CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

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CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

12.1 MANUFACTURER IMPACT ANALYSIS METHODOLOGY

In determining whether a standard is economically justified, the Secretary of Energy is required to consider "the economic impact of the standard on the manufacturers and on the consumers of the products subject to such a standard."[a] The legislation also calls for an assessment of the impact of any lessening of competition as determined in writing by the Attorney General. The Department conducted the manufacturer impact analysis (MIA) to estimate the financial impact of efficiency standards on the residential furnace and boiler industry and to assess the impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative components. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry-cash-flow model adapted for this rulemaking. The key GRIM inputs relate to industry cost structure, shipments, and pricing strategies. The GRIM's key output is the industry net present value (INPV). The model estimates the financial impact of higher efficiency standards by comparing changes in INPV between the base case and the various trial standard levels (TSLs). The qualitative part of the MIA addresses factors such as product characteristics, characteristics of particular firms, and market and product trends, and includes an assessment of the impacts of standards on subgroups of manufacturers.

In the Department's Framework Document published on July 17, 2001, DOE outlined the procedural and analytical approaches for the MIA. As outlined, the Department conducted the MIA in three phases. Phase 1, "Industry Profile," consisted of the preparation of an industry characterization, including data on market share, sales volumes and trends, pricing, employment and financial structure. Phase 2, "Industry Cashflow," focused on the industry as a whole. In this phase, DOE used the GRIM to prepare an industry cashflow analysis. Using publicly available information developed in Phase 1, the Department adapted the GRIM's generic structure to perform an analysis of residential furnace and boiler energy conservation standards. In Phase 3, the "Subgroup Impact Analysis," DOE conducted interviews with manufacturers representing over 80 percent of domestic furnace and boiler sales. This group included large and small manufacturers of furnaces and boilers providing a representative cross-section of the industry. During these interviews, the Department discussed engineering, manufacturing, procurement, and financial topics specific to each company and also obtained each manufacturer's view of the industry as a whole. The interviews provided valuable information that the Department used to evaluate the impacts of a standard on manufacturers' cashflows, manufacturing capacities, and employment levels.

The following subsections describe more specifically the steps DOE took in developing the information on which it based the MIA.

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[a] 42 U.S.C. 6295(O)(2)(B)(i)(I). The Department of Energy's standards program for residential products is conducted under Title III, Part B of the Energy Policy and Conservation Act (EPCA), 42 U.S.C. 6291-6309.

12.1.1 Phase 1: Industry Profile

In Phase 1 of the MIA, the Department prepared a profile of the residential furnace and boiler industry that built on the market and technology assessments originally prepared for the Advanced Notice of Proposed Rulemaking (ANOPR) analysis and subsequently updated for the Notice of Proposed Rulemaking (NOPR) analysis. Prior to initiating the detailed impact studies, DOE collected information on the present and past structure and market characteristics of residential furnace and boiler manufacturing. At that time, DOE collected information on market share, product shipments, markups, and cost structure for various manufacturers. The industry profile includes further detail on product characteristics, estimated manufacturer market shares, the financial situation of manufacturers, trends in the number of firms, the market, and product characteristics of the residential furnaces and boilers industry.

The industry profile included a topdown cost analysis of residential furnace and boiler manufacturers that DOE used to derive cost and preliminary financial inputs for the GRIM (e.g., revenues; material; labor; overhead; depreciation; selling, general and administrative expenses (SG&A); and research and development (R&D) expenses). The Department also used public sources of information to further calibrate its initial characterization of the industry, including Securities and Exchange Commission (SEC) 10–K reports, Moody’s company data reports, Standard & Poor’s (S&P) stock reports, Value Line industry composites, corporate annual reports, the U.S. Census Bureau’s Economic Census, Dun & Bradstreet reports, and industry analyses from Ibbotson Associates and Dow Jones Financial Services.

12.1.2 Phase 2: Industry Cashflow Analysis

Phase 2 of the MIA focused on the financial impacts of new standards on the industry as a whole. Energy conservation standards can affect furnace and boiler manufacturers in three distinct ways: (1) require additional investment, (2) raise production costs, (3) impact revenues through higher prices and, possibly, lower shipments. The analytical tool DOE uses for calculating the financial impacts of standards on manufacturers is the GRIM. To quantify these impacts in Phase 2 of the MIA, the Department performed a cashflow analysis using the GRIM on the residential furnace and boiler industry.

For the industry cashflow analysis, DOE prepared a set of financial parameters based upon public sources of information for use in the GRIM. The Department derived prices from the engineering analysis cost-efficiency curves and estimated typical manufacturer markups from public financial reports and interviews with manufacturers. DOE developed alternative markup scenarios based on discussions with manufacturers during the NOPR phase of the rulemaking. The Department’s shipments analysis, as presented in Chapter 9 of the technical support document (TSD), provided the basis for the shipments projection under each of the trial standard levels in the GRIM. The NES-shipment forecasts were reviewed with manufacturers during the Phase 3 interviews and in some cases, revised shipment scenarios referred to as manufacturers’-shipments forecast were developed to reflect manufacturer data and comments.

12.1.3 Phase 3: Sub-Group Impact Analysis

Using average cost assumptions to develop an industry cashflow estimate is not adequate for assessing differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost structure that differs largely from the industry average could be more negatively impacted. The Department uses the results of the industry characterization to group manufacturers exhibiting similar characteristics.

In the Framework Document and at the ANOPR public meeting, the Department invited stakeholders to comment on the manufacturing subgroups that should be analyzed for the MIA. The Department established six subgroups corresponding to each of the product classes in the ANOPR document. No public comments were received at the public meeting or in response to either document. Consequently, the Department decided to use six subgroups that correspond to each of the product classes in the MIA based upon the market assessment.

Based on this decision, the Department prepared two different interview guides – one for furnaces and one for boilers. These interview guides were used to tailor the GRIM to incorporate unique financial characteristics from both industries. Within each of these industries, the Department contacted companies from its database of manufacturers, which provided a representation of each subgroup. Small and large companies, subsidiaries and independent firms, and public and private corporations were interviewed. The Department also made an effort to interview companies who had previously participated in the Department's rulemaking process for residential furnaces and boilers. The purpose of the meetings was to enhance the Department's understanding of how manufacturer impacts vary with the trial standard levels. During the course of the MIA, the Department interviewed manufacturers representing over 80 percent of domestic furnace and boiler sales, including nine interviews with furnace manufacturers and five interviews with boiler manufacturers. Finally, a GRIM was developed for each of the six subgroups. The industry-wide cashflow analysis is an aggregation of these six subgroups.

The Department also evaluated the impact of the energy conservation standards on small businesses. Small businesses, as defined by the Small Business Administration (SBA) for the furnace and boiler manufacturing industry, are manufacturing enterprises with 750 or fewer employees. The Department created a more tailored version of the interview guide for small furnace and boiler manufacturers. DOE contacted eleven small businesses to determine if they were interested in discussing differential impacts standards would have on their companies. Further discussion of the small business impact analysis is discussed in section 12.1.3.1.

12.1.3.1 Small-Business Manufacturer Subgroup

The Department undertook a small-business subgroup analysis to assess the importance of small businesses within the furnace and boiler industry and understand how the impacts of the energy conservation standards on small businesses might be different from those on large manufacturers. Small businesses, as defined by the Small Business Administration (SBA) for the furnace and boiler industry, are manufacturing enterprises with no more than 750 employees.[a] To prepare a list of eligible companies, the Department constructed a furnace and boiler manufacturers database containing available data from multiple sources, including the Gas Appliance Manufacturers Association (GAMA)'s Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment (2005) and the Department's stakeholder contact list for this rulemaking.[b] The Department also asked stakeholders and GAMA representatives within the residential furnace and boiler industry about information regarding small businesses within the furnace and boiler industry. The Department then selected small businesses if they met the SBA's definition of a small manufacturing facility and had their U.S.-based manufacturing facilities. The Department contacted these manufacturers to assess their interest in participating in an interview. If a small business was interested, the Department sent them a short questionnaire and scheduled a date for discussion.

The Department's database includes approximately eleven small businesses. In addition to the two small businesses that underwent detailed, structured, face-to-face interviews, DOE interviewed three additional small businesses by phone. Upon reviewing the material provided by the small businesses interviewed, DOE found that in general, small manufacturers have the same concerns regarding energy conservation standards as large manufacturers within the furnace and boiler industry. In addition, the Department found no significant differences in the research and development marketing strategies between small businesses and large businesses. Therefore, the Department believes that the GRIM analysis, which models each product class separately, captures and represents the differential impacts on small businesses within the furnace and boiler industry.

12.1.3.2 Niche-Product Manufacturer Subgroup

The Department identified several types of residential furnaces and boilers that are used in particular or unusual applications and have features that differ from those of the vast majority of products available in the marketplace. The Department refers to these types of products as "niche products." During the manufacturer interviews, several manufacturers claimed that certain niche products would not be viable if required to meet higher efficiency standards, and have suggested that the Department maintain efficiency standards at current levels. All of these products are believed to serve relatively small niche markets and as such, the efficiency standards established for these products will have little effect on national energy savings. Further, each of the identified niche products serves some unique utility.

The Department identified the potential niche products through information received during the manufacturer interview process. Table 12.1.1 demonstrates the niche product classes identified by manufacturers.

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[a] Small Business Administration - www.sba.gov/size/indextableofsize.html

[b] http://www.gamanet.org/gama/inforesources.nsf/vAttachmentLaunch/C2AAFB8D41D003F485256E9000607F66/$FILE/0505_gas_fr.pdf

Table 12.1.1 Niche Products Identified During Manufacturer Interviews

Product Class	Potential Niche Products
Non-Weatherized Gas Furnaces	Down-Flow, Non-Weatherized Gas Furnaces
Weatherized Gas Furnaces	Thru-the-Wall, Weatherized Gas Furnaces
Mobile Home Furnaces	Convertible, Compact Design Mobile Home Furnaces
Oil-fired Furnaces	Horizontal Oil Furnaces
Gas Boilers	Steam Gas-fired Boilers
	Outdoor Gas-fired Boilers
Oil-fired Boilers	Steam Oil Boilers

- *Down-flow configuration* - One manufacturer identified non-weatherized gas furnaces with a down-flow configuration as a niche product. The down-flow, or counter-flow, design is used in houses that have an under-the-floor type of heat distribution system. The fan is located above the heat exchanger. The return-air plenum is connected to the top of the unit. The manufacturer believed that manufacturers of down-flow non-weatherized gas furnaces could experience higher conversion expenditures than other non-weatherized gas furnace manufacturers in order to manufacturer products with higher efficiencies due to the location of the heat exchanger. Down-flow, non-weatherized gas furnaces are very similar in design, size, cost, and efficiency as non-weatherized gas furnaces and may not warrant special consideration in this rulemaking.

- *Thru-the-wall configuration* - One manufacturer commented that thru-the-wall weatherized gas furnaces used in replacement applications are tightly space-constrained in two dimensions and identified them as a niche product. Furthermore, manufacturers of these products would have difficulty making products within the condensing range due to these size constraints. However, this manufacturer also believes that products could be manufactured within the range of 78-percent to 83-percent AFUE.

- *Convertible and compact furnaces* - Convertible and compact furnaces are categories of mobile home furnaces that were identified as presenting unique challenges. During manufacturer interviews, one manufacturer identified numerous mobile home furnaces that allow the consumer to switch the type of fuel. The manufacturer also suggested that if mobile home oil-fired furnaces were to have a more stringent energy conservation standard than the energy conservation standard for mobile home gas furnaces, these convertible products may no longer be viable. In addition, the manufacturer stated that customers may be forced to enlarge their existing furnace closet for compact mobile home furnaces to account for the increase in size of a more efficient furnace, which would only be possible at a considerable expense. The present analysis considers the effects of increased energy conservation standards on all mobile home products regardless of fuel type. Therefore, a single, uniform efficiency level for the entire mobile home furnace product class is being considered. Since all mobile home furnaces are space constrained products, the impacts on the entire product class as a result of increased energy conservation standards encompasses the impacts to convertible and compact furnaces.

- *Horizontal configuration* - Horizontal oil-fired furnaces are used in attic spaces or crawl spaces and other locations where the height of the furnace is the constrained dimension. Air enters at one end of the unit through the fan compartment, is forced horizontally over the heat exchanger, and then exits at the opposite end. These types of oil-fired furnaces are typically serviced annually to maintain the rated efficiency of the unit. In order for manufacturers to design a product that will meet an increased minimum energy conservation standard, they usually expand the heat exchanger, which in turn increases the physical size of the unit. Larger, more-efficient units would reduce the crawl or attic space available for maintenance purposes, which could cause an increase in maintenance cost to the consumer. Since maintenance cost is only one of the factors in the life-cycle cost analysis, a small increase in maintenance cost would not likely cause horizontal oil-fired furnace manufacturers to be disproportionately affected by standards.

- *Steam boilers* - Manufacturers identified steam, gas boilers and steam, oil-fired boilers as a niche product class because they are sold primarily into the replacement market in the Northeast. Currently, the National Appliance Energy Conservation Act (NAECA) sets the federal minimum AFUE standards for steam, gas boilers and steam, oil-fired boilers 2-percentage points lower than the AFUE standards for hot water, gas boilers and hot water, oil-fired boilers. Manufacturers stated during the interviews that they believe the differential established by NAECA is appropriate for steam boilers. In addition, manufacturers commented that, as the Department considers increased efficiency standards for these products, steam products have the potential to be eliminated from the market. If the standard level chosen by the Department eliminates steam, gas boilers and steam, oil-fired boilers from the market, manufacturers believe consumers would experience significant impacts because they would be forced to convert their homes to use a hot water boiler rather than a steam boilers and oil-boilers through re-piping and the replacement of the existing radiator.

- *Outdoor boilers* - One manufacturer urged the Department to consider outdoor weatherized gas boilers as a niche product with very low shipments. The manufacturer believes that as the Department increases efficiency standards for these products, the conversions costs exceed the revenues generates by this product.

12.2 MANUFACTURING KEY ISSUES

The first question of each of the MIA interview guides asks: "What are the key issues for your company regarding the furnace and boiler energy conservation standard rulemaking?" This open question initiated dialogue with the manufacturers, enabling them to identify key points that the Department would explore and discuss during the interview. This section describes the issues that the manufacturers interviewed raised most often.

Manufacturers indicated that, for the most part, the risks associated with these issues increase with increasing trial standard level. The first three issues are overall concerns that many manufacturers expressed regardless of product class.

- *Venting* - Venting was the most common concern discussed by manufacturers, both at the

2004 ANOPR public meeting and during the manufacturer interviews. Proper venting is necessary because of the safety and reliability issues associated with corrosion that is caused from condensation within the venting systems at certain efficiency levels. Due to this concern, many manufacturers commented that residential furnaces and boilers cannot be properly or safely vented at certain AFUE levels. Instead, some manufacturers stated that they would choose not to manufacturer an entire line of products at those efficiency levels for which the safety concerns exceed the benefits. To address these concerns, the Department requested additional information from manufacturers. For example, for non-weatherized gas furnaces, the Department requested information from manufacturers on the costs for designing, manufacturing, and selling an entire furnace family at an 81-percent-AFUE efficiency level. The Department used manufacturer responses to update product costs in the engineering analysis and investment figures in the MIA. However, this still does not fully address manufacturer concerns with venting because some manufacturers stated they are not willing to bear the increased risk at any cost.

- *Warranty and liability costs* - Liability under such warranties is based on future product performance and durability. Companies accrue for those costs that they view as probable and that they can reasonably estimate. The costs associated with product performance warranties require estimates over the full term of a product's life and requires management to consider factors such as the extent of future repair needs and the future cost of material and labor to perform the services. Generally, estimated warranty costs are calculated as the ratio of historical warranty costs to historical sales. When no warranty history is available for new or reengineered products, estimated warranty costs are based on the warranty history of similar products. Warranty costs include the cost of labor and parts to repair equipment under warranty and they are usually a component of cost of goods sold (COGS), as are parts costs, raw materials, and factory overhead. Manufacturers generally estimate their future warranty costs for each product line. The number of units that are expected to be repaired or replaced is determined by applying the estimated failure rate, which is generally based on historical experience, to the number of units that have been sold and are still under warranty. The estimated units to be repaired under warranty are multiplied by the average cost to repair or replace such products to determine the Company's estimated future warranty cost. Warranty costs as a percentage of sales for heating equipment manufacturers are generally in the range of one to two percent. Manufacturers of furnaces and boilers stated that the development, manufacture, sale, and use of the products at near-condensing levels would increase the risk of warranty and product liability claims, and that such claims could be substantial and have a significant adverse effect on their future profitability. During the interviews, manufacturers indicated that their warranty costs could double or even triple. Considering that earnings before interest and taxes are typically about seven percent for manufactures of furnaces and boilers, this level of increase in warranty costs could reduce profits by twenty percent or more. Although the Department attempted to quantify the estimated impacts for warranty cost increases in a side analysis, it did not consider the increased warranty costs in its assessment on INPV.

- *Shipments* - Many manufacturers expressed concern during the interviews regarding the shipments forecasted by the NES model. The NES model forecasts the total number of products sold and the efficiency distribution of these products for the base case and all trial standard levels. During the course of the interviews, DOE asked manufacturers to comment on the NES forecasts. For many product classes, manufacturers generally agreed with the projected impacts of standards on total shipments and the distribution mix of efficiencies. However, most manufacturers stated that the shipment levels predicted at higher efficiency levels (trial standard levels 4 and 5) were overestimated. In some cases, they maintained that consumers would stop buying furnaces and boilers and would choose heat pumps and/or combination systems instead. The manufacturers expressed a common view that new construction markets and southern States are most susceptible to product switching. They also noted that higher efficiency standards will affect replacement market sales, where consumers may be more inclined to repair their existing system than to purchase a new system with a costly installation. Finally, manufacturers commented on the predicted distribution of products by efficiency level for the year 2015. In several instances, they provided revised estimates, which the Department used to revise the shipment forecasts in the GRIM. The manufacturers'-shipments forecast and the NES-shipments forecast are further detailed in section 12.3.5 and 12.3.6.

The issues below are specific concerns that many manufacturers expressed at specific AFUE levels associated with a particular product class.

- *Non-weatherized gas furnaces* - Many manufacturers believe that non-weatherized gas furnaces at 81-percent AFUE can not be safely vented. Manufacturers are not willing to accept the risk and/or cost involved in producing a full line of products at 81-percent AFUE. Manufacturers stated there are variations and constraints that must be addressed, which require a margin of safety. The safety margin is needed to account for variations due to manufacturing tolerances, gas quality, vent length and number of bends, altitude, gas fuel pump performance, makeup air conditions, installation location, and installer experience. With increasing minimum efficiency requirements, this margin of safety is diminished and a standard at 81-`percent AFUE does not provide an adequate amount of safety margin.

- *Weatherized gas furnaces* - Some manufacturers of weatherized gas furnaces believe that efficiency levels at or above 81-percent AFUE can not be made safely and reliably due to vent and heat exchanger condensation. Corrosion in the heat exchanger itself can significantly shorten heat exchanger and appliance lifetime. Furthermore, units with economizers also increase the probability of condensation in the vent system.

- *Mobile home furnaces* - Manufacturers of mobile home furnaces expressed concern over a standard of 81-percent AFUE due to a lack of training and experience among installers. In their view, vents are installed improperly more often in mobile homes than on-site built homes and are much more likely to have corrosion problems.

- *Oil furnaces* - Manufacturers of oil-fired furnaces expressed concerns about increased maintenance costs due to sulfur in the fuel and exhaust gas at or above 83-percent AFUE. In addition, one manufacturer expressed concerns over the use of vent dampers in oil-fired furnaces to increase AFUE. Vent dampers trap exhaust gases during standby mode and may cause an undesirable oil-fuel smell in residential homes.

- *Gas and oil-fired boilers* - Boiler manufacturers have concerns regarding condensation at efficiency levels of 84 percent AFUE or greater for gas boilers and 85-percent AFUE or greater for oil-fired boilers. Manufacturers stated that condensation of flue gases for boilers is more variable than for furnaces because there is greater variability in flue temperature. For example, the heat distribution system and the heating load directly impact return water temperature to the boiler, which in turn has a direct impact on the probability of condensation. In addition, other factors affect condensation in a boiler system, including system thermal mass, boiler input rate and efficiency, radiator heat transfer area, and the season in which the boiler operates.

Some of the other key issues that were expressed to the Department during the manufacturer interviews are listed below:

- Material Use - Several manufacturers are concerned with increasing material prices and the availability of raw materials. Raw materials costs have increased from 68 to 70 percent of manufacturer costs to 75 to 78 percent of manufacturer costs in recent years. In addition, there has been a 300-percent to 400-percent increase in demand for AL29-4C and 409 stainless steel.
- Potential reduction in equipment reliability and longevity at higher standard levels.
- Possible loss of affordability and utility of furnaces and boilers to the consumer such as pilot lights.
- Preservation of consumer options.
- Gas quality - The market has seen an increase in gas quality (i.e. the energy content of natural gas) fluctuations. Fluctuations in gas quality directly affect the performance and efficiency of the gas furnace. Manufacturers expressed concern that a variation in gas quality will cause variations in efficiency, which could increase their risk of condensing problems.

12.3 GRIM INPUTS AND ASSUMPTIONS

12.3.1 Overview of the GRIM

The GRIM serves as the main tool for assessing the impact on industry of implementing new efficiency standards. The GRIM is a financial model of the industry that captures the impact of efficiency standards on industry value. The basic structure of the GRIM, illustrated in Figure 12.3.1, is a standard annual cashflow analysis that uses manufacturer prices, manufacturing costs, shipments, and industry financial information as inputs, and accepts a set of regulatory conditions as changes in costs, investments, and associated margins. The GRIM spreadsheet calculates a series of annual cashflows, beginning with the base year of the analysis, 2004, and continuing explicitly to 2038. The model calculates the INPV by summing the stream of annual discounted cashflows during this period.[1]

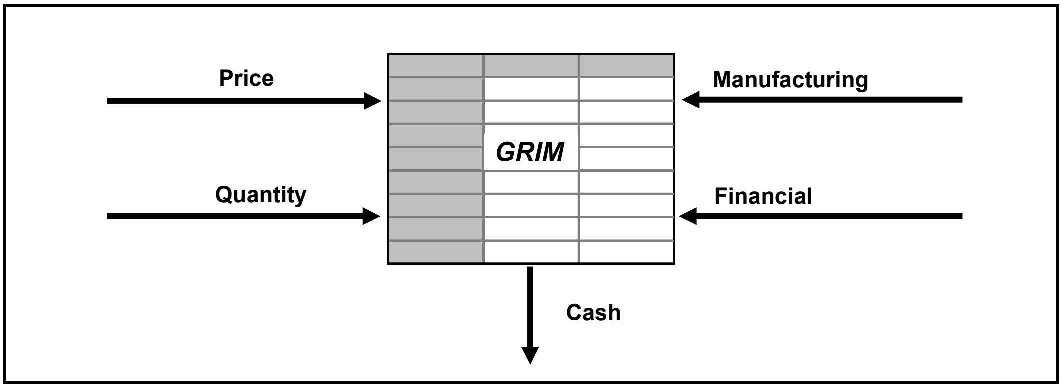

Figure 12.3.1 Using the GRIM to Calculate Cashflow

The Department used the GRIM to project cashflows based upon standard accounting principles and compared changes in INPV between a base case (no change in standard level) and different trial standard levels for the energy conservation standard (the standard case). The difference in INPV between the base case and the standard case(s) represents the primary measure of financial impact of the standard on manufacturers. Appendix Y of the TSD provides more technical detail and user information for the GRIM.

12.3.2 Sources of GRIM Inputs

The GRIM used several different sources for data inputs in determining the cashflows for the industry, including corporate annual reports, credit ratings, the shipments model, the engineering analysis, and the manufacturer interviews.

12.3.2.1 Corporate Annual Reports

Corporate annual reports to the Securities and Exchange Commission (SEC 10-Ks) provided many of the financial inputs to the GRIM.[2] These reports exist for publicly held companies, and are freely available to the general public.

The Department used these annual reports to derive the following draft GRIM inputs:

- Tax rate,
- Working capital,
- Selling, general, and administrative expenses,
- Research and development expenses,
- Depreciation,
- Capital expenditures, and
- Net property, plant, and equipment.

The Department then revised its own estimates of financial parameters through interviews with manufacturers during both the ANOPR and notice of proposed rulemaking (NOPR) phases of the rulemaking. It relied on manufacturer input for these revisions for two reasons. First, many furnace and boiler manufacturers, both large and small, are not public corporations, so industry-wide financial data are not readily available. Second, many manufacturers of furnaces and boilers are diverse businesses that participate in markets that are substantially different from furnace and boiler markets; therefore, the available financial information is not clearly representative of the furnace and boiler market. Table 12.3.1 provides the representative financial parameters that DOE used for each product class.

The Department also used information from the SEC 10-K reports to calibrate the GRIM's base case operating profit margin to be representative of the industry. Operating margin is defined as earnings before interest and taxes, as a percentage of net revenue.

12.3.2.2 Standard and Poor and Moody's Credit Ratings

Standard and Poor[3] (S&P) and Moody's[4] provide independent credit ratings, research, and financial information for a nominal fee. The Department relied on S&P and Moody's reports to determine the industry's average cost of debt for the cost of capital calculation.

12.3.2.3 Shipments Model

The GRIM used shipment projections derived from the Department's shipments model in the national impact analysis. The model relied on historical shipments data provided primarily by the Gas Appliance Manufacturers Association (GAMA) and supplemented by other sources. Weatherized gas furnace shipments were estimated from 1990-1997 shipments of packaged air conditioning equipment. Mobile home gas furnace shipments were estimated from Census Bureau total mobile home placements, and from the American Housing survey. Chapter 9 of the TSD describes the methodology and analytical model DOE used to forecast shipments. Additional shipment projections not included in the shipments model, were developed for the MIA based upon manufacturer information obtained during the interviews.

12.3.2.4 Engineering Analysis

During the engineering analysis, DOE developed reverse-engineering manufacturing cost estimates for furnaces and boilers. DOE's teardown analysis included models that are representative of the efficiency levels and design options available for residential furnaces and boilers impacted by the proposed rulemaking. The analysis provided labor, materials, and overhead production costs[a]. The Department calibrated the reverse-engineering cost model with individual manufacturers' cost data, and aggregated the costs for individual manufacturers to create cost-efficiency curves for the industry. The Department then used the cost-efficiency curves from the engineering analysis as manufacturing cost inputs to the GRIM.

[a] Installation costs have not been included in the GRIM, as these costs are incurred subsequent to sale of the furnace or boiler appliance.

12.3.2.5 Manufacturer Interviews

During the course of the manufacturer impact analysis, DOE conducted interviews with manufacturers representing over 80 percent of the industry. During these discussions, the Department obtained information which it used to determine and verify GRIM input assumptions.

Key topics discussed during the interviews and reflected in the GRIM include:

- Conversion capital expenditures (one-time investments in property, plant, and equipment).
- Product conversion expenses (one-time investments in research, product development, testing, and marketing).
- The portion of the conversion capital expenditures that companies use to replace stranded assets.
- Premium Products.
- Attributes of premium products.
- The current manufacturer and industry ratio of baseline to premium product shipments.
- The predicted change to premium product ratios at each trial standard level.
- The profitability of baseline and premium products.
- Venting Concerns.

All of the information gathered during the manufacturer interviews were taken into consideration for the final manufacturer impact analysis. Copies of the interview guides for residential furnaces and boilers are contained in Appendix Y.

12.3.3 Financial Parameters

Table 12.3.1 provides financial parameters used in the GRIM that represent industry averages based on financial data for public companies engaged in manufacturing and selling residential furnaces and boilers. The values described are averages, over an eight-year period (1996-2003). These public companies are weighted by their market shares in each of the product classes.

Table 12.3.1 GRIM Financial Parameters

Parameter	Industry Weighted Average by Product Class			
	Gas Furnaces	Mobile Home Furnaces	Oil Furnaces	Boilers
Tax Rate (% of Taxable Income)	38%	38%	42%	37%
Working Capital (% of Sales)	9%	22%	23%	23%
SG&A (% of Sales)	18%	17%	21%	21%
R&D (% of Sales)	1.3%	1.0%	1.2%	0.9%
Depreciation (% of Sales)	1.7%	1.8%	2.0%	1.8%
Capital Expenditures (% of Sales)	2.0%	1.8%	1.7%	2.2%
Net Property, Plant, and Equipment (% of Sales)	14%	15%	12%	25%

Source: SEC, 10K Reports, Fiscal Years 1990-2003.

The Department used information from SEC 10-K reports to calibrate the GRIM's operating profit margin against that representative for the industry in the base case. Operating margin is defined as earnings before interest and taxes as a percentage of net revenue.

12.3.4 Corporate Discount Rate

The Department used the weighted average cost of capital (WACC) for each product class within the industry as the discount rate to calculate INPV. A company's assets are financed by a combination of debt and equity. The WACC is the total cost of debt and equity weighted by their respective proportions in the capital structure of the industry.[5] The Department estimated the WACC for the industry based on a few representative companies as described by Equation 1.

$$\mathrm{WACC} = (\mathrm{AfterTaxCostofDebt} \times \mathrm{DebtRatio}) + (\mathrm{CostofEquity} \times \mathrm{EquityRatio}) \qquad \text{Eq. 1.}$$

The cost of equity is the rate of return that equity investors (including, potentially, the company) expect to earn on a company's stock. These expectations are reflected in the market price of the company's stock. The capital asset pricing model (CAPM) provides one widely used means to estimate the cost of equity. According to the CAPM, the cost of equity (expected return) is:

$$\mathrm{CostofEquity} = \mathrm{RiskFreeRateofReturn} + \mathrm{Beta} \times \mathrm{RiskPremium} \qquad \text{Eq. 2,}$$

where:

Risk free rate of return is the rate of return on a "safe" benchmark investment. In practice, investors use a variety of different maturity Treasury notes to estimate the risk-free rate. The Department used a long-term Treasury note return (10-year bond return) in the GRIM because it captures long-term inflation expectations and is less volatile than short-term rates. The risk free rate is estimated as six percent, which is the average 10-year Treasury note return from 1990 to 2004.

Risk premium is the difference between the expected return on stocks and the riskless rate.

Beta is the covariance of a stock with the market as a fraction of the market's variance. The Beta equals one if the stock is perfectly correlated with the S&P 500 market index. A Beta lower than one means the stock is less volatile than the market index.

The Department determined that the industry average cost of equity is 12.1 percent and 10.3 percent as calculated in Table 12.3.3, respectively, for residential furnaces and boilers.

Table 12.3.2 Cost of Equity Calculation

Parameter	Industry-Weighted Average		Manufacturer						
	Furnaces	Boilers	A	B	C	D	E	F	G
(1) Average Beta (1990-2002)	0.65	0.44	0.60	0.93	0.80	0.40	1.26	0.42	0.53
(2) Yield on 10 Year Treasury note (1990-2002)	6%	6%	6%	6%	6%	6%	6%	6%	6%
Cost of Equity (2+1*Risk Premium)	12%	10%	12%	15%	13%	10%	18%	10%	11%
Equity/Total Capital	68%	78%	34%	68%	78%	74%	--	75%	97%

Source: SEC 10-K Reports, Fiscal Years 1990-2003.

Bond ratings are a tool to measure default risk and arrive at a cost of debt. Each bond rating is associated with a particular spread. One way of estimating a company's cost of debt is to treat it as a spread (usually expressed in basis points) over the risk-free rate. The Department used this method to calculate the cost of debt for all five manufacturers. Moody's and S&P had bond ratings for most manufacturers, so the Department used these ratings to estimate the manufacturers' cost of debt by adding the relevant spread to the risk-free rate. There was one manufacturer with no Moody's or S&P bond rating available. In this case, DOE used the company's size and interest coverage ratio to arrive at the spread of corporate debt over risk-free securities. The interest coverage ratio measures a company's ability to service its debt-financing obligation through its earnings.[6]

For the cost of debt, S&P's Credit Services provided the average spread of corporate bonds for public manufacturers over the period 1990-2003. To this, DOE added the industry-weighted average spread to the average Treasury note yield over the same period.[7] Since proceeds from debt issuance are tax deductible, DOE adjusted the gross cost of debt by the industry average tax rate to determine the net cost of debt for the industry. Table 12.3.2 presents the derivation of the cost of debt. Also shown is the capital structure of the industry, i.e. the debt ratio (debt/total capital).[a]

[a] In previous rulemakings, this was based on book value. In this rulemaking, a slightly more accurate debt ratio is based on market value of equity rather than book value. The book value of long-term debt, however, is used to estimate the debt ratio.

Table 12.3.3 Cost of Debt Calculation

	Industry Weighted Average		Manufacturers						
	Furnaces	Boilers	A	B	C	D	E	F	G
Moody/ S&P Bond Rating	- -	- -	B1/ A	BAA1/ BBB	BA2 /BB+	/B-	A2 /A+	A+	CC
(1) Spread over 10 year Treasury note [%]	5	3	1	2	3	9	1	2	12
(2) Yield on 10 year Treasury note [%] (1990-2002)	6	6	6	6	6	6	6	6	6
(3) Gross cost of debt [%] (1)+(2)	11	9	7	8	9	15		8	18
(4) Tax Rate [%]	37.5	37.3	42	26	7	2	9	39	27
Net Cost of Debt (3)*(1 - (4))	6	9	4	6	6	9	5	5	13
Debt/Total Capital [%]	32	22	66	2	2	6	--	25	3

Source: SEC 10-K Reports, Fiscal Years 1990-2003.

The Department estimated the furnace industry's WACC to be approximately 10 percent, and the boiler industry's WACC to be approximately 9 percent. Subtracting an inflation rate of 2.9 percent between 1990 and 2003, the inflation adjusted WACC, and the corporate discount rate used in the GRIM is 7.4 percent and 6.2 percent, respectively. For validation, Ibbotson Associates[8] also provides a weighted average cost of capital for the air-conditioning, warm air-heating, and commercial refrigeration equipment industry; under Standard Industrial Classification (SIC) Code 3585. The Ibbotson nominal WACC is approximately 11 percent, which gives an inflation-adjusted WACC of approximately 8 percent.

12.3.5 NES-Shipment Forecasts

The GRIM estimates manufacturer revenues based on total-unit-shipment forecasts and the distribution of these values by AFUE levels. Changes in the efficiency mix by standard level are a key driver of manufacturer finances. For this analysis, the GRIM used both the NES- and the manufacturers'-shipments forecasts for each product from 2004 to 2038. Total shipments forecasted by the NES for all trial standard levels in 2015 are shown in Table 12.3.4 and are further detailed below.

Table 12.3.4 Total NES-Forecasted Shipments in 2015 (Millions)

Product Class	Base Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Non-weatherized gas furnaces (NWGFs)	2.77	2.77	2.77	2.76	2.74	2.67
Weatherized gas furnaces (WGFs)	0.424					
Mobile home gas furnaces (MHFs)	0.196	0.195	0.195	0.192	0.182	0.182
Oil-fired furnaces (OFs)	0.0879					
Gas boilers (GBs)	0.279					
Oil-fired boilers (OBs)	0.120					

For this analysis, the GRIM used shipment forecasts of each product class for different efficiencies for the years 2004 to 2038. Based on its analysis of the furnaces and boiler industry, DOE assumed that shipments at lower efficiencies were most likely to roll up into higher efficiency levels in response to increases in the efficiency standard. In other words, at an increased minimum standard level, the shipments at efficiencies below the new minimum standard level will be added to the shipments at the new minimum standard level. Tables 12.3.5 through 12.3.10 provide a summary of NES shipments for each product class. Each table includes total unit shipments at each trial standard level for the year 2015 and includes a distribution of shipments by efficiency level. Also included is a forecast of the reduction in total shipments at each trial standard level compared to the base case.

Table 12.3.5 NES Distribution and Total Shipments for Non-Weatherized Gas Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (80%)	TSL 3 (81%)	TSL 4 (90%)	TSL 5 (96%)
78%	2%					
80%	62%	64%	64%			
81%	1%	1%	1%	65%		
90%	9%	9%	9%	9%	73%	
92%	23%	23%	23%	23%	23%	
96%	4%	4%	4%	4%	4%	100%
Total Unit Shipments	2.77	2.77	2.77	2.76	2.74	2.67
Percent Difference in Shipments Relative to Base Case	-	0%	0%	-0.4%	-2.7%	-3.6%

Table 12.3.6 NES Distribution and Total Shipments for Weatherized Gas Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (83%)	TSL 3 (83%)	TSL 4 (83%)	TSL 5 (83%)
78%	2%					
80%	52%	54%				
81%	26%	26%				
82%	20%	20%				
83%	0%	0%	100%	100%	100%	100%
Total Unit Shipments	0.424	0.424	0.424	0.424	0.424	0.424
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	0%

Table 12.3.7 NES Distribution and Total Shipments for Mobile Home Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (75%)	TSL 1 (80%)	TSL 2 (80%)	TSL 3 (81%)	TSL 4 (90%)	TSL 5 (90%)
75%	15%					
80%	80%	95%	95%			
81%	0%	0%	0%	95%		
90%	5%	5%	5%	5%	100%	100%
Total Unit Shipments	0.196	0.195	0.195	0.192	0.182	0.182
Percent Difference in Shipments Relative to Base Case	-	-0.5%	-0.5%	-2.0%	-7.1%	-7.1%

Table 12.3.8 NES Distribution and Total Shipments for Oil Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (82%)	TSL 3 (82%)	TSL 4 (84%)	TSL 5 (85%)
78%	4%					
80%	57%	61%				
81%	9%	9%				
82%	8%	8%	77%	77%		
83%	8%	8%	8%	8%		
84%	8%	8%	8%	8%	92%	
85%	8%	8%	8%	8%	8%	100%
Total Unit Shipments	0.0879	0.0879	0.0879	0.0879	0.0879	0.0879
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	0%

Table 12.3.9 NES Distribution and Total Shipments for Gas Boilers by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (80%)	TSL 1 (82%)	TSL 2 (84%)	TSL 3 (84%)	TSL 4 (84%)	TSL 5 (99%)
80%	35%					
81%	22%					
82%	14%	71%				
83%	15%	15%				
84%	9%	9%	95%	95%	95%	
91%	3%	3%	3%	3%	3%	
99%	3%	3%	3%	3%	3%	100%
Total Unit Shipments	0.279	0.279	0.279	0.279	0.279	0.279
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	0%

Table 12.3.10 NES Distribution and Total Shipments for Oil Boiler by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (80%)	TSL 1 (83%)	TSL 2 (83%)	TSL 3 (83%)	TSL 4 (84%)	TSL 5 (95%)
80%	5%					
81%	5%					
82%	5%					
83%	23%	38%	38%	38%		
84%	23%	23%	23%	23%	61%	
85%	23%	23%	23%	23%	23%	
86%	7%	7%	7%	7%	7%	
90%	7%	7%	7%	7%	7%	
95%	0%	0%	0%	0%	0%	100%
Total Unit Shipments	0.120	0.120	0.120	0.120	0.120	0.120
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	0%

12.3.6 Manufacturers'-Shipments Forecast

The NES forecasts the total number of products sold and the efficiency distribution of these products for the base case and all trial standard levels. During the course of the interviews, manufacturers were asked to comment on the NES-shipment forecasts. For many product classes, manufacturers were in general agreement with the NES results. For other product classes, however, there were different views concerning the impacts of standards on total shipments and distribution mix of efficiencies.

Manufacturers stated during interviews that the NES understated the decline in shipments at increased efficiency levels. In particular, some manufacturers commented that at trial standard level 4 and above, for non-weatherized gas furnaces, they expect consumers to switch to heat pumps or repair their existing equipment due to the increased cost of condensing non-weatherized gas furnaces. Manufacturers also suggested that there will be a market shift away from non-weatherized gas furnaces at 90-percent AFUE and above in the southern climates, where heat pumps are more feasible. One manufacturer expects on the order of a 50-percent drop in shipments at trial standard level 5 and a 25-percent drop in shipments at trial standard level 4 for the non-weatherized gas furnace industry. Manufacturers also expressed their concern that, at trial standard levels 1, 2, and 3, equipment switching alone would cause shipment drops that did not seem to be characterized by the NES.

For weatherized gas furnaces, some manufacturers stated that there would be a decline in shipments for all efficiency levels above the current standard, with more significant declines at 83-percent AFUE. One manufacturer commented that consumers would be more likely to purchase heat pumps because of their reliability, and because of the increased risk of condensation with 83-percent-AFUE furnaces. However, some manufacturers acknowledged that consumers usually buy weatherized gas furnaces with an air-conditioning unit, and the air-conditioning unit is the key driver in consumers' decision.

Manufacturers expressed similar concerns for mobile home furnaces as they did for non-weatherized gas furnaces at and above 90-percent AFUE. They commented that consumers will switch to heat pumps or combination systems rather than make an increased investment in more-efficient mobile home furnaces. For oil-fired furnaces, manufacturers suggested that the industry for this equipment will begin to shrink at trial standard levels 4 and 5. In addition, they foresee a drop in shipments at higher efficiency levels because consumers will either change to alternative heating sources like heat pumps or use propane. Finally, manufacturers of boilers expressed concern that the NES analysis did not forecast any decline in shipments at any of the trial standard levels. They stated that, because of increased first cost, consumers are more likely to choose radiant or electric furnaces than more-efficient boiler systems. One manufacturer recognized that there had already been consolidation within the boiler industry and predicted that increased efficiency standards would cause further consolidation within the boiler industry. Furthermore, other manufacturers stated that they believe that the industry would continue to move toward consolidation even in the absence of increased energy efficiency standards.

The Department took into consideration all of the manufacturers' concerns with the NES-shipments forecast and derived an alternative shipments forecast (referred to as "manufacturers'-shipments forecast") for each product class, based on information received during the manufacturer interviews. Table 12.3.11 shows the manufacturers'-shipments forecast for all trial standard levels in 2015 by product class.

Table 12.3.11 Manufacturers' Forecasted Shipments in 2015 (Millions)

Product Class	NAECA	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Non-weatherized gas furnaces	2.77	2.77	2.77	2.76	2.33	1.49
Weatherized gas furnaces	0.424					
Mobile home gas furnaces	0.196	0.195	0.195	0.192	0.182	0.182
Oil-fired furnaces	0.0879	0.0879	0.0879	0.0879	0.0859	0.0819
Gas boilers	0.279	0.279	0.251	0.251	0.251	0.223
Oil-fired boilers	0.120	0.120	0.120	0.120	0.120	0.0956

The manufacturers'-shipments forecast shows increased declines over the declines forecasted by the NES model for most product classes at increased efficiency levels. Trial standard level 5 shows a more significant decline for all product classes except weatherized gas furnaces. For non-weatherized gas furnaces, the difference between the decline forecasted by the manufacturers' shipments and the decline forecasted by the NES shipments for trial standard levels 4 and 5 is approximately −14 percent and −44 percent, respectively. For weatherized gas furnaces, the Department used the NES-shipments forecast because the prices of the products did not largely vary across trial standard levels and, thus, the Department would not expect a decline in the total shipments. Finally, based on its analysis of the furnace and boiler industry, DOE assumed that shipments at lower efficiencies were most likely to be rolled up into higher efficiency levels in response to increases in the efficiency standard. In other words, at an increased minimum standard level, the shipments at efficiencies below the new minimum standard level will be added to the shipments at the new minimum standard level. The Department took both the NES-shipments forecast and the manufacturers'-shipments forecast into consideration when assessing impacts on the industry.

Manufacturers also commented on the predicted distribution of product sales by efficiency level for the year 2015. In several instances, they provided revised estimates which the Department used to revise the shipment forecasts in the GRIM. The revised shipment scenarios are described in Tables 12.3.12 to 12.3.17. Manufacturers of non-weatherized gas furnaces stated that they assume a slightly higher proportion of condensing units will occur by 2015, driven by higher future heating costs. Weatherized gas furnace manufacturers believe that the efficiency mix will not shift from current distributions because consumers purchase these appliances on the basis of air-conditioning efficiency, not heating. Just like non-weatherized gas furnace manufacturers, oil-fired furnace manufacturers assume a slight increase in efficiency, which will be driven by higher future heating costs. Manufacturers of gas boilers believe that the condensing market for gas boilers will increase dramatically by 2015. Unlike gas boiler manufacturers, oil-fired boiler manufacturers stated that they believed efficiencies of the products on the market will be more sharply distributed at a slightly lower efficiency.

Table 12.3.12 Manufacturer Distribution and Total Shipments for Non-Weatherized Gas Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (80%)	TSL 3 (81%)	TSL 4 (90%)	TSL 5 (96%)
78%	0%					
80%	59%	59%	59%			
81%	0.3%	0.3%	0.3%	59%		
90%	12%	12%	12%	12%	71%	
92%	26%	26%	26%	26%	26%	
96%	4%	4%	4%	4%	4%	100%
Total Unit Shipments	2.77	2.77	2.77	2.76	2.33	1.49
Percent Difference in Shipments Relative to Base Case	-	0%	0%	-0.36%	-15.9%	-46.2%

Table 12.3.13 Manufacturer Distribution and Total Shipments for Weatherized Gas Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (83%)	TSL 3 (83%)	TSL 4 (83%)	TSL 5 (83%)
78%	20%					
80%	50%	70%				
81%	30%	30%				
82%	0%	0%				
83%	0%	0%	100%	100%	100%	100%
Total Unit Shipments	0.424	0.424	0.424	0.424	0.424	0.424
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	0%

Table 12.3.14 Manufacturer Distribution and Total Shipments for Mobile Home Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (75%)	TSL 1 (80%)	TSL 2 (80%)	TSL 3 (81%)	TSL 4 (90%)	TSL 5 (90%)
75%	15%					
80%	80%	95%	95%			
81%	0%	0%	0%	95%		
90%	5%	5%	5%	5%	100%	100%
Total Unit Shipments	0.196	0.195	0.195	0.192	0.182	0.182
Percent Difference in Shipments Relative to Base Case	**-**	-0.5%	-0.5%	-2.0%	-7.1%	-7.1%

Table 12.3.15 Manufacturer Distribution and Total Shipments for Oil Furnaces by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (78%)	TSL 1 (80%)	TSL 2 (82%)	TSL 3 (82%)	TSL 4 (84%)	TSL 5 (85%)
78%	0%					
80%	0%	0%				
81%	82%	82%				
82%	5%	5%	87%	87%		
83%	5%	5%	5%	5%		
84%	5%	5%	5%	5%	96%	
85%	5%	5%	5%	5%	5%	100%
Total Unit Shipments	0.0879	0.0879	0.0879	0.0879	0.0859	0.0819
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	-2.3%	-6.8%

Table 12.3.16 Manufacturer Distribution and Total Shipments for Gas Boilers by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (80%)	TSL 1 (82%)	TSL 2 (84%)	TSL 3 (84%)	TSL 4 (84%)	TSL 5 (99%)
80%	22%					
81%	4%					
82%	22%	48%				
83%	20%	20%				
84%	4%	4%	72%	72%	72%	
86%	8%	8%	8%	8%	8%	
91%	20%	20%	20%	20%	20%	
99%	0%	0%	0%	0%	0%	100%
Total Unit Shipments	0.279	0.279	0.251	0.251	0.251	0.223
Percent Difference in Shipments Relative to Base Case	-	0%	-10.0%	-10.0%	-10.0%	-20.1%

Table 12.3.17 Manufacturers Distribution and Total Shipments for Oil Boilers by Efficiency Level in 2015 (Shipments in Millions)

Shipments Efficiency Level (AFUE)	Base Case (80%)	TSL 1 (83%)	TSL 2 (83%)	TSL 3 (83%)	TSL 4 (84%)	TSL 5 (95%)
80%	5%					
81%	5%					
82%	5%					
83%	23%	38%	38%	38%		
84%	23%	23%	23%	23%	61%	
85%	23%	23%	23%	23%	23%	
86%	7%	7%	7%	7%	7%	
90%	7%	7%	7%	7%	7%	
95%	0%	0%	0%	0%	0%	100%
Total Unit Shipments	0.120	0.120	0.120	0.120	0.120	0.096
Percent Difference in Shipments Relative to Base Case	-	0%	0%	0%	0%	-20.3%

12.3.7 Production Costs

Changes in product costs impact revenues and gross profits. As shown in the engineering analysis, more efficient products cost more to produce. For the MIA, DOE adopted the production costs derived in the engineering analysis, with appropriate production volume assumptions. For instance, high-efficiency products sold under existing efficiency standards are manufactured at lower production volumes than standard-efficiency products. The enactment of higher energy conservation standards will increase production volumes for units with higher efficiencies.

The GRIM included the proportion of costs devoted to labor, materials, freight, depreciation, and non-depreciation overhead that make up the full production cost of these products. The Department estimated the proportion of costs associated with each cost category by deriving sub-curves to the manufacturer cost-efficiency curves developed in the engineering analysis.

Tables 12.3.16 through 12.3.21 provide the production cost assumptions used in the GRIM for each residential furnace and boiler product class analyzed. Costs are presented for baseline model equipment capacities based on the most commonly sold size, as shown in Chapter 6 of the engineering analysis. Overhead excludes depreciation but includes shipping

Table 12.3.18 Unit Production Costs used in the GRIM for Non-Weatherized Gas Furnaces (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
78%	240	58	41	339
80%	242	59	41	342
81%	251	59	42	352
90%	374	63	57	494
92%	441	77	60	578
96%	782	86	79	947

Table 12.3.19 Unit Production Costs used in the GRIM for Weatherized Gas Furnaces (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
78%	543	81	101	724
80%	545	81	101	727
81%	548	81	101	730
82%	551	81	101	733
83%	556	81	102	739

Table 12.3.20 Unit Production Costs used in the GRIM for Mobile Home Furnaces (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
75%	184	40	55	279
80%	207	44	57	308
81%	212	45	58	315
90%	294	55	68	417

Table 12.3.21 Unit Production Costs used in the GRIM for Oil Furnaces (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
78%	379	132	78	589
80%	381	132	78	591
81%	383	132	78	594
82%	385	132	78	596
83%	387	132	79	598
84%	389	132	79	600
85%	394	132	79	605

Table 12.3.22 Unit Production Costs used in the GRIM for Gas Boilers (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
80%	379	64	58	501
81%	410	64	58	532
82%	417	64	60	540
83%	425	64	60	548
84%	430	64	60	554
86%	501	73	63	637
91%	758	63.53	58	879
99%	1094	94.98	136	1325

Table 12.3.23 Unit Production Costs used in the GRIM for Oil Boilers (Cost in 2004 Dollars)

Efficiency Level (AFUE)	Material	Labor	Overhead	Total
80%	513	50	68	631
81%	514	52	69	635
82%	515	55	69	638
83%	516	57	70	642
84%	517	59	70	646
85%	519	63	71	653
86%	521	63	71	655
90%	807	82	162	1051
95%	1282	82	97	1461

12.3.8 Markups

To understand how baseline and premium products are differentiated, DOE reviewed manufacturer catalogs. The data shows that for non-weatherized gas furnaces and mobile home furnaces, available products cluster around two distinct groups, consistent with differentiation based on venting and the presence of an undesirable, near-condensing, efficiency region. The data on model availability for the remaining product classes – weatherized gas furnaces, non-weatherized oil-fired furnaces, and boilers – do not exhibit any particular clustering. However, manufacturers gave strong indications during interviews that while product availability is relatively diffuse for some classes, actual product sales correspond to the existence of baseline and premium products.

Many manufacturers interviewed stated that, for premium products above mandatory standard levels, profitability levels (and corresponding markups) were higher. Manufacturers generally differentiate between baseline and premium products and include both in their mix of product offerings. The Department learned that premium products are usually differentiated from baseline equipment by having higher efficiency levels and additional features. For non-weatherized gas furnaces attributes of premium products include two-stage heating, variable speed blowers, thermostatic controls, and other additional feature sets.

To estimate the manufacturer price of the equipment sold, DOE applied markups to the production costs. For the analysis, DOE considered four distinct markup scenarios based on manufacturer input for each furnace and boiler product class. Scenarios were used to bound the range of expected product prices following standards. For each product class the Department used the markup scenarios that best characterized the prevailing markup conditions and described the range of market responses manufacturers expect as a result of standards.

12.3.8.1 Flat Markups

Under a flat markup strategy, DOE applied a single uniform "flat markup" across all products. A flat markup assumes no differentiation in gross-margin percentage across product efficiency levels. The markup is calculated from industry data using the formula:

$$\text{Markup} = \frac{1}{(1 - \text{GrossMargin})}, \qquad \text{Eq. 3}$$

where:

$$\text{Gross Margin} = \frac{(\text{Revenues} - \text{Cost of Goods Sold})}{\text{Revenues}} \qquad \text{Eq. 4}$$

The Department found differences in the way public manufacturers report Costs of Goods Sold (COGS). Specifically, product warranty and shipping expenses are treated differently; some companies include both of these costs as part of COGS, others only include one of them, and some do not include these items as part of COGS at all. To develop comparable markups across manufacturers, DOE removed warranty, shipping expenses, and depreciation from COGS. The Department arrived at industry-average markups for each product class and the results are presented below in Table 12.3.22.

Table 12.3.24 Flat Manufacturer Markups Used in GRIM

	Product Class Average					
	NWGF	**WGF**	**MHF**	**OF**	**GB**	**OB**
Adjusted Markup	1.40	1.40	1.29	1.40	1.44	1.44

12.3.8.2 Two-Tier Markups

DOE's research on the residential furnaces and boilers industry and feedback from manufacturers indicated that some companies use a two-tier markup strategy on certain product classes. Based on this finding, DOE developed estimates for a two-tier markup strategy. In other words, baseline or commodity products receive one markup and premium or higher-end equipment receive another, higher markup.

The commodity and premium product markups were determined by aggregating market-share, shipment-weighted manufacturer information obtained during the interviews. The markups used are described in section 12.3.8.5.

12.3.8.3 Three-Tier Price Markup

For boilers, DOE learned from manufacturers that pricing is determined on the basis of the three product tiers. During the MIA interviews, manufacturers provided information on the range of typical AFUE levels in these three tiers and the change in profitability for each level. The Department used this information, product costs from its engineering analysis, and industry average gross margins to estimate markups for boilers under a three-tier pricing strategy. These values are described in section 12.3.8.5.

12.3.8.4 Constant Price Markup

For some products, manufacturers believe that they will not be able to recover any incremental product costs resulting from new standards. The Department modeled this situation by assuming that manufacturers would maintain baseline (those units that currently represent the majority of the market) prices constant. In other words, as efficiency improves and production costs increase, constant prices translate into reduced margins for manufacturers.

12.3.8.5 Markup Scenarios

DOE used findings from its various analyses and feedback from manufacturers to determine the appropriate markup scenarios for each product class. These scenarios bound the range of expected profitability levels following standards. Tables 12.3.23 through 12.3.28 exhibit the markup scenarios used for each product class. For the flat markup scenario, DOE used the values indicated in table 12.3.23 for all efficiency levels.

Table 12.3.25 Summary of Markups Scenarios by Product Class

Product Class	Flat Markup	Two-Tier Markup	Three-Tier Markup	Constant Price Markup
NWGF	x (1.40)	x		
WGF	x (1.40)			x
MHF	x (1.29)			
OF	x (1.40)			x
GB	x (1.44)		x	
OB	x (1.44)		x	

Table 12.3.26 Two-Tier Manufacturer Markups for Non-Weatherized Gas Furnaces

Trial Standard Level	AFUE Level					
	78%	80%	81%	90%	92%	96%
Baseline Unit	1.35	1.35	1.35	1.43	1.43	1.43
TSL 1		1.35	1.35	1.43	1.43	1.43
TSL 2		1.35	1.35	1.43	1.43	1.43
TSL 3			1.35	1.43	1.43	1.43
TSL 4				1.35	1.35	1.35
TSL 5						1.35

Table 12.3.27 Constant Price Markups for Weatherized Gas Furnaces

Trial Standard Level	AFUE Level				
	78%	80%	81%	82%	83%
Baseline Unit	1.40	1.40	1.40	1.40	1.40
TSL 1		1.39	1.40	1.40	1.40
TSL 2					1.37
TSL 3					1.37
TSL 4					1.37
TSL 5					1.37

Table 12.3.28 Constant Price Markups for Oil Furnaces

Trial Standard Level	AFUE Level						
	78%	80%	81%	82%	83%	84%	85%
Baseline Unit	1.40	1.40	1.40	1.40	1.40	1.40	1.40
TSL 1		1.40	1.40	1.40	1.40	1.40	1.40
TSL 2				1.38	1.40	1.40	1.40
TSL 3				1.38	1.40	1.40	1.40
TSL 4						1.37	1.38
TSL 5							1.36

Table 12.3.29 Three-Tier Manufacturer Markups for Gas Boilers

Trial Standard **Level**	AFUE Level							
	80%	**81%**	**82%**	**83%**	**84%**	**86%**	**91%**	**99%**
Baseline Unit	1.40	1.40	1.40	1.40	1.47	1.47	1.50	1.50
TSL 1			1.40	1.40	1.40	1.47	1.50	1.50
TSL 2					1.40	1.40	1.50	1.50
TSL 3					1.40	1.40	1.50	1.50
TSL 4					1.40	1.40	1.50	1.50
TSL 5								1.40

Table 12.3.30 Three-Tier Manufacturer Markups for Oil Boilers

Trial Standard Level	**AFUE Level**								
	80%	**81%**	**82%**	**83%**	**84%**	**85%**	**86%**	**90%**	**95%**
Baseline Unit	1.40	1.40	1.40	1.40	1.47	1.47	1.47	1.50	1.50
TSL 1				1.40	1.40	1.40	1.46	1.49	1.49
TSL 2				1.40	1.40	1.40	1.46	1.49	1.49
TSL 3				1.40	1.40	1.40	1.46	1.49	1.49
TSL 4					1.40	1.40	1.40	1.49	1.49
TSL 5									1.40

12.3.8.6 Conversion Costs

New efficiency standards typically cause manufacturers to incur one-time conversion costs to bring their production facilities and product designs into compliance with the new regulation. For the purpose of the MIA, DOE classified these one-time conversion costs into two major groups. Product conversion expenses are one-time investments in research, development, testing, and marketing focused on making product designs comply with the new efficiency standard. Conversion-capital expenditures are one-time investments in property, plant, and equipment to adapt or change existing production facilities so that new product designs can be fabricated and assembled under the new regulation.

12.3.8.7 Product Conversion Expenses

The Department assessed the R&D expenditures manufacturers would be required to invest as a result of the various trial standard levels. DOE gained financial information through manufacturer interviews and presented results in an aggregated form in order to mask any proprietary or confidential information from any one specific manufacturer. For each class and trial standard level, a number of manufacturer replies were summed, and an estimate of total class market share for these taken. The sum of replies was divided by the estimated total product class market share to estimate a figure for the total product class.

Table 12.3.29 summarizes the resulting product conversion costs for all product classes modeled in the GRIM. It should be noted that these conversion costs are above and beyond the normal R&D expenses considered in the GRIM. The GRIM separately accounts for ordinary R&D of approximately 1 to1.3 percent of revenues. From a development and testing standpoint, most manufacturers employ engineers and testing personnel on staff and maintain their own testing facilities. However, insufficient testing facilities represent a bottleneck in the product development cycle for many firms. Manufacturers will have to dedicate their design staff and testing facilities almost exclusively to comply with the new standard, leaving few resources available to conduct their ordinary product development and testing efforts.

Table 12.3.31 Summary of Product Conversion Costs Used in the GRIM (Cost in Million Dollars)

	NWGF	WGF	MHF	OF	GB	OB
TSL 1	0	49	0	3	5	4
TSL 2	0	64	0	5	7	4
TSL 3	60	64	1	5	7	4
TSL 4	62	64	7	9	7	5
TSL 5	90	64	7	9	14	10

12.3.8.8 Conversion-Capital Expenditures

The Department evaluated the level of capital investments needed to comply with energy conservation standards. The size of the products and the time required to fabricate and assemble them increases as efficiency increases. Larger equipment implies not only reduced production capacity, but also reduced warehouse capacity. Therefore, manufacturers must increase plant and warehouse capacity to compensate for larger equipment size resulting from higher standards.

As with product conversion expenditures, the Department developed estimates for capital investments primarily based on manufacturer interview responses including the percentage of assets stranded at each trial standard level. Manufacturers explained how the different trial standard levels impacted their ability to use existing plant, warehousing, tooling, and equipment. From the interviews, the Department was able to estimate what proportion of existing manufacturing assets needed to be replaced and/or reconfigured, and what additional manufacturing assets were required to manufacturer the higher-efficiency equipment. Higher standards usually resulted in a larger proportion of existing assets needing to be replaced.

The capital equipment expenditures were verified using two other approaches. First, estimates were prepared using the manufacturing cost model developed for the engineering analysis. The model assumes an optimized green field plant for a single baseline capacity. As a result, it does not take into account stranded assets. Therefore, it only provides a lower bound for the capital expenditures because there is no replacement capital. Second, the Department estimated the capital requirements assuming the industry would maintain its historical capital structure. The Department estimated plant, property, and equipment requirements as a function of revenue for each trial standard level. Both of these estimates were then compared to the numbers derived from the manufacturer interviews. Any discrepancies were the subject of follow-on discussions and the values were adjusted.

Table 12.3.30 summarizes the resulting capital conversion costs for all product classes. It should be noted that these capital conversion costs are above and beyond the normal capital expenses modeled in the GRIM. The GRIM separately accounts for ordinary capital expenditures of approximately 1.8 to 2.5 percent of revenues. These funds are used for capital improvement projects, cost reduction efforts, and replacement of worn out equipment.

Table 12.3.32 Summary of Conversion Capital Expenses Used in the GRIM (Cost in Million Dollars)

	NWGF	WGF	MHF	OF	GB	OB
TSL 1	0	28	0	0	9	3
TSL 2	0	122	0	0	12	3
TSL 3	113	122	6	0	12	3
TSL 4	163	122	12	4	12	3
TSL 5	280	122	12	5	20	70

12.4 INDUSTRY FINANCIAL IMPACTS

Using the inputs and assumptions described in the previous sections, the GRIM produced indicators of financial impacts on the residential furnace and boiler manufacturing industries. This document reports the results of the MIA on two key financial metrics: net present value and annual cashflows.

12.4.1 Trial Standard Levels

The Department developed four trial standard levels that include combinations of energy conservation standards for both non-weatherized gas furnaces, weatherized gas furnaces, mobile home furnaces, oil-fired furnaces, gas boilers, and oil-fired boilers. The AFUE levels used in the GRIM are presented in Table 12.4.1.

Table 12.4.1 Trial Standard Levels Evaluated in the MIA for Residential Furnaces and Boilers

Trial Standard Level	NWGF	WGF	MHF	OF	GB	OB
NAECA Efficiency	78%	78%	75%	78%	80%	80%
TSL 1	80%	80%	80%	80%	82%	83%
TSL 2	80%	83%	80%	82%	84%	83%
TSL 3	81%	83%	81%	82%	84%	83%
TSL 4	90%	83%	90%	84%	84%	84%
TSL 5	96%	83%	90%	85%	99%	95%

12.4.2 Impacts on Industry Net Present Value

The Department used the INPV in the MIA to compare the financial impacts of different trial standard levels on furnace and boiler manufacturers. The INPV is the sum of all net cash flows discounted at the industry's cost of capital, or discount rate. Because the INPV applies only to the furnace and boiler manufacturing industry, the INPV is different from the NPV that the Department used to assess the cumulative benefit or cost of standards to consumers on a national basis. The GRIM estimated cash flows between 2004 and 2038, which is consistent with the forecasted period used in the national impacts analysis.

The Department compared the INPV of the base case (no new efficiency standard) to that of each trial standard level. The difference in INPV is an estimate of the economic impacts that implementing that particular standard would have on the entire industry. To evaluate the range of cash flow impacts on the industry, the Department constructed up to four different GRIM scenarios for each product class that used different assumptions for markups and shipments, as described above. Tables 12.4.2 through 12.4.7 provide the net present value estimates for the industry under the different scenarios.

Table 12.4.2 Changes in Industry Net Present Value, Non-Weatherized Gas Furnaces*

TSL	Flat Markup, NES Shipments			Two-Tier Markup, NES Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$1,044	-	-	$1,010	-	-
1	$1,044	$0	0%	$1,010	$0	0%
2	$1,044	$0	0%	$1,010	$0	0%
3	$974	($69)	-$7%	$938	($72)	-7%
4	$1,056	$13	1%	$801	($209)	-21%
5	$1,258	$214	21%	$824	($186)	-18%
TSL	**Flat Markup, Manufacturers' Shipments**			**Two-Tier Markup, Manufacturers' Shipments**		
	INPV $MM	**Change in INPV from Base**		**INPV $MM**	**Change in INPV from Base**	
		$MM	**% Change**		**$MM**	**% Change**
Base case	$1,068	-	-	$1,073	-	-
1	$1,068	$0	0%	$1,073	$0	0%
2	$1,068	$0	0%	$1,073	$0	0%
3	$998	($71)	-7%	$1,000	($73)	-7%
4	$980	($88)	-8%	$777	($295)	-28%
5	$807	($261)	-24%	$575	($498)	-46%

* The numbers each column were rounded off and may not add up due to rounding.

Table 12.4.3 Changes in Industry Net Present Value, Weatherized Gas Furnaces*

TSL	Flat Markup, NES Shipments			Constant-Price Markup, NES Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$246	-	-	$246	-	-
1	$220	($27)	-11%	$215	($31)	-13%
2	$199	($47)	-19%	$167	($79)	-32%
3	$199	($47)	-19%	$167	($79)	-32%
4	$199	($47)	-19%	$167	($79)	-32%
5	$199	($47)	-19%	$167	($79)	-32%

* The numbers each column were rounded off and may not add up due to rounding.

Table 12.4.4 Changes in Industry Net Present Value, Mobile Home Gas Furnaces*

TSL	Flat Markup, NES Shipments			Flat Markup, Manufacturers' Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$21	-	-	$21	-	-
1	$21	$0	0%	$21	$0	0%
2	$21	$0	0%	$21	$0	0%
3	$18	($3)	-14%	$18	($3)	-14%
4	$12	($9)	-42%	$11	($10)	-49%
5	$12	($9)	-42%	$11	($10)	-49%

* The numbers each column were rounded off and may not add up due to rounding.

Table 12.4.5 Changes in Industry Net Present Value, Oil Furnaces*

TSL	Flat Markup, NES Shipments			Constant-Price Markup, NES Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$36	-	-	$36	-	-
1	$34	($2)	-5%	$34	($2)	-5%
2	$33	($3)	-8%	$31	($4)	-12%
3	$33	($3)	-8%	$31	($4)	-12%
4	$29	($7)	-19%	$26	($10)	-27%
5	$28	($8)	-21%	$23	($12)	-35%

* The numbers each column were rounded off and may not add up due to rounding.

Table 12.4.6 Changes in Industry Net Present Value, Gas Boilers*

TSL	Flat Markup, Manufacturers' Shipments			Three-Tier Markup, Manufacturers' Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$167	-	-	$167	-	-
1	$166	($1)	-1%	$163	($4)	-3%
2	$155	($12)	-7%	$148	($20)	-12%
3	$155	($12)	-7%	$148	($20)	-12%
4	$155	($12)	-7%	$148	($20)	-12%
5	$140	($27)	-16%	$83	($84)	-50%

* The numbers each column were rounded off and may not add up due to rounding.

Table 12.4.7 Changes in Industry Net Present Value, Oil Boilers*

TSL	Flat Markup, Manufacturers' Shipments			Three-Tier Markup, Manufacturers' Shipments		
	INPV $MM	Change in INPV from Base		INPV $MM	Change in INPV from Base	
		$MM	% Change		$MM	% Change
Base case	$84	-	-	$84	-	-
1	$82	($3)	-3%	$73	($11)	-13%
2	$82	($3)	-3%	$73	($11)	-13%
3	$82	($3)	-3%	$73	($11)	-13%
4	$82	($2)	-2.5%	$72	($12)	-14%
5	$69	($16)	-19%	$46	($38)	-45%

* The numbers each column were rounded off and may not add up due to rounding.

12.4.3 Impacts on Annual Cashflow

While INPV is useful for evaluating the long-term effects of standards, short-term changes in net cash flow are also important and indicative of the impacts on industry during the years between final rule publication and the standard effective date. For example, a large investment over a period of one or two years could strain the industry's access to capital. Consequently, the sharp drop in net cash flow might lead to additional borrowing; changes in leverage, interest coverage ratios, and/or bond ratings; and possibly increased concern among investors. Thus, a short-term disturbance can have long-term effects that the INPV cannot capture. To get an idea of the behavior of annual net cash flows, the Department reports the annual net or free cash flows from 2004 through 2020 for the different trial standard level levels. Figures 12.4.1 and 12.4.12 present the annual net cash flows for the base case and each of the trial standard levels evaluated for the two different markup and shipment scenarios by product class.

Several observations are general to all the industry net cashflow figures. Prior to the effective date, the cashflows are nearly identical for all scenarios after final rule publication. Cashflows are driven by the level of capital investments and product conversion expenses and the proportion of these investments spent every year. In addition, in the year of the standards, a relatively large investment in working capital may be required if total revenues increase. Also, where applicable, a one-time write-down on stranded assets yields a positive increase in cashflows due to lower taxes paid that year. Prior to the standard announcement date, industry cashflows begin to decline as companies use their financial resources to prepare for the new standard. As expected, the more stringent the energy conservation standard, the bigger the impact on industry cashflows.

For greater insight into the behavior of cashflows, consider Figures 12.4.1 for non-weatherized gas furnaces. In this particular case, cashflows for all five trial standard levels show a slight increase around 2004 as unit shipments decline thus freeing cash tied in working capital. By 2010, the behavior of cashflows for different trial standard levels starts to diverge. For instance, the base case, trial standard level 1 and trial standard level 2 have the same slight upward trend. Also starting in 2010, cashflows for trial standard level 3 through trial standard level 5 show significant differences both in terms of the degree and rate of change. For example, trial standard level 3 shows a more gradual decline in net cashflows starting in 2012, approaching zero by 2014 and quickly recovering to pre-standard levels thereafter. By contrast, the more stringent standards considered for trial standard level 4 would force industry to make additional investments in capital and product conversion expenses. In addition, it is worth noting that under trial standard level 4, cashflows cross into negative values in 2013 and then quickly go back to positive cashflows that are even slightly higher, than the base-case cashflows because all standards-induced product costs markup at the same baseline flat markup. Finally, trial standard level 5 shows the most dramatic changes crossing over into negative cashflows by 2011 and peaking at over $200 million in negative cashflows in 2013. Again, the degree and rate of the change is cashflows is tied to the capital investments and production conversion expenses required to conform to the new standard. The recovery under trial standard level 5 is as dramatic, as positive cashflows after implementation of the standard are significantly higher than those for all other trial standard levels. However, four years of significant negative cashflows could have a devastating effect on the industry.

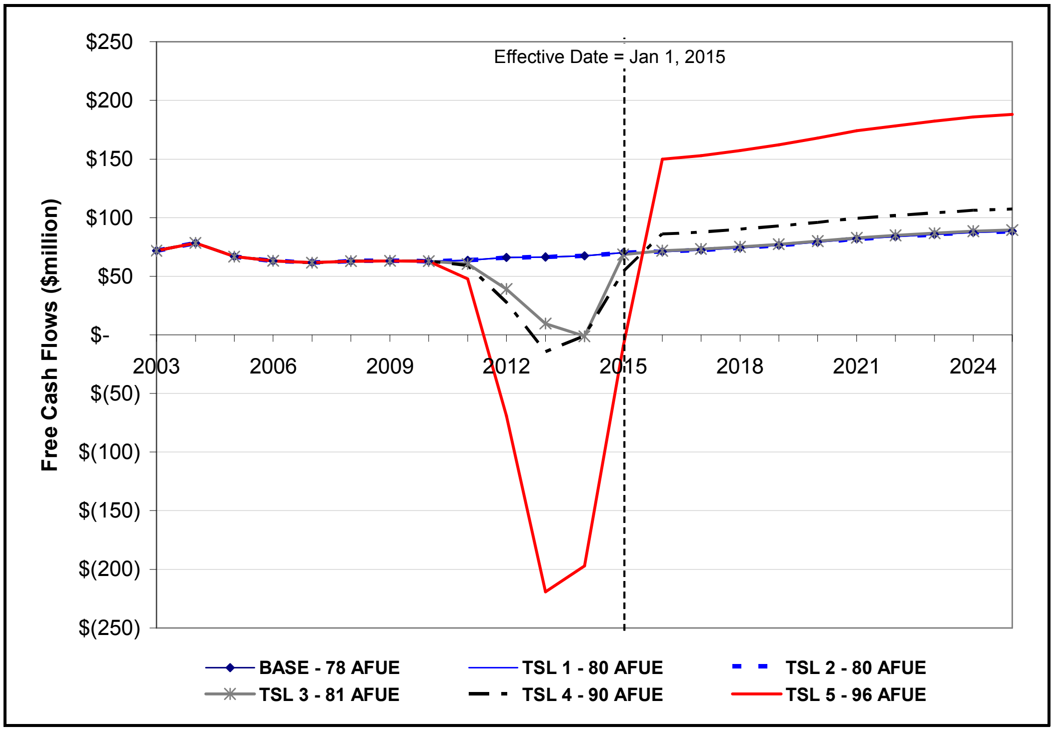

Figure 12.4.1 Industry Net Cashflow for Non-Weatherized Gas Furnaces, NES- Shipments Forecast, and a Flat-Markup Scenario

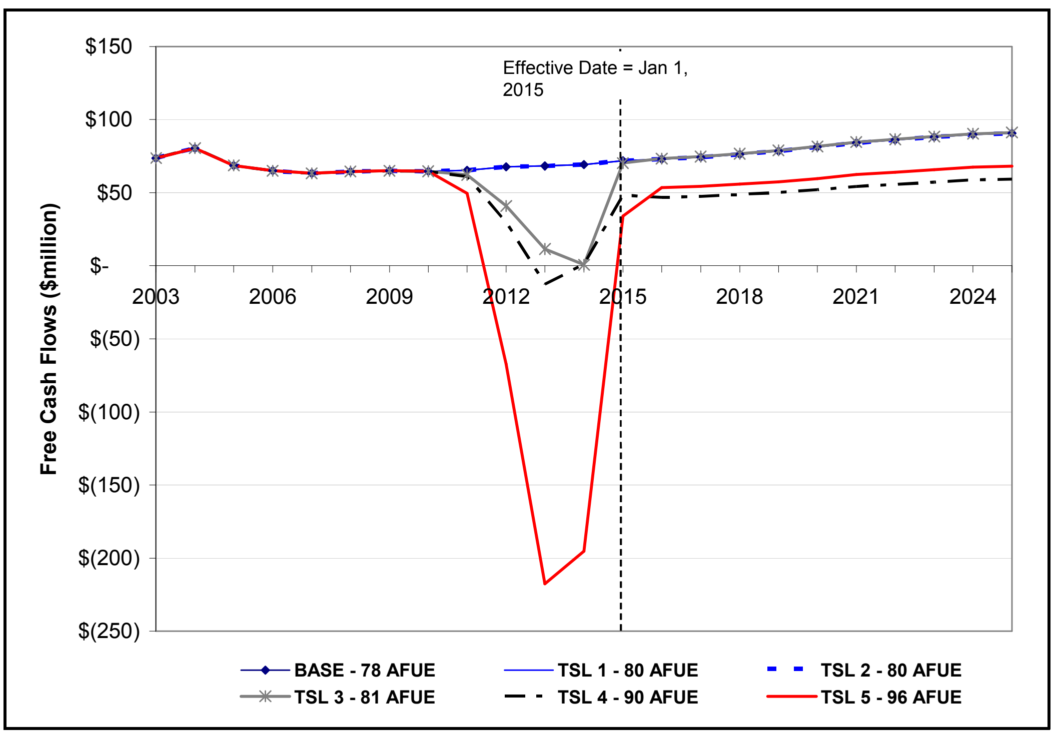

Figure 12.4.2 Industry Net Cashflow for Non-Weatherized Gas Furnaces, Manufacturers'-Shipments Forecast, and a Two-Tier-Markup Scenario

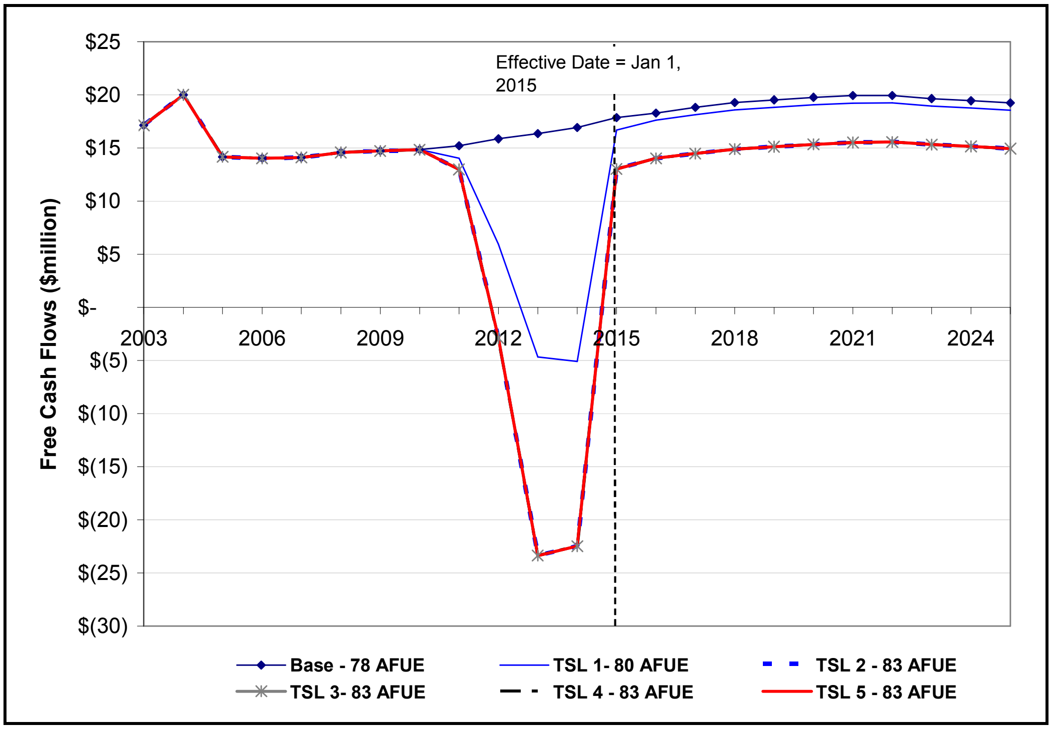

Figure 12.4.3 Industry Net Cashflow for Weatherized Gas Furnaces, NES-Shipments Forecast, and Constant Price-Markup Scenario.

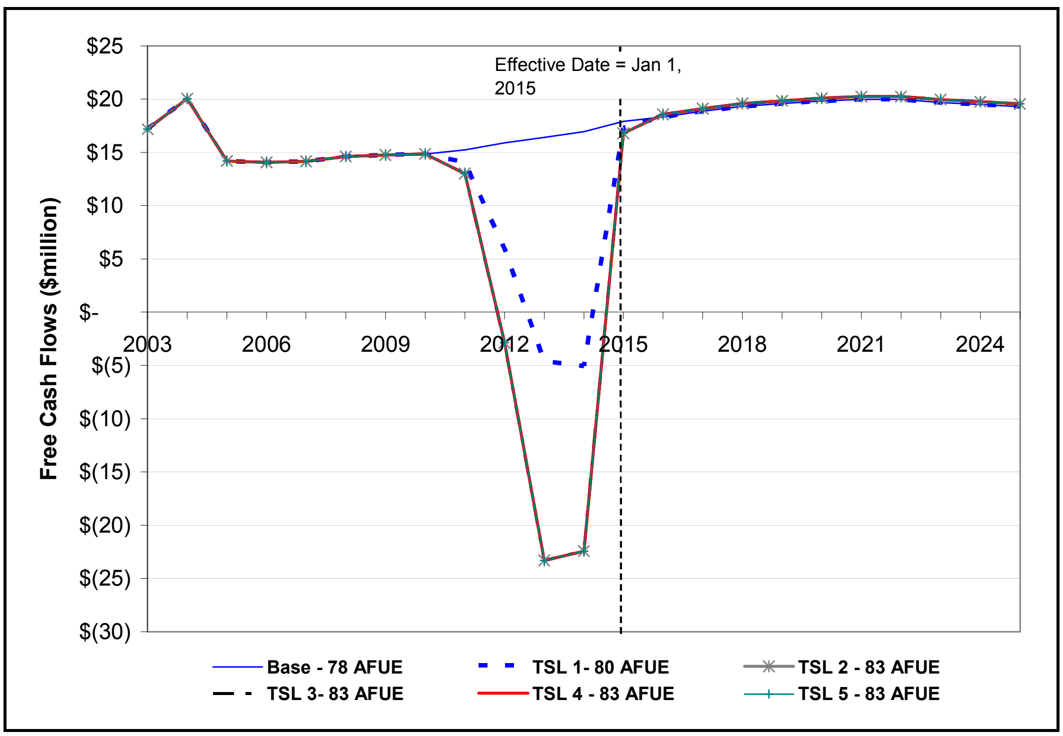

Figure 12.4.4 Industry Net Cashflow for Weatherized Gas Furnaces, NES-Shipments Forecast, and a Flat-Markup Scenario.

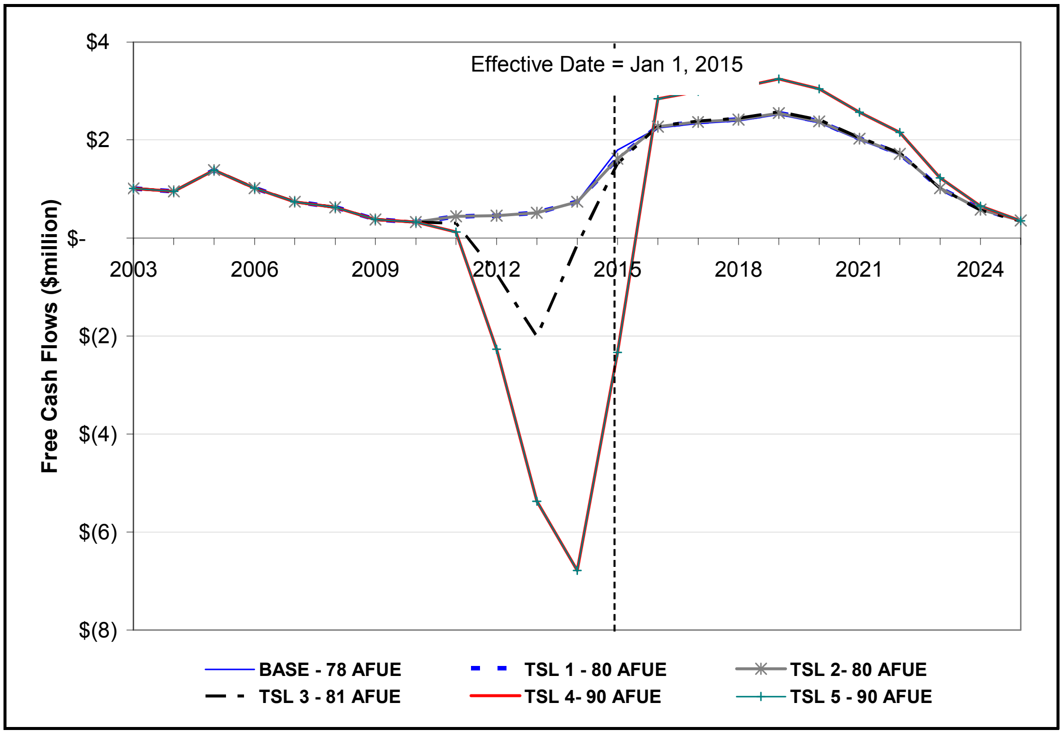

Figure 12.4.5 Industry Net Cashflow for Mobile Home Furnaces, NES-Shipments Forecast, and a Flat-Markup

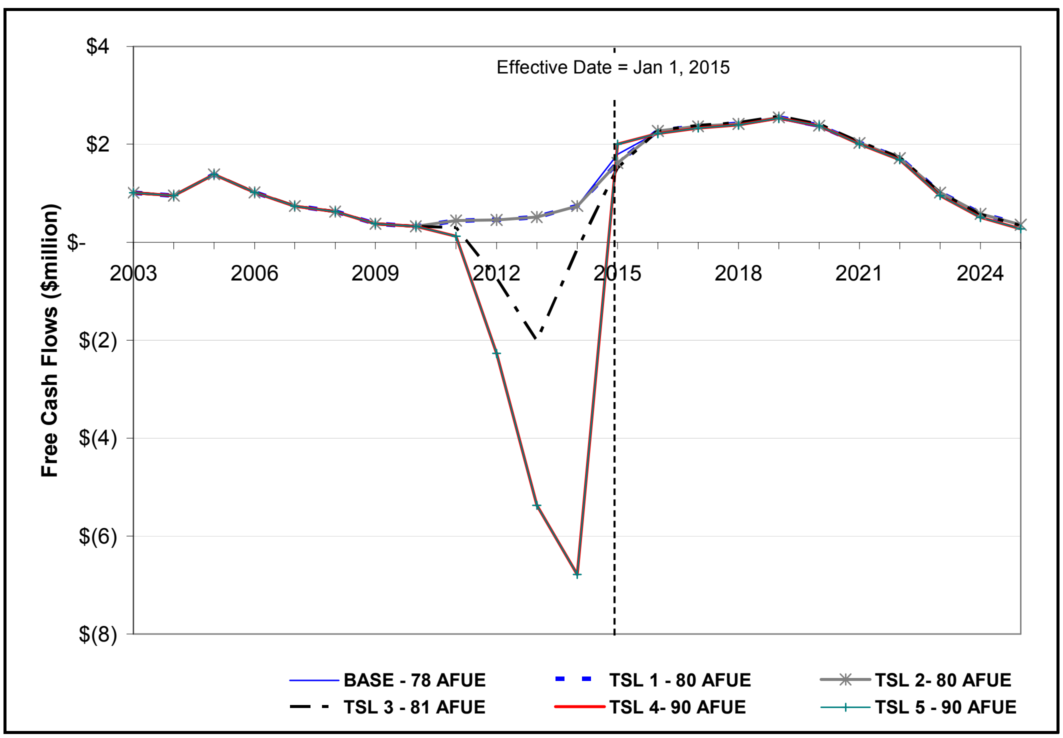

Figure 12.4.6 Industry Net Cashflow for Mobile Home Furnaces, Manufacturers'-Shipments Forecast, and a Flat-Markup Scenario

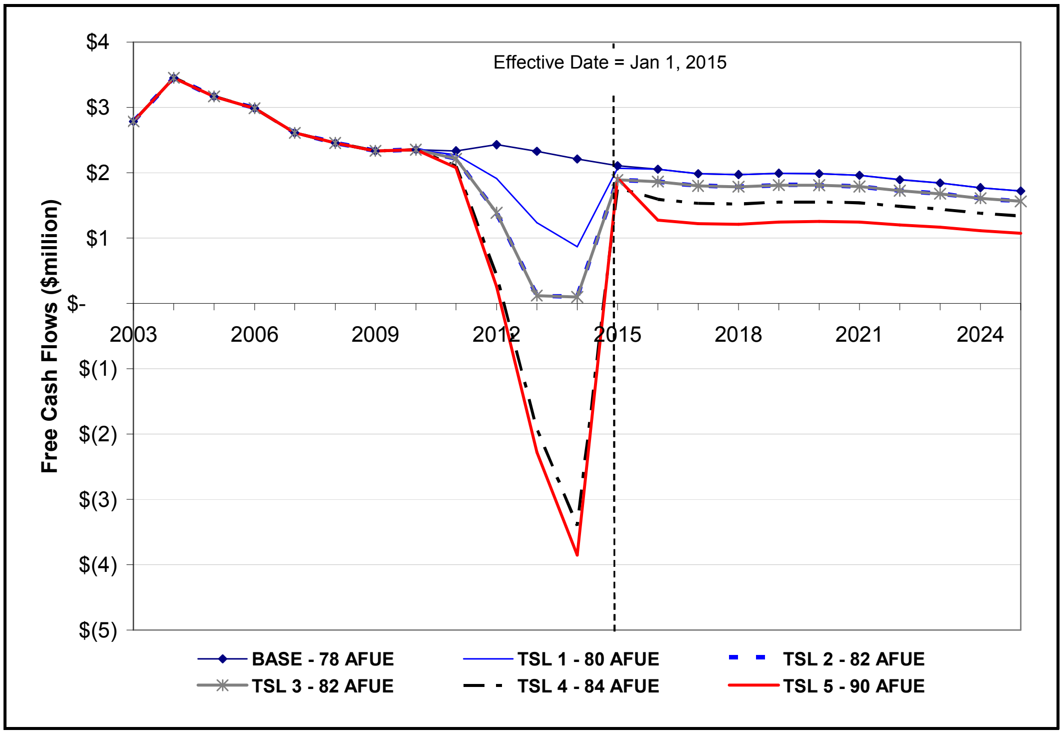

Figure 12.4.7 Industry Net Cashflow for Oil-fired Furnaces, NES-Shipments Forecast, and a Constant Price-Markup Scenario.

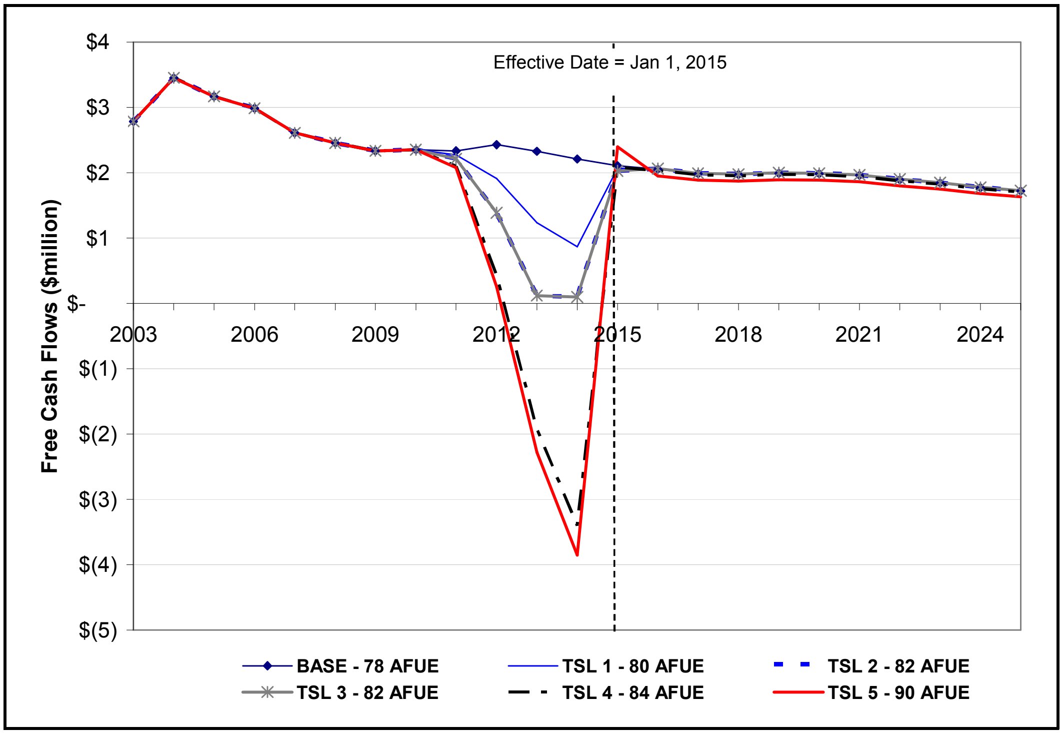

Figure 12.4.8 Industry Net Cashflow for Oil-fired Furnaces, NES-Shipments Forecast, and a Flat-Markup Scenario.

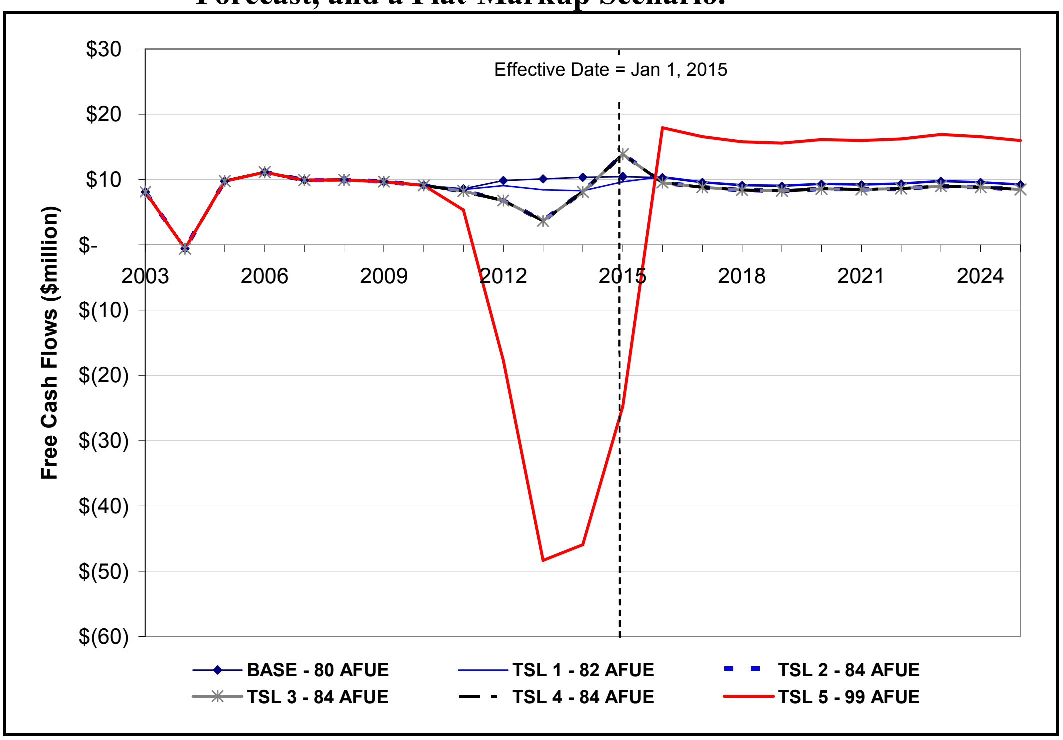

Figure 12.4.9 Industry Net Cashflow for Gas Boilers, Manufacturers'-Shipments Forecast, and a Flat-Markup Scenario.

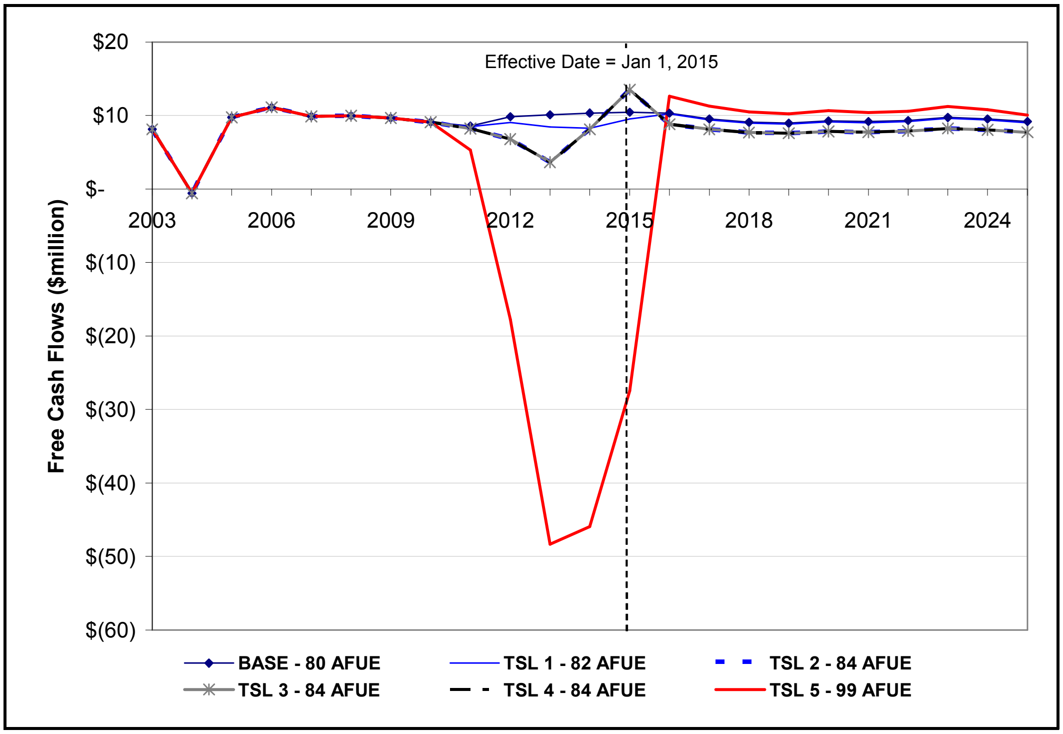

Figure 12.4.10 **Industry Net Cashflow for Gas Boilers, Manufacturers'-Shipments Forecast, and a Three-Tier-Markup Scenario**

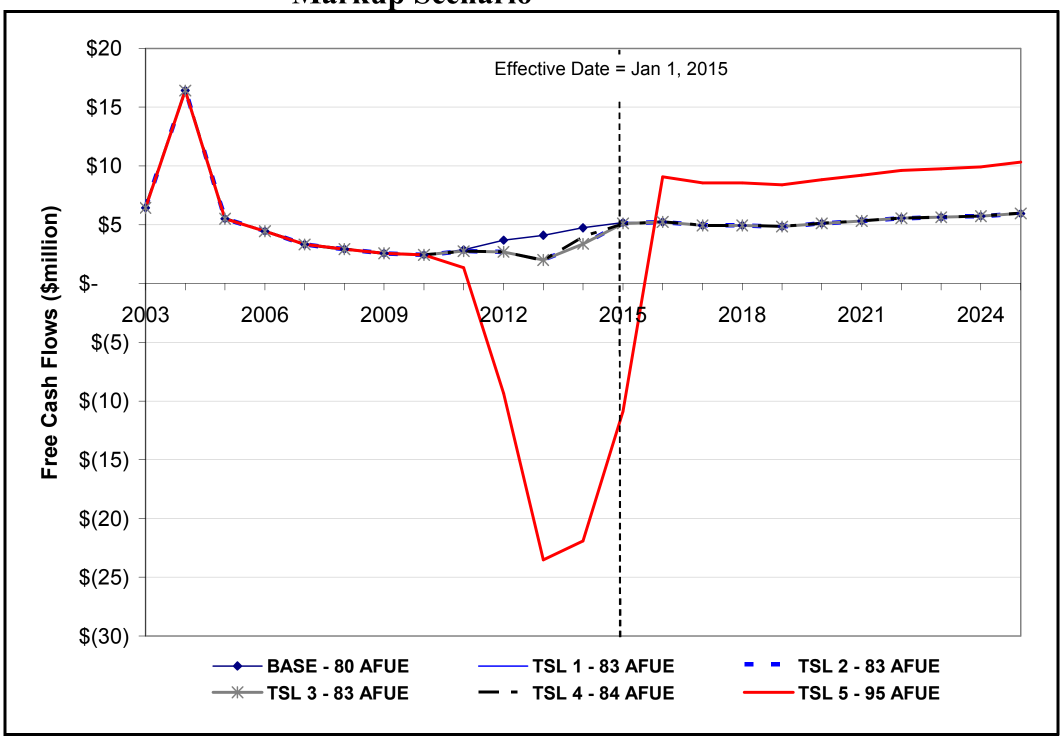

Figure 12.4.11 **Industry Net Cashflow for Oil Boilers, Manufacturers'-Shipments Forecast, and Flat-Markup Scenario**

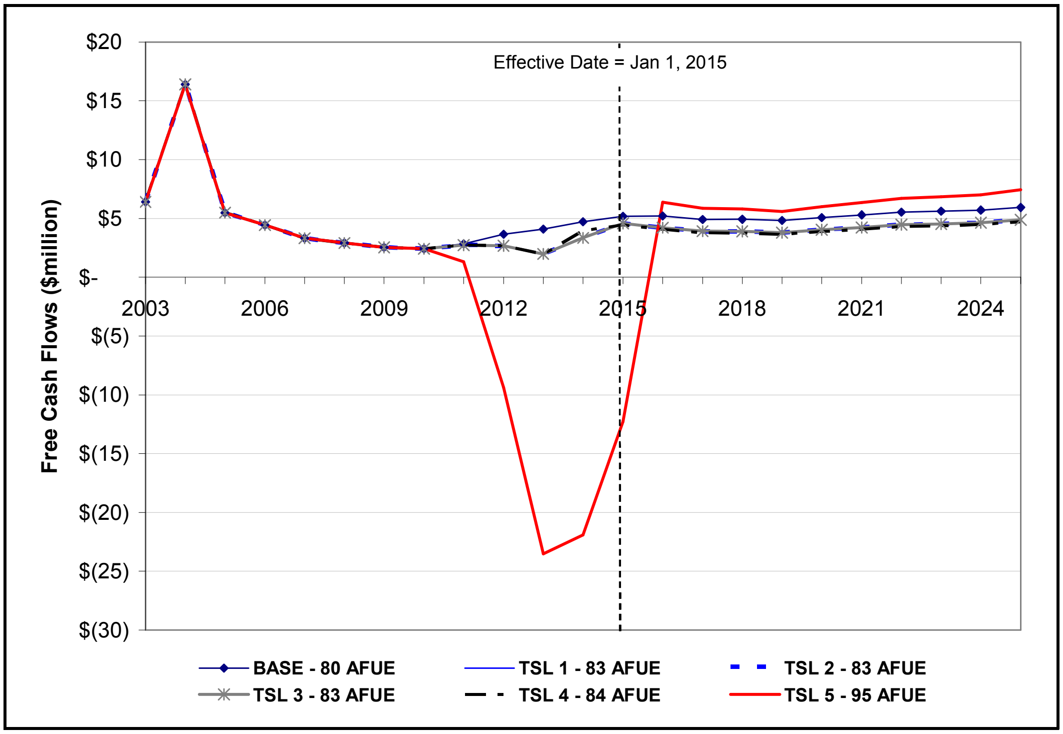

Figure 12.4.12 Industry Net Cashflow for Oil Boilers, Manufacturers'-Shipments Forecast, and Three-Tier-Markup Scenario

12.5 OTHER IMPACTS

12.5.1 Employment

Manufacturers generally indicated that, for each furnace or boiler unit they produce, the amount of labor, and hence direct labor costs, are proportional to the amount of materials costs. Therefore, assuming constant wages and disregarding fluctuations in the market prices of materials, they would expect employment levels to scale with the cost of materials for the industry. The Department incorporated this into the GRIM, which projects labor expenditures annually. Labor expenditures are a function of the labor intensity of the product, the sales volume, and an implicit wage assumption that remains fixed over time.

The Department analyzed employment impacts by estimating the cumulative labor expenses as a percentage of industry revenues for each product class. Table 12.5.1 presents those scenarios with the worst employment impacts for each product class.

Table 12.5.1 Projected Change in Cumulative Labor Expenditures by Product Class using the Scenario with the Greatest Impact (2015 - 2038)

Trial Standard Level					
Scenario	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
Non-Weatherized Gas Furnaces, Two-Tier Markup, Manufacturers' Shipments	0%	0.0%	-0.2%	-13%	-28%
Weatherized Gas Furnaces, Constant Price Markup, NES Shipments	0.02%	0.02%	0.02%	0.02%	0.02%
Mobile Home Furnaces Flat Markup, Manufacturers' Shipments	1.1%	1.1%	0.99%	12.4%	12.4%
Oil-Fired Furnaces Constant Two-Tier Markup, NES Shipments	0%	-0.03%	-0.03%	-1.7%	-6.5%
Gas Boilers Three-Tier Markup, Manufacturers' NES	0%	-10%	-10%	-10%	-18.2%
Oil Boilers Three-Tier Markup, Manufacturers' NES	1.2%	1.2%	1.2%	2.6%	9.1%

The Department's analysis shows significant employment impacts for non-weatherized gas furnaces at trial standard level 4 and 5, mobile home furnaces at trial standard level 4 and 5, and gas boilers at trial standard level 2, 3, 4 and 5. Reductions in labor expenditures are driven primarily by a reduction in unit shipments. Inversely, increases in employment expenditures result from raising industry product costs.

12.5.2 Manufacturing Capacity

To the extent that more stringent energy conservation standards increase the size of the heat exchanger, they could reduce plant throughput, particularly for those plants that are constrained in their heat exchanger fabrication area. The standards thus could necessitate that manufacturers add floor space to their existing plants and warehouses. In addition, assembly and fabrication times could increase for the larger equipment. In an attempt to recoup capacity, manufacturers might need to invest in productivity, or equipment, or consider outsourcing some heat exchanger production.

It is not clear that all new capacity would be added in the United States. During the MIA interviews, several manufacturers stated that there has been a trend in the industry to move production facilities to overseas locations where labor markets offer cost savings. Some of these companies commented that new standards could speed up this trend.

For condensing gas boilers, in particular, the European market is as large as the non-weatherized gas furnace market in the United States, with attendant high-volume pricing and large company suppliers. If standards were to require condensing technology, it is likely that manufacturers would out-source heat exchangers to European countries.

12.5.3 Exports

Residential furnace and boiler exports comprise about 2 percent of total furnace and boiler sales, and about one-quarter of that flows to Canada. A few major manufacturers look to foreign markets, particularly Latin America and the Middle East, as a source of revenue growth. Efficiency standards in these markets lag those in the United States and therefore, as the U.S. efficiency standard increases, baseline domestic furnaces and boilers become less attractive for the export markets. If sales of residential furnaces and boilers to foreign markets decrease as a result of higher standards, there will be a negative effect, albeit small, on company revenues that the GRIM does not capture since it only considers domestic shipments.

12.5.4 Cumulative Regulatory Burden

One aspect of the assessment of manufacturer burden is the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States that affect the manufacture of a covered product. The Department believes that a standard level is not economically justified if it contributes to an unacceptable cumulative regulatory burden. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden.

Companies that produce a wider range of regulated products may be faced with more capital and product development expenditures than their competitors. This can prompt those companies to exit the market or reduce their product offerings, potentially reducing competition. Smaller companies can be especially affected, since they have lower sales volumes over which to amortize the costs of meeting new regulations.

12.5.4.1 Federal Regulations on Residential Furnaces and Boilers and Other Products Produced by the Same Manufacturers

In addition to the efficiency regulations on residential furnaces and boilers, several other federal, state and international regulations as well as pending regulations apply to residential furnaces and boilers and other products produced by the same manufacturers. The most significant regulatory actions affecting the furnace and boiler industries are compliance with more stringent Federal energy conservation standards for residential and commercial air conditioners, and the U.S. Environmental Protection Agency (EPA)-mandated phase out of hydrofluorocarbon (HFC) and hydrochlorofluorocarbon (HCFC) refrigerants. Manufacturers of residential furnaces and boilers also manufacturer approximately 82 percent of the residential central air conditioners and heat pumps and many of these manufacturers also manufacture commercial unitary air conditioners and heat pumps. The effective date for the residential AC rulemaking was January 23, 2006. Manufacturers were working to redesign all of the product lines and have allocated most of their capital resources for redesigning and retooling of their production lines to meet the new minimum efficiency standard. The effective date for the new commercial unitary air conditioner and heat pump standards is January 1, 2010, as specified in EPACT 2005. Manufacturers are now re-designing their product offerings and will need to retool to meet those standards. In addition, the EPA-mandated refrigerant phase out comes into effect on January 1, 2010, and is expected to have the biggest cumulative impact on residential furnace and boiler manufacturers.

Table 12.5.2 Summary of Major Regulations on Residential Furnace and Boiler Manufacturers

Regulation	Key Affected Appliances	Effective Date
DOE appliance energy efficiency requirements	Residential central air conditioners (13 SEER)	January 23, 2006
	Room air conditioners	October 1, 2000
	Water heaters	January 20, 2004
	Commercial Unitary Air Conditioners and Heat Pumps	September 2008*
EPA phaseout of HCFC refrigerants for new equipment	Room and residential central air conditioners, and commercial air conditioners	January 1, 2010
Consumer Product Safety Commission-prompted voluntary standards for flammable vapor ignition	Residential water heaters	July 1, 2003
EPA standards on emissions of allowable hazardous air pollutants from the coating of large appliances (NESHAP/MACT standards, Clean Air Act Section 112(d))	Central air conditioners, commercial air conditioners, and furnaces	July 23, 2002
DOE adoption of ASHRAE 90.1-1999 energy efficiency standards for commercial buildings	Unitary and applied air conditioners, furnaces, boilers, PTACs and PTHPs	2003-2005 (January 1, 2010* for PTACs and PTHPs)

* Anticipated effective date.

The U.S. Environmental Protection Agency (EPA)'s National Emission Standards for Hazardous Air Pollutants Maximum Achievable Control Technology (NESHAP/MACT) regulations impact primarily the painting, or surface coating, of furnaces, boilers, and other large appliances. These rules established a standard for the emission of hazardous atmospheric pollutants for a facility based on the maximum achievable control technology as displayed by the facility's peers. According to EPA estimates, the impacts on the entire industry from this rule are approximately $1.63 million, including activities such as the reformulation of coatings.

Table 12.5.3 lists market shares of major HVAC manufactures subject to the regulations listed in Table 12.5.2. High market shares imply that the companies will bear a significant portion of the burden of the regulation.

Table 12.5.3 Market Shares of Major Furnace and Boiler Manufacturers in Regulated Products

	Residential Furnace and Boiler Manufacturers	Others	All Manufacturers
Residential Central Air Conditioners	82%	18%	100%
Room Air Conditioners	2%	98%	100%
Residential Water Heaters	38%	62%	100%

Source: Appliance Magazine, September 2003, and DOE estimates.

Table 12.5.4 indicates the level of impacts that the furnace and boiler industry may face due to other federal regulations that will become effective over the next ten years. The estimated investment for the residential furnace and boiler industry in each category is the product of the total industrial expenditures in the category and the total market share of residential furnace and boiler manufacturing companies presented in Table 12.5.3.

However, it is important to note that the uncertainty surrounding these values is high for several reasons. First, manufacturer impacts depend largely on the company's ability to pass conversion costs through to consumers. Second, information on capital expenditures, R&D, and other conversion costs and project plans are usually considered to be confidential. Third, companies may be able to incorporate regulatory-driven expenditures into other product development or process improvement efforts.

Table 12.5.4 Estimated Investments Required to Meet Impending Federal Regulations ($MM)

Regulation	Total Investment Incurred by All Manufacturers	Estimated Investment Incurred by Furnace and Boiler Manufacturers	Source of Estimate
Residential Central AC efficiency	232	190	Estimated investment in DOE rulemaking
Residential Room AC efficiency	8	0.16	Estimated investment in DOE rulemaking
Water Heater Efficiency	61	23	DOE water heater efficiency rulemaking
Commercial Unitary Air Conditioners and Heat Pumps	n/a	n/a	Estimates not yet available, rulemaking underway
HCFC-22 ban (residential)	350	287	Estimated investment in DOE rulemaking
HCFC-22 ban (commercial)	144	118	Estimated investment in DOE rulemaking
Flammable Vapor Ignition	95	36	Water heater consortium estimate
NESHAP/MACT	2	N/A	EPA rulemaking estimate

12.5.4.2 Other Pending Regulations and Standards

During the MIA interviews, some manufacturers expressed concerns regarding other voluntary or mandatory standards that might cause additional economic impacts. Estimates of the magnitude of the potential impacts from these standards are not available and cannot be quantified without separate analyses. While these impacts cannot be quantified with reasonable certainty, it is worth noting that they could cause additional cumulative burdens on this industry. The following paragraphs provide a qualitative discussion of some of these regulations and standards.

Ventilation Rates and Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62 specifies levels for ventilation rates and other indoor air quality parameters, such as formaldehyde, lead, and carbon monoxide. ASHRAE's Standard 62.2-2004 provides updates to the procedures for achieving acceptable indoor air quality. Standard 62 has been incorporated into many State and local building codes.

In addition, the International Mechanical Code, which is referenced in many local jurisdictions, has adopted a rigid interpretation of the Ventilation Rate Procedure of the Standard and requires devices and controls to maintain per-person ventilation requirements at all load conditions. During the MIA interviews, manufacturers indicated that the increasing adoption of ASHRAE 62.2 could translate into additional costs to research, develop, and manufacture products that perform according to this standard.

Large unitary air conditioners (>240,000 Btu/h). Additionally, manufacturers expressed concerns regarding existing efforts to add energy conservation standards for large commercial unitary equipment, units with capacities larger than 240,000 Btu/h, to State building codes. Adoption of standards at the State level could translate into additional burdens if these standards are not uniform. Industry members initiated a joint effort to petition Congress for a uniform Federal standard that would mitigate the financial impacts of complying with different State standards. In either case, whether under a Federal standard or State building codes, manufacturers will face additional financial impacts once large unitary air conditioners are regulated.

ASHRAE 90.1-1989 and 1999. ASHRAE 90.1-1989 is a set of requirements to design energy-efficient buildings. American National Standards Institute (ANSI)/ASHRAE/ Illuminating Engineering Society of North America (IESNA) Standard 90.1-1999, Energy Standard for Buildings Except Low-Rise Residential Buildings, has been established by the DOE as the commercial building reference standard for State building energy codes under the Federal Energy Conservation and Production Act. The Act requires all states to certify that they have State energy codes in place that are at least as stringent as 90.1-1999, or justify why they cannot comply with this. DOE determined that Standard 90.1-1999 saves more energy than Standard 90.1- 1989, which was the previously referenced standard in the Act. Acceptance of these standards varies widely across states, creating a regulatory patchwork that imposes additional burdens on manufacturers.

Material Recycling. In recent years, efforts to regulate the disposal and treatment of waste from manufacturing processes have regained momentum. During the MIA interviews, some manufacturers mentioned concerns regarding further requirements for recycling waste and producing with recovered materials Some parts of Europe have up-front regulations to pay recycling fees when manufacturers ship the units. Some states are considering similar requirements.

12.5.4.3 Regulations and Pending Regulations at the State Level

Manufacturers also identified several regulations that are either being imposed or under consideration at the State level, which include:

1. Compliance with the International Standards Organization (ISO) testing procedures, which will likely require duplicate testing and certification for products.
2. State-level safety regulations.

3. State-level equipment recycling requirements.
4. Furnace fan electrical efficiency (currently under discussion in MN, MA, MD, VT, and CA).
5. NOx emissions requirements (CA, TX, MN, NV).
6. CO emissions requirements (MA).
7. Minimum consumer warranty requirements (FL only, MA and MD pending).
8. California Title 24 building code requirements such as duct tightness, AC charging, etc.
9. California Title 20 appliance standards 9th Circuit Court in CA on Title 20, reporting requirements and marketing requirements.
   - Marketing and data submittal, Title 20 of California Law.
   - Administrative burdens (~15 items to report).

Manufacturers agreed that ISO testing procedures and safety regulations will have little incremental impact on the industry, as ISO quality programs and health and safety protocols are now a routine, integral part of the manufacture of many products, including furnaces and boilers.

12.5.4.4 Other Regulations

Manufacturers also identified proposed or implemented regulations for international, local, or voluntary organizations. Some furnace and boiler manufacturers sell a small portion of their total production to countries besides the U.S., such as Canada. In those cases, the products must meet the energy-efficiency standards for that country. Based on manufacturer interviews, companies may design some units to meet even more stringent standards than the U.S. Other regulations include:

1. Technical Standards & Safety Authority, public safety regulation (Ontario, Canada).

2. Natural Resources Canada, emissions & efficiency (Canada).

3. Energy Star, voluntary standards.

12.6 CONCLUSIONS

12.6.1 Non-Weatherized Gas Furnaces

For non-weatherized gas furnaces, the Department considered four cash flow scenarios: The flat markup and two-tier markup scenarios are each combined with NES-shipment forecasts and manufacturers' shipment forecasts. To assess the lower end of the range of potential impacts, the Department used the flat markup and NES-shipments scenario, which represents an optimistic situation where shipments are not greatly affected by even a large increase in cost to the consumer. In addition, this scenario assumes that manufacturers do not differentiate their baseline products from their premium products, either in the base case or the standards case—thus, the scenario assumes a constant markup across all efficiencies. The Department did not reduce this profit margin to offset some of the price burden passed on to the consumer in the standards case. Consequently, some of the manufacturer impacts on INPV are positive.

To assess the higher end of the range of potential impacts, the Department used the manufacturers'-shipments forecast and modeled a two-tiered markup structure. The two-tier scenario assumes that the proportion of premium-margin sales will be reduced by the "roll-up" of lower efficiency products to the new standard level. The manufacturers'-shipments forecast assumes an increased drop in shipments for trial standard levels 4 and 5 due to equipment switching and an increase in repairs of current systems. As can be observed from the cash flow results, both the shipment scenario and the markup scenario have a significant impact on the results.

At trial standard levels 1 and 2 (80-percent AFUE), the impact on INPV and cash flow would be slight, since the bulk of the product being sold is already at the 80-percent AFUE level; thus, industry revenues and costs are not significantly negatively impacted. Furthermore, little investment is required to meet the standard.

At trial standard level 3 (81-percent AFUE), concern over safety and reliability associated with corrosion due to condensation is the dominant issue for manufacturers of non-weatherized gas furnaces. Based on information submitted by industry, to mitigate theses concerns a standard at trial standard level 3 would require a complete redesign of furnace heat exchangers, entailing $60 million in product conversion expenses and a $121-million investment in new tooling and equipment. Furthermore, manufacturers maintain that this capital outlay does not fully address their safety, reliability, and equipment longevity concerns. Finally, manufacturers stated that, at trial standard level 3, they must address additional liability impacts that are not illustrated by the quantitative results presented here. The impact on INPV at trial standard level 3 is -7 percent and cash flow in the year leading to the effective date would be reduced to approximately zero from a base case value of $67 million.

Many manufacturers commented that 81-percent AFUE equipment cannot be safely vented. Some manufacturers stated that there are variations and constraints that require a margin of safety. These safety margins need to account for the many factors that contribute to faulty venting in residential furnace systems, which include variations in gas quality, vent length, number of bends within the vent, altitude, location of the furnace within the house, quantity of the ventilated air (ASHRAE 62.2 requires more outside ventilation air, which in turn reduces the flue temperatures), and the amount of experience of the vent installer. Manufacturers stated that, with increasing minimum efficiency requirements for non-weatherized gas furnaces, this margin of safety is diminished and a standard at 81-percent AFUE does not provide an adequate safety margin. Most manufacturers stated that they are not willing to accept the risk and/or cost involved in producing a full line of products at 81-percent AFUE. Those manufacturers that would not be willing to bear the liability risk associated with an 81-percent AFUE efficiency level, and thus chose not to sell non-condensing models, would be at a competitive disadvantage to those willing to bear the risk.

Trial standard level 4 requires the production of 90-percent-AFUE condensing, non-weatherized gas furnaces. If manufacturers lose the ability to market and sell premium products, such as high AFUE condensing products, then the impact on INPV is expected to be larger. Another key uncertainty in future profitability is the market response to the higher price and corresponding energy savings of the condensing product. Manufacturers predict a much greater drop in unit sales than the NES analysis forecasted. The INPV impacts range from +1 percent to −28 percent. The required product and capital conversion costs are significant and estimated to be $82 million and $174.3 million, respectively, because of the need for a secondary heat exchanger. At this level, the industry cash flow becomes slightly negative, −$1 million, compared to the base case value of $67 million in the year leading up to the standards.

At trial standard level 5 (96-percent AFUE), the impact on INPV would range between +21 percent and −46 percent, depending on markup and shipment assumptions. The industry would experience an increase in value if it were able to fully pass through to consumers the incremental production costs and associated markups, and the shipments were reduced according to the forecasts in the NES-shipments model. However, there is a risk of very large negative impacts if shipments were reduced according to manufacturers' expectations and in the very likely situation that manufacturers were no longer able to offer premium products at higher margins. During the interviews, manufacturers expressed disbelief at the possibility of manufacturing an entire product line at 96-percent AFUE, since there is only one model currently being manufactured at this efficiency level. Most manufacturers did not provide DOE with projected product conversion costs or capital conversion costs at this level, since they could not conceive of what designs might reach this efficiency level. The Department estimated the required product and capital conversion costs, based on limited input, to be $144 million and $705 million, respectively for trial standard level 5. The impact on annual cash flow from product conversion and capital expenditures prior to the standard would be severe. The peak negative cash flow would be approximately four times the magnitude of the base-case positive cash flow.

12.6.2 Weatherized Gas Furnaces

For weatherized gas furnaces, the Department considered two cash flow scenarios, which include the flat-markup and the constant-price scenario—both using NES-shipments forecasts. The flat-markup and NES-shipments scenario represents a situation where shipments are not greatly affected, even by a large increase in cost to the consumer. In the second scenario, the constant-price aspect assumes that manufacturers of weatherized gas furnaces will not be able to recover the incremental product costs resulting from increased standards. The Department used these two markup scenarios because manufacturers currently do not differentiate between baseline and premium products, since condensing technologies are not used in weatherized gas furnaces and therefore are not a differentiating feature that requires a premium markup. Consequently, the Department did not consider a two-tier markup scenario.

The impact on INPV for weatherized gas furnaces at trial standard level 1 (81-percent AFUE) ranges between −11 percent and −13 percent. Even with the flat-markup assumption and accepting the NES-shipments forecast unaltered, the industry value drops because of the large conversion costs relative to industry revenues. To achieve 81-percent AFUE, manufacturers estimate product conversion costs of $49 million and capital conversion expenses of $28 million. Negative cash flows peak at approximately $5 million from a base-case value of $17 million in 2014.

Manufacturers expressed concern over condensation in flue gases, in furnaces above 81-percent AFUE, which can lead to corrosion issues. The minimum standard for trial standard level 2 through trial standard level 5 is 83-percent AFUE. At 83-percent AFUE, the INPV is forecasted to drop between 19 percent and 32 percent. Manufacturers must make the investment in corrosion-resistant materials. The required product-conversion and capital-conversion costs are estimated at $70 million and $61 million, respectively. Manufacturers stated that this is primarily due to the need for stainless steel heat exchangers. Net cash flow would drop to approximately −$25 million, a drop of $40 million from the base case.

Finally, there are two additional factors to be considered from the standpoint of manufacturers of weatherized gas furnaces. First, some manufacturers believe that furnaces with efficiency levels at or above 81-percent AFUE cannot be made safely and reliably due to vent and heat exchanger condensation. This type of furnace uses cold, outside air for combustion and economizer operation introduces cold air to the heat exchanger. Both these factors lower the flue temperature at the risk of causing condensation and corrosion in the heat exchanger and draft inducers. While shorter vents mitigate vent corrosion somewhat, corrosion in the heat exchanger itself can significantly shorten heat exchanger lifetime and, therefore, appliance lifetime. In addition, units with economizers have an increased probability of condensation in the vent system. Second, buyers of these units value heating efficiency less than they value the cooling efficiency of the air-conditioning unit, making it difficult for manufacturers to recover cost increases of the heating equipment.

12.6.3 Mobile Home Furnaces

For mobile home furnaces, the Department considered two cash flow scenarios: the flat-markup and NES-shipments scenario, and the flat-markup and manufacturers'-shipments scenario. The flat-markup and NES-shipments scenario represents a situation where shipments are not greatly affected by a large increase in cost to the consumer. The Department used the flat-markup because it does not believe there is a large variation in gross margin across all available efficiency levels. Since there are currently only a small number of shipments of condensing mobile home furnace this implies manufacturers will have little ability to market premium efficiency product at a premium mark-up. To represent the higher range of potential impacts, the Department used the flat-markup and manufacturers'-shipments scenario. The manufacturers'-shipments forecast shows a decline in mobile home furnace shipments at trial standard levels 4 and 5. Manufacturers stated that consumers are more likely to choose heat pumps, combination systems, electric furnaces, or electric strip heaters, instead of buying the more efficient, more costly mobile home furnaces at trial standard levels 4 and 5.

Trial standard level 1 and trial standard level 2 require that mobile home gas furnaces achieve 80-percent AFUE. At these levels, the INPV and cashflow impacts are negligible, and little investment is required to meet the standard.

At trial standard level 3 (81-percent AFUE), venting once again becomes a major concern for manufacturers. An increased risk of corrosion could increase liability and warranty costs. In addition, mobile home furnaces are susceptible to fuel switching at efficiency levels above 80-percent AFUE. Manufacturers stated that mobile home furnaces are typically installed in lower cost situations, where consumers will look at heat pumps or electric heat as an alternative heat source. Consequently, at trial standard level 3, the INPV is estimated to drop by 14 percent. Product conversion and capital conversion costs are estimated at $1.7 million and $6 million, respectively. Net cashflow drops precipitously from +$1 million to slightly negative values in the year 2014. This drop is even more serious in 2013, as negative cashflows drop to approximately -$2 million.

At 90-percent AFUE, trial standard levels 4 and 5, product-conversion costs of $6.7 million and capital expenditures of $12 million contribute to lowering the INPV by 42 to 49 percent. Net cash flow becomes negative by a factor of more than seven times the base-case value.

Additional factors to be considered from the standpoint of manufacturers of mobile home furnaces include the following:

- At levels above 75-percent AFUE, standing pilot models will no longer be available to customers.

- Mobile home furnaces are susceptible to condensation at AFUE levels above 80 percent due to their concentric vent, which introduces cold outside air through the outer ring while exhaust gases are vented from the interior core.

- Mobile home installations face space constraints from both footprint and height dimensions.

- Shipments of mobile home furnaces have been declining and are forecasted to continue on this trend. It is risky to invest in design and tooling for a product with a declining revenue base.

12.6.4 Oil-fired Furnaces

For oil-fired furnaces, the Department considered two cash flow scenarios: the flat-markup and NES-shipments scenario, and the constant-price and NES-shipments scenario. The flat-markup and NES-shipments scenario represents a situation where shipments are not greatly affected by increased cost to the consumer. For the second scenario, the Department also used the NES-shipments forecast and applied a constant-margin assumption. While the Department realizes that there will be a drop in shipments at trial standard levels 4 and 5 due to equipment switching, the Department used the NES-shipments forecast because the difference between the NES shipments and the manufacturers' shipments was small and some manufacturers stated that they expected a small drop in shipments at higher proposed standard levels. Furthermore, the Department does not expect a change in shipments when applying a constant-price assumption, because there will be no change in the product costs as a result of new efficiency standards.

At trial standard level 1 (80-percent AFUE), the INPV impacts are estimated to be −5 percent for oil-fired furnaces. Cash flow is cut approximately in half, from approximately $2 million to $1 million in 2014. Product-conversion costs are estimated at $3 million and capital requirements total $1 million.

At 82-percent AFUE, trial standard levels 2 and 3, the INPV impacts are estimated to range from −8 percent to −12 percent for oil-fired furnaces. Cash flow would be slightly positive in 2014, a drop of $2 million from the base case. Product-conversion costs are estimated at $4.5 million and capital requirements total $3.6 million. At 82-percent AFUE, one manufacturer indicated the firm would not invest the necessary capital, since it could not justify the investment.

At trial standard level 4 (84-percent AFUE), the INPV impacts range from −19 percent to −27 percent, and at trial standard level 5 (85-percent AFUE) the impacts range from −21 percent to −35-percent. Achieving these efficiency levels would require new heat exchanger designs, which raises the product conversion costs to $8.5 million at both trial standard level 4 and trial standard level 5. Total capital requirements rise to $7 million at trial standard level 4 and $8 million at trial standard level 5. Net cash flow is reduced by nearly 200 percent to −$3.4 million at trial standard level 4.

Other considerations from the standpoint of manufacturers of oil-fired furnaces include the possibility of implementing a de-rating strategy at trial standard levels 1, 2, and 3 to reduce capital costs. A de-rating strategy aims to achieve higher efficiency levels by using a larger capacity furnace compensated with a downsized burner. This would reduce the span of the product line through elimination of some higher capacity models. In addition, for oil-fired furnaces at 82-percent AFUE, some manufacturers expressed concerns about increased maintenance costs due to sulfur in the fuel and exhaust gas. This sulfur can form a residue that potentially would increase maintenance costs as efficiency rises.

12.6.5 Gas Boilers

For gas boilers, the Department considered two cash flow scenarios: the flat markup and the three-tier markup, both using manufacturer-supplied shipment estimates. The Department did not use NES shipments in the GRIM, since they did not demonstrate any price responses by shipments—even at very high efficiency levels. Manufacturers stated that shipments would decrease with increases in efficiency, particularly at the higher levels where consumers would repair existing systems rather than replace them.

The two scenarios are therefore defined by the assumed markup strategy—a flat markup or a three-tiered markup. The Department learned from manufacturers that the pricing of boilers is determined on the basis of three product tiers. During the MIA interview, manufacturers provided information on the range of typical AFUE levels for each of the three tiers and the change in profitability associated with each level for gas boilers.

At trial standard level 1 (82-percent AFUE), the impact on INPV ranges from −0.9 percent to −3 percent for gas boilers. Product-conversion costs and capital-conversion costs are estimated at $7.5 and $9.5 million, respectively. Net cash flow is reduced from $10 million to $9 million in 2014.

At 84-percent AFUE, trial standard levels 2, 3, and 4, the impact on INPV for gas boilers ranges from −7 percent to −12 percent. Product-conversion costs are estimated at $8.7 million and capital requirements total $12.5 million. Cash flow is reduced from $10 million to $8 million in 2014. The most severe impacts are in 2013 when cashflows is reduced in excess of 50 percent from the base case. Several manufacturers stated that, at this efficiency level, there is a high risk of safety and reliability issues. There is also a great likelihood that standing-pilot versions of these products would be eliminated.

At trial standard level 5 (99-percent AFUE), the impact on INPV for gas boilers ranges between −16 percent and −50 percent. During the interviews, manufacturers stated that this level is simply not achievable with current technologies and is beyond the maximum technologically feasible level. Instead, some manufacturers recommended that the max tech level would more reasonably be 96-percent or 97-percent AFUE. In addition, some manufacturers would not provide product-conversion cost or capital-conversion costs at this level, since they could not conceive what designs might reach this efficiency level. Consequently, with limited responses from manufacturers, DOE estimated the required product and capital conversion costs to be $20 million and $150 million, respectively. The net cash flow is reduced to nearly −$45 million.

Gas boiler manufacturers mentioned similar concerns as those expressed by non-weatherized gas furnace manufacturers surrounding the increased possibility of corrosion within the heat exchanges as the efficiency level increases. Additional factors to be considered from the standpoint of manufacturers of gas boilers include the following:

- At levels at or above 84-percent AFUE, standing pilot models will no longer be available to customers.
- With increasing efficiency requirements in the non-condensing region, some manufacturers would consider switching their designs to condensing, considering that there has been a recent increase in condensing sales over the past few years and that venting requirements are not as expensive to the consumer.
- Radiant floor-heating systems installed with boilers create condensation concerns at 84-percent AFUE, due to lower return water temperature to the boiler.

Some manufacturers of boilers stated that they have concerns regarding condensation at efficiency levels of 84-percent AFUE or greater for gas boilers and 85-percent AFUE or greater for oil-fired boilers. Boiler manufacturers stated that condensation of flue gases for boilers is more variable than for furnaces because there is greater variability in flue temperature. For example, the heat distribution system and the heating load directly affect return water temperature to the boiler, which in turn has a direct impact on the probability of condensation. In addition, other factors—including system thermal mass, boiler input rate and efficiency, radiator heat transfer area, and the season in which the boiler operates—affect condensation in a boiler system.

12.6.6 Oil-fired Boilers

For oil-fired boilers, the Department considered two cash flow scenarios: the flat markup and the three-tiered markup, both using manufacturer-supplied shipment estimates. The Department considered only manufacturer-supplied shipment estimates for the same reasons given for gas boilers. Manufacturers stated that shipments would decrease for oil-fired boilers at higher efficiency levels, because the market would move toward radiant or electric furnaces and consumers would repair rather than replace their existing boilers.

Thus, similarly to the markups defined for gas-boilers, the two scenarios are defined by the assumed markup strategy—a flat markup or a three-tiered markup. The Department learned from manufacturers that the pricing of boilers is determined on the basis of three product tiers. During the MIA interviews, manufacturers provided information on the range of typical AFUE levels for each of the three tiers and the change in profitability associated with each level for oil-fired boilers.

At 83-percent AFUE, trial standard levels 1, 2, and 3, the impact on INPV ranges from −3 percent to −13 percent for oil-fired boilers. At trial standard level 4 (84-percent AFUE), the impact on INPV ranges from between −2.5 percent to −14 percent. Product-conversion costs and capital-conversion costs are estimated at $4 million and $3.2 million, respectively, for trial standard levels 1, 2, and 3. For trial standard level 4, product-conversion costs and capital-conversion costs are estimated at $4.1 million and $3.4 million, respectively. At these levels, manufacturers would likely use a de-rating strategy to reduce capital costs. This would reduce the span of the product line through elimination of some higher capacity models. Cash flow is reduced from $5 million to $4 million in 2014 for trial standard levels 1 through 4. The most severe cashflow impacts are in the year 2013 when net cashflow is reduced by approximately 50 percent.

At trial standard level 5 (95-percent AFUE), the impact on INPV ranges from −19 percent to −45 percent. Net cash flow would be reduced to approximately -$22 million. Product-conversion and capital-conversion costs are estimated at $10.3 and $70.4 million, respectively. At this level, manufacturers expect complete loss of sales to competing products.

The same safety concerns expressed by manufacturers for gas boilers above 84-percent AFUE also apply to oil-fired boilers above 84-percent AFUE. In particular, manufacturers of oil-fired boilers expressed concern that an increased AFUE standard would cause consolidation within the industry and further reduce total shipments.

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