advances in the factors that drive the cost of renewable energy and (3) more rapid penetration of industrial and commercial CHP, than forecast by the AEO2001 Reference Case.

These runs comprehensively incorporate the forced renewable CHP capacity additions as specified by PERI (2001a) and, with the exception of MSW, the renewables levelized cost of energy forecasts reported in the *1997 Renewable Energy Technology Characterizations* (RETC) for six renewable energy technologies through 2020. Modifications to improve the treatment of certain renewable energy technologies by the model were also implemented. Results indicate a substantial increase in renewable electric power generation as well as a significant reduction in carbon emissions for each of the scenarios. Generally, the AL case produced the most dramatic results, although individual technologies were affected differently in each case. Wind development received the greatest boost from the modifications to NEMS-GPRA. For all technologies, the AL case resulted in an increase in generation that was greater than either the increase in the individual simulations, but less than their sum.

Wind, which has a comparatively low cost of energy in the RETC, experienced an increase in generation in the AL case over nearly 21 times that of the reference case by 2020.

Solar thermal generation was up 2.8 times and geothermal up 2.5 times over the reference by 2020 in the AL Case 7.

The forecast for PV, with its relatively high cost of energy, did not change in the TC Case 3 case, but generation did increase by 93% in 2020 in both the RA Case 2 and AL Case 7.

The projection for MSW, a 13.3% increase in generation by 2020, is the same for AL and RA Case 2, as expected since cost of energy assumptions have not changed from the reference case.

In each scenario, carbon emissions decreased in comparison to AEO2001 every year between 2001 and 2020. By 2020, carbon emissions were down 4 Mt/a (0.2%) in RA Case 2, 28 Mt/a (1.4%) in TC Case 3, 4 Mt/a (0.2%) in HP Case 4, 9 Mt/a (0.4% in NG Case 5, 33 Mt/a (1.6%) in WN Case 6, and 62 Mt/a (3%) in AL Case 7.

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Appendix of Tables

Table FX- 1. Case 1 Capacity from Renewable Technologies and AEO2001

Appendix 1FX. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 1 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
FX01	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.04	4.20	4.34	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.2	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
FX01	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
FX01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
FX01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
FX01	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
FX01	2.76	3.53	3.80	4.01	4.28	4.49	5.22	5.46	5.71	5.98	6.08	6.15	6.24	6.24	6.24	6.27	6.30	6.30	6.30	6.30	6.32
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5
% Difference	0.0	0.0	0.0	0.0	1.4	1.4	12.3	11.7	11.1	10.5	10.3	10.2	10.1	10.1	10.1	10.0	9.9	9.9	9.9	9.4	9.3
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
FX01	10.20	11.11	11.47	11.76	12.77	13.56	14.58	15.41	16.10	16.76	17.27	17.70	18.15	18.21	18.27	18.38	18.55	18.62	18.68	18.75	18.83
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5
% Difference	0.0	0.0	0.0	0.0	0.5	0.4	4.1	3.8	3.6	3.5	3.4	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.1	2.9	2.9

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table FX- 2. Case 1 Generation from Renewable Technologies and AEO2001

Appendix 2FX. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 1 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
FX01	13.39	13.56	13.59	13.60	13.56	15.85	17.36	20.88	22.86	24.14	25.25	25.71	25.72	25.72	25.74	25.75	25.75	25.76	25.76	25.77	25.77
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1
% Difference	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.3	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
FX01	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.95	32.07	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
FX01	10.77	13.58	16.82	14.29	15.16	17.94	19.07	19.58	20.48	21.36	22.38	21.96	22.76	22.96	22.84	23.31	23.27	24.33	22.65	22.44	22.12
Difference	0.0	0.0	-0.2	0.0	0.1	0.7	-0.3	-0.2	0.0	0.8	0.8	0.3	1.1	0.4	0.2	0.1	0.0	1.2	0.0	0.0	0.0
% Difference	0.0	-0.3	-1.4	0.1	0.6	3.9	-1.8	-1.0	-0.1	3.8	3.7	1.4	4.8	2.0	0.8	0.4	0.1	5.3	0.0	-0.1	-0.1
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
FX01	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
FX01	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
FX01	5.18	6.62	7.73	8.33	9.05	9.60	11.62	12.24	12.88	13.55	13.95	14.14	14.33	14.39	14.39	14.46	14.53	14.55	14.55	14.55	14.64
Difference	0.0	0.0	0.0	0.0	0.2	0.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5
% Difference	0.0	0.0	0.0	0.0	1.9	1.9	16.2	15.3	14.4	13.5	13.1	12.9	12.7	12.6	12.6	12.6	12.5	12.5	12.4	11.8	12
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
FX01	48.63	53.73	58.55	56.88	64.22	71.90	76.92	82.03	86.17	89.76	93.20	94.5	96.7	97.6	97.8	98.6	99.1	100.5	99.1	99.2	99.2
Difference	0.0	0.0	-0.2	0.0	0.3	0.8	1.3	1.4	1.5	2.4	2.4	1.9	2.6	2.0	1.7	1.7	1.6	2.8	1.6	1.5	1.5
% Difference	0.0	-0.1	-0.4	0.0	0.4	1.2	1.7	1.8	1.8	2.7	2.6	2.0	2.8	2.1	1.8	1.7	1.6	2.9	1.6	1.5	1.5

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table FX- 3. Case 1 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3FX. Total Carbon Emissions (Mt/a): Case 1 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
FX01	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.4	730.3	740.5	750.6	760.3	769.3	780.8	792.3	803.6	815.0	825.4	835.4	845.5	856.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	-0.2	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
FX01	265.4	272.1	279.4	285.3	289.2	291.9	296.1	299.7	303.2	306.1	309.8	312.9	316.9	319.9	323.4	327.4	330.8	334.0	337.1	340.0	343.2
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.0	0.0	0.0	0.3	0.0	0.0	-0.1	-0.2	-0.1	-0.1	0.0	-0.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
FX01	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.5	69.6
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FX01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
FX01	569.8	587.3	601.5	615.5	625.3	632.9	638.5	653.0	661.6	667.9	679.9	687.1	694.8	705.6	715.0	728.1	736.6	745.9	753.7	761.2	771.6
Difference	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-1.1	-0.2	0.0	0.1	0.8	0.0	-0.9	-0.7	-0.5	0.6	1.5	-0.6	0.0	-0.3	0.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.1	0.0	-0.1	-0.1	-0.1	0.1	0.2	-0.1	0.0	0.0	0.0
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
FX01	1535	1576	1611	1643	1668	1690	1712	1742	1765	1784	1810	1830	1851	1876	1900	1929	1952	1975	1996	2016	2041
Difference	0.0	-1.0	0.0	0.0	0.0	0.0	-1.0	0.0	0.0	0.0	1.0	0.0	0.0	-1.0	-1.0	1.0	1.0	-1.0	0.0	-1.0	0.0
% Difference	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	-0.1	0.1	0.1	-0.1	0.0	0.0	0.0

[1]From AEO2001 Table A19

Table RA- 1. Case 2 Capacity from Renewable Technologies and AEO2001

Appendix 1RA. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 2 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
RA01	2.93	2.93	2.93	2.96	2.92	3.22	3.43	3.90	4.21	4.39	4.58	4.70	4.75	4.80	4.85	4.90	4.94	4.97	5.01	5.05	5.08
Difference	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7
% Difference	0.0	0.0	0.0	1.0	1.4	2.2	2.7	2.9	4.0	4.3	5.5	6.6	7.7	8.8	10.0	11.1	12.0	12.7	13.6	14.5	15.2
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
RA01	2.64	2.76	2.78	2.83	3.50	3.84	3.89	3.97	4.07	4.19	4.34	4.49	4.67	4.71	4.74	4.78	4.86	4.89	4.92	4.96	4.99
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
% Difference	0.0	0.0	0.0	0.7	-1.1	1.1	1.3	1.8	2.3	2.7	3.3	3.5	3.5	4.0	4.2	4.6	4.7	4.9	5.1	5.5	5.7
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
RA01	1.53	1.54	1.60	1.65	1.71	1.75	1.81	1.89	2.00	2.14	2.29	2.46	2.64	2.68	2.72	2.77	2.84	2.86	2.88	2.90	2.92
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6
% Difference	0.0	0.0	0.0	1.9	3.0	4.2	5.8	7.4	8.7	10.9	12.3	13.4	13.8	15.5	17.2	18.9	19.8	20.7	21.5	22.4	23.2
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
RA01	0.33	0.33	0.33	0.34	0.36	0.37	0.38	0.40	0.46	0.52	0.58	0.63	0.69	0.74	0.80	0.86	0.89	0.92	0.96	0.99	1.03
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6
% Difference	0.0	0.0	0.0	0.0	2.9	5.7	5.6	8.1	21.1	33.3	45.0	57.5	68.3	76.2	86.0	95.5	102.3	104.4	108.7	110.6	114.6
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
RA01	0.01	0.02	0.03	0.05	0.07	0.09	0.12	0.14	0.21	0.28	0.35	0.44	0.52	0.61	0.70	0.79	0.87	0.96	1.04	1.12	1.20
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7
% Difference	0.0	0.0	0.0	0.0	16.7	0.0	9.1	7.7	40.0	55.6	66.7	83.3	92.6	103.3	112.1	113.5	117.5	118.2	121.3	119.6	122.2
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
RA01	2.76	3.53	3.80	4.28	4.75	5.22	5.71	6.21	6.83	7.46	7.93	8.31	8.71	9.02	9.33	9.67	9.80	9.90	10.00	10.12	10.24
Difference	0.0	0.0	0.0	0.3	0.5	0.8	1.1	1.3	1.7	2.1	2.4	2.7	3.0	3.4	3.7	4.0	4.1	4.2	4.3	4.4	4.5
% Difference	0.0	0.0	0.0	6.7	12.6	17.8	22.8	27.0	32.9	37.9	43.9	48.9	53.6	59.1	64.6	69.6	71.0	72.8	74.5	75.7	77.2
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
RA01	10.20	11.11	11.47	12.11	13.31	14.49	15.34	16.51	17.78	18.98	20.07	21.03	21.98	22.56	23.14	23.77	24.20	24.50	24.81	25.14	25.46
Difference	0.0	0.0	0.0	0.4	0.6	1.0	1.3	1.7	2.2	2.8	3.4	3.9	4.4	4.9	5.4	6.0	6.2	6.4	6.7	6.9	7.2
% Difference	0.0	0.0	0.0	3.0	4.7	7.3	9.5	11.3	14.4	17.2	20.2	22.7	25.0	27.8	30.7	33.4	34.5	35.7	36.9	38.0	39.1

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table RA- 2. Case 2 Generation from Renewable Technologies and AEO2001

Appendix 2RA. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 2 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
RA01	13.39	13.56	13.59	13.79	13.94	16.41	18.10	21.81	24.24	25.70	27.22	28.14	28.56	28.98	29.41	29.83	30.13	30.43	30.73	31.02	31.32
Difference	0.0	0.0	0.0	0.2	0.4	0.6	0.7	0.9	1.3	1.5	2.0	2.4	2.8	3.2	3.6	4.0	4.3	4.6	4.9	5.2	5.5
% Difference	0.0	0.0	0.0	1.4	2.8	3.5	4.3	4.4	5.8	6.3	7.7	9.2	10.8	12.4	14.0	15.6	16.7	17.9	19.0	20.1	21.3
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
RA01	18.36	19.03	19.44	19.74	25.00	27.64	28.01	28.49	29.17	29.99	30.96	32.02	33.24	33.85	34.10	34.34	34.80	35.14	35.37	35.62	35.86
Difference	0.0	0.0	0.0	0.1	-0.4	0.3	0.4	0.5	0.6	0.8	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9
% Difference	0.0	0.0	0.0	0.5	-1.4	1.1	1.4	1.7	2.2	2.7	3.2	3.4	3.6	3.9	4.2	4.4	4.6	4.9	5.1	5.4	5.6
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
RA01	10.34	15.66	16.86	13.97	15.04	18.80	19.07	19.83	22.04	21.94	22.29	22.92	23.48	23.69	23.65	24.09	24.16	25.46	25.26	25.29	23.41
Difference	-0.4	2.0	-0.2	-0.3	0.0	1.5	-0.3	0.1	1.5	1.4	0.7	1.3	1.8	1.2	1.0	0.9	0.9	2.4	2.6	2.8	1.3
% Difference	-4.0	15.0	-1.2	-2.1	-0.2	8.9	-1.8	0.3	7.5	6.7	3.2	5.8	8.2	5.2	4.4	3.8	3.9	10.2	11.6	12.6	5.7
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
RA01	0.89	0.89	0.90	0.93	0.99	1.04	1.08	1.14	1.40	1.66	1.91	2.13	2.36	2.60	2.84	3.08	3.21	3.35	3.49	3.63	3.77
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.1	2.2	2.3	2.4
% Difference	0.0	0.0	0.0	2.2	5.3	8.3	10.2	12.9	33.3	53.7	72.1	88.5	105.2	122.2	134.7	148.4	154.8	159.7	166.4	170.9	175.2
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
RA01	0.04	0.05	0.07	0.12	0.16	0.22	0.28	0.34	0.47	0.63	0.78	0.97	1.15	1.33	1.53	1.73	1.91	2.08	2.26	2.44	2.62
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
% Difference	0.0	0.0	0.0	9.1	6.7	10.0	7.7	9.7	27.0	43.2	52.9	64.4	74.2	79.7	84.3	88.0	89.1	89.1	91.5	92.1	92.6
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
RA01	5.18	6.62	7.73	9.08	10.38	11.68	13.02	14.39	16.07	17.79	19.23	20.31	21.39	22.34	23.23	24.18	24.53	24.83	25.11	25.48	25.84
Difference	0.0	0.0	0.0	0.8	1.5	2.3	3.0	3.8	4.8	5.9	6.9	7.8	8.7	9.6	10.5	11.3	11.6	11.9	12.2	12.5	12.7
% Difference	0.0	0.0	0.0	9.0	16.9	24.0	30.2	35.5	42.7	49.0	56.0	62.2	68.3	74.8	81.8	88.3	90.0	92.0	94.0	95.7	97
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
RA01	48.20	55.81	58.59	57.63	65.51	75.79	79.56	86.00	93.39	97.71	102.39	106.5	110.2	112.8	114.8	117.3	118.7	121.3	122.2	123.5	122.8
Difference	-0.4	2.0	-0.2	0.8	1.5	4.7	3.9	5.4	8.7	10.3	11.6	13.9	16.1	17.2	18.8	20.4	21.2	23.6	24.7	25.8	25.1
% Difference	-0.9	3.8	-0.3	1.4	2.4	6.7	5.2	6.7	10.3	11.8	12.8	15.0	17.1	18.0	19.5	21.0	21.8	24.1	25.3	26.3	25.6

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table RA- 3. Case 2 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3RA. Total Carbon Emissions (Mt/a): Case 2 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
RA01	631.2	648.0	661.7	672.4	682.9	695.5	707.6	719.4	730.2	740.5	750.4	760.2	769.2	780.7	792.0	803.5	814.8	825.1	835.2	845.3	855.9
Difference	0.0	0.0	0.0	0.0	-0.6	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.1	-0.3	-0.1	-0.4	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2
% Difference	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
RA01	265.4	272.1	279.4	285.3	289.7	291.9	296.2	299.8	303.4	306.4	310.1	313.2	317.2	320.2	324.0	327.8	331.2	334.4	337.5	340.3	343.5
Difference	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.6	0.3	0.6	0.3	0.2	0.3	0.3	0.3	0.2
% Difference	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
RA01	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.4	69.4	69.5	69.5	69.5	69.6
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RA01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
RA01	569.9	586.7	601.7	615.8	625.8	633.4	638.9	652.5	660.0	665.5	676.0	683.6	691.1	702.0	711.1	723.2	732.1	742.3	750.2	757.3	767.8
Difference	0.1	-0.7	0.1	0.2	0.4	0.3	-0.7	-0.7	-1.6	-2.3	-3.1	-3.5	-4.6	-4.3	-4.4	-4.3	-3.0	-4.2	-3.5	-4.2	-3.7
% Difference	0.0	-0.1	0.0	0.0	0.1	0.0	-0.1	-0.1	-0.2	-0.3	-0.5	-0.5	-0.7	-0.6	-0.6	-0.6	-0.4	-0.6	-0.5	-0.6	-0.5
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
RA01	1535	1576	1611	1643	1668	1690	1712	1741	1763	1782	1806	1826	1847	1872	1897	1924	1948	1971	1992	2013	2037
Difference	0.0	-1.0	0.0	0.0	0.0	0.0	-1.0	-1.0	-2.0	-2.0	-3.0	-4.0	-4.0	-5.0	-4.0	-4.0	-3.0	-5.0	-4.0	-4.0	-4.0
% Difference	0.0	-0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2	-0.3	-0.2	-0.2	-0.2

[1]From AEO2001 Table A19

Table TC- 1. Case 3 Capacity from Renewable Technologies and AEO2001

Appendix 1TC. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 3 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
TC01	2.93	2.93	2.93	2.93	2.88	3.85	4.70	5.88	6.77	7.56	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85
Difference	0.0	0.0	0.0	0.0	0.0	0.7	1.4	2.1	2.7	3.4	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
% Difference	0.0	0.0	0.0	0.0	0.0	22.2	40.7	55.1	67.2	79.6	80.9	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
TC01	2.64	2.76	2.78	2.81	3.21	3.73	3.77	3.83	3.91	4.01	4.13	4.27	4.44	4.46	4.48	4.50	4.57	4.59	4.61	4.63	4.65
Difference	0.0	0.0	0.0	0.0	-0.3	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
% Difference	0.0	0.0	0.0	0.0	-9.3	-1.8	-1.8	-1.8	-1.8	-1.7	-1.7	-1.6	-1.6	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
TC01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
TC01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
TC01	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
TC01	2.76	3.53	3.80	4.01	4.42	5.56	9.27	12.06	14.09	15.97	17.97	20.38	23.19	25.45	28.67	32.89	37.64	41.87	45.12	49.01	52.93
Difference	0.0	0.0	0.0	0.0	0.2	1.1	4.6	7.2	9.0	10.6	12.5	14.8	17.5	19.8	23.0	27.2	31.9	36.1	39.4	43.3	47.2
% Difference	0.0	0.0	0.0	0.0	4.7	25.5	99.4	146.6	174.1	195.2	226.1	265.2	309.0	348.9	405.6	477.0	556.9	630.7	687.4	750.9	815.7
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
TC01	10.20	11.11	11.47	11.76	12.58	15.26	19.92	24.03	27.14	30.04	32.60	35.31	38.48	40.80	44.08	48.38	53.27	57.57	60.88	64.84	68.82
Difference	0.0	0.0	0.0	0.0	-0.1	1.8	5.9	9.2	11.6	13.8	15.9	18.2	20.9	23.2	26.4	30.6	35.3	39.5	42.8	46.6	50.5
% Difference	0.0	0.0	0.0	0.0	-1.0	13.0	42.2	61.9	74.6	85.4	95.2	106.0	118.8	131.2	148.9	171.5	196.1	218.8	236.0	255.9	276.1

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table TC- 2. Case 3 Generation from Renewable Technologies and AEO2001

Appendix 2TC. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 3 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
TC01	13.39	13.56	13.59	13.60	13.56	21.34	28.02	37.37	44.32	50.56	52.90	52.90	52.91	52.91	52.93	52.93	52.94	52.94	52.95	52.96	52.96
Difference	0.0	0.0	0.0	0.0	0.0	5.5	10.7	16.5	21.4	26.4	27.6	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1
% Difference	0.0	0.0	0.0	0.0	0.0	34.6	61.4	78.9	93.4	109.2	109.3	105.3	105.2	105.2	105.2	105.1	105.1	105.1	105.1	105.1	105.0
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
TC01	18.36	19.03	19.44	19.64	22.76	26.80	27.08	27.47	27.99	28.65	29.46	30.42	31.54	32.05	32.20	32.35	32.72	32.97	33.12	33.26	33.42
Difference	0.0	0.0	0.0	0.0	-2.6	-0.6	-0.6	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.6	-0.5
% Difference	0.0	0.0	0.0	0.0	-10.3	-2.0	-2.0	-1.9	-1.9	-1.8	-1.8	-1.7	-1.7	-1.7	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
TC01	10.57	12.54	14.15	14.25	17.76	19.90	20.58	22.09	20.61	22.07	22.73	23.36	23.21	23.49	23.14	23.12	22.71	24.40	22.61	22.46	21.80
Difference	-0.2	-1.1	-2.9	0.0	2.7	2.6	1.2	2.3	0.1	1.5	1.1	1.7	1.5	1.0	0.5	-0.1	-0.5	1.3	0.0	0.0	-0.3
% Difference	-1.9	-7.9	-17.1	-0.1	17.9	15.2	6.0	11.7	0.5	7.3	5.3	7.8	6.9	4.3	2.2	-0.4	-2.3	5.6	-0.1	0.0	-1.6
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
TC01	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
TC01	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
TC01	5.18	6.62	7.73	8.33	9.53	12.99	26.30	36.49	43.91	50.90	58.49	67.16	77.57	86.24	97.59	112.70	129.80	144.90	157.30	172.20	186.70
Difference	0.0	0.0	0.0	0.0	0.6	3.6	16.3	25.9	32.7	39.0	46.2	54.6	64.9	73.5	84.8	99.9	116.9	132.0	144.4	159.2	173.6
% Difference	0.0	0.0	0.0	0.0	7.3	37.9	163.0	243.6	290.0	326.3	374.4	436.4	510.3	574.8	663.6	777.7	905.4	1020.6	1115.6	1222.6	1325
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
TC01	48.43	52.69	55.88	56.84	64.70	82.19	103.22	124.74	138.25	153.70	165.20	175.6	187.0	196.6	207.9	223.3	240.4	257.6	268.5	283.5	297.6
Difference	-0.2	-1.1	-2.9	0.0	0.7	11.1	27.6	44.1	53.6	66.3	74.4	82.9	93.0	101.0	111.9	126.4	142.9	159.9	170.9	185.8	199.8
% Difference	-0.4	-2.0	-4.9	0.0	1.2	15.7	36.5	54.7	63.3	75.9	81.9	89.5	98.8	105.7	116.5	130.4	146.6	163.6	175.2	190.1	204.4

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table TC- 3. Case 3 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3TC. Total Carbon Emissions (Mt/a): Case 3 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
TC01	631.2	648.0	661.7	672.4	682.9	695.5	707.6	719.2	730.1	740.4	750.4	760.1	769.1	780.5	791.8	803.2	814.7	824.0	833.6	844.8	855.3
Difference	0.0	0.0	0.0	0.0	-0.6	0.0	0.0	-0.3	-0.2	-0.1	-0.2	-0.2	-0.4	-0.3	-0.6	-0.5	-0.3	-1.4	-1.8	-0.7	-0.8
% Difference	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.2	-0.2	-0.1	-0.1
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
TC01	265.4	272.1	279.4	285.3	289.8	291.9	296.1	299.7	303.2	306.2	310.1	313.1	317.0	320.2	323.9	327.6	331.0	335.1	338.6	340.5	344.0
Difference	0.0	0.0	0.0	0.0	0.6	0.0	-0.1	0.0	0.1	0.1	0.3	0.2	0.4	0.3	0.5	0.1	0.0	1.0	1.4	0.5	0.7
% Difference	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.0	0.0	0.3	0.4	0.1	0.2
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
TC01	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.4	69.4	69.5	69.4	69.4	69.5
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.1
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TC01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
TC01	569.8	587.5	602.3	615.6	624.9	631.0	634.9	645.6	653.7	658.2	665.2	672.5	678.9	688.4	697.4	707.9	714.8	723.2	730.2	736.4	744.1
Difference	0.0	0.1	0.7	0.0	-0.5	-2.1	-4.7	-7.6	-7.9	-9.6	-13.9	-14.6	-16.8	-17.9	-18.1	-19.6	-20.3	-23.3	-23.5	-25.1	-27.4
% Difference	0.0	0.0	0.1	0.0	-0.1	-0.3	-0.7	-1.2	-1.2	-1.4	-2.0	-2.1	-2.4	-2.5	-2.5	-2.7	-2.8	-3.1	-3.1	-3.3	-3.6
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
TC01	1535	1577	1612	1643	1667	1688	1708	1734	1757	1774	1795	1815	1835	1859	1883	1908	1930	1952	1972	1991	2013
Difference	0.0	0.0	1.0	0.0	-1.0	-2.0	-5.0	-8.0	-8.0	-10.0	-14.0	-15.0	-16.0	-18.0	-18.0	-20.0	-21.0	-24.0	-24.0	-26.0	-28.0
% Difference	0.0	0.0	0.1	0.0	-0.1	-0.1	-0.3	-0.5	-0.5	-0.6	-0.8	-0.8	-0.9	-1.0	-0.9	-1.0	-1.1	-1.2	-1.2	-1.3	-1.4

[1]From AEO2001 Table A19

Table HP- 1. Case 4 Capacity from Renewable Technologies and AEO2001

Appendix 1HP. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 4 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
HP01	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.19	4.34	4.39	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
HP01	2.64	2.76	2.78	2.81	3.47	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
Difference	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
HP01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
HP01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
HP01	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
HP01	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
HP01	10.20	11.11	11.47	11.76	12.64	13.50	14.01	14.84	15.54	16.18	16.70	17.12	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
Difference	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table HP- 2. Case 4 Generation from Renewable Technologies and AEO2001

Appendix 2HP. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 4 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
HP01	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.90	22.93	24.09	25.22	25.68	25.82	25.83	25.84	25.85	25.85	25.86	25.86	25.87	25.87
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
HP01	18.36	19.03	19.44	19.64	24.80	27.35	27.63	28.01	28.53	29.19	29.99	30.95	32.07	32.59	32.74	32.88	33.25	33.51	33.65	33.81	33.95
Difference	0.0	0.0	0.0	0.0	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
HP01	10.35	13.01	17.17	14.20	15.11	17.10	19.19	21.08	20.47	21.34	22.07	21.78	22.17	22.82	22.66	22.58	22.64	24.33	24.05	22.55	22.11
Difference	-0.4	-0.6	0.1	-0.1	0.0	-0.2	-0.2	1.3	0.0	0.8	0.5	0.1	0.5	0.3	0.0	-0.6	-0.6	1.2	1.4	0.1	0.0
% Difference	-4	-4	1	0	0	-1	-1	7	0	4	2	1	2	1	0	-3	-3	5	6	0	0
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
HP01	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
HP01	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
HP01	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.93	13.02	13.10
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
HP01	48.21	53.16	58.90	56.79	63.44	70.89	75.42	81.93	84.61	88.08	91.23	92.7	94.6	95.9	96.1	96.3	96.9	99.0	99.0	97.9	97.8
Difference	-0.4	-0.6	0.1	-0.1	-0.5	-0.2	-0.2	1.3	0.0	0.7	0.4	0.0	0.5	0.4	0.0	-0.6	-0.6	1.3	1.4	0.1	0.0
% Difference	-1	-1	0	0	-1	0	0	2	0	1	0	0	1	0	0	-1	-1	1	1	0	0

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table HP- 3. Case 4 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3HP. Total Carbon Emissions (Mt/a): Case 4 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
HP01	631.2	648.0	661.7	672.5	683.6	695.6	707.8	719.5	730.5	740.8	750.9	760.6	769.6	780.9	792.5	804.0	815.3	825.7	835.7	845.8	856.5
Difference	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.0	0.2	0.3	0.3	0.3	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3	0.4
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
HP01	265.4	272.1	279.4	285.5	289.5	292.4	297.0	300.8	304.5	307.7	311.7	314.8	318.8	322.1	325.6	329.6	333.1	336.4	339.6	342.6	345.9
Difference	0.0	0.0	0.0	0.2	0.3	0.5	0.8	1.1	1.4	1.6	1.9	1.9	2.2	2.2	2.2	2.1	2.1	2.3	2.4	2.6	2.6
% Difference	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
HP01	68.9	69.0	68.7	69.5	69.6	69.9	69.9	70.0	70.0	70.0	70.2	70.1	70.2	70.2	70.2	70.2	70.2	70.2	70.2	70.2	70.3
Difference	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7
% Difference	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HP01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
HP01	569.9	587.5	601.5	614.8	624.5	631.1	635.5	648.3	656.2	662.2	671.5	679.5	687.6	697.7	709.1	721.5	729.8	740.1	747.8	754.8	764.1
Difference	0.1	0.1	-0.1	-0.8	-0.9	-2.0	-4.1	-4.9	-5.4	-5.6	-7.6	-7.6	-8.1	-8.6	-6.4	-6.0	-5.3	-6.4	-5.9	-6.7	-7.4
% Difference	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
HP01	1536	1577	1611	1642	1667	1689	1710	1739	1761	1781	1804	1825	1846	1871	1898	1925	1948	1972	1993	2014	2037
Difference	1.0	0.0	0.0	-1.0	-1.0	-1.0	-3.0	-3.0	-4.0	-3.0	-5.0	-5.0	-5.0	-6.0	-3.0	-3.0	-3.0	-4.0	-3.0	-3.0	-4.0
% Difference	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1	-0.2

[1]From AEO2001 Table A19

Table HP- 4. Case 4 Fuel Consumption by Sector and Fuel Type and AEO2001

Appendix 4HP. Fuel Consumption by Sector and Fuel Type[1](Quads): Case 4 and AEO2001

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential Petroleum																					
AEO2001	1.44	1.50	1.49	1.48	1.45	1.42	1.40	1.37	1.35	1.32	1.29	1.28	1.27	1.26	1.26	1.24	1.24	1.22	1.22	1.21	1.21
HP01	1.44	1.50	1.49	1.48	1.45	1.42	1.40	1.37	1.35	1.32	1.29	1.28	1.27	1.26	1.26	1.24	1.23	1.22	1.22	1.21	1.21
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
Residential Natural Gas																					
AEO2001	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.55	5.61	5.65	5.69	5.75	5.82	5.87	5.93	5.99	6.06	6.11	6.17	6.23	6.30
HP01	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.56	5.62	5.65	5.70	5.76	5.83	5.88	5.94	5.99	6.07	6.11	6.17	6.23	6.31
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential Coal																					
AEO2001	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
HP01	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential Electricity[2]																					
AEO2001	3.96	4.06	4.17	4.27	4.39	4.50	4.58	4.67	4.78	4.86	4.96	5.04	5.14	5.21	5.28	5.37	5.46	5.53	5.61	5.70	5.80
HP01	3.96	4.05	4.17	4.28	4.40	4.50	4.57	4.67	4.78	4.86	4.96	5.04	5.14	5.20	5.28	5.37	5.47	5.54	5.62	5.71	5.81
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial Petroleum																					
AEO2001	0.59	0.63	0.64	0.65	0.65	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66
HP01	0.59	0.63	0.64	0.65	0.65	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
Commercial Natural Gas																					
AEO2001	3.27	3.39	3.52	3.62	3.68	3.71	3.75	3.79	3.82	3.85	3.88	3.92	3.96	3.99	4.02	4.05	4.07	4.09	4.11	4.12	4.13
HP01	3.27	3.39	3.52	3.62	3.68	3.72	3.75	3.79	3.83	3.86	3.89	3.93	3.97	4.00	4.03	4.06	4.09	4.11	4.13	4.15	4.16
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Commercial Coal																					
AEO2001	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
HP01	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial Electricity[2]																					
AEO2001	3.78	3.90	4.03	4.13	4.23	4.35	4.45	4.57	4.68	4.78	4.89	4.98	5.08	5.17	5.25	5.32	5.39	5.45	5.51	5.56	5.61
HP01	3.78	3.90	4.03	4.13	4.24	4.35	4.46	4.57	4.68	4.79	4.89	4.99	5.08	5.17	5.25	5.32	5.39	5.45	5.50	5.56	5.61
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table HP-4 Cont'd. Case 4 Fuel Consumption by Sector and Fuel Type and AEO2001

Appendix 4HP cont'd. Fuel Consumption by Sector and Fuel Type[1] (Quads): Case 4 and AEO2001

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Industrial Petroleum																					
AEO2001	9.31	9.44	9.55	9.67	9.82	9.95	10.07	10.23	10.34	10.44	10.55	10.63	10.69	10.85	11.00	11.14	11.28	11.39	11.51	11.64	11.77
HP01	9.31	9.44	9.55	9.67	9.82	9.96	10.04	10.23	10.35	10.46	10.56	10.64	10.71	10.86	11.01	11.16	11.29	11.41	11.52	11.66	11.79
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial Natural Gas																					
AEO2001	9.66	9.84	10.04	10.26	10.33	10.43	10.61	10.76	10.87	10.98	11.11	11.21	11.35	11.47	11.59	11.76	11.88	12.00	12.11	12.22	12.34
HP01	9.66	9.83	10.04	10.27	10.35	10.46	10.70	10.82	10.96	11.07	11.23	11.33	11.47	11.60	11.72	11.89	12.01	12.15	12.27	12.37	12.50
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2
% Difference	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Industrial Coal																					
AEO2001	2.61	2.61	2.59	2.62	2.62	2.62	2.62	2.62	2.62	2.61	2.62	2.61	2.61	2.61	2.62	2.61	2.61	2.61	2.61	2.61	2.62
HP01	2.61	2.61	2.59	2.62	2.63	2.64	2.63	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.65
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Industrial Electricity[2]																					
AEO2001	3.68	3.72	3.78	3.83	3.85	3.90	3.97	4.03	4.08	4.13	4.18	4.23	4.27	4.33	4.40	4.47	4.53	4.60	4.66	4.74	4.81
HP01	3.68	3.72	3.78	3.81	3.82	3.86	3.91	3.95	3.99	4.02	4.06	4.10	4.15	4.20	4.26	4.33	4.39	4.45	4.51	4.58	4.66
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1
% Difference	0	0	0	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Total[3]																					
AEO2001	43.37	44.35	45.19	46.00	46.57	47.12	47.74	48.37	48.94	49.41	49.96	50.44	50.98	51.55	52.14	52.74	53.31	53.79	54.30	54.82	55.38
HP01	43.37	44.33	45.19	46.00	46.59	47.15	47.75	48.38	48.99	49.46	50.01	50.50	51.05	51.60	52.18	52.79	53.36	53.87	54.37	54.90	55.49
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] From AEO2001 Table A2
[2] Excludes losses
[3] As expected, overall consumption decreases when electricity losses are included

Table NG- 1. Case 5 Capacity from Renewable Technologies and AEO2001

Appendix 1NG. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 5 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
NG01	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.53	4.78	4.92	4.92	4.93	4.93	4.93	4.93	4.93	4.93
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	8.4	11.6	11.6	11.8	11.8	11.8	11.8	11.8	11.8
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
NG01	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.47	4.70	4.87	4.90	4.93	4.95	5.02	5.04	5.06	5.08	5.10
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	8.3	8.0	8.2	8.4	8.3	8.2	8.2	8.1	8.1	8.1
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
NG01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.36	2.45	2.52	2.79	3.04	3.11	3.11	3.11
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.7	0.7	0.7	0.7
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	5.6	8.2	17.7	28.3	31.2	31.2	31.2
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
NG01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
NG01	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
NG01	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.72	5.78	5.83	5.83	5.83	5.83	5.83
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4	1.7	1.7	1.7	1.2	0.9
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
NG01	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.97	17.62	18.32	18.57	18.78	18.99	19.41	19.73	19.86	19.93	19.99
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7	0.9	1.1	1.2	1.4	1.7	1.7	1.7	1.7
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.8	4.2	5.2	6.0	6.6	7.9	9.2	9.6	9.4	9.2

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table NG- 2. Case 5 Generation from Renewable Technologies and AEO2001

Appendix 2NG. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 5 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
NG01	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	26.71	28.74	29.79	29.80	29.95	29.95	29.96	29.96	29.97	29.97
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	3.0	4.0	4.0	4.1	4.1	4.2	4.1	4.2	4.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	11.5	15.6	15.5	16.0	16.0	16.1	16.0	16.1	16.0
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
NG01	18.36	19.03	19.44	19.64	25.36	27.35	27.62	28.01	28.53	29.19	32.15	33.78	34.96	35.48	35.70	35.91	36.29	36.54	36.69	36.83	36.97
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.8	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	9.1	9.0	8.9	9.0	9.2	9.1	9.0	9.0	8.9	8.9
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
NG01	10.77	13.62	17.06	14.27	15.07	17.27	19.35	21.51	23.98	26.29	24.19	29.01	23.45	21.41	19.00	18.65	19.03	19.88	19.92	19.76	19.32
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	1.7	3.5	5.7	2.6	7.4	1.7	-1.1	-3.7	-4.6	-4.2	-3.2	-2.7	-2.7	-2.8
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	8.8	16.9	27.8	12.0	33.9	8.0	-4.9	-16.1	-19.6	-18.2	-13.9	-12.0	-12.1	-12.8
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
NG01	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
NG01	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
NG01	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.93	13.08	13.22	13.24	13.24	13.24	13.24
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.3	0.3	0.2	0.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.9	2.4	2.4	2.3	1.7	1
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
NG01	48.63	53.77	58.79	56.86	63.96	71.06	75.57	82.35	88.11	93.11	95.56	103.7	101.7	101.4	99.5	99.8	100.8	102.0	102.3	102.4	102.2
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	1.7	3.5	5.7	4.8	11.1	7.6	5.8	3.5	2.8	3.3	4.3	4.8	4.7	4.5
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	2.2	4.1	6.5	5.2	12.0	8.1	6.1	3.6	2.9	3.3	4.4	4.9	4.8	4.6

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table NG- 3. Case 5 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3NG. Total Carbon Emissions (Mt/a): Case 5 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
NG01	631.2	648.0	661.7	672.4	683.5	695.5	707.9	720.0	731.2	742.1	752.6	763.3	773.0	784.8	796.1	805.8	813.5	824.2	834.2	843.7	855.2
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.9	1.6	2.0	3.0	3.5	4.0	3.7	2.1	-1.5	-1.2	-1.2	-1.8	-0.9
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.5	0.5	0.3	-0.2	-0.1	-0.1	-0.2	-0.1
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
NG01	265.4	272.1	279.4	285.3	289.2	291.9	293.1	293.7	294.1	293.8	294.2	292.9	293.0	292.3	293.1	295.0	298.7	297.7	297.9	298.3	297.8
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-3.1	-6.0	-9.0	-12.3	-15.6	-20.0	-23.6	-27.6	-30.3	-32.5	-32.3	-36.4	-39.3	-41.7	-45.5
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-2.0	-3.0	-4.0	-5.0	-6.4	-7.5	-8.6	-9.4	-9.9	-9.8	-10.9	-11.7	-12.3	-13.3
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
NG01	68.9	69.0	68.7	69.4	69.4	69.6	69.6	69.7	69.8	69.8	70.0	70.0	70.1	70.2	70.3	70.3	70.3	70.4	70.5	70.5	70.7
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9	0.8	0.9	1.0	1.0	1.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.6	0.7	0.9	0.9	1.0	1.2	1.3	1.2	1.3	1.4	1.4	1.6
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NG01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
NG01	569.8	587.4	601.6	615.6	625.4	633.1	633.6	646.2	654.3	660.7	675.9	692.6	708.4	726.7	741.6	758.4	769.8	779.7	785.8	797.5	808.6
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-6.0	-7.0	-7.3	-7.1	-3.2	5.5	12.7	20.4	26.1	30.9	34.7	33.2	32.1	36.0	37.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	-1.1	-1.1	-1.1	-0.5	0.8	1.8	2.9	3.6	4.2	4.7	4.4	4.3	4.7	4.8
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
NG01	1535	1577	1611	1643	1668	1690	1704	1730	1750	1766	1793	1819	1845	1874	1901	1930	1952	1972	1988	2010	2032
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-9.0	-12.0	-15.0	-18.0	-16.0	-11.0	-6.0	-3.0	0.0	2.0	1.0	-4.0	-8.0	-7.0	-9.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-0.7	-0.8	-1.0	-0.9	-0.6	-0.3	-0.2	0.0	0.1	0.1	-0.2	-0.4	-0.3	-0.4

[1]From AEO2001 Table A19

Table WN- 1. Case 6 Capacity from Renewable Technologies and AEO2001

Appendix 1WN. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 6 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
WN01	2.93	2.93	2.93	2.93	2.88	3.78	4.51	5.67	6.54	7.14	7.40	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42
Difference	0.0	0.0	0.0	0.0	0.0	0.6	1.2	1.9	2.5	2.9	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
% Difference	0.0	0.0	0.0	0.0	0.0	20.0	35.0	49.6	61.5	69.6	70.5	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
WN01	2.64	2.76	2.78	2.81	3.26	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
Difference	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	-7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
WN01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
WN01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
WN01	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
WN01	2.76	3.53	3.80	4.01	4.49	5.48	9.61	12.34	15.03	18.25	21.15	24.47	28.33	32.92	36.74	41.22	45.26	50.28	53.89	60.92	65.71
Difference	0.0	0.0	0.0	0.0	0.3	1.1	5.0	7.5	9.9	12.8	15.6	18.9	22.7	27.3	31.1	35.5	39.5	44.6	48.2	55.2	59.9
% Difference	0.0	0.0	0.0	0.0	6.4	23.7	106.7	152.4	192.4	237.3	283.8	338.5	399.6	480.6	548.0	623.2	689.9	777.5	840.5	957.6	1036.9
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
WN01	10.20	11.11	11.47	11.76	12.70	15.18	20.14	24.17	27.92	31.97	35.40	39.04	43.26	47.91	51.79	56.35	60.53	65.62	69.29	76.39	81.24
Difference	0.0	0.0	0.0	0.0	0.0	1.7	6.1	9.3	12.4	15.8	18.7	21.9	25.7	30.3	34.1	38.5	42.5	47.6	51.2	58.2	62.9
% Difference	0.0	0.0	0.0	0.0	-0.1	12.4	43.8	62.9	79.7	97.3	112.0	127.8	145.9	171.4	192.4	216.2	236.5	263.3	282.4	319.3	343.9

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table WN- 2. Case 6 Generation from Renewable Technologies and AEO2001

Appendix 2WN. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 6 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
WN01	13.39	13.56	13.59	13.60	13.56	20.82	26.54	35.68	42.52	47.30	49.35	49.53	49.53	49.54	49.55	49.56	49.57	49.57	49.58	49.58	49.59
Difference	0.0	0.0	0.0	0.0	0.0	5.0	9.2	14.8	19.6	23.1	24.1	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
% Difference	0.0	0.0	0.0	0.0	0.0	31.3	52.9	70.8	85.5	95.7	95.3	92.2	92.1	92.2	92.1	92.0	92.1	92.1	92.0	92.0	92.0
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
WN01	18.36	19.03	19.44	19.64	23.10	27.35	27.63	28.01	28.53	29.19	30.00	30.95	32.10	32.59	32.74	32.88	33.26	33.51	33.65	33.80	33.94
Difference	0.0	0.0	0.0	0.0	-2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	-8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
WN01	10.57	13.39	16.97	14.20	15.02	18.35	19.24	19.72	20.60	20.55	22.01	22.39	22.76	22.92	22.82	22.67	22.20	24.75	24.79	23.93	22.22
Difference	-0.2	-0.2	-0.1	-0.1	-0.1	1.1	-0.2	-0.1	0.1	0.0	0.4	0.7	1.1	0.4	0.2	-0.5	-1.1	1.7	2.2	1.5	0.1
% Difference	-1.9	-1.7	-0.5	-0.5	-0.3	6.3	-0.9	-0.3	0.4	-0.1	1.9	3.4	4.8	1.8	0.8	-2.3	-4.5	7.1	9.5	6.5	0.3
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
WN01	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
WN01	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
WN01	5.18	6.62	7.73	8.33	9.77	12.61	27.14	36.85	46.63	58.29	69.18	81.95	96.81	114.90	130.60	148.90	165.60	186.20	201.00	230.90	251.20
Difference	0.0	0.0	0.0	0.0	0.9	3.2	17.1	26.2	35.4	46.4	56.9	69.4	84.1	102.1	117.8	136.1	152.7	173.3	188.1	217.9	238.1
% Difference	0.0	0.0	0.0	0.0	10.0	33.9	171.4	247.0	314.1	388.2	461.1	554.6	661.7	799.1	921.9	1059.7	1182.7	1340.1	1453.3	1673.4	1818
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
WN01	48.43	53.54	58.70	56.79	62.54	80.29	101.79	121.58	139.70	156.85	172.16	186.5	203.0	221.9	237.8	256.2	272.9	296.4	311.5	340.8	359.7
Difference	-0.2	-0.2	-0.1	-0.1	-1.4	9.2	26.2	41.0	55.1	69.5	81.4	93.9	108.9	126.3	141.7	159.3	175.4	198.7	214.0	243.1	261.9
% Difference	-0.4	-0.4	-0.2	-0.1	-2.2	13.0	34.6	50.8	65.1	79.5	89.6	101.4	115.8	132.1	147.6	164.4	179.9	203.3	219.4	248.7	267.9

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table WN- 3. Case 6 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3WN. Total Carbon Emissions (Mt/a): Case 6 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
WN01	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.4	730.2	740.4	750.4	760.1	769.2	780.4	791.7	803.0	814.6	824.5	834.5	842.2	855.2
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	-0.4	-0.7	-0.7	-0.4	-0.9	-0.9	-3.3	-0.9
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.4	-0.1
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
WN01	265.4	272.1	279.4	285.3	289.3	291.9	296.1	299.7	303.2	306.1	309.9	313.0	317.0	320.2	323.8	327.7	331.0	334.7	337.8	342.8	343.9
Difference	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.1	0.0	0.1	0.1	0.4	0.3	0.4	0.2	0.0	0.6	0.6	2.8	0.6
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.8	0.2
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
WN01	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.4	69.4	69.4	69.4	69.4	69.5
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WN01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
WN01	569.8	587.5	601.6	615.6	625.5	631.4	635.1	645.8	652.5	658.3	667.6	673.8	679.7	687.8	697.0	706.9	713.6	721.3	727.2	732.2	739.6
Difference	0.0	0.1	0.0	0.0	0.1	-1.7	-4.5	-7.4	-9.1	-9.5	-11.5	-13.3	-16.0	-18.5	-18.5	-20.6	-21.5	-25.2	-26.5	-29.3	-31.9
% Difference	0.0	0.0	0.0	0.0	0.0	-0.3	-0.7	-1.1	-1.4	-1.4	-1.7	-1.9	-2.3	-2.6	-2.6	-2.8	-2.9	-3.4	-3.5	-3.8	-4.1
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
WN01	1535	1577	1611	1643	1668	1688	1708	1735	1755	1774	1797	1816	1835	1858	1882	1907	1929	1950	1969	1987	2008
Difference	0.0	0.0	0.0	0.0	0.0	-2.0	-5.0	-7.0	-10.0	-10.0	-12.0	-14.0	-16.0	-19.0	-19.0	-21.0	-22.0	-26.0	-27.0	-30.0	-33.0
% Difference	0.0	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.4	-0.6	-0.6	-0.7	-0.8	-0.9	-1.0	-1.0	-1.1	-1.1	-1.3	-1.4	-1.5	-1.6

[1]From AEO2001 Table A19

Table AL- 1. Case 7 Capacity from Renewable Technologies and AEO2001

Appendix 1AL. Electric Generators' Capacity of Renewable Technologies[1] (GW): Case 7 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
AL01	2.93	2.93	2.93	2.96	2.92	3.79	4.54	5.72	6.65	7.34	7.72	8.65	8.79	8.90	8.96	9.01	9.04	9.08	9.11	9.15	9.19
Difference	0.0	0.0	0.0	0.0	0.0	0.6	1.2	1.9	2.6	3.1	3.4	4.2	4.4	4.5	4.6	4.6	4.6	4.7	4.7	4.7	4.8
% Difference	0.0	0.0	0.0	1.0	1.4	20.3	35.9	50.9	64.2	74.3	77.9	96.1	99.3	101.8	103.2	104.3	105.0	105.9	106.6	107.5	108.4
Municipal Solid Waste[3]																					
AEO2001	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
AL01	2.64	2.76	2.78	2.83	3.24	3.84	3.89	3.97	4.07	4.19	4.57	4.80	4.99	5.03	5.07	5.11	5.19	5.22	5.26	5.29	5.32
Difference	0.0	0.0	0.0	0.0	-0.3	0.0	0.1	0.1	0.1	0.1	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6
% Difference	0.0	0.0	0.0	0.7	-8.5	1.1	1.3	1.8	2.3	2.7	8.8	10.6	10.6	11.0	11.4	11.8	11.9	12.0	12.4	12.6	12.7
Biomass																					
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
AL01	1.53	1.54	1.60	1.65	1.71	1.75	1.81	1.89	2.00	2.14	2.29	2.46	2.64	2.68	2.72	2.77	2.84	2.86	2.88	2.90	2.92
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6
% Difference	0.0	0.0	0.0	1.9	3.0	4.2	5.8	7.4	8.7	10.9	12.3	13.4	13.8	15.5	17.2	18.9	19.8	20.7	21.5	22.4	23.2
Solar Thermal																					
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
AL01	0.33	0.33	0.33	0.34	0.36	0.37	0.38	0.40	0.46	0.52	0.58	0.63	0.69	0.74	0.80	0.86	0.89	0.92	0.96	0.99	1.03
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6
% Difference	0.0	0.0	0.0	0.0	2.9	5.7	5.6	8.1	21.1	33.3	45.0	57.5	68.3	76.2	86.0	95.5	102.3	104.4	108.7	110.6	114.6
Solar Photovoltaic																					
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
AL01	0.01	0.02	0.03	0.05	0.07	0.09	0.12	0.14	0.21	0.28	0.35	0.44	0.52	0.61	0.70	0.79	0.87	0.96	1.04	1.12	1.20
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7
% Difference	0.0	0.0	0.0	0.0	16.7	0.0	9.1	7.7	40.0	55.6	66.7	83.3	92.6	103.3	112.1	113.5	117.5	118.2	121.3	119.6	122.2
Wind																					
AEO2001	2.76	3.53	3.80	4.01	4.22	4.43	4.65	4.89	5.14	5.41	5.51	5.58	5.67	5.67	5.67	5.70	5.73	5.73	5.73	5.76	5.78
AL01	2.76	3.53	3.80	4.28	5.02	6.29	10.69	13.93	17.50	20.98	25.71	32.35	38.75	42.81	47.80	51.95	58.47	64.63	66.79	69.79	74.80
Difference	0.0	0.0	0.0	0.3	0.8	1.9	6.0	9.0	12.4	15.6	20.2	26.8	33.1	37.1	42.1	46.3	52.7	58.9	61.1	64.0	69.0
% Difference	0.0	0.0	0.0	6.7	19.0	42.0	129.9	184.9	240.5	287.8	366.6	479.7	583.4	655.0	743.0	811.4	920.4	1027.9	1065.6	1111.6	1194.1
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
AL01	10.20	11.11	11.47	12.11	13.32	16.13	21.43	26.05	30.89	35.45	41.22	49.33	56.38	60.77	66.05	70.49	77.30	83.67	86.04	89.24	94.46
Difference	0.0	0.0	0.0	0.4	0.6	2.6	7.4	11.2	15.4	19.3	24.5	32.2	38.8	43.1	48.3	52.7	59.3	65.6	67.9	71.0	76.2
% Difference	0.0	0.0	0.0	3.0	4.8	19.5	53.0	75.5	98.8	118.8	146.8	187.8	220.5	244.3	273.0	295.6	329.7	363.3	374.8	389.8	416.2

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table AL- 2. Case 7 Generation from Renewable Technologies and AEO2001

Appendix 2AL. Electric Generators' Generation from Renewable Technologies[1] (TWh): Case 7 and AEO2001[2]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal																					
AEO2001	13.39	13.56	13.59	13.60	13.56	15.86	17.36	20.89	22.92	24.17	25.27	25.77	25.78	25.78	25.80	25.81	25.81	25.81	25.82	25.82	25.83
AL01	13.39	13.56	13.59	13.79	13.94	20.87	26.78	36.09	43.49	48.91	51.95	59.26	60.41	61.30	61.73	62.16	62.46	62.75	63.05	63.35	63.65
Difference	0.0	0.0	0.0	0.2	0.4	5.0	9.4	15.2	20.6	24.7	26.7	33.5	34.6	35.5	35.9	36.4	36.7	36.9	37.2	37.5	37.8
% Difference	0.0	0.0	0.0	1.4	2.8	31.6	54.3	72.8	89.7	102.4	105.6	130.0	134.3	137.8	139.3	140.8	142.0	143.1	144.2	145.4	146.4
Municipal Solid Waste[3]																					
AEO2001	18.36	19.03	19.44	19.64	25.36	27.35	27.63	28.01	28.53	29.19	30.00	30.96	32.08	32.59	32.74	32.88	33.26	33.51	33.65	33.81	33.96
AL01	18.36	19.03	19.44	19.74	22.95	27.64	28.01	28.49	29.16	29.98	32.77	34.44	35.77	36.40	36.68	36.96	37.43	37.77	38.01	38.24	38.47
Difference	0.0	0.0	0.0	0.1	-2.4	0.3	0.4	0.5	0.6	0.8	2.8	3.5	3.7	3.8	3.9	4.1	4.2	4.3	4.4	4.4	4.5
% Difference	0.0	0.0	0.0	0.5	-9.5	1.1	1.4	1.7	2.2	2.7	9.2	11.2	11.5	11.7	12.0	12.4	12.5	12.7	13.0	13.1	13.3
Biomass																					
AEO2001	10.77	13.62	17.06	14.27	15.07	17.27	19.41	19.77	20.51	20.57	21.59	21.66	21.71	22.52	22.65	23.21	23.25	23.10	22.64	22.47	22.15
AL01	10.45	14.40	15.56	14.34	15.16	18.28	19.22	20.59	21.70	25.56	27.97	28.35	26.03	23.19	21.99	21.45	21.92	19.53	19.51	19.59	19.31
Difference	-0.3	0.8	-1.5	0.1	0.1	1.0	-0.2	0.8	1.2	5.0	6.4	6.7	4.3	0.7	-0.7	-1.8	-1.3	-3.6	-3.1	-2.9	-2.8
% Difference	-3.0	5.7	-8.8	0.5	0.6	5.8	-1.0	4.1	5.8	24.3	29.6	30.9	19.9	3.0	-2.9	-7.6	-5.7	-15.5	-13.8	-12.8	-12.8
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
AL01	0.89	0.89	0.90	0.93	0.99	1.04	1.08	1.14	1.40	1.66	1.91	2.13	2.36	2.60	2.84	3.08	3.21	3.35	3.49	3.63	3.77
Difference	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.1	2.2	2.3	2.4
% Difference	0.0	0.0	0.0	2.2	5.3	8.3	10.2	12.9	33.3	53.7	72.1	88.5	105.2	122.2	134.7	148.4	154.8	159.7	166.4	170.9	175.2
Solar Photovoltaic																					
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	0.66	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
AL01	0.04	0.05	0.07	0.12	0.16	0.22	0.28	0.34	0.47	0.63	0.78	0.97	1.15	1.33	1.53	1.73	1.91	2.08	2.26	2.44	2.62
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
% Difference	0.0	0.0	0.0	9.1	6.7	10.0	7.7	9.7	27.0	43.2	52.9	64.4	74.2	79.7	84.3	88.0	89.1	89.1	91.5	92.1	92.6
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33	12.52	12.71	12.78	12.78	12.84	12.91	12.93	12.94	13.02	13.10
AL01	5.18	6.62	7.73	9.08	11.28	14.91	30.21	41.61	54.39	66.61	83.76	108.40	132.10	147.60	167.60	184.20	210.50	236.20	245.10	257.40	279.00
Difference	0.0	0.0	0.0	0.8	2.4	5.5	20.2	31.0	43.1	54.7	71.4	95.9	119.4	134.8	154.8	171.4	197.6	223.3	232.2	244.4	265.9
% Difference	0.0	0.0	0.0	9.0	27.0	58.3	202.1	291.8	383.0	457.9	579.3	765.8	939.3	1054.9	1211.4	1334.6	1530.5	1726.8	1794.1	1877.0	2030
TOTALS																					
AEO2001	48.63	53.77	58.79	56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
AL01	48.31	54.55	57.29	58.00	64.48	82.96	105.58	128.26	150.61	173.35	199.14	233.6	257.8	272.4	292.4	309.6	337.4	361.7	371.4	384.7	406.8
Difference	-0.3	0.8	-1.5	1.1	0.5	11.9	29.9	47.7	66.0	86.0	108.3	140.9	163.7	176.8	196.4	212.7	239.9	263.9	273.9	286.9	309.1
% Difference	-0.7	1.5	-2.6	2.0	0.8	16.7	39.6	59.1	77.9	98.4	119.3	152.1	174.0	185.0	204.5	219.5	246.1	270.0	280.8	293.6	316.1

[1]Excludes cogeneration
[2]From AEO2001 Table A17
[3]Includes landfill gas

Table AL- 3. Case 7 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3AL. Total Carbon Emissions (Mt/a): Case 7 and AEO2001[1]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
AL01	631.2	648.0	661.7	672.4	683.6	695.5	707.8	720.1	731.3	742.2	752.7	762.8	772.4	783.8	795.7	802.2	813.2	822.7	833.8	843.2	854.3
Difference	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.6	1.0	1.7	2.1	2.5	2.9	3.0	3.3	-1.5	-1.8	-2.7	-1.6	-2.3	-1.8
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	-0.2	-0.2	-0.3	-0.2	-0.3	-0.2
Natural Gas																					
AEO2001	265.4	272.1	279.4	285.3	289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4	327.5	331.0	334.1	337.2	340.0	343.3
AL01	265.4	272.1	279.4	285.4	289.5	292.5	294.0	294.8	295.4	295.1	295.6	294.7	295.2	295.1	295.0	299.9	300.1	300.7	299.2	299.7	299.5
Difference	0.0	0.0	0.0	0.1	0.3	0.6	-2.2	-4.9	-7.7	-11.0	-14.2	-18.2	-21.4	-24.8	-28.4	-27.6	-30.9	-33.4	-38.0	-40.3	-43.8
% Difference	0.0	0.0	0.0	0.0	0.1	0.2	-0.7	-1.6	-2.5	-3.6	-4.6	-5.8	-6.8	-7.8	-8.8	-8.4	-9.3	-10.0	-11.3	-11.9	-12.8
Coal																					
AEO2001	68.9	69.0	68.7	69.4	69.4	69.6	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	69.6
AL01	68.9	69.0	68.7	69.5	69.6	69.9	70.0	70.2	70.3	70.3	70.5	70.5	70.7	70.7	70.8	70.7	70.8	71.0	71.0	71.0	71.2
Difference	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.3	1.3	1.5	1.5	1.5	1.6
% Difference	0.0	0.0	0.0	0.1	0.3	0.4	0.7	1.0	1.2	1.3	1.4	1.6	1.7	1.7	1.9	1.9	1.9	2.2	2.2	2.2	2.3
Other																					
AEO2001	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
AL01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
AL01	569.8	587.2	601.7	614.7	623.6	628.6	626.9	635.2	640.4	644.5	654.5	666.4	678.2	693.2	704.7	718.3	724.8	732.5	736.9	746.9	753.6
Difference	0.0	-0.2	0.1	-0.9	-1.8	-4.5	-12.7	-18.0	-21.2	-23.3	-24.6	-20.7	-17.5	-13.1	-10.8	-9.2	-10.3	-14.0	-16.8	-14.6	-17.9
% Difference	0.0	0.0	0.0	-0.1	-0.3	-0.7	-2.0	-2.8	-3.2	-3.5	-3.6	-3.0	-2.5	-1.9	-1.5	-1.3	-1.4	-1.9	-2.2	-1.9	-2.3
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
AL01	1535	1576	1612	1642	1666	1687	1699	1720	1737	1752	1773	1795	1817	1843	1866	1891	1909	1927	1941	1961	1979
Difference	0.0	-1.0	1.0	-1.0	-2.0	-3.0	-14.0	-22.0	-28.0	-32.0	-36.0	-35.0	-34.0	-34.0	-35.0	-37.0	-42.0	-49.0	-55.0	-56.0	-62.0
% Difference	0.0	-0.1	0.1	-0.1	-0.1	-0.2	-0.8	-1.3	-1.6	-1.8	-2.0	-1.9	-1.8	-1.8	-1.8	-1.9	-2.2	-2.5	-2.8	-2.8	-3.0

[1]From AEO2001 Table A19

Table AL- 4. Case 7 Fuel Consumption by Sector and Fuel Type and AEO2001

Table 6AL-5. Fuel Consumption by Sector and Fuel Type[1](Quads): Case 7 and AEO2001

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential Petroleum																					
AEO2001	1.44	1.50	1.49	1.48	1.45	1.42	1.40	1.37	1.35	1.32	1.29	1.28	1.27	1.26	1.26	1.24	1.24	1.22	1.22	1.21	1.21
AL01	1.44	1.50	1.49	1.48	1.45	1.42	1.40	1.37	1.35	1.32	1.30	1.29	1.29	1.28	1.27	1.26	1.26	1.25	1.25	1.25	1.25
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	1	1	2	2	1	2	2	2	2	3	3
Residential Natural Gas																					
AEO2001	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.55	5.61	5.65	5.69	5.75	5.82	5.87	5.93	5.99	6.06	6.11	6.17	6.23	6.30
AL01	4.97	5.14	5.26	5.35	5.43	5.47	5.43	5.39	5.36	5.30	5.25	5.21	5.19	5.14	5.10	5.07	5.04	4.99	4.96	4.93	4.91
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.8	-0.9	-1.0	-1.1	-1.2	-1.3	-1.4
% Difference	0	0	0	0	0	0	-1	-3	-4	-6	-8	-9	-11	-12	-14	-15	-17	-18	-20	-21	-22
Residential Coal																					
AEO2001	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
AL01	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential Electricity[2]																					
AEO2001	3.96	4.06	4.17	4.27	4.39	4.50	4.58	4.67	4.78	4.86	4.96	5.04	5.14	5.21	5.28	5.37	5.46	5.53	5.61	5.70	5.80
AL01	3.96	4.06	4.17	4.27	4.40	4.50	4.53	4.62	4.74	4.83	4.91	5.01	5.11	5.19	5.28	5.39	5.50	5.58	5.68	5.79	5.92
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1	-1	0	0	0	1	1	1	2	2
Commercial Petroleum																					
AEO2001	0.59	0.63	0.64	0.65	0.65	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66
AL01	0.59	0.63	0.64	0.65	0.65	0.66	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.80
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	0	2	1	3	4	6	7	10	12	13	15	18	20	21	21
Commercial Natural Gas																					
AEO2001	3.27	3.39	3.52	3.62	3.68	3.71	3.75	3.79	3.82	3.85	3.88	3.92	3.96	3.99	4.02	4.05	4.07	4.09	4.11	4.12	4.13
AL01	3.27	3.39	3.52	3.62	3.68	3.72	3.69	3.66	3.62	3.57	3.52	3.48	3.44	3.40	3.35	3.30	3.24	3.19	3.13	3.07	3.01
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.8	-0.8	-0.9	-1.0	-1.1	-1.1
% Difference	0	0	0	0	0	0	-2	-3	-5	-7	-9	-11	-13	-15	-17	-19	-20	-22	-24	-25	-27
Commercial Coal																					
AEO2001	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
AL01	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial Electricity[2]																					
AEO2001	3.78	3.90	4.03	4.13	4.23	4.35	4.45	4.57	4.68	4.78	4.89	4.98	5.08	5.17	5.25	5.32	5.39	5.45	5.51	5.56	5.61
AL01	3.78	3.90	4.03	4.13	4.23	4.35	4.43	4.54	4.66	4.77	4.86	4.97	5.07	5.16	5.25	5.34	5.42	5.50	5.57	5.64	5.71
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	1	1	1	1	2

Table AL- 4 Cont'd. Case 7 Fuel Consumption by Sector and Fuel Type and AEO2001

Table 6AL-5 cont'd. Fuel Consumption by Sector and Fuel Type[1] (Quads): Case 7 and AEO2001

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Industrial Petroleum																					
AEO2001	9.31	9.44	9.55	9.67	9.82	9.95	10.07	10.23	10.34	10.44	10.55	10.63	10.69	10.85	11.00	11.14	11.28	11.39	11.51	11.64	11.77
AL01	9.31	9.44	9.55	9.67	9.82	9.95	10.05	10.26	10.39	10.52	10.61	10.68	10.76	10.91	10.94	10.90	10.98	11.02	11.16	11.22	11.35
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	-0.1	-0.2	-0.3	-0.4	-0.4	-0.4	-0.4
% Difference	0	0	0	0	0	0	0	0	0	1	1	0	1	1	-1	-2	-3	-3	-3	-4	-4
Industrial Natural Gas																					
AEO2001	9.66	9.84	10.04	10.26	10.33	10.43	10.61	10.76	10.87	10.98	11.11	11.21	11.35	11.47	11.59	11.76	11.88	12.00	12.11	12.22	12.34
AL01	9.66	9.83	10.04	10.27	10.35	10.46	10.65	10.74	10.83	10.89	11.00	11.05	11.13	11.21	11.41	11.70	11.82	11.96	11.96	12.10	12.17
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.3	-0.2	-0.1	-0.1	0.0	-0.1	-0.1	-0.2
% Difference	0	0	0	0	0	0	0	0	0	-1	-1	-1	-2	-2	-2	-1	-1	0	-1	-1	-1
Industrial Coal																					
AEO2001	2.61	2.61	2.59	2.62	2.62	2.62	2.62	2.62	2.62	2.61	2.62	2.61	2.61	2.61	2.62	2.61	2.61	2.61	2.61	2.61	2.62
AL01	2.61	2.61	2.59	2.62	2.63	2.64	2.64	2.65	2.65	2.65	2.66	2.66	2.66	2.66	2.67	2.66	2.67	2.67	2.67	2.67	2.68
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
% Difference	0	0	0	0	0	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Industrial Electricity[2]																					
AEO2001	3.68	3.72	3.78	3.83	3.85	3.90	3.97	4.03	4.08	4.13	4.18	4.23	4.27	4.33	4.40	4.47	4.53	4.60	4.66	4.74	4.81
AL01	3.68	3.72	3.78	3.81	3.82	3.86	3.90	3.95	4.00	4.04	4.10	4.16	4.22	4.29	4.36	4.45	4.53	4.61	4.68	4.77	4.86
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
% Difference	0	0	0	-1	-1	-1	-2	-2	-2	-2	-2	-2	-1	-1	-1	0	0	0	0	1	1
Total[3]																					
AEO2001	43.37	44.35	45.19	46.00	46.57	47.12	47.74	48.37	48.94	49.41	49.96	50.44	50.98	51.55	52.14	52.74	53.31	53.79	54.30	54.82	55.38
AL01	43.37	44.34	45.19	45.99	46.58	47.15	47.50	47.97	48.40	48.70	49.03	49.34	49.71	50.10	50.50	50.95	51.35	51.68	51.98	52.37	52.79
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.4	-0.5	-0.7	-0.9	-1.1	-1.3	-1.5	-1.6	-1.8	-2.0	-2.1	-2.3	-2.5	-2.6
% Difference	0	0	0	0	0	0	-1	-1	-1	-1	-2	-2	-2	-3	-3	-3	-4	-4	-4	-4	-5

[1] From AEO2001 Table A2
[2] Excludes losses
[3] As expected, overall consumption decreases when electricity losses are included