CHAPTER 2. ANALYTIC FRAMEWORK

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CHAPTER 2. ANALYTIC FRAMEWORK

2.1 INTRODUCTION

Section 342(a)(6)(A) of the Energy Policy and Conservation Act (EPCA) requires the Department of Energy (DOE) to set forth energy conservation standards that are technologically feasible and economically justified and would result in significant energy conservation. This chapter provides a description of the general analytical framework that DOE uses in developing such standards, with particular focus on residential furnaces and boilers. Essentially, the analytical framework is a description of the methodology, the analytical tools, and relationships among the various analyses that are part of this rulemaking. For example, the methodology that addresses the statutory requirement for economic justification includes analyses of life-cycle cost (LCC), economic impact on manufacturers and users, national benefits, impacts on utilities, and any impacts from lessening of competition.

Figure 2.1.1 summarizes the analytical components of the rulemaking process. The focus of this figure is the center column, identified as "Analysis." The columns labeled "Key inputs" and "Key Outputs" indicate 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 stakeholders or persons with special knowledge. Key outputs are analytical results that feed directly into the standards-setting process. Dotted lines connecting analyses indicate types of information that feed from one analysis to another.

The analyses DOE performs in the advance notice of proposed rulemaking (ANOPR) stage include:

- A market and technology assessment to characterize the relevant equipment markets and existing technology options.
- A screening analysis to review each technology option and determine if it is practicable to manufacture, install, and service; if it would adversely affect equipment utility or equipment availability; or if it would have adverse impacts on health and safety.
- A markup analysis to describe how manufacturing costs are marked up to obtain retail prices.
- An engineering analysis to develop cost/efficiency relationships that show the cost of achieving increased efficiency.
- An LCC and payback period (PBP) analysis to calculate, at the customer level, the discounted savings in operating costs (less maintenance and repair costs) throughout the estimated average life of the covered equipment, 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 shipments by product class, in the absence or presence of new standards.

- A national impacts analysis to estimate the national net present value (NPV) of total consumer LCC savings and the national energy savings (NES).

The analyses DOE performs in the subsequent notice of proposed rulemaking (NOPR) stage include those listed below. In addition, DOE re-analyzes the work done in the ANOPR stage.

- An LCC subgroup analysis to evaluate variations in key factors (e.g., energy prices, equipment use behavior, installation costs) that might cause a standard to impact particular customer subgroups differently than the overall population.
- A manufacturer impact analysis (MIA) 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 the effects of proposed standards on electric and gas utilities.
- A net national employment impact analysis to assess the aggregate impacts on national employment.
- An environmental assessment to provide estimates of impacts on power plant and site emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulfur dioxide (SO_2).
- A regulatory impact analysis to evaluate major alternatives to proposed standards that could achieve substantially the same regulatory goal.

After the publication of the NOPR, DOE reviews stakeholder comments and revises its analyses as appropriate before issuing the final rule.

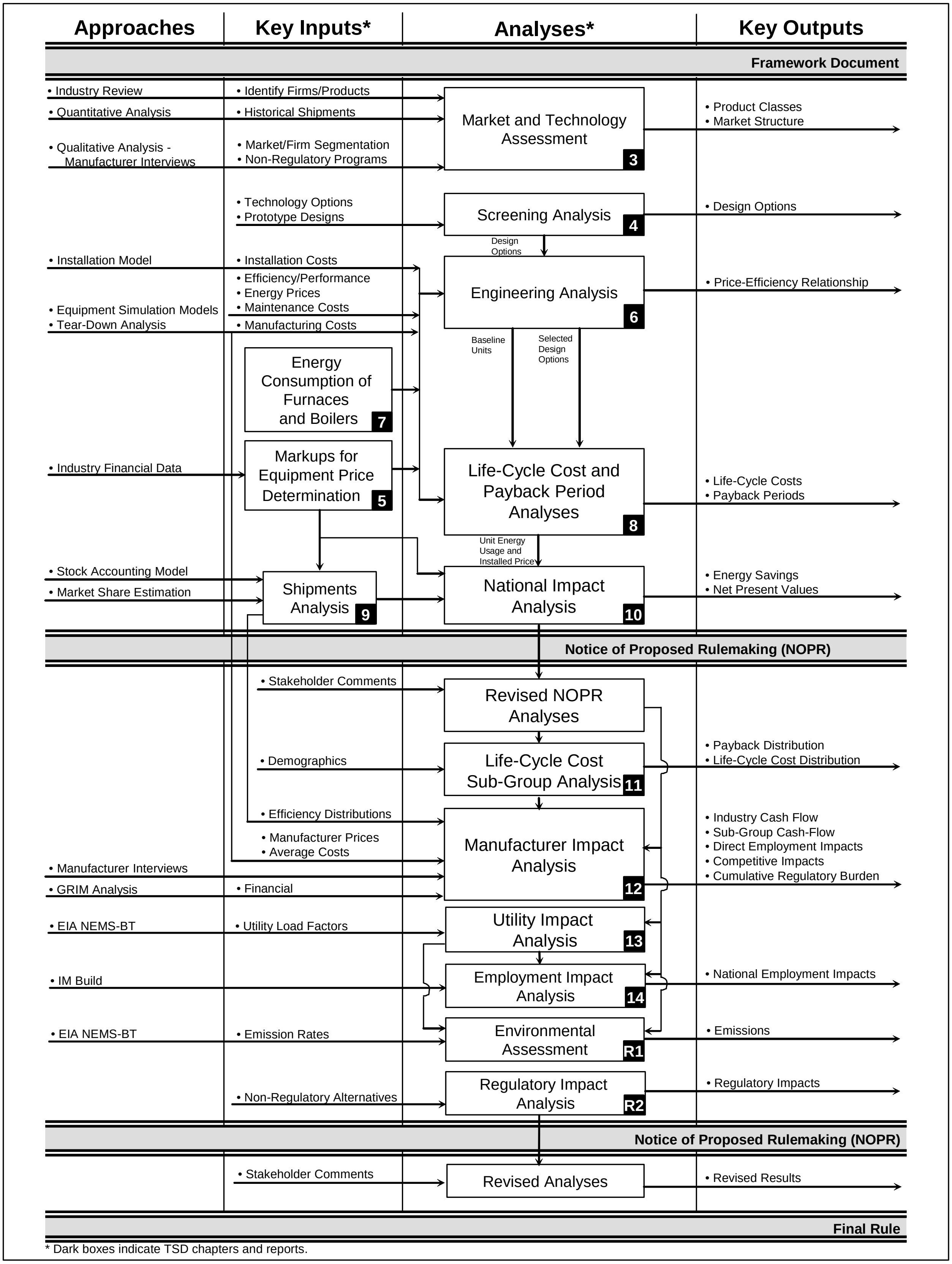

Figure 2.1.1 Analytic Framework for Residential Furnaces and Boilers Rulemaking

2.2 BACKGROUND

As described in Chapter 1, the Process Rule outlined procedural improvements to the standards rulemaking process which included a review of the following elements used in the rulemaking process: (1) economic models; (2) analytical tools; (3) methodologies; (4) non-regulatory approaches; and (5) prioritization of future rules. See appendix A to subpart C of Title 10 Code of Federal Regulations Part 430 (10 CFR Part 430). The Process Rule also required DOE to take into account uncertainty and variability by doing scenario or probability analyses.

DOE developed the analytical framework for the furnace and boiler rulemaking pursuant to the Process Rule. DOE presented this analytical framework to stakeholders during a public meeting on July 17, 2001. The following sections provide a general description of the different analytical components of the rulemaking framework.

2.3 MARKET AND TECHNOLOGY ASSESSMENT

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

2.3.1 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.

DOE reviewed existing marketing materials and literature, and interviewed manufacturers to get an overall picture of the market for furnaces and boilers in the United States. Industry publications and trade journals, government agencies, and trade organizations provided most of the information, including: (1) manufacturer market share, (2) equipment efficiency, and (3) shipments by capacity and efficiency level.

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

2.3.2 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 energy efficiency levels. In consultation with interested parties, DOE develops a list of technologies that it can and should consider in its rulemaking. Initially, these technologies encompass all those considered to be technologically feasible.

DOE developed its list of technologically feasible design options for this rulemaking in consultation with manufacturers of components and systems, and using trade publications and technical papers. Since many options for improving product efficiency are available in existing equipment, product literature and direct examination provided additional information.

2.3.3 Product Classes

EPCA Section 321 (23) states that the term "furnace" includes forced-air and gravity central furnaces and low-pressure steam and hot-water boilers with a heat input of less than 300,000 Btu/hr for boilers and less than 225,000 Btu/hr for furnaces. For this rulemaking, however, DOE adopted the terminology used in the heating, ventilation, and air-conditioning (HVAC) industry, which considers furnaces and boilers as separate categories, within the above size ranges.

Based on the market and technology assessment and stakeholder comments, DOE developed a number of well-defined product classes. (See the ANOPR for residential furnaces and boilers. 58 FR 47326)

- Gas furnaces
  - Non-weatherized
  - Weatherized
- Oil-fired furnaces
  - Non-weatherized
  - Weatherized
- Mobile home furnaces
  - Gas
  - Oil
- Electric resistance furnaces
- Hot water boilers
  - Gas
  - Oil
- Steam boilers
  - Gas
  - Oil
- Combination space/water heating appliances
  - Water-heater/fancoil combination units
  - Boiler/tankless coil combination units

Of the above product classes, DOE included six product classes in the analysis for today's Final Rule, as presented in Chapter 6.

2.4 SCREENING ANALYSIS

The screening analysis examines various technologies as to whether they: (a) are technologically feasible; (b) are practicable to manufacture, install, and service; (c) have an adverse impact on equipment utility or availability; and (d) have adverse impacts on health and safety. As described in section 2.3.2, DOE developed an initial list of efficiency enhancement options from the technologies identified in the technology assessment. Then DOE, in consultation with interested parties, reviewed 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 the engineering analysis, DOE further scrutinized efficiency enhancement options not eliminated in the screening process.

2.5 ENGINEERING ANALYSIS

The engineering analysis establishes the relationship between the cost and efficiency of the equipment concerned. To estimate the cost to consumers of furnaces and boilers, DOE estimated manufacturing costs, markups in the distribution chain, installation costs, and maintenance costs. DOE then calculated payback periods for higher-efficiency equipment, calculating furnace or boiler energy use according to the DOE test procedure, 10 CFR Part 430, subpart B, Appendix N, *Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers*.

2.5.1 Baseline Models

To analyze design options for energy efficiency improvements, DOE defined a baseline model unit for each product class. DOE defined baseline models as appliances with the most popular and cost-effective features that just meet the current minimum efficiency standard. In its selection process, DOE considered technical descriptions of the covered equipment, definitions of the product classes as described in the Framework Document, results of the market assessment, and suggestions from stakeholders.

2.5.2 Manufacturing Cost Analysis

There are several ways to develop the relationship between cost and performance. DOE chose to use a component-based engineering analysis, or teardown analysis. This approach identifies potential technological paths manufacturers could use to achieve increased equipment energy efficiency. DOE purchased “off-the-shelf” units commercially available on the market and physically analyzed them, i.e., dismantled them component-by-component to determine what technologies and designs manufacturers currently employ to increase energy efficiency. DOE then used independent costing methods, along with manufacturer and component-supplier data, to estimate the costs of the components.

DOE determined the efficiency levels corresponding to various design options from commercially available information on products, data submitted by manufacturers, and/or engineering calculations. It obtained cost estimates from detailed incremental manufacturer cost data, which include the cost of the equipment components, labor, purchased parts and materials, shipping/packaging, and investment. DOE estimated manufacturing costs using a combination of teardown analysis, manufacturer-supplied estimates, and its own estimates. It used a single set of cost-efficiency estimates in its analysis, and accounted for variability and uncertainty by using ranges.

The teardown analysis relied on inputs provided by individual manufacturers through a process approved by the Gas Appliance Manufacturers Association (GAMA). Since DOE analyzed only the "off-the-shelf" equipment at hand, the analysis could not capture new combinations of existing technologies or prototypical designs.

2.5.3 Markup Analysis

To carry out the engineering and LCC analyses, DOE needed to determine the cost to the customer of a baseline model furnace or boiler and the cost of more-efficient units. The customer price of such units is not generally known. By applying a multiplier called a "markup" to the manufacturers' costs estimated in the engineering analysis, DOE estimated the customers' prices for baseline model and more-efficient equipment. In addition to estimating average markups, DOE characterized the markups with probability distributions. DOE used these distributions in the LCC analysis.

DOE defined two types of distribution channels that describe how most equipment passes from the manufacturer to the customer. The first distribution channel applies to furnaces and boilers installed in retrofit applications. In this distribution channel, the manufacturer sells the equipment to a wholesaler, who sells it to a contractor, who in turn sells it to the customer. The second distribution channel applies to furnaces and boilers installed in new construction, and thus includes an additional link in the chain—the home builder. In this distribution channel, the manufacturer sells the equipment to a wholesaler, who sells it to a contractor, who in turn sells it to a builder, who in turn sells it to the customer as part of the house.

For each of the markups, DOE further differentiated between a baseline markup and an incremental markup. DOE defines baseline markups as coefficients that relate the manufacturer price of a baseline model to the wholesale or contractor sales price of such equipment. Incremental markups are coefficients that relate changes in the manufacturer price of a baseline model to changes in the wholesale or contractor sales price.

2.5.4 Installation Cost Analysis

To determine installation costs, DOE developed a cost model, called the Installation Model, for the following product classes: non-weatherized gas furnaces, hot water gas boilers, oil-fired furnaces, and oil-fired boilers. DOE used RS Means, a well-known and respected construction cost estimation method, to develop labor costs, and obtained quotes from national distributors to develop material costs. The Installation Model weight-averaged detailed costs for a large variety of typical installations in the field, including both new construction and retrofit installations; single and multifamily housing; plastic, metal, and masonry chimney vents; single and double-wall vent connectors; and common venting with other appliances.

Weatherized gas furnaces and mobile home furnaces have no vent or a very short vent; therefore a venting cost model was not required for these product classes. DOE applied simpler RS Means estimates, and estimates of factory installation costs, to estimate the installation costs for these product classes.

2.6 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSIS

In determining whether an energy efficiency standard is economically justified, EPCA directs DOE to consider the economic impact of potential standards on consumers. To address that impact, DOE calculated changes in equipment LCC for consumers that are likely to result from a candidate standard, as well as PBPs. The effects of standards on individual consumers include changes in operating expenses (usually lower) and changes in total installed cost (usually higher). DOE analyzed the net effect of these changes by calculating the changes in LCC compared to a base case forecast. The LCC calculation considers total installed cost (equipment purchase price plus installation cost), operating expenses (energy and maintenance costs), equipment lifetime, and a discount rate. The analysis compares the LCC of equipment with efficiency improvements designed to meet possible energy-efficiency standards with the LCC of the equipment chosen in the absence of standards.

The PBP represents the number of years of operation required to achieve savings sufficient to pay for the increased efficiency features. It is the change in total installed cost due to an increased efficiency standard divided by the change in annual operating cost from increased efficiency.

DOE conducted the LCC and PBP analysis using a range of typical values to reflect conditions in the field for appliance price and lifetime, fuel costs, energy usage, and discount rates. Much of the input for this analysis came from the engineering analysis. Other major inputs were a database of furnace and boiler specifications, and distributions of manufacturing costs from GAMA.

In previous analyses, DOE estimated the life-cycle costs of consumer energy savings possible from appliance energy efficiency standards based on average energy prices. However, using marginal energy prices (the cost of the last unit of energy purchased or saved) in energy conservation standards analyses is more theoretically sound. In April 1998, the Advisory Committee on Appliance Energy Efficiency Standards recommended that DOE replace the use of national average energy prices with the full range of consumer marginal energy rates in its LCC analyses. In this analysis, DOE used data from DOE's Energy Information Administration (EIA)'s Residential Energy Consumption Survey (RECS) to calculate marginal energy prices for residential consumers.[1]

Using data from RECS, DOE developed a representative sample of households for each of the analyzed product classes. To account for uncertainty and variability among consumers, DOE used a weighted sampling of households with furnaces and boilers from the RECS database. The LCC model uses Monte Carlo simulations to perform the analysis. The model specifies uncertainty and variability in the inputs with probability distributions.

Based on results of the LCC and PBP analysis, DOE selected candidate standard levels for analysis. The national impacts analysis used the outputs of the LCC analysis.

2.7 NATIONAL IMPACT ANALYSIS

The assessment of the aggregate impacts of new standards at the national level reports national energy savings and the NPV of standards for consumers. Analyzing impacts of standards requires a comparison of projected energy consumption with and without new standards. DOE refers to the cases without new standards as base case forecast projections. The forecasts contain projections of annual equipment shipments, unit energy consumption of new equipment, and the total price of purchased equipment.

2.7.1 Shipments Analysis

The shipments forecast estimates the total number of furnaces and boilers of all fuel types purchased in a year and the market shares by product class for furnace and boiler shipments. DOE first developed a base case forecast of equipment shipments in the absence of new standards. This forecast included a distribution of shipments by efficiency level. DOE used an accounting model to track units installed in new construction and existing buildings. It based the retirement of units on the range of lifetimes of the equipment. For non-weatherized gas furnaces, DOE expressed market shares as a function of installed cost and operating cost to capture the impact of standards on fuel choice.

2.7.2 National Energy Savings Analysis

DOE calculated national energy consumption in each year by multiplying the number of units, or stock, of furnaces and boilers (by vintage) by the unit energy consumption (also by vintage). Vintage represents the age of the equipment. DOE calculated national annual energy savings from the difference between national energy consumption in the base case forecast (without new standards) and in each standards case forecast. The analysis includes estimated energy savings by fuel type used for generating electricity. DOE estimated energy consumption and savings based on site energy, and then converted the site energy consumption and savings to source energy. Cumulative energy savings are the sum of the annual NES, which DOE determined over specified time periods.

The stock of equipment is dependent on annual shipments and the lifetime of the equipment. DOE developed shipments projections under the base case forecast and standards case forecasts. Shipments projections under the standards cases are lower than shipments in the base case projection, because of the higher installed cost of the more-efficient equipment. As a result, DOE used the standards case shipments projection and, in turn, the resulting stock of equipment under the standards case, to determine the NES. Calculating the NES in this manner avoids the inclusion of savings resulting from displaced shipments.

The inputs for the determination of NES are: (1) annual energy consumption per unit; (2) shipments; (3) equipment stock; (4) national energy consumption; and (5) site-to-source conversion factors.

2.7.3 Net Present Value Analysis

DOE calculated net savings each year as the difference between total operating cost savings (including energy, repair, and maintenance cost savings) and increases in total installed costs (including equipment price and installation cost). DOE calculated NPV as the difference between the present value of operating cost savings and the present value of increased total installed costs. It discounted future costs and savings to the present with a discount factor.

DOE calculated increases in total installed costs as the product of 1) the difference in the total installed cost between the base case forecast and standards case forecast and 2) the annual sales volume or shipments in the standards case. Because costs of the more-efficient equipment purchased in the standards case are higher than those of equipment purchased in the base case forecast, price increases appear as negative values in the NPV.

DOE expressed operating cost savings as decreases in operating costs associated with the higher energy efficiency of equipment purchased in the standards case compared to the base case forecast. Total operating cost savings are the product of savings per unit and the number of units of each vintage surviving in a particular year.

The inputs for the determination of 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.

2.8 CONSUMER SUBGROUP ANALYSIS

The consumer subgroup analysis evaluates economic impacts on subgroups of consumers, particularly those who might be adversely affected by any change in the national energy efficiency standards levels for the equipment concerned. DOE evaluated the impacts of new standards on particular subgroups of consumers by analyzing the LCC and PBP for these particular customers. The consumer subgroup analysis evaluated households with senior-only occupants or low income levels using non-weatherized gas furnaces. DOE also analyzed the impact of standards for non-weatherized gas furnaces on households located in northern (cold-climate) and southern (warm-climate) regions.

DOE evaluated variations in regional energy prices and energy use that might affect the NPV of an energy efficiency standard to consumers subgroups. To the extent possible, DOE obtained estimates of the variability of each input parameter and considered this variability in its calculation of consumers impacts. Variations in energy use for a particular equipment type depend on factors such as climate and building type. DOE performed sensitivity analyses to consider how differences in energy use affect various subgroups of consumers. It was particularly sensitive to increases in the purchase price of furnaces and boilers to avoid a negative economic impact on any identified customer subgroup.

2.9 MANUFACTURER IMPACT ANALYSIS

DOE conducted the MIA after the ANOPR and reported the results in the NOPR. This analysis estimates the financial impact of standards on manufacturers and also calculates the impact of standards on competition, direct employment, and manufacturing capacity within the industry. Three important elements of the MIA approach are the analysis of industry cash flow, the development of a process to consider subgroup cash flow, and the design of a guide to interview manufacturers and others in gathering information.

The policies outlined in the Process Rule resulted in substantial revisions to the analytical framework DOE uses in performing the MIA for each rulemaking. In its Framework Document for this rulemaking, DOE described and obtained comments on the methodology it uses to perform the MIA. It conducts the MIA in three phases. Phase 1 consists of two activities: preparation of an industry characterization and identification of issues. Phase 2 evaluates the industry from a macro perspective. In this phase, DOE uses the Government Regulatory Impact Model (GRIM) to perform an industry cash flow analysis. Phase 3 involves repeating the process described in Phase 2 (the industry cash-flow analysis) but on different subgroups of manufacturers. Phase 3 also entails calculating additional impacts on competition, direct employment, and manufacturing capacity.

2.9.1 Industry Characterization

Phase 1 of the MIA consists of collecting pertinent financial and market information. This activity involves both quantitative and qualitative efforts. Data gathered include market share, corporate operating ratios, wages, employment, and production cost ratios. DOE incorporated these data into the engineering analysis in the estimation of equipment production costs and distribution markups. The sources of information used for Phase 1 include experts from industry as well as reports published by the Gas Appliance Manufacturers Association and the Gas Research Institute, trade journals, the U.S. Census Bureau, and U.S. Securities and Exchange Commission (SEC) 10-K filings.

2.9.2 Industry Cash Flow

Increased efficiency standards affect manufacturers in three ways: 1) by requiring additional investment, 2) by raising production costs, and 3) by affecting revenue because of higher prices, and possibly, lower quantities sold. To quantify these manufacturer impacts, DOE performed an industry cash flow analysis using the GRIM. This analysis used manufacturing costs, shipments forecasts, and price forecasts developed for the LCC and NES analyses. DOE developed financial information, also required as an input to the GRIM, based on publicly available data and manufacturer information confidentially submitted to DOE's contractor.

The GRIM analysis uses a number of factors—annual expected revenues; manufacturer costs such as cost of sales; selling, general and administrative (SG&A) costs; property taxes; and capital expenditures related to depreciation, new standards, and maintenance—to arrive at a series of annual cash flows beginning from before implementation of standards and continuing explicitly for several years after implementation. The analysis calculated industry net present values by discounting the annual cash flows from the period before implementation of standards to some future point in time.

2.9.3 Manufacturer Subgroup Analysis

Assessment of impacts on subgroups of manufacturers is Phase 3 of the MIA. Using industry "average" cost values is not adequate for assessing the variation in impacts among subgroups of manufacturers. Smaller manufacturers, niche manufacturers, or manufacturers exhibiting a cost structure largely different from industry averages could be affected differently. Ideally, DOE would consider the impact on every firm individually. In highly concentrated industries this may be possible. In industries having numerous participants, DOE uses the results of the industry characterization to group manufacturers exhibiting similar characteristics. The financial analysis of the "prototypical" firm performed in the Phase 2 industry analysis can serve as a benchmark against which DOE can analyze manufacturer subgroups.

DOE used the manufacturing cost data collected for the engineering analysis, to the extent practical, in the subgroup impact analysis. To be useful, however, these data were dis-aggregated to reflect the variability in costs between relevant subgroups of firms.

DOE conducted detailed interviews with manufacturers to gain insight into the potential impacts of furnace and boiler standards. During these interviews, DOE solicited the information necessary to evaluate cash flows and to assess impacts on competition, direct employment, and manufacturing capacity. DOE considered company-specific cumulative burden.

2.9.4 Interview Process

The revised rulemaking process under the Process Rule provides for greater public input and for improved analytical approaches, with particular emphasis on earlier and more extensive information gathering from interested parties. The three-phase MIA process drew on multiple information sources, including structured interviews with manufacturers and a broad cross-section of interested parties. DOE conducted interviews during all phases of the analyses, as determined in Phase 1 of the MIA.

The interview process has a key role in the MIA, since it provides an opportunity for manufacturers to privately express their views on important issues. A key characteristic of the interview process is that it is designed to allow DOE to consider confidential information in the rulemaking process.

The initial industry characterization collected information from relevant industry and market publications, industry trade organizations, company financial reports, and product literature. This information aided in the development of detailed and focused questionnaires to perform all phases of the MIA. DOE took steps to ensure that the contents of questionnaires and the list of interview participants were publicly vetted before initiating the interview process.

The Phase 3 (subgroup analysis) questionnaire solicited information on the possible impacts of potential efficiency levels on manufacturing costs, product prices, and sales. Evaluation of the possible impacts on direct employment, capital assets, and industry competitiveness drew heavily on the information gathered during the interviews. The questionnaires solicited both qualitative and quantitative information. DOE requested supporting information whenever applicable.

DOE scheduled interviews well in advance to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire was acceptable, DOE preferred an interactive interview process because it helped clarify responses and provided the opportunity for additional issues to be identified.

DOE requested that interview participants identify all confidential information provided in writing or orally. Approximately two weeks following each interview, DOE provided participants with an interview summary to give them the opportunity to confirm the accuracy and protect the confidentiality of all collected information. DOE considered all the information transmitted, when appropriate, in its decision-making process. However, confidential information is not available in the public record.

DOE's contractor collated the completed interview questionnaires and prepared a summary of the major issues and outcomes. DOE sought public comment on the outcome of the interview process.

2.9.5 Competitive Impact Assessment

Executive Order 12866 directs DOE to consider any lessening of competition that is likely to result from standards. It further directs the Attorney General to gauge the impacts, if any, of any lessening of competition. DOE made an effort to gather and report firm-specific financial information and impacts. The competitive analysis focused on assessing the impacts to smaller, yet significant, manufacturers. DOE based the assessment on manufacturing cost data and on information collected from interviews with manufacturers, consistent with Phase 3 of the MIA. The interview questions pertained to assessing the likelihood of increases in market concentration levels and other market conditions that could lead to anti-competitive pricing behavior. The manufacturer interviews focused on gathering information that would help in assessing asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (e.g., proprietary technologies).

2.10 UTILITY IMPACT ANALYSIS

To estimate the effects of any proposed energy-efficiency standards for furnaces and boilers on the electric and gas utility industry, DOE used a variant of DOE/EIA's National Energy Modeling System (NEMS)[a]. DOE/EIA uses NEMS to produce the *Annual Energy Outlook* (*AEO*). DOE used a variant, known as NEMS-BT, to provide key inputs to the analysis and estimate the impacts on the utility industry from energy efficiency standards. Thus, the utility impact analysis is a comparison between NEMS-BT results for the base case forecast and

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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 the *National Energy Modeling System: An Overview 2000*, DOE/EIA-0581(2000), March, 2000. 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). NEMS-BT was previously called NEMS-BRS.

for policy cases in which proposed standards are in place. The results of the analysis consist of differences between the base case forecast and standards case forecasts for electricity generation, installed capacity, sales, and prices. DOE conducted the utility impact analysis during the NOPR stage of this rulemaking.

In general, the use of NEMS-BT for the utility impact analysis offers several advantages. As the official DOE energy forecasting model, it relies on a set of assumptions that are transparent and have received wide exposure and commentary. NEMS-BT also allows DOE to estimate the interactions between the various energy supply and demand sectors and the economy as a whole. The utility impact analysis reports any changes in installed capacity and generation of electricity by fuel type that resulted from each trial energy efficiency standard level, as well as changes in electricity sales.

DOE conducted the utility impact analysis as a policy deviation from the *AEO*, applying the same basic set of assumptions. For example, the operating characteristics (e.g., energy conversion efficiency and emissions rates) of future electricity generating plants were as specified in the *AEO* reference case, as were the prospects for natural gas supply.

To represent alternative futures, DOE explored deviations from some of the reference case assumptions corresponding to medium growth. Two such alternative scenarios use the high and low economic growth cases of the *AEO*. The high economic growth case assumes higher projected growth rates for population, labor force, and labor productivity, resulting in lower predicted inflation and interest rates, and higher overall aggregate economic growth relative to the reference case. The opposite is true for the low-growth case.

2.11 EMPLOYMENT IMPACT ANALYSIS

DOE estimated the impacts of energy efficiency standards for furnaces and boilers on employment for equipment manufacturers, relevant service industries, energy suppliers, and the economy in general. DOE separated employment impacts into indirect and direct impacts. Direct employment impacts would result if standards led to a change in the number of employees at manufacturing plants and related supply and service firms. Indirect impacts are impacts on the national economy other than in the manufacturing sector being regulated. Indirect impacts might result both from expenditures shifting among goods (substitution effect), and changes in income, which could lead to a change in overall expenditure levels (income effect). DOE defines indirect employment impacts from energy efficiency standards as net jobs eliminated or created in the general economy, as a consequence of increased spending on the purchase price of equipment and reduced customer spending on energy.

DOE found that new furnace and boiler standards increase the total installed cost of equipment but decrease energy consumption, and therefore reduce customer expenditures for energy. Over time, the increased total installed cost would be paid back through energy savings. The savings in energy expenditures could then be spent on new investment and other items. Using an input/output model of the U.S. economy, this analysis sought to estimate the effects on different sectors and the net impact on jobs. It used public and commercially available data sources and software to estimate employment impacts.

DOE uses a spreadsheet model (IMBUILD) to analyze indirect employment impacts. IMBUILD is a special purpose version of the Impact Analysis for Planning (IMPLAN) national input-output model that specifically estimates the employment and income effects of building energy technologies. IMPLAN was developed originally by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency (FEMA) and the Bureau of Land Management (BLM), to assist the Forest Service in land and resource management planning. IMBUILD is an economic analysis system that focuses on those sectors most relevant to buildings, and characterizes the interconnections among 35 sectors as national input-output matrices. The IMBUILD output includes employment, industry output, and wage income. Changes in expenditures due to appliance standards can be introduced to IMBUILD as perturbations to existing economic flows, allowing the estimation of the resulting net national impact on jobs by sector.

2.12 ENVIRONMENTAL ASSESSMENT

DOE conducted an assessment of the impacts of furnace and boiler standards levels on certain environmental indicators. The environmental assessment considered two pollutants, SO_2 and NO_x, and one emission, carbon (tracked in the NEMS-BT as CO_2). For each of the energy efficiency standards levels, DOE calculated total emissions using NEMS-BT and external analyses as needed.

DOE conducted the environmental assessment as a policy deviation from the *AEO*, applying the same basic set of assumptions. DOE's assessment took into account any factors affecting the type of electricity generation and, in turn, the type and amount of airborne emissions being generated by the utility industry.

The results of the environmental assessment are similar to a complete NEMS run as published in the *AEO*. These include power sector emissions for SO_2, NO_x, and carbon, and SO_2 prices, in five-year forecasted increments. DOE reports the outcome of the assessment for each trial standard level as a deviation from the *AEO* reference cases.

2.13 REGULATORY IMPACT ANALYSIS

Under Executive Order 12866, "Regulatory Planning and Review," DOE prepared a draft regulatory impact analysis which would be subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA). 58 FR 51735 (October 4, 1993).

The RIA includes a quantitative analysis of alternatives to energy conservation standards. DOE used the NES Spreadsheet Model (discussed earlier in section 2.7) to calculate the NES and the NPV corresponding to specified alternatives to standards.

As part of the regulatory impact analysis, DOE identified and sought to mitigate the overlapping effects on manufacturers of new or revised DOE energy efficiency standards and other regulatory actions affecting the same equipment. Through manufacturer interviews and literature searches, DOE compiled information on burdens from existing and impending regulations affecting residential furnaces and boilers.

REFERENCES

1. U.S. Department of Energy - Energy Information Administration. *Residential Energy Consumption Survey: Household Energy Consumption and Expenditures 2001*. 2001. (Last accessed May 18, 2005.) <http://www.eia.doe.gov/emeu/recs/recs2001/publicuse2001.html>