CHAPTER 2. ANALYTICAL FRAMEWORK

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 2. ANALYTICAL FRAMEWORK

2.1 INTRODUCTION

Section 6295(o)(2)(A) of 42 U.S.C. requires the U.S. Department of Energy (DOE) to set forth energy conservation standards that are technologically feasible and economically justified and would result in significant additional energy conservation. This chapter provides a description of the general analytical framework that DOE uses in developing such standards, as well as aspects specific to the analysis of microwave oven standby power. The analytical framework is a description of the methodology, the analytical tools, and relationships among the various analyses that are part of this rulemaking.

Figure 2.1.1 summarizes the analytical components of the standards-setting process. The focus of this figure is the center column, identified as “Analyses.” The columns labeled “Key Inputs” and “Key Outputs” show how the analyses fit into the rulemaking process, and how the analyses relate to each other. Key inputs are the types of data and information that the analyses require. Some key inputs exist in public databases; DOE collects other inputs from interested parties or persons with special knowledge. Key outputs are analytical results that feed directly into the standards-setting process. Dotted lines connecting analyses show types of information that feed from one analysis to another.

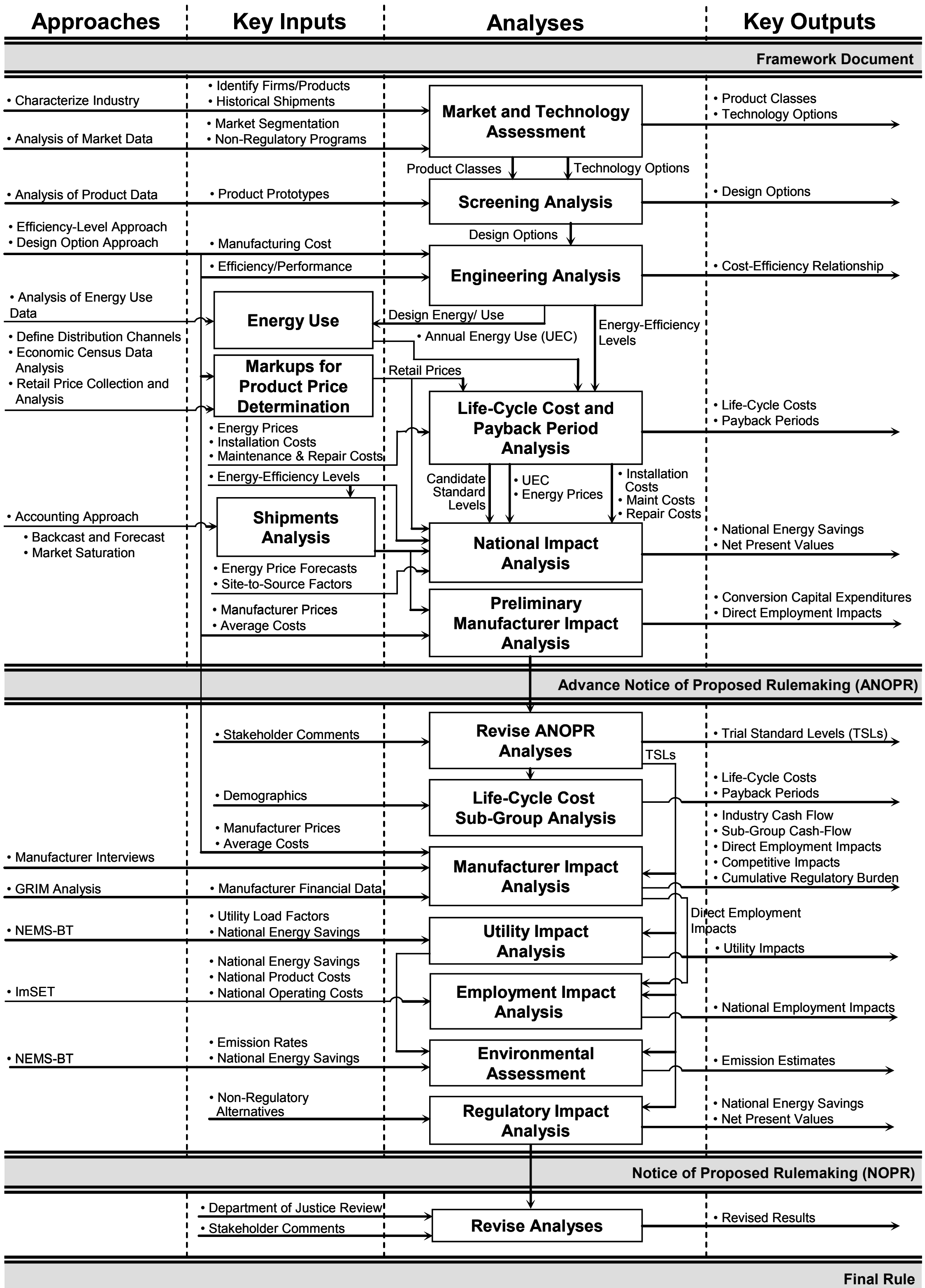

Figure 2.1.1 Flow Diagram of Analyses for the Rulemaking Process

The analyses performed in the advance notice of proposed rulemaking stage, and updated for the SNOPR, include:

- A market and technology assessment to characterize the relevant equipment markets and existing technology options, including prototype designs.
- A screening analysis to review each technology option and determine if it is technologically feasible; is practical to manufacture, install, and service; would adversely affect equipment utility or equipment availability; or would have adverse impacts on health and safety.
- An engineering analysis to develop cost-efficiency relationships, which indicate the manufacturer's production cost (material, labor, and factory overhead) of achieving increased efficiency.
- A markups analysis to convert the manufacturer costs estimates from the engineering analysis to customer prices, which are then used in the LCC and payback period (PBP) analyses and the manufacturer impact analysis.
- An energy use analysis to determine the annual energy use of the considered products at specific efficiency levels.
- An LCC and PBP analysis to calculate, at the consumer level, the discounted savings in operating costs (less maintenance and repair costs) throughout the estimated average life of the covered products, compared to any increase in the installed cost for the equipment likely to result directly from the imposition of the standard.
- A shipments analysis to forecast product shipments, which are then used to calculate the national impacts of standards on energy consumption and costs, net present value (NPV), and future manufacturer cash flows.
- A national impact analysis to assess the aggregate impacts at the national level of the NPV of total consumer LCC and national energy savings (NES).

The analyses DOE performed in the subsequent notice of proposed rulemaking (NOPR) stage and updated for the SNOPR include those listed below. Because the Energy Independence and Security Act of 2007 (Pub. L. No. 110-140) amended the Energy Policy and Conservation Act (EPCA) of 1975 (42 U.S.C. 6291–6309) to establish revised energy conservation standards for residential dishwashers and dehumidifiers (42 U.S.C. 6295(g)(9) and (cc)), DOE did not propose standards for these products in the NOPR and instead codified these statutory standards in a subsequent final rule. 74 FR 12058 (March 23, 2009). Therefore, DOE did not re-analyze dishwashers and dehumidifiers for the NOPR.

- A consumer subgroup analysis to evaluate variations in customer characteristics that might cause a standard to impact particular customer sub-populations differently than the overall population.

- A manufacturer impact analysis to estimate the financial impact of standards on manufacturers and to calculate impacts on competition, employment, and manufacturing capacity.

- A utility impact analysis to estimate effects of proposed standards on electric and gas utilities.

- An employment impact analysis to assess the aggregate impacts of standards on national employment.

- An environmental assessment to provide estimates of the effects of standards on three pollutants—sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury—as well as carbon emissions.

- A regulatory impact analysis to present major alternatives to proposed standards that could achieve energy savings at a lower cost.

After the publication of the NOPR, DOE reviewed comments from interested parties and revised its analyses as appropriate before issuing a final rule. In addition, information DOE received from interested parties regarding the NOPR indicated that further analyses were warranted for CCWs and microwave ovens as to standby power. As a result, DOE continued the rulemaking for these products, and a final rule for conventional cooking products (*i.e.*, cooktops and ovens) and microwave oven energy factor (EF) was published on April 8, 2009. 74 FR 16040. DOE also published a final rule on January 8, 2010 (75 FR 1122; the "January 2010 Final Rule") amending the energy conservation standards for commercial clothes washers.

Discussion of the analyses that were conducted at the NOPR stage for the covered products can be found in the NOPR technical support document (TSD) for this rulemaking, and updated analyses for the final rule for conventional cooking products and microwave oven energy factor (EF) are presented in the final rule TSD for those products. Details of the revised analyses for commercial clothes washers are presented in the final rule TSD for that product. This SNOPR TSD contains details of the revised NOPR analyses conducted for microwave oven standby power consumption.

2.2 MARKET AND TECHNOLOGY ASSESSMENT

The market and technology assessment characterizes the relevant product markets and existing technology options, including prototype designs, for the considered products.

2.2.1 Market Assessment

When initiating a standards rulemaking, DOE develops information on the present and past industry structure and market characteristics for the equipment concerned. This activity assesses the industry and equipment, both quantitatively and qualitatively, based on publicly available information. As such, for the considered products, DOE addressed the following: (1) manufacturer market share and characteristics; (2) existing regulatory and non-regulatory equipment efficiency improvement initiatives; and (3) trends in product characteristics and retail markets. This information serves as resource material throughout the rulemaking.

DOE reviewed existing literature and interviewed manufacturers to get an overall picture of the markets for the considered products in the United States. Industry publications and trade journals, government agencies, and trade organizations provided the bulk of the information, including information on: (1) manufacturers and their market share; (2) shipments by capacity; and (3) market saturation. The appropriate sections of this TSD describe the resulting information as DOE used it in the analysis.

DOE has used and will use the most reliable and accurate data available at the time of each analysis in this rulemaking. All data will be available for public review.

2.2.2 Technology Assessment

DOE typically uses information relating to existing and past technology options and prototype designs as inputs to determine what technologies manufacturers use to attain higher performance levels. In consultation with interested parties, DOE develops a list of technologies for consideration. Initially, these technologies encompass all those it believes are technologically feasible. DOE developed its list of technologically feasible design options for the considered products through consultation with manufacturers of components and systems, and from trade publications and technical papers.

2.3 SCREENING ANALYSIS

The screening analysis examines various technologies as to whether they: (1) are technologically feasible; (2) are practicable to manufacture, install, and service; (3) have an adverse impact on equipment utility or availability; and (4) have adverse impacts on health and safety. As described in section 2.2.2 above, DOE develops an initial list of efficiency-enhancement options from the technologies identified as technologically feasible in the technology assessment. Then DOE, in consultation with interested parties, reviews the list to determine if these options are practicable to manufacture, install, and service, would adversely affect equipment utility or availability, or would have adverse impacts on health and safety. In addition, DOE removed from the list technology options that lack energy consumption data as well as technology options whose energy consumption could not be adequately measured by existing DOE test procedures. In the engineering analysis, DOE further considers efficiency enhancement options that it did not screen out in the screening analysis.

2.4 ENGINEERING ANALYSIS

As presented in chapter 5, the engineering analysis establishes the relationship between the cost and efficiency of the considered products. This relationship serves as the basis for cost/benefit calculations in terms of individual consumers, manufacturers, and the nation. Chapter 5 discusses the product classes DOE analyzed, the representative baseline units, the incremental efficiency levels, the methodology DOE used to develop manufacturing costs, the methodology it used to develop the energy consumption model, the cost-efficiency consumption curves, the impact of efficiency improvements on the considered products, and the methodology DOE used to extend the analysis to low-shipment-volume product classes.

In the engineering analysis, DOE evaluates a range of product efficiency levels and their associated manufacturing costs. The purpose of the analysis is to estimate the incremental MPCs for a product that would result from increasing efficiency levels above the level of the baseline model in each product class. The engineering analysis considers technologies not eliminated in the screening analysis, although certain technologies were not analyzed due to negligible incremental efficiency improvements or the inability of the existing DOE test procedures to measure any reduction in energy use. DOE considers the remaining technologies, designated as design options, in developing the cost-efficiency curves, which are subsequently used for the LCC and PBP analyses.

For each of the product classes presented in chapter 5, DOE selected efficiency levels and obtained incremental cost data at each of these levels.

2.4.1 Manufacturing Cost Assessment

The manufacturing cost assessment estimated the manufacturing costs associated with an increase in energy efficiency for the considered products. This approach involved the disassembly of specific units, analysis of the materials and manufacturing processes, and development of a spreadsheet cost model, using a clear and consistent manufacturing cost assessment methodology. DOE built a detailed manufacturing cost assessment model that accurately predicts manufacturing cost, and reports the manufacturing costs in aggregated form to maintain confidentiality of the data. DOE obtained input from interested parties on the manufacturing cost estimates and assumptions to confirm their accuracy.

2.5 ENERGY USE ANALYSIS

The energy use analysis assesses the energy-savings potential of various efficiencies for the considered products. As part of the energy use analysis, DOE makes certain engineering assumptions regarding product application, including how the product is operated and under what conditions. DOE also developed a test procedure to measure the efficiencies of covered products. On March 9, 2011, DOE published in the *Federal Register* a test procedure interim final rule for microwave ovens that incorporates a measurement of standby power. 76 FR 12825.

2.6 MARKUPS ANALYSIS

Retail prices are required for the baseline efficiency level and all other efficiency levels under consideration in the LCC and PBP analysis and the manufacturer impact analysis. DOE derived retail prices by applying manufacturer-to-consumer markups to the estimated manufacturer selling price. To develop markups, DOE identified distribution channels (*i.e.*, how the products are distributed from the manufacturer to the consumer). After identifying appropriate distribution channels, DOE relied on economic census data from the U.S. Census Bureau and input from the industry to define how products are marked up from the manufacturer to the consumer.

2.7 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSIS

New or amended energy conservation standards for products result in changes in operating expenses—usually a decrease—and changes in consumer price—usually an increase. DOE analyzed the net effect of new standards on consumers by evaluating the net LCC using the cost-efficiency relationship derived in the engineering analysis, as well as the energy costs derived from the energy use determination. Inputs to the LCC calculation include the installed cost to the consumer (consumer price plus installation cost); operating expenses (energy expenses and maintenance costs); the lifetime of the appliance; and a discount rate.

Given that installed cost typically increases while operating cost typically decreases, there comes a time in the life of a product that operates at higher-than-baseline efficiency when the net operating cost benefit (in dollars) from the time of purchase is equal to the incremental first cost of purchasing the higher-efficiency product. The length of time required for a product to reach this cost-equivalence point is known as the payback period.

To estimate the LCC for microwave oven standby power, DOE had to determine several input values, including retail prices; electricity prices; discount rates; maintenance, service, and installation costs; and product lifetimes. DOE used typical values to reflect the conditions in the field for product life, product retail price, and energy consumption. DOE reviewed the Energy Information Administration (EIA)'s energy price data to establish electricity prices for residential consumers. DOE used EIA's *Annual Energy Outlook* (*AEO*) as the default source of projections of future energy prices for its LCC and PBP analysis.

To forecast product costs, DOE developed price factors based on learning rates calculated for electric cooking equipment, including microwave ovens. The learning rates were calculated using the historic Producer Price Index for electric cooking equipment along with historic shipments data, which indicate cumulative production of this equipment.

DOE developed discount rates for residential consumers based on estimates of the interest or finance cost to purchase residential appliances. Following financial theory, the finance cost of raising funds can be interpreted as: (1) the financial cost of any debt incurred to purchase products, principally interest charges on debt; or (2) the opportunity cost of any equity used to purchase products, principally interest earnings on household equity.

DOE considered expected changes to maintenance, repair, and installation costs for the product covered in this rulemaking. Typically, small incremental changes in product efficiency incur no, or only very small, changes in repair and maintenance costs over baseline efficiency products. There is a greater probability that products having efficiencies that are significantly greater than the baseline will incur increased repair and maintenance costs because such products are more likely to incorporate technologies that are new to the industry and not widely available.

DOE used information from various literature sources (*e.g.*, *Appliance* magazine) and input from manufacturers and other stakeholders to establish average product lifetimes for use in the LCC and subsequent analyses.

2.8 SHIPMENTS ANALYSIS

Shipment forecasts are required to calculate the national impacts of standards on energy consumption, NPV, and future manufacturer cash flows. DOE developed shipment forecasts using historical data as a basis for projecting future shipments of microwave ovens. In projecting shipments, DOE accounted for two market segments: (1) new construction; (2) existing residential buildings (*i.e.*, replacing failed products). To estimate the impacts of prospective standards on product shipments (*i.e.*, forecasting standards-case shipments), DOE accounted for the combined effects of changes in purchase price, annual operating cost, and household income on the consumer purchase decision.

2.9 NATIONAL IMPACT ANALYSIS

The national impact analysis assesses the NPV of total consumer costs and benefits. DOE determined both the NPV and the national energy savings (NES) for the efficiency levels considered for both product classes of microwave ovens. To make the analysis more accessible and transparent to all stakeholders, DOE prepared an NES spreadsheet model in Microsoft Excel to forecast energy savings and the national economic costs and savings resulting from new standards. The NES spreadsheet model does not use probability distributions for inputs or outputs. To assess the impact of input uncertainty on the NES and NPV results, DOE can conduct sensitivity analyses by running scenarios on input variables that are of interest to stakeholders.

2.9.1 National Energy Savings

The inputs for determining NES are: (1) annual energy consumption per unit; (2) shipments; (3) product stock; (4) national energy consumption; and (5) site-to-source conversion factors. DOE calculated the national energy consumption by multiplying the number of units, or stock, of products (by vintage) by the unit energy consumption (also by vintage).[a] DOE calculated national annual energy savings as the difference between national energy consumption in the base case (without new efficiency standards) and in each higher-efficiency standards case. The analysis included estimated energy savings by fuel type used for generating electricity. DOE estimates energy consumption and savings based on site energy, and then converts the electricity consumption and savings to source energy. Cumulative energy savings are the sum of the annual NES over the forecast period.

The stock of products depends on annual shipments and the lifetime of the product. DOE projected shipments under the base-case efficiency and for various standards-case efficiency scenarios and product efficiency trends. DOE determined that shipment projections under the higher standard efficiency cases were lower than those under the base-case efficiency projection. The projections indicated that higher installed costs would cause some consumers to forego product purchases. As a result, DOE used the higher efficiency standards-case shipments projection and, in turn, the resulting stock of product under that case, to determine the NES. Calculating the NES in this way avoids including savings that result from displaced shipments.

2.9.2 Net Present Value

The inputs for determining NPV are: (1) total annual installed cost; (2) total annual operating cost savings; (3) discount factor; (4) present value of costs; and (5) present value of savings. DOE calculated NPV as the difference between the present value of operating cost savings and the present value of increased total installed costs. It calculated net savings each year as the difference between total operating cost savings (including electricity, repair, and maintenance cost savings) and increases in total installed costs (product price). DOE calculated savings over the life of the product, accounting for differences in yearly energy rates, and used a discount factor to discount future costs and savings to the present.

DOE calculated increases in total installed costs as the product of the difference in the total installed cost between the base case and standards case and the annual shipments in the standards case. Because costs of the more efficient products bought in the standards case are higher than those of products bought in the base case, price increases appear as negative values in the NPV analysis.

DOE expressed operating cost savings as decreases in operating costs associated with the lower energy consumption of products bought in the standards case compared to the base

[a] Vintage represents the age of the equipment.

efficiency case. Total operating cost savings are the product of savings per unit and the number of units of each vintage surviving in a particular year.

2.9.3 Forecasted Efficiencies

Several of the inputs for determining NES (*e.g.*, annual energy consumption per unit) and NPV (*e.g.*, total annual installed cost and total annual operating cost savings) depend on the efficiency of the product. Thus, DOE forecasted efficiencies for the base case and standards cases. The forecasted efficiencies specify the annual average shipment-weighted product efficiencies for future years.

DOE based the development of product efficiencies in the base case on the assignment of product efficiencies in 2014. In other words, DOE determined the distribution of product efficiencies currently in the marketplace to develop a shipment-weighted efficiency for 2014. As described in chapter 10, DOE assumed that forecasted efficiencies remain frozen at the efficiency level in 2014 until the end of the forecast period (2043).

DOE developed standards-case forecasts (*i.e.*, forecasts of efficiency trends after standards take effect) based on a roll-up efficiency scenario. Under a roll-up scenario, all products that operate at performance levels below a prospective standard are moved, or rolled up, to the minimum performance level allowed under the new standard. The distribution of products at efficiency levels above the new minimum standard levels is unaffected (*i.e.*, those products remain at their pre-standard performance levels.) The roll-up efficiency scenario dictates how DOE determines efficiency distributions in the first year a new standard takes effect. As it did for the base case, DOE assumed that forecasted efficiencies under the standards cases remain frozen at the efficiency level in 2014 until the end of the forecast period.

2.10 CONSUMER SUBGROUP ANALYSIS

The consumer subgroup analysis evaluates economic impacts of standards on identifiable groups of consumers who might be disproportionately affected by new or amended energy efficiency standards. DOE evaluated the impacts of particular subgroups of consumers in part by using the LCC spreadsheet model to analyze the LCC and PBP for those particular consumers.

In the case of microwave ovens, DOE analyzed two subgroups: (1) low-income households and (2) households occupied by senior citizens.

2.11 MANUFACTURER IMPACT ANALYSIS

The manufacturer impact analysis (MIA) assesses the impacts of new energy efficiency standards on manufacturers of the considered products. Potential impacts include financial effects, both quantitative and qualitative, that might lead to changes in the manufacturing practices for these products. DOE identified these potential impacts through interviews with manufacturers and other interested parties.

DOE conducted the MIA in three phases, and further tailored the analytical framework based on stakeholder comments. In Phase I, an industry profile was created to characterize the industry, and a preliminary MIA was conducted to identify important issues that required consideration. In Phase II, an industry cash flow model and an interview questionnaire were prepared to guide subsequent discussions. In Phase III, manufacturers were interviewed, and the impacts of standards were assessed both quantitatively and qualitatively. Industry and sub-group cash flow and NPV were assessed through use of the Government Regulatory Impact Model (GRIM). Then impacts on competition, manufacturing capacity, employment, and cumulative regulatory burden were assessed based on manufacturer interview feedback and discussions.

2.12 EMPLOYMENT IMPACT ANALYSIS

Energy conservation standards can affect employment both directly and indirectly. Direct employment impacts are changes in the number of employees at the plants that produce the covered products, and at the affiliated distribution and service companies, resulting from the imposition of new standards. DOE evaluates direct employment impacts in the manufacturer impact analysis. Indirect employment impacts may result from expenditures shifting between goods (the substitution effect) and changes in income and overall expenditure levels (the income effect) that occur because of the imposition of standards.

DOE investigated indirect employment impacts for microwave oven standby power standards using the Pacific Northwest National Laboratory (PNNL)'s "Impact of Sector Energy Technologies" (ImSET) model. PNNL developed the ImSET model for DOE's Office of Planning, Budget, and Analysis. The model estimates the employment and income effects of energy-saving technologies in buildings, industry, and transportation. In comparison with simple economic multiplier approaches, ImSET allows for more complete and automated analysis of the economic impacts of energy conservation investments.

2.13 UTILITY IMPACT ANALYSIS

The utility impact analysis assesses the effect of higher efficiency standards on the electric utility industries. To carry out this analysis, DOE uses a variant of the EIA's National Energy Modeling System (NEMS). NEMS is a large, multi-sectoral, partial-equilibrium model of the U.S. energy sector that EIA has developed over the past decade, primarily for the purpose of preparing the *AEO*. DOE uses a variant known as NEMS-BT to provide key inputs to the analysis.[b]

[a] For more information on NEMS, please refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2000*,

NEMS, which is available in the public domain, produces a widely recognized baseline energy forecast for the United States through 2035. Typical NEMS outputs include forecasts of electricity sales, price, and avoided electric generating capacity. DOE conducted the utility impact analysis as a scenario departing from the latest *AEO* reference case. In other words, DOE modeled the energy savings impacts from amended energy conservation standards using NEMS-BT to generate forecasts that deviate from the *AEO* reference case.

2.14 ENVIRONMENTAL ASSESSMENT

Pursuant to the National Environmental Policy Act and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a), DOE prepared an environmental assessment of the impacts of amended energy conservation standards for microwave oven standby power on the human environment. The primary environmental effects of these standards would be reduced power plant emissions resulting from reduced consumption of electricity. DOE assessed these environmental effects by using NEMS-BT to provide key inputs to its analysis. The portion of the environmental assessment produced by NEMS-BT considers carbon dioxide (CO_2), nitrogen oxides (NO_x), and mercury (Hg). The environmental assessment also considers impacts on SO_2 emissions and discusses particulate matter (PM) emissions. After a brief discussion of general methodology, this section will address each of the relevant emissions. The following section explains how DOE plans to monetize the benefits associated with emissions reductions.

2.14.1 Carbon Dioxide

In the absence of any Federal emissions control regulation of power plant emissions of CO_2, a DOE standard is likely to result in reductions of these emissions. The CO_2 emission reductions likely to result from a standard were estimated using NEMS-BT and national energy savings estimates drawn from the NIA spreadsheet model. The net benefit of the standard is the difference between emissions estimated by NEMS-BT at each standard level considered and the *AEO* Reference Case. NEMS-BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

2.14.2 Sulfur Dioxide

SO_2 emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs, and DOE has preliminarily determined that these programs create uncertainty about the standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in all 50 states and the

DOE/EIA-0581(2000), March 2000. 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 EIA assumptions, DOE refers to the model as NEMS-BT (BT is DOE's Building Technologies Program, under whose aegis this work has been performed). NEMS-BT previously was called NEMS-BRS.

District of Columbia (D.C.). SO_2 emissions from 28 eastern states and D.C. are also limited under the Clean Air Interstate Rule (CAIR, 70 Fed. Reg. 25162 (May 12, 2005)), which created an allowance-based trading program. Although CAIR has been remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), see *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008), it remains in effect temporarily, consistent with the D.C. Circuit's earlier opinion in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2010, EPA proposed the Transport Rule, a replacement for CAIR, which would limit emissions from EGUs in 32 states, potentially through the interstate trading of allowances, among other options. 75 FR 45210 (Aug. 2, 2010).

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, and under the Transport Rule if it is finalized, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emissions allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS-BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

2.14.3 Nitrogen Oxides

A cap on NO_x emissions, affecting electric generating units in the CAIR region, would mean that energy conservation standards may have little or no physical effect on these emissions in the 28 eastern states and the D.C. covered by CAIR or any states covered by the proposed Transport Rule if it is finalized. The standards would, however, reduce NO_x emissions in those 22 states not affected by the CAIR. As a result, DOE used NEMS-BT to estimate the emissions reductions from possible standards in the states where emissions are not capped.

2.14.4 Mercury

Similar to emissions of SO_2 and NO_x, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 Fed. Reg. 28606 (May 18, 2005). CAMR would have permanently capped emissions of mercury for new and existing coal-fired power plants in all states by 2010. However, on February 8, 2008, the D.C. Circuit issued a decision in *New Jersey v. Environmental Protection Agency*, in which it vacated CAMR. 517 F.3d 574 (D.C. Cir. 2008). EPA has decided to develop emissions standards for power plants under the Clean Air Act (Section 112), consistent with the D.C. Circuit's opinion on CAMR. See http://www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf. Pending EPA's forthcoming revisions to the rule, DOE is excluding CAMR from its Environmental Analysis. In the absence of CAMR, a DOE standard would likely reduce Hg emissions and DOE used NEMS-BT to estimate these emission reductions. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

2.14.5 Particulate Matter

DOE acknowledges that particulate matter (PM) exposure can impact human health. Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant are in the form of particulates as they leave the smoke stack. These are direct, or primary, PM emissions. However, the great majority of PM emissions associated with power plants are in the form of secondary sulfates, which are produced at a significant distance from power plants by complex atmospheric chemical reactions that often involve the gaseous (non-particulate) emissions of power plants, mainly SO_2 and NO_x. The quantity of the secondary sulfates produced is determined by a very complex set of factors including the atmospheric quantities of SO_2 and NO_x, and other atmospheric constituents and conditions. Because these highly complex chemical reactions produce PM comprised of different constituents from different sources, EPA does not distinguish direct PM emissions from power plants from the secondary sulfate particulates in its ambient air quality requirements, PM monitoring of ambient air quality, or PM emissions inventories. For these reasons, it is not currently possible to determine how the amended standard impacts either direct or indirect PM emissions. Therefore, DOE is not planning to assess the impact of these standards on PM emissions. Further, as described previously, it is uncertain whether efficiency standards will result in a net decrease in power plant emissions of SO_2 and NO_x, since those pollutants are now largely regulated by cap and trade systems.

2.15 MONETIZING CARBON DIOXIDE AND OTHER EMISSIONS REDUCTIONS

DOE considered the estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that are expected to result from each of the standard levels considered.

In order to estimate the monetary value of benefits resulting from reduced emissions of CO_2 emissions, it is DOE’s intent to use in its analysis the most current Social Cost of Carbon (SCC) values developed and/or agreed to by interagency reviews. The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

At the time of this analysis, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010, expressed in 2010$, were $4.9, $22.3,

$36.5, and $67.6 per metric ton. For emissions that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although DOE will give preference to consideration of the global benefits of reducing CO_2 emissions. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

DOE recognizes that scientific and economic knowledge continues to evolve rapidly as to the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy. Thus, these values are subject to change.

DOE also estimated the potential monetary benefit of reduced NO_X emissions resulting from the standard levels it considered. For NO_x emissions, available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $450 to $4,623 per ton in 2010$).[c] In accordance with U.S. Office of Management and Budget (OMB) guidance, DOE will conduct two calculations of the monetary benefits derived using each of the economic values used for NO_x, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[d]

DOE does not plan to monetize estimates of Hg in this rulemaking. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

2.16 REGULATORY IMPACT ANALYSIS

Pursuant to Executive Order 12866 ("Regulatory Planning and Review," 58 FR 51735, October 4, 1993), DOE prepared a regulatory impact analysis (RIA), which was subject to review under the Executive Order by the Office of Information and Regulatory Affairs at the Office of Management and Budget. The RIA evaluated non-regulatory alternatives to standards in terms of their ability to achieve significant energy savings at a reasonable cost, and compared the effectiveness of each to the effectiveness of the proposed standards.

DOE recognizes that voluntary or other non-regulatory efforts by manufacturers, utilities, and other interested parties can result in substantial improvements to energy efficiency or reductions in energy consumption. DOE considered the likely effects of non-regulatory

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[c] For additional information, refer to U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, 2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities, Washington, DC.
[d] OMB, Circular A-4: Regulatory Analysis (Sept. 17, 2003).

initiatives on product energy use, consumer utility, and LCC. DOE based its assessment on the actual impacts of any such initiatives to date, but also considered information presented regarding the impacts that any existing initiative might have in the future.