CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

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CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

12.1 INTRODUCTION

In determining whether a standard is economically justified, the U.S. Department of Energy (DOE) 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." (42 U.S.C. 6313(a)(6)(B)(i)) The law also calls for an assessment of the impact of any lessening of competition as determined in writing by the Attorney General. *Id*. DOE conducted a manufacturer impact analysis (MIA) to estimate the financial impact of more stringent energy conservation standards on manufacturers of residential water heaters, direct heating equipment (DHE), and gas-fired pool heaters, and assessed the impact of such standards on direct employment and manufacturing capacity.

The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model adapted for each product in this rulemaking. The GRIM inputs include information on 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 more stringent energy conservation standards for each product by comparing changes in INPV between a base case and the various trial standard levels (TSLs) in the standards case. The qualitative part of the MIA addresses product characteristics, manufacturer characteristics, market and product trends, as well as the impact of standards on subgroups of manufacturers.

12.2 METHODOLOGY

DOE conducted the MIA in three phases. Phase I, "Industry Profile," consisted of preparing an industry characterization for the residential water heater, DHE, and pool heater industries, including data on market share, sales volumes and trends, pricing, employment, and financial structure. In Phase II, "Industry Cash Flow," DOE used the GRIM to assess the impacts of amended energy conservation standards on ten major product types for this rulemaking:

Residential Water Heaters
1) Gas-fired storage water heaters
2) Electric storage water heaters
3) Oil-fired storage water heaters
4) Gas-fired instantaneous water heaters

Direct Heating Equipment
5) Gas wall fan direct heating equipment
6) Gas wall gravity direct heating equipment
7) Gas floor direct heating equipment
8) Gas room direct heating equipment
9) Gas hearth direct heating equipment

Pool Heaters
10) Gas-fired pool heaters

In Phase II, DOE created a separate GRIM for each of the three heating products and separate interview guides to gather information on the potential impacts on manufacturers. These interview guides included one for storage water heaters (gas-fired storage, electric storage, and oil-fired storage water heaters), one for gas-fired instantaneous water heaters, one for traditional DHE (gas wall fan, gas wall gravity, gas floor, and gas room DHE), one for gas hearth DHE, and one for gas-fired pool heaters. In the MIA, DOE aggregated the results for similar product classes made by the same manufacturers and in the same production facilities to allow DOE to better assess the impacts of amended energy conservation standards on manufacturers.

In Phase III, "Subgroup Impact Analysis," DOE interviewed manufacturers representing over 95 percent of residential storage water heater sales, about 50 percent of gas-fired instantaneous water heater sales, approximately 99 percent of traditional DHE sales (gas wall fan, gas wall gravity, gas floor, and gas room DHE), over 50 percent of gas hearth DHE sales, and about 75 percent of gas-fired pool heater sales. Interviewees included large and small manufacturers, providing a representative cross-section of the industries. During interviews, DOE discussed financial topics specific to each manufacturer and obtained each manufacturer's view of the industry. The interviews provided DOE with valuable information for evaluating the impacts of amended energy conservation standards on manufacturer cash flows, investment requirements, and employment.

DOE groups the MIA results by product classes that are made by the same manufacturers. DOE presents results for gas-fired storage and electric storage water heaters together because manufacturers typically produce both types of water heaters in the same facilities. Results for oil-fired storage and gas-fired instantaneous water heaters are presented separately. MIA results for DHE are separated into traditional DHE and gas hearth DHE. Results for gas-fired pool heaters are also presented separately.

12.2.1 Phase I: Industry Profile

In Phase I of the MIA, DOE prepared a profile of the residential water heater, DHE, and pool heater industries that built upon the market and technology assessment prepared for this rulemaking. (See chapter 3 of this Technical Support Document (TSD).) Before initiating the detailed impact studies, DOE collected qualitative and quantitative financial information and past and present market data, including estimated market shares, corporate operating ratios, wages, employment, and production cost ratios for several heating product manufacturers. The industry profile included a top-down cost analysis of residential water heater, DHE, and pool heater manufacturers, from which DOE derived cost and preliminary financial inputs for the GRIM analysis (*e.g.*, depreciation; selling, general and administrative expenses (SG&A); and research and development (R&D) expenses).

DOE also used public information to further calibrate its initial characterization of the residential water heater, DHE, and pool heater industries, including Securities and Exchange Commission (SEC) 10–K reports,[1] Standard & Poor's (S&P) stock reports,[2] Dun and Bradstreet (D&B) company profiles,[3] corporate annual reports, and the U.S. Census Bureau's 2007 Annual Economic Census.[4] DOE also characterized these industries using information from its engineering analysis and the life-cycle cost analysis.

12.2.2 Phase II: Industry Cash-Flow Analysis and Interview Guide

Phase II focused on the financial impacts of amended energy conservation standards on the residential water heater, DHE, and pool heater industries. Amended standards can affect manufacturers in these industries in three distinct ways: (1) require additional investment, (2) raise production costs, and (3) change revenues through higher prices and possibly lower shipments. In Phase II, DOE performed preliminary industry cash-flow analyses and prepared written guides for manufacturer interviews. DOE performed a cash flow analysis using a separate GRIM for manufacturers of residential water heaters, DHE, and gas-fired pool heaters.

12.2.2.1 Industry Cash-Flow Analysis

The GRIM uses several factors to determine a series of annual cash flows from the announcement year of amended energy conservation standards until several years after the standards' compliance date. These factors include annual expected revenues, costs of sales, SG&A, taxes, and capital expenditures related to the amended standards. Inputs to the GRIM include manufacturing costs and selling prices and shipments forecasts developed in other analyses. DOE derived the manufacturing costs from the engineering analysis and information provided by the industry and estimated typical manufacturer markups from public financial reports and interviews with manufacturers. DOE developed alternative markup scenarios for each GRIM based on discussions with manufacturers. DOE's shipments analysis, presented in chapter 10 of this TSD, provided the basis for the shipment projections in each GRIM. The financial parameters were developed using publicly available manufacturer data and were revised with information submitted confidentially during manufacturer interviews. The GRIM results are compared to base case projections for each industry. The financial impact of amended energy conservation standards is the difference between the base-case and standards-case at each TSL discounted annual cash flows.

12.2.2.2 Interview Guides

During Phase III of the MIA, DOE interviewed manufacturers to gather information on the effects of amended energy conservation on revenues and finances, direct employment, capital assets, and industry competitiveness. Before the interviews, DOE distributed an interview guide for each major product group: storage water heaters, gas-fired instantaneous water heaters, traditional DHE, gas hearth DHE, and gas-fired pool heaters. The interview guides provided a starting point to identify relevant issues and help identify the impacts of amended energy conservation standards on individual manufacturers or subgroups of manufacturers. Most of the information DOE received from these meetings is protected by non-disclosure agreements and resides with DOE's contractors. Before each telephone interview or site visit, DOE provided company representatives with an interview guide that included the topics for which DOE sought input. The MIA interview topics included (1) key issues to this rulemaking; (2) a company overview and organizational characteristics; (3) manufacturer production costs (MPCs) and selling prices; (4) manufacturer markups and profitability; (5) shipment projections and market shares; (6) product mix; (7) financial parameters; (8) conversion costs; (9) cumulative regulatory burden; (10) direct employment impact assessment; (11) exports, foreign competition, and outsourcing; (12) consolidation; and (13) impacts on small business. The MIA interview guide for storage water heaters also included questions about ultra-low-NO_X water heaters, unit shipping methods and associated costs, and alternative energy efficiency equations. The interview guides are presented in Appendix 12-A.

12.2.3 Phase III: Subgroup Analysis

For its analysis, DOE grouped the impacts on gas-fired and electric storage water heaters. DOE also grouped the impacts on traditional DHE. DOE presented the impacts on oil-fired storage water heaters, gas-fired instantaneous water heaters, gas hearth DHE, and pool heaters separately. While conducting the MIA, DOE interviewed a representative cross-section of residential water heater, DHE, and pool heater manufacturers. The MIA interviews broadened the discussion to include business-related topics. DOE sought to obtain feedback from industry on the approaches used in the GRIMs and to isolate key issues and concerns. During interviews, DOE defined one manufacturer subgroup of small businesses that could be disproportionately impacted by amended energy conservation standards. For DHE, DOE identified 12 small business manufacturers, of which two manufacture traditional DHE, nine manufacture hearth products, and one manufactures both.

12.2.3.1 Manufacturing Interviews

The information gathered in Phase I and the cash-flow analysis performed in Phase II are supplemented with information gathered from manufacturer interviews in Phase III. The interview process provides an opportunity for interested parties to express their views on important issues privately, allowing confidential or sensitive information to be considered in the rulemaking process.

DOE used these interviews to tailor each GRIM to reflect unique financial characteristics of each product group. Within each manufacturer group, DOE contacted companies from its database of manufacturers. Small and large companies, subsidiaries and independent firms, and public and private corporations were interviewed to provide a representation of the industry. Interviews were scheduled well in advance to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire was acceptable, DOE sought interactive interviews, which help clarify responses and identify additional issues. The resulting information provides valuable inputs to the GRIMs developed for the product classes.

12.2.3.2 Revised Industry Cash-Flow Analysis

In Phase II of the MIA, DOE provided manufacturers with preliminary GRIM input financial figures for review and evaluation. During the interviews, DOE requested comments on the values it selected for the parameters. DOE revised its industry cash-flow models based on this feedback. Section 12.4.3 provides more information on how DOE calculated the parameters.

12.2.3.3 Manufacturer Subgroup Analysis

Using average cost assumptions to develop an industry cash flow estimate is not adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers and other manufacturers with a cost structure significantly different from the industry average could be more negatively affected. DOE uses the results of the industry characterization to group manufacturers exhibiting similar characteristics. During the interviews, DOE discussed the potential subgroups and subgroup members it identified for the analysis. DOE asked manufacturers and other interested parties to suggest what subgroups or characteristics are the most appropriate to analyze. As described in section 12.2.3, DOE presents the industry impacts by major product groupings. These product groupings represent separate markets served by the same manufacturers that are typically produced in the same factories. Grouping these product categories reduced the need for a subgroup analysis to the consideration of small manufacturers, because the impacts of each group are characterized by the MIA separately.

12.2.3.4 Small-Business Manufacturer Subgroup

DOE used the Small Business Administration (SBA) small business size standards published on August 22, 2008, as amended, and the North American Industry Classification System (NAICS) code, presented in Table 12.2.1, to determine whether any small entities would be affected by the rulemaking.[a] For the product classes under review, the SBA bases its small business definition on the total number of employees for a business, its subsidiaries, and its parent companies. An aggregated business entity with fewer employees than the listed limit is considered a small business.

Table 12.2.1 SBA and NAICS Classification of Small Businesses Potentially Affected by This Rulemaking

Industry Description	Revenue Limit	Employee Limit	NAICS
Residential Water Heater Manufacturing	N/A	500	335228
Direct Heating Equipment Manufacturing	N/A	500	333414
Pool Heater Manufacturing	N/A	500	333414

DOE used the Air-Conditioning, Heating, and Refrigeration Institute (AHRI),[5] the Hearth, Patio, and Barbecue Association (HPBA),[6] and the Association of Pool and Spa Professionals[7] member directories to identify manufacturers of residential water heaters, DHE, and pool heaters. DOE also reviewed public certification databases including the California Energy Commission (CEC),[8] ENERGY STAR,[9] and other databases. DOE asked interested parties and industry representatives if they were aware of other small business manufacturers. Then, DOE consulted publicly available data, reports from vendors such as D&B, and manufacturers to determine which manufacturers meet SBA's definition of a small business.

Based on this analysis, DOE estimates that five residential water heater manufacturers, 12 DHE manufacturers, and one pool heater manufacturer are considered small businesses. DOE attempted to contact the small business to solicit feedback on the potential impacts of energy conservation standards. The businesses replied with varying amounts of information in written responses and/or interviews. In addition to posing the standard MIA interview questions, DOE solicited data on differential impacts these companies might experience from amended energy conservation standards.

DOE found that small water heater and pool heater manufacturers were focused on manufacturing products not covered by this rulemaking. Of those products that are covered, most already meet the amended standards or were a small portion of their overall sales and, thus,

[a] The size standards are available on the SBA's website at www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.

would not be differentially impacted. DOE also found that the small business gas hearth DHE manufacturers, while having the potential to be differentially harmed relative to larger manufacturers, would not be unduly burdened by the amended energy conservation standard. However, many small traditional DHE manufacturers could be differentially impacted by amended energy conservation standards. DOE reports the potential impacts on small DHE manufacturers in section 12.6.

12.2.3.5 Manufacturing Capacity Impact

One significant outcome of amended energy conservation standards could be the obsolescence of existing manufacturing assets, including tooling and investment. The manufacturer interview guides have a series of questions to help identify impacts of amended standards on manufacturing capacity, specifically capacity utilization and plant location decisions in the United States and North America, with and without amended standards; the ability of manufacturers to upgrade or remodel existing facilities to accommodate the new requirements; the nature and value of any stranded assets; and estimates for any one-time changes to existing plant, property, and equipment (PPE). DOE's estimates of the one-time capital changes and stranded assets affect the cash flow estimates in the GRIMs. These estimates can be found in section 12.4.8; DOE's discussion of the capacity impact can be found in section 12.7.2.

12.2.3.6 Employment Impact

The impact of amended energy conservation standards on employment is an important consideration in the rulemaking process. To assess how domestic direct employment patterns might be affected, the interviews explored current employment trends in the residential water heater, DHE, and pool heater industries. The interviews also solicited manufacturer views on changes in employment patterns that may result from more stringent standards. The employment impacts section of the interview guide focused on current employment levels associated with manufacturers at each production facility, expected future employment levels with and without amended energy conservation standards, and differences in workforce skills and issues related to the retraining of employees. The employment impacts are reported in section 12.7.1.

12.2.3.7 Cumulative Regulatory Burden

DOE seeks to mitigate the overlapping effects on manufacturers due to amended energy conservation standards and other regulatory actions affecting the same products. DOE analyzed the impact on manufacturers of multiple, product-specific Federal regulations with a compliance date within three years of the compliance date of this rulemaking.. Based on its own research and discussions with manufacturers, DOE also identified other regulations relevant to residential water heater, DHE, and pool heater manufacturers, such as State regulations, that impact the covered products and other products made by the same manufacturers. Discussion of the cumulative regulatory burden can be found in section 12.7.3.

12.3 MANUFACTURER IMPACT ANALYSIS KEY ISSUES

Each MIA interview starts by asking: "What are the key issues for your company regarding the energy conservation standard rulemaking?" This question prompts manufacturers to identify the issues they feel DOE should explore and discuss further during the interview. The following section describes key issues manufacturers mentioned for all product classes under review.

12.3.1 Storage Water Heater Key Issues

12.3.1.1 Installation Problems for a Significant Number of Consumers

During interviews, manufacturers stated that the majority of water heater shipments are replacements for the large installed base. Most of the existing stock does not meet the current baseline energy factors (EFs). Some manufacturers commented that amended energy conservation standards could create serious installation problems for some replacements if unit size increases. More efficient storage water heaters are typically larger because of thicker insulation and technology-specific components. Many higher efficiency units will not fit into the existing spaces in condos, apartments, manufactured homes, and mobile homes, where installations are typically in small utility closets designed for individual heating and water installation with small volume water heaters. Installing larger replacement water heaters in these locations would be prohibitively expensive if the structure had to be altered. In some States, especially in the Southeast, water heaters and furnaces are typically located in the attic. If the size of the water heater significantly increases, the water heaters would no longer fit through the attic opening.

According to manufacturers, gas-fired storage water heaters installation can be problematic in other ways as well. Almost any improvement over baseline units requires an installation with appropriate venting and fresh air, which might not be possible in a utility closet or attic. These consumers would incur additional costs from adding line power and installing a more expensive power venting unit if the new water heater fit in the existing space.

Depending on the stringency of the amended energy conservation standard, these problems could cause some consumers to incur thousands of dollars in installation costs. At a minimum, manufacturers were concerned that consumers could be forced to switch to smaller capacity units, which could affect consumer utility if the change results in insufficient hot water. Manufacturers are also concerned that costly replacements could lead consumers to undertake unsafe repairs themselves to prolong the life of the existing water heater rather than pay for a substantially more expensive replacement.

12.3.1.2 Fuel Switching

All of the interviewed manufacturers expressed concern that this energy conservation standard rulemaking could cause fuel switching. While most storage water heater manufacturers also sell gas-fired instantaneous water heaters, storage manufacturers are concerned that a more aggressive standard on gas-fired and electric storage units could increase the market penetration of gas-fired instantaneous water heaters by lowering the first cost differential. Increased penetration of gas-fired instantaneous water heaters would reduce the shipments of storage water heaters, resulting in lower profitability for storage water heater manufacturers if they lose market share to companies that exclusively manufacture instantaneous water heaters.

12.3.1.3 Ultra-Low Nitrogen Oxide (NO_X) Requirements

Manufacturers of gas-fired storage water heaters are concerned about the high product development costs to meet the ultra-low-NO_X requirements in some regions of the Southwest. Manufacturers are particularly concerned that higher EFs, lower NO_X emissions, and compliance with existing safety regulations are often at odds. Manufacturers also stated that the higher cost of the ultra-low-NO_X gas storage water heaters would hurt consumers in those regions and could cause them to switch to less expensive electric storage units.

12.3.1.4 Commercial Installations in Residential Settings

Manufacturers agreed with the current definitions for residential storage water heaters. Manufacturers added that DOE should not encourage the installation of commercial products that could pose safety concerns in residential settings. Manufacturers stated that this could be more of an issue with future gas-fired storage products that combine higher input ratings and less storage capacity.

12.3.1.5 Profitability

Manufacturers stated that amended energy conservations standards could affect profitability. At any TSL, manufacturers will be forced to discontinue some of their existing products and make potentially significant product and plant modifications. If manufacturers earn a lower markup for more efficient products after the amended energy conservation standard, their profit margin would decrease. Energy conservation standards could also harm total profit by eliminating opportunities to up-sell more efficient units that earn a greater absolute profit. While manufacturers generally agree with DOE's MPC estimates, many noted that product offerings are segmented into multiple models made at various production locations. Multiple product offerings could make it more difficult to reach the price points DOE calculates. Higher production costs would result in lower margins than those DOE assumes and less profitability.

12.3.1.6 Appropriateness of Heat Pump Water Heaters

Heat pump water heaters are effectively required for all rated storage volumes at TSL 7 and TSL 8 and for a portion of the market at TSL 5 and TSL 6 for electric storage water heaters to meet the specified efficiency level. Most electric storage water heater manufacturers disagreed with DOE's decision to include heat pump water heaters in the electric storage water heater product class. In addition, all electric storage water heater manufacturers agreed that this technology is only appropriate for the ENERGY STAR level, not the minimum required efficiency. While many manufacturers intend to design heat pump water heaters in response to ENERGY STAR criteria or are currently doing so, manufacturers believe that setting a minimum standard during the design phase could cause serious and negative consequences.

Manufacturers listed many reasons why this technology is not ready to be applied across the millions of electric storage water heaters needed to satisfy demand. A significant problem is that heat pump water heaters could not be installed in a large portion of existing homes without substantial and costly modifications to the structure, causing some consumers to incur tremendous costs. Several manufacturers commented that the technology has not been fully developed and has not yet been proven reliable for large scale manufacturing. Some manufacturers are concerned that any problems that arise with applying the technology across millions of electric storage water heaters that could not be proven by the compliance date of the rule would cause significant harm to their industry. Manufacturers anticipate other problems with the production of heat pump water heaters if the standard were set at TSL 7 or TSL 8. For example, there is little existing capacity to manufacture water heaters that use heat pump technology, especially on the scale that an amended energy conservation standard would require. Requiring over 4 million annual shipments in 2015 could lead to acquisition problems because component suppliers are not prepared for such an increase in demand. In particular, acquiring sufficient compressors, thermal expansion valves, and other purchased parts to meet market demand could be a challenge.

Manufacturers added that setting the energy conservation at a level effectively requiring the use of heat pump technology would cause many negative impacts on the industry even if the technology were proven by the compliance date specified in the final rule. Because of the increased labor required, manufacturers would consider shifting a considerable portion of production overseas to obtain viable production costs, as was true for the residential air-conditioning industry. Domestic employment in the industry would be affected because only part of the production would likely remain in the United States after the compliance date of the amended energy conservation standard.

Manufacturers also stated they would also incur significant conversion costs if the standard level effectively mandates heat pump water heaters. Every main assembly line and feeder line would need modifications to integrate the new assembly into existing production facilities. Finally, manufacturers would face a significant challenge to retrain their service technicians and installers for a completely new technology. Because the technology has not been fully developed, the skills needed to service and install heat pump water heaters have also not been developed. However, manufacturers indicated that their existing technicians do not have the combination of plumbing and HVAC skills that would be required.

12.3.1.7 Issues with Condensing Technology

Condensing gas-fired water heaters are effectively required for all rated storage volumes at TSL 8 and for large rate storage volumes at TSL5 and TSL 6. According to manufacturers, customers and manufacturers would be harmed if the gas-fired storage water heater energy conservation standard were set at these TSLs. Currently, no manufacturer offers residential condensing water heaters. Because of the low volumes for commercial applications, the technology and manufacturing capabilities for condensing residential storage water heaters on a large scale are not fully developed. The technology is available only in commercial storage water heaters and would need to be applied to much lower output capacity and would require substantial product development. Manufacturers would also need to make extensive assembly and sub-assembly line changes as well as add equipment to manufacture new coils and tanks. Some manufacturers also indicated that this technology was not appropriate for all installations, as line power, special venting, and condensate management are needed.

12.3.1.8 Capital Conversion Costs for Oil-Fired Storage Water Heaters

Oil-storage manufacturers indicated that capital conversion costs for oil-fired storage water heaters at higher efficiency levels, while perhaps not appearing prohibitively large on a nominal basis, are extremely significant relative to the size of oil-fired water heater shipments. At any level above TSL 1, at least one manufacturer with substantial market share indicated that there is a real risk that these capital and product conversion costs could cause the company to exit the market.

12.3.2 Gas-Fired Instantaneous Water Heaters Key Issues

12.3.2.1 Shipment Trends

Some manufacturers expressed concern over using the Australian study from the preliminary analysis to determine the market penetration of gas-fired instantaneous water heaters.[10] Some manufacturers stated that Australian government programs made the price points for instantaneous water heaters lower, which could affect their adoption in the United States.

12.3.2.2 Potential Market Distortion

Manufacturers stated that amended energy conservation standard could greatly affect the market penetration of gas-fired instantaneous water heaters. If the prices were greatly increased relative to storage water heaters, market penetration could be slowed. A drastic increase in the required efficiency (at TSL 8) could disrupt current arrangements with overseas suppliers or parent companies and limit product availability in the United States.

12.3.2.3 Retraining Field Technicians

Manufacturers stated that an energy conservation standard mandating condensing gas-fired instantaneous water heaters at TSL 8 would add a significant burden on manufacturers, who would have to retrain their service and field technicians.

12.3.2.4 Ultra-Low-NO_X Requirements

Manufacturers of gas-fired instantaneous water heaters expressed great concern about the conflicting requirements of more stringent EF requirements and pending ultra-low-NO_X requirements. At most efficiency levels, manufacturers commented that there is a tradeoff in burner design between higher efficiency and lower NO_X emissions. Manufacturers indicated that they have not found a solution and are very concerned about concurrently meeting the ultra-low-NO_X requirements and the energy conservation standards.

12.3.3 Traditional Direct Heating Equipment Key Issues

12.3.3.1 Consumer Impacts

Manufacturers remarked that energy conservation standards could hurt consumers, arguing that many existing installations cannot be replaced with more efficient units because of space considerations. Customers that choose these units would either have to pay for structural modifications or switch to a different heat source. Some manufacturers also noted that improvements in efficiency for the most common type of traditional DHE (gas wall gravity DHE) have long payback periods at any TSL.

All manufacturers stated that gas wall gravity and gas room DHE provide a unique utility because they can operate in the event of a power failure. Manufacturers stated that consumers could lose this utility if these products required line power because it could leave many without a backup source of heat.

12.3.3.2 Significant Capital and Product Development Costs

Manufacturers stated that any product conversion or capital conversion cost would be difficult to justify because of the very low shipment volumes of each product line. Manufacturers remarked that any required investments could force them to reduce their product offerings at best and permanently exit the market at worst. Due to the large number of product offerings that would need to be recertified and/or redesigned, some manufacturers argued that 3 years would not be enough lead time. Because shipment volumes are so low, any investment would significantly add to the final cost of the product, assuming that manufacturers could pass part of the increased cost on to consumers.

Manufacturers are also concerned that higher production costs could drive more consumers to purchase a central system rather than replace their failed direct heating system. If shipments declined at all, manufacturers stated they would be less able to justify the required investment to upgrade products and product lines, which would hurt their industry further. All manufacturers said that energy conservation standards are a real threat to their business and could cause them to exit the market completely.

12.3.3.3 Current Market

Manufacturers expressed concern about the low-volume of the DHE market. Besides low shipment volume, the number of manufacturers also has been declining over the past decade. Because shipments are mostly low-volume replacements, manufacturers stated that most of the traditional DHE market has become a niche.

12.3.3.4 Limited Opportunities to Improve Efficiency

Manufacturers commented that most products on the market today have limited opportunities to improve efficiency. Because these products have been through many development lifecycles, opportunities to save energy cost effectively for consumers have been implemented.

12.3.3.5 Profitability

Manufacturers believe that energy conservation standards could reduce profitability because more efficient products include more purchased parts. Manufacturers were concerned that expensive purchase parts could lower profitability because they would earn a lower margin on units in which they assemble rather than manufacture most of the final product

12.3.4 Gas Hearth Direct Heating Equipment Key Issues

12.3.4.1 Loss of Aesthetic Appeal for Decorative Products

According to manufacturers, all gas hearth products primarily have an aesthetic function in addition to a heating function. Gas hearth DHE are used mostly to zone heat when occupants are in close proximity or to supplement a central heating system, and only rarely as a primary heating source.

Because gas hearth DHE are decorative items in residences, manufacturers believe that energy conservation standards could have a different impact on their industry than other products covered by this rulemaking. Gas hearth manufacturers stated that the utility of the heating products used strictly for heating is not affected by the appearance of the products and would not be affected at any standard level. That is, the utility of water heaters would not be affected by amended energy conservation standards as long as hot water is still delivered. Hearth manufacturers stated that due to the low usage patterns, consumers choices are typically not driven by energy efficiency. Since the aesthetic appeal of their products could be greatly compromised by amended energy efficiency standards, demand for their products could diminish at higher efficiency standards. Manufacturers stated that they earn premiums for aesthetic features such as better-looking flames and better looking masonry, rather than higher efficiency. Multiple manufacturers stated that the yellow flames that consumers look for in a log set depend on a rich gas-to-air mixture, which inherently limits the achievable energy efficiency. Hence, at higher efficiency levels it becomes more difficult to improve efficiency and maintain a desirable flame color, an impact that is hard to measure yet which could have a significant effect on the industry.

12.3.4.2 Product Switching and Profitability

Because the aesthetic appeal of the unit and the flame are critical features, manufacturers believe that overly-stringent energy conservation standards could cause customers to switch to non-covered hearth products like wood burning stoves or strictly decorative units if the energy conservation standards greatly raised product prices. This is particularly true for builders, who purchase a significant portion of the available gas hearth products.

Besides higher prices potentially causing a switching to non-covered products, manufacturers were also concerned that more stringent standards had the potential to lower demand. At higher costs, manufacturers believe that customers would no longer regularly purchase inserts for existing homes or that that gas hearth products in new homes would become an option rather than a standard feature. Manufacturers also believe that a shrinking market would reduce profits.

12.3.4.3 Large Capital and Product Conversion Costs

According to manufacturers, much of the existing production equipment is hard tooled. An energy conservation standard that greatly changes the assembly of current product lines would increase capital conversion costs and result in stranded assets. At TSL 4 and above, much of the capital conversion costs are expected to involve changes to hard tooling to handle new materials like additional insulation and baffling, changes to the heat shields, and new stamping dies.

All manufacturers indicated that product conversion costs could also be significant due to the large number of models currently on the market. In addition, manufacturers believe they could face product development problems for certain products. More stringent annual fuel utilization efficiency (AFUE) requirements would be harder to reach with manufacturers' higher volume product lines, such as built-in direct vent fireplaces. Conversely, it is easier to meet higher efficiencies with less-popular, free-standing stoves because they can radiate heat in more directions. Finally, manufacturers said the product development resources used to meet an energy conservation standard that greatly increases efficiency could negatively impact their existing products because resources would be shifted away from aesthetic elements.

12.3.5 Gas-Fired Pool Heaters Key Issues

12.3.5.1 Impacts on Consumers

Manufacturers stated that energy conservation standards set above an efficiency level achievable using atmospheric technology (TSL 3 through TSL 6) could hurt consumers. According to manufacturers, customers will not recoup the initial higher costs with lower utility bills at these TSLs. Because most residential pool heaters are a luxury item with low usage patterns, most customers do not currently purchase units at TSL 4 and above. Thus, manufacturers stated that more-efficient residential pool heaters are only appropriate in commercial settings (*e.g.*, hotels, gyms) because the higher usage allows such customers to recoup the higher initial costs.

12.3.5.2 Future Shipment Trends

Manufacturers commented that pool heater shipments follow new housing starts. Because the new housing market is down, manufacturers have lowered their projections for future pool heater sales as well. Manufacturers also do not expect future shipments to return to historical levels as recent new housing starts have increasingly been on smaller lots that do not have the room to accommodate swimming pools.

Manufacturers are concerned that energy conservation standards could further decrease future sales. Because pool heaters are not a necessity, the higher initial cost could dissuade some consumers from replacing a failed unit or adding a heater to a new pool or spa. Manufacturers are also concerned that a higher price point for gas-fired pool heaters could hurt future shipments by making alternatives like solar or heat pump pool heaters comparatively cheaper. Manufacturers stated that this trend is already a concern because a few States and utilities have offered subsidies for solar water heaters.

12.3.5.3 Concerns about Condensing and Near-Condensing Efficiency Levels

Based on the engineering technology options, TSL 5 would require near-condensing technologies and TSL 6 would require a fully condensing pool heater. Because of the significantly higher costs of near-condensing and condensing products and the lack of a payback for most customers, the majority of gas-fired pool heater shipments are atmospheric units. Manufacturers indicated that there would be significant capital conversion costs if the energy conservation standard were set at a level that eliminated these atmospheric products (TSL 5 and TSL 6.

Some manufacturers have additional concerns about non-atmospheric technologies. These manufacturers indicated that at higher efficiencies, products become more complicated and can result in higher maintenance costs. Condensing models especially introduce more complications to managing condensate, which can cause the units to be less reliable. Manufacturers indicated that these reliability and maintenance concerns also occur at near-condensing levels. Because many of the costly components necessary to manage condensate are required at near-condensing levels (TSL 5), some manufacturers expect the market to move to fully condensing products if DOE sets the energy conservation standard at TSL 5.

12.3.5.4 Future NO_X Requirements

While pool heaters are subject to low-NO_X requirements, residential gas-fired pool heaters have been exempted from revisions to NO_X emission standards in Southwest air quality management districts that would require ultra-low-NO_X emissions. However, most manufacturers expressed concern over future requirements. If air quality management districts set more restrictive NO_X requirements, some manufacturers may be required to undertake a costly redesign of their burner systems.

12.4 GRIM INPUTS AND ASSUMPTIONS

The GRIM serves as the main tool for assessing the impacts on industry due to amended energy conservation standards. DOE relies on several sources to obtain inputs for the GRIM. Data and assumptions from these sources are then fed into an accounting model that calculates the industry cash flow both with and without amended energy conservation standards.

12.4.1 Overview of the GRIM

The basic structure of the GRIM, illustrated in Figure 12.4.1, is an annual cash flow analysis that uses manufacturer prices, manufacturing costs, shipments, and industry financial information as inputs, and accepts a set of regulatory conditions such as changes in costs, investments, and associated margins. The GRIM spreadsheet uses a number of inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis, 2010, and continuing to 2043 for DHE and gas-fired pool heaters, and extending to 2045 for water heaters. The model calculates the INPV by summing the stream of annual discounted cash flows during this period.[11]

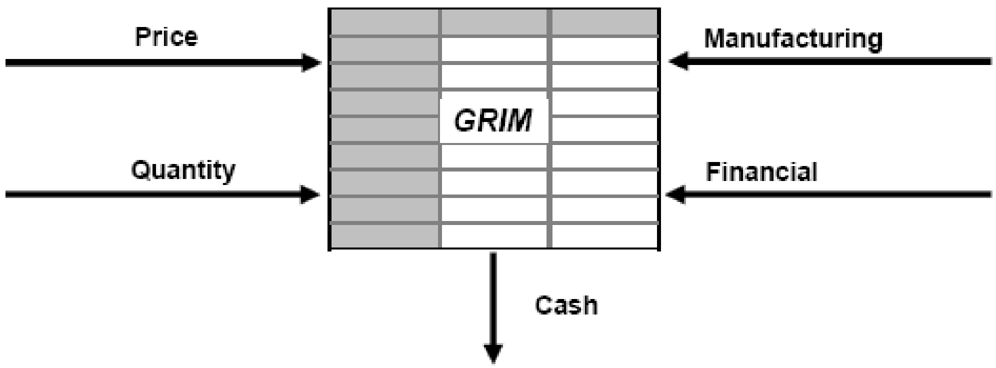

Figure 12.4.1 Using the GRIM to Calculate Cash Flow

The GRIM projects cash flows using standard accounting principles and compares changes in INPV between the base-case and the standard-case scenario induced by amended energy conservation standards. The difference in INPV between the base case and the standard case(s) represents the estimated financial impact of the amended energy conservation standard on manufacturers. Appendix 12-A provides more technical details and user information for the GRIM.

12.4.2 Sources for GRIM Inputs

The GRIM uses several different sources for data inputs in determining industry cash flow. These sources include corporate annual reports, company profiles, Census data, credit ratings, the shipments model, the engineering analysis, and the manufacturer interviews.

12.4.2.1 Corporate Annual Reports

Corporate annual reports to the SEC (SEC 10-Ks) provided many of the financial inputs to the GRIM. These reports exist for publicly held companies and are freely available to the general public. DOE developed initial financial inputs to the GRIM by examining the annual SEC 10-K reports filed by publicly-traded manufacturers primarily engaged in manufacturing heating products and whose combined product range includes water heaters, DHE, and gas-fired pool heaters. Because these companies produce a range of different products, DOE initially assumed that the industry average figures calculated for these companies were representative of manufacturing for each heating product. Since these companies do not provide detailed information about their individual product lines, DOE used the financial information for the entire companies as its initial estimates of the financial parameters in all three GRIM analyses. These figures were later revised using feedback from interviews to be representative of manufacturing for each product class. DOE used corporate annual reports to derive the following initial inputs to the GRIM:

- Tax rate
- Working capital
- SG&A
- R&D

- Depreciation
- Capital expenditures
- Net PPE

12.4.2.2 Standard and Poor Credit Ratings

S&P provides independent credit ratings, research, and financial information. DOE relied on S&P reports to determine the industry's average cost of debt when calculating the cost of capital.

12.4.2.3 Dunn and Bradstreet Reports

D&B provides independent research on company cash flows, revenues, employees, and credit-worthiness. Besides conducting manufacturer interviews, DOE used D&B reports to profile several manufacturers with the potential to be small businesses.

12.4.2.4 Shipment Model

The GRIM used shipment projections derived from DOE's shipments model in the national impact analysis (NIA). The model relied on historical shipments data for water heaters, DHE, and gas-fired pool heaters. Chapter 10 of the TSD describes the methodology and analytical model DOE used to forecast shipments.

12.4.2.5 Engineering Analysis

During the engineering analysis, DOE used a manufacturing cost model to develop MPC estimates for residential water heaters, DHE, and gas-fired pool heaters. The analysis provided the labor, materials, overhead, and total production costs for products at each efficiency level. The engineering analysis also estimated a manufacturer markup to provide the manufacturer selling price (MSP) for each product at every efficiency level and a standard shipping cost for storage water heaters.

12.4.2.6 Manufacturer Interviews

During the course of the MIA, DOE conducted interviews with a representative cross-section of manufacturers. DOE also interviewed manufacturers representing a significant portion of sales in every product class. During these discussions, DOE obtained information to determine and verify GRIM input assumptions in each industry. Key topics discussed during the interviews and reflected in the GRIM include:

- capital conversion costs (one-time investments in PPE);
- product conversion costs (one-time investments in research, product development, testing, marketing, and other costs associated with making product designs comply with amended energy conservation standards);
- product cost structure, or the portion of the MPCs related to materials, labor, overhead, and depreciation costs;
- projected total shipment and shipment distribution mix; and
- MPCs estimated in the engineering analysis.

12.4.3 Financial Parameters

Table 12.4.1 provides financial parameters for six public companies engaged in manufacturing and selling residential heating products. The values listed are averages over a 6-year period (2003 to 2008).

Table 12.4.1 Financial Parameters Based on 2003-2008 Weighted Company Financial Data

Parameter	**Weighted Average**	**Manufacturer**					
		A	B	C	D	E	F
Tax Rate ***% of taxable income***	27.5	26.0	19.9	35.1	34.5	31.2	36.9
Working Capital ***% of revenues***	11.4	14.7	9.7	18.9	5.3	15.1	28.2
SG&A ***% of revenues***	20.9	14.9	23.1	12.6	27.5	16.5	21.9
R&D ***% of revenues***	1.5	2.1	1.2	N/A	1.1	1.6	2.2
Depreciation ***% of revenues***	2.2	3.0	1.3	3.7	2.9	2.0	3.2
Capital Expenditures ***% of revenues***	2.2	3.0	1.7	3.5	2.1	2.0	2.1
Net PPE ***% of revenues***	13.3	20.2	8.2	22.0	13.2	12.9	16.0

These six companies constitute a significant portion of the water heater, DHE, and pool heater market. The values calculated in Table 12.4.1 represent the weighted average estimates using financial data from all publicly traded manufacturers that make heating products. While most of these companies also manufacture products not covered by this rulemaking, DOE used these parameters as initial estimates in each of the straw-man GRIMs. During interviews, water heater, DHE, and pool heater manufacturers were asked to provide their own figures for the parameters listed in Table 12.4.1. Where applicable, DOE adjusted the parameters in each GRIM using this feedback to reflect manufacturing certain product types.

12.4.4 Corporate Discount Rate

DOE used the weighted-average cost of capital (WACC) as the discount rate to calculate the 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. DOE estimated the WACC for the residential water heater, DHE, and pool heater industries based on several representative companies, using the following formula:

WACC = After-Tax Cost of Debt x (Debt Ratio) + Cost of Equity x (Equity Ratio) 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:

Cost of Equity = Riskless Rate of Return + β x Risk Premium Eq. 2

where:

Riskless rate of return is the rate of return on a "safe" benchmark investment, typically considered the short-term Treasury Bill (T-Bill) yield.

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

Beta (β) is the correlation between the movement in the price of the stock and that of the broader market. In this case, 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.

DOE determined that the industry average cost of equity for water heater, DHE, and pool heater industries is 14.9 percent (Table 12.4.2).

Table 12.4.2 Cost of Equity Calculation

Parameter	**Industry-Weighted Average %**	**Manufacturer**					
		A	B	C	D	E	F
(1) Average Beta	1.0	.66	.90	.40	1.19	1.2	1.0*
(2) Yield on 10-Year T-Bill (1990-2007)	5.8	-	-	-	-	-	-
(3) Market Risk Premium (1926-1999)	9.2	-	-	-	-	-	-
Cost of Equity (2)+[(1)*(3)]	14.9	-	-	-			
Equity/Total Capital	38.4	33.1	47.4	16.5	37.3	35.3	.03

* Estimated Beta

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. DOE used this method to calculate the cost of debt for all six manufacturers by using S&P ratings and adding the relevant spread to the risk-free rate.

In practice, investors use a variety of different maturity Treasury bonds to estimate the risk-free rate. DOE used the 10-year Treasury bond return because it captures long-term inflation expectations and is less volatile than short-term rates. The risk free rate is estimated to be approximately 6 percent, which is the average 10-year Treasury bond return between 1990 and 2008.

For the cost of debt, S&P's Credit Services provided the average spread of corporate bonds for the six public manufacturers between 2003 and 2008. DOE added the industry-weighted average spread to the average T-Bill yield over the same period. 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 12.4.3 presents the derivation of the cost of debt and the capital structure of the industry (*i.e.* the debt ratio (debt/total capital)).

Table 12.4.3 Cost of Debt Calculation

Parameter	**Industry-Weighted Average %**	**Manufacturer**					
		A	B	C	D	E	F
S&P Bond Rating	--	A-	BB+	CCC	AAA	BB-	A+
(1) Yield on 10-Year T-Bill (1990-2007)	5.8	-	-	-	-	-	-
(2) Gross Cost of Debt	8.4	7.5	9.0	13.3	7.05	9.45	7.2
(3) Tax Rate	27.5	26.0	19.9	35.1	34.5	31.2	36.9
Net Cost of Debt (2) x ((1)-(3))	6.1	-	-	-	-	-	-
Debt/Total Capital	60.6	66.9	52.6	-	62.7	64.7	99.97

Using public information for these six companies, the initial estimate for the water heater, DHE, and pool heater industries' WACC was approximately 11.4 percent. Subtracting an inflation rate of 2.9 percent between 1990 and 2008, the inflation-adjusted WACC and the initial estimate of the discount rate used in the straw-man GRIM is 8.5 percent. DOE also asked for feedback on the 8.5 percent discount during manufacturer interviews. Where applicable, DOE adjusted the discount rate for certain product types using this feedback.

12.4.5 Trial Standard Levels

DOE developed TSLs for residential water heaters, DHE, and gas-fired pool heaters. Table 12.4.4 through Table 12.4.6 present the efficiency level and engineering technology option at each TSL used in each GRIM. DOE uses an equation to calculate the efficiency at each TSL for water heaters and scales the efficiency for other input rating ranges for DHE. Consequently, the efficiencies shown Table 12.4.4 through Table 12.4.6 only apply to the indicated rated storage volume for water heaters and input capacity range for DHE. However, the technology options and the efficiency levels are consistent across all rated volumes and input capacity ranges.

Table 12.4.4 Water Heater Efficiency Levels and TSLs

		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5*	TSL 6*	TSL 7	TSL 7
Gas-Fired Storage Water Heaters	**EF (at or below 60 gallons unless indicated)**	0.675 – (0.0015 x Rated Storage Volume in gallons)	0.675 – (0.0012 x Rated Storage Volume in gallons)	0.675 – (0.0012 x Rated Storage Volume in gallons)	0.675 – (0.0012 x Rated Storage Volume in gallons)	For Rated Storage Volume at or below 55 gallons: 0.675 – (0.0015 x Rated Storage Volume in gallons)	For Rated Storage Volume at or below 55 gallons: 0.675 – (0.0012 x Rated Storage Volume in gallons)	0.675 – (0.0012 x Rated Storage Volume in gallons)	0.8012 – (0.00078 x Rated Storage Volume in gallons)
	EF (above 60 gallons unless indicated)	0.699 – (0.0019 x Rated Storage Volume in gallons)	0.717 – (0.0019 x Rated Storage Volume in gallons)	0.717 – (0.0019 x Rated Storage Volume in gallons)	0.717 – (0.0019 x Rated Storage Volume in gallons)	For Rated Storage Volume above 55 gallons: 0.8012 – (0.00078 x Rated Storage Volume in gallons)	For Rated Storage Volume above 55 gallons: 0.8012 – (0.00078 x Rated Storage Volume in gallons)	0.717 – (0.0019 x Rated Storage Volume in gallons)	0.8012 – (0.00078 x Rated Storage Volume in gallons)
	Efficiency Level	EL 1	EL 2	EL 2	EL 2	EL 1 / EL 6	EL 2 / EL 6	EL 2	EL 6
	Technology Option	Standing pilot, 1.5” insulation	Standing pilot, 2” insulation	Standing pilot, 2” insulation	Standing pilot, 2” insulation	Standing pilot, 1.5” insulation / Condensing, power vent, 2” ins	Standing pilot, 2” insulation / Condensing, power vent, 2” ins	Standing pilot, 2” insulation	Condensing, power vent, 2” ins
Electric Storage Water Heaters	**EF (at or below 80 gallons unless indicated)**	0.967 – (0.00095 x Rated Storage Volume in gallons)	0.966 – (0.0008 x Rated Storage Volume in gallons)	0.965 – (0.0006 x Rated Storage Volume in gallons)	0.960 – (0.0003 x Rated Storage Volume in gallons)	For Rated Storage Volume at or below 55 gallons: EF = 0.960 – (0.0003 x Rated Storage Volume in gallons)	For Rated Storage Volume at or below 55 gallons: EF = 0.960 – (0.0003 x Rated Storage Volume in gallons)	2.057 – (0.00113 x Rated Storage Volume in gallons)	2.406 – (0.00113 x Rated Storage Volume in gallons)
	EF (above 80 gallons unless indicated)	1.013 – (0.00153 x Rated Storage Volume in gallons)	1.026 – (0.00155 x Rated Storage Volume in gallons)	1.051 – (0.00168 x Rated Storage Volume in gallons)	1.088 – (0.0019 x Rated Storage Volume in gallons)	For Rated Storage Volume above 55 gallons: EF = 2.057 – (0.00113 x Rated Storage Volume in gallons)	For Rated Storage Volume above 55 gallons: EF = 2.057 – (0.00113 x Rated Storage Volume in gallons)	2.057 – (0.00113 x Rated Storage Volume in gallons)	2.406 – (0.00113 x Rated Storage Volume in gallons)
	Efficiency Level	EL 2	EL 3	EL 4	EL 5	EL 5 / EL 6	EL 5 / EL 6	EL 6	EL 7
	Technology Option	2.25" foam insulation	2.5" foam insulation	3" foam insulation	4" foam insulation	4" foam insulation / Heat pump water heater	4" foam insulation / Heat pump water heater	Heat pump water heater	Heat pump water heater, more efficient compressor

Oil-Fired Storage Water Heaters	**EF**	0.64 – (0.0019 x Rated Storage Volume in gallons)	0.66 – (0.0019 x Rated Storage Volume in gallons)	0.66 – (0.0019 x Rated Storage Volume in gallons)	0.68 – (0.0019 x Rated Storage Volume in gallons)	0.68 – (0.0019 x Rated Storage Volume in gallons)	0.68 – (0.0019 x Rated Storage Volume in gallons)	0.68 – (0.0019 x Rated Storage Volume in gallons)	0.74 – (0.0019 x Rated Storage Volume in gallons)
	Efficiency Level	EL 3	EL 4	EL 5	EL 5	EL 5	EL 5	EL5	EL 7
	Technology Option	2.5” fiberglass insulation	2” foam insulation	2.5” foam insulation	2.5” foam insulation	2.5” foam insulation	2.5” foam insulation	2.5” foam insulation	1” foam insulation, multi-flue design
Gas-Fired Instantaneous Water Heaters	**EF**	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.82 – (0.0019 x Rated Storage Volume in gallons)	0.95 – (0.0019 x Rated Storage Volume in gallons)
	Efficiency Level	EL 4	EL 4	EL 4	EL 4	EL 4	EL 4	EL 4	EL 8
	Technology Option	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, improved HX area	Electronic ignition, power vent, direct vent, condensing

* TSL 5 and TSL 6 have different efficiency requirements for gas-fired and electric storage water heater with rated storage volumes equal to or below 55-gallons and above 55-gallons. The technology options and efficiency levels in the table show the split requirements at TSL 5 and TSL 6.

Table 12.4.5 Direct Heating Equipment Efficiency Levels and TSLs

		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas Wall Fan (ovar 42,000 Btu/h)	**Annual Fuel Utilization Efficiency (AFUE)* %**	75	76	77	80	75	80
	Efficiency Level	EL 1	EL 2	EL 3	EL 4	EL 1	EL 4
	Technology Option	Intermittent ignition, two-speed blower	Intermittent ignition, improved HX	Intermittent ignition, two-speed blower, improved HX	Induced draft, electronic ignition	Intermittent ignition, two-speed blower	Induced draft, electronic ignition
Gas Wall Gravity (between 27,000 Btu/h and 46,000 Btu/h)	**AFUE %**	66	66	69	69	70	70
	Efficiency Level	EL 1	EL 1	EL 3	EL 3	EL 4	EL 4
	Technology Option	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Electronic ignition	Electronic ignition
Gas Floor (over 37,000 Btu/h)	**AFUE %**	58	58	58	58	58	58
	Efficiency Level	EL 1	EL 1	EL 1	EL 1	EL 1	EL 1
	Technology Option	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX
Gas Room (between 27,000 Btu/h and 46,000 Btu/h)	**AFUE %**	66	67	68	68	83	83%
	Efficiency Level	EL 2	EL 3	EL 4	EL 4	EL 5	EL 5
	Technology Option	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Standing pilot, improved HX	Electronic ignition, multiple heat exchanger design	Electronic ignition, multiple heat exchanger design
Gas Hearth (between 27,000 and 46,000 Btu/h)	**AFUE %**	67	67	67	72	72	93%
	Efficiency Level	EL 1	EL 1	EL 1	EL 2	EL 2	EL 3
	Technology Option	Electronic ignition	Electronic ignition	Electronic ignition	Fan assisted	Fan assisted	Condensing

* The AFUE requirements are for the indicated input rating ranges only. As described in the engineering analysis, the AFUE requirements are scaled for other input rating ranges.

Table 12.4.6 Pool Heater Efficiency Levels and TSLs

		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Gas-Fired Pool Heaters	**Thermal Efficiency %**	81	82	83	84	86	95
	Efficiency Level	EL 2	EL 3	EL 4	EL 5	EL 6	EL 8
	Technology Option	Improved HX	Improved HX, more effective insulation (combustion chamber)	Power venting	Power venting, improved HX	Sealed combustion, improved HX	Sealed combustion, condensing, improved HX

12.4.6 NIA Shipment Forecast

The GRIM estimates manufacturer revenues based on total-unit-shipment forecasts and the distribution of these values by efficiency level. Changes in the efficiency mix at each standard level are a key driver of manufacturer finances. For this analysis, the GRIM used the NIA shipments forecasts from 2008 to 2045 for water heaters and 2008 to 2043 for DHE and gas-fired pool heaters. However, for all heating products, only the shipments in 2010 and after have an impact on INPV because 2010 is the base year to which future cash flows are summed. Chapter 10 of the TSD explains DOE's calculations of total shipments in detail. Table 12.4.7 shows total shipments forecasted in the shipment analysis for water heaters in 2015; Table 12.4.8 through Table 12.4.10 show the distribution of storage water heaters by rated storage volume; Table 12.4.11 shows forecasted shipments for DHE and gas-fired pool heaters in 2013.

Table 12.4.7 Total NIA Shipments Forecast in 2015 in the Main NIA Shipment Scenario[b]

Product Class	**Total Industry Shipments***
Gas-Fired Storage Water Heaters	4,642,500
Electric Storage Water Heaters	5,140,800
Oil-Fired Storage Water Heaters	34,800
Gas-Fired Instantaneous Water Heaters	1,172,400

*Estimates rounded to the nearest hundred.

[b] The estimated compliance date for the residential water heater energy conservation standard is estimated to be March 2015.

Table 12.4.8 Breakdown of Total Gas-Fired Storage Water Heater Shipments by Rated Storage Volume

Rated Storage Volume	Percentage of Gas-Fired Storage Water Heater Shipments (with no capacity switching)	Percentage of Gas-Fired Storage Water Heater Shipments (with capacity switching at TSL 5 and TSL 6)
30-Gallons	14.1	14.1
40-Gallons	44.6	45.1
50-Gallons	37.5	37.9
66-Gallons	2.0	1.4
75-Gallons	1.9	1.6

Table 12.4.9 Breakdown of Total Electric Storage Water Heater Shipments by Rated Storage Volume

Rated Storage Volume	Percentage of Electric Storage Water Heater Shipments (with no capacity switching)	Percentage of Electric Storage Water Heater Shipments (with capacity switching at TSL 5 and TSL 6)
30-Gallons	23.9	23.9
40-Gallons	32.5	34.0
50-Gallons	34.8	36.6
66-Gallons	3.5	1.5
80-Gallons	4.0	3.1
119-Gallons	1.3	0.9

Table 12.4.10 Breakdown of Total Oil-Fired Storage Water Heater Shipments by Rated Storage Volume

Rated Storage Volume	Percentage of Oil-Fired Storage Water Heater Shipments
32-Gallons	67.0
50-Gallons	33.0

Table 12.4.11 Total NIA Shipments Forecast in 2013[c]

Product Class	Total Industry Shipments*
Gas Wall Fan DHE	31,800
Gas Wall Gravity DHE	97,400
Gas Floor DHE	2,000
Gas Room DHE	19,200
Hearth DHE	768,300
Gas-Fired Pool Heaters	152,300

*Estimates rounded to the nearest hundred.

[c] The estimated compliance date for the DHE and pool heater energy conservation standard is estimated to be March 2013.

12.4.6.1 Base Case Shipments Forecast

As part of the shipment analysis, DOE estimated the shipment distribution by efficiency level for residential water heaters, DHE, and gas-fired pool heaters. Table 12.4.12 through Table 12.4.21 show the base case distributions of shipments by TSL estimated in the NIA for various product classes for the year the amended energy conservation standards take effect.

Table 12.4.12 Base-Case Distribution of Efficiencies for Gas-Fired Storage Water Heaters in 2015 (all rated storage volumes)

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6
Required EF for a 40-Gallon Rated Storage Volume*	0.59	0.62	0.63	0.64	0.65	0.67	0.77
Percentage of Total Shipments at Each Efficiency Level	64.0	13.7	10.2	5.6	0.3	4.8	1.4

* The indicated EFs are only for the 40-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.

Table 12.4.13 Base-Case Distribution of Efficiencies for Total Electric Storage Water Heaters in 2015 (all rated storage volumes)

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7
Required EF for a 50-Gallon Rated Storage Volume*	0.90	0.91	0.92	0.93	0.94	0.95	2.00	2.35
Percentage of Total Shipments at Each Efficiency Level	32.2	24.0	4.6	22.7	7.0	4.4	4.2	1.0

* The indicated EFs are only for the 50-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.

Table 12.4.14 Base-Case Distribution of Efficiencies for Total Oil-Fired Storage Water Heaters in 2015 (all rated storage volumes)

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7
Required EF for a 32-Gallon Rated Storage Volume*	0.53	0.54	0.56	0.58	0.60	0.62	0.66	0.68
Percentage of Total Shipments at Each Efficiency Level	0.0	23,7	0.0	22.5	6.9	13.5	16.8	16.8

* The indicated EFs are only for the 32-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.

Table 12.4.15 Base-Case Distribution of Efficiencies for Total Gas-Fired Instantaneous Water Heaters in 2015

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7	EL 8
EF	0.62	0.69	0.78	0.80	0.82	0.84	0.85	0.92	0.95
Percentage of Total Shipments at Each Efficiency Level	0.9	2.9	1.0	4.5	51.8	2.2	4.1	20.5	12.1

Table 12.4.16 Base-Case Distribution of Efficiencies for Total Gas Wall Fan Direct Heating Equipment in 2013

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4
AFUE %*	74	75	76	77	80
Percentage of Total Shipments at Each Efficiency Level	40.3	6.7	26.9	19.2	6.8

* The indicated AFUEs are only for the over 42,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.17 Base-Case Distribution of Efficiencies for Total Gas Wall Gravity Direct Heating Equipment in 2013

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4
AFUE %*	64	66	68	69	70
Percentage of Total Shipments at Each Efficiency Level	25.0	25.2	12.8	37.1	0.0

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.18 Base-Case Distribution of Efficiencies for Total Gas Floor Direct Heating Equipment in 2013

Efficiency Level	Baseline	EL 1
AFUE %*	57	58
Percentage of Total Shipments at Each Efficiency Level	42.1	57.9

* The indicated AFUEs are only for the over 37,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.19 Base-Case Distribution of Efficiencies for Total Gas Room Direct Heating Equipment in 2013

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5
AFUE %*	64	65	66	67	68	83
Percentage of Total Shipments at Each Efficiency Level	25.5	0.0	24.8	25.1	24.6	0.0

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.20 Base-Case Distribution of Efficiencies for Total Gas Hearth Direct Heating Equipment in 2013

Efficiency Level	Baseline	EL 1	EL 2	EL 3
AFUE %*	64	67	72	93
Percentage of Total Shipments at Each Efficiency Level	39.3	37.6	22.6	0.6

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.21 Base-Case Distribution of Efficiencies for Total Gas-Fired Pool Heaters in 2013

Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7	EL 8
Thermal Efficiency %	78	79	81	82	83	84	86	90	95
Percentage of Total Shipments at Each Efficiency Level	1.5	26.7	20.6	28.2	2.5	11.5	7.7	0.0	1.3

12.4.6.2 Standards Case Shipments Forecast

To examine the effects of amended energy conservation standards on shipments, which affect the INPV, DOE used the base case shipments described in the previous section. For the standards case, DOE assumed shipments at lower efficiencies would roll up into higher efficiency levels in response to an increase in energy conservation standards. This scenario assumes that demand for high efficiency equipment is a function of its price without regard for the standard level. Table 12.4.22 through Table 12.4.31 show the distributions of efficiencies for the various product classes in 2015 in the standards case.

Table 12.4.22 Distribution of Total Gas-Fired Storage Water Heater Shipments in the Standards Case in 2015 (all storage volumes)

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline	64								
EL 1	14	78				75			
EL 2	10	10	88	88	88	10	85	88	
EL 3	6	6	6	6	6	6	6	6	
EL 4	0	0	0	0	0	0	0	0	
EL 5	5	5	5	5	5	5	5	5	
EL 6	1	1	1	1	1	4	4	1	100

Table 12.4.23 Distribution of Total Electric Storage Water Heater Shipments in the Standards Case in 2015 (all storage volumes)

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline	32								
EL 1	24								
EL 2	5	61							
EL 3	23	23	83						
EL 4	7	7	7	90					
EL 5	4	4	4	4	95	89	89		
EL 6	4	4	4	4	4	10	10	99	
EL 7	1	1	1	1	1	1	1	1	100

Table 12.4.24 Distribution of Total Oil-Fired Storage Water Heater Shipments in the Standards Case in 2015 (all storage volumes)

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline	0								
EL 1	24								
EL 2	0								
EL 3	23	46							
EL 4	7	7	53						
EL 5	13	13	13	67	67	67	67	67	
EL 6	17	17	17	17	17	17	17	17	
EL 7	17	17	17	17	17	17	17	17	100

Table 12.4.25 Distribution of Total Residential Gas-Fired Instantaneous Water Heater Shipments in the Standards Case in 2015

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline	1								
EL 1	3								
EL 2	1								
EL 3	5								
EL 4	52	61	61	61	61	61	61	61	
EL 5	2	2	2	2	2	2	2	2	
EL 6	4	4	4	4	4	4	4	4	
EL 7	20	20	20	20	20	20	20	20	
EL 8	12	12	12	12	12	12	12	12	100

Table 12.4.26 Distribution of Total Gas Wall Fan Direct Heating Equipment Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	40						
EL 1	7	47				47	
EL 2	27	27	74			27	
EL 3	19	19	19	93		19	
EL 4	7	7	7	7	100	7	100

Table 12.4.27 Distribution of Total Gas Wall Gravity Direct Heating Equipment Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	25						
EL 1	25	50	50				
EL 2	13	13	13				
EL 3	37	37	37	100	100		
EL 4	0	0	0	0	0	100	100

Table 12.4.28 Distribution of Total Gas Floor Direct Heating Equipment Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	42						
EL 1	58	100	100	100	100	100	100

Table 12.4.29 Distribution of Total Gas Room Direct Heating Equipment Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	26						
EL 1	0						
EL 2	25	50					
EL 3	25	25	75				
EL 4	25	25	25	100	100		
EL 5	0	0	0	0	0	100	100

Table 12.4.30 Distribution of Total Gas Hearth Direct Heating Equipment Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	39						
EL 1	38	77	77	77			
EL 2	23	23	23	23	99	99	
EL 3	1	1	1	1	1	1	100

Table 12.4.31 Distribution of Total Gas-Fired Pool Heater Shipments in the Standards Case in 2013

Percentage of Total Shipments at Each Efficiency Level	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline	2						
EL 1	27						
EL 2	21	49					
EL 3	28	28	77				
EL 4	2	2	2	79			
EL 5	12	12	12	12	91		
EL 6	8	8	8	8	8	99	
EL 7	0	0	0	0	0	0	
EL 8	1	1	1	1	1	1	100

DOE calculated the residential water heater shipments using the scenarios developed in the NIA. To calculate the likely impacts water heater manufacturers at each TSL in the standards case, DOE used the main NIA shipment scenario. The main NIA shipment scenario accounts for fuel switching. In this scenario, DOE considered the potential for current electric storage water heaters to be replaced by a gas-fired storage water heater if amended energy conservation standards for electric storage water heaters were to require the use of heat pump technology. This scenario affects the gas-fired and electric storage water heater results at TSL 6 and TSL 7 only. The fuel switching scenario also accounts for consumers switching from rated storage volumes above 55-gallons to smaller capacities at TSL 5 and TSL 6 due to the higher costs of the technologies used for larger rated storage volumes.

While the NIA also included scenarios that estimate the market penetration of gas-fired instantaneous water heaters. To calculate the INPV impacts on gas-fired, electric, and gas-fired instantaneous water heaters, DOE used the main NIA scenario that uses the reference gas-fired instantaneous market penetration scenario. Finally, the main NIA scenario used the reference economic growth scenario and the moderate rate of efficiency growth shipments scenarios. In the GRIM, the user can calculate the results for any combination of the fuel switching and gas-fired instantaneous market penetration shipment scenarios.

For the DHE and pool heater shipments, DOE used the NIA shipments for each TSL in the standards case. DOE describes the NIA scenarios in chapters 10 and 11 of the TSD.

12.4.7 Production Costs

Changes in production costs affect revenues and gross profits. Products that are more efficient typically cost more to produce than baseline products (chapter 5). For the MIA, DOE used the MPCs derived in the engineering analysis using appropriate production volume estimates. For instance, more efficient products sold under existing energy conservation standards are manufactured at lower production volumes than baseline efficiency products. Enacting more stringent energy conservation standards will increase production volumes for more efficient units. The GRIM also included the proportion of costs devoted to labor, materials, overhead, and depreciation that make up the full cost of production or MPCs. DOE estimated the proportion of costs associated with each cost category by using information from the engineering analysis. DOE used the same percentages for material, labor, and total overhead (depreciation and factory overhead) from the engineering analysis. For the MPC breakdown in the MIA, DOE developed different depreciation values for each product type by using a deprecation value that is consistent with historical information in SEC 10-Ks. The remainder of total overhead was allocated to factory overhead.

For gas-fired storage water heaters in the MIA, DOE used both the standard and ultra-low-NO_X MPCs developed in the engineering analysis. In the MIA DOE used the weighted average MPC of water heaters with standard and ultra-low-NO_X burners at each efficiency level.

As discussed in the engineering analysis, the MSP is comprised of production costs (the direct manufacturing costs or MPCs), non-production costs (indirect costs like SG&A), and profit. For gas-fired, electric, and oil-fired storage water heaters, DOE calculated a standard shipping cost at each efficiency level analyzed (chapter 5). For gas-fired, electric, and oil-fired storage water heaters in the MIA, MSP is calculated by multiplying the MPC by the manufacturer markup and adding the shipping cost. The MSPs for DHE and pool heaters are calculated by multiplying the MPCs by the appropriate manufacturer markup for that product.

Table 12.4.32 through Table 12.4.42 show the production cost estimates used in the GRIM for the representative storage volume and input rating.

Table 12.4.32 MPC Breakdown for 40-Gallon Gas-Fired Storage Water Heaters*

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	Shipping Cost $	MSP $
Baseline	20.01	143.60	17.97	5.60	187.18	18	263.20
TSL 1, 5 (EL 1)	20.49	150.85	18.75	5.86	195.96	21	277.23
TSL 2, 3, 4, 6, 7 (EL 2)	21.45	166.84	19.02	6.40	213.71	27	306.82
TSL 8 (EL 6)	40.30	398.34	32.57	14.54	485.74	52	688.32

* The cost information for gas-fired storage water heaters uses a weighted average of the standard and ultra-low-NO_X costs developed in the engineering analysis.

Table 12.4.33 MPC Breakdown for 50-Gallon Electric Storage Water Heaters

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	Shipping Cost $	MSP $
Baseline	17.49	93.09	16.59	3.83	131	20	188
TSL 1 (EL 2)	18.16	101.81	16.91	4.12	141	21	201
TSL 2 (EL 3)	18.40	105.29	17.07	4.24	145	21	207
TSL 3 (EL 4)	18.99	112.13	17.41	4.47	153	27	223
TSL 4, 5, 6 (EL 5)	20.02	126.49	18.52	4.97	170	56	274
TSL 7 (EL 6)	56.00	447.16	36.59	16.26	556	64	776
TSL 8 (EL 7)	71.92	494.98	46.61	18.48	632	64	873

Table 12.4.34 MPC Breakdown for 32-Gallon Oil-Fired Storage Water Heaters

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	Shipping Cost $	MSP $
Baseline	29.30	403.27	140.92	25.50	599	16	795
TSL 1 (EL 3)	30.85	421.33	146.21	26.61	625	25	838
TSL 2 (EL 4)	30.94	416.79	145.87	26.40	620	18	824
TSL 3, 4, 5, 6, 7 (EL 5)	31.47	425.16	149.42	26.95	633	25	848
TSL 8 (EL 7)	61.00	473.12	157.14	30.74	722	16	955

Table 12.4.35 MPC Breakdown for 199 kBtu/h Gas-Fired Instantaneous Water Heaters

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	MSP $
Baseline Level	88.11	169.28	40.32	10.29	308	447
TSL 1–7 (EL 4)	107.46	335.79	41.01	16.74	501	726
TSL 8 (EL 8)	171.59	762.36	63.58	34.48	1,032	1,496

Table 12.4.36 MPC Breakdown for Gas Wall Fan Direct Heating Equipment with an Input Rating Greater than 42,000 Btu/h

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	MSP $
Baseline	89.05	174.63	89.16	10.80	364	491
TSL 1, 5 (EL 1)	93.09	195.52	89.35	11.57	390	526
TSL 2 (EL 2)	97.21	199.81	92.00	11.91	401	541
TSL 3 (EL 3)	101.64	212.67	94.82	12.52	422	569
TSL 4, 6 (EL 4)	106.13	266.19	95.12	14.31	482	650

Table 12.4.37 MPC Breakdown for Gas Wall Gravity Direct Heating Equipment with an Input Rating Between 27,000 Btu/h and 46,000 Btu/h

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	MSP $
Baseline	35.37	115.66	57.06	6.37	214	290
TSL 1–2 (EL 1)	36.25	121.67	77.30	7.20	242	327
TSL 3–4 (EL 3)	49.59	145.54	91.36	8.77	295	399
TSL 5–6 (EL 4)	50.71	204.86	90.73	10.60	357	482

Table 12.4.38 MPC Breakdown for Gas Floor Direct Heating Equipment with an Input Rating Over 37,000 Btu/h

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	MSP $
Baseline	104.87	180.82	73.17	10.98	370	499
TSL 1–TSL 6 (EL 1)	110.21	198.30	74.48	11.72	395	533

Table 12.4.39 MPC Breakdown for Room Direct Heating Equipment with an Input Rating Between 27,000 Btu/h and 46,000 Btu/h

TSL (Efficiency Level)	Labor *$*	Material *$*	Overhead *$*	Depreciation *$*	MPC *$*	MSP *$*
Baseline	44.45	114.72	68.02	6.95	234	316
TSL 1 (EL 2)	53.64	133.03	70.67	7.88	265	358
TSL 2 (EL 3)	53.00	141.98	69.39	8.09	272	368
TSL 3–4 (EL 4)	55.56	159.84	58.03	8.37	282	380
TSL 5–6 (EL 5)	61.10	274.82	72.20	12.49	421	568

Table 12.4.40 MPC Breakdown for Gas Hearth Direct Heating Equipment with an Input Rating Between 27,000 Btu/h and 46,000 Btu/h

TSL (Efficiency Level)	Labor *$*	Material *$*	Overhead *$*	Depreciation *$*	MPC *$*	MSP *$*
Baseline	56.32	198.59	105.97	11.05	372	502
TSL 1–3 (EL 1)	57.04	198.38	103.45	10.98	370	499
TSL 4–5 (El 2)	85.58	296.59	151.61	16.34	550	743
TSL 6 (EL 3)	101.61	620.20	168.82	27.26	918	1,239

Table 12.4.41 MPC Breakdown for Gas-Fired Pool Heaters with a Standing Pilot with a 250,000 Btu/h Input Rating

TSL (Efficiency Level)	Labor *$*	Material *$*	Overhead *$*	Depreciation *$*	MPC *$*	MSP *$*
Baseline	87.66	355.25	108.85	16.24	568	738
TSL 1 (El 2)	96.62	370.56	108.85	16.96	593	771
TSL 2 (El 3)	101.51	397.50	109.09	17.90	626	814

Table 12.4.42 MPC Breakdown for Gas-Fired Pool Heaters with Electronic Ignition with a 250,000 Btu/h Input Rating

TSL (Efficiency Level)	Labor $	Material $	Overhead $	Depreciation $	MPC $	MSP $
Baseline	87.66	374.24	108.31	16.79	587	763
TSL 1 (El 2)	96.63	389.56	108.31	17.50	612	796
TSL 2 (EL 3)	101.51	416.50	108.55	18.45	645	839
TSL 3 (EL 4)	111.54	472.92	111.07	20.48	716	931
TSL 4 (EL 5)	117.18	523.18	115.39	22.25	778	1,011
TSL 5 (EL 6)	128.92	747.20	125.40	29.49	1,031	1,340
TSL 6 (EL 8)	156.00	1,333.26	132.00	47.73	1,669	2,170

12.4.8 Conversion Costs

Amended energy conservation standards typically cause manufacturers to incur one-time conversion costs to bring their production facilities and product designs into compliance with new regulations. For the MIA, DOE classified these one-time conversion costs into two major groups: capital conversion costs and product conversion costs. Capital conversion costs are one-time investments in PPE to adapt or change existing production facilities so that new product designs can be fabricated and assembled under the new regulation. Product conversion costs are one-time investments in research, development, testing, marketing and other costs to make product designs comply with amended energy conservation standards. 3 – 3

For consistency in nominal dollars, for the final rule DOE inflated the NOPR capital and product conversion costs to 2009$ from 2008$ using producer price index (PPI) information for the relevant industries. See http://data.bls.gov:8080/PDQ/outside.jsp?survey=pc. The PPI industry information is related to the North American Industry Classification System (NAICS) code. For gas-fired storage, oil-fired storage, and gas-fired instantaneous water heaters, DOE updated the conversion costs using PPI information under series id PCU3352283352283 – “Household water heaters, except electric.” DOE updated the conversion costs for electric storage water heaters using series id PCU3352283352281 – “Household water heaters, electric, for permanent installation.” DOE updated the DHE conversion costs using series id PCU3334143334147 – “Floor and wall furnaces, unit heaters, infrared heaters, and mechanical stokers.” Finally, DOE updated the conversion costs for pool heaters using series id PCU3334143334149 – “Other heating equipment, except electric.” DOE also updated its product line analysis for traditional DHE to account for new products that have come on the market and changes to the efficiency levels and TSLs for the final rule. The following sections describe the inputs DOE used in the GRIM in greater detail.

12.4.8.1 Capital Conversion Costs

DOE evaluated the level of capital conversion costs manufacturers would incur to comply with amended energy conservation standards. This evaluation drew from multiple data sources and methodologies. Table 12.4.43 through Table 12.4.52 show DOE's estimates of the capital conversion costs used for each product class. The methodology used to calculate the capital conversion costs for each product class is also described below.

During the MIA interviews, DOE asked manufacturers to estimate the capital conversion costs needed to expand their production of higher efficiency products and to describe the tooling and plant changes those changes would entail. For most TSLs for residential gas-fired storage water heaters and electric storage water heaters, DOE based its capital conversion cost estimates on these interviews. DOE weighted the data submittals from manufacturers by market share and then extrapolated the manufacturers' capital conversion costs for each product class to represent the industry-wide cost. DOE verified the reasonableness of the capital conversion cost submittals for gas-fired and electric storage water heaters by performing a separate bottoms-up estimate based on the number of sub-assembly and assembly lines for each manufacturer and the extent of tooling changes needed at each TSL. Assembly line modification costs were based on the costs for recent line upgrades. Finally, DOE used a top-down approach to verify that the sum of new investments and existing capital stock resulted in a ratio of net PPE to revenue that was characteristic of the industry structure from manufacturers' SEC 10-K reports.

For gas-fired and electric storage water heaters with rated storage volumes equal to or below 55-gallons at TSL 5 and TSL 6, DOE used its industry-wide estimate for the capital conversion costs to reach the required efficiencies. However, at TSL 5 and TSL 6 DOE also estimated the additional capital conversion costs required for gas-fired and electric storage water heaters with rated storage volumes greater than 55-gallons. For electric storage water heaters, DOE estimated the additional tooling and production equipment that would be required for a dedicated heat pump assembly line for rated storage volumes greater than 55-gallons. The tooling and equipment costs were estimated for each manufacturer to build an annex to an existing production facility for a given shipment volume of heat pump water heaters, assuming that manufacturers would integrate purchased heat pump assemblies into their products. To calculate the total capital conversion cost for heat pumps with large rated storage volumes at TSL 5 and TSL 6, DOE used market share data to estimate the shipments of large volume heat pump water heaters that would be needed to meet each manufacturer's current demand. Assuming that each manufacturer would only build a dedicated production line in one of their existing facilities, DOE then estimated the additional capital conversion costs for each manufacturer to build its estimated shipment volume of heat pumps and totaled the estimate for each manufacturer. The gas-fired storage water heater capital conversion costs for large volumes at TSL 5 and TSL 6 were calculated using individual estimates for each manufacturer as well. Similarly, these estimates included the tooling and production equipment that would be required to build a dedicated condensing line for different shipment volumes of large water heaters as an annex. In addition, the estimates assumed that manufacturers would produce new coils in-house and included coil production as part of the capital conversion costs. DOE used market share data to estimate the shipment volume required for each manufacturer and assumed that each manufacturer would build a dedicated condensing line for large volume water heaters in only one of their existing production facilities. To calculate the total capital conversion costs for condensing water heaters with large rated volumes at TSL 5 and TSL 6, DOE totaled its estimate for each manufacturer to build its estimate large size condensing line.

Table 12.4.43 and Table 12.4.44 show DOE's estimates for the gas-fired and electric storage water heater capital conversion costs. For gas-fired storage water heaters, the changes to the insulation thickness at TSL 1 through TSL 7 do not require manufacturers to make substantial changes to their existing plants or assembly lines. At TSL 5 and TSL 6, the capital conversion costs reflect DOE's estimate for each manufacturer to build a dedicated condensing gas-fired storage water heater line and new heat exchanger assembly equipment in an existing facility for rated storage volumes above 55-gallons. The condensing designs for gas-fired storage water heaters at TSL 8 would also require costly changes to manufacture much more complex products across all gas-fired shipments. A significant expense at TSL 8 would involve purchasing new coil manufacturing equipment at every manufacturing facility to supply millions of annual shipments. In addition, all existing assembly lines would need to be overhauled to accommodate manufacturing products with the new technology. Plant layouts would also have to be restructured and existing flexible assembly lines would likely be discontinued. For electric storage water heaters, manufacturers would need to purchase additional foaming stations to reach the efficiencies at TSL 2 through TSL 6. However, the existing plant layouts would not need to be greatly altered at TSL 1 through TSL 3. At TSL 4 through TSL 6, the increased insulation thickness would require manufacturers to lengthen existing assembly lines or add additional assembly lines because the much thicker insulation lowers the throughput of existing assembly lines. The capital conversion costs at TSL 5 and TSL 6 reflect the costs for manufacturers to significantly increase the insulation thickness for water heaters with rated storage volumes equal to or below 55-gallons. The capital conversion costs at TSL 5 and TSL 6 also include the costs for manufacturers to each build a dedicated heat pump assembly line for water heaters with rated storage volumes greater than 55-gallons. The capital conversion costs at TSL 7 and TSL 8 include the capital required to manufacture heat pump water heaters across all rated storage volumes. DOE assumed that manufacturers would initially source the heat pump modules. However, at these TSLs all electric assembly and subassembly lines would require significant conversion to accommodate the top-heavy assembly. All electric assembly lines would also need to be lengthened to integrate merging new tank assembly with the heat pump modules. Finally, the major technology changes for water heaters that use condensing or heat pump technology would require manufacturers to install much more sophisticated testing equipment.

Table 12.4.43 Total Gas-Fired Storage Water Heater Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	1	Standing pilot, 1.5" insulation	0.0
TSL 2–TSL 4	2	Standing pilot, 2.0" insulation	0.0
TSL 5*	1 / 6	Standing pilot, 1.5" insulation / Condensing, power vent, 2" insulation	11.7
TSL 6*	2 / 6	Standing pilot, 2.0" insulation / Condensing, power vent, 2" insulation	11.7
TSL 7	2	Standing pilot, 2.0" insulation	0.0
TSL 8	6	Condensing, power vent, 2" insulation	122.4

*The efficiency levels and technology options are shown for rated storage volumes equal to or below 55-gallons / above 55-gallons.

Table 12.4.44 Total Electric Storage Water Heater Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	2	2.25" foam insulation	0.0
TSL 2	3	2.5" foam insulation	4.3
TSL 3	4	3" foam insulation	4.3
TSL 4	5	4" foam insulation	40.7
TSL 5 and TSL 6*	5 / 6	4" foam insulation / Heat pump water heater	51.9
TSL 7	6	Heat pump water heater	76.0
TSL 8	7	Heat pump water heater, more efficient compressor	85.6

* The efficiency levels and technology options are shown for rated storage volumes equal to or below 55-gallons / above 55-gallons.

For oil-fired storage water heaters, DOE did not receive a representative number of estimates or enough information during interviews to base its capital conversion costs on a top-down estimate. For these product classes, DOE relied primarily on a bottom-up approach to verify the feedback provided during interviews. DOE based the bottom-up estimates on feedback from manufacturer interviews to estimate the types and cost of the production equipment that the industry would be required to change or purchase at each TSL. DOE then used product catalogs and available certification databases to determine how many product lines would need to be upgraded or converted for each manufacturer at each TSL. DOE calculated the industry-wide capital conversion cost by multiplying its estimate for changing an existing production line or creating a new production line by the number of lines that would need to be converted at each TSL. Table 12.4.45 shows the estimates for the oil-fired storage water heater capital conversion costs. The capital conversion cost estimates for TSL 1 through TSL 7 involve relatively minor changes to existing production lines. The capital conversion costs are relatively minor because the basic assembly and technology of the existing products on the market that meet these efficiencies do not vary significantly at these TSLs. However, TSL 8 would require significant changes for some manufacturers. A multi-flue design would require manufacturers that do not offer products to purchase equipment to assemble the new head design. Existing assembly lines would also require modification because existing products are mainly assembled from the bottom up whereas a multi-flue design requires new equipment to manufacture both the tank and water heater head.

Table 12.4.45 Total Oil-Fired Storage Water Heater Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	3	2.5” fiberglass insulation	0.2
TSL 2	4	2” foam insulation	0.2
TSL 3–TSL 7	5	2.5” foam insulation	0.2
TSL 8	7	1” foam insulation, multi flue design	4.0

DOE calculated its capital conversion cost estimates for gas-fired instantaneous water heaters in a similar manner as the oil-fired storage water heater estimates. DOE based its capital conversion costs on a bottom-up estimate that also used feedback from manufacturer interviews. DOE estimate cost of the production equipment and plant modifications that the industry would require at each TSL if it did not currently have products that met that efficiency. DOE then used product catalogs and certification databases to determine how many product lines would be upgraded by each manufacturer at each TSL. DOE calculated the industry-wide capital conversion cost by multiplying its estimate for changing an existing production line or creating a new production line by the number of production lines that would need to be converted at each TSL. Table 12.4.46 shows the estimates for the capital conversion costs for gas-fired instantaneous water heaters. At TSL 1 through TSL 7 would not require the industry to change their existing production facilities because every manufacturer offers products that meet these efficiencies. In addition, manufacturers offer products at TSL 1 through TSL 7 in sufficient quantities that no additional equipment would need to be purchased if the amended energy conservation were set at this efficiency. At TSL 8, manufacturers would be required to purchase equipment to manufacture different heat exchangers. In addition, existing product lines would also require modification to accommodate different sized components for the redesigned products.

Table 12.4.46 Total Gas-Fired Instantaneous Water Heater Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 7	4	Electronic ignition, power vent, improved HX area	0.0
TSL 8	8	Electronic ignition, power vent, direct vent, condensing	10.6

DOE calculated the traditional DHE capital conversion costs in a similar manner as oil-fired storage and gas-fired instantaneous water heaters. DOE used information from manufacturer interviews to understand the types of changes that would be required to reach certain efficiencies. DOE then estimated a cost per product line at each efficiency for manufacturers to either upgrade existing product lines or, if manufacturers did not offer existing products, change equipment to manufacture standards-compliant products. DOE also used product catalogs and certification databases to determine how many product lines would be upgraded or converted for each manufacturer at each TSL. DOE calculated the industry-wide capital conversion cost by multiplying its estimate for to cost to change existing production lines by the number of production lines that would need to be converted at each TSL. Because total manufacturing scale is critical for traditional DHE businesses to remain viable, DOE calculated the capital conversion costs for the traditional DHE market assuming that all product lines that did not meet the required efficiencies would be converted. However, if fewer product lines were converted at more stringent TSLs the per-product line capital conversion costs would increase per manufacturer. Table 12.4.47 through Table 12.4.50 show DOE's estimates for the traditional DHE product classes. The traditional DHE capital conversion costs are related to the number and efficiencies of the existing products manufacturers offer. If manufacturers offer existing products in the market, the per-product line costs assumed by DOE was lower. If manufacturers currently offer products that meet the efficiencies required at that TSL, DOE assumed that some of the capital conversion costs would be shared across the product lines that needed to be upgraded and most of the additional capital conversion costs would be to increase the production of low-volume products in the market. The capital conversion costs for each manufacturer increase if they do not currently offer related products. At these efficiencies, manufacturers would have to purchase significantly more equipment, including dies to manufacture products that differ greatly from most of their existing products and to assemble newly designed heat exchangers.

Table 12.4.47 Total Gas Wall Fan Direct Heating Equipment Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1, TSL 5	1	Intermittent ignition, two-speed blower	0.0
TSL 2	2	Intermittent ignition, improved HX	0.4
TSL 3	3	Intermittent ignition, two-speed blower, improved HX	1.0
TSL 4, TSL 6	4	Induced draft, electronic ignition	2.4

Table 12.4.48 Total Gas Wall Gravity Direct Heating Equipment Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 2	1	Standing pilot, improved HX	1.3
TSL 3–TSL 4	3	Standing pilot, improved HX	2.3
TSL 5–TSL 6	4	Electronic ignition	4.1

Table 12.4.49 Total Gas Floor Direct Heating Equipment Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 6	1	Standing pilot, improved HX	0.1

Table 12.4.50 Total Gas Room Direct Heating Equipment Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	2	Standing pilot, improved HX	0.5
TSL 2	3	Standing pilot, improved HX	1.5
TSL 3–TSL 4	4	Standing pilot, improved HX	2.2
TSL 5–TSL 6	5	Electronic ignition, multiple heat exchanger design	2.6

DOE calculated the gas hearth capital conversion costs in a similar manner as traditional DHE. DOE used information from manufacturer interviews to understand the types of changes that would be required to reach certain efficiencies. DOE then estimated a cost per product line at each efficiency for manufacturers to either upgrade existing product lines or, if products did not exist, change equipment to manufacture standards-compliant products. DOE also used product catalogs and certification databases to determine how many product lines would be upgraded or converted for each manufacturer at each TSL. DOE calculated the industry-wide capital conversion cost by multiplying its estimate for to cost to change existing production lines by the number of production lines that would need to be converted at each TSL. For gas hearth DHE, DOE assumed that the extremely large number of products in the market would make it likely that manufacturers would convert only a portion of their existing products at more stringent TSLs. DOE assumed that manufacturers would only convert up to 50-percent of their existing product lines that did meet the required efficiencies. Table 12.4.51 show DOE’s estimates for the total gas hearth DHE capital conversion costs. The capital conversion costs at TSL 1 through TSL 3 do not involve substantial plant changes. These small capital conversion costs involve minor changes for a few manufacturers to accommodate other improvements such as additional baffling. At TSL 4 and TSL 5, the capital conversion costs involve changes to handle new materials like additional insulation and baffling, changes to the heat shields, and some new stamping dies for manufacturers that need to greatly alter their existing designs that do not reach the required efficiencies. However, at TSL 1 through TSL 5, the capital conversion costs are relatively minor because the efficiency requirements can be met with purchased parts. These changes result in relatively low capital conversion costs because the purchased parts would not require the industry to replace major hard tooling at TSL 1 through TSL 5. However, the capital conversion costs greatly increase at TSL 6 because manufacturers would likely need a secondary heat exchanger at the max-tech level, which could alter the size and structure of most existing product lines. DOE assumed that manufacturers would only convert up to 50-percent of their existing product lines which does lower the required capital conversion costs for the industry at TSL 6. However, manufacturers would be able to continue to supply their customers even if they offer fewer product lines after standards. Because most product lines are typically produced on separate lines and are produced in runs, manufacturers would not lose sales due to plant capacity constraints even if they offered fewer total gas hearth DHE products covered by this rulemaking.

Table 12.4.51 Total Gas Hearth Direct Heating Equipment Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Capital Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 3	1	Electronic ignition	0.2
TSL 4–TSL 5	2	Fan assisted	0.5
TSL 6	3	Condensing	4.2

DOE calculated the gas-fired pool heater capital conversion costs in a similar manner as gas-fired and electric storage water heaters. DOE used the estimates manufacturers provided about the required tooling and plant changes needed to offer products at higher efficiencies. DOE weighted the estimates provided by manufacturers by market share and then extrapolated capital conversion costs to represent the industry-wide cost. DOE verified these estimates by performing a separate bottoms-up estimate of the required tooling for each manufacturer at higher efficiencies and verifying that the total capital conversion resulted in a characteristic ratio of net

PPE to industry-wide revenue. Table 12.4.52 shows the estimated conversion costs for gas-fired pool heaters. The conversion costs at TSL 1 and TSL 2 are relatively minor because most manufacturers currently offer products that meet these efficiencies and would not be required to make significant changes to their production facilities. At TSL 4 and TSL 5, most manufacturers would have to make relatively minor changes to their existing production lines. At these TSLs, most of the capital conversion costs involve changes to the heat exchanger fabrication equipment. The capital conversion costs also include the additional equipment manufacturers need to expand the production of currently low-volume products. At TSL 5 and TSL 6, the capital conversion costs increase substantially for manufacturers. In addition to changing subassembly lines for component parts including heat exchanger fabrication, manufacturers would also have to make changes to their main assembly lines. The capital conversion costs also increase at these TSLs because the different materials used by manufacturers would require changes to production equipment on their feeder lines, especially to fabricate heat exchangers. Finally, the capital conversion costs increase substantially at TSL 6 because manufacturers that do not currently offer condensing products would have to purchase costly fabrication equipment.

Table 12.4.52 Total Pool Heater Capital Conversion Costs by TSL

TSL	**Efficiency Level**	**Technology Option**	**Total Capital Conversion Costs** ***2009$ millions***
Baseline	-	-	0.0
TSL 1	2	Improved HX	0.0
TSL 2	3	Improved HX, more effective insulation (combustion chamber)	0.2
TSL 3	4	Power venting	1.3
TSL 4	5	Power venting, improved HX	1.5
TSL 5	6	Sealed combustion, Improved HX	4.6
TSL 6	8	Sealed combustion, condensing, improved HX	7.4

12.4.8.2 Product Conversion Costs

DOE assessed the product conversion costs that manufacturers would be required to make at each TSL. For residential gas-fired and electric storage water heaters and gas-fired pool heaters, DOE obtained estimates for these costs through manufacturer interviews. DOE estimated average industry product conversion expenditures by weighting the estimates by market share. DOE then extrapolated the interviewed manufacturers' product conversion costs for each product class to account for the market share of companies that were not interviewed. DOE verified the estimates by comparing them to its own estimate of the product development, testing, certification, and training effort required by each manufacturer at each TSL. DOE also compared its estimates to the total cost of other recent product development efforts manufacturers also provided (such as the cost to redesign burners to comply with ultra-low-NO_X requirements).

For gas-fired and electric storage water heaters with rated storage volumes equal to or below 55-gallons at TSL 5 and TSL 6, DOE used its industry-wide estimate for the product conversion costs to reach the required efficiencies. However, at TSL 5 and TSL 6 DOE also estimated the additional product conversion costs required for gas-fired and electric storage water heaters with rated storage volumes greater than 55-gallons. At TSL 5 and TSL 6, DOE used the total industry-wide product conversion costs for the required efficiencies of water heaters with rated storage volumes at or below 55-gallons. DOE assumed the additional product conversion costs for the larger sizes at TSL 5 and TSL 6 scaled with the industry-wide product conversion costs for condensing and heat pump water heaters. At TSL 5 and TSL 6 for electric storage water heaters, DOE multiplied the product conversion estimates at TSL 7, which would essentially require heat pump water heaters across the full range of rated storage volumes, by the percentage of total electric storage water heater models that are above 55-gallons (*i.e.*, 27 percent). Similarly, DOE estimated the product conversion costs for larger gas-fired storage water heaters at TSL 5 and TSL 6 by multiplying its industry-wide product conversion cost for condensing water heaters at TSL 8 by the percentage of total gas-fired water heaters that are above 55-gallons (*i.e.*, 11 percent).

For DHE and instantaneous water heaters, DOE did not receive sufficient manufacturer data to serve as the basis for industry-wide product conversion estimates. For these products, DOE reviewed product literature and publicly available information about the efficiency of existing product lines. DOE used this information to estimate the number of product lines that manufacturers would need to modify or develop at each TSL. DOE also used information from interviews with manufacturers and conversations with industry experts to estimate the engineering, certification, and product development time required per product line at each TSL. DOE assumed that these costs represent the product conversion costs for a manufacturer that has to upgrade product lines to meet that efficiency. DOE also assumed that that the product development costs increase as the design changes become more complex and if manufacturers do not currently offer products that meet or exceed the required efficiency. DOE calculated the industry-wide product conversion costs by multiplying its estimates of a per-line product development cost by the number of product lines manufacturers would need to modify or develop at each TSL. For traditional DHE and gas-fired water heaters, DOE assumed that manufacturers would convert all existing product lines that did not meet the efficiencies required at that TSL. However, for gas hearth DHE DOE assumed that manufacturers would only convert up to 50-percent of their existing product lines that did not meet the required efficiencies. Table 12.4.53 through Table 12.4.62 illustrate DOE's estimates of the product conversion cost.

Table 12.4.53 Total Gas-Fired Storage Water Heater Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	1	Standing pilot, 1.5” insulation	6.1
TSL 2–TSL 4	2	Standing pilot, 2.0” insulation	6.1
TSL 5*	1 / 6	Standing pilot, 1.5” insulation / Condensing, power vent, 2” insulation	8.5
TSL 6*	2 / 6	Standing pilot, 2.0” insulation / Condensing, power vent, 2” insulation	8.5
TSL 7	2	Standing pilot, 2.0” insulation	6.1
TSL 8	6	Condensing, power vent, 2” insulation	22.3

*The efficiency levels and technology options are shown for rated storage volumes equal to or below 55-gallons / above 55-gallons.

Table 12.4.54 Total Electric Storage Water Heater Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	2	2.25” foam insulation	6.0
TSL 2	3	2.5” foam insulation	8.4
TSL 3	4	3” foam insulation	8.4
TSL 4	5	4” foam insulation	8.4
TSL 5 and TSL 6*	5 / 6	4” foam insulation / Heat pump water heater	23.2
TSL 6	6	Heat pump water heater	55.0
TSL 7	7	Heat pump water heater, more efficient compressor	57.4

* The efficiency levels and technology options are shown for rated storage volumes equal to or below 55-gallons / above 55-gallons

Table 12.4.55 Total Oil-Fired Storage Water Heater Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	3	2.5” fiberglass insulation	0.3
TSL 2	4	2” foam insulation	0.3
TSL 3–TSL 7	5	2.5” foam insulation	0.3
TSL 8	7	1” foam insulation, multi flue design	1.1

Table 12.4.56 Total Gas-Fired Instantaneous Water Heater Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *20098$ millions*
Baseline	-	-	0.0
TSL 1–TSL 7	4	Electronic ignition, power vent, improved HX area	0.0
TSL 8	8	Electronic ignition, power vent, direct vent, condensing	8.8

Table 12.4.57 Total Gas Wall Fan Direct Heating Equipment Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1, TSL 5	1	Intermittent ignition, two-speed blower	0.1
TSL 2	2	Intermittent ignition, improved HX	0.2
TSL 3	3	Intermittent ignition, two-speed blower, improved HX	0.5
TSL 4, TSL 6	4	Induced draft, electronic ignition	1.0

Table 12.4.58 Total Gas Wall Gravity Direct Heating Product Capital Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1, TSL 2	1	Standing pilot, improved HX	0.5
TSL 3, TSL 4	3	Standing pilot, improved HX	0.9
TSL 5, TSL 6	4	Electronic ignition	2.6

Table 12.4.59 Total Gas Floor Direct Heating Equipment Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 6	1	Standing pilot, improved HX	0.1

Table 12.4.60 Total Gas Room Direct Heating Equipment Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	2	Standing pilot, improved HX	0.2
TSL 2	3	Standing pilot, improved HX	0.6
TSL 3–TSL 4	4	Standing pilot, improved HX	0.9
TSL 5–TSL 6	5	Electronic ignition, multiple heat exchanger design	2.2

Table 12.4.61 Total Gas Hearth Direct Heating Equipment Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1–TSL 3	1	Electronic ignition	0.6
TSL 4–TSL 5	2	Fan assisted	1.5
TSL 6	3	Condensing	8.4

Table 12.4.62 Total Pool Heater Product Conversion Costs by TSL

TSL	Efficiency Level	Technology Option	Total Product Conversion Costs *2009$ millions*
Baseline	-	-	0.0
TSL 1	2	Improved HX	0.0
TSL 2	3	Improved HX, more effective insulation (combustion chamber)	0.0
TSL 3	4	Power venting	2.7
TSL 4	5	Power venting, improved HX	2.7
TSL 5	6	Sealed combustion, Improved HX	4.8
TSL 6	8	Sealed combustion, condensing, improved HX	5.7

12.4.9 Markup Scenarios

DOE used several standards case markup scenarios to represent the uncertainty about the impacts of amended energy conservation standards on prices and profitability. In the base case, DOE used the same baseline markups calculated in the engineering analysis for all product classes. In the standards case, DOE considered different markup scenarios for each type of product (*i.e.*, water heaters, DHE, and gas-fired pool heaters). DOE then used markup scenarios to bound the range of profitability following amended energy conservation standards for each TSL. For each product class, DOE used the markup scenarios that characterize the range of possible market responses after amended energy standards. For the three heating products, DOE considered two markup scenarios: the preservation of return on invested capital (ROIC) and the preservation of operating profit.

12.4.9.1 Preservation of Return on Invested Capital Markup Scenario

ROIC is the net operating profit after taxes (NOPAT) divided by the total invested capital. The total invested capital includes both fixed assets and working capital, or net PPE plus working capital. In this scenario, the markups are calibrated to yield the same return on invested capital the year after the compliance date of the amended energy conservation standards as the return in the base case. This scenario models the situation in which manufacturers maintain a similar level of profitability from the investments required by amended energy conservation standards as they do from their current business operations. Under this scenario, manufacturers have higher NOPAT after standards, but manufacturers also have greater working capital and investment requirements. Because manufacturers are able to earn additional returns on the investments required by amended energy conservation standards, the preservation of return on invested capital markup scenario represents the high bound to profitability. For those standard levels where the investments are consistent with historical ratios of revenue to net PPE, the resulting markups are consistent with baseline markups. Table 12.4.63 through Table 12.4.76 lists the products DOE analyzed with the corresponding markups at each TSL.

Table 12.4.63 Preservation of Return on Invested Capital Markups for Gas-Fired Storage Water Heaters

EL	**Markups by TSL**								
(EF)*	**Baseline**	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5****	**TSL 6****	**TSL 7**	**TSL 8**
Baseline (0.59)	1.31	-	-	-	-	-	-	-	-
EL 1 (0.62)	1.31	1.31	-	-	-	-	-	-	-
EL 2 (0.63)	1.31	1.31	1.30	1.30	1.30	1.31 / -	1.30 / -	1.30	-
EL 3 (0.64)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 4 (0.65)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 5 (0.67)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 6 (0.77)	1.31	1.31	1.31	1.31	1.31	1.31 / 1.29	1.31 / 1.29	1.31	1.29

* The indicated EFs are only for the 40-gallon representative storage volume. As described in the engineering analysis, the required EF are calculated using an equation.
** For TSL 5 and TSL 6, markups are shown for rated storage volumes equal to or below 55-gallons / above55-gallons

Table 12.4.64 Preservation of Return on Invested Capital Markups for Electric Storage Water Heaters

EL (EF)*	Markups by TSL								
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5**	TSL 6**	TSL 7	TSL 8
Baseline (0.90)	1.28	-	-	-	-	-	-	-	-
EL 1 (0.91)	1.28	-	-	-	-	-	-	-	-
EL 2 (0.92)	1.28	1.28	-	-	-	-	-	-	-
EL 3 (0.93)	1.28	1.28	1.28	-	-	-	-	-	-
EL 4 (0.94)	1.28	1.28	1.28	1.28	-	-	-	-	-
EL 5 (0.95)	1.28	1.28	1.28	1.28	1.28	1.28 / -	1.28 / -	-	-
EL 6 (2.00)	1.28	1.28	1.28	1.28	1.28	1.28 / 1.26	1.28 / 1.26	1.26	-
EL 7 (2.35)	1.28	1.28	1.28	1.28	1.28	1.28 / 1.28	1.28 / 1.28	1.28	1.26

* The indicated EFs are only for the 50-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.
** For TSL 5 and TSL 6, markups are shown for rated storage volumes equal to or below 55-gallons / above 55-gallons

Table 12.4.65 Preservation of Return on Invested Capital Markups for Oil-Fired Storage Water Heaters

EL (EF)*	Markups by TSL								
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline (0.53)	1.30	-	-	-	-	-	-	-	-
EL 1 (0.54)	1.30	-	-	-	-	-	-	-	-
EL 2 (0.56)	1.30	-	-	-	-	-	-	-	-
EL 3 (0.58)	1.30	1.30	-	-	-	-	-	-	-
EL 4 (0.60)	1.30	1.30	1.30	-	-	-	-	-	-
EL 5 (0.62)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 6 (0.66)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 7 (0.68)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.32

* The indicated EFs are only for the 32-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.

Table 12.4.66 Preservation of Return on Invested Capital Markups for Gas-Fired Instantaneous Water Heaters

EL (EF)	Markups by TSL								
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**	**TSL 7**	**TSL 8**
Baseline (0.62)	1.45	-	-	-	-	-	-	-	-
EL 1 (0.69)	1.45	-	-	-	-	-	-	-	-
EL 2 (0.78)	1.45	-	-	-	-	-	-	-	-
EL 3 (0.80)	1.45	-	-	-	-	-	-	-	-
EL 4 (0.82)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 5 (0.84)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 6 (0.85)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 7 (0.92)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 8 (0.95)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.42

Table 12.4.67 Preservation of Return on Invested Capital Markups for Gas Wall Fan Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (74%)	1.35	-	-	-	-	-	-
EL 1 (75%)	1.35	1.35	-	-	-	1.35	-
EL 2 (76%)	1.35	1.35	1.36	-	-	1.35	-
EL 3 (77%)	1.35	1.35	1.35	1.36	-	1.35	-
EL 4 (80%)	1.35	1.35	1.35	1.35	1.37	1.35	1.37

* The indicated AFUEs are only for the over 42,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.68 Preservation of Return on Invested Capital Markups for Gas Wall Gravity Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (66%)	1.35	1.37	1.37	-	-	-	-
EL 2 (68%)	1.35	1.35	1.35	-	-	-	-
EL 3 (69%)	1.35	1.35	1.35	1.36	1.36	-	-
EL 4 (70%)	1.35	1.35	1.35	1.35	1.35	1.36	1.36

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.69 Preservation of Return on Invested Capital Markups for Gas Floor Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (57%)	1.35	-	-	-	-	-	-
EL 1 (58%)	1.35	1.37	1.37	1.37	1.37	1.37	1.37

* The indicated AFUEs are only for the over 37,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.70 Preservation of Return on Invested Capital Markups for Gas Room Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (65%)	1.35	-	-	-	-	-	-
EL 2 (66%)	1.35	1.39	-	-	-	-	-
EL 3 (67%)	1.35	1.35	1.42	-	-	-	-
EL 4 (68%)	1.35	1.35	1.35	1.42	1.42	-	-
EL 5 (83%)	1.35	1.35	1.35	1.35	1.3500	1.40	1.40

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.71 Preservation of Return on Invested Capital Markups for Gas Hearth Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (67%)	1.35	1.35	1.35	1.35	-	-	-
EL 2 (72%)	1.35	1.35	1.35	1.35	1.34	1.34	-
EL 3 (93%)	1.35	1.35	1.35	1.35	1.35	1.35	1.34

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.72 Preservation of Return on Invested Capital Markups for Gas-Fired Pool Heaters

TSL (Thermal Efficiency)	Markups by TSL						
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline (78%)	1.30	-	-	-	-	-	-
EL 1 (79%)	1.30	-	-	-	-	-	-
EL 2 (81%)	1.30	1.30	-	-	-	-	-
EL 3 (82%)	1.30	1.30	1.30	-	-	-	-
EL 4 (83%)	1.30	1.30	1.30	1.30	-	-	-
EL 5 (84%)	1.30	1.30	1.30	1.30	1.30	-	-
EL 6 (86%)	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 7 (90%)	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 8 (95%)	1.30	1.30	1.30	1.30	1.30	1.30	1.29

12.4.9.2 Preservation of Operating Profit

Operating profit is defined as earnings before interest and taxes. The implicit assumption of this markup scenario is that industry maintains only its base case operating profit (in absolute dollars) after the amended standard. DOE implemented this scenario in the GRIM by setting the manufacturer markups at each TSL to yield the base case operating profit the year after the compliance date. Industry profitability is reduced in this scenario because higher production costs are not fully passed on to customers. As manufacturing costs increase, manufacturers are more severely harmed because they can only pass through a portion of these higher costs. The industry passes through its increased production costs on to customers, but higher R&D, SG&A, and other non-production costs lower the per-unit profit. This scenario represents the lower bound of industry profitability following amended energy conservation standards because higher production costs do not bring manufacturers additional NOPAT. Table 12.4.73 through Table 12.4.82 lists the products DOE analyzed with the corresponding markups at each TSL.

Table 12.4.73 Preservation of Operating Profit Markups for Gas-Fired Storage Water Heaters

EL (EF)*	Markups by TSL								
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5****	**TSL 6****	**TSL 7**	**TSL 8**
Baseline (0.59)	1.31	-	-	-	-	-	-	-	-
EL 1 (0.62)	1.31	1.31	-	-	-	-	-	-	-
EL 2 (0.63)	1.31	1.31	1.30	1.30	1.30	1.31 / -	1.30 / -	1.30	-
EL 3 (0.64)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 4 (0.65)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 5 (0.67)	1.31	1.31	1.31	1.31	1.31	1.31 / -	1.31 / -	1.31	-
EL 6 (0.77)	1.31	1.31	1.31	1.31	1.31	1.31 / 1.26	1.31 / 1.26	1.31	1.26

* The indicated EFs are only for the 40-gallon representative storage volume. As described in the engineering analysis, the required EF are calculated using an equation.
** For TSL 5 and TSL 6, markups are shown for rated storage volumes equal to or below 55-gallons / above55-gallons

Table 12.4.74 Preservation of Operating Profit Markups for Electric Storage Water Heaters

EL (EF)*	Markups by TSL								
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5****	**TSL 6****	**TSL 7**	**TSL 7**
Baseline (0.90)	1.28	-	-	-	-	-	-	-	-
EL 1 (0.91)	1.28	-	-	-	-	-	-	-	-
EL 2 (0.92)	1.28	1.28	-	-	-	-	-	-	-
EL 3 (0.93)	1.28	1.28	1.28	-	-	-	-	-	-
EL 4 (0.94)	1.28	1.28	1.28	1.27	-	-	-	-	-
EL 5 (0.95)	1.28	1.28	1.28	1.28	1.27	1.27 / -	1.27 / -	-	-
EL 6 (2.00)	1.28	1.28	1.28	1.28	1.28	1.28 / 1.23	1.28 / 1.23	1.23	-
EL 7 (2.35)	1.28	1.28	1.28	1.28	1.28	1.28 / 1.28	1.28 / 1.28	1.28	1.23

* The indicated EFs are only for the 50-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.
** For TSL 5 and TSL 6, markups are shown for less rated storage volumes equal to or below 55-gallons / above 55-gallons

Table 12.4.75 Preservation of Operating Profit Markups for Oil-Fired Storage Water Heaters

EL (EF)*	Markups by TSL								
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline (0.53)	1.30	-	-	-	-	-	-	-	-
EL 1 (0.54)	1.30	-	-	-	-	-	-	-	-
EL 2 (0.56)	1.30	-	-	-	-	-	-	-	-
EL 3 (0.58)	1.30	1.30	-	-	-	-	-	-	-
EL 4 (0.60)	1.30	1.30	1.30	-	-	-	-	-	-
EL 5 (0.62)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 6 (0.66)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 7 (0.68)	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.29

* The indicated EFs are only for the 32-gallon representative storage volume. As described in the engineering analysis, the required EFs are calculated using an equation.

Table 12.4.76 Preservation of Operating Profit Markups for Gas-Fired Instantaneous Water Heaters

EL (EF)	Markups by TSL								
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Baseline (0.62)	1.45	-	-	-	-	-	-	-	-
EL 1 (0.69)	1.45	-	-	-	-	-	-	-	-
EL 2 (0.78)	1.45	-	-	-	-	-	-	-	-
EL 3 (0.80)	1.45	-	-	-	-	-	-	-	-
EL 4 (0.82)	1.45	1.44	1.44	1.44	1.44	1.44	1.44	1.44	-
EL 5 (0.84)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 6 (0.85)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 7 (0.92)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	-
EL 7 (0.95)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.39

Table 12.4.77 Preservation of Operating Profit Markups for Gas Wall Fan Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (74%)	1.35	-	-	-	-	-	-
EL 1 (75%)	1.35	1.35	-	-	-	1.35	-
EL 2 (76%)	1.35	1.35	1.35	-	-	1.35	-
EL 3 (77%)	1.35	1.35	1.35	1.34	-	1.35	-
EL 4 (80%)	1.35	1.35	1.35	1.35	1.34	1.35	1.34

* The indicated AFUEs are only for the over 42,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.78 Preservation of Operating Profit Markups for Gas Wall Gravity Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (66%)	1.35	1.35	1.35	-	-	-	-
EL 2 (68%)	1.35	1.35	1.35	-	-	-	-
EL 3 (69%)	1.35	1.35	1.35	1.34	1.34	-	-
EL 4 (70%)	1.35	1.35	1.35	1.35	1.35	1.33	1.33

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.79 Preservation of Operating Profit Capital Markups for Gas Floor Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**	**TSL 6**
Baseline (57%)	1.35	-	-	-	-	-	-
EL 1 (58%)	1.35	1.35	1.35	1.35	1.35	1.35	1.35

* The indicated AFUEs are only for the over 37,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.80 Preservation of Operating Profit Markups for Gas Room Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (65%)	1.35	-	-	-	-	-	-
EL 2 (66%)	1.35	1.35	-	-	-	-	-
EL 3 (67%)	1.35	1.35	1.35	-	-	-	-
EL 4 (68%)	1.35	1.35	1.35	1.35	1.35	-	-
EL 5 (83%)	1.35	1.35	1.35	1.35	1.35	1.33	1.33

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.81 Preservation of Operating Profit Markups for Gas Hearth Direct Heating Equipment

TSL (AFUE)*	Markups by TSL						
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline (64%)	1.35	-	-	-	-	-	-
EL 1 (67%)	1.35	1.35	1.35	1.35	-	-	-
EL 2 (72%)	1.35	1.35	1.35	1.35	1.33	1.33	-
EL 3 (93%)	1.35	1.35	1.35	1.35	1.35	1.35	1.32

* The indicated AFUEs are only for the between 27,000 Btu/h and 46,000 Btu/h representative input rating range. As described in the engineering analysis, the required AFUE is scaled for other input rating ranges.

Table 12.4.82 Preservation of Operating Profit Markups for Gas-Fired Pool Heaters

TSL (Thermal Efficiency)	Markups by TSL						
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6
Baseline (78%)	1.30	-	-	-	-	-	-
EL 1 (79%)	1.30	-	-	-	-	-	-
EL 2 (81%)	1.30	1.30	-	-	-	-	-
EL 3 (82%)	1.30	1.30	1.30	-	-	-	-
EL 4 (83%)	1.30	1.30	1.30	1.29	-	-	-
EL 5 (84%)	1.30	1.30	1.30	1.30	1.29	-	-
EL 6 (86%)	1.30	1.30	1.30	1.30	1.30	1.28	-
EL 7 (90%)	1.30	1.30	1.30	1.30	1.30	1.30	-
EL 8 (95%)	1.30	1.30	1.30	1.30	1.30	1.30	1.26

12.5 INDUSTRY FINANCIAL IMPACTS

Using the inputs and scenarios described in the previous sections, the GRIM estimated indicators of financial impacts on the residential water heater, DHE, and pool heater industries. The following sections detail additional inputs and assumptions for residential gas-fired storage, electric storage, oil-fired storage, and gas-fired instantaneous water heaters. The main results of the MIA are also reported in this section. The MIA consists of two key financial metrics: INPV and annual cash flows.

12.5.1 Introduction

The INPV measures the industry value and is used in the MIA to compare the economic impacts of different TSLs in the standards case. The INPV is different from DOE’s NPV, which is applied to the U.S. economy. The INPV is the sum of all net cash flows discounted at the industry’s cost of capital or discount rate. The water heater GRIM estimates cash flows from 2008 to 2045; the DHE and pool heater GRIM estimates cash flows from 2008 to 2043. All three of the GRIM analyses use the same analysis period used in the NIA (chapter 11).

In the MIA, DOE compares the INPV of the base case (no amended energy conservation standards) to that of each TSL in the standards case. The difference between the base case and a standards case INPV is an estimate of the economic impacts that implementing that particular TSL would have on the industry. For the residential water heater, DHE, and pool heater industries, DOE examined the two markup scenarios described above: the preservation of return on invested capital and the preservation of operating profit to bound the potential range of impacts.

While INPV is useful for evaluating the long-term effects of amended energy conservation standards, short-term changes in cash flow are also important indicators of the industry's financial situation. For example, a large investment over one or two years could strain the industry's access to capital. Consequently, the sharp drop in financial performance could cause investors to flee, even though recovery may be possible. 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, Figure 12.5.1 through Figure 12.5.6 below present the annual net or free cash flows from 2008 through 2021 for the base case and different TSLs in the standards case.

Because the same markup scenarios are used for the three heating products, each of the figures below has a similar shape. Annual cash flows are discounted to the base year, 2010. Before 2010, there are no differences between the base case and each TSL in the standards cases. Between 2010 and the compliance date of the amended energy conservation standard, cash flows are driven by the level of conversion costs and the proportion of these investments spent every year. After the standard announcement date (*i.e.*, the publication date of the final rule), industry cash flows begin to decline as companies use their financial resources to prepare for the amended energy conservation standard. The more stringent the amended energy conservation standard, the greater the impact on industry cash flows in the years leading up to the compliance date, as product conversion costs lower cash inflows from operations and capital conversion costs increase cash outflows for capital expenditures.

Free cash flow in the year the amended energy conservation standards take effect is driven by two competing factors. In addition to capital and product conversion costs, amended energy conservation standards could create stranded assets, *i.e.*, tooling and equipment that would have enjoyed longer use if the energy conservation standard had not made them obsolete. In this year, manufacturers write down the remaining book value of existing tooling and equipment whose value is affected by the amended energy conservation standard. This one time write down acts as a tax shield that alleviates decreases in cash flow from operations in the year of the write-down. In this year, there is also an increase in working capital that reduces cash flow from operations. A large increase in working capital is needed due to more costly production components and materials, higher inventory carrying to sell more expensive products, and higher accounts receivable for more expensive products. Depending on these two competing factors, cash flow can either be positively or negatively affected in the year the standard takes effect.

In the years following the compliance date of the standard, the impact on cash flow depends on the operating revenue. More stringent TSLs typically have a positive impact on cash flows relative to the base case under the preservation of return on invested capital scenario because manufacturers are able to earner higher NOPAT at each TSL in the standards case, which increases operating income. There is very little impact on cash flow from operations under the preservation of operating profit scenario because this scenario is calibrated to have the same operating income in the standards case at each TSL as the base case as in the year after the standard takes effect.

12.5.2 Water Heater Industry Financial Impacts

Table 12.5.1 through Table 12.5.6 provide the INPV estimates for the residential water heater industry. Figure 12.5.1 through Figure 12.5.6 present the annual net cash flows for gas-fired and electric storage water heaters, gas-fired oil water heaters, and gas-fired instantaneous water heaters for each of the different markup scenarios.

Table 12.5.1 Changes in Industry Net Present Value for Gas-Fired and Electric Storage Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	880.4	875.5	876.0	875.1	875.5	854.4	856.8	869.9	959.6
Change in INPV	*(2009$ millions)*	-	-4.9	-4.3	-5.2	-4.8	-25.9	-23.6	-10.5	79.2
	(%)	-	-0.56	-0.49	-0.59	-0.55	-2.94	-2.68	-1.19	9.00

Table 12.5.2 Changes in Industry Net Present Value for Gas-Fired and Electric Storage Water Heaters (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	880.4	866.1	849.0	842.1	790.9	757.8	745.7	530.2	233.4
Change in INPV	*(2009$ millions)*	-	-14.2	-31.4	-38.3	-89.4	-122.6	-134.6	-350.2	-647.0
	(%)	-	-1.62	-3.56	-4.35	-10.16	-13.93	-15.29	-39.78	-73.49

Table 12.5.3 Changes in Industry Net Present Value for Oil-Fired Storage Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	9.1	8.9	8.9	8.9	8.9	8.9	8.9	8.9	7.7
Change in INPV	*(2009$ millions)*	-	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-1.4
	(%)	-	-1.98	-1.85	-2.01	-2.01	-2.01	-2.01	-2.01	-15.37

Table 12.5.4 Changes in Industry Net Present Value for Oil-Fired Storage Water Heaters (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	9.1	8.8	8.8	8.7	8.7	8.7	8.7	8.7	5.3
Change in INPV	*(2009$ millions)*	-	-0.4	-0.3	-0.4	-0.4	-0.4	-0.4	-0.4	-3.8
	(%)	-	-3.85	-3.56	-4.23	-4.23	-4.23	-4.23	-4.23	-41.44

Table 12.5.5 Changes in Industry Net Present Value for Gas-Fired Instantaneous Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	648.2	650.6	650.6	650.6	650.6	650.6	650.6	650.6	739.7
Change in INPV	*(2009$ millions)*	-	2.3	2.3	2.3	2.3	2.3	2.3	2.3	91.4
	(%)	-	0.36	0.36	0.36	0.36	0.36	0.36	0.36	14.10

Table 12.5.6 Changes in Industry Net Present Value for Gas-Fired Instantaneous Water Heaters (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	2	3	4	5	6	7	8
INPV	*(2009$ millions)*	648.2	647.0	647.0	647.0	647.0	647.0	647.0	647.0	590.6
Change in INPV	*(2009$ millions)*	-	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-57.6
	(%)	-	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-8.89

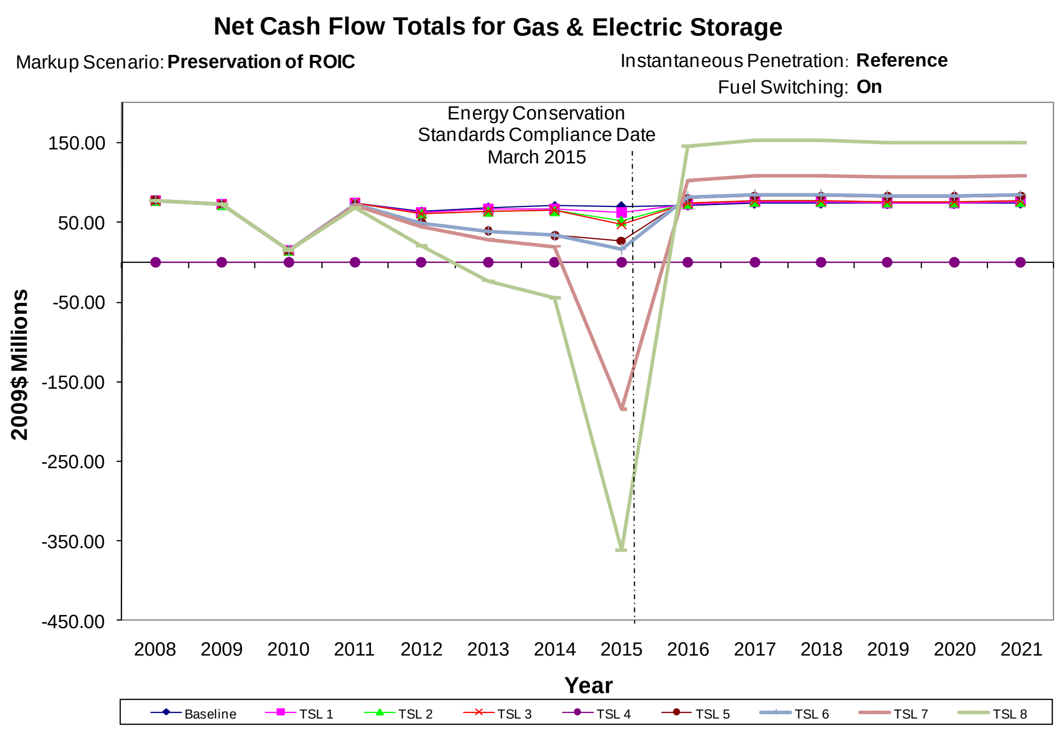

Figure 12.5.1 Annual Industry Net Cash Flows for Gas-Fired and Electric Storage Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

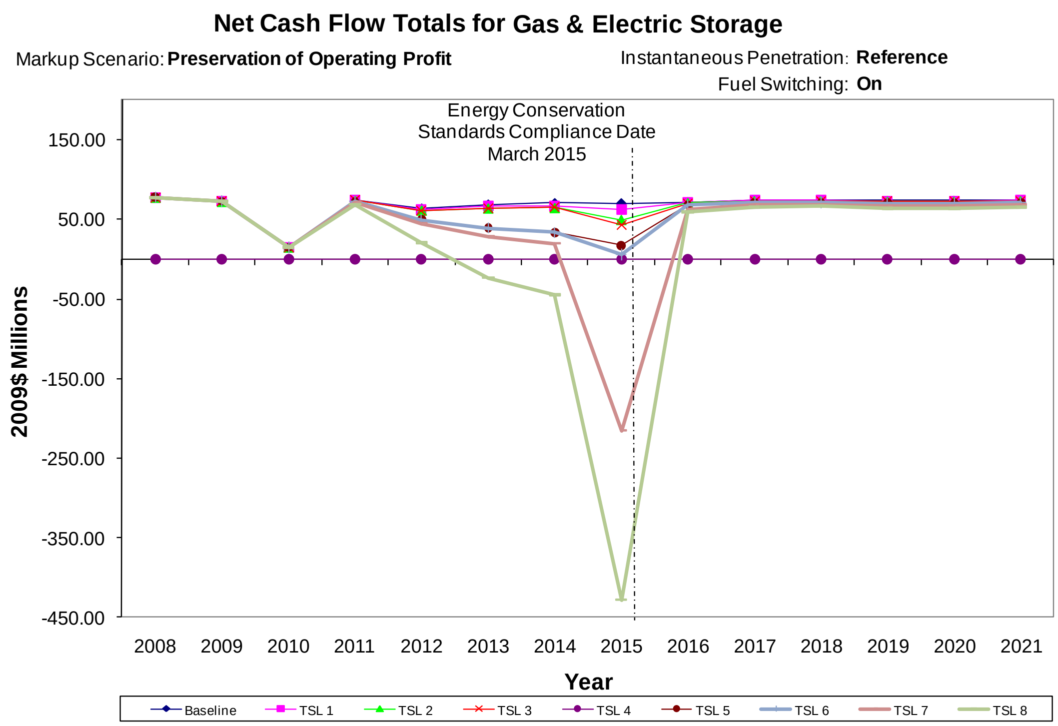

Figure 12.5.2 Annual Industry Net Cash Flows for Gas-Fired and Electric Storage Water Heaters (Preservation of Operating Profit Markup Scenario)

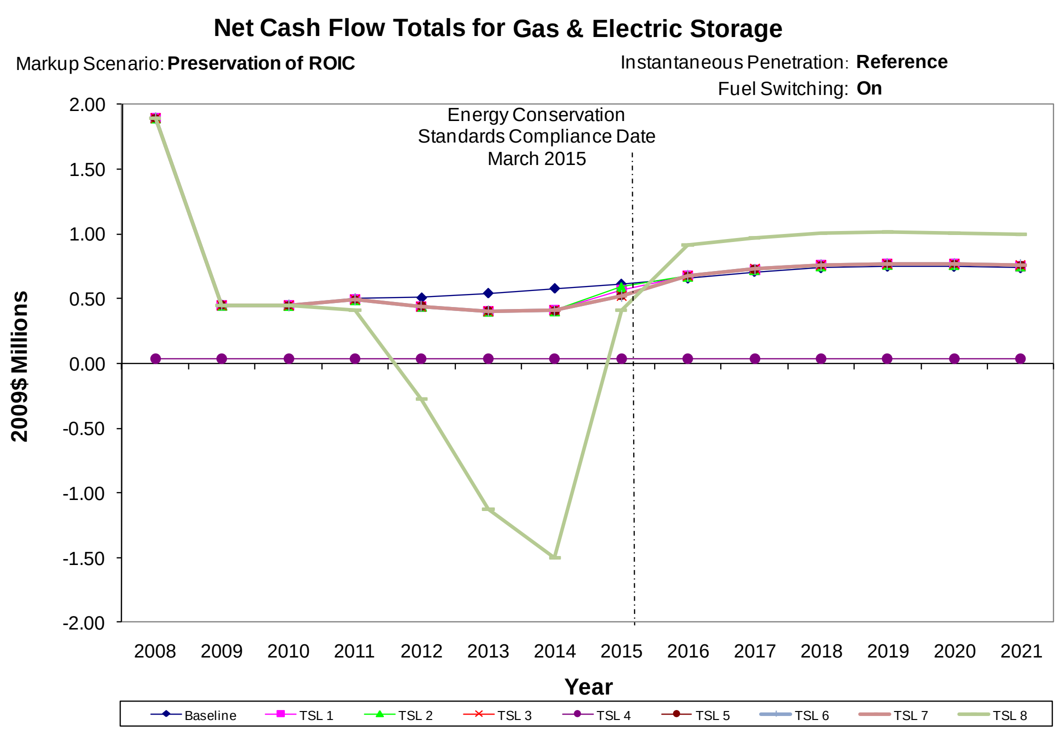

Figure 12.5.3 Annual Industry Net Cash Flows for Oil-Fired Storage Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

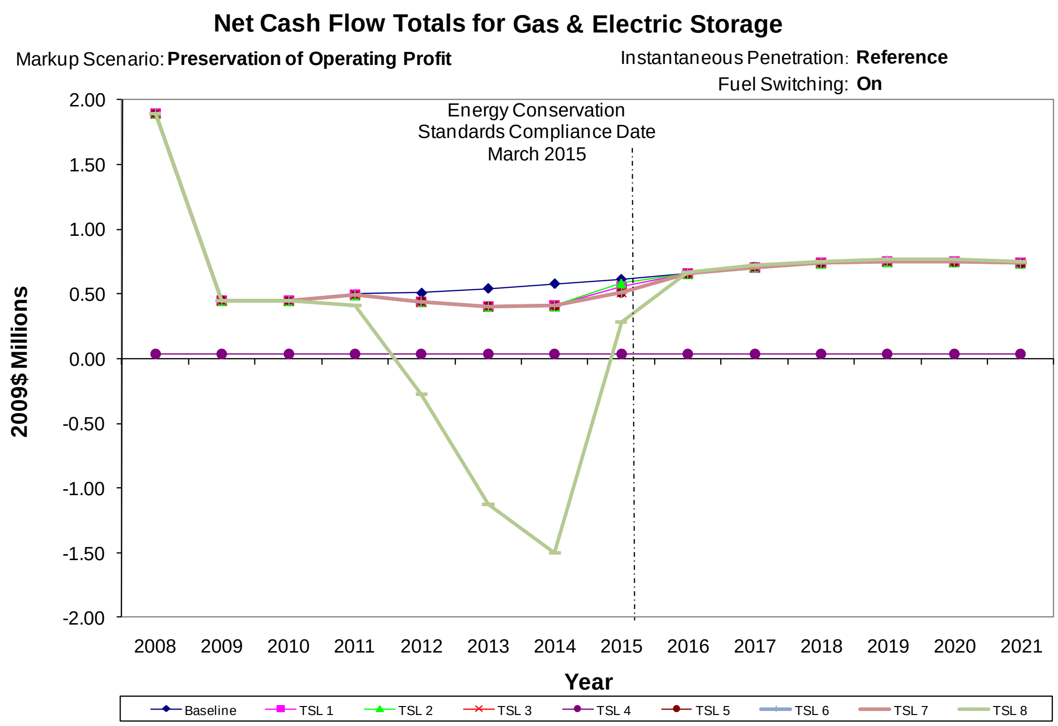

Figure 12.5.4 Annual Industry Net Cash Flows for Oil-Fired Storage Water Heaters (Preservation of Operating Profit Markup Scenario)

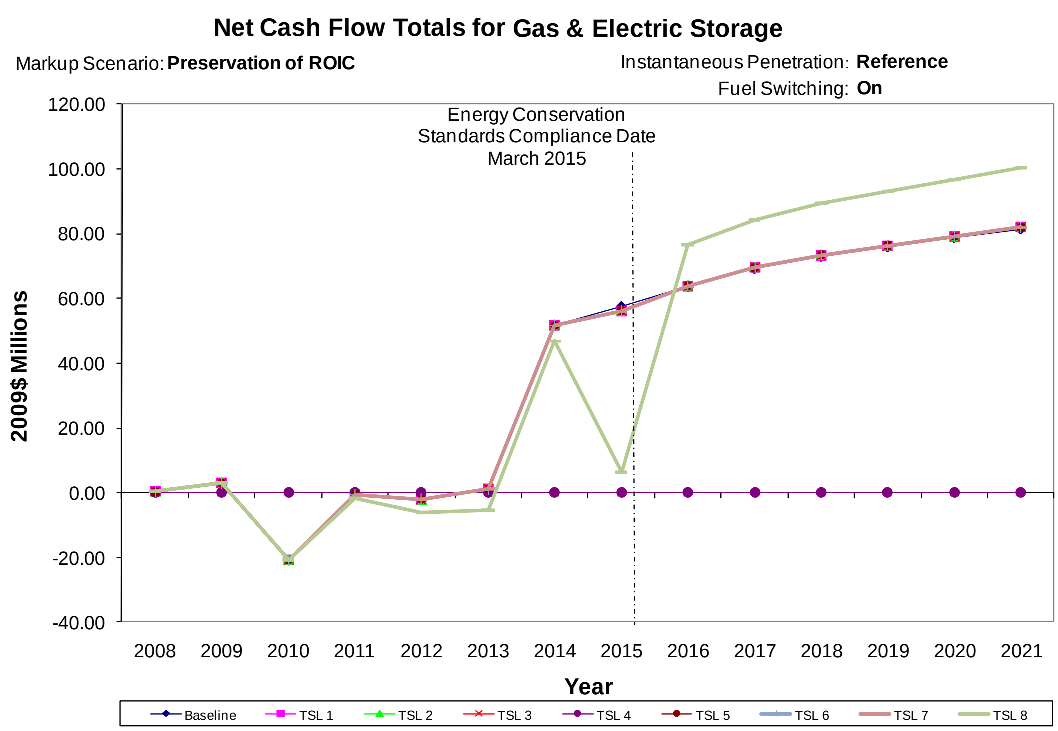

Figure 12.5.5 Annual Industry Net Cash Flows for Gas-Fired Instantaneous Water Heaters (Preservation of Return on Invested Capital Markup Scenario)

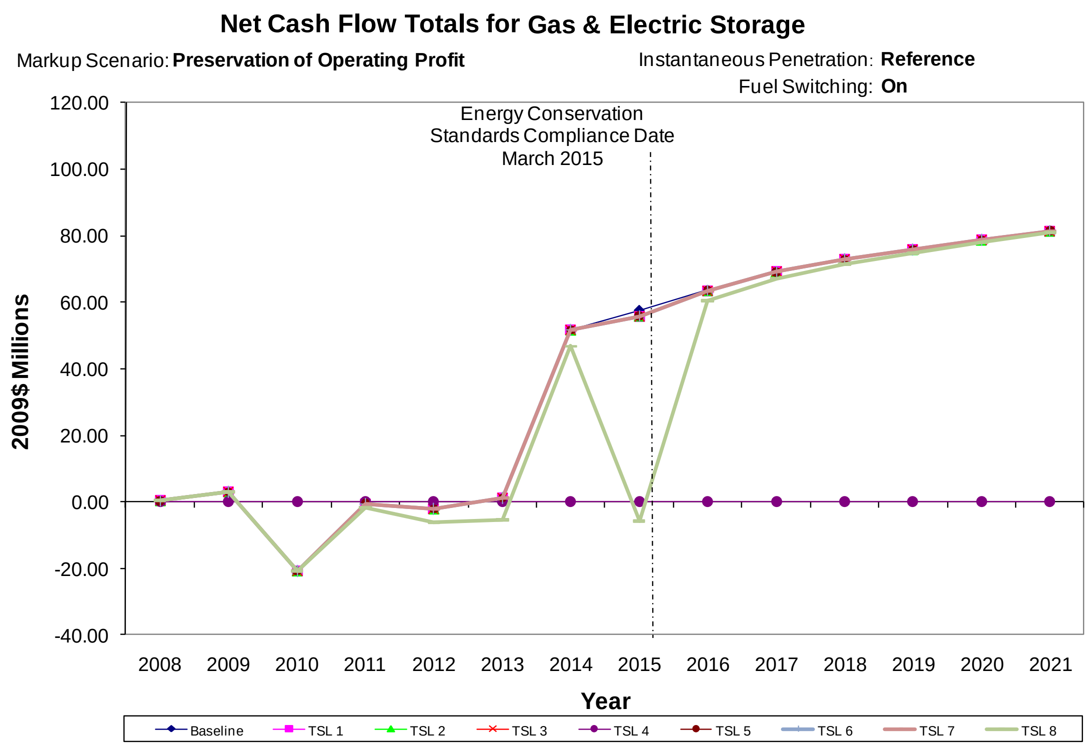

Figure 12.5.6 Annual Industry Net Cash Flows for Gas-Fired Instantaneous Water Heaters (Preservation of Operating Profit Markup Scenario)

12.5.3 Direct Heating Equipment Industry Financial Impacts

Table 12.5.7 through Table 12.5.10 provide the INPV estimates for the DHE industry. Figure 12.5.7 through Figure 12.5.10 present the annual net cash flows for traditional DHE and gas hearth DHE for each markup scenario.

Table 12.5.7 Changes in Industry Net Present Value for Traditional Direct Heating Equipment (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	2	3	4	5	6
INPV	*(2009$ millions)*	16.6	15.7	15.4	14.7	14.7	12.8	12.7
Change in INPV	*(2009$ millions)*	-	-0.9	-1.2	-1.9	-1.9	-3.8	-3.9
	(%)	-	-5.24	-7.17	-11.31	-11.62	-22.74	-23.65

Table 12.5.8 Changes in Industry Net Present Value for Traditional Direct Heating Equipment (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	**2**	**3**	**4**	**5**	**6**
INPV	*(2009$ millions)*	16.6	14.1	12.7	9.6	7.8	6.2	3.2
Change in INPV	*(2009$ millions)*	-	-2.5	-3.9	-7.0	-8.8	-10.4	-13.4
	(%)	-	-14.88	-23.61	-42.38	-53.12	-62.40	-80.85

Table 12.5.9 Changes in Industry Net Present Value for Gas Hearth Direct Heating Equipment (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	**2**	**3**	**4**	**5**	**6**
INPV	*(2009$ millions)*	77.1	76.2	76.2	76.2	78.7	78.7	85.7
Change in INPV	*(2009$ millions)*	-	-0.9	-0.9	-0.9	1.6	1.6	8.6
	(%)	-	-1.22	-1.22	-1.22	2.04	2.04	11.09

Table 12.5.10 Changes in Industry Net Present Value for Gas Hearth Direct Heating Equipment (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	**2**	**3**	**4**	**5**	**6**
INPV	*(2009$ millions)*	77.1	76.9	76.9	76.9	63.9	63.9	23.5
Change in INPV	*(2009$ millions)*	-	-0.2	-0.2	-0.2	-13.2	-13.2	-53.6
	(%)	-	-0.30	-0.30	-0.30	-17.13	-17.13	-69.49

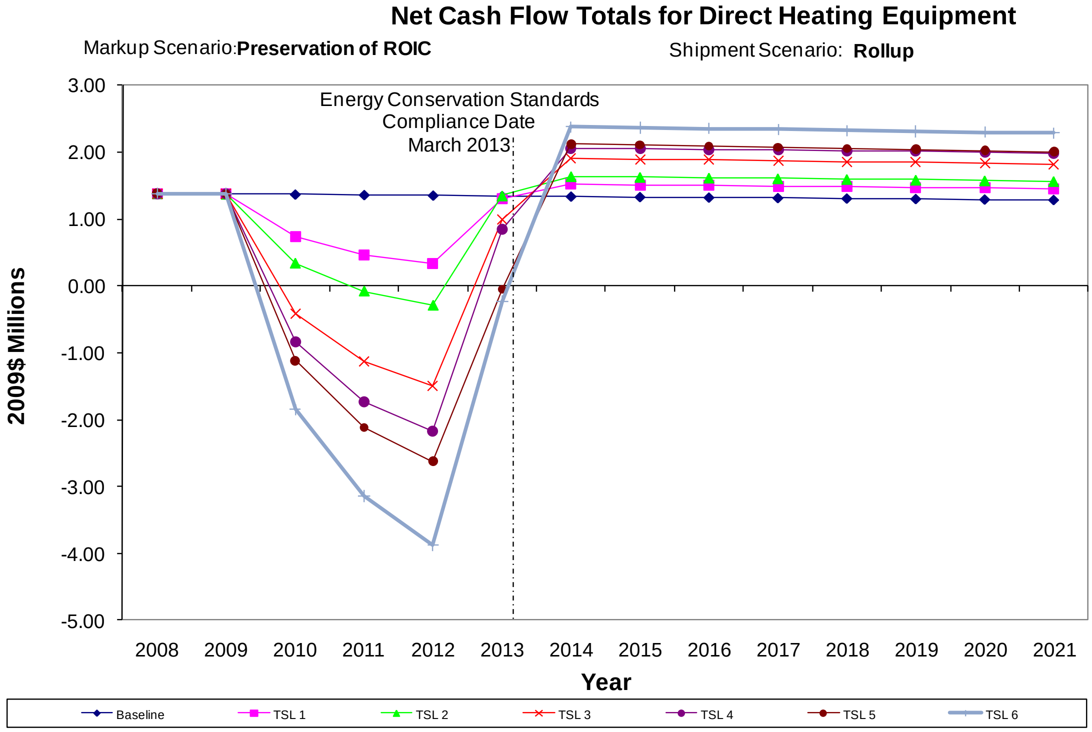

Figure 12.5.7 Annual Industry Net Cash Flows for Traditional Direct Heating Equipment (Preservation of Return on Invested Capital Markup Scenario)

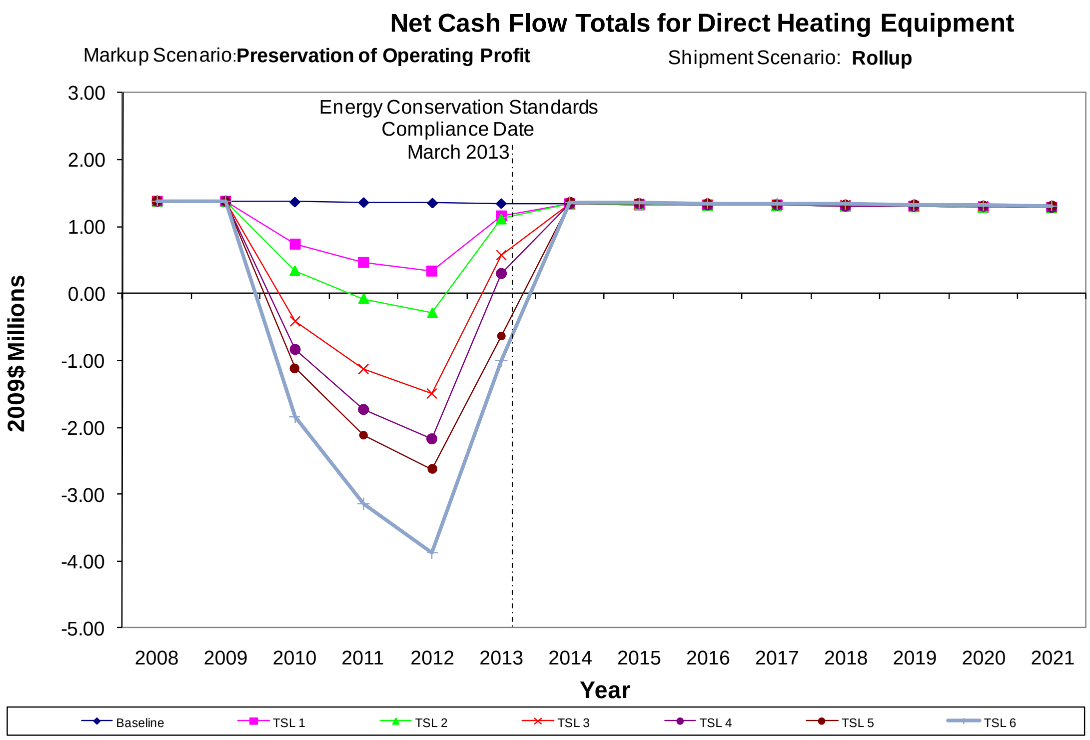

Figure 12.5.8 Annual Industry Net Cash Flows for Traditional Direct Heating Equipment (Preservation of Operating Profit Markup Scenario)

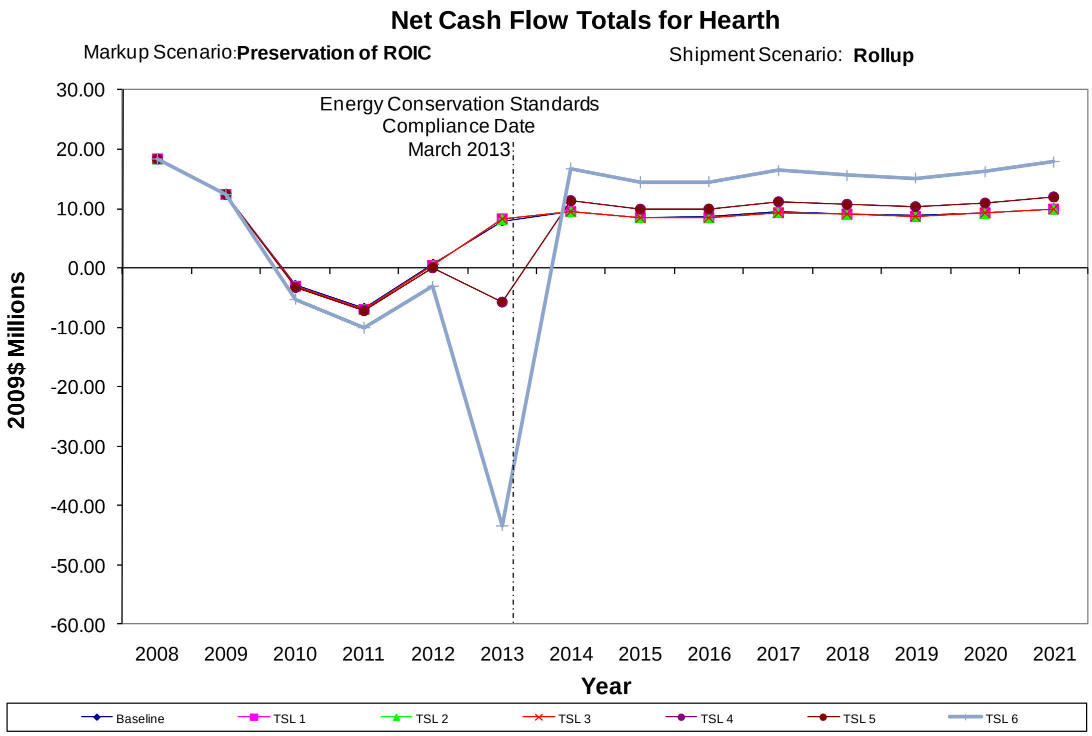

Figure 12.5.9 Annual Industry Net Cash Flows for Gas Hearth Direct Heating Equipment (Preservation of Return on Invested Capital Markup Scenario)

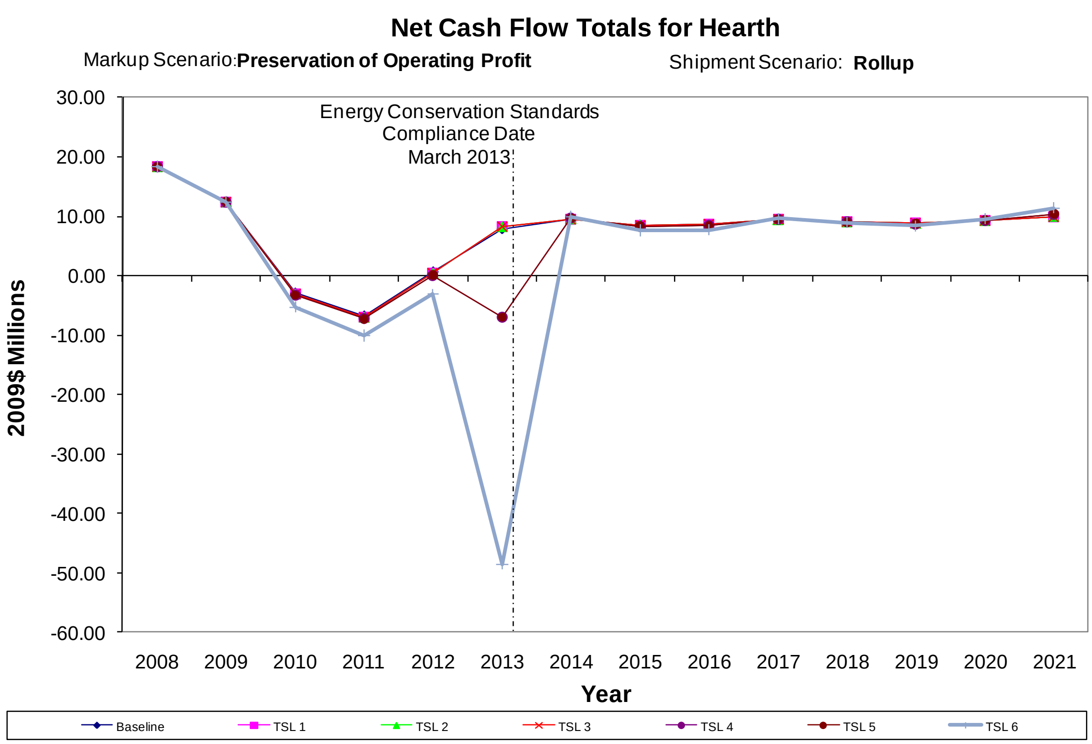

Figure 12.5.10 Annual Industry Net Cash Flows for Gas Hearth Direct Heating Equipment (Preservation of Operating Profit Markup Scenario)

12.5.4 Pool Heater Industry Financial Impacts

Table 12.5.11 and Table 12.5.12 provide the estimates for the pool heater industry. Figure 12.5.11 and Figure 12.5.12 present the annual net cash flows for pool heaters for each markup scenario.

Table 12.5.11 Changes in Industry Net Present Value for Gas-Fired Pool Heaters (Preservation of Return on Invested Capital Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	2	3	4	5	6
INPV	*(2009$ millions)*	49.0	49.1	49.3	48.2	48.7	49.8	56.4
Change in INPV	*(2009$ millions)*	-	0.0	0.3	-0.8	-0.3	0.8	7.3
	(%)	-	0.10	0.54	-1.72	-0.63	1.61	14.93

Table 12.5.12 Changes in Industry Net Present Value for Gas-Fired Pool Heaters (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level					
			1	2	3	4	5	6
INPV	*(2009$ millions)*	49.0	48.9	48.2	44.0	42.4	31.9	10.8
Change in INPV	*(2009$ millions)*	-	-0.1	-0.8	-5.0	-6.6	-17.2	-38.3
	(%)	-	-0.25	-1.72	-10.22	-13.48	-35.05	-78.00

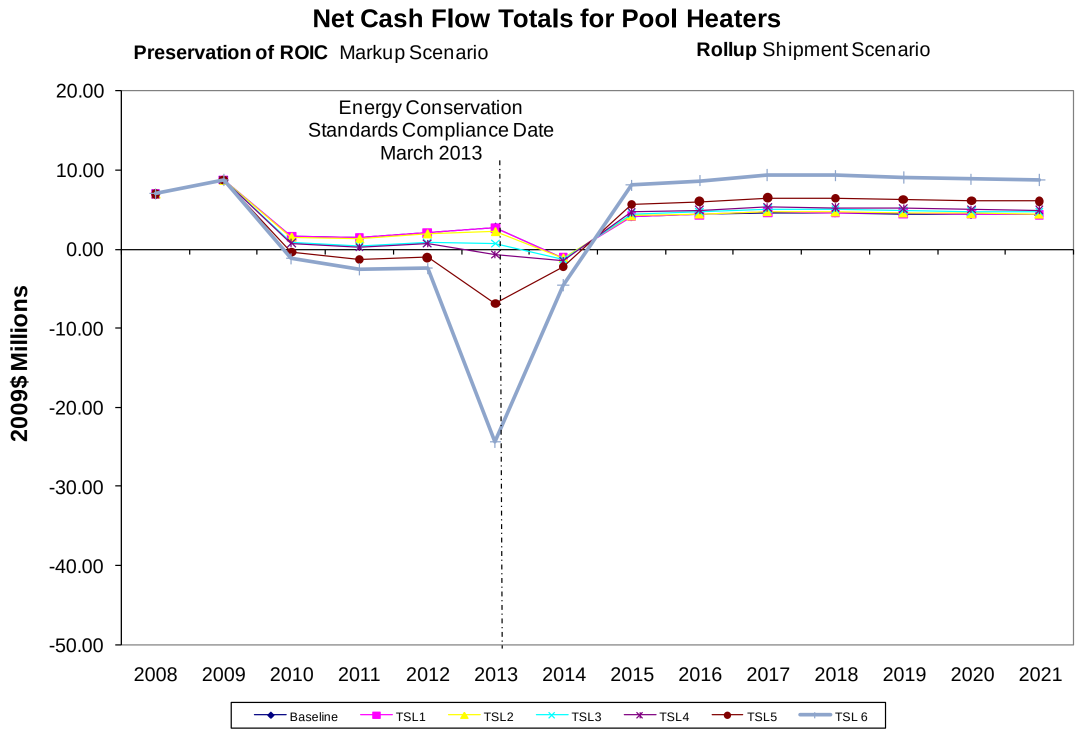

Figure 12.5.11 Annual Industry Net Cash Flows for Gas-Fired Pool Heaters (Preservation of Return on Invested Capital Markup Scenario)

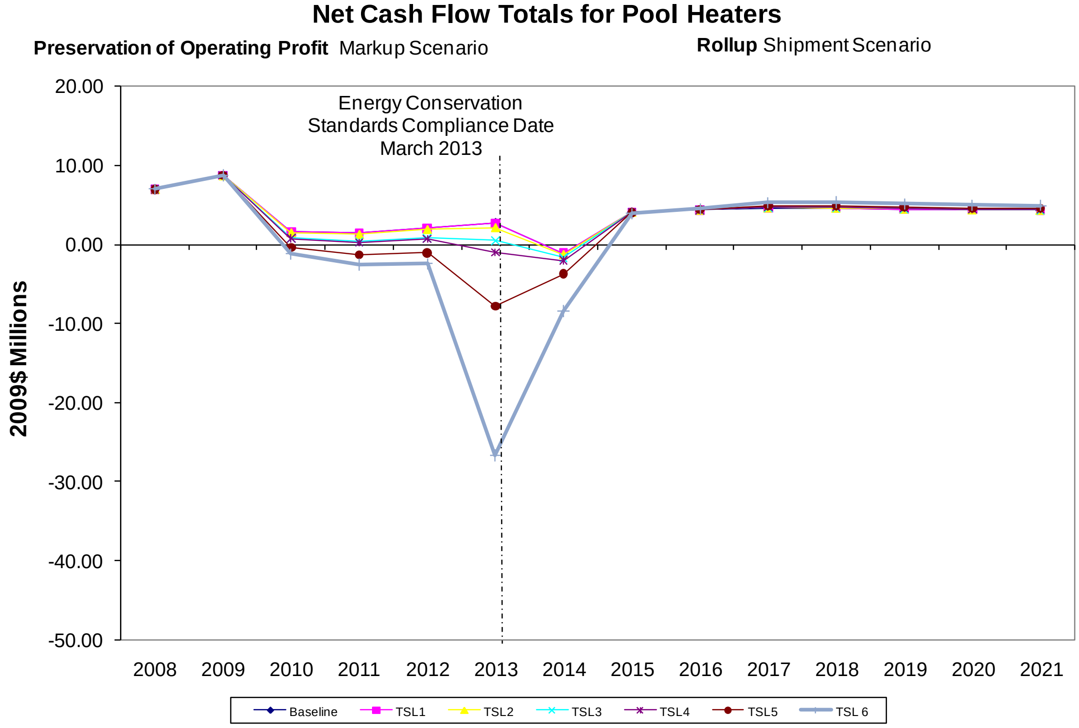

Figure 12.5.12 Annual Industry Net Cash Flows for Gas-Fired Pool Heaters (Preservation of Operating Profit Markup Scenario)

12.6 IMPACTS ON SMALL DIRECT HEATING EQUIPMENT MANUFACTURERS

DOE identified 12 small business DHE manufacturers in the market and technology assessment. Of these 12 small business manufacturers, three manufacture traditional DHE, 10 manufacture gas hearth DHE, and one manufactures both traditional and gas hearth DHE. To determine the number of small direct heating manufacturers that could be affected by this rulemaking, DOE conducted a more focused examination of the characteristics of the DHE manufacturers. DOE used all available public information to identify potential small businesses DHE manufacturers. DOE's research involved the AHRI and HPBA membership directories, the AHRI and CEC product databases, individual company websites, and marketing research tools, including D&B reports. DOE also asked interested parties and industry representatives if they are aware of any other small business manufacturers. DOE used this information to create a list of every company that manufactures or sells DHE. DOE reviewed all publicly available data and contacted select companies on its list, as necessary, to determine whether they meet SBA's definition of a small business manufacturer of covered DHE. DOE screened out companies that did not offer products covered by this rulemaking, did not meet the definition of a small business, branded products as distributors but were not the original equipment manufacturer, or are foreign owned and operated.

In the December 2009 NOPR, DOE had an analysis of the differential impacts both on small business manufacturers of traditional DHE and gas hearth DHE. However, DOE did not receive any comments on its analysis and has concluded that the impacts on small business manufacturers of gas hearth at the amended energy conservation standards are not unduly burdensome. DOE's analysis of the impacts on traditional DHE manufacturers has been updated and is presented in the following sections[d].

12.6.1 Introduction

Traditional DHE manufacturers are extremely concerned about the potential for amended energy conservation standards to harm their industry. The small shipment volume of products in the traditional market has greatly reduced the number of competitors in the past decade. The traditional DHE market is mostly a replacement market. While DOE explicitly analyzed one representative input capacity range for the gas wall gravity, gas wall fan, gas floor, and gas room types of DHE, manufacturers offer product lines that typically span multiple input rating ranges with many different features. This can result in many individual products, or stock keeping units, offered by each manufacturer in each product line. The wide range of product offerings is a legacy of the previously higher volume market. The remaining manufacturers have stayed in business by consolidating brands and the legacy products of companies that are no longer in business to take increasing shares of a smaller total market. DHE manufacturers offer a wide scope of products manufactured at low production volumes to ensure that they can maintain a viable portion of the replacement market.

Three major manufacturers control almost 100 percent of the traditional DHE market. Two of the three major manufacturers of traditional DHE meet the SBA's small business criteria. One of the small businesses produces only traditional DHE and has products in all four traditional DHE product classes (*i.e.*, gas wall fan, gas wall gravity, gas floor, and gas room DHE). The second small business manufacturer produces all five product classes of DHE, including gas hearth DHE. A third small business has less than 1 percent of the traditional DHE market. This company offers two gas wall gravity models, but is mainly focused on specialty hearth products not covered by this rulemaking. Because of its focus on specialty hearth products, this company likely would discontinue production of these two gas wall gravity models if the amended energy conservation standard is set above the current efficiencies of these products. However, the company does not certify these products, making it difficult to determine if they will need to be upgraded in response to amended energy conversation standards. To show the differential impacts on small businesses in the traditional DHE market, DOE focused on how the two major small business manufacturers would be harmed relative to the higher-volume company in the market.

12.6.2 Conversion Costs for Traditional Direct Heating Equipment Manufacturers

Because each product line is manufactured in low volumes, the discrepancy between unit shipments and the number of product lines requiring significant product and capital conversion costs results in negative impacts for all manufacturers. Many product development costs (*e.g.*, testing, certification) are somewhat fixed, making manufacturing scale an important consideration in determining whether the product conversion costs are economically justified.

[d] For DOE's analysis of the impact on small business manufacturers of gas hearth DHE, please see chapter 12 of the the December 2009 NOPR TSD. Available at http://www1.eere.energy.gov/buildings/appliance_standards/residential/water_pool_heaters_nopr_tsd.html. The analysis is also presented in the NOPR document. 74 FR 65852, 65984-92 (December 11, 2009).

Similarly, although capital conversion costs can be capitalized over a number of years, these costs must be paid upfront and have a large enough volume to justify an added per-unit cost.

DOE calculated its capital and product conversion costs for traditional DHE by estimating a per-product line cost and assuming that every manufacturer would face the same per product line costs in each product class. DOE also assumed that any product line that does not meet the efficiency level being analyzed would be upgraded, requiring both product conversion and capital conversion costs. DOE used public data to calculate the number of product lines that would need to be upgraded at each TSL for each product class. To determine industry-wide capital and product conversion costs, DOE multiplied the estimate of the per-product line product and capital conversion cost at each TSL by the number of product lines that would require capital and product conversion costs. The estimates DOE used for capital conversion and product conversion costs rose as products became more complex. In addition, the estimates assume that every product line that falls below the required efficiency will be upgraded.

12.6.3 Estimated Conversion Costs for a Typical Small and Typical Large Traditional Direct Heating Equipment Manufacturer

To show how the small business traditional DHE manufacturers could be differentially harmed, DOE compared the conversion costs for a typical large and a typical small manufacturer. To calculate conversion costs for a typical small and large manufacturer, DOE used the same publicly available information to determine the average number of product lines that meet each efficiency in each product class for a typical small business and a typical large traditional DHE manufacturer. For its estimates of the typical small business manufacturer, DOE did not include the product lines of the small business manufacturer that only offers two gas room heaters. Since the other two small business manufacturers have a significant market share and are focused heavily on products covered by this rulemaking, the product lines of these two small business manufacturers were averaged to create an estimate for the typical small manufacturer shown in the following sections. For both the small and large manufacturer, DOE multiplied the number of product lines that fall below the required efficiency by its estimate of the per-line capital and product conversion costs. Table 12.6.1 and Table 12.6.2 show DOE's estimates for the number of product lines at each TSL for a typical small and a typical large traditional DHE manufacturer, respectively.

Table 12.6.1 Number of Product Lines Requiring Conversion for a Typical Small Business Manufacturer

	Number of Gas Wall Fan Product Lines Requiring Conversion	Number of Gas Wall Gravity Product Lines Requiring Conversion	Number of Gas Floor Product Lines Requiring Conversion	Number of Gas Room Product Lines Requiring Conversion	Total Number of Product Lines Requiring Conversion	Total Product Lines that Meet Each or Exceed Each TSL
Baseline	0	0	0	0	0	13
TSL 1	2	2.5	0.5	1	6	7
TSL 2	2	2.5	0.5	1.5	6.5	6.5
TSL 3	3	4	0.5	2	9.5	3.5
TSL 4	3.5*	4	0.5	2	10	3
TSL 5	2	4	0.5	2	8.5	4.5
TSL 6	3.5	4	0.5	2	10	3

*Fractions of product lines result from taking the average number of product lines from publicly-available information

Table 12.6.2 Number of Product Lines Requiring Conversion for a Typical Large Manufacturer

	Number of Gas Wall Fan Product Lines Requiring Conversion	Number of Gas Wall Gravity Product Lines Requiring Conversion	Number of Gas Floor Product Lines Requiring Conversion	Number of Gas Room Product Lines Requiring Conversion	Total Number of Product Lines Requiring Conversion	Total Product Lines that Meet Each or Exceed Each TSL
Baseline	0	0	0	0	0	18
TSL 1	1	0	1	1	3	15
TSL 2	2	0	1	1	4	14
TSL 3	4	3	1	2	10	8
TSL 4	7	3	1	2	13	5
TSL 5	1	6	1	3	11	7
TSL 6	7	6	1	3	17	1

Amended energy conservation standards could impact small business manufacturers more seriously because they lack the resources necessary to alter their existing products and production facilities for those TSLs requiring major redesigns. While DOE expects all manufacturers could be negatively impacted by amended energy conservation standards to varying degrees, small business manufacturers will face higher product conversion costs at lower TSLs than their higher-volume competitor. Both large and small manufacturers have several product offerings in each product class, sometimes at varying efficiency levels, but the larger manufacturer benefits more from manufacturing scale. As a result, small business manufacturers will have to upgrade more product lines at lower TSLs. Table 12.6.3 through Table 12.6.12 show the conversion costs for each product category for a typical small business and large manufacturer.

Table 12.6.3 Conversion Costs for a Typical Small Business Manufacturer for Gas Wall Fan DHE

Efficiency Level	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*
Baseline	2	-	-	-
EL 1 (TSL 1–TSL 2)	0	-	0.05	0.05
EL 2 (TSL 2)	1	0.12	0.05	0.17
EL 3 (TSL 3)	0.5	0.30	0.14	0.44
EL 4 (TSL 4, TSL 6)	1	0.59	0.25	0.84

Table 12.6.4 Conversion Costs for a Typical Large Manufacturer for Gas Wall Fan DHE

Efficiency Level	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*
Baseline	1	-	-	-
EL 1 (TSL 1–TSL 2)	1	-	0.02	0.02
EL 2 (TSL 2)	2	0.12	0.05	0.17
EL 3 (TSL 3)	3	0.40	0.19	0.59
EL 4 (TSL 4, TSL 6)	0	1.18	0.51	1.69

Table 12.6.5 Conversion Costs for a Typical Small Business Manufacturer for Gas Wall Gravity DHE

Efficiency Level	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*
Baseline	2.5	-	-	-
EL 1 (TSL 1–TSL 2)	1	0.65	0.26	0.91
EL 2	0.5	0.53	0.21	0.75
EL 3 (TSL 3–TSL 4)	0	0.83	0.33	1.17
EL 4 (TSL 4–TSL 6)	1.5	1.17	0.75	1.92

Table 12.6.6 Conversion Costs for a Typical Large Manufacturer for Gas Wall Gravity DHE

Efficiency Level	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*
Baseline	0	-	-	-
EL 1 (TSL 1–TSL 2)	2	-	-	-
EL 2	1	0.30	0.12	0.43
EL 3 (TSL 3–TSL 4)	3	0.63	0.25	0.88
EL 4 (TSL 5–TSL 6)	0	1.75	1.13	2.88

Table 12.6.7 Conversion Costs for a Typical Small Business Manufacturer for Gas Floor DHE

Efficiency Level	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*
Baseline	0.5	-	-	-
EL 1 (TSL 1–TSL 6)	0.5	0.03	0.02	0.05

Table 12.6.8 Conversion Costs for a Typical Large Manufacturer for Gas Floor DHE

Efficiency Level	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*
Baseline	1	-	-	-
EL 1 (TSL 1–TSL 6)	1	0.05	0.04	0.09

Table 12.6.9 Conversion Costs for a Typical Small Business Manufacturer for Gas Room DHE

Efficiency Level	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*
Baseline	1	-	-	-
EL 1	0	0.18	0.08	0.26
EL 2 (TSL 1)	0.5	0.18	0.08	0.26
EL 3 (TSL 2)	0.5	0.55	0.23	0.78
EL 4 (TSL 3–TSL 4)	0	0.73	0.31	1.04
EL 5 (TSL 5–TSL 6)	0	0.73	0.63	1.36

Table 12.6.10 Conversion Costs for a Typical Large Manufacturer for Gas Room DHE

Efficiency Level	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Product Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*
Baseline	0	-	-	-
EL 1	1	-	-	-
EL 2 (TSL 1)	0	0.18	0.08	0.26
EL 3 (TSL 2)	1	0.37	0.16	0.52
EL 4 (TSL 3–TSL 4)	1	0.73	0.31	1.04
EL 5 (TSL 5–TSL 6)	0	1.10	0.94	2.04

Table 12.6.11 Total Conversion Costs for a Typical Small Manufacturer of Traditional Direct Heating Equipment (for all traditional DHE)

	Total Capital Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Product Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Small Manufacturer *(2009$ Millions)*
Baseline	0	0	0
TSL 1	0.86	0.41	1.27
TSL 2	1.35	0.57	1.92
TSL 3	1.89	0.81	2.70
TSL 4	2.18	0.92	3.10
TSL 5	1.93	1.44	3.37
TSL 6	2.52	1.65	4.17

Table 12.6.12 Total Conversion Costs for a Typical Large Manufacturer of Traditional Direct Heating Equipment (for all traditional DHE)

	Total Capital Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Product Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*	Total Conversion Costs for a Typical Large Manufacturer *(2009$ Millions)*
Baseline	0	0	0
TSL 1	0.23	0.14	0.38
TSL 2	0.54	0.25	0.79
TSL 3	1.81	0.79	2.60
TSL 4	2.59	1.11	3.70
TSL 5	2.90	2.13	5.03
TSL 6	4.08	2.61	6.69

Modifying facilities and developing new, more efficient products causes a typical small manufacturer to incur higher product conversion costs than a typical larger manufacturer for TSL 1 through TSL 3.

12.6.4 Impact of Conversion Costs on a Typical Small Business Traditional Direct Heating Equipment Manufacturer

Despite being similar in absolute terms, at these TSLs the small business manufacturers are more likely to be disproportionately harmed because they have a much lower volume over which to spread similar conversion costs. To show how a smaller scale could greatly harm a typical small manufacturer, DOE used estimates of the market shares within the industry for each product class to estimate the annual revenue, operating profit, R&D expense, and capital expenditures for a typical large and small manufacturer. To determine the annual revenue of a typical small and a typical large manufacturer, DOE multiplied the 2010 revenue calculated in the GRIM for each product category by the market share of a typical large and a typical small manufacturer for that product category. DOE used the same industry financial parameters for the percentage of revenue operating profit, R&D, and capital expenditures for a typical small and large manufacturer for all product classes. To calculate the annual typical operating profit, R&D

expense, and capital conversion expense, DOE multiplied the revenue of typical small and large manufacturers by these parameters and compared this figure to its estimate of product and capital conversion costs for those manufacturers. Table 12.6.13 through Table 12.6.22 show these comparisons for each product category.

Table 12.6.13 Comparison of a Typical Small Business Manufacturer's Gas Wall Fan DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Wall Fan *%*	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Wall Fan *%*	Total Conversion Cost as a Percentage of Annual Revenue for Gas Wall Fan *%*	Total Conversion Cost as a Percentage of Annual EBIT for Gas Wall Fan *%*
Baseline	2	0	0	0	0
EL 1 (TSL 1–TSL 2)	0	0	83	1	35
EL 2 (TSL 2)	1	142	92	5	130
EL 3 (TSL 3)	0.5	352	248	12	331
EL 4 (TSL 4, TSL 6)	1	689	445	22	631

Table 12.6.14 Comparison of a Typical Large Manufacturer's Gas Wall Fan DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Wall Fan *%*	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Wall Fan *%*	Total Conversion Cost as a Percentage of Annual Revenue for Gas Wall Fan *%*	Total Conversion Cost as a Percentage of Annual EBIT for Gas Wall Fan *%*
Baseline	1	0	0	0	0
EL 1 (TSL 1–TSL 2)	1	0	18	0	8
EL 2 (TSL 2)	2	62	40	2	57
EL 3 (TSL 3)	3	204	144	7	192
EL 4 (TSL 4, TSL 6)	0	600	388	19	550

Table 12.6.15 Comparison of a Typical Small Business Manufacturer's Gas Wall Gravity DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Wall Gravity %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Wall Gravity %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Wall Gravity %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Wall Gravity %
Baseline	2.5	0	0	0	0
EL 1 (TSL 1–TSL 2)	1	355	214	11	318
EL 2	0.5	622	375	20	558
EL 3 (TSL 3–TSL 4)	0	975	588	31	875
EL 4 (TSL 4–TSL 6)	1	1366	1323	51	1438

Table 12.6.16 Comparison of a Typical Large Manufacturer's Gas Wall Gravity DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Wall Gravity %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Wall Gravity %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Wall Gravity %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Wall Gravity %
Baseline	0	0	0	0	0
EL 1 (TSL 1–TSL 2)	2	0	0	0	0
EL 2	1	72	43	2	65
EL 3 (TSL 3–TSL 4)	3	148	89	5	133
EL 4 (TSL 5–TSL 6)	0	415	402	15	437

Table 12.6.17 Comparison of a Typical Small Business Manufacturer's Gas Floor DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Floor %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Floor %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Floor %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Floor %
Baseline	0.5	0	0	0	0
EL 1 (TSL 1–TSL 6)	0.5	264	298	10	296

Table 12.6.18 Comparison of a Typical Large Manufacturer's Gas Floor DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Floor %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Floor %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Floor %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Floor %
Baseline	1	0	0	0	0
EL 1 (TSL 1–TSL 6)	1	500	565	20	561

Table 12.6.19 Comparison of a Typical Small Business Manufacturer's Gas Room DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Small Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Room %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Room %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Room %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Room %
Baseline	1	0	0	0	0
EL 1	0	274	14	389	274
EL 2 (TSL 1)	0.5	274	14	389	274
EL 3 (TSL 2)	0.5	823	41	1168	823
EL 4 (TSL 3–TSL 4)	0	1098	55	1557	1098
EL 5 (TSL 5–TSL 6)	0	2196	71	2024	2196

Table 12.6.20 Comparison of a Typical Large Manufacturer's Gas Room DHE Conversion Costs to Annual Expenses, Revenue, and Operating Profit

	Number of Product Lines for a Typical Large Manufacturer	Capital Conversion Cost as a Percentage of Annual Capex for Gas Room %	Product Conversion Cost as a Percentage of Annual R&D Expense for Gas Room %	Total Conversion Cost as a Percentage of Annual Revenue for Gas Room %	Total Conversion Cost as a Percentage of Annual EBIT for Gas Room %
Baseline	0	0	0	0	0
EL 1	1	0	0	0	0
EL 2 (TSL 1)	0	247	160	8	226
EL 3 (TSL 2)	1	494	319	16	452
EL 4 (TSL 3–TSL 4)	1	988	638	32	905
EL 5 (TSL 5–TSL 6)	0	1482	1914	62	1765

Table 12.6.21 Comparison of a Typical Small Business Manufacturer's Conversion Costs to Annual Expenses, Revenue, and Operating Profit (for all traditional DHE)

	Capital Conversion Cost as a Percentage of Annual Capital Expenditures (Capex) %	Product Conversion Cost as a Percentage of Annual R&D Expense %	Total Conversion Cost as a Percentage of Annual Revenue %	Total Conversion Cost as a Percentage of Annual Earnings Before Interest and Taxes (EBIT) %
Baseline	0	0	0	0
TSL 1	267	190	9	252
TSL 2	332	210	11	302
TSL 3	466	299	15	426
TSL 4	537	341	17	489
TSL 5	474	535	19	531
TSL 6	619	612	23	657

Table 12.6.22 Comparison of a Typical Large Manufacturer's Conversion Costs to Annual Expenses, Revenue, and Operating Profit (for all traditional DHE)

	Capital Conversion Cost as a Percentage of Annual Capex %	Product Conversion Cost as a Percentage of Annual R&D Expense %	Total Conversion Cost as a Percentage of Annual Revenue %	Total Conversion Cost as a Percentage of Annual EBIT %
Baseline	0	0	0	0
TSL 1	33	30	1	34
TSL 2	77	53	3	72
TSL 3	257	169	8	237
TSL 4	368	237	12	337
TSL 5	412	456	16	458
TSL 6	580	559	22	610

12.6.5 Conclusion

Though the investments required at each TSL can be considered substantial for all companies, the impacts could be worse for a typical small business because they have much lower production volumes yet a comparable number of product offerings. At more stringent TSLs, it is more likely that manufacturers of traditional DHE will reduce the number of product lines they offer to keep their conversion costs at manageable levels. Additionally, small business manufacturers will face increasingly difficult decisions on whether to invest the capital required to be able to continue offering a full range of products, cut product lines, consolidate to maintain a large enough combined scale to spread the required conversion costs and operating expenses, or to exit the market altogether. Because of the high and somewhat fixed conversion costs, all manufacturers are likely to eliminate their lower volume product lines first. Small business manufacturers might only be able to afford to selectively upgrade their most popular products and be forced to discontinue lower volume products because the product development costs that would be required to upgrade all of their existing product lines would be too high.

DOE's product line analysis reveals that small business manufacturers could be disproportionately harmed at more stringent TSLs as small business traditional direct heating manufacturers have less access to capital than their large, higher-volume competitor. For example, larger manufacturers can more easily justify new capital equipment that can be shared among multiple product lines. Additionally, higher-volume manufacturers are usually more diversified and can thus fund capital and product conversion costs using cash generated from all products. Unlike higher-volume manufacturers, small business manufacturers cannot leverage resources from other departments. With these considerations, it is more likely that small businesses would have to spend an even greater proportion of their annual R&D and capital expenditures than shown in the industry-wide figures.

Finally, small business manufacturers have less buying power than their larger, diversified competitors. Traditional DHE is a low-volume industry, which can make it difficult for any manufacturer to take advantage of bulk purchasing power or economies of scale. The two small businesses have approximately half the market share of their larger competitors, which puts them at a disadvantage when purchasing components and raw materials. In addition, the large manufacturer has a parent company that manufactures products and equipment other than traditional DHE. This manufacturer's larger scale and additional manufacturing capacity (required for products and equipment other than DHE) also give the company more leverage with its suppliers because it purchases greater volumes of components and raw materials. During the manufacturer interviews, small businesses commented that to comply with amended energy conservation standards, they would likely have to buy more purchased parts instead of producing them in house. This would increase per-product costs and reduce profits since they will manufacture a smaller portion of higher cost products. Because the large manufacturer has an advantage in purchasing power that would likely allow it to buy purchased parts at lower costs, an amended energy conservation standard that requires more purchased parts could disproportionately harm the profitability of small businesses.

12.7 OTHER IMPACTS

12.7.1 Employment

12.7.1.1 Methodology

To quantitatively assess the impacts of amended energy conservation standards on residential water heater, DHE, and pool heater manufacturing employment, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the base case and at each TSL in the standards case throughout the analysis period. DOE used statistical data from the U.S. Census Bureau, the results of the engineering analysis, and interviews with manufacturers to estimate the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels.

In the GRIM, DOE used the labor content of each product and the MPCs from the engineering analysis to estimate the annual labor expenditures in each industry. In the GRIMs, the labor expenditures in each year are calculated by multiplying the MPCs by the labor percentage of each product from the engineering analysis. DOE used information from the manufacturer interviews to estimate the portion of total labor expenditures for the United States.

DOE multiplied the total annual labor expenditures in the GRIM by the percentage of U.S. production for domestic consumption to calculate domestic labor expenditures for production labor in each industry. The domestic annual labor expenditures in the GRIM were converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the 2007 Economic Census.[e] DOE calculated the number of non-production employees by multiplying the number of production workers by the ratio of non-production workers to production workers calculated using the employment data in the 2007 Economic Census.

DOE calculated the domestic annual labor expenditures and employment levels for the base case and at each TSL. The impacts on domestic employment due to standards can be assessed by comparing the employment results in the base case to the results at each TSL. In the

[e] The labor rates and production hours per year per employee found in the Census Bureau's 2006 are similar to figures reported in the engineering analysis. DOE used 2006 ASM figures to ensure a consistent set of publicly available data for the manufacturing employment analysis.

GRIM analyses, the estimates are the maximum potential employment in the industry because they assume manufacturers would continue to produce the same scope of covered products in the same production facilities. Consequently, the upper bound of the employment impacts calculated in the GRIM assumes that domestic production is not shifted to lower-labor-cost countries. Because there is a real risk of manufacturers exiting the market or no longer offering the same scope of covered products in response to amended energy conservation standards, the lower end of the range of employment results in this section include the estimate of the total number of U.S. production workers in the industry that could lose their job if all existing production were to no longer be made domestically. Consequently, the lower bound of the potential negative employment analysis does not account for some manufacturers' dependence on the total production volume of all products produced in a facility to achieve an adequate scale. For example, should a water heater manufacturer move part of its production abroad, its domestic production facility may no longer have the manufacturing scale to get volume discounts on its purchases or be able to justify maintaining major capital equipment. Thus, the impact on a manufacturing facility due to a line closure can affect far more employees than just the production workers directly associated with a covered product.

While the results present a range of employment impacts following the compliance date of amended energy conservation standards, the discussion below also includes a qualitative discussion of the likelihood of negative employment impacts at the various TSLs.

12.7.1.2 Gas-Fired and Electric Storage Water Heater Employment Impacts

The GRIM forecasts the gas-fired and electric storage domestic labor expenditure for production labor in 2015 will be approximately $135 million. Using the $18.32 wage rate and 2,043 production hours per year per employee found in the Economic, the GRIM estimates there will be approximately 3,610 U.S. production employees involved in manufacturing gas-fired and electric storage water heaters covered by this rulemaking. In addition, DOE estimates that 641 non-production employees in the United States will support gas-fired and electric storage water heater production.[f] The employment spreadsheet of the water heater GRIM shows the annual domestic employment impacts in further detail. Approximately two-thirds of gas-fired and electric storage water heaters sold in the United States are manufactured domestically.

[f] As defined in the 2006 Annual Survey of Manufacturers, production workers number include "workers (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial and guard services, product development, auxiliary production for plant's own use (*e.g.*, power plant), recordkeeping, and other services closely associated with these production operations at the establishment covered by the report. Employees above the working-supervisor level are excluded from this item." Non-production workers are defined as "employees of the manufacturing establishment including those engaged in factory supervision above the line-supervisor level. It includes sales (including driver-salespersons), sales delivery (highway truck drivers and their helpers), advertising, credit, collection, installation and servicing of own products, clerical and routine office functions, executive, purchasing, financing, legal, personnel (including cafeteria, medical, etc.), professional, and technical employees. Also included are employees on the payroll of the manufacturing establishment engaged in the construction of major additions or alterations utilized as a separate work force."

Table 12.7.1 illustrates the range of potential impacts of amended energy conservation standards on domestic production employment levels at each TSL for the gas-fired and electric storage water heater market.

Table 12.7.1 Potential Changes in the Total Number of Domestic Gas-Fired and Electric Storage Water Heater Production Workers in 2015

	Trial Standard Level								
	Baseline	1	2	3	4	5	6	7	8
Total Number of Domestic Production Workers in 2015 (without changes in production locations)	3,610	3,665	3,738	3,778	3,866	4,138	4,198	6,984	9,925
Potential Changes in Domestic Production Workers in 2015*	-	(3,610) - 55	(3,610) - 128	(3,610) - 168	(3,610) - 256	(3,610) - 523	(3,610) - 588	(3,610) - 3,374	(3,610) - 6,315

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

During manufacturer interviews, gas-fired and electric storage water heater manufacturers stated that they expect employment levels to remain relatively constant at TSL 1 through TSL 4. At these TSLs, baseline gas-fired and electric storage water heaters would be improved by increasing the insulation thickness around the tank. These improvements would not greatly alter the manufacturing process and are not likely to significantly change employment levels.

At TSL 5 and TSL 6, domestic employment would likely increase if manufacturers build their dedicated heat pump line for large rated storage volumes in the United States. However, because the labor content to assemble fully integrated heat pump water heaters is much higher than most models currently on the market, manufacturers could also decide to build these lines in existing overseas production facilities. At TSL 5 and TSL 6, the sourcing decisions would also impact the likely employment impacts. If manufacturers built a dedicated condensing line for large rated storage volumes in the United States, domestic employment could increase.

The employment impacts calculated show TSL 7 and TSL 8 estimate changes to domestic gas-fired and electric storage water heater employment. These TSLs effectively would require the use of integrated heat pump water heater technology for electric storage water heaters for all rated volumes. Manufacturers stated that at these levels, they initially would expect to purchase fully-assembled heat pump modules from off-shore suppliers since they lack the experience, space, and scale to assemble such units. The purchased modules would be joined to modified tanks assemblies made on existing assembly lines. DOE noted that some heat pump modules are wholly self-contained (i.e. the refrigerant system is sealed prior to being shipped to the water heater manufacturer) while other modules require some final assembly on-site to create a sealed system. Heat pump water heaters would also require significantly more testing compared to traditional resistance-style water heaters. While the industry typically has manufacturing facilities with a mix of dedicated and non-dedicated assembly lines by fuel type, flexible assembly lines may have to be discontinued at TSL 7 and TSL 8, because heat pump water heaters are top-heavy, take longer to test, and take significantly longer to assemble than electric storage water heaters that use resistance-heater elements. Present facilities would likely need line extensions to accommodate the additional time and labor required for assembling and testing heat pump water heaters while maintaining throughput. Therefore, if manufacturers source the heat pump modules and continue to assemble electric storage water heaters in their existing facilities, it is likely that employment would increase. However, the expected increase in the labor required to manufacturer heat pump water heaters may also accelerate the trend of water heater manufacturers locating new or expanding existing production facilities outside the United States, especially if a manufacturer decides to assemble heat pump modules in-house. Because TSL 8 requires additional improvements over TSL 7, the potential positive impacts on employment at TSL 8 are greater if manufacturers upgrade existing facilities because the additional improvements also require more labor.

At TSL 8 (the max-tech level) gas-fired storage water heaters would have to operate in a fully condensing mode. DOE research suggests that condensing gas-fired water heaters would be more complex than standard power-vent products and less efficient products and therefore would require additional labor to assemble. If manufacturers did not change their sourcing decisions at TSL 8, it is likely there would be positive employment impacts for gas-fired storage water heaters.

12.7.1.3 Oil-Fired Storage Water Heater Employment Impacts

The GRIM calculates that the oil-fired domestic labor expenditure for production labor in 2015 will be approximately $1.4 million. Using the $18.32 wage rate and 2,043 production hours per year per employee found in the 2007 Economic Census, the GRIM estimates there will be approximately 37 U.S. production employees involved in manufacturing oil-fired storage water heaters covered by this rulemaking in 2015. In addition, DOE estimates that seven non-production employees in the United States will support oil-fired storage water heater production and manufacturer sales. The employment spreadsheet of the water heater GRIM shows the annual domestic employment impacts in further detail. Approximately 95 percent of oil-fired storage water heaters sold in the United States are manufactured domestically.

Table 12.7.2 illustrates the range of potential impacts of amended energy conservation standards on domestic production employment levels at each TSL for the oil-fired water heater market.

Table 12.7.2 Potential Changes in the Total Number of Domestic Oil-Fired Storage Water Heater Production Workers in 2015

	Trial Standard Level								
	Baseline	1	2	3	4	5	6	7	8
Total Number of Domestic Production Workers in 2015 (without changes in production locations)	37	37	37	38	38	38	38	38	55
Potential Changes in Domestic Production Workers in 2015*	-	(37) - 0	(37) - 0	(37) - 1	(37) - 1	(37) - 1	(37) - 1	(37) - 1	(37) - 18

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

At TSL 1 through TSL 7, DOE does not expect substantial changes to domestic employment in the oil-fired storage water heater market if manufacturers are able to use the insulation type and thickness technology options in the engineering analysis to reach the efficiency requirements at these TSLs. At TSL 8, DOE research suggests that if all current suppliers continue to compete, domestic employment would likely increase slightly, because the non-proprietary, higher-efficiency heat exchangers required to reach this TSL would also require more labor to fabricate and assemble. However, given the size of the oil-fired storage water heater market and the expected product conversion costs, companies that do not currently make oil-fired storage water heaters at these efficiency levels could choose to exit the market. If the remaining manufacturers do not need to increase employment levels to meet the total market demand, employment in the residential oil-fired market could hence decline.

12.7.1.4 Gas-Fired Instantaneous Water Heater Employment Impacts

DOE's research suggests that currently no gas-fired instantaneous water heaters are made domestically. All manufacturers or their domestic distributors do maintain offices in the United States to handle technical support, training, certification, and other requirements. However, as amended energy conservation standards for instantaneous water heaters are raised, the additional complexity of standards-compliant water heaters may require additional training and field support, thereby resulting in higher employment levels. Thus domestic employment may increase marginally due to amended energy conservation standards.

12.7.1.5 Traditional Direct Heating Equipment Employment Impacts

The GRIM calculates that the traditional DHE domestic labor expenditure for production labor in 2013 will be approximately $8 million. Using the $15.48 wage rate and 1,968 production hours per year per employee found in the 2007 Economic Census, the GRIM estimates there will be approximately 275 U.S. production employees involved in manufacturing traditional DHE covered by this rulemaking. DOE also estimates that 164 non-production employees in the United States will support traditional DHE production. The employment spreadsheet of the DHE GRIM shows the annual domestic employment impacts in further detail. Approximately 100 percent of traditional DHE sold in the United States are manufactured domestically.

Table 12.7.3 illustrates the range of potential impacts of amended energy conservation standards on domestic production employment levels at each TSL for the traditional DHE market.

Table 12.7.3 Potential Changes in the Total Number of Domestic Traditional Direct Heating Production Workers in 2013

	TSL						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	275	279	281	308	312	310	319
Potential Changes in Domestic Production Workers in 2013*	-	(275) - 4	(275) - 6	(275) - 33	(275) – 37	(275) - 35	(275) - 44

There could be negative employment impacts for direct heating equipment at any of the considered TSLs if manufacturers' expectations are realized regarding higher prices yielding reduced demand. Besides increasing component costs, more stringent TSLs put additional pressure on manufacturers that could require them to invest in low-volume products, discontinue product lines that do not meet the required efficiency level, or exit the market altogether. The results shown in Table 12.7.3 above reflect upper end of the range of potential employment impacts.

While multiple manufacturers could be adversely affected by amended energy conservation standards, at TSL 1 and TSL 2, approximately 60 percent of the existing product lines meet the energy conservation requirements at TSL 2. If manufacturers chose to expand production of those products that meet the required efficiencies, employment could increase slightly. Any manufacturer that decided to discontinue product lines could reduce total employment within the industry if it impacted the availability of substitute replacement products. Net employment impacts if manufacturers discontinued product lines at TSL 1 and TSL 2 would depend on total product demand and the source of replacement production labor. At TSL 3 and above, products become increasingly more complex, require higher capital and product conversion costs, and, hence, are likely to lead to the discontinuation of more product lines. Additionally, due to the efficiencies of the existing product lines, the required conversion costs roughly double to $8 million at TSL 3. These conversion costs for an amended energy conservation standard at TSL 3 and above could cause small businesses to exit the market completely or stop producing certain product classes. If small and large manufacturers discontinued product lines or exited the market, domestic employment would be impacted if replacements were not available or a manufacturer exited the market and its market share was not captured by another manufacturer.

12.7.1.6 Gas Hearth Direct Heating Equipment Employment Impacts

The GRIM calculates that, absent amended energy conservation standards, the gas hearth DHE domestic labor expenditure for production labor in 2013 will be approximately $39 million. Using the $15.48 wage rate and 1,968 production hours per year per employee found in the 2007 Economic Census, the GRIM estimates there will be approximately 1,280 U.S. production employees involved in manufacturing gas hearth DHE covered by this rulemaking in 2013. In addition, DOE estimates that 764 non-production employees in the United States will support gas hearth DHE production. The employment spreadsheet of the DHE GRIM shows the annual domestic employment impacts in further detail. Approximately 80 percent of gas hearth DHE sold in the United States are manufactured domestically.

Table 12.7.4 illustrates the range of potential impacts of amended energy conservation standards on domestic production employment levels at each TSL for the gas hearth DHE market.

Table 12.7.4 Potential Changes in the Total Number of Domestic Gas Hearth Direct Heating Equipment Production Workers in 2013

	TSL						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	1,280	1,286	1,286	1,286	1,728	1,728	2,050
Potential Changes in Domestic Production Workers in 2013*	-	(1,280) - 6	(1,280) - 6	(1,280) - 6	(1,280) - 448	(1,280) - 448	(1,280) - 770

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

DOE does not expect significant employment impacts at TSL 1 through TSL 3. A substantial portion of the industry meets the requisite efficiencies required by these TSLs and DOE research suggests manufacturers can make products at these TSLs by replacing standing pilot ignition systems with electronic ignition systems. For TSL 4 through TSL 6, manufacturers would be increasingly likely to exit the market or reduce their product offerings. At TSL 4 and TSL 5, air circulating blowers are required and at TSL 6 condensing operation is required, making these products increasingly complex. At these levels, manufacturers suggested the size of the gas hearth DHE market covered by today's rulemaking could be impacted due to possible consumer reactions, which could also put additional pressure on domestic firms to consolidate or exit the market. A smaller market could reduce employment if the higher labor content required to manufacturer standards-compliant products is more than offset by a decline industry sales.

12.7.1.7 Pool Heater Employment Impacts

The GRIM calculates that the pool heater domestic labor expenditure for production labor in 2013 will be approximately $16 million. Using the $15.48 wage rate and 1,968 production hours per year per employee found in the 2006 ASM, the GRIM estimates there will be approximately 512 U.S. production employees involved in manufacturing gas-fired pool heaters covered by this rulemaking. In addition, DOE estimates that 306non-production employees will support gas-fired pool heater production. The employment spreadsheet of the pool heater GRIM shows the annual domestic employment impacts in further detail. Approximately 100 percent of gas-fired pool heaters sold in the United States are manufactured domestically.

Table 12.7.5 illustrates the range of potential impacts of amended energy conservation standards on domestic production employment levels at each TSL for the gas-fired pool heater market.

Table 12.7.5 Potential Changes in the Total Number of Domestic Pool Heater Production Workers in 2013

	TSL						
	Baseline	1	2	3	4	5	6
Total Number of Domestic Production Workers in 2013 (without changes in production locations)	512	519	531	570	593	647	780
Potential Changes in Domestic Production Workers in 2013*	-	(512) - 7	(512) - 19	(512) - 58	(512) - 81	(512) - 135	(512) - 268

*DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

As shown in Table 12.7.5, there are relatively minor employment impacts at TSL 1 through TSL 4 because the technology options at these TSLs involve mostly component changes that do not greatly affect labor. For example, the technology changes for existing products that meet TSLs 3 and 4 require power venting. While this technology would change the installation of much of the installed base and cause manufacturers to increase the production of low-volume products, the basic assembly of the pool heater at the point of manufacture is not substantially changed. However, the existing products in the market at TSL 5 are near-condensing products and products at TSL 6 use fully condensing technology. At TSL 5 and above, manufacturers must either upgrade an increasing number of products or discontinue products. The higher-efficiency products at TSL 5 and TSL 6 are typically more complex and take longer to assemble, resulting in increased employment if shipments levels are maintained. However, manufacturers have stated that the higher prices of higher-efficiency products could result in fewer annual shipments, which could reduce employment as well. At TSL 5 and TSL 6, manufacturers are especially concerned that the closer their products come to condensing technology, the higher production costs could reduce industry-wide shipments. If manufacturers experienced a drop in total shipments, the domestic employment in the gas-fired pool heater industry could be negatively affected.

12.7.2 Production Capacity

12.7.2.1 Gas-Fired and Electric Storage Water Heaters Capacity Impacts

Amended energy conservation standards could cause short term capacity constraints for gas-fired storage water heaters at TSL 8 and cause short term capacity constraints for electric storage water heaters at TSL 7 and TSL 8. However, the remaining TSLs, manufacturers could maintain capacity levels and continue to meet market demand under amended energy conservation standards.

DOE research suggests for the efficiency requirements for gas-fired storage water heaters could be met by adding more foam insulation to all volume sizes at TSL 1 through TSL 4 and TSL 6. These changes would not require gas-fired storage water heater manufacturers to greatly alter their existing production facilities or equipment and would not cause capacity constraints. TSL 5 and TSL 6 could also result in a constrained market for large volume sizes if manufacturers do not make the required investments to offer gas-fired condensing water heaters at relatively low shipment volumes.

The dramatically different technology required at the max-tech level for gas-fired storage water heaters introduces problems that could cause short-term capacity constraints in the market. At TSL 8 (the max-tech level), all manufacturers would need to redesign all of their existing products because none currently offer residential water heaters that use condensing technology. Manufacturers would also have to retrain their installers and servicers to handle technology that varies significantly from the majority of existing products on the market. The fundamental fabrication and production equipment of gas-fired storage water heaters are substantially different for water heaters that use condensing technology. Equipment to manufacture required heat exchangers and new tank designs would be required, as well as substantial changes to all subassembly and main assembly lines to handle the new technology. DOE estimates that manufacturers would incur over $122 million in capital conversion costs to make these plant modifications if all residential gas-fired storage water heaters required condensing technology. For comparison, the base-case estimate for the net PPE for gas-fired storage water heaters is approximately $172 million. This comparison of the estimate of current net PPE to the required capital conversion costs indicates the plant and equipment changes require manufacturers to almost completely modify or replace a substantial portion of their existing production assets for gas-fired storage water heaters. DOE also estimates that these changes would strand approximately $28 million of existing assists, mainly the book value of existing equipment that can no longer be used with condensing technology. In addition, manufacturers believe that there could be problems with quality control to manufacture more complex products on high-volume production lines. Throughput issues could further increase the capital costs required if the line rates required manufacturers to install additional production lines. Manufacturers indicated that these potential problems and the extremely substantial changes that are required to their facilities could cause a constrained market until the production equipment is installed and the high speed manufacturing of what are currently low-volume commercial products can be expanded to meet the demand of the gas-fired residential water heater market.

For electric storage water heaters, TSL 1 through TSL 3 would require only minor changes to existing products to increase the tank insulation thickness. At TSL 4, more substantial plant modifications would be required because changes to the insulation thickness would require more foaming stations and additional production lines due to a lower throughput. However, electric storage water heater manufacturers would be able to maintain manufacturing capacity levels and continue to meet market demand under amended energy conservation standards at these TSLs. These TSLs do not require prohibitively costly or complex changes to existing facilities or most products on the market today. TSL 5 and TSL 6 could also result in a constrained market for large volume sizes if manufacturers do not make the required investments to offer electric heat pump water heaters at relatively low shipment volumes.

Electric storage water heater manufacturers indicated that there could be potential capacity impacts at TSL 7 or TSL 8, which effectively require heat pump technology. However, manufacturers of electric storage water heaters indicated that significant changes to production facilities would be required if amended energy conservation standards effectively mandated heat pump water heaters for all rated volume sizes (TSL 7 and TSL 8). Several manufacturers stated that they could move all or part of their production to Mexico to take advantage of lower labor costs if more complex heat pump water heaters were required. Manufacturers indicated that they would likely source the heat pump module initially if they were required to exclusively manufacture heat pump water heaters. However, a dramatic increase in the demand for heat pump modules could strain suppliers, especially in the short-term. Finally, manufacturers also stated that they have very little experience with manufacturing heat pump water heaters. Manufacturers indicated that the changes to their facilities (including potential plant sourcing decisions) could cause a constrained market until the production equipment is installed and any problems with high speed manufacturing are resolved.

12.7.2.2 Oil-Fired Storage Water Heaters Capacity Impacts

While amended energy conservation standards could impact the current market shares in the oil-fired market, it is unlikely that standards would result in a constrained market. For oil-fired storage water heaters, the fundamental fabrication and assembly equipment would not be expected to change significantly in order to comply with TSL 1 through TSL 7. While DOE research suggests that products that meet TSL 1 though TSL 7 require relatively minor changes to the insulation material or thickness, the product conversion costs necessary at these TSLs could cause at least one manufacturer with significant market share to exit the residential oil-fired storage water heater market due to the low total shipment volumes. At any efficiency level that would likely require a multi-flue heat exchanger (*i.e.*, TSL 8), all but one manufacturer would need to make a significant and costly redesign of existing residential oil-fired product lines and related manufacturing facilities. These substantial changes could cause manufacturers to exit the residential oil-fired storage water heater market. However, even TSL 8 is unlikely to result in a constrained market even if any manufacturer exited the oil-fired residential water heater market. One residential oil-fired storage water heater manufacturer with significant market share has products that meet the max-tech level. Due to the low shipment volumes of oil-fired storage water heaters, this manufacturer could meet the total industry demand and industry-wide capacity would not be impacted.

12.7.2.3 Gas-Fired Instantaneous Water Heaters Capacity Impacts

Short-term capacity constraints for gas-fired instantaneous water heaters could develop at TSL 8. DOE research suggests that all gas-fired instantaneous water heaters are currently imported. If the amended energy conservation standards required more-efficient products than those currently offered, foreign manufacturers and parent companies would have to decide whether the relatively small market for gas-fired instantaneous water heaters in the United States would justify the required investments. DOE expects that TSL 1 through TSL 7 would be unlikely to disrupt supply to the United States because of the number of existing product lines that manufacturers could offer without substantial product development. The number of existing product lines on the market drops substantially at TSL 8. There could be capacity constraints in response to amended energy conservation standards at TSL 8 which could lead to capacity constraints once amended efficiency standards go into effect, depending on the reactions of manufacturers.

12.7.2.4 Traditional Direct Heating Equipment Capacity Impacts

Amended energy conservation standards could lead to a constrained traditional DHE market. DOE does not expect that traditional DHE manufacturers would need to substantially modify existing facilities in response to amended energy conservation standards at TSL 1 or TSL 2. However, at TSL 3 though TSL 6, some manufacturers would face complete product redesigns for either gas wall fan or gas room DHE. A complete redesign would entail significant product development, tooling, certification and testing costs. Some manufacturers indicated that low shipment volumes would make these costs unjustifiable for many product lines, thereby leading to the discontinuation of those lines. Small businesses with less access to capital would be even more likely to face this problem than higher-volume, more diversified competitors, possibly resulting in further industry consolidation. Pressure that forced manufacturers to consolidate or exit the market could also strain the remaining manufacturers' capacity to increase production to meet industry demand. However at TSL 3, manufacturers would enough existing products in multiple product classes that they could selectively upgrade enough product lines to meet industry demand and remain in business. However, setting an amended energy conservation standard above TSL 3 could lead to manufacturing capacity problems for certain product classes if manufacturers cannot make the tooling changes in time to meet the standard, manufacturers do not have the resources to develop products that meet the required efficiencies, or manufacturers discontinue product lines rather than to invest an amount equal to the required conversion costs.

12.7.2.5 Gas Hearth Direct Heating Equipment Capacity Impacts

Gas hearth DHE manufacturers did not indicate that amended energy conservation standards would lead to a constrained market. Rather, such manufacturers are concerned that more stringent energy conservation standards could exert additional pressures on companies to consolidate or exit the market. Manufacturers predict that unit shipments would decline increasingly as the amended energy conservation standard is set closer to max-tech (*i.e.*, TSL 6). Manufacturers also indicated that the high capital conversion costs would lead all manufacturers to drop product lines or to not convert all existing product lines at TSL 4 through TSL 6 because of the smaller market for covered gas hearth products that is anticipated in the event of a more stringent amended energy conservation standard. The reduction in market demand and the lower number of product lines available are likely to lead to an overcapacity of covered products within the industry, even if multiple lower-volume competitors exit the market.

12.7.2.6 Gas-Fired Pool Heaters Capacity Impacts

Manufacturers indicated that, while potentially negative impacts were possible at lower TSLs, industry capacity could be impacted at more stringent TSLs. At TSL 1 through TSL 4, DOE research suggests that manufacturers could retool without causing capacity constraints in the market. At these TSLs, manufacturers have the experience necessary to achieve the required efficiencies and to offer durable products by the compliance date for the amended energy convervation standards. If DOE were to set amended energy conservation standards at near-condensing or condensing levels, most gas-fired pool heater manufacturers stated that short-term production capacity could be affected. While only TSL 6 requires fully-condensing products, manufacturers indicated that adoption of amended standards at TSL 5 and above could cause them to only manufacture fully-condensing products in order to minimize longevity and warranty issues. Thus, TSL 5 and TSL 6 would require manufacturers to incur significant product and capital conversion costs. Consequently, an amended energy conservation standard at or above TSL 5 could lead to short-term capacity problems if manufacturers cannot make the tooling, equipment, and assembly changes in time to meet the standard.

12.7.3 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. For the cumulative regulatory burden analysis, DOE describes other significant product-specific regulations that could affect residential water heater, DHE, and pool heater manufacturers that will take effect 3 years before or after the compliance date of amended energy conservation standards for these products.[g] In addition to the amended energy conservation regulations on residential water heaters, DHE, and gas-fired pool heaters, several other Federal regulations and pending regulations apply to these products and other equipment produced by the same manufacturers. While, the cumulative regulatory burden focuses on the impacts on manufacturers of other Federal requirements, DOE also has described a number of State and local regulations in sections 12.7.3.2 through 12.7.3.7 because it recognizes that these regulations also impact the products covered by this rulemaking.

Companies that produce a wide range of regulated products may be faced with more capital and product development expenditures than competitors with a narrower scope of products. Regulatory burdens can prompt companies to exit the market or reduce their product offerings, potentially reducing competition. Smaller companies in particular can be affected by regulatory costs since these companies have lower sales volumes over which they can amortize the costs of meeting new regulations. A proposed standard is not economically justified if it contributes to an unacceptable level of cumulative regulatory burden.

12.7.3.1 Federal DOE Regulations for Other Products Produced by Heating Product Manufacturers

In addition to the amended energy conservation standards on heating products, several other Federal regulations and pending regulations apply to other products produced by the same manufacturers. DOE recognizes that each regulation can significantly affect a manufacturer's financial operations. Multiple regulations affecting the same manufacturer can quickly strain manufacturers' profits and possibly cause an exit from the market. Table 12.7.6 through Table 12.7.8 list the Federal regulations that could also affect manufacturers of residential water heaters, DHE, and pool heaters in the three years leading up to and after the compliance date of amended energy conservation standards for these products. The amount of cumulative burden on any particular firm is extremely variable since the product scope of each company is different.

[g] The compliance date for residential water heaters is 5 years from the date of publication of the final rule (approximately March 2015). The compliance date for direct heating equipment and pool heaters is 3 years from the date of publication of the final rule (approximately March 2013).

Table 12.7.6 Other DOE and Federal Actions Affecting the Residential Water Heater Industry

Regulation	Approximate Compliance Date*	Number of Impacted Companies from the Market and Technology Assessment (MTA) (See chapter 3)	Estimated Industry Total Conversion Expenses
Cooking Products	2012	1	$22.6 (2006$)[h]
Residential Boilers	2012	4	N/A†
General Service Fluorescent Lamps and Incandescent Reflector Lamps	2012	1	$363.1 million (2008$)[i]
Direct Heating Equipment	2013*	1	See section 12.4.8
Residential Pool Heaters	2013*	2	See section 12.4.8
Residential Clothes Dryers	2014*	1	N/A††
Fluorescent Lamp Ballasts	2014*	1	N/A††
Residential Refrigerators and Freezers	2014*	1	N/A††
Residential Clothes Washers	2015*	2	N/A††
Small Electric Motors	2015*	1	N/A††
Commercial Distribution Transformers	2015*	1	N/A††
High Intensity Discharge Lamps	2015*	1	N/A††
Commercial Small Electric Motors	2015*	1	N/A††
Residential Central Air Conditioners	2016*	1	N/A††

*The dates listed are an approximation. The exact dates are pending final DOE action.
† Energy conservation standards and compliance dates for residential boilers can be found at 10 CFR 430.32(e)(2)(ii)-(iv).
†† For energy conservation standards for rulemakings awaiting DOE final action, DOE does not have a finalized estimated total industry conversion cost. For minimum performance requirements prescribed by the Energy Independence and Security Act of 2007 (EISA 2007), DOE did not estimate total industry conversion costs because an MIA was not completed as part of a rulemaking. Pub. L. 110-140. EISA 2007 made numerous amendments to the Energy Policy and Conservation Act (EPCA) of 1975, Pub. L. 94-163, (42 U.S.C. 6291–6309), which established an energy conservation program for major household appliances and industrial and commercial equipment.

[h] Estimated industry conversion expenses were published in the TSD for the April 2009 residential cooking products final rule. 74 FR 16040. The TSD for the 2009 residential cooking products final rule can be found at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/74fr16040.pdf

[i] Estimated industry conversion expenses were published in the TSD for the July 2009 general service fluorescent lamps and incandescent reflector lamps final rule. 74 FR 34154. The TSD for the July 2009 general service fluorescent lamps and incandescent reflector lamps final rule can be found at: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/74fr34080.pdf

Table 12.7.7 Other DOE and Federal Actions Affecting the Direct Heating Equipment Industry

Regulation	**Approximate Compliance Date***	**Number of Impacted Companies from the MTA**	**Estimated Industry Total Conversion Expenses**
Residential Dehumidifiers	2012	1	N/A†
Residential Boilers	2012*	1	N/A††
Residential Water Heaters	2015*	1	See section 12.4.8
Residential Central Air Conditioners	2016*	1	N/A†

*The dates listed are an approximation. The exact dates are pending final DOE action.
† For energy conservation standards for rulemakings awaiting DOE final action, DOE does not have a finalized estimated total industry conversion expense.
†† Energy conservation standards and compliance dates for residential boilers can be found at 10 CFR 430.32(e)(2)(ii)-(iv).

Table 12.7.8 Other DOE and Federal Actions Affecting the Pool Heater Industry

Regulation	**Approximate Compliance Date***	**Number of Impacted Companies from the MTA**	**Estimated Industry Total Conversion Expenses**
Residential Boilers	2012*	2	N/A†
Residential Water Heaters	2015*	2	See section 12.4.8
Residential Central Air Conditioners	2016*	1	N/A††

*The dates listed are an approximation. The exact dates are pending final DOE action.
† Energy conservation standards and compliance dates for residential boilers can be found at 10 CFR 430.32(e)(2)(ii)-(iv).
††For energy conservation standards for rulemakings awaiting DOE final action, DOE does not have a finalized estimated total industry conversion cost.

12.7.3.2 United States Clean Air Act

The Clean Air Act is defines the EPA's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. The most significant of these additional regulations are the EPA mandated phase-out of hydro chlorofluorocarbons (HCFCs). The Act demands on a quarterly basis that any person who produced, imported, or exported certain substances, including HCFC refrigerants, must report the amount produced, imported and exported. Additionally, effective January 1, 2015, selling, manufacturing, and using any such substance is banned unless such substance has been used, recovered, and recycled; is used and entirely consumed in the production of other chemicals; or is used as a refrigerant in appliances manufactured prior to January 1, 2020. Finally, production phase-outs will continue until January 1, 2030 when such production will be illegal. These bans could trigger design changes to natural or low global warming potential refrigerants and could impact the insulation used in products covered by this rulemaking.

12.7.3.3 State Energy Conservation Standards

The State of California mandates energy conservation standards for residential water heaters, DHE, and pool heaters. The California water heater standards are identical to existing Federal standards for covered water heaters, DHE, and pool heaters. California regulations include products outside of the rated storage and input capacity ranges for the product types covered by Federal standards in this rulemaking. California has specific regulations for instantaneous oil-fired water heaters, which are similar to Federal standards for oil-fired storage water heaters. California also issues standards for oil-fired and electric heat pump pool heaters.

12.7.3.4 Other State Regulations

California Lead Regulation

The California State Assembly issued AB 1953, which will phase out lead from brass plumbing used to convey drinking water in water utility distribution pipes and in consumer plumbing fittings and faucets. Beginning on January 1, 2010, only the lead-free plumbing components meeting the AB 1953 0.25 percent lead content standard can be sold in California. This regulation could affect components used in water heater manufacturing.

Standing Pilot Light Ban

California Title 20 and Florida HB 7135 banned constant burning pilots on gas-fired pool heaters. Both State laws also require that gas-fired pool heaters have an on/off switch mounted outside the pool heater that allows users to shut off the heater without adjusting the thermostat setting. The California law is in effect; the Florida law will go into effect after July 1, 2011. Other states have expressed intentions of enacting similar standards.

ASME Required Certification

Some states are moving toward requiring units certified by the American Society of Mechanical Engineers (ASME), a non-profit group that sets many industrial and manufacturing standards. A pool heater that is made to ASME standards will perform to a set of specifications determined by ASME, specifically in relation to the operating water pressure the appliance can handle.

12.7.3.5 State Emission Requirements

SCAQMD – Ultra-Low-NO_X Requirements

The South Coast Air Quality Management District (SCAQMD) is the air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. The SCAQMD covers about half of the population of the state of California. The SCAQMD has enacted two rules concerning natural gas-fired water heaters as part of its efforts to limit NO_X emissions in its area. Rule 1121 covers residential water heaters with a rated heat input capacity of less than 75,000 Btu/h, and Rule 1146.2 sets emission requirements for instantaneous water heaters by covering all residential water heaters with a rated heat capacity of less than 2,000,000 Btu/h. Rule 1146.2 also includes standards for mobile home water heaters. The specific requirements and compliance dates set by the SCAQMD for each set of products are shown in Table 12.7.9.

BAAQMD – Ultra-Low-NO_X Requirements

The Bay Area Air Quality Management District (BAAQMD) is the public agency entrusted with regulating stationary sources of air pollution in the San Francisco Bay area. The BAAQMD passed Rule 9-6, which phases in emission requirements for residential water heaters with a rated heat capacity of less than 75,000 Btu/h. Additionally, Rule 9-6 sets standards for instantaneous water heaters and gas-fired pool heaters that must be complied with in 2013. The specific requirements and compliance dates set by the BAAQMD for each set of products are shown in Table 12.7.9.

Valley Air District – Ultra-Low-NO_X Requirements

The San Joaquin Valley Air Pollution Control District (Valley Air District) sets emission control measures in California's Central Valley area. The Valley Air District adopted Rule 4902, which set emission requirements for residential water heaters, including mobile home water heaters. In addition to these standards which are already in effect, Rule 4902 sets future NO_X emission requirements for residential water heaters, instantaneous water heaters, and gas-fired pool heaters. The specific requirements and compliance dates set by the Valley Air District for each set of products are shown in Table 12.7.9.

TCEQ – Low NO_X Requirements

The Texas Commission on Environmental Equality (TCEQ) is the environmental agency for the state of Texas. The TCEQ has the authority to set emission requirements and place them in the Texas Administrative Code, including Rule 117.3205, which has been in effect since 2007. Rule 117.3205 set standards for residential water heaters, including mobile home water heaters and instantaneous water heaters. Although the TCEQ set low NO_X emissions requirements, it has not developed ultra-low-NO_X requirements like several of California's regional agencies. The specific requirements set by the TCEQ for each set of products are shown in Table 12.7.9.

Potential Future NO_X Requirements

DHE and gas-fired pool heater manufacturers have not been affected by NO_X emissions reduction standards yet, but many anticipate State and regional legislation, particularly in California. Low NO_X emissions standards already exist in California for natural gas-fired water heaters and natural gas-fired fan central furnaces. If low NO_X emissions standards are established for DHE and gas-fired pool heaters, manufacturers would face significant compliance costs for independent lab certification. DHE manufacturers would also face compliance costs for redesigning burners and gas-fired pool heater manufacturers would face compliance costs for redesigning units.

Table 12.7.9 Air Quality Management District Low and Ultra-Low-NOX Requirements

Product Type	Input Range (kBtu/h)	SCAQMD			BAAQMD			Valley Air District			
		Current Requirement	Future Requirement	Compliance Date	Current Requirement	Future Requirement	Compliance Date	Current Requirement	Future Requirement	Compliance Date	Current Requirement
Atmospheric Water Heaters (</= 50 Gal.)	<75	10 ng/j or 15 ppm	N/A	N/A	10 ng/j	N/A	N/A	40 ng/j	10 ng/j	1/1/2010	40 ng/j or 55 ppm
Atmospheric Water Heaters (> 50 Gal.)	<75	10 ng/j or 15 ppm	N/A	N/A	40 ng/j	10 ng/j	1/1/2010	40 ng/j	10 ng/j	1/1/2010	40 ng/j or 55 ppm
Direct-Vent, Power-Vent, and Power Direct-Vent Storage Tank Water Heaters	<75	10 ng/j or 15 ppm	N/A	N/A	40 ng/j	10 ng/j	1/1/2011	40 ng/j	10 ng/j	1/1/2010	40 ng/j or 55 ppm
Mobile Home Water Heaters	<75	40 ng/j or 55 ppm	N/A	N/A	40 ng/j	N/A	N/A	40 ng/j	N/A	N/A	40 ng/j
Instantaneous Water Heaters	75 - 200	40 ng/j or 55 ppm	14 ng/j or 20 ppm[1]	1/1/2012	40 ng/j	14 ng/j	1/1/2013	N/A	14 ng/j	1/1/2012	40 ng/j or 55 ppm
Pool Heaters		N/A	N/A	N/A	40 ng/j or 55 ppm	14 ng/j or 20 ppm	1/1/2013	N/A	40 ng/j	1/1/2010	N/A
Direct Heating Equipment		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1) SCAQMD does not specifically set emission requirements for instantaneous water heaters, but by setting standards for all Type 1 water heaters (75,001 Btu/h - 400,000 Bt
covered instantaneous water heaters within that rated heat input capacity must meet this requirement.

12.7.3.6 International Energy Conservation Standards

Canada Requirements for Residential Electric Storage Tank Water Heaters and Gas-Fired Pool Heaters

The Canadian Standards Association (CSA) enacted C191-04, a national standard specifying requirements related to delivery, minimum standby performance, heater element ratings, and marking of electric storage tank water heaters. This standard applies to stationary storage tank water heaters that have a rated capacity of 184 or 284 L (40 or 60 gal) and are intended for use with pressure systems in residential premises and similar locations.

The CSA has specified energy conservation standards for gas-fired pool heaters similar to Federal energy conservation standards. By adopting ANSI Z21.56/CSA 4.7, the CSA sets a minimum thermal efficiency of 78 percent.

While Canada has not issued standards for direct heating equipment, Canada has established product classes for vented gas fireplaces and fireplace heaters. Manufacturers indicated that the P4 test procedure to rate products in Canada does contribute a cumulative burden.

Mexico - Requirements for Residential and Commercial Water Heaters

The National Commission for Energy Efficiency (CONUEE) is a decentralized agency under Mexico's Secretary of Energy that develops official national standards for energy efficiency. One such standard, NOM-003-ENER-2000, applies to residential and commercial water heaters and places special emphasis on limits, test methods, and labeling. An amendment to this standard in 2002 adjusted the thermal efficiency for residential and commercial use to 74 percent and 79 percent, respectively. It is currently under revision.

12.7.3.7 Uniform Plumbing and Safety Codes

Plumbing, building, and safety codes are adopted by local jurisdictions to provide safety for users and to protect public health. They define requirements for construction, installation, and specification for gas vented hearth products.

Designated as an American National Standard, the Uniform Plumbing Code (UPC) is a model code developed by the International Association of Plumbing and Mechanical Officials to govern the installation and inspection of plumbing systems as a means of promoting the public's health, safety and welfare. Similarly, the International Building Code (IBC), which has been adopted throughout most of the United States, is a model building code developed by the International Code Council. Both codes are updated on a three year basis and impact specifications of water heater and gas vented hearth product manufacturing and installation.

The American National Standards Institute (ANSI) and the Canadian Standards Association (CSA) jointly promote safety standards for gas-fired pool heaters and vented gas fireplaces. ANSI Z21.56/CSA 4.7 and ANSI Z21.88-2009/CSA 2.33, also an American National Standard, are model standards representing a basic criterion for safe operation, substantial and durable construction, and acceptable performance of gas-fired pool heaters and vented gas fireplace heaters, respectively. These codes are updated frequently and impact specifications of pool heater and vented gas fireplace heater manufacturing.

Manufacturers of all heating products must comply with various local building, plumbing, and safety codes and standards within the United States as well as codes and standards adopted internationally.

12.8 CONCLUSION

The following sections summarize the different impacts for the scenarios DOE believes are most likely to capture the range of impacts on residential water heater, DHE, and pool heater manufacturers at each TSL in the standards case. While these scenarios bound the range of the most plausible impacts on manufacturers, some circumstances could cause manufacturers to experience impacts outside this range.

12.8.1 Residential Water Heaters

12.8.1.1 Gas-Fired and Electric Storage Water Heaters

TSL 1 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.62 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. For electric storage water heaters TSL 1 represents an improvement in efficiency from the baseline level of 0.90 EF to 0.92 EF for the representative rated storage volume of 50 gallons. At TSL 1, DOE estimates the impacts on INPV to range from -$4.9 million to -$14.2 million, or a change in INPV of -0.56 percent to -1.62 percent. At this level, the industry cash flow is estimated to decrease by approximately 4.6 percent, to $67.4 million, compared to the base-case value of $70.6.0 million in the year leading up to the standards. Currently, approximately 64 percent of the gas-fired storage water heaters are sold at the baseline level. However, all manufacturers also offer a full line of gas-fired storage water heaters that meet the gas-fired efficiencies at TSL 1. Although the majority of the electric storage water heater shipments do not meet TSL 1, every manufacturer also offers a full line of electric storage water heaters at or above this level. Because manufacturers have existing products and manufacturers could reach the required efficiencies with relatively minor changes to the foam insulation thickness at TSL 1, manufacturers of gas-fired and electric storage water heaters would have minimal conversion costs at TSL 1. Because the technology required at TSL 1 is similar to the baseline, the INPV impacts are similar for both markup scenarios. It is hence unlikely that TSL 1 would greatly reduce manufacturers' profitability.

TSL 2 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. For electric storage water heaters, TSL 2 represents an improvement in efficiency from the baseline level of 0.90 EF to 0.93 EF for the representative rated storage volume of 50 gallons. At TSL 2, DOE estimates the impacts on INPV to range from -$4.3 million to -$31.4 million, or a change in INPV of -0.49 percent to -3.56 percent. At this level, the industry cash flow is estimated to decrease by approximately 8.2 percent, to $64.8 million, compared to the base-case value of $70.6 million in the year leading up to the standards. Currently, over 77 percent of the gas-fired storage water heaters sold do not meet TSL 2. At TSL 2, manufacturers are expected to meet the gas-fired efficiency requirements by adding additional insulation to their existing products. The conversion costs at TSL 2 are relatively minor for gas-fired storage water heaters because most manufacturers have a full line of products at the required efficiency for TSL 2 and only minor changes in the manufacturing process would be required. Although the majority of the electric storage water heater market is below the efficiency specified for electric storage water heaters at TSL 2, more than 39 percent of the market is at or above this level. Manufacturers would have increasing conversion costs for both capital and product conversion for electric storage water heaters to modify production facilities to accommodate the extra insulation required at TSL 2. Because the technology required at TSL 2 is similar to the baseline for gas-fired and electric storage water heaters, however, it is unlikely that TSL 2 would greatly impact manufacturers' profitability.

Similar to TSL 2, TSL 3 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Because the efficiency requirements for gas-fired storage water heaters are the same at TSL 3 as at TSL 2, the impacts on manufacturers are the same as at TSL 2 for the gas-fired storage efficiency requirements. There are small impacts on manufacturers to improve the efficiency of the majority of the gas-fired storage shipments from the baseline. However, because these changes are expected to be relatively minor increases to the insulation thickness, the impacts on the industry are not substantial because these changes do not greatly alter the current manufacturing process. TSL 3 represents a further improvement in efficiency for electric storage water heaters from the baseline level of 0.90 EF to 0.94 EF for the representative rated storage volume of 50 gallons. To achieve the efficiency levels for TSL 3, electric storage manufacturers would be expected to further increase tank insulation thickness, with still relatively small conversion costs because many manufacturers already manufacture storage water heaters at TSL 3. DOE estimates the INPV impacts to range from -$5.2 million to -$38.3 million, or a change in INPV of -0.59 percent to -4.35 percent. At this level, the industry cash flow is estimated to decrease by approximately 8.2 percent to $64.8 million, compared to the base-case value of $70.6 million in the year leading up to the standards.

Similar to TSL 2 and TSL 3, TSL 4 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Because the efficiency requirements for gas-fired storage water heaters are the same at TSL 4 as at TSL 2 and TSL 3, the impacts on gas-fired manufacturers are the same. There are small impacts on manufacturers to improve the efficiency of the majority of the gas-fired storage shipments from the baseline. However, because these changes are expected to be relatively minor increases to the insulation thickness, the impacts on the industry are not substantial because these changes do not greatly alter the current manufacturing process. TSL 4 represents a further improvement in efficiency from the baseline level of 0.90 EF to 0.95 EF for electric storage water heaters at the representative rated storage volume of 50 gallons. Based on a review of units on the market at these efficiency levels, DOE expects that manufacturers would likely further increase insulation levels. Because not all manufacturers have models at this efficiency currently available on the market, however, DOE expects that electric storage water heater manufacturers would incur higher conversion costs at TSL 4 than at TSL 3. At TSL 4, DOE estimates the INPV impacts to range from -$4.8 million to

-$89.4 million, or a change in INPV of -0.55 percent to -10.16 percent. At this level, the industry cash flow is estimated to decrease by approximately 31.4 percent to $48.4 million, compared to the base-case value of $70.6 million in the year leading up to the standards. Only a small number of electric storage water heaters on the market meet the efficiency level for electric storage water heaters required by TSL 4. Electric storage manufacturers would have increasing conversion costs for both capital and product conversion to greatly increase the production of low volume products. The capital conversion costs for electric storage water heaters are more substantial than for gas-fired storage water heaters because each production line would require additional foaming stations to accommodate the greatly increased insulation thicknesses and, due to slower production speeds, adding additional production lines in existing facilities to maintain current shipment volumes. Manufacturers also noted that they were concerned about TSL 4 for electric storage water heaters because of problems with the test procedure that could make it difficult replicate the efficiencies required at this TSL.

TSL 5 has the same efficiency requirements as TSL 4 for electric storage water heaters with rated storage volumes less than 55-gallons and has the same efficiency requirements as TSL 1 for gas-fired storage water heaters with rated storage volumes less than 55-gallons. Because the efficiency requirements for gas-fired and electric storage water heaters with rated storage volumes less than 55-gallons are equal to TSL 1 for gas-fired storage water heaters and TSL 4 for electric storage water heaters, at TSL 5 manufacturers share the same concerns for these rated storage volumes as at TSL 1 and TSL 4, respectfully . However, the efficiency requirements for gas-fired storage water heaters with rated storage volumes greater than 55-gallons effectively require condensing technology, and the efficiency requirements for electric storage water heaters with rated storage volumes greater than 55-gallons effectively require heat pump technology. At TSL 5, DOE estimates the INPV impacts to range from -$25.9 million to -$122.6 million, or a change in INPV of -2.94 percent to -13.93 percent. At this level, the industry cash flow is estimated to decrease by approximately 52.7 percent to $33.4 million, compared to the base-case value of $61.0 million in the year leading up to the standards. The higher, negative impacts on INPV are largely caused by the additional conversion costs required to substantially change the technology commonly used in large size gas-fired and electric storage water heaters today. DOE estimates the approximately 4 percent of gas-fired storage water heater shipments with rated volumes greater than 55-gallons would require an additional $14 million in conversion costs to use condensing technology. DOE estimates the approximately 9 percent of gas-fired storage water heater shipments with rated volumes greater than 55-gallons would require an additional $26 million in conversion costs to use heat pump technology.

Much of the additional capital conversion costs calculated for large volume sizes at TSL 5 involve creating additional gas-fired and electric storage assembly lines in a facility adjacent to a current production facility. Because high-volume manufacturing facilities are typically arranged for units with similar assembly processes, the more complex technology used for larger rated volumes at TSL 5 could not be accommodated on existing production lines. The estimated product conversion costs at TSL 5 would involve retraining existing service and installation personnel, who have little experience installing and servicing storage water heaters that use these advanced technologies. To minimize unit damage and warranty claims and to improve market acceptance, manufacturers would likely have to expend significant additional resources to hire training staff to provide more technical support. The other portion of the product conversion costs for large rated volumes are the product development effort to redesign existing products.

Manufacturers could face constraints regarding the abilities of their engineering teams to develop multiple water heater families at TSL 5, as many engineering departments have limited experience with either technology. At a minimum, the efficiency requirements at TSL 5 would require manufacturers to convert existing commercial condensing gas products for residential use. However, multiple manufacturers would also have to develop completely new platforms in order to remain cost-competitive. Even if a manufacturer were to offer incur these high conversion costs, the high product development and capital conversion costs for a small segment of the overall market make it likely that consumers will have fewer product families to choose from after the compliance date of the final rule.

Even if manufacturers offer gas condensing and electric heat pump water heaters for the large gallon sizes at TSL 5, there could be additional, negative impacts on consumers that could lead to a smaller market for these products. Consumers might no longer purchase water heaters with rated storage volumes above 55-gallons because of substantially higher increased first costs than most products currently on the market, the unfamiliar technologies, and size limitations. Because of these changes in the market, at TSL 5, manufacturers could decide that the demand for residential heat pump and condensing gas water heaters would drop to a point where the high product conversion and capital costs required for a small portion of total shipments are not justified. As a result, manufacturers would no longer manufacture residential storage water heaters at rated storage volumes above 55-gallons. In addition, consumers could be impacted if fewer contractors were willing to install these more complex products, especially if field technicians did not obtain any additional licenses and test equipment that could be required to service heat pump water heaters. These additional requirements would also likely increase installation and service costs beyond current levels since consumers would have fewer servicers/installers to choose from.

TSL 6 has the same efficiency requirements as TSL 4 for gas-fired and electric storage water heaters with rated storage volumes less than 55-gallons. Because the efficiency requirements for gas-fired and electric storage water heaters with rated storage volumes less than 55-gallons are equal to TSL 4, at TSL 5 manufacturers share the same concerns for these rated storage volumes as at TSL 4. However, at TSL 6 the efficiency requirements for gas-fired storage water heaters with rated storage volumes greater than 55-gallons are the same as at TSL 5 and effectively require condensing technology. At TSL 6, the efficiency requirements for electric storage water heaters with rated storage volumes greater than 55-gallons are the same as at TSL 5 and effectively require heat pump technology. Consequently, manufacturers share the same concerns for large rated storage volumes at TSL 6 as at TSL 5. At TSL 6, DOE estimates the INPV impacts to range from -$23.6 million to -$134.6 million, or a change in INPV of -2.68 percent to -15.29 percent. At this level, the industry cash flow is estimated to decrease by approximately 52.7 percent to $33.4 million, compared to the base-case value of $70.6 million in the year leading up to the standards.

Similar to TSL 2 through TSL 4, TSL 7 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.63 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. Similarly, the impacts on manufacturers due to the gas-fired storage efficiencies are relatively minor because the required efficiencies for all volume sizes can likely be met with relatively minor changes to the insulation thickness. For electric storage water heaters, TSL 7 represents an improvement in efficiency from the baseline level of 0.90 EF to 2.0

EF for electric storage water heaters at the representative rated storage volume of 50 gallons. At TSL 7, DOE estimates the impacts on INPV to range from -$10.5 million to -$350.2 million, or a change in INPV of -1.19 percent to -39.78 percent. At TSL 6, the industry cash flow is estimated to decrease by approximately 71.7 percent, to $20.0 million, compared to the base-case value of $70.6 million in the year leading up to the standards. To achieve efficiencies at or above TSL 7 would effectively require the use of heat pumps for electric storage water heaters for all rated volumes, a technology option that has yet to see wide adoption in the U.S. market. The higher expected purchased part content and market pressures would be expected to reduce manufacturer profits margins substantially. Although most electric storage water heater manufacturers indicated that they are in the process of developing heat pump water heaters, all manufacturers believe that an efficiency level that requires heat pump water heater technology is not appropriate as an amended energy conservation standard. Manufacturers stated that they would face substantial costs to switch their entire electric storage water heater production over to heat pump electric storage water heaters. Several manufacturers expect that they will have to buy the heat pump modules from outside vendors since most water heater manufacturers have no experience manufacturing heat pumps and have limited space in their facilities to produce heat pump systems. Multiple manufacturers stated that even if they were to simply buy and integrate heat pump modules, there would be substantial product development and capital conversion costs because present facilities are not adequate to handle the heat pump modules. DOE estimates that manufacturers would incur almost $76 million in capital conversion costs to modify production facilities to exclusively manufacture heat pump electric storage water heaters. These capital conversion cost estimates do not include the cost of building manufacturing capacity to produce the refrigeration units because manufacturers indicated that these are likely to be purchased subassemblies.

Furthermore, manufacturers stated that they would consider moving all or part of their existing production capacity abroad if the energy conservation standard is set at TSL 7 because many manufacturers expect that they would have to redesign their facilities completely to accommodate a minimum energy conservation standard at this TSL. According to these manufacturers, building a new facility entails less business disruption risk than attempting to completely redesign and upgrade existing facilities, and lower labor rates in Mexico and other countries abroad may entice manufacturers to move their production facilities outside of the U.S. In addition, manufacturers are very concerned about the significant number of customers who would face extremely costly installations for electric storage water heater replacements if a standard effectively requiring heat pump technology is mandated. According to manufacturers, a significant percentage of electric storage water heaters are installed in space-constrained environments which cannot accommodate the additional space required for the heat pump module. This is especially true for mobile homes and other consumer sub-groups that use smaller capacity tanks.

Another concern of manufacturers at TSL 7 is the amount of additional training that would be necessary to upgrade the installation, distribution, and maintenance networks on the scale necessary to support an electric storage water heater market that used heat pump technology exclusively. Manufacturers are concerned that the typical installer or repair person would not have the requisite knowledge to troubleshoot or repair heat pump water heaters. Manufacturers also expressed concern about profitability if amendments to the minimum energy conservation standard for electric storage water heaters were to require the use of heat pump technology. An amended energy conservation standard that effectively mandated heat pump technology would completely change the nature of their business. The production costs for an integrated heat pump water heater at the 50-gallon representative rated storage volume are over four times the baseline production costs. Specifically, manufacturers believe that because this technology results in much more expensive units than the majority of products on the market today, not all of the increased costs could be passed on to the customer. In addition, the significantly higher production costs would require an additional $273 million in working capital to purchase significantly more expensive components, carry more costly inventory, and handle higher accounts receivable. DOE estimates that the working capital requirement and conversion costs would cause electric storage water heater manufacturers to incur a total one-time investment of at least $404 million in an electric storage market valued at approximately $301 million. Finally, manufacturers believe it is unlikely that they could earn the same return on these extremely large investments, so profitability would be expected to decrease after the compliance date of the amended energy conservation standards.

TSL 8 represents an improvement in efficiency from the baseline level of 0.59 EF to 0.77 EF for gas-fired storage water heaters for the representative rated storage volume of 40 gallons. TSL 7 represents an improvement in efficiency from the baseline level of 0.90 EF to 2.35 EF for electric storage water heaters at the representative rated storage volume of 50 gallons. At TSL 7, DOE estimates the impacts on INPV to range from $79.2 million to -$647.0 million, or a change in INPV of 9.00 percent to -73.49 percent. At TSL 8, the industry cash flow is estimated to decrease by approximately 163.0 percent, to -$44.8 million, compared to the base-case value of $70.6 million in the year leading up to the standards. Because TSL 8 also requires improved heat pump technology (with additional efficiency-related improvements to both the heat pump module and the water heater tank), electric storage water heater manufacturers shared the same concerns at TSL 8 as they had at TSL 7. Because additional, more-costly improvements to heat pump technology are required, however, electric storage water heater manufacturers were more concerned about the potential for energy conservation standards to greatly disrupt the industry if the amended energy conservation standard were set at TSL 8.

For gas-fired storage water heaters, TSL 8 requires manufacturers to produce fully-condensing gas-fired storage water heaters, which is significantly more complex than the insulation changes required at most lower TSLs. Currently no manufacturer offers residential gas-fired storage water heaters with condensing technology. Manufacturers would need to redesign their products at the condensing level, which would force manufacturers to incur significant product and capital conversion costs. Some loss in product utility may also occur for units that are presently installed in space-constrained applications because condensing water heaters require greater installation space to accommodate bigger heat exchangers, fully-installed blowers, and other components that non-condensing models do not feature. At the condensing level, manufacturers would be required to purchase substantial tooling to fabricate new coil and tank designs and make changes to all subassembly and main assembly lines. DOE estimates that manufacturers would incur approximately $122 million in capital conversion costs to modify their production facilities. Some gas-fired storage water heater manufacturers stated during interviews that they would consider moving facilities offshore at TSL 8 to take advantage of lower labor costs. In addition, due to the complexity and large size of storage water heaters at this efficiency, manufacturers are concerned that installations will be far more difficult and could force many consumers to pay substantially higher installed costs if their replacement water heater does not fit into their existing space. Manufacturers are also concerned about profitability if standards were set at a level that would effectively require condensing technology. An amended energy conservation standard that effectively mandated condensing gas-fired storage water heaters would completely change the existing structure of the industry. Because this technology results in much more expensive units than the majority of products on the market today, manufacturers argued that not all of the increased costs could be passed on to the customer. In addition, the significantly higher production costs would require at least an additional $177 million in working capital to purchase significantly more expensive components, carry more costly inventory, and handle higher accounts receivable. DOE estimates that the working capital requirement and conversion costs would cause gas-fired storage water heater manufacturers to incur a total one-time investment of at least $321 million in a gas-fired storage market valued at approximately $580 million. While there is a slightly positive impact if manufacturers get the same return on these investments as in the base case, manufacturers believe that they will not earn the same return from the substantially higher capital requirements at TSL 8.

12.8.1.2 Oil-Fired Storage Water Heaters

TSL 1 represents an improvement in efficiency for oil-fired storage water heaters from the baseline level of 0.53 EF to 0.58 EF for the representative rated storage volume of 32 gallons. At TSL 1, DOE estimates the impacts on INPV to range from -$0.2 to -$0.4 million, or a change in INPV of -1.98 percent to -3.85 percent. At this level, the industry cash flow would be expected to decrease by approximately 42.6 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At TSL 1, one of the two major manufacturers would have to incur relatively small product and capital conversion costs to slightly modify their existing product line. DOE research suggests that this TSL can be met with changes to the insulation thickness of baseline products. However, if more costly design changes were required it could have more of an impact on the industry.

TSL 2 represents an improvement in efficiency from the baseline level of 0.53 EF to 0.60 EF for the representative rated storage volume of 32 gallons. At TSL 2, DOE estimates the impacts on INPV to range from -$0.2 million to -$0.3 million, or a change in INPV of -1.85 percent to -3.56 percent. At this level, the industry cash flow is estimated to decrease by approximately 42.6 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. Similar to TSL 1, at TSL 2 DOE has concluded, based on a review of existing products on the market, that TSL 2 could be met with changes to the type and thickness of the insulation. The impacts at TSL 1 are slightly worse than at TSL 2 because the technology option for existing oil-fired storage water heaters on the market results in lower product costs at TSL 2. However, if TSL 2 is met with similar insulation changes, only one of two major manufacturers would still be required to slightly modify their current residential oil-fired storage product lines at TSL 2.

TSL 3 through TSL 7 represent an improvement in efficiency from the baseline level of 0.53 EF to 0.62 EF for the representative rated storage volume of 32 gallons. At these levels, DOE estimates the impacts on INPV to range from -$0.2 million to -$0.4 million, or a change in INPV of -2.01 percent to -4.23percent. At this level, the industry cash flow decreases by approximately 42.6 percent, to $0.4 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At these TSLs, one major manufacturer would have to incur relatively minor product and capital conversion costs to modify their existing oil-fired residential storage water heater product line. DOE has concluded based on a review of existing products on the market that the efficiency requirements at TSL 3 through TSL 7 could be met with changes to the type and thickness of the insulation. Due to the low volume of oil-fired storage water heaters, if any manufacturer had to make substantial product or capital conversion costs to reach the amended energy conservation standard using a more complex technology, these substantial costs could force them to consider exiting the residential oil-fired storage water heater market.

TSL 8 (the max-tech level) represents an improvement in efficiency from the baseline level of 0.53 EF to 0.68 EF for the representative rated storage volume of 32 gallons. At TSL 8, DOE estimates the impacts on INPV to range from -$1.4 million to -$3.8 million, or a change in INPV of -15.37 percent to -41.44 percent. At this level, the industry cash flow is estimated to decrease by approximately 138.7 percent, to -$1.5 million, compared to the base-case value of $0.6 million in the year leading up to the standards. At TSL 8, at least one major manufacturer would have to incur very substantial product and capital conversion to redesign the combustion and baffling system to include a multi flue design. Given the small size of the residential oil-fired storage water heater market, this manufacturer stated that these extremely large substantial product and capital conversion costs would be difficult to justify. At TSL 8, it is possible that this manufacturer would exit the residential oil-fired storage water heater market. Because there are only two main manufacturers that supply the vast majority of U.S. shipments of oil-fired storage water heaters, any manufacturer exiting the market could lead to a market disruption.

12.8.1.3 Gas-Fired Instantaneous Water Heaters

TSL 1 through TSL 7 represent an improvement in efficiency from the baseline gas-fired instantaneous water heater efficiency level of 0.62 EF to 0.82 EF for the representative input capacity of 199 kBtu/h. At TSL 1 through TSL 7, DOE estimates the INPV impacts to range from $2.3 million to -$1.2 million, or a change in INPV of 0.36 percent to -0.19 percent. At this level, the industry cash flow is estimated to remain at the base-case value of $51.7 million in the year leading up to the standards. DOE research suggests that over 90 percent of gas-fired instantaneous products sold today meet or exceed this efficiency, and nearly all manufacturers of gas-fired instantaneous water heaters currently make products that meet or exceed the efficiency required by TSL 1 through TSL 7. Hence, there appears to be little risk that TSL 1 through TSL 7 would greatly harm manufacturers or reduce the number of manufacturers that sell these products.

TSL 8 (the max-tech level) represents an improvement in efficiency from the baseline level of 0.62 EF to 0.95 EF for the representative input capacity of 199 kBtu/h. At TSL 7, DOE estimates the INPV impacts to range from $91.4 million to -$57.6 million, or a change in INPV of 14.10 percent to -8.89 percent. At this level, the industry cash flows are estimated to decrease by approximately 9.5 percent to $46.8 million, compared to the base-case value of $51.7 million in the year leading up to the standards. Only one manufacturer currently offers a gas-fired instantaneous water heater that meets the max-tech efficiency on the U.S. market. Most manufacturers would incur substantial product conversion and capital conversion costs to upgrade their existing products at TSL 8. To reach 0.95 EF, a more complex condensing model would need to be developed. Because only one manufacturer offers products that meet this efficiency, TSL 8 could greatly reduce the number of gas-fired instantaneous water heaters offered for sale in the United States.

12.8.2 Direct Heating Equipment

12.8.2.1 Traditional Direct Heating Equipment

For traditional DHE, TSL 1 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 75-percent AFUE for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 66-percent for gas wall gravity DHE, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 66-percent AFUE for gas room DHE at their respective representative input rating ranges. DOE research suggests that manufacturers would use an intermittent ignition and a two-speed blower for gas wall fan DHE and an improved heat exchanger design for gas wall gravity, gas floor units, and gas room DHE to achieve the efficiencies required by TSL 1. At TSL 1, DOE estimates the impacts on INPV to range from $0.9 to -$2.5 million, or a change in INPV of -5.24 percent to -14.88 percent. At this level, the industry cash flow is estimated to decrease by approximately 14.3 percent, to $1.2 million, compared to the base-case value of $1.4 million in the year leading up to the standards. While some manufacturers may need to make redesigns to some of their products even at TSL 1, manufacturers generally have a significant number of products that meet the required efficiencies for most traditional DHE product types, and for this reason, a complete exit from the market by any manufacturer is unlikely.

TSL 2 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 76-percent for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 66-percent AFUE for gas wall gravity DHE, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 67-percent for gas room DHE at the representative input rating ranges for each product type. DOE research suggests that at TSL 2, manufacturers would opt to use an improved heat exchanger and intermittent ignition for gas wall fan DHE, make further improvements to the heat exchanger for gas room DHE, and use the same improved heat exchanger for gas wall gravity and gas floor DHE as at TSL 1 to reach the efficiency levels required by TSL 2. At TSL 2, DOE estimates the impacts in INPV to range from -$1.2 million to -$3.9 million, or a change in INPV of -7.17 percent to -23.61 percent. At this level, the industry cash flow is estimated to decrease by approximately 17.3 percent, to $1.1 million, compared to the base-case value of $1.4 million in the year leading up to the standards. At TSL 2, every manufacturer would face higher product development costs in order to offer a similar range of product offerings. However, at TSL 2, it is likely that more products would be discontinued because more of the current products on the market fall below the required efficiencies. As a result, manufacturers must either expend resources to cover the necessary product conversion and capital conversion costs, or they will be forced to discontinue some of their existing product lines. While TSL 2 would have a significant impact on manufacturers, most manufacturers would not be expected to face a complete redesign for most traditional DHE product types. Even if manufacturers lowered the number of product lines offered in certain product classes, manufacturers would have enough existing products that meet or exceed the required efficiencies to upgrade most of their existing product lines and maintain viable production volumes after the compliance date of the energy conservation standards.

TSL 3 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 77-percent for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 69-percent AFUE for gas wall gravity units, an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 68-percent for gas room DHE at the representative input rating ranges. DOE research suggests that manufacturers would improve baseline units by adding an intermittent ignition, a two-speed blower, and an improved heat exchanger for gas wall fan units, make further improvements to the heat exchanger used to reach TSL 2 for gas wall gravity and gas room units, and use the same improved heat exchanger for gas floor DHE as at TSL 1 and TSL 2 to reach the efficiency levels of TSL 3. At TSL 3, DOE estimates the INPV impacts to range from -$1.9 million to -$7.0 million, or a change in INPV of -11.31 percent to -42.38 percent. At this level, the industry cash flow is estimated to decrease by approximately 57.8 percent to $0.6 million, compared to the base-case value of 1.4 million in the year leading up to the standards. The large estimated impact on INPV suggests that manufacturers would be substantially harmed if profitability were impacted.

At TSL 3, products increasingly rely on purchased parts, making it more likely that manufacturers’ profitability would decline. At TSL 3, it is likely that some manufacturers would reduce the number of product lines offered in order to lower the product conversion and capital conversion costs required at TSL 3. Discontinuing product lines would still have a negative impact on the manufacturers that selectively upgrade existing product lines since many manufacturers rely on aggregated production scale from all products they sell to secure favorable purchased part and raw material prices. The fixed portion of product conversion costs, such as certification and the total capital conversion costs, typically require a minimum shipment volume in order to be economically justifiable to the manufacturer. Because manufacturers have a substantial number of product lines that meet the required efficiencies at TSL3, even if manufacturers selectively upgrade their existing product lines, they would be expected to maintain a viable production volume after the compliance date of the energy conservation and not exit the market completely.

TSL 4 is the max-tech level for gas wall fan DHE. TSL 4 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 80-percent for gas wall fan DHE at the representative input rating range. The efficiency requirements for gas wall gravity, gas floor, and gas room DHE are the same at TSL 4 as at TSL 3. To achieve the max-tech level for gas wall fan DHE, DOE research suggests that manufacturers would need to use an electronic ignition and induced draft. DOE anticipates that manufacturers would make the same improvements to the heat exchangers as necessary to achieve TSL 3 for gas wall gravity, gas floor, and gas-room DHE. At TSL 4, DOE estimates the INPV impacts to range from -$1.9 million to -$8.8 million, or a change in INPV of -11.62 percent to -53.12 percent. At this level, the industry cash flow is estimated to decrease by approximately 77.6 percent to $0.3 million, compared to the base-case value of $1.4 million in the year leading up to the standards.

Most manufacturers' products are below the max-tech level for gas wall fan DHE, which further increases the total capital and product conversion costs over TSL 3. At TSL 4, most manufacturers would have to completely redesign their gas wall fan products and purchase new tooling. The discrepancy between the number of unit shipments and the number of product lines requiring significant product development to meet the potential energy conservation standards is a large driver of the negative impacts at TSL 4. When faced with these substantial costs, most manufacturers would likely discontinue products in this product class or possibly exit the market altogether. In addition, at TSL 4 every manufacturer would face significant conversion costs in every product type, making it much more likely that the industry would offer far fewer products and that the industry would have fewer competitors after the compliance date of the amended standards. Besides the likelihood of multiple manufacturers discontinuing product lines or exiting the market, the large impact on INPV shows that manufacturers would also be substantially harmed if profitability were impacted for existing or redesigned products.

TSL 5 represents an improvement in efficiency from the baseline level of 74-percent AFUE to 75-percent AFUE for gas wall fan DHE, an improvement in efficiency from the baseline level of 64-percent AFUE to 70-percent AFUE for gas wall gravity units (the max-tech level), an improvement in efficiency from the baseline level of 57-percent AFUE to 58-percent AFUE for gas floor DHE (the max-tech level), and an improvement in efficiency from the baseline level of 64-percent AFUE to 83-percent AFUE (the max-tech level) for gas room DHE at the representative input rating ranges for each product type. To achieve the efficiencies required by TSL 5, DOE research suggests that manufacturers would need to use an intermittent ignition and a two-speed blower for gas wall fan DHE, use an electronic ignition for gas wall gravity DHE, use an improved heat exchanger for gas floor DHE, and use electronic ignition and a multiple heat exchanger design for gas room DHE. At TSL 5, DOE estimates the impacts on INPV to range from -\$3.8 million to -\$10.4 million, or a change in INPV of -22.74 percent to -62.40 percent. At this level, the industry cash flow is estimated to decrease by approximately 146.9 percent, to -\$0.6 million, compared to the base-case value of \$1.4 million in the year leading up to the standards.

Most traditional DHE models available on the market today are below the max-tech level for gas wall gravity and gas room DHE, which leads to higher total capital and product conversion costs and more negative impacts on INPV at TSL 5 than TSL 4. DOE research suggests that at TSL 5, most manufacturers would have to completely redesign and buy new tooling in order to offer gas wall gravity and gas room products at these efficiency levels. The small number of unit shipments and the large number of product lines that would require significant product development to meet the energy conservation standards is a large driver of the negative impacts at TSL 5. Hence, the potential number of product lines being discontinued and the number of manufacturers exiting the market at TSL 5 would be expected to be greater than at TSL 4, with even greater repercussions on consumer choice, employment, and competition.

TSL 6 is set at the max-tech level for all traditional DHE product classes. The efficiency requirements for gas wall gravity, gas floor, and gas room DHE are the same at TSL 6 as at TSL 5. However, TSL 6 also represents an improvement from 75-percent to 80-percent AFUE for gas wall fan DHE (the max-tech level). To achieve the max-tech level for gas wall fan DHE, DOE research suggests that manufacturers would need to use an electronic ignition and induced draft.

As to the other products, DOE anticipates that manufacturers would need to use an electronic ignition for gas wall gravity DHE, use an improved heat exchanger for gas floor DHE, and use electronic ignition and a multiple heat exchanger design for gas room DHE. At the max-tech TSL (TSL 6), DOE estimates the INPV impacts to range from -$3.9 million to -$13.4 million, or a change in INPV of -23.65 percent to -80.85. At this level, the industry cash flow is estimated to decrease by approximately 174.1 percent to -$1.0 million, compared to the base-case value of $1.4 million in the year leading up to the standards. Most products currently available are below the max-tech level for all product classes. At the max-tech level, most manufacturers would be faced with complete product redesigns for almost all product lines and significant plant changes to remain in the market. Most manufacturers would be expected to discontinue products or exit the market altogether. Due to the low volume of shipments in the industry, it unlikely that any manufacturer could offer close to the range of products currently offered today. Hence, some product classes may cease to be commercially available. It is very likely that multiple manufacturers would exit the market at the max-tech level for every product class.

12.8.2.2 Gas Hearth Direct Heating Equipment

TSL 1 through TSL 3 represents an improvement in efficiency from the baseline level of 64-percent AFUE to 67-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. To reach 67-percent AFUE from baseline efficiency, manufacturers would likely use an electronic ignition. At TSL 1 through TSL 3, DOE estimates the impacts on INPV to range from -$0.2 million to -$0.9 million, or a change in INPV of -0.30 percent to -1.22 percent. At this level, the industry cash flow is estimated to decrease by approximately 32.5 percent, to $0.5 million, compared to the base-case value of $0.7 million in the year leading up to the standards. Most manufacturers offer multiple products that meet this efficiency level. Because there are so many product lines at the baseline efficiency, however, there could be fairly substantial product conversion costs at this TSL because manufacturers would have to recertify all of the baseline products after slight modification. In addition, some manufactures could be required to make other minor changes to their production lines to accommodate other improvements such as additional baffling. DOE research suggests that such changes may be inexpensive since they would not require the industry to replace major hard tooling at TSL 1 through TSL 3. Because of the small change in product costs at TSL 1 through TSL 3, it is unlikely that manufacturer profitability would decrease appreciably to maintain the existing shipments.

TSL 4 and TSL 5 represent an improvement in efficiency from the baseline level of 64-percent AFUE to 72-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. DOE research suggests that fan-assisted gas hearth DHE products could reach 72-percent AFUE from baseline efficiency. At TSL 4 and TSL 5, DOE estimates the impacts on INPV to range from $1.6 million to -$13.2 million, or a change in INPV of 2.04 percent to -17.13 percent. At this level, the industry cash flow is estimated to decrease by approximately 85.2 percent, to $0.1 million, compared to the base-case value of $0.7 million in the year leading up to the standards. At TSL 4 and TSL 5, gas hearth manufacturers would likely reduce the scope of their product offerings to lower the required conversion costs to comply with the energy conservation standard. Many of the smaller manufacturers could consider exiting the market when faced with fairly substantial product and capital conversion costs that are not justified by their shipment volumes. Much of the capital conversion costs are expected to involve changes to handle new materials like additional insulation and baffling, changes to the heat shields, and new stamping dies for many manufacturers that need to greatly alter their existing designs. Manufacturers will also incur additional product conversion costs for product development and certification because most products currently sold would not meet the efficiency requirements of TSL 4 and TSL 5. While most of the changes above the baseline require manufacturers to purchase or manufacture more costly components that increase MPC, the resulting higher MSPs also concerned manufacturers. Manufacturers stated that the market is very price sensitive, so any increase in unit price could invariably lead to fewer sales. Hence, manufacturers expect that the industry would have to lower its profit margins in order to reduce shipments impacts that could result from cost increases related to potential energy efficiency improvements.

TSL 6 represents an improvement in efficiency from the baseline level of 64-percent AFUE to 93-percent AFUE for gas hearth DHE at the 27,000 Btu/h to 46,000 Btu/h representative input rating range. To reach 93-percent AFUE from the baseline efficiency, manufacturers would need to use a condensing design. At the max-tech TSL (TSL 6), DOE estimates the impacts on INPV to range from $8.6 million to -$53.6 million, or a change in INPV of 11.09 percent to -63.49 percent. At this level, the industry cash flow is estimated to decrease by approximately 551.2 percent, to -$3.1 million, compared to the base-case value of $0.7 million in the year leading up to the standards.

At TSL 6, manufacturers indicated they would greatly reduce the scope of their product offerings to lower the required costs to comply with an amended energy conservation standard at this level. Because there are very few products on the market today that use this technology, the product development costs greatly increase at this TSL. DOE research suggests that manufacturers would likely need a secondary heat exchanger at the max-tech level, which could alter the size and structure of most existing product lines. Manufacturers expressed concern regarding their ability to use existing tooling and equipment, much of which may become obsolete when hearths have to be redesigned from the ground up to accommodate the efficiency requirements at this level. It is also very likely that many of the 10 small business manufacturers could be forced to exit the market when faced with these substantial conversion costs since they do not have the access to capital, the product development resources, or the shipment volumes to justify these conversion costs.

Manufacturers also stated that they were concerned about consumer utility issues at TSL 6. Smaller units would likely be significantly impacted at this TSL because the low inherent interior volume makes it much more difficult to accommodate a secondary heat exchanger without narrowing the area available for the logs and flame. Manufacturers also indicated that it gets progressively more difficult to imitate a natural, wood-burning flame appearance at this efficiency level, which could hurt sales and reduce consumer utility. Finally, manufacturers were concerned that the MPCs at the max-tech level are estimated to be more than double the baseline costs for the representative input rating range. In order to maintain shipments of gas hearth DHE with substantially higher costs and potential consumer utility impacts, manufacturers believe that profitability would be greatly impacted.

12.8.3 Pool Heaters

TSL 1 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 81-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 1, DOE estimates the INPV impacts to range from $0.0 million to -$0.1 million, or a change in INPV of 0.10 percent to -0.25 percent. At this level, the industry cash flow would not be expected to change from the base-case value of $2.0 million in the year leading up to the standards. Over 70 percent of current gas-fired pool heaters meet or exceed the efficiency requirements at TSL 1. DOE research suggests that changes to the heat exchanger would allow baseline products to meet TSL 1. These changes would not require major modifications to existing units, resulting in minimal impacts to manufacturers at TSL 1.

TSL 2 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 82-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 2, DOE estimates the INPV impacts to range from $0.3 to -$0.8 million, or a change in INPV of 0.54 percent to -1.72 percent. At this level, the industry cash flow is expected to decrease by approximately 5.5 percent to $1.9 million, compared to the base-case value of $2.0 million in the year leading up to the standards. Almost half of the pool heaters currently are sold at or above this efficiency level, and nearly all manufacturers make products that can achieve the efficiency required at TSL 2. DOE research suggests that minor improvements to heat exchangers and insulation surrounding the combustion chamber would need to be made to convert lower-efficiency units to this efficiency, causing manufacturers to incur small capital conversion costs. However, because the basic designs of atmospheric pool heaters that comprise the majority of current shipments remain relatively unchanged at TSL 2, there are minimal impacts on manufacturers.

TSL 3 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 83-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 3, DOE estimates the INPV impacts to range from -$0.8 to -$5.0 million, or a change in INPV of -1.72 percent to -10.22 percent. At this level, the industry cash flow is estimated to decrease by approximately 60.3 percent to $0.8 million, compared to the base-case value of $2.0 million in the year leading up to the standards. DOE research suggests that most manufacturers would have to improve product lines to reach an 83-percent thermal efficiency by using power venting technology. DOE research also suggests that while the MPCs are not expected to increase significantly, most manufacturers would incur some product and capital conversion costs to increase their production of existing lower volume products at TSL 3. TSL 3 would eliminate most common atmospheric models on the market today, which could hurt profitability if consumer demand for gas-fired pool heaters holds at its current level despite the higher production costs at this TSL.

TSL 4 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 84-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 4, DOE estimates the INPV impacts to range from -$0.3 million to -$6.6 million, or a change in INPV of -0.63 percent to -13.48 percent. At this level, the industry cash flow is estimated to decrease by approximately 64.4 percent to $0.7 million, compared to the base-case value of $2.0 million in the year leading up to the standards. Similar to TSL 3, TSL 4 would require fairly substantial capital and product conversion costs. Because this efficiency level eliminates all atmospheric models that are currently on the market and requires additional improvements over TSL 3, the capital conversion costs are even higher at TSL 4. DOE research suggests that manufacturers would have to design products that use power venting and an improve heat exchanger, which could be costly to develop. Manufacturers stated that the high component costs at TSL 4 would result in substantially higher costs for consumers. The higher production costs and conversion costs make it more likely that manufacturers' concerns about reduced profitability would be realized at TSL 4.

TSL 5 represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 86-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 5, DOE estimates the INPV impacts to range from $0.8 million to -$17.2 million, or a change in INPV of 1.61 percent to -35.05 percent. At this level, the industry cash flow is estimated to decrease by approximately 152.89 percent to -$1.1 million, compared to the base-case value of $2.0 million in the year leading up to the standards. Over 90 percent of current shipments are below this efficiency level. Manufacturers would incur a significant conversion costs at TSL 5 and would likely significantly reduce the scope of their product offerings. DOE research suggests that manufacturers would switch remaining units to sealed combustion systems and improved heat exchanger designs, adding substantial production cost and eliminating unpowered units from the market. Manufacturers believe that consumers would look for alternatives to gas-fired pool heaters or not replace failed units due to the higher product costs that would result from an amended energy conservation standard at TSL 5. Manufacturers also indicated that problems at efficiencies they consider near-condensing could force some companies to only offer fully condensing units with even greater negative paybacks for consumers. A further concern of manufacturers relates to the current installer and maintenance base for pool heaters, which would require significant additional training to be able to properly install, troubleshoot, and service increasingly complex pool heaters.

TSL 6 (max-tech level) represents an improvement in efficiency from the baseline level of 78-percent thermal efficiency to 95-percent thermal efficiency for the representative input rating of 250,000 Btu/h. At TSL 6, DOE estimates the INPV impacts to range from $7.3 million to -$38.3 million, or a change in INPV of 14.93 percent to -78.00 percent. At this level, the industry cash flow is estimated to decrease by approximately 220.5 percent to -$2.5 million, compared to the base-case value of $2.0 million in the year leading up to the standards. Almost all gas-fired pool heaters currently on the market are well below this efficiency level. Manufacturers would face significant conversion costs at TSL 6 in order to develop condensing systems or refine existing designs to achieve lower cost condensing pool heaters. DOE research suggests that heat exchanger materials would need to withstand acidic condensate created by condensing pool heaters. In light of strong concerns about consumer reaction to a substantially-increased first cost at TSL 6, manufacturers do not believe this efficiency level could be justified for residential pool heater consumers due to low usage and significantly higher costs. Manufacturers believe that consumers would not be willing to purchase such an expensive product and would either find an alternative to gas-fired pool heaters or no longer purchase a gas-fired pool heater. In addition, at TSL 6 manufacturers are also concerned about the industry's ability to educate and retrain installers and servicers of pool heaters in time for the compliance date of the standard. Condensing units with sealed combustion are more complex than the vast majority of atmospheric units on the market today and would require significant additional training for safe installation and maintenance. Manufacturers also expect product support costs to increase significantly as complexity increases the likelihood and frequency of events such as component failures and unit lockouts that would require manufacturer support and servicing, as well as increased warranty costs. Besides increasing warranty costs for manufacturers, the issues and costs associated with proper unit maintenance post-warranty could potentially cause them to switch fuel sources (e.g., switching to heat pump or solar water heaters) or abandon pool heating altogether.

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