CHAPTER 14. UTILITY IMPACT ANALYSIS

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CHAPTER 14. UTILITY IMPACT ANALYSIS

14.1 INTRODUCTION

DOE analyzed the effects of its amended standard levels on the electric utility industry using a variant of the DOE/Energy Information Administration (EIA)'s National Energy Modeling System (NEMS).[a] NEMS is a public domain, multi-sectored, partial equilibrium model of the U.S. energy sector. Each year, DOE/EIA uses NEMS to produce an energy forecast for the United States, the *Annual Energy Outlook (AEO)*. The *AEO* for 2011 *(AEO2011)* forecasts energy supply and demand through 2035.[1] DOE used a variant of this model, referred to as NEMS-BT,[b] to account for the impacts of dishwasher energy conservation standards. DOE's utility impact analysis consists of a comparison between model results for the *AEO2011* Reference Case and for cases in which standards are in place, and applies the same basic set of assumptions as the *AEO2011*. The *AEO2011* reference case corresponds to medium economic growth.

The utility impact analysis reports the changes in electric installed capacity and generation that result for each trial standard level (TSL) by plant type, as well as changes in residential electricity and natural gas consumption.

NEMS-BT has several advantages that have led to its adoption as the forecasting tool in the analysis of energy conservation standards. NEMS-BT uses a set of assumptions that are well known and fairly transparent, due to the exposure and scrutiny each *AEO* receives. In addition, the comprehensiveness of NEMS-BT permits the modeling of interactions among the various energy supply and demand sectors, producing a complete picture of the effects of energy conservation standards. Perhaps most importantly, NEMS-BT can be used to estimate marginal effects, which yield a better estimate of the actual impact of energy conservation standards than considering only average effects.

14.2 METHODOLOGY

NEMS provides reference case load shapes for several end uses. The model uses predicted growth in demand for each end use to build up a projection of the total electric system load growth for each region, which it uses in turn to predict the necessary additions to capacity. DOE uses NEMS-BT to account for the implementation of energy conservation standards by decrementing the appropriate reference case load shape. For dishwashers the cooking end use

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[a] For more information on NEMS, refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2003*. DOE/EIA-0581(2003), March 2003.

[b] DOE/EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on DOE/EIA assumptions, DOE refers to it by the name NEMS-BT (BT is DOE's Building Technologies Program, under whose aegis this work has been performed).

was decremented. These decrements are also divided amongst the nine U.S. Census divisions based upon the share of energy end use consumption in each division, as given in NEMS.

DOE used the site energy savings developed in the national impact analysis (chapter 10) for each TSL as input to NEMS-BT. The magnitude of the energy decrement that would be required for NEMS-BT to produce stable results out of the range of numerical noise is larger than the highest efficiency standard under consideration. Therefore, DOE estimated results corresponding to each TSL using interpolation. DOE ran higher energy use reduction levels in NEMS-BT, representing multipliers of each TSL, and used these outputs to linearly interpolate the results to estimate actual changes in generation and capacity due to the standard.

Although the current time horizon of NEMS-BT is 2035, other parts of the energy conservation standards analysis extend through the year 2044. It is not feasible to extend the forecast period of NEMS-BT for the purposes of this analysis, nor does DOE/EIA have an approved method for extrapolation of many outputs beyond 2035. While it might seem reasonable to make simple linear extrapolations of results, in practice this is not advisable because outputs could be contradictory. An analysis of various trends sufficiently detailed to guarantee consistency is beyond the scope of this work, and, in any case, would involve a great deal of uncertainty. Therefore, all extrapolations beyond 2035 are simple replications of year 2035 results. To emphasize the extrapolated results wherever they appear, they are shaded in gray to distinguish them from actual NEMS-BT results.

14.3 RESULTS

This utility impact analysis reports NEMS-BT forecasts for residential sector electricity and natural gas consumption, total electricity generation by fuel type, and installed electricity generation capacity by fuel type. Results are presented in five-year increments through 2035. Beyond 2035, an extrapolation through 2047 for each TSL represents a simple replication of the 2035 results.

The results from the *AEO2011* Reference Case are shown in Table 14.3.1. The results for the seven TSLs are presented in Table 14.3.2 through Table 14.3.6. Each table shows forecasts using interpolated results, as described in section 14.2, for total U.S. electricity generation and installed capacity.

The considered dishwasher TSLs reduce energy consumption compared to the *AEO2011* Reference Case. The electricity savings predicted by the NIA Model for dishwasher products range from 0.0002 percent to 0.28 percent of residential electricity consumption in the year 2035. The natural gas savings predicted by the NIA model for dishwasher products range from 0.01 percent to 0.66 percent of residential natural gas consumption in 2035.

Table 14.3.1 AEO 2011 Reference Case Forecast

NEMS-BT Results: AEO 2011 Reference Case

	2005	2010	2015	2020	2025	2030	2035
Residential Sector Energy Consumption [1]							
Electricity Sales (TWh) [2]	1,359	1,455	1,348	1,394	1,461	1,538	1,613
Natural Gas (EJ)	5.23	5.17	5.21	5.25	5.24	5.23	5.17
Other (EJ)	1.96	1.66	1.56	1.50	1.44	1.40	1.36
Natural Gas (Quads)	4.96	4.90	4.94	4.98	4.96	4.95	4.90
Other (Quads) [3]	1.86	1.57	1.48	1.42	1.37	1.33	1.29
Total U.S. Electric Generation [4]							
Coal (TWh)	2,013	1,864	1,799	1,907	2,069	2,137	2,218
Gas (TWh)	759	1,010	999	1,000	1,000	1,148	1,283
Petroleum (TWh)	122	45	43	44	44	45	46
Nuclear (TWh)	782	803	839	877	877	877	874
Renewables (TWh)	360	414	556	608	673	703	724
Total (TWh) [5]	4,036	4,136	4,236	4,436	4,663	4,911	5,146
Installed Generating Capacity [6]							
Coal (GW)	314	322	322	323	326	329	334
Other Fossil (GW) [7]	439	471	471	470	490	530	571
Nuclear (GW)	100	101	106	110	110	110	110
Renewables (GW)	100	132	154	159	169	176	180
Total (GW) [8]	953	1,027	1,052	1,061	1,095	1,146	1,196

[1] Comparable to Table A2 of AEO2011: Energy Consumption

[2] Comparable to Table A8 of AEO2011: Electricity Sales by Sector

[3] Includes distillate fuel, commercial fuel, kerosene, LPG, motor gasoline, coal, and renewable energy

[4] Comparable to Table A8 of AEO2011: Electric Generators and Cogenerators

[5] Excludes "Other Gaseous Fuels" cogenerators and "Other" cogenerators

[6] Comparable to Table A9 of AEO2011: Electric Generators and Cogenerators Capability

[7] Includes "Other Gaseous Fuels" cogenerators

[8] Excludes Pumped Storage and Fuel Cells

Table 14.3.2 Dishwashers Trial Standard Level 1 Forecast

NEMS-BT Results:					Difference from AEO2011 Reference Case					Extrapolation		
	2020	2025	2030	2035		2020	2025	2030	2035	2040	2044	2047
Residential Sector Energy Consumption					*Residential Sector Energy Consumption*							
Electricity Sales (TWh)	1,394	1,461	1,538	1,613	Electricity Sales (TWh)	-0.027	-0.047	-0.057	-0.062	-0.065	-0.068	-0.051
Natural Gas (EJ)	5.25	5.24	5.23	5.17	Natural Gas (EJ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other (EJ)	1.50	1.44	1.40	1.36	Other (EJ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas (Quads)	4.98	4.96	4.95	4.90	Natural Gas (Quads)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other (Quads)	1.42	1.37	1.33	1.29	Other (Quads)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total U.S. Electric Generation					*Total U.S. Electric Generation*							
Coal (TWh)	1,907	2,069	2,137	2,218	Coal (TWh)	-0.016	-0.018	-0.014	-0.012	-0.012	-0.012	-0.012
Gas (TWh)	1,000	1,000	1,148	1,283	Gas (TWh)	-0.005	-0.020	-0.031	-0.034	-0.034	-0.034	-0.034
Petroleum (TWh)	44	44	45	46	Petroleum (TWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nuclear (TWh)	877	877	877	874	Nuclear (TWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Renewables (TWh)	608	673	703	724	Renewables (TWh)	-0.004	-0.007	-0.006	-0.008	-0.008	-0.008	-0.008
Total (TWh)	4,436	4,663	4,911	5,146	Total (TWh)	-0.026	-0.045	-0.051	-0.054	-0.054	-0.054	-0.054
Installed Generating Capacity					*Installed Generating Capacity*							
Coal (GW)	323	326	329	334	Coal (GW)	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
Other Fossil (GW)	470	490	530	571	Other Fossil (GW)	-0.001	-0.004	-0.007	-0.008	-0.008	-0.008	-0.008
Nuclear (GW)	110	110	110	110	Nuclear (GW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Renewables (GW)	159	169	176	180	Renewables (GW)	-0.001	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Total (GW)	1,061	1,095	1,146	1,196	Total (GW)	-0.003	-0.007	-0.010	-0.011	-0.011	-0.011	-0.011

Table 14.3.3 Dishwashers Trial Standard Level 2 Forecast

NEMS-BT Results:							Difference from AEO2011 Reference Case						Extrapolation		
	2010	2015	2020	2025	2030	2035		2010	2015	2020	2025	2030	2035	2040	2044	2047
Residential Sector Energy Consumption							*Residential Sector Energy Consumption*									
Electricity Sales (TWh)	1,455	1,348	1,394	1,461	1,538	1,613	Electricity Sales (TWh)	0.000	0.002	-0.004	-0.007	-0.006	-0.004	-0.002	-0.001	0.007
Natural Gas (EJ)	5.17	5.21	5.25	5.24	5.22	5.17	Natural Gas (EJ)	0.000	-0.001	-0.002	-0.002	-0.003	-0.003	-0.003	-0.003	-0.002
Other (EJ)	1.66	1.56	1.50	1.44	1.40	1.36	Other (EJ)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural Gas (Quads)	4.90	4.94	4.98	4.96	4.95	4.90	Natural Gas (Quads)	0.000	-0.001	-0.002	-0.002	-0.003	-0.003	-0.003	-0.003	-0.002
Other (Quads)	1.57	1.48	1.42	1.37	1.33	1.29	Other (Quads)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total U.S. Electric Generation							*Total U.S. Electric Generation*									
Coal (TWh)	1,864	1,799	1,907	2,069	2,137	2,218	Coal (TWh)	-0.003	-0.009	-0.002	-0.003	-0.002	-0.001	-0.001	-0.001	-0.001
Gas (TWh)	1,010	999	1,000	1,000	1,148	1,283	Gas (TWh)	0.003	0.007	-0.001	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002
Petroleum (TWh)	45	43	44	44	45	46	Petroleum (TWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nuclear (TWh)	803	839	877	877	877	874	Nuclear (TWh)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Renewables (TWh)	414	556	608	673	703	724	Renewables (TWh)	0.000	0.002	-0.001	-0.001	-0.001	0.000	0.000	0.000	0.000
Total (TWh)	4,136	4,236	4,436	4,663	4,911	5,146	Total (TWh)	0.000	0.001	-0.004	-0.007	-0.006	-0.003	-0.003	-0.003	-0.003
Installed Generating Capacity							*Installed Generating Capacity*									
Coal (GW)	322	322	323	326	329	334	Coal (GW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other Fossil (GW)	471	471	470	490	530	571	Other Fossil (GW)	0.000	0.000	0.000	-0.001	-0.001	0.000	0.000	0.000	0.000
Nuclear (GW)	101	106	110	110	110	110	Nuclear (GW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Renewables (GW)	132	154	159	169	176	180	Renewables (GW)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total (GW)	1,027	1,052	1,061	1,095	1,146	1,196	Total (GW)	0.000	0.001	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001

Table 14.3.4 Dishwashers Trial Standard Level 3 Forecast

NEMS-BT Results:					Difference from AEO2011 Reference Case					Extrapolation		
	2020	2025	2030	2035		2020	2025	2030	2035	2040	2044	2047
Residential Sector Energy Consumption					*Residential Sector Energy Consumption*							
Electricity Sales (TWh)	1,392	1,458	1,535	1,609	Electricity Sales (TWh)	-1.76	-3.07	-3.72	-4.05	-4.28	-4.46	-3.41
Natural Gas (EJ)	5.25	5.23	5.22	5.16	Natural Gas (EJ)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Other (EJ)	1.50	1.44	1.40	1.36	Other (EJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas (Quads)	4.97	4.96	4.94	4.89	Natural Gas (Quads)	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Other (Quads)	1.42	1.37	1.33	1.29	Other (Quads)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total U.S. Electric Generation					*Total U.S. Electric Generation*							
Coal (TWh)	1,906	2,067	2,137	2,217	Coal (TWh)	-1.03	-1.16	-0.91	-0.79	-0.79	-0.79	-0.79
Gas (TWh)	1,000	998	1,146	1,281	Gas (TWh)	-0.34	-1.30	-2.01	-2.20	-2.20	-2.20	-2.20
Petroleum (TWh)	44	44	45	46	Petroleum (TWh)	-0.02	0.00	0.01	-0.01	-0.01	-0.01	-0.01
Nuclear (TWh)	877	877	877	874	Nuclear (TWh)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables (TWh)	607	672	703	723	Renewables (TWh)	-0.29	-0.47	-0.42	-0.54	-0.54	-0.54	-0.54
Total (TWh)	4,434	4,660	4,907	5,142	Total (TWh)	-1.68	-2.92	-3.33	-3.55	-3.55	-3.55	-3.55
Installed Generating Capacity					*Installed Generating Capacity*							
Coal (GW)	323	325	329	334	Coal (GW)	-0.06	-0.06	-0.05	-0.06	-0.06	-0.06	-0.06
Other Fossil (GW)	469	490	530	571	Other Fossil (GW)	-0.09	-0.28	-0.47	-0.52	-0.52	-0.52	-0.52
Nuclear (GW)	110	110	110	110	Nuclear (GW)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables (GW)	158	169	176	180	Renewables (GW)	-0.06	-0.10	-0.13	-0.14	-0.14	-0.14	-0.14
Total (GW)	1,061	1,095	1,145	1,195	Total (GW)	-0.20	-0.44	-0.66	-0.72	-0.72	-0.72	-0.72

Table 14.3.5 Dishwashers Trial Standard Level 4 Forecast

NEMS-BT Results:					Difference from AEO2011 Reference Case					Extrapolation		
	2020	2025	2030	2035		2020	2025	2030	2035	2040	2044	2047
Residential Sector Energy Consumption					*Residential Sector Energy Consumption*							
Electricity Sales (TWh)	1,392	1,458	1,534	1,609	Electricity Sales (TWh)	-1.94	-3.39	-4.12	-4.50	-4.78	-5.00	-3.85
Natural Gas (EJ)	5.24	5.21	5.20	5.14	Natural Gas (EJ)	-0.01	-0.03	-0.03	-0.03	-0.04	-0.04	-0.03
Other (EJ)	1.50	1.44	1.40	1.36	Other (EJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas (Quads)	4.96	4.94	4.92	4.87	Natural Gas (Quads)	-0.01	-0.02	-0.03	-0.03	-0.03	-0.04	-0.03
Other (Quads)	1.42	1.36	1.32	1.29	Other (Quads)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total U.S. Electric Generation					*Total U.S. Electric Generation*							
Coal (TWh)	1,906	2,067	2,136	2,217	Coal (TWh)	-1.14	-1.28	-1.01	-0.88	-0.88	-0.88	-0.88
Gas (TWh)	1,000	998	1,146	1,281	Gas (TWh)	-0.38	-1.44	-2.23	-2.45	-2.45	-2.45	-2.45
Petroleum (TWh)	44	44	45	46	Petroleum (TWh)	-0.02	0.00	0.01	-0.01	-0.01	-0.01	-0.01
Nuclear (TWh)	877	877	877	874	Nuclear (TWh)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables (TWh)	607	672	703	723	Renewables (TWh)	-0.32	-0.52	-0.47	-0.60	-0.60	-0.60	-0.60
Total (TWh)	4,434	4,660	4,907	5,142	Total (TWh)	-1.85	-3.23	-3.69	-3.95	-3.95	-3.95	-3.95
Installed Generating Capacity					*Installed Generating Capacity*							
Coal (GW)	323	325	329	334	Coal (GW)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
Other Fossil (GW)	469	490	530	571	Other Fossil (GW)	-0.10	-0.31	-0.53	-0.58	-0.58	-0.58	-0.58
Nuclear (GW)	110	110	110	110	Nuclear (GW)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables (GW)	158	169	176	180	Renewables (GW)	-0.07	-0.11	-0.15	-0.15	-0.15	-0.15	-0.15
Total (GW)	1,061	1,095	1,145	1,195	Total (GW)	-0.23	-0.49	-0.73	-0.80	-0.80	-0.80	-0.80

Table 14.3.6 presents the estimated reduction in electricity generating capacity in 2047 for the TSLs that DOE considered in this rulemaking.

Table 14.3.6 Reduction in Electric Generating Capacity in 2047 Under Dishwasher Trial Standard Levels

	TSL 1	TSL 2	TSL 3	TSL 4
	gigawatts			
Dishwashers	0.011	0.001	0.719	0.800

REFERENCES

1. Energy Information Administration. *Annual Energy Outlook 2010 with Projections to 2035: Reference Case Service Report*. 2010. Washington, DC. April. Report No. DOE/EIA-0383(2010). (Last accessed July 11, 2012.) <http://infousa.state.gov/economy/technology/docs/0383.pdf>