METHODOLOGY OF THE UTILITY AND ENVIRONMENTAL ANALYSES FOR RESIDENTIAL WATER HEATER EFFICIENCY STANDARDS

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UTILITY ANALYSIS

Authority

The Energy Policy and Conservation Act, as amended, sets energy conservation standards for water heaters among other products and authorizes the Secretary of Energy to revise the energy conservation standards according to a statutory schedule. This report is a part of the preliminary analysis for the water heater energy efficiency rulemaking. This report will be revised and completed as the work progresses.

Summary

Analysis of the effects of proposed water heater standard levels on both the gas and electric utility industries have been conducted using a variant of the Energy Information Administration's (EIA) National Energy Modeling System (NEMS), together with some minor external calculations. The version of NEMS to be used for appliance standards analysis is called NEMS-NAECA. NEMS was used by the EIA to produce the *1998 Annual Energy Outlook* (AEO98). Because the gas industry is already largely deregulated, and electric utility restructuring is underway, it is no longer valid to assume the traditional cost recovery regulatory environment. Therefore, the electricity and gas utility analyses will consist of a comparison between model results for the base case and policy cases in which proposed standards are in place. Outputs of the utility analysis are presented in a format similar to the results in AEO98.

Purpose of the Analysis

The gas and electricity utility analyses are intended to estimate the effects of the sales losses implied by improved appliance efficiency on these industries and, ultimately, on their customers. The requirement that an analysis be conducted of the effects of proposed standards on electric utilities has a long history, but interest in the gas industry is much more recent, and no analysis of proposed standards on gas utilities has been published in the Federal Register. Historically, analysis of the effects of proposed standards on the electric utility industry has taken the form of an estimation of the saved fuel and capital costs compared to the likely reduction in revenues implied by lower electricity sales. In the short term, ratepayers would gain because of reduced energy use at fixed prices. Any imbalance between revenue and costs would disappear in the long run, as traditional regulation would make utilities whole. In a restructured industry, however, only local distribution companies will be made whole and prices are not rigid in the short run, so the basis of the analysis must change. Therefore, the goal of assessing the effect of efficiency standards on the industry is addressed in a simpler and more direct fashion through the reporting of key industry parameters.

Assumptions

The use of NEMS for the utility analysis offers several advantages. As the official DOE

energy forecasting model, it relies upon a set of assumptions which are fairly transparent due to the exposure and scrutiny the AEO receives. NEMS also offers a sophisticated picture of the effect of appliance standards since its scale allows it to measure the interactions between the various energy supply and demand sectors and the economy as a whole. In addition, the scale of NEMS allows an analysis of the effects of standards on both the electric and gas utility industries.

The entire utility analysis will be conducted as a policy deviation from the AEO98, with the same basic set of assumptions applied. For example, the operating characteristics (energy conversion efficiency, emissions rates, etc.) of future electricity generating plants are exactly those used in AEO98, as are the prospects for natural gas supply. Deviations from some of these assumptions have also been explored through a few scenarios that represent alternative futures.

Restructuring of the U.S. electric utility industry is well underway. In California, currently the lead state, the Independent System Operator (ISO) and the Power Exchange (PX) officially began operations on 1 April 1998. In general, the goal of these reforms is to create an increased level of competition in electricity generation, to provide free access to transmission for non-utility generators, and to allow customers a choice among electricity suppliers. Transmission and distribution of electricity are still considered natural monopolies, and, in the U.S., continue under the traditional regulatory framework. As a result of restructuring, the past electric utility analysis that was based on traditional cost recovery regulation for all levels of the industry, must be rethought. The implications of industry restructuring are only partially implemented in the AEO98 version of NEMS. The consequences of a wider restructuring pattern will be explored through an appropriate scenario in NEMS-NAECA.

Methods

NEMS is a large multi-sectoral partial equilibrium model of the U.S. energy sector that has been developed over several years by the EIA primarily for the purpose of preparing the *Annual Energy Outlook*. NEMS produces a widely recognized baseline forecast for the U.S. through 2020 and is available in the public domain. NEMS-NAECA is the model that is used for appliance standards analysis and is based on the AEO98 version of NEMS with minor modifications.[1] The electric utility industry analysis will consist of NEMS-NAECA forecasts for generation, installed capacity, and prices.

Since the AEO98 version of NEMS forecasts only to the year 2020, a method for extrapolating price data to 2030 is required. The adopted method uses the EIA approach to forecast fuel prices for the Federal Energy Management Program (FEMP). These are the prices used by FEMP to estimate life-cycle costs of federal equipment procurements. For petroleum products, the average

[1] EIA approves use of the name *NEMS* only to describe an AEO version of the model without any modification to code or data. Since, in this work, there are some minor code modifications and the model is run under various policy scenarios that deviate from AEO assumptions, Berkeley Lab proposed the use of the name NEMS-NAECA for the model as used here.

growth rate for the world oil price over the years 2010 to 2020 is used in combination with the refinery and distribution markups from the year 2020 to determine the regional price forecasts. Similarly, natural gas prices are derived from an average growth rate figure in combination with regional price margins from the year 2020. Electricity prices are held constant at 2020 levels on the assumption that the transition to a restructured utility industry will have been completed.

Published results will include sales and price forecasts for the electric and gas utilities. Below is an example output table of basic NEMS-NAECA results for the AEO98 case. Final results will include equivalent tables for the AEO98 case with residential energy demand reduced by the levels forecast by the National Energy Savings spreadsheet models, and all results will be extrapolated to 2030, as described above. Similar tables will also be presented for the alternative scenarios.

NEMS-NAECA: AEO98 Baseline	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Residential Consumption							
Electricity Sales (Pwh)(Trillions of kWh)	1.16	1.26	1.35	1.45	1.55	1.65	1.77
Natural Gas (EJ)	5.64	5.60	5.76	5.97	6.11	6.29	6.48
LPG (EJ)	0.47	0.50	0.52	0.53	0.54	0.55	0.56
Oil (EJ)	0.90	0.83	0.81	0.78	0.76	0.73	0.71
Natural Gas (Quads)	5.35	5.31	5.46	5.66	5.79	5.96	6.14
LPG (Quads)	0.45	0.47	0.49	0.50	0.51	0.52	0.53
Oil (Quads)	0.85	0.79	0.77	0.74	0.72	0.70	0.67
Residential Prices							
Electricity (¢/kWh)	7.82	7.51	7.30	6.96	6.83	6.83	6.83
Natural Gas ($/GJ)	6.09	5.86	5.74	5.60	5.77	6.06	6.36
LPG ($/GJ)	12.20	12.88	13.12	13.12	13.26	13.73	14.22
Oil ($/GJ)	7.54	7.88	7.98	8.07	8.13	8.42	8.72
Natural Gas ($/MBtu)	5.77	5.55	5.44	5.31	5.47	5.74	6.03
LPG ($/MBtu)	11.56	12.21	12.44	12.44	12.57	13.01	13.48
Oil ($/MBtu)	7.15	7.47	7.56	7.65	7.71	7.98	8.27

ENVIRONMENTAL ANALYSIS

Authority

The Energy Policy and Conservation Act, as amended, sets energy conservation standards for water heaters among other products and authorizes the Secretary of Energy to revise the energy conservation standards according to a statutory schedule. This report is a part of the preliminary analysis for the water heater energy efficiency rulemaking. This report will be revised and completed as the work progresses.

Summary

The water heater environmental analysis uses a variant of EIA's National Energy Modeling System (NEMS), plus some minor additional analysis. Outputs of the environmental analysis are in a similar format as the results of AEO98, with some additions.

Purpose of the Analysis

The environmental analysis is intended to provide emissions results to policymakers and interveners, and to fulfill requirements that the environmental effects of all new federal rules be properly quantified and considered. The environmental analysis considers only two pollutants, SO_2 and NOx, and one emission, carbon. The only form of carbon tracked by NEMS-NAECA is CO_2, so the carbon discussed in this report is only in the form of CO_2. For each of the standard levels, total emissions will be calculated using NEMS-NAECA in part, with some external analysis required.

Assumptions

The environmental analysis will be conducted as a policy deviation from the AEO98, with the same basic set of assumptions applied. For example, the emissions characteristics of an electricity generating plant will be exactly those used in AEO98.

Methods

Carbon emissions are tracked in NEMS-NAECA by a detailed carbon module; this gives good results because of its broad coverage of all sectors and inclusion of interactive effects. Past experience with carbon results from NEMS suggests that emissions estimates are somewhat lower than emissions based on simple average factors. One of the reasons for this divergence is that NEMS tends to predict that conservation displaces renewable generating capacity in the out years. On the whole, NEMS-NAECA provides carbon emissions results of reasonable accuracy, a level consistent with other Federal published results.

The two airborne pollutant emissions that have been reported in past analyses, NOx and SO_2,

are reported by NEMS-NAECA. The Clean Air Act Amendments of 1990 set an SO_2 emissions cap on all power generation. The attainment of this target, however, is flexible among generators and is enforced by applying market forces, through the use of emissions allowances and tradable permits. NEMS includes a module for SO_2 allowance trading and delivers a forecast of SO_2 allowance prices. Please note that accurate simulation of SO_2 trading tends to imply that physical emissions effects will be zero because emissions will always be at the ceiling. This fact has caused considerable confusion in the past. However, there is an SO_2 benefit from conservation in the form of a lower allowance price and, if big enough to be calculable by NEMS-NAECA, this value will be reported. One small effect that NEMS-NAECA must consider in addition to AEO98 calculations is the effect of standards on SO_2 emissions from in-house combustion of oil, since the emissions cap does not apply to households. This effect is calculated using simple emissions factors.

NEMS also has an algorithm for estimating NOx emissions from power generation, but it is somewhat inadequate for this analysis because it does not estimate in-house emissions. In-house emissions account for the combustion of fossil fuels, primarily natural gas, within individual homes. Since households that use natural gas, fuel oil or coal contribute to NOx emissions, LBNL has added a separate household NOx emissions estimation capability, based on simple emissions factors derived from general literature.

Deliverables

As described, the results for the environmental analysis are similar to a complete NEMS-NAECA run. Some key results are summarized in the table below. The outcome of the analysis for each case are reported as deviations from the AEO98 result. All results are extrapolated to 2030 and include household emissions.

NEMS: AEO98 Baseline	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
In-house Combustion							
NOx (Mt/a)	0	13.3	16.8	30.8	44.9	73.4	120.0
Carbon (Mt/a)	11.1	54.7	88.5	134.7	165.7	226.7	310.2
SO_2 (Mt/a)							
Power Sector Emissions							
NOx (Mt/a)	5.05	5.16	5.32	5.52	5.71	5.92	6.13
Carbon (Mt/a)	1577	1685	1798	1882	1950	2031	2115
SO_2 (Mt/a)	10.19	9.69	9.22	9	9	9	9
SO_2 Trading Price ($/t)	120.9	173.1	218.9	181.1	165.2	143.5	124.7