CHAPTER 10: Economic Impact Analysis

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This chapter contains the Economic Impact Analysis (EIA) prepared to estimate the economic impacts of this rule on producers and consumers of nonroad engines, equipment, fuel and related industries. This EIA relies on the Nonroad Diesel Economic Impact Model (NDEIM), developed for this analysis, to estimate market-level changes in prices and outputs for affected engine, equipment, fuel, and application markets as well as the social costs and their distribution across economic sectors affected by the program. The basis for this analysis is provided in the Economic Impact Analysis technical support document prepared for the proposal for this rule, as updated by a technical memoranda (RTI, 2003a, RTI 2004).

This analysis is based on an earlier version of the engineering costs developed for this rule. The final cost estimates for the engine program are slightly higher ($142 million) and the final fuel costs are slightly lower ($246 million), resulting in a 30-year net present value of $27.1 billion (30 year net present values in the year 2004, using a 3% Discount Rate, $2002) or $104 million less than the engineering costs used in this analysis. We do not expect that the revised engineering costs would change the overall results of this economic impact analysis given the small portion of engine, equipment, and fuel costs to total production costs for goods and services using these inputs and given the inelastic value of the estimated demand elasticities for the application markets.

The first section of this chapter briefly describes the methodology we used to estimate the economic impacts of this rule and presents an overview of the results. According to this analysis, this rule would be highly beneficial to society, with a net present value of social costs of about $27.2 billion, compared to net present value benefits through 2036 of $780 billion (30 year net present values in the year 2004 using 3% discount rate, $2002). The impact of these costs on society should be minimal, with the average price of goods and services produced using equipment and fuel affected by the final rule expected to increase by about 0.1 percent. The second section of this chapter presents a more detailed description of the economic methodology behind the NDEIM and certain modeling assumptions. The third section describes the markets included in the model and data inputs as well as the solution algorithm. Finally, the appendices to this chapter contain detailed results, additional information on the model, and a sensitivity analysis.

10.1 Overview and Results

10.1.1 What is an Economic Impact Analysis?

An Economic Impact Analysis is prepared to inform decision makers within the Agency about the potential economic consequences of a regulatory action. The analysis contains estimates of the social costs of a regulatory program and explores the distribution of these costs across stakeholders. These estimated social costs can then be compared with estimated social benefits (as presented in Chapter 9). As defined in EPA's *Guidelines for Preparing Economic*

Analyses (EPA 2000, p. 113), *social costs* are the value of the goods and services lost by society resulting from a) the use of resources to comply with and implement a regulation and b) reductions in output. In this analysis, social costs are explored in two steps. In the first step, called the *market analysis*, we estimate how prices and quantities of good directly and indirectly affected by the emission control program can be expected to change once the emission control program goes into effect. The estimated price and quantity changes for engines, equipment, fuel, and goods produced using these inputs are examined separately. In the second step, called the *economic welfare analysis*, we look at the total social costs associated with the program and their distribution across stakeholders.

10.1.2 What Methodology Did EPA Use in this Economic Impact Assessment?

The Nonroad Diesel Economic Impact Model (NDEIM) developed for this EIA estimates how producers and consumers can be expected to respond to the regulatory compliance costs associated with this rule. The NDEIM uses a multi-market analysis framework that considers interactions between regulated markets and other markets to estimate how compliance costs can be expected to ripple through these markets. The analysis provides an estimate of the average increase in price and decrease in quantity of output produced for the markets examined. It also allows us to estimate the social costs of the rule and identify how the various groups of affected stakeholders will bear them. The economic theory on which the NDEIM is based is described in Section 10.2. Market characteristics, compliance costs, and other data used in the NDEIM are described in Section 10.3.

The NDEIM tracks average price and quantity changes for 62 integrated product markets. Figure 10.1-1 illustrates the connections between the industry segments included in the model and the flow of regulatory compliance costs through the economic system. The rule will increase the cost of producing nonroad diesel engines. Engine manufacturers are expected to attempt to pass some or all of their direct compliance costs on to equipment manufacturers in the form of higher diesel engine prices. Similarly, equipment manufacturers are expected to attempt to pass some or all of their direct compliance costs (in the form of equipment redesign costs) and indirect compliance costs (in the form of increased engine costs) to application market producers through higher diesel equipment prices. Petroleum refiners are also expected to attempt to pass some or all of their direct compliance costs on to application market producers and to the locomotive and marine transportation service sectors through higher prices for diesel fuel. Finally, application market producers are expected to pass on some or all of their increased equipment and diesel fuel costs to consumers of final application market products and services. It is the interaction of suppliers and purchasers in each of the markets that determines the extent to which prices and quantities of goods produced change in response to the compliance costs associated with the rule. The amount of the compliance costs that can be passed on is affected by the price sensitivity of purchasers in the relevant market. The NDEIM explicitly models market linkages and behavioral responses and estimates new equilibrium prices and output and the resulting distribution of social costs across affected stakeholders.

Diesel engines, equipment, and fuel represent only a small portion of the total production costs for each of the three application market sectors (the final users of the engines, equipment and fuel affected by this rule). Other more significant production costs include land, labor, other capital, raw materials, insurance, profits, etc. These other production costs are not affected by

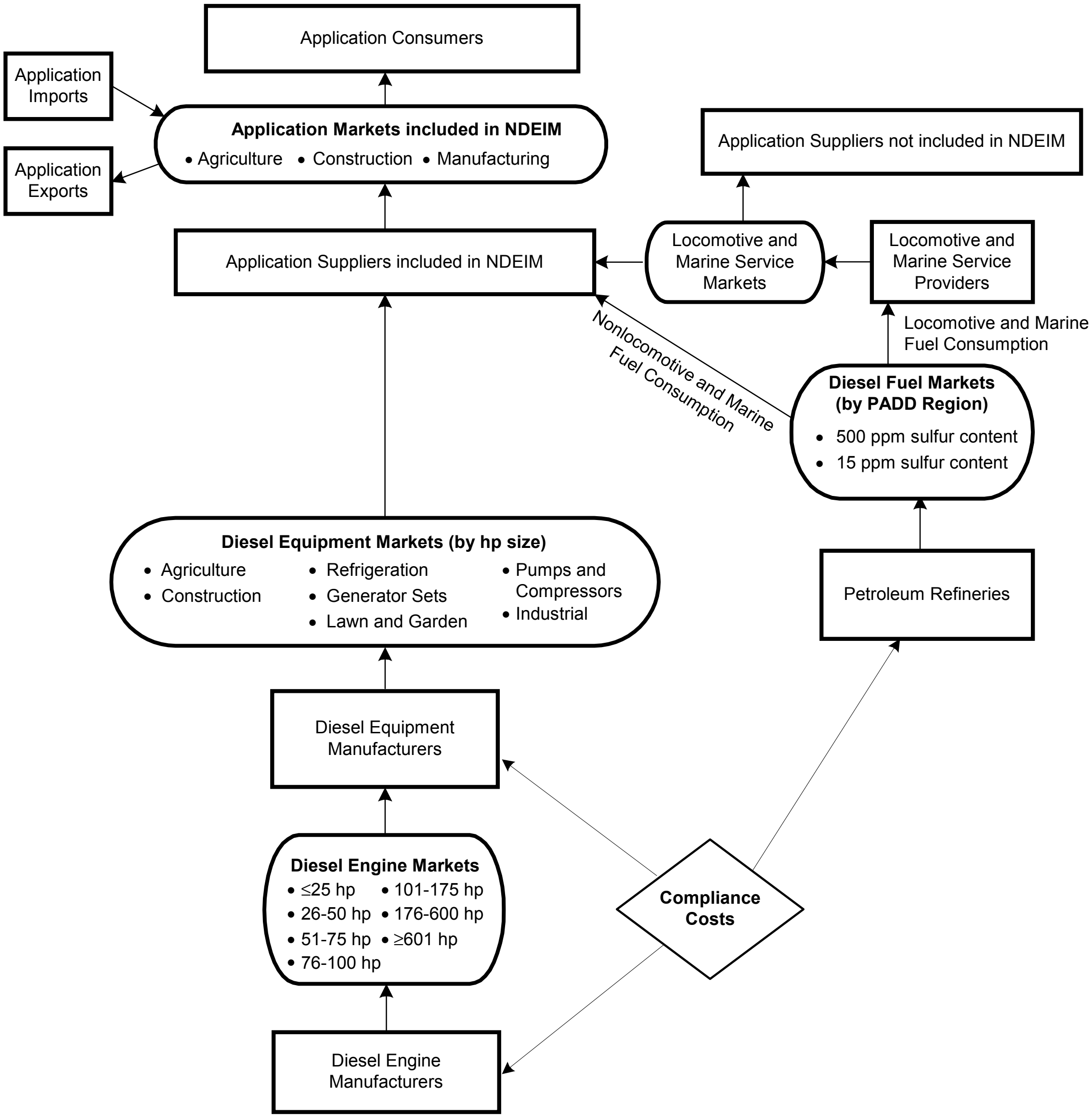

Figure 10.1-1. Market Linkages Included in the Economic Model

this emission control program. This is important because it means that this rule directly affects only a small part of total inputs for the relevant markets. Therefore, rule is not expected to have a large adverse impact on output and prices of goods produced in the three application sectors.

10.1.3 What are the key features of the NDEIM?

10.1.3.1 Brief Description of the NDEIM

The NDEIM is a computer model comprised of a series of spreadsheet modules that define the baseline characteristics of supply and demand for the relevant markets and the relationships between them. The basis for this analysis is provided in the EIA technical support document, as updated by a technical memo (RTI, 2003a, RTI 2004). The model methodology, as explained in Section 10.2.2, is firmly rooted in applied microeconomic theory and was developed following the *OAQPS Economic Analysis Resource Document* (EPA, 1999). The NDEIM uses a multi-market partial equilibrium approach to track changes in price and quantity for the modeled product markets. As explained in the *EPA Guidelines for Preparing Economic Analyses* (EPA 2000, 125-6; see also Section 10.2.2, below), 'partial' equilibrium refers to the fact that the supply and demand functions are modeled for just one or a few isolated markets and that conditions in other markets are assumed either to be unaffected by a policy or unimportant for social cost estimation. Multi-market models go beyond partial equilibrium analysis by extending the inquiry to more than just a single market. Multi-market analysis attempts to capture at least some of the interactions between markets.

The NDEIM uses an intermediate run time frame and assumes perfect competition in the market sectors. These model features are explained in Sections 10.2.3.1 and 10.2.3.2. The use of the intermediate run means that some factors of production are fixed and some are variable. This modeling period allows analysis of the economic effects of the rule's compliance costs on current producers. The short run, in contrast, imposes all compliance costs on the manufacturers (no pass-through to consumers), while the long run imposes all costs on consumers (full cost pass-through to consumers). The perfect competition assumption is appropriate given the number of firms and other key characteristics for each market (no indications of barriers to entry; the firms are not price setters; there is no evidence of high levels of strategic behavior in the price and quantity decisions of the firms; the products produced within each market are somewhat homogeneous in that engines from one firm can be purchased instead of engines from another firm; see Section 10.2.3.1, below). The use of the intermediate run time frame and the assumption of perfect competition are based on widely accepted economic practice for this type of analysis (see for example EPA, 2000, p. 126).

The NDEIM is constructed based on the market characteristics and inter-connections described in this chapter. The model is shocked by applying the engineering compliance cost estimates to the appropriate market suppliers, and then numerically solved using an iterative auctioneer approach by "calling out" new prices until a new equilibrium is reached in all markets simultaneously. The output of the model is new equilibrium prices and quantities for all affected markets. This information is used to estimate the social costs of the model and how those costs are shared among affected markets.

10.1.3.2 Product Markets Included in the Model

There are 62 integrated product markets included in the model, as follows:

- 7 diesel engine markets: less than 25 hp, 26 to 50 hp, 51 to 75 hp, 76 to 100 hp, 101 to 175 hp, 176 to 600 hp, and greater than 600 hp. The EIA includes more horsepower categories than the standards to allow more efficient use of the engine compliance costs estimates. The additional categories also allow estimating economic impacts for a more diverse set of markets.
- 42 diesel equipment markets: 7 horsepower categories within 7 application categories: agricultural, construction, general industrial, pumps and compressors, generator and welder sets, refrigeration and air conditioning, and lawn and garden. There are 7 horsepower/application categories that did not have sales in 2000 and are not included in the model, so the total number of diesel equipment markets is 42 rather than 49.
- 3 application markets: agricultural, construction, and manufacturing.
- 8 nonroad diesel fuel markets: 2 sulfur content levels (15 ppm and 500 ppm) for each of 4 PADDs. PADDs 1 and 3 are combined for the purpose of this analysis. It should be noted that PADD 5 includes Alaska and Hawaii. Also, California fuel volumes that are not affected by the program (because they are covered by separate California nonroad diesel fuel standards) are not included in the analysis.
- 2 transportation service markets: locomotive and marine.

Table 10.1-1 summarizes the characteristics of each of these five groups of markets. More detailed information on NDEIM model inputs in provided in Section 10.3.

Table 10.1-1
Summary of Markets in Nonroad Diesel Economic Impact Model (NDEIM)

Model Dimension	Markets (number)				
	Diesel Engines (7)	Diesel Equipment (42)	Diesel Fuel (8)	Application (3)	Locomotive and Marine Transportation Sectors (2)
Geographic scope	National	National	Regional by PADDs	National	National
Product groupings	7 horsepower categories consistent with emission standards[a]	7 horsepower categories within seven application categories[b,c]	2 diesel fuels by sulfur content (500, 15 ppm) for 4 regional markets[d]	Three broad commodity categories[e]	2: rail and marine transportation services
Market structure	Perfectly competitive	Perfectly competitive	Perfectly competitive	Perfectly competitive	Perfectly competitive
Baseline population	Power Systems Research (PSR) database for 2000 as modified by EPA	Assume one-to-one relationship with engine population[f]	Based on Energy Information Administration (EIA) 2000 fuel consumption data	Value of shipments for 2000 from U.S. Census Bureau	Service expenditures, BEA. 1997 Benchmark I-O Supplementary Make, Use and Direct Requirements Tables at the Detailed Level, Table 4
Growth projections	Growth rates used in cost analysis; see Section 8.1	Growth rates used in cost analysis; see Section 8.1	Based on nonroad model and EIA	Average of equipment growth rates consumed by these markets	EPA's SO_2 inventory projections for marine engines that use diesel distillate fuel (50-state annual inventory, 1999-2003)
Supply elasticity	Econometric estimate (elastic)	Econometric estimate (elastic)	Published econometric estimate (inelastic)	Published econometric estimate (inelastic)	Published econometric estimate (elastic)
Demand elasticity	Derived demand	Derived demand	Derived demand	Econometric estimate (inelastic)	Derived demand
Regulatory shock	Direct compliance costs cause shift in supply function	Direct compliance costs and higher diesel engine prices cause shift in supply function	Direct compliance costs cause shift in supply function	No direct compliance costs but higher prices for diesel equipment and fuel cause shift in supply function	No direct compliance costs but higher prices for diesel fuel cause shift in supply function

[a] Horsepower categories are 0-25, 26-50, 51-75, 76-100, 101-175, 176-600, and 601 hp and greater; the EIA includes more horsepower categories than the standards, allowing more efficient use of the engine compliance cost estimates.

[b] Engine categories are agricultural, construction, pumps and compressors, generator and welder sets, refrigeration and air conditioning, general industrial, and lawn and garden.

[c] There are seven horsepower/application categories that do not have sales in 2000 and are not included in the model. These are: agricultural equipment >600 hp; gensets & welders > 600 hp; refrigeration & A/C > 71 hp (4 hp categories); and lawn & garden >600 hp. Therefore, the total number of diesel equipment markets is 42 rather than 49.

[d] PADDs 1 and 3 are combined for the purpose of this analysis). Note that PADD 5 includes Alaska and Hawaii. Also, California fuel volumes that are not affected by the program (because they are covered by separate California nonroad diesel fuel standards) are not included in the analysis.

[e] Application market categories are construction, agriculture, and manufacturing.

[f] See Section 10.3.1 for an explanation of how the engines were allocated to the seven categories.

Analysis of the three application markets is limited to market output. The economic impacts on particular groups of application market suppliers (e.g., the profitability of farm production units or manufacturing or construction firms) or particular groups of consumers (e.g., households and companies that consume agricultural goods, buildings, or durable or consumer goods) are not estimated. In other words, while we estimate that the application markets will bear most of the burden of the regulatory program and we apportion the decrease in application market surplus between application market producers and application market consumers, we do not estimate how those social costs will be shared among specific application market producers and consumers (e.g., farmers and households). In some cases, application market producers may be able to pass most if not all of their increased costs to the ultimate consumers of their products; in other cases, they may be obliged to absorb a portion of these costs. The focus on market-level impacts in this analysis is appropriate because the standards in this emission control program are technical standards that apply to nonroad engines, equipment, and fuel regardless of how they are used and the structure of the program does not suggest that different sectors will be affected differently by the requirements.

10.1.3.3 Supply and Demand Elasticities

The estimated social costs of this emission control program are a function of the ways in which producers and consumers of the engines, equipment, and fuels affected by the standards change their behavior in response to the costs incurred in complying with the standards. As the compliance costs ripple through the markets, producers and consumers change their production and purchasing decisions in response to changes in prices. In the NDEIM, these behavioral changes are modeled by the demand and supply elasticities (behavioral-response parameters), which measure the price sensitivity of consumers and producers.

The supply elasticities for the equipment, engine, diesel fuel, and transportation service markets and the demand and supply elasticities for the application markets used in the NDEIM were obtained from peer-reviewed literature sources or were estimated using econometric methods. These econometric methods are well-documented and are consistent with generally accepted econometric practice. Details on sources and estimation method are provided in Section 10.3 and Appendix 10H.

The equipment and engine supply elasticities are elastic, meaning that quantities supplied are expected to be fairly sensitive to price changes. This means that manufacturers are more likely (better able) to change production levels in response to price changes.

The supply elasticities for the fuel, transportation service, and the supply and demand elasticities for the three application markets are inelastic or unit elastic, meaning that the quantity supplied/demanded is expected to be fairly insensitive to price changes or will vary one-to-one with price changes. For the agricultural application market, the inelastic supply and demand elasticities reflect the relatively constant demand for food products and the high fixed cost nature of food production. For the construction and manufacturing application markets, the estimated demand and supply elasticities are less inelastic, because consumers have more flexibility to substitute away from construction and manufactured products and producers have more flexibility to adjust production levels. The estimated supply elasticity for the diesel fuel market is inelastic, reflecting the fact that most refineries operate near capacity and are therefore less responsive to fluctuations in market prices. Note that these elasticities reflect intermediate run behavioral changes. In the long run, supply and demand are expected to be more elastic since more substitutes may become available.

The inelastic values for the demand elasticities for the application markets are consistent with the Hicks-Allen derived demand relationship, according to which a low cost-share in production combined with limited substitution yields inelastic demand.[A] As noted above, diesel engines, equipment, and fuel represent only a small portion of the total production costs for each of the three application sectors. The limited ability to substitute for these inputs is discussed in Section 10.2.3.4.

Because the elasticity estimates are a key input to the model, a sensitivity analysis for supply and demand elasticity parameters was performed as part of this EIA. The results are presented in Appendix 10I. In general, varying the elasticity values across the range of values reported in the literature or using the upper and lower bounds of a 90 percent confidence interval around estimated elasticities has no impact on the magnitude of the total social costs and only a minimal impact on the distribution of costs across stakeholders. This is not surprising because equipment and diesel fuel costs are a relatively small share of total production costs in the construction, agriculture, and manufacturing industries.

In contrast to the above, the demand elasticities for the engine, equipment, fuel, and transportation markets are internally derived as part of the process of running the model. This is an important feature of the NDEIM, which allows it to link the separate market components of the model and simulate how compliance costs can be expected to ripple through the affected economic sectors. In the real world, for example, the quantity of nonroad equipment units produced in a particular period depends on the price of engines (the engine market) and the demand for equipment (the application markets). Similarly, the number of engines produced depends on the demand for engines (the equipment market) which depends on the demand for equipment (the application markets). Changes in conditions in one of these markets will affect the others. By designing the model to derive the engine, equipment, transportation market, and fuel demand elasticities, the NDEIM simulates these connections between supply and demand among all the product markets and replicates the economic interactions between producers and consumers.

10.1.3.4 Fixed and Variable Costs

Engines and Equipment. The EIA treats the fixed costs expected to be incurred by engine and equipment manufacturers differently in the market and social costs analyses. This feature of

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[A] If the elasticity of demand for a final product is less than the elasticity of substitution between an input and other inputs to the final product, then the demand for the input is less elastic the smaller its cost share. Hicks, J.R., 1961, 1963.

the model is described in greater detail in Section 10.2.3.3. In the market analysis, estimated engine and equipment market impacts (changes in prices and quantities) are based solely on the expected increase in variable costs associated with the standards. Fixed costs are not included in the market analysis reported in Table 10.1-2 because in an analysis of competitive markets the industry supply curve is based on its marginal cost curve and fixed costs are not reflected in changes in the marginal cost curve. In addition, the fixed costs associated with the rule are primarily R&D costs for design and engineering changes. Firms in the affected industries currently allocate funds for R&D programs and this rule is not expected to lead firms to change the size of their R&D budget. Therefore, changes in fixed costs for engine and equipment redesign associated with this rule are not likely to affect the prices of engines or equipment. These fixed costs are reported in the social cost analysis reported in Table 10.1-4, however, as an additional cost to producers. This is appropriate because even though firms currently allocated funds to R&D those resources are intended for other purposes such as increasing engine power, ease of use, or comfort. These improvements will therefore be postponed for the length of the rule-related R&D program. This is a cost to society.

It may be the case, however, that some firms will maintain their current R&D budget and allocate additional funds to comply with the this rule. Therefore, a sensitivity analysis was performed as part of this EIA in which fixed costs are included in intermediate-run decision-making. The results of this sensitivity analysis are presented in Appendix 10.I. In this scenario, including fixed costs in the model results in a transfer of economic welfare losses from engine and equipment markets to the application markets (engine and equipment producer surplus losses decrease; consumer surplus losses increase), but does not change the overall social costs associated with the rule.

Fuels. Unlike for engines and equipment, most of the petroleum refinery fixed costs are for production hardware. Refiners are expected to have to make physical changes to their refineries and purchase additional equipment to produce 500 ppm and then 15 ppm fuel. Therefore, fixed costs are included in the market analysis for fuel price and quantity impacts.

10.1.3.5 Compliance Costs

Engine and Equipment Compliance Costs. The NDEIM uses the engine and equipment compliance costs described in Chapter 6. Engine and equipment costs vary over time because fixed costs are recovered over five to ten year periods while total variable costs, despite learning effects that serve to reduce costs on a per unit basis, continue to increase at a rate consistent with new sales increases. Similarly, engine operating costs also vary over time because oil change maintenance savings, PM filter maintenance, and fuel economy effects, all of which are calculated on the basis of gallons of fuel consumed, change over time consistent with the growth in nationwide fuel consumption.

The relative magnitude of engine and equipment compliance costs is expected to have a predictable relationship on market prices and quantities. Generally, the estimated price increases and quantity reductions for engines and equipment are expected to vary depending on the magnitude of compliance costs relative to total engine or equipment costs. In general, higher (lower) price increases are expected as a result of a high (low) relative level of compliance costs to market price. The change in price is also expected to be highest when compliance costs are highest.

Fuel Compliance Costs. The NDEIM uses the fuel compliance costs described in Chapter 7. Fuel-related compliance costs (costs for refining and distributing regulated fuels) also change over time. These changes are more subtle than the engine costs, however, as the fuel provisions are largely implemented in discrete steps instead of phasing in over time. Compliance costs were developed on a ¢/gallon basis; total compliance costs are determined by multiplying the ¢/gallon costs by the relevant fuel volumes. Therefore, total fuel costs increase as the demand for fuel increases. The variable operating costs are based on the natural gas cost of producing hydrogen and for heating diesel fuel for the new desulfurization equipment, and thus would fluctuate along with the price of natural gas.

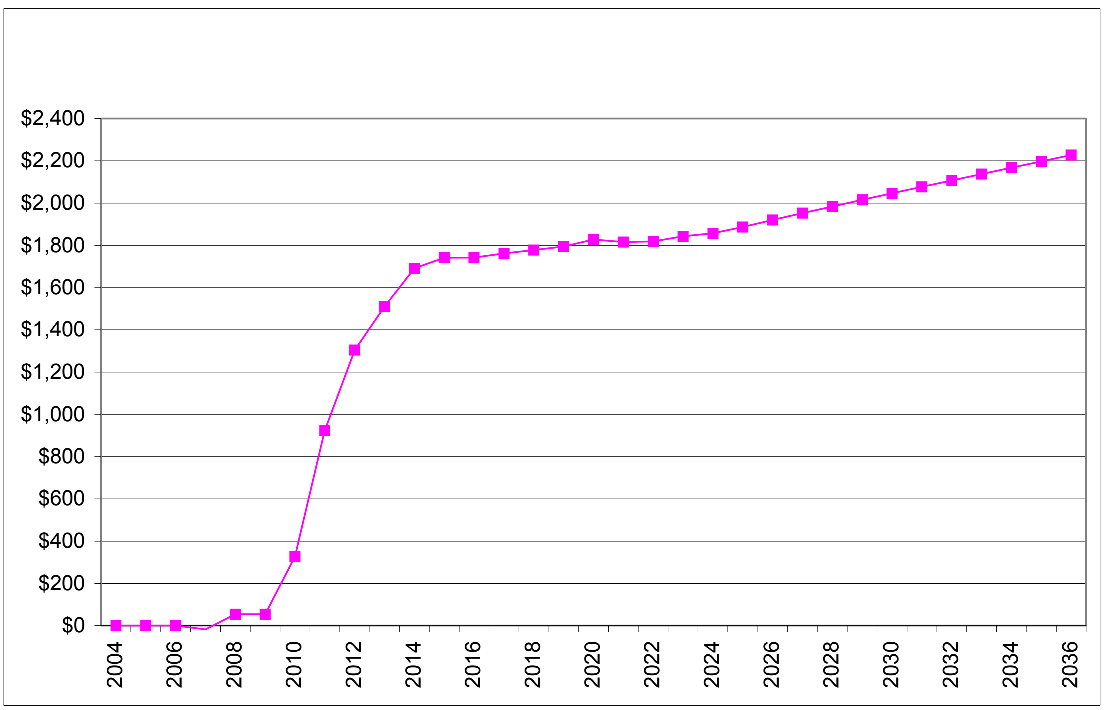
10.1.3.6 Other NDEIM Features

Substitution. In modeling the market impacts and social costs of this rule, the NDEIM considers only diesel equipment and fuel inputs to the production of goods in the applications markets. It does not explicitly model alternate production inputs that would serve as substitutes for new nonroad equipment or nonroad diesel fuel. In the model, market changes in the final demand for application market goods and services directly correspond to changes in the demand for nonroad equipment and fuel (i.e., in normalized terms there is a one-to-one correspondence between the quantity of the final goods produced and the quantity of nonroad diesel equipment and fuel used as inputs to that production). We believe modeling the market in this manner is economically sound and reflects the general experience for the nonroad market. Section 10.2.3.4 describes several alternative means of production that could serve as substitutes for new nonroad equipment and fuel and explains why they are not included in the NDEIM.

Operating Savings. Operating savings refers to changes in operating costs that are expected to be realized by users of both existing and new nonroad diesel equipment as a result of the reduced sulfur content of nonroad diesel fuel. These include operating savings (cost reductions) due to fewer oil changes, which accrue to nonroad, marine and locomotive engines that are already in use as well as new nonroad engines that will comply with the standards (see Section 6.2.3). These also include any extra operating costs associated with the new PM emission control technology which may accrue to certain new engines that use this technology. Operating savings are not included in the market analysis because some of the savings accrue to existing engines and because, as explained in Chapter 6, these savings are not expected to affect consumer decisions with respect to new engines. Operating savings are included in the social cost analysis, however, because they accrue to society. They are added into the estimated social costs as an additional savings to the application and transportation service markets, since it is the users of these engines and fuels who will see these savings. A sensitivity analysis was performed as part of this EIA that includes the operating savings in the market analysis. The results of this sensitivity analysis are presented in Appendix 10.I.

Fuel Marker Costs. Fuel marker costs refers to costs associated with marking high sulfur heating oil to distinguish it from high sulfur diesel fuel produced after 2007 through the use of early sulfur credits or small refiner provisions. Only heating oil sold outside of the Northeast is affected. The higher sulfur NRLM fuel is not allowed to be sold in most of the Northeast, so the marker need not be added in this large heating oil market. These costs are expected to be about $810,000 in 2007, increasing to $1.38 million in 2008, but steadily decreasing thereafter to about $940,000 in 2040 (see Chapter 10 of the RIA). Because these costs are relatively small, they are incorporated into the estimated compliance costs for the fuel program (see discussion of fuel costs, above). They are therefore not counted separately in this economic impact analysis. This means that the costs of marking heating fuel are allocated to all users of the fuel affected by this rule (nonroad, locomotive, and marine) instead of uniquely to heating oil users. This is a reasonable approach since it is likely that refiners will pass the marker costs along their complete nonroad diesel product line and not just to heating oil.

Figure 10.1-2
Heating Oil Marker Costs ($Million, $2002)



Fuel Spillover. Spillover fuel is highway grade diesel fuel consumed by nonroad equipment, stationary diesel engines, boilers, and furnaces. As described in 7.1, refiners are expected to produce more 15 ppm fuel than is required for the highway diesel market. This excess 15 ppm fuel will be sold into markets that allow fuel with a higher sulfur level (i.e., nonroad for a limited period of time, locomotive, marine diesel and heating oil). This spillover fuel is affected by the diesel highway rule and is not affected by this regulation. Therefore, it is important to differentiate between spillover and nonspillover fuel to ensure that the compliance costs for that fuel pool are not counted twice. In the NDEIM, this is done by incorporating the impact of increased fuel costs associated with the highway rule prior to analysis of the final nonroad rule (see Section 10.3.8).

Compliance Flexibility Provisions. Consistent with the engine and equipment cost discussion in Chapter 6, the EIA does not include any cost savings associated with the equipment transition flexibility program or the nonroad engine ABT program. As a result, the results of this EIA can be viewed as somewhat conservative.

Locomotive and Marine Fuel Costs. The locomotive and marine transportation sectors are affected by this rule through the sulfur limits on the diesel fuel used by these engines. These sectors provide transportation to the three application markets as well as to other markets not considered in the NDEIM (e.g., public utilities, nonmanufacturing service industries, government). As explained in Section 10.3.1.5, the NDEIM applies only a portion of the locomotive and marine fuel costs to the three application markets. The rest of the locomotive and marine fuel costs are added as a separate item to the total social cost estimates (as Application Markets Not Included in NDEIM).

10.1.4 Summary of Economic Analysis

Economic impact results for 2013, 2020, 2030, and 2036 are presented in this section. The first of these years, 2013, corresponds to the first year in which the standards affect all engines, equipment, and fuels. It should be noted that, as illustrated in Table 10.1-3, aggregate program costs peak in 2014; increases in costs after that year are due to increases in the population of engines over time. The other years, 2020, 2030 and 2036, correspond to years analyzed in our benefits analysis. Detailed results for all years are included in the appendices for this chapter.

In the following discussion, social costs are computed as the sum of market surplus offset by operating savings. Market surplus is equal to the aggregate change in consumer and producer surplus based on the estimated market impacts associated with the rule. As explained above, operating savings are not included in the market analysis but instead are listed as a separate category in the social cost results tables.

In considering the results of this analysis, it should be noted that the estimated output quantities for diesel engines, equipment, and fuel are not identical to those estimated in the engineering cost discussions in Chapters 6 and 7. The difference is due to the different methodologies used to estimate these costs. As noted above, social costs are the value of goods and services lost by society resulting from a) the use of resources to comply with and implement a regulation (i.e., compliance costs) and b) reductions in output. Thus, the social cost analysis considers both price and output (quantity) effects associated with consumer and producer reaction to increased prices associated with the regulatory compliance costs. The engineering cost analysis, on the other hand, is based on applying additional technology to comply with the new regulations. The engine population in the engineering cost analysis does not adjust to reflect consumer and producer reactions to the compliance costs. Consequently, the estimated output quantities from the cost analysis are slightly larger than the estimated output quantities from the social cost analysis.

10.1.4.1 What are the Rule's Expected Market Impacts?

The estimated market impacts for 2015, 2020, 2030, and 2036 are presented in Table 10.1-2. The market-level impacts presented in this table represent production-weighted averages of the individual market-level impact estimates generated by the model: the average expected price increase and quantity decrease across all of the units in each of the engine, equipment, fuel, and final application markets. For example, the model includes seven individual engine markets that reflect the seven different horsepower size categories. The 21.4 percent price change for engines shown in Table 10.1-2 for 2013 is an average price change across all engine markets weighted by the number of production units. Similarly, the equipment impacts presented in Table 10.1-2 are the weighted averages of 42 equipment-application markets, such as small (< 25hp) agricultural equipment and large (>600hp) industrial equipment. Note that price increases and quantity decreases for specific types of engines, equipment, application sectors, or diesel fuel markets are likely to be different. The aggregated data presented in this table provide a broad overview of the expected market impacts that is useful when considering the impacts of the rule on the economy as a whole. Individual market-level impacts are presented in Appendix 10A through Appendix 10D.[B]

The market impacts of this rule suggest that the overall economic impact on society is expected be small, on average. With regard to the market analysis, the average price of goods and services produced using affected equipment and fuel is expected to increase by less than 0.1 percent despite the high level of cost pass-through to those markets.

Engine Market Results: This analysis suggests that most of the variable costs associated with the rule will be passed along in the form of higher prices. The average price increase in 2013 for engines is estimated to be about 21.4 percent. This percentage is expected to decrease to about 18.3 percent by 2020. In 2036, the last year considered, the average price increase is expected to be about 18.2 percent. This expected price increase varies by engine size because compliance costs are a larger share of total production costs for smaller engines. In 2013, the largest expected percent price increase is for engines between 25 and 50 hp: 29 percent or $850; the average price for an engine in this category is about $2,900. However, this price increase is expected to drop to 22 percent, or about $645, for 2015 and later. The smallest expected percent

[B]The NDEIM distinguishes between "merchant" engines and "captive" engines. "Merchant" engines are produced for sale to another company and are sold on the open market to anyone who wants to buy them. "Captive" engines are produced by a manufacturer for use in its own nonroad equipment line (this equipment is said to be produced by "integrated" manufacturers). The market analysis for engines includes compliance costs for merchant engines only. The market analysis for equipment includes equipment compliance costs plus a portion of the engine compliance costs attributable to captive engines.

price increase in 2013 is for engines in the greater than 600 hp category. These engines are expected to see price increases of about 3 percent increase in 2013, increasing to about 7.6 percent in 2015 and then decreasing to about 6.6 percent in 2017 beyond. The expected price increase for these engines is about $2,240 in 2013, increasing to about $6,150 in 2015 and then decreasing to $5,340 in 2017 and later, for engines that cost on average about $80,500.

The market impact analysis predicts that even with these increased in engine prices, total demand is not expected to change very much. The expected average change in quantity is less than 150 engines per year, out of total sales of more than 500,000 engines. The estimated change in market quantity is small because as compliance costs are passed along the supply chain they become a smaller share of total production costs. In other words, firms that use these engines and equipment will continue to purchase them even at the higher cost because the increase in costs will not have a large impact on their total production costs (diesel equipment is only one factor of production for their output of construction, agricultural, or manufactured goods).

Equipment Market Results: Estimated price changes for the equipment markets reflect both the direct costs of the new standards on equipment production and the indirect cost through increased engine prices. In general, the estimated percentage price changes for the equipment are less than that for engines because the engine is only one input in the production of equipment. In 2013, the average price increase for nonroad diesel equipment is estimated to be about 2.9 percent. This percentage is expected to decrease to about 2.5 percent for 2020 and beyond. The range of estimated price increases across equipment types parallels the share of engine costs relative to total equipment price, so the estimated percentage price increase among equipment types also varies. For example, the market price in 2013 for agricultural equipment between 175 and 600 hp is estimated to increase about 1.2 percent, or $1,740 for equipment with an average cost of $143,700. This compares with an estimated engine price increase of about $1,700 for engines of that size. The largest expected price increase in 2013 for equipment is $2,290, or 2.6 percent, for pumps and compressors over 600 hp. This compares with an estimated engine price increase of about $2,240 for engines of that size. The smallest expected price increase in 2013 for equipment is $120, or 0.7 percent, for construction equipment less than 25 hp. This compares with an estimated engine price increase of about $120 for engines of that size.

Again, the market analysis predicts that even with these increased equipment prices total demand is not expected to change very much. The expected average change in quantity is less than 250 pieces of equipment per year, out of a total sales of more than 500,000 units. The average decrease in the quantity of nonroad diesel equipment produced as a result of the regulation is estimated to be about 0.02 percent for all years. The largest expected decrease in quantity in 2013 is 18 units of construction equipment per year for construction equipment between 100 and 175 hp, out of about 63,000 units. The smallest expected decrease in quantity in 2013 is less than one unit per year in all hp categories of pumps and compressors.

It should be noted that the absolute change in the number of engines and equipment does not match. This is because the absolute change in the quantity of engines represents only engines sold on the market. Reductions in engines consumed internally by integrated engine/equipment manufacturers are not reflected in this number but are captured in the cost analysis.

Table 10.1-2
Summary of Market Impacts ($2002)

Market	Engineering Cost	Change in Price		Change in Quantity	
	Per Unit	Absolute ($million)	Percent	Absolute	Percent
2013					
Engines	$1,052	$821	21.4	–79[a]	–0.014
Equipment	$1,198	$975	2.9	–139	–0.017
Loco/Marine Transp[b]			0.009		–0.007
Application Markets[b]			0.097		–0.015
No. 2 Distillate Nonroad	$0.06	$0.07	6.0	–2.75[c]	–0.019
2020					
Engines	$950	$761	18.3	–98[a]	–0.016
Equipment	$1,107	$976	2.5	–172	–0.018
Loco/Marine Transp[b]			0.01		–0.008
Application Markets[b]			0.105		–0.017
No. 2 Distillate Nonroad	$0.07	$0.07	7.0	–3.00[c]	–0.021
2030					
Engines	$937	$751	18.2	–114[a]	–0.016
Equipment	$968	$963	2.5	–200	–0.018
Loco/Marine Transp[b]			0.010		–0.008
Application Markets[b]			0.102		–0.016
No. 2 Distillate Nonroad	$0.07	$0.07	7.0	–3.53[c]	–0.022
2036					
Engines	$931	$746	18.2	–124[a]	–0.016
Equipment	$962	$956	2.5	–216	–0.018
Loco/Marine Transp[b]			0.010		–0.008
Application Markets[b]			0.101		–0.016
No. 2 Distillate Nonroad	$0.07	$0.07	7.0	–3.85[c]	–0.022

[a] The absolute change in the quantity of engines represents only engines sold on the market. Reductions in engines consumed internally by integrated engine/equipment manufacturers are not reflected in this number but are captured in the cost analysis. For this reason, the absolute change in the number of engines and equipment does not match.
[b] The model uses normalized commodities in the application markets because of the great heterogeneity of products. Thus, only percentage changes are presented.
[c] Units are in million of gallons.

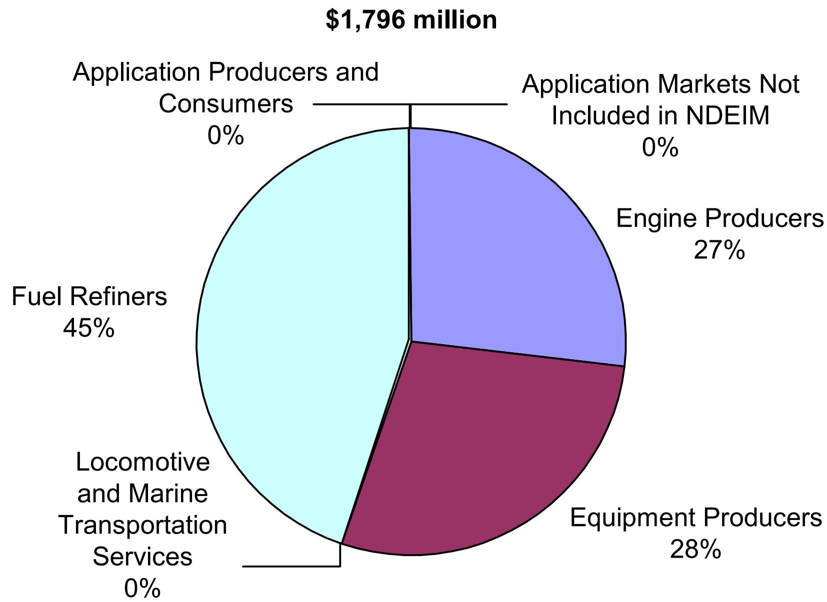
Transportation Market Results: The estimated price increase associated with the proposed standards in the locomotive and marine transportation markets is negligible, at 0.01 percent for all years. This means that these transportation service providers are expected to pass along nearly all of their increased costs to the agriculture, construction, and manufacturing application markets, as well as other application markets not explicitly modeled in the NDEIM. This price increases represent a small share of total application market production costs, and therefore are not expected to affect demand for these services.

Application Market Results: The estimated price increase associated with the new standards in all three application markets is very small and averages about 0.1 percent for all years. In other words, on average, the prices of goods and services produced using the affected engines, equipment, and fuel are expected to increase negligibly. This results from the observation that compliance costs passed on through price increases represent a very small share of total production costs in all the application markets. For example, the construction industry realizes an increase in production costs of approximately $580 million in 2013 because of the price increases for diesel equipment and fuel. However, this represents less than 0.001 percent of the $820 billion value of shipments in the construction industry in 2000. The estimated average commodity price increase in 2013 ranges from 0.08 percent in the manufacturing application market to about 0.5 percent in the construction application market. The percentage change in output is also estimated to be very small and averages less than 0.02 percent for all years. Note that these estimated price increases and quantity decreases are average for these sectors and may vary for specific subsectors. Also, note that absolute changes in price and quantity are not provided for the application markets in Table 10.1-2 because normalized commodity values are used in the market model. Because of the great heterogeneity of manufactured or agriculture products, a normalized commodity ($1 unit) is used in the application markets. This has no impact on the estimated percentage change impacts but makes interpretation of the absolute changes less informative.

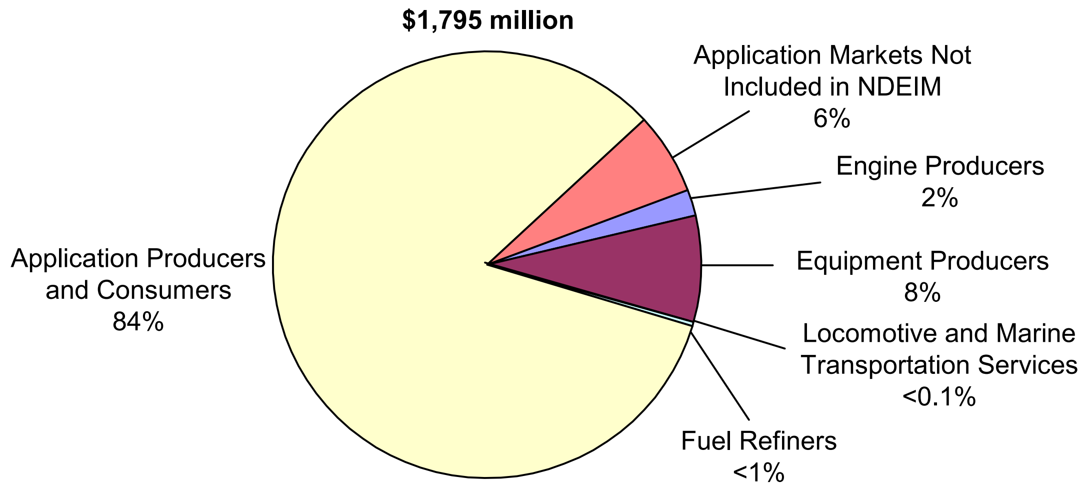
Fuel Markets Results: The estimated average price increase across all nonroad diesel fuel is about 7 percent for all years. For 15 ppm fuel, the estimated price increase for 2013 ranges from 5.6 percent in the East Coast region (PADD 1&3) to 9.1 percent in the mountain region (PADD 4). The average national output decrease for all fuel is estimated to be about 0.02 percent for all years, and is relatively constant across all four regional fuel markets.

10.1.4.2 What are the Rule's Expected Social Costs?

Social costs include the changes in market surplus estimated by the NDEIM and changes in operating costs associated with the regulation. Table 10.1-3 shows the time series of engineering compliance costs and social cost estimates for 2004 through 2036. As shown, these estimates for engineering and social costs are of similar magnitude for each year of the analysis. However, the compliance costs are distributed differently than the social costs. As illustrated in Figure 10.1-3a, engineering compliance costs are distributed evenly across engine, equipment, and fuel producers. However, as illustrated in Figure 10.1-3b, the social costs that result from those compliance costs are borne mostly by producers and consumers in the application markets (about 84 percent when the operating savings are not considered) due to the increased prices for diesel engines, equipment, and fuel. This means that engine, equipment, and fuel producers are expected to be able to pass on most of their compliance costs. Specifically, engine producers are expected to be able to pass on about 91.3 percent their compliance costs through higher prices. The remaining 8.7 percent are primarily fixed R&D costs that are internalized by engine manufacturers and not passed into the market. Equipment manufacturers are expected to retain a slightly higher share of compliance costs (28.5 percent) because they have greater fixed costs. Diesel fuel refiners are expected to pass about 99 percent of their compliance costs on to the application producers and consumers because, as discussed in Chapter 6, refiners pass both fixed and variable costs into the market.



a) Engineering Cost Distribution[a]



b) Social Cost Distribution[a]

Figure 10.1-3. Comparing the Distribution of Engineering Compliance Costs with Social Cost Estimates by Industry (2013)

[a] Costs do not include operating cost savings, which represent negative $285 million in costs (i.e., benefits).

Table 10.1-3
National Engineering Compliance Costs and
Social Costs Estimates for the Rule (2004 - 2036)($2002; $Million)

Year	Engineering Compliance Costs	Total Social Costs
2004	$0	$0
2005	$0	$0
2006	$0	$0
2007	($17)	($18)
2008	$54	$54
2009	$54	$54
2010	$328	$327
2011	$923	$922
2012	$1,305	$1,304
2013	$1,511	$1,510
2014	$1,691	$1,690
2015	$1,742	$1,741
2016	$1,743	$1,743
2017	$1,763	$1,762
2018	$1,778	$1,778
2019	$1,795	$1,795
2020	$1,829	$1,828
2021	$1,816	$1,815
2022	$1,819	$1,818
2023	$1,844	$1,843
2024	$1,858	$1,857
2025	$1,888	$1,887
2026	$1,921	$1,920
2027	$1,954	$1,952
2028	$1,985	$1,984
2029	$2,017	$2,016
2030	$2,047	$2,046
2031	$2,078	$2,077
2032	$2,108	$2,107
2033	$2,139	$2,137
2034	$2,169	$2,167
2035	$2,198	$2,197
2036	$2,228	$2,227
NPV at 3%	$27,247	$27,232
NPV at 7%	$13,876	$13,868

Figure 10.1-4 shows the time series of total social costs from 2004 through 2036. Social costs increase rapidly between 2007 and 2014 as engine, equipment and fuel costs are phased into the regulation. Estimated net annual social costs (including operating savings) in 2014 are about $1,690 million. After 2014, per unit compliance costs decrease as fixed costs are depreciated. However, due to growth in engine and equipment sales and related fuel consumption, net social costs are expected continue to increase, but at a slower rate, from 2015 to 2036. The estimated net present value of social costs over the time period 2004 through 2036 based on a social discount rate of 3 percent is reported in Table 10.1-3 and is about $27.2 billion. The present value over this same period based on a social discount rate of 7 percent is about $13.9 billion. As shown in Table 10.1-3, these results suggest that total engineering costs exceed compliance costs by a small amount. This is due primarily to the fact that the estimated output quantities for diesel engines, equipment, and fuel are not identical to those estimated in the engineering cost analysis, which is due to the different methodologies used to estimate these costs (see previous discussion in this Section 10.1.4).

Estimated social costs are disaggregated by market in Table 10.1-4, for 2015, 2020, 2030, and 2036. A more detailed time series from 2007 to 2030 provided is in Appendix 10E. The data in Table 10.1-4 shows that in 2013, social costs are expected to be about $1,510 million ($2002). About 83 percent of the total social costs is expected to be borne by producers and consumers in the application markets in 2013, indicating that the majority of the compliance costs associated with the rule are expected to be passed on in the form of higher prices. When these estimated impacts are broken down, about 58.5 percent of the social costs are expected to be borne by consumers in the application markets and about 41.5 percent are expected to be borne by producers in the application markets. Equipment manufacturers are expected to bear about 9.5 percent of the total social costs. Engine manufacturers and diesel fuel refineries are expected to bear 2.8 percent and 0.5 percent, respectively. The remaining 4.2 percent of the social costs is expected to be borne by the locomotive and marine transportation service sector. In this last sector, about 97 percent of the gross decrease in market surplus is expected to be borne by the application markets that are not included in the NDEIM but that use these services (e.g., public utilities, nonmanufacturing service industries, government) while about 3 percent is expected to be borne by locomotive and marine service providers. Because of the way the NDEIM is structured, with the fuel savings added separately, the results imply that locomotive and marine service provides would see net benefits from the rule due to the operating savings associated with low sulfur fuel. In fact, they are likely to pass along some or all of those operating savings to the users of their services, reducing the size of the welfare losses for those users.

Total social costs continue to increase over time and are projected to be about $2,046 million by 2030 and $2,227 million in 2036 ($2002). The increase is due to the projected annual growth in the engine and equipment populations. Producers and consumers in the application markets are expected to bear an even larger portion of the costs, approximately 96 percent. This is consistent with economic theory, which states that, in the long run, all costs are passed on to the consumers of goods and services.

Table 10.1-4

Summary of Social Costs Estimates Associated with Primary Program
2015, 2020, 2030, and 2036 ($2002, $Million)[a,b]

2013				
	Market Surplus ($$10^6$)	Operating Savings ($$10^6$)	Total	Percent
Engine Producers Total	**$42.0**		**$42.0**	**2.8%**
Equipment Producers Total	**$143.1**		**$143.1**	**9.5%**
Construction Equipment	$64.0		$64.0	
Agricultural Equipment	$51.8		$51.8	
Industrial Equipment	$27.2		$27.2	
Application Producers & Consumers Total	**$1,496.7**	**($243.2)**	**$1,253.5**	**83.0%**
Total Producer	*$620.9*			*41.5%*
Total Consumer	*$875.7*			*58.5%*
Construction	$584.3	($115.2)	$469.2	
Agriculture	$430.0	($78.2)	$351.8	
Manufacturing	$482.4	($49.8)	$432.5	
Fuel Producers Total	**$8.0**		**$8.0**	**0.5%**
PADD I&III	$4.1		$4.1	
PADD II	$3.3		$3.3	
PADD IV	$0.0		$0.0	
PADD V	$0.6		$6.0	
Transportation Services, Total	**$104.9**	**($41.5)**	**$63.4**	**4.2%**
Locomotive	$1.6	($12.4)	($10.8)	
Marine	$0.9	($9.9)	($9.0)	
Application markets not included in NDEIM	$102.4	($19.2)	$83.2	
Total	**$1,794.7**	**($284.7)**	**$1,510.0**	**100.0%**

2020				
	Market Surplus ($$10^6$)	Operating Savings ($$10^6$)	Total	Percent
Engine Producers Total	**$0.1**		**$0.1**	**0.0%**
Equipment Producers Total	**$122.7**		**$122.7**	**6.7%**
Construction Equipment	$57.8		$57.8	
Agricultural Equipment	$39.7		$39.7	
Industrial Equipment	$25.2		$25.2	
Application Producers & Consumers Total	**$1,826.1**	**($192.3)**	**$1,633.8**	**89.4%**
Total Producer	*$762.2*			*41.7%*
Total Consumer	*$1,063.8*			*58.3%*
Construction	$744.0	($91.1)	$653.0	
Agriculture	$524.3	($61.8)	$462.5	
Manufacturing	$557.8	($39.4)	$518.3	
Fuel Producers Total	**$11.2**		**$11.2**	**0.6%**
PADD I&III	$5.6		$5.6	
PADD II	$4.6		$4.6	

PADD IV	$0.2		$0.2	
PADD V	$0.8		$0.8	
Transportation Services, Total	**$95.7**	**($35.1)**	**$60.6**	**3.3%**
Locomotive	$2.0	($7.2)	($5.2)	
Marine	$1.1	($11.6)	($10.5)	
Application markets not included in NDEIM	$92.6	($16.3)	$76.3	
Total	**$2,055.7**	**($227.4)**	**$1,828.3**	**100.0%**
	2030			
Engine Producers Total	**$0.1**		**$0.1**	**0.0%**
Equipment Producers Total	**$5.9**		**$5.9**	**0.3%**
Construction Equipment	$4.0		$4.0	
Agricultural Equipment	$1.9		$1.9	
Industrial Equipment	$0.1		$0.1	
Application Producers & Consumers Total	**$2,112.3**	**($154.2)**	**$1,958.1**	**95.7%**
Total Producer	*$882.2*			*41.7%*
Total Consumer	*$1,230.1*			*58.3%*
Construction	$863.8	($73.0)	$790.8	
Agriculture	$606.8	($49.6)	$557.2	
Manufacturing	$641.6	($31.6)	$610.0	
Fuel Producers Total	**$13.2**		**$13.2**	**0.6%**
PADD I&III	$6.7		$6.7	
PADD II	$5.2		$5.2	
PADD IV	$0.3		$0.3	
PADD V	$1.0		$1.0	
Transportation Services, Total	**$109.1**	**($39.9)**	**$69.2**	**3.4%**
Locomotive	$2.5	($7.8)	($5.3)	
Marine	$1.4	($13.6)	($12.2)	
Application markets not included in NDEIM	$105.2	($18.5)	$86.7	
Total	**$2,240.6**	**($194.1)**	**$2,046.4**	**100.0%**
	2036			
	Market Surplus ($$10^6$)	Operating Savings ($$10^6$)	Total	Percent
Engine Producers Total	**$0.2**		**$0.2**	**0.0%**
Equipment Producers Total	**$6.4**		**$6.4**	**0.3%**
Construction Equipment	$4.3		$4.3	
Agricultural Equipment	$2.0		$2.0	
Industrial Equipment	$0.1		$0.1	
Application Producers & Consumers Total	**$2,287.4**	**($155.7)**	**$2,131.7**	**95.7%**
Total Producer	*$955.5*			*41.7%*

Total Consumer	*$1,331.9*			*58.3%*
Construction	$936.4	($50.0)	$862.7	
Agriculture	$657.8	($73.7)	$607.8	
Manufacturing	$693.2	($31.9)	$661.3	
Fuel Producers Total	**$14.5**		**$14.5**	**0.7%**
PADD I&III	$7.3		$7.3	
PADD II	$5.8		$5.8	
PADD IV	$0.3		$0.3	
PADD V	$1.0		$1.0	
Transportation Services, Total	**$116.9**	**($42.6)**	**$74.3**	**3.3%**
Locomotive	$2.8	($8.2)	($5.4)	
Marine	$1.6	($14.6)	($13.0)	
Application markets not included in NDEIM	$112.5	($19.8)	$92.7	
Total	**$2,425.3**	**($198.4)**	**$2,227.0**	**100.0%**

[a] Figures are in 2002 dollars.

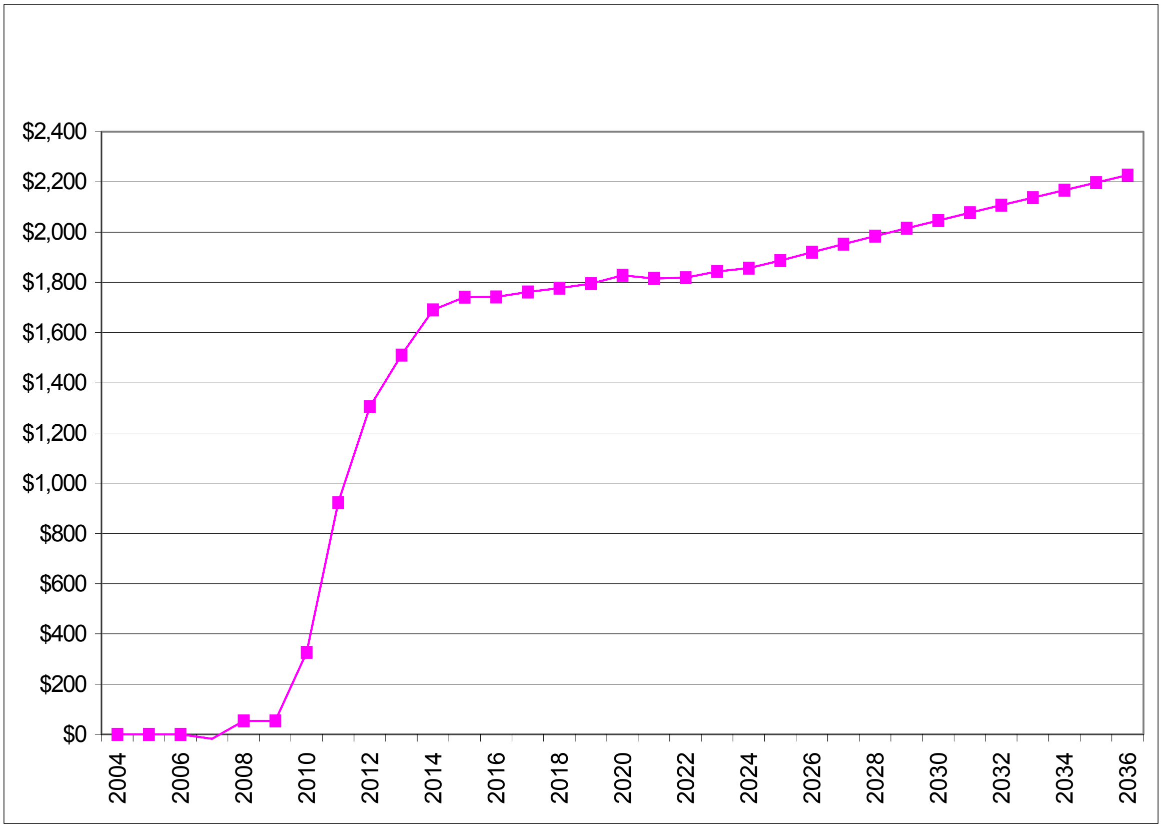
[b] Operating savings are shown as negative costs.

Table 10.1-5
Summary of Social Costs Estimates Associated with Primary Program:
NPV, 3%, 2004-2036 ($million)[a,b]

	Market Surplus ($$10^6$)	Operating Savings ($$10^6$)	Total	Percent
Engine Producers Total	**$256.0**		**$256.0**	**0.9%**
Equipment Producers Total	**$1,162.0**		**$1,162.0**	**4.3%**
Construction Equipment	$545.0		$545.0	
Agricultural Equipment	$397.0		$397.0	
Industrial Equipment	$220.0		$220.0	
Application Producers & Consumers Total	**$28,429.0**	**($3,757.0)**	**$24,672.0**	**90.6%**
Total Producer	*$11,838.0*			*41.6%*
Total Consumer	*$16,591.0*			*58.4%*
Construction	$11,526.0	($1,779.0)	$9,746.0	
Agriculture	$8,181.0	($1,208.0)	$6,973.0	
Manufacturing	**$8,723.0**	**($770.0)**	**$7,953.0**	
Fuel Producers Total	**$169.0**		**$169.0**	**0.6%**
PADD I&III	$85.0		$85.0	
PADD II	$69.0		$69.0	
PADD IV	$3.0		$3.0	
PADD V	$12.0		$12.0	
Transportation Services Total	**$1,653.0**	**($679.0)**	**$973.0**	**3.6%**
Locomotive	$31.0	($160.0)	($129.0)	
Marine	$18.0	($204.0)	($187.0)	
Application markets not included in NDEIM	$1,604.0	($315.0)	$1,228.0	
Total	**$31,669.0**	**($4,437.0)**	**$27,232.0**	**100.0%**

[a] Figures are in 2002 dollars.
[b] Operating savings are shown as negative costs.

Figure 10.1-4
Total Social Costs (2004-2036; $2002; $Million)



10.2 Economic Methodology

Economic impact analysis uses a combination of theory and econometric modeling to evaluate potential behavior changes associated with a new regulatory program. As noted above, the goal is to estimate the impact of the regulatory program on producers and consumers. This is done by creating a mathematical model based on economic theory and populating the model using publically available price and quantity data. A key factor in this type of analysis is estimating the responsiveness of the quantity of engines, equipment, and fuels demanded by consumers or supplied by producers to a change in the price of that product. This relationship is called the elasticity of demand or supply. This section discusses the economic theory underlying the modeling for this EIA and several key issues that affect the way the model was developed.

10.2.1 Behavioral Economic Models

Models incorporating different levels of economic decision making can generally be categorized as *with*-behavior responses or *without*-behavior responses (engineering cost analysis). Engineering cost analysis is an example of the latter and provides detailed estimates of the cost of a regulation based on the projected number of affected units and engineering estimates of the annualized costs.

The behavioral approach builds on the engineering cost analysis and incorporates economic theory related to producer and consumer behavior to estimate changes in market conditions. Owners of affected plants are economic agents that can make adjustments, such as changing production rates or altering input mixes, that will generally affect the market environment in which they operate. As producers change their production levels in response to a regulation, consumers are typically faced with changes in prices that cause them to alter the quantity that they are willing to purchase. These changes in price and output from the market-level impacts are used to estimate the distribution of social costs between consumers and producers.

Generally, the behavioral approach and engineering cost approach yield approximately the same total cost impact. However, the advantage of the behavioral approach is that it illustrates how the costs flow through the economic system and identifies which stakeholders, producers, and consumers are most affected.

10.2.2 Conceptual Economic Approach

This EIA models basic economic relationships between supply and demand to estimate behavioral changes expected to occur as a result of the rule. An overview of the basic economic theory used to develop the model to estimate the potential effect of the rule on market outcomes is presented in this section. Following the *OAQPS Economic Analysis Resource Document* (EPA, 1999), standard concepts in microeconomics are used to model the supply of affected products and the impacts of the regulations on production costs and the operating decisions.

10.2.2.1 Types of Models: Partial vs. General Equilibrium Modeling Approaches

In the broadest sense, all markets are directly or indirectly linked in the economy; thus, the rule will affect all commodities and markets to some extent. The appropriate level of market interactions to be included in an EIA is determined by the number of industries directly affected by the requirements and the ability of affected firms to pass along the regulatory costs in the form of higher prices. Alternative approaches for modeling interactions between economic sectors can generally be divided into three groups:

- *Partial equilibrium model*—Individual markets are modeled in isolation. The only factor affecting the market is the cost of the regulation on facilities in the industry being modeled; there are no interaction effects with other markets.
- *General equilibrium model*—All sectors of the economy are modeled together, incorporating interaction effects between all sectors included in the model. General

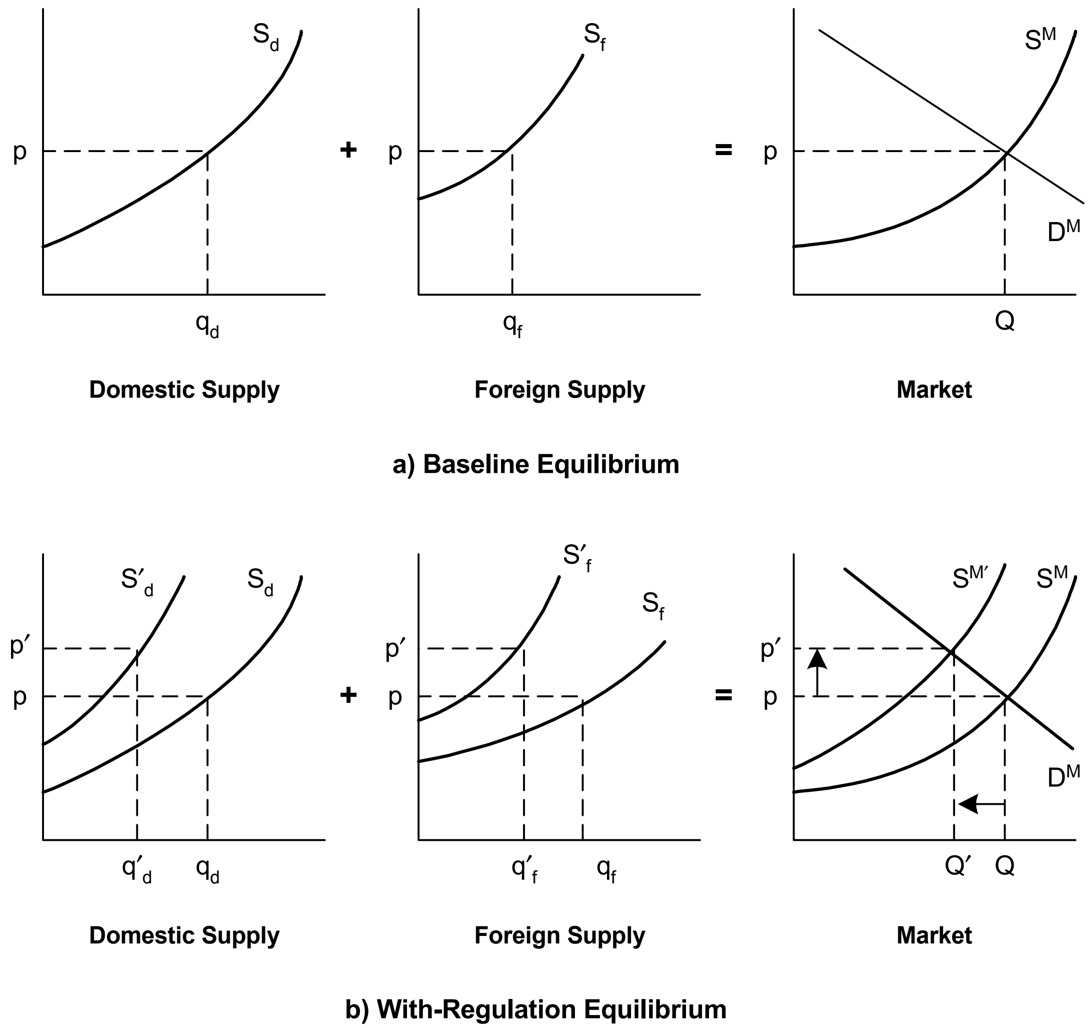
equilibrium models operationalize neoclassical microeconomic theory by modeling not only the direct effects of control costs but also potential input substitution effects, changes in production levels associated with changes in market prices across all sectors, and the associated changes in welfare economy-wide. A disadvantage of general equilibrium modeling is that substantial time and resources are required to develop a new model or tailor an existing model for analyzing regulatory alternatives.

- *Multimarket model*—A subset of related markets is modeled together, with sector linkages, and hence selected interaction effects, explicitly specified. This approach represents an intermediate step between a simple, single-market partial equilibrium approach and a full general equilibrium approach. This technique has most recently been referred to in the literature as "partial equilibrium analysis of multiple markets" (Berck and Hoffmann, 2002).

This analysis uses a behavioral multimarket framework because the benefits of increasing the dimensions of the model outweigh the cost associated with additional model detail. As Bingham and Fox (1999) note, this increased scope provides "a richer story" of the expected distribution of economic welfare changes across producers and consumers. Therefore, the NDEIM developed for this analysis consists of a spreadsheet model that links a series of standard partial equilibrium models by specifying the interactions between the supply and demand for products. Changes in prices and quantities are then solved across all markets *simultaneously*. The following markets were included in the model; their linkages are illustrated in Figure 10.2-1 and they are described in detail in Section 10.3.3 below:

- seven diesel engine markets categorized by engine size;
- 42 equipment markets, including construction, agriculture, refrigeration, lawn and garden, pumps and compressors, generators and welder sets, and general industrial equipment types—with five to seven horsepower size categories for each equipment type;
- eight fuel markets, four regions (PADDs) each with two nonroad diesel fuel markets (500 ppm and 15 ppm); and
- three application markets (construction, agriculture, and manufacturing).

Figure 10.2-1
Market Equilibrium without and with Regulation



10.2.2.2 Market Equilibrium in a Single Commodity Market

A graphical representation of a general economic competitive model of price formation, as shown in Figure 10.2-1(a), posits that market prices and quantities are determined by the intersection of the market supply and market demand curves. Under the baseline scenario, a market price and quantity (p,Q) are determined by the intersection of the downward-sloping market demand curve (D^M) and the upward-sloping market supply curve (S^M). The market supply curve reflects the sum of the domestic (S_d) and import (S_f) supply curves.

With the regulation, the costs of production increase for suppliers. The imposition of these regulatory control costs is represented as an upward shift in the supply curve for domestic and import supply, by the estimated compliance costs. As a result of the upward shift in the supply curve, the market supply curve will also shift upward as shown in Figure 10.2-1(b) to reflect the increased costs of production.

At baseline without regulation, the industry produces total output, Q, at price, p, with domestic producers supplying the amount q_d and imports accounting for Q minus q_d, or q_f. With the regulation, the market price increases from p to p′, and market output (as determined from the market demand curve) declines from Q to Q′. This reduction in market output is the net result of reductions in domestic and import supply.

10.2.2.3 Incorporating Multimarket Interactions

The above description is typical of the expected market effects for a single product market (e.g., diesel engine manufacturers) considered in isolation. However, the modeling problem for this EIA is more complicated because of the need to investigate affected equipment manufacturers and fuel producers as well as engine manufacturers.

For example, the Tier 4 standards will affect equipment producers in two ways. First, these producers are affected by higher input costs (increases in the price of diesel engines) associated with the rule. Second, the standards will also impose additional production costs on equipment producers associated with equipment changes necessary to accommodate changes in engine design.

The demand for diesel engines is directly linked to the production of diesel equipment. A single engine is typically used in each piece of equipment, and there are no substitutes (i.e., to make diesel equipment one needs a diesel engine). For this reason, it is reasonable to assume that the input-output relationship between the diesel engines and the equipment is strictly fixed and that the demand for engines varies directly with the demand for equipment.[C]

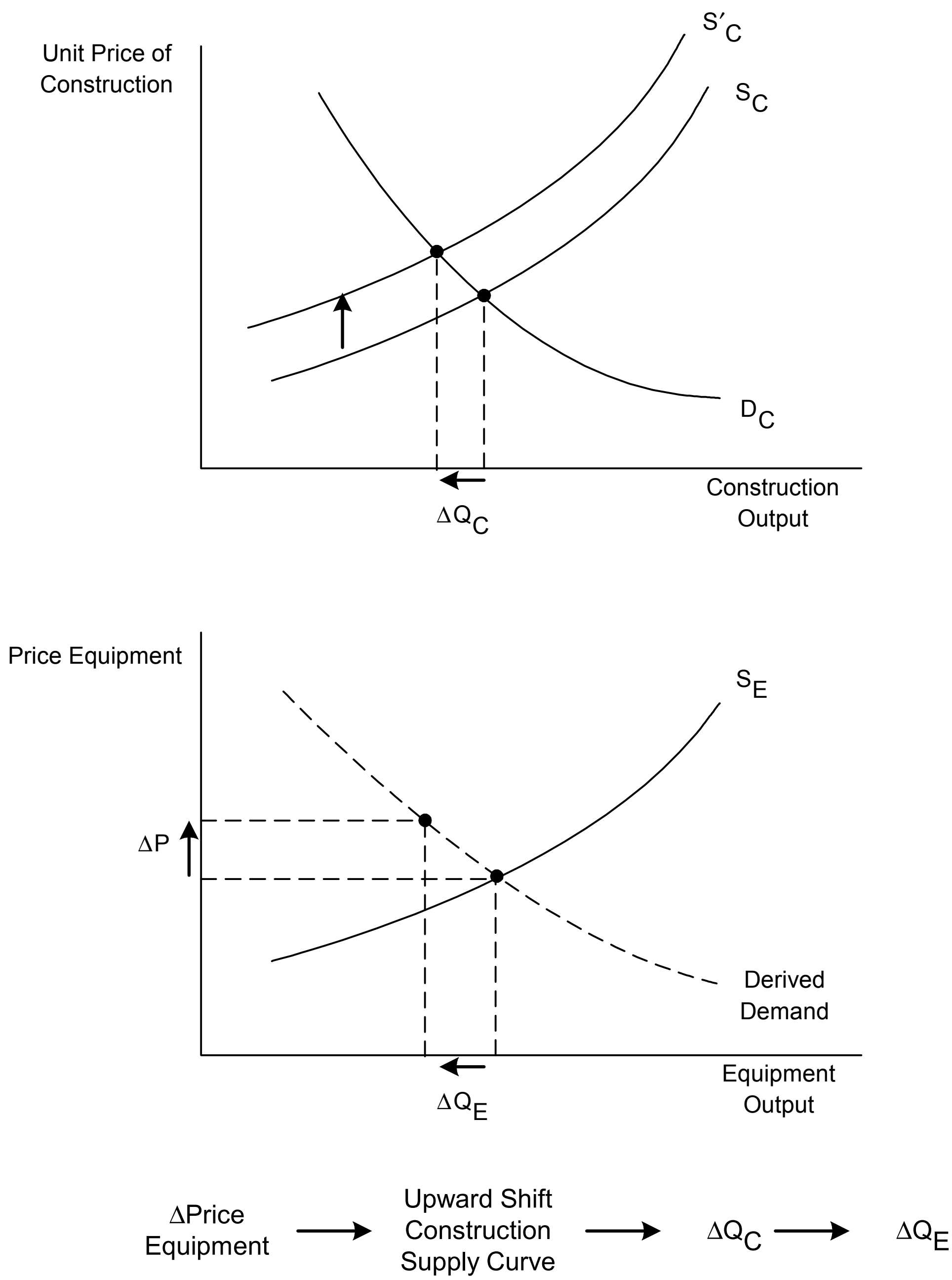
The demand for diesel equipment is directly linked to the production of final goods and services that use diesel equipment. For example, the demand for agricultural equipment depends on the final demand for agricultural products and the total price of supplying these products. Thus, any change in the price of agricultural equipment will shift the agriculture supply curve, leading to a decrease in agricultural production and hence decreased consumption of agricultural equipment. Assuming a fixed input-output relationship, the percentage change in agricultural production will equal the percentage change in agricultural equipment production.

These relationships link the demand for engines and equipment directly to the level of production of goods and services in the application markets. A demand curve specified in terms of its downstream consumption is referred to as a derived demand curve. Figure 10.2-2 graphically illustrates how a derived demand curve is identified. Consider an event in the

[C]This one-to-one relationship holds for engines sold on the market and for engines consumed internally by integrated engine/equipment manufacturers.

construction equipment market that causes the price of equipment to increase by ΔP (such as an increase in the price of engines). This increase in the price of equipment will cause the supply curve in the construction market to shift up, leading to a decreased quantity of construction activity (ΔQ_C). The change in construction activity leads to a decrease in the demand for construction equipment (ΔQ_E). The new point ($Q_E - \Delta Q_E$, $P - \Delta P$) traces out the derived demand curve. Note that the supply and demand curves in the construction applications market are needed to identify the derived demand in the construction equipment market. The construction application market supply and demand curves are functional form and elasticity parameters described in Appendix10F.

Figure 10.2-2
Derived Demand for Construction Equipment



Each point on the derived demand curve equals the construction industry's willingness to pay for the corresponding marginal input. This is typically referred to as the input's net value of marginal product (VMP), which is equal to the price of the output (P_x) times the input's marginal physical product (MPP). MPP is the incremental construction output attributable to a change in equipment inputs:

$$\text{Value Marginal Product (VMP)} = P_x * \text{MPP}.$$

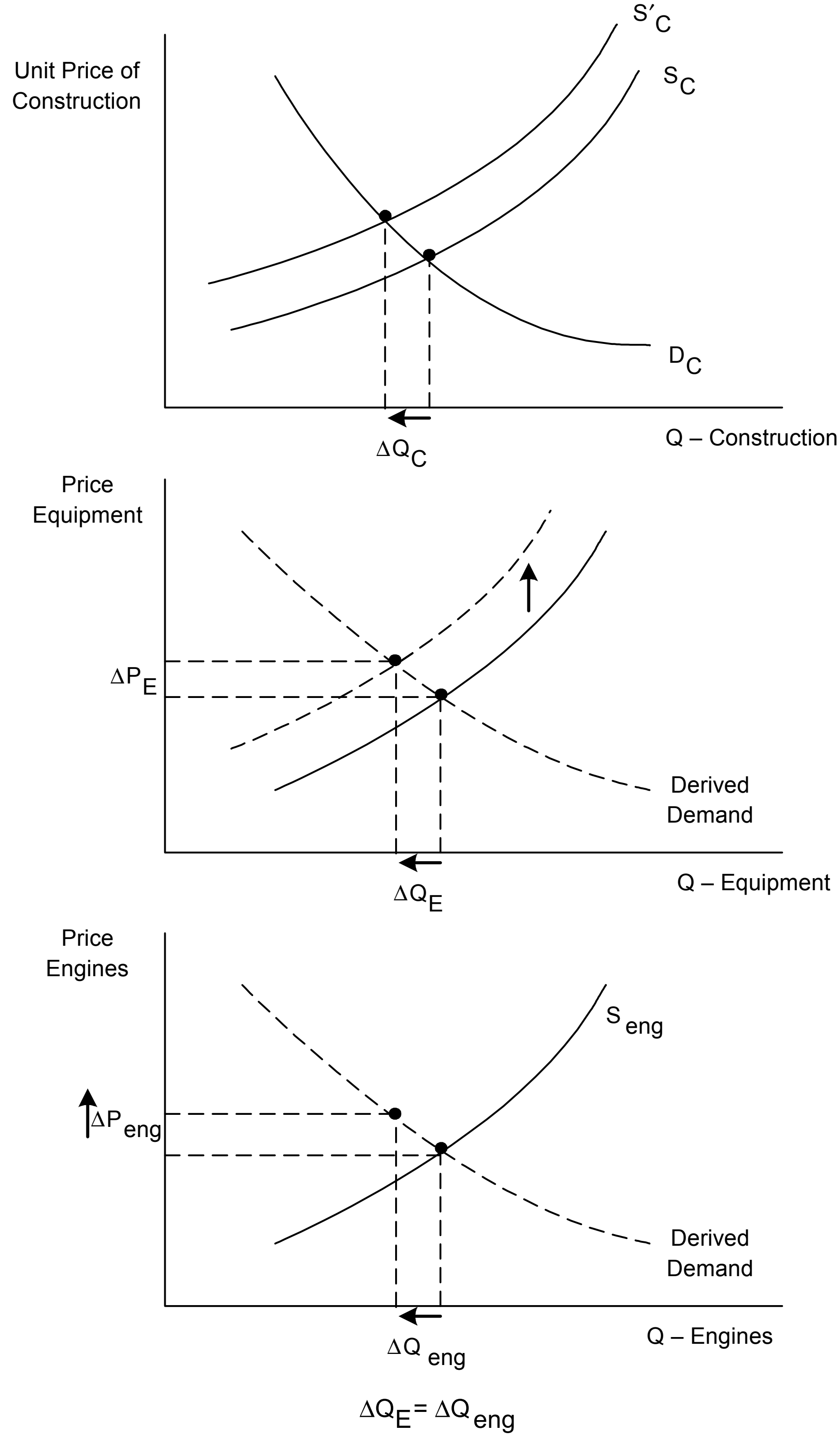
An increase in regulatory costs ©) associated with equipment will lower the VMP of all inputs, leading to a decrease in the net marginal product:

$$\text{Net Value Marginal Product} = (P_x - c) * \text{MPP}.$$

This decrease in the VMP of equipment, as price increases, is what leads the downward-sloping derived demand curve in the equipment market.

Similarly, derived demand curves are developed for the engine markets that supply the equipment markets. As shown in Figure 10.2-3, the increased price of engines resulting from regulatory costs shifts the supply curve for engines and leads to a shift in the supply curve for equipment. The resulting increased price of equipment leads to a shift in the supply curve for the construction industry, decreasing construction output. The decrease in construction output flows back through the equipment market, resulting in decreased demand for engines (ΔQeng).

Figure 10.2-3
Derived Demand for Engines



10.2.3 Key Modeling Elements

In addition to specifying the type of model used and the relationships between the markets, it is also necessary to specify several other key model characteristics. These characteristics include the degree of competition in each market, the time horizon of the analysis, and how fixed costs affect firms' production decisions. The specification of the industry/market characteristics and how regulatory costs are introduced into the model has an impact on the size and interpretation of the estimated economic impacts. These modeling issues are discussed below.

10.2.3.1 Perfect vs. Imperfect Competition

For all markets that are modeled, the analyst must characterize the degree of competition within each market. The discussion generally focuses on perfect competition (price-taking behavior) versus imperfect competition (the lack of price-taking behavior). The central issue is whether individual firms have sufficient market power to influence the market price.

Under imperfect (such as monopolistic) competition, firms produce products that have unique attributes that differentiate them from competitors' products. This allows them to limit supply, which in turn increases the market price, given the traditional downward-sloping demand curve. Decreasing the quantity produced increases the monopolist's profits but decreases total social surplus because a less than optimal amount of the product is being consumed. In the monopolistic equilibrium, the value society (consumers) places on the marginal product, the market price, exceeds the marginal cost to society (producers) of producing the last unit. Thus, social welfare is increased by inducing the monopolist to increase production.

Social cost estimates associated with a regulation are larger with monopolistic market structures because the regulation exacerbates an already existing social inefficiency of too little output from a social perspective. The Office of Management and Budget (OMB) explicitly mentions the need to consider these market power-related welfare costs in evaluating regulations under Executive Order 12866 (OMB, 1996).

However, as discussed in the industry profiles in Chapter 1, most of the diesel engine and equipment markets have significant levels of domestic and international competition. Even in markets where a few firms dominate the market, there is significant excess capacity enabling competitors to quickly respond to changes in price. In addition, there are no indications of barriers to entry, the firms in these markets are not price setters, and there is no evidence of high levels of strategic behavior in the price and quantity decisions of the firms. Also, the products produced within each market are somewhat homogeneous in that engines from one firm can be purchased instead of engines from another firm. Finally, according to contestable market theory, oligopolies and even monopolies will behave very much like firms in a competitive market if it is possible to enter particular markets costlessly (i.e., there are no sunk costs associated with market entry or exit).[D] With regard to the nonroad engine market, production capacity is not fully utilized. This means that manufacturers could potentially switch their product line to compete in another segment of the market without a significant investment. For these reasons, for the nonroad diesel rule analysis, it is assumed that within each modeled engine and equipment market the commodities of interest are similar enough to be considered homogeneous (e.g., perfectly substitutable) and that the number of buyers and sellers is large enough so that no individual buyer or seller has market power or influence on market prices (i.e., perfect competition). As a result of these conditions, producers and consumers take the market price as given when making their production and consumption choices. The assumption of perfect competition in this case is consistent with widely accepted economic practice for this type of analysis (see for example EPA 2000, p. 126).

With regard to the fuel market, the Federal Trade Commission (FTC) has developed an approach to ensure competitiveness in this sector. The FTC reviews oil company mergers and frequently requires divestiture of refineries, terminals, and gas stations to maintain a minimum level of competition. Therefore, it is reasonable to assume a competitive structure for this market. At the same time, however, there are several ways in which refiners may pass along their fuel compliance costs. This analysis explores three approaches. The primary modeling scenario is the average cost scenario, according to which the change in market price is driven by the average total (variable + fixed) regional cost of the regulation. The two other approaches are modeled in a sensitivity analysis and reflect the case in which the highest-cost producer sets the market price in a region. The first of these is the maximum variable cost scenario, according to which the market price is drive by the maximum variable regional cost of the regulation. The second is the maximum total (fixed + variable) regional cost of the regulation. The results of the sensitivity analyses for these two fuel scenarios are contained in Appendix 10I.

10.2.3.2 Short- vs. Long-Run Models

In developing the multimarket partial equilibrium model, the choices available to producers must be considered. For example, are producers able to increase their factors of production (e.g., increase production capacity) or alter their production mix (e.g., substitution between materials, labor, and capital)? These modeling issues are largely dependent on the time horizon for which the analysis is performed. Three benchmark time horizons are discussed below: the very short run, the long run, and the intermediate run. This discussion relies in large part on the material contained in the *OAQPS Economic Analysis Resource Guide* (U.S. EPA, 1999).

[D] A monopoly or firms in oligopoly may not behave as neo-classical economic theories of the firm predict because they may be fearful of new entrants to the market. If super-normal profits are earned potential competitors may enter the market, so it is argued that the existing firm(s) will keep prices and output at a level where only normal profits are made, setting price and output at or close to the competitive price and output. Baumol W J, Panzer J and Willig R D, (1982); Baumol, 1982.

In the very short run, all factors of production are assumed to be fixed, leaving the directly affected entity with no means to respond to increased costs associated with the regulation. Within a very short time horizon, regulated producers are constrained in their ability to adjust inputs or outputs due to contractual, institutional, or other factors and can be represented by a vertical supply curve as shown in Figure 10.2-4. In essence, this is equivalent to the nonbehavioral model described earlier. Neither the price nor quantity change and the manufacturer's compliance costs become fixed or sunk costs. Under this time horizon, the impacts of the regulation fall entirely on the regulated entity. Producers incur the entire regulatory burden as a one-to-one reduction in their profit. This is referred to as the "full-cost absorption" scenario and is equivalent to the engineering cost estimates. While there is no hard and fast rule for determining what length of time constitutes the very short run, it is inappropriate to use this time horizon for this analysis because it assumes economic entities have no flexibility to adjust factors of production.

In the long run, all factors of production are variable, and producers can be expected to adjust production plans in response to cost changes imposed by a regulation. Figure 10.2-5 illustrates a typical, if somewhat simplified, long-run industry supply function. The function is horizontal, indicating that the marginal and average costs of production are constant with respect to output.[E] This horizontal slope reflects the fact that, under long-run constant returns to scale, technology and input prices ultimately determine the market price, not the level of output in the market.

[E]The constancy of marginal costs reflects an underlying assumption of constant returns to scale of production, which may or may not apply in all cases.

Figure 10.2-6
Partial Cost Pass-Through of Regulatory Costs

Figure 10.2-4
Full Cost Absorption of Regulatory Costs

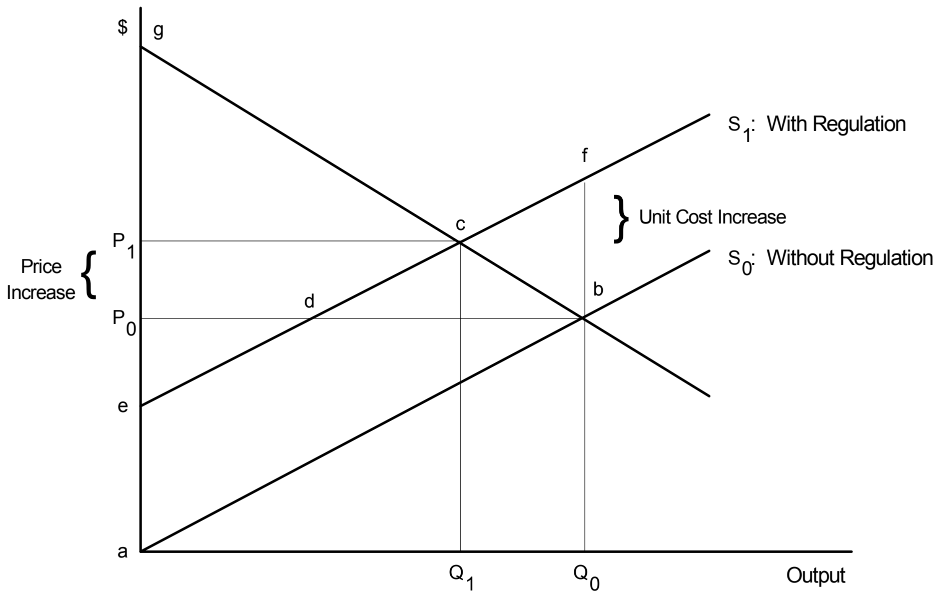
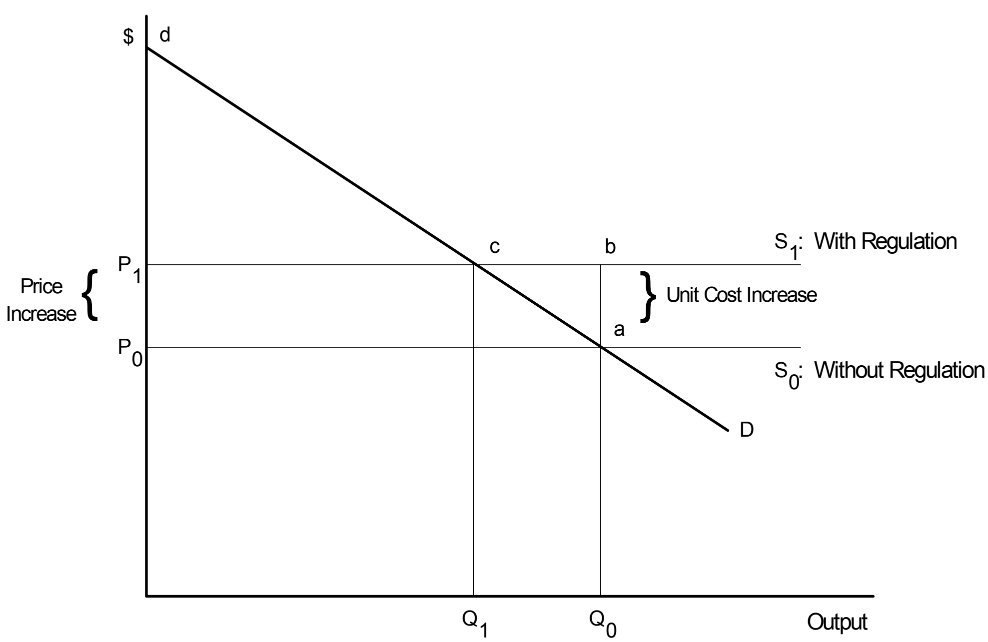


Figure 10.2-5
Full-Cost Pass-Through of Regulatory Costs



Market demand is represented by the standard downward-sloping curve. The market is assumed here to be perfectly competitive; equilibrium is determined by the intersection of the supply and demand curves. In this case, the upward parallel shift in the market supply curve represents the regulation's effect on production costs. The shift causes the market price to increase by the full amount of the per-unit control cost (i.e., from P_0 to P_1). With the quantity demanded sensitive to price, the increase in market price leads to a reduction in output in the new with-regulation equilibrium (i.e., Q_0 to Q_1). As a result, consumers incur the entire regulatory burden as represented by the loss in consumer surplus (i.e., the area P_0 ac P_1). In the nomenclature of EIAs, this long-run scenario is typically referred to as "full-cost pass-through," and is illustrated in Figure 10.2-5.

Taken together, impacts modeled under the long-run/full-cost-pass-through scenario reveal an important point: under fairly general economic conditions, a regulation's impact on producers is transitory. Ultimately, the costs are passed on to consumers in the form of higher prices. However, this does not mean that the impacts of a regulation will have no impact on producers of goods and services affected by a regulation. For example, the long run may cover the time taken to retire all of today's capital vintage, which could take decades. Therefore, transitory impacts could be protracted and could dominate long-run impacts in terms of present value. In addition, to evaluate impacts on current producers, the long-run is approach is not appropriate. Consequently an time horizon that falls between the very short-run/full-cost-absorption case and the long-run/full-cost-pass-through case is most appropriate for this EIA.

The intermediate run can best be defined by what it is not. It is not the very short run and it is not the long run. In the intermediate run, some factors are fixed; some are variable.[F] The existence of fixed production factors generally leads to diminishing returns to those fixed factors. This typically manifests itself in the form of a marginal cost (supply) function that rises with the output rate, as shown in Figure 10.2-6.

Again, the regulation causes an upward shift in the supply function. The lack of resource mobility may cause producers to suffer profit (producer surplus) losses in the face of regulation; however, producers are able to pass through some of the associated costs to consumers, to the extent the market will allow. As shown, in this case, the market-clearing process generates an increase in price (from P_0 to P_1) that is less than the per-unit increase in costs (fb), so that the regulatory burden is shared by producers (net reduction in profits) and consumers (rise in price). In other words there is a loss of both producer and consumer surplus.

10.2.3.3 Variable vs. Fixed Regulatory Costs

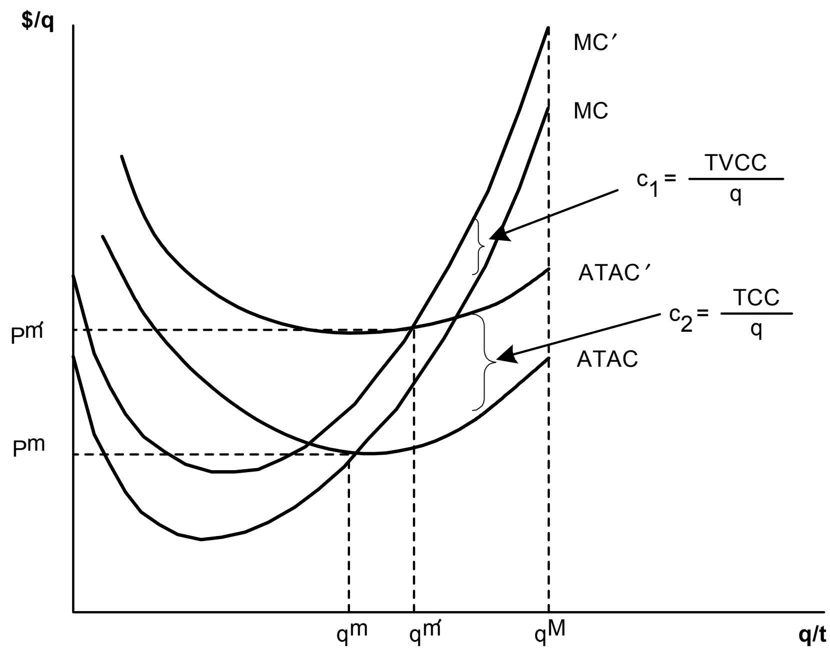
Related to short-run versus long-run modeling issues is the question of how fixed and variable cost increases affect market prices and quantities. The engineering estimates of fixed R&D and capital costs and variable material and operating and maintenance (O&M) costs provide an initial measure of total annual compliance costs without accounting for behavioral

[F]As a semantical matter, the situation where some factors are variable and some are fixed is often referred to as the "short run" in economics, but the term "intermediate run" is used here to avoid any confusion with the term "very short run."

responses. The starting point for assessing the market impacts of a regulatory action is to incorporate the regulatory compliance costs into the production decision of the firm.

In general, shifting the supply curve by the total cost per unit implies that both capital and operating costs vary with output levels. At least in the case of capital, this raises some questions. In the long run, all inputs (and their costs) can be expected to vary with output. But a short(er)-run analysis typically holds some capital factors fixed. For instance, to the extent that a market supply function is tied to existing facilities, there is an element of fixed capital (or one-time R&D). As indicated above, the current market supply function might reflect these fixed factors with an upward slope. As shown in Figure 10.2-7, the MC curve will only be affected, or shift upwards, by the per-unit variable compliance costs, while the ATAC curve will shift up by the per-unit total compliance costs (c_2). Thus, the variable costs will directly affect the production decision (optimal output rate), and the fixed costs will affect the closure decision by establishing a new higher reservation price for the firm (i.e., $P^{m'}$). In other words, the fixed costs are important in determining whether the firm will stay in this line of business (i.e., produce anything at all), and the variable costs determine the level (quantity) of production.

Figure 10.2-7
Modeling Fixed Costs



(a) Upward-sloping supply function

In the EIA for this rule, it is assumed that only the variable cost influences the firm's production decision level and that the fixed costs are absorbed by the firm. Fixed costs associated with the engine emission standards are not included in the market analysis, because in an analysis of competitive markets the industry supply curve is based on its marginal cost curve, and fixed costs are not reflected in changes in the marginal cost curve. In addition, fixed costs are primarily R&D costs associated with design and engineering changes, and firms in the affected industries currently allocate funds for these costs (see below). These costs are still a cost to society because they displace other R&D activities that may improve the quality or performance of engines and equipment. However, in this example, the fixed costs do not influence the market price or quantity in the intermediate run. Therefore, fixed costs are not likely to affect the prices of engines or equipment.

R&D costs are a long-run concern, and decisions to invest or not invest in R&D are made in the long run. If funds have to be diverted from some other activity into R&D needed to meet the environmental regulations, then these costs represent a component of the social costs of the rule. Therefore, fixed R&D costs are included in the welfare impact estimates reported in Table 10.1-4 as unavoidable costs that reduce producer surplus. In other words, engine manufacturers budget for research and development programs and include these charges in their long-run strategies. In the absence of new standards, these resources would be focused on design changes to increase customer satisfaction. Engine manufacturers are expected to redirect these resources toward compliance with the standards, instead of adding additional resources to research and development programs.

Operationally, the model used in this EIA shifts the diesel engines' and equipment markets' supply curves by the variable cost per unit only. The rule's estimated fixed costs are calculated to reflect their opportunity costs and then added to the producer surplus decrease after the new market (with-regulation) equilibrium has been established.[G] The primary fixed costs in these markets are associated with one-time expenditures to redesign products and retool production lines to comply with the regulation. These fixed costs can be recovered as part of the industry's routine R&D budget and hence are not likely to lead to additional price increases. This assumption is supported by information received from a number of nonroad engine and equipment manufacturers, with whom EPA met to discuss redesign and equipment costs. The manufacturers indicated that their redesign budgets (for emissions or other product changes) are constrained by R&D budgets that are set annually as a percentage of annual revenues. While the decision to redesign may be driven by anticipated future revenues for an individual piece of equipment, the resources from with the redesign budget is allocated are determined from the current year's R&D budget. Thus, redesigns to meet emission standards represent a reallocation of resources that would have been spent for other kinds of R&D (i.e., a lost opportunity cost). To account for the value to the company of this loss, the engineering cost analysis includes a 7 percent rate of return for all fixed costs"recovered" over a defined period for the emission compliant products.

An alternative approach for R&D expenditures can be used, in which these costs are included in intermediate-run decision-making. This alternative assumes that manufacturers will change

[G]The fixed R&D costs capture the lost opportunity of forgone investments to the firm.

their behavior based on the R&D required for compliance with the standards. A sensitivity analysis in Appendix 10I reflects this approach.

Fixed costs on the refiner side are treated differently in the NDEIM. Unlike for engines and equipment where the fixed costs are primarily for up-front R&D, most of the petroleum refinery fixed costs are for production hardware. The decision to invest to increase, maintain, or decrease production capacity may be made in response to anticipated or actual changes in price. To reflect the different ways in which refiners can pass costs through to refiners, three scenarios were run for the following supply shifts in the diesel fuel markets:

- shift by average total (variable + fixed cost)
- shift by max total (variable + fixed cost)
- shift by max variable cost.

The first, shift by average total cost (variable + fixed), is the primary scenario and is included in the NDEIM. The other two are investigated using sensitivity analyses. These supply shifts are discussed further in sensitivity analysis presented in Appendix10I.

10.2.3.4 Substitution

In modeling the market impacts and social costs of this rule, the NDEIM considers only diesel equipment and fuel inputs to the production of goods in the applications markets. It does not explicitly model alternate production inputs that could serve as substitutes for new nonroad equipment or nonroad diesel fuel. In the model, market changes in the final demand for application goods and services directly correspond to changes in the demand for nonroad equipment and fuel (i.e., in normalized terms there is a one-to-one correspondence between the quantity of the final goods produced and the quantity of nonroad diesel equipment and fuel used as inputs to that production). We believe modeling the market in this manner is economically sound and reflects the general experience for the nonroad market.

Alternate means of production include pre-buying, delayed buying, extending the life of a current machine, and substituting with different (e.g., gasoline-powered) equipment. For the reasons described below, we conclude that revising the NDEIM to include these effects would be inappropriate.

The term “pre-buying” refers to the possibility that the suppliers in the application market could choose to buy additional unneeded quantities of nonroad equipment prior to the beginning of the Tier 4 program and then use that equipment as an alternate means of production during the time period of the Tier 4 program, thus avoiding the higher cost for the Tier 4 equipment. Although such pre-buying may be economically rational in some very limited situations, its use as a substitute is severely limited. First, it should be clear that this form of pre-buying only applies to equipment and not to nonroad diesel fuel. The high cost to storing any significant quantity of nonroad diesel fuel prior to Tier 4 makes such pre-buying unlikely. For nonroad equipment, the logic behind pre-buying is relatively straightforward and analogous to the average consumer deciding to buy a new car at the end of the model year in the anticipation that next year’s model will be more expensive. The critical difference is that the nonroad equipment is bought early and then held idle until it is needed as an input to production. The economic viability of such strategic purchases are limited by the cost of idle capital and the cost for maintaining unused equipment. In simple terms, if one assumed that the value of capital tied up in an idle piece of equipment would have returned 7 percent in some other investment and the cost of equipment were to go up by 7 percent, it would be economically rational to pre-buy equipment up to one-year earlier than needed. If the equipment will not be needed as an input to production in the next year, it would be more rational to invest the money elsewhere and then purchase the equipment when it is actually needed. In real terms, the window for which pre-buying can be a rational choice is even more limited due to the cost of maintaining, storing and insuring equipment that is not being used. In practice then, such strategic purchases are limited to a time period of a few months around the start of a new regulation. The NDEIM is intended to model market reactions in the intermediate run time frame and thus models a period of time well beyond the scope of the short time period during which any potential pre-buy might be rational. We therefore have not tried to include pre-buying as a means of substitution in NDEIM.

"Delayed-buying" refers to the possibility that producers in the application market would defer purchasing new equipment initially but would eventually (after a delay period?) buy new equipment. The economic rationality of such a delay is not clear (i.e., what cheaper substitute might be used). However, since in the end it is assumed that the new more expensive equipment is purchased, such a substitution method would appear to be inappropriate for an economic model designed to model the intermediate run time frame.

In addition, there are many other factors besides a new regulatory program that may affect a consumer's decision to pre-buy or delay a purchase. Specifically, manufacturer short-term pricing promotions or marketing strategies such as rebates, dealer incentives, and advertising can change consumer behavior. These effects are not well captured in a general equilibrium model such as the one used in the NDEIM, the goal of which is to estimate the rule's impact on equilibrium prices and quantities. Distinguishing these effects would require the use of a sales function, which is beyond the scope of the NDEIM.

Extending the life of a current machine is suggested as another alternative to purchasing new equipment. We believe this would also be a short term phenomenon that is not relevant for the intermediate time frame of the NDEIM. Based on our meetings with equipment users and suppliers, we do not believe that extending the life of nonroad equipment will prove to be an economically rational substitute to the purchase of new equipment. Based on our understanding of the nonroad equipment market, we believe that most users of nonroad equipment already do this to the maximum extent possible. That is, we believe it is already economically rational to extend the life of nonroad equipment as long as possible. It is our understanding that new nonroad equipment is only bought when: 1) the existing equipment can no longer perform its function; or 2) when new demand for production requires additional means for production; or 3) when new equipment offers a cheaper means of production than existing equipment. The changes in equipment due to the Tier 4 program will not substantially change these three primary reasons for purchasing new equipment. Further, were we to discover that extending equipment life is economically rational (i.e., if it were cheaper to extend equipment life rather than to buy new equipment), this would lower the cost of nonroad equipment as an input to production and thus would reduce the economic impact of the Tier 4 program compared to our estimate. For all of the reasons stated here, we have decided not to attempt to model an extended equipment life in the NDEIM.

Finally, stakeholders suggested that equipment users may choose to substitute with different equipment or perhaps more generally different inputs to production. These could include the use of gasoline powered equipment, or the use of additional labor (i.e., the use of a laborer and shovel instead of a backhoe), or some other unknown substitute. We have specifically considered the possibility of substitution to gasoline technology. Gasoline engines are an alternative power source for equipment in the lowest power categories (i.e., below 75 horsepower). Above this size range there are very limited viable gasoline engine substitutes today, and we do not believe that such substitutes will arise in the future. We should also note that there are a number of benefits to diesel engines and some stakeholders have argued that there are no acceptable substitutes for diesel powered equipment.[H] The fuel economy advantage of diesel engines compared to gasoline engines dominates the overall operating costs for larger equipment and makes the application of large gasoline engines to large nonroad equipment economically infeasible.[I] For smaller nonroad equipment, where the fuel portion of operating costs are not as important, gasoline and diesel engines are both provided today. The dominant reasons for choosing diesel engines over the substantially cheaper gasoline engines include better performance from diesel engines, lower fuel consumption from diesel engines, and the ability to use diesel fuel. This latter reason is a significant advantage for two reasons: diesel fuel is safer to store and dispense due to its lower volatility and, hence, greater resistance to accidental ignition, and it is compatible with the fuel needed for larger equipment at the same worksite. Thus, the costs for addressing safety issues with gasoline fuel storage and the costs for storing two fuels onsite (gasoline for small engines and diesel for large) acts as a barrier to entry to the market for gasoline powered equipment. Where such a barrier doesn't exist, gasoline engines already enjoy a substantial economic advantage over diesel. In cases where the more expensive diesel powered equipment is currently used, an incremental increase in new equipment cost is unlikely to provide the necessary economic incentives for switching to gasoline based power systems. In short, we believe that users who can economically dispense gasoline fuel already choose the substantially cheaper gasoline technology, while diesel users are already choosing a more expensive technology due to reasons that will persist independent of this rulemaking. The incremental equipment costs are not expected to be large enough to change these market characteristics. Therefore, we have not attempted to model the possibility of substitution to gasoline equipment in NDEIM.

[H] "To date, there is no substitute for diesel power." Associated General Contractors of America, OAR-2003-0012-0791.

[I] Preamble Table VI.C-1 documents the lifetime operating costs (for fuel and oil only) for a 500 hp bulldozer as $77,850. If simplistically, we assumed that a gasoline engine would have a 30 percent higher operating cost (in practice it would likely be higher), the extra operating cost for a gasoline engine would be in excess of $23,000 dwarfing any additional control cost from the Tier 4 program.

10.2.4 Estimation of Social Costs

The economic welfare implications of the market price and output changes with the regulation can be examined by calculating consumer and producer net "surplus" changes associated with these adjustments. This is a measure of the negative impact of an environmental policy change and is commonly referred to as the "social cost" of a regulation. It is important to emphasize that this measure does not include the benefits that occur outside of the market, that is, the value of the reduced levels of air pollution with the regulations. Including this benefit will reduce the net cost of the regulation and even make it positive.

The demand and supply curves that are used to project market price and quantity impacts can be used to estimate the change in consumer, producer, and total surplus or social cost of the regulation (see Figure 10.2-8).

The difference between the maximum price consumers are willing to pay for a good and the price they actually pay is referred to as "consumer surplus." Consumer surplus is measured as the area under the demand curve and above the price of the product. Similarly, the difference between the minimum price producers are willing to accept for a good and the price they actually receive is referred to as "producer surplus." Producer surplus is measured as the area above the supply curve below the price of the product. These areas can be thought of as consumers' net benefits of consumption and producers' net benefits of production, respectively.

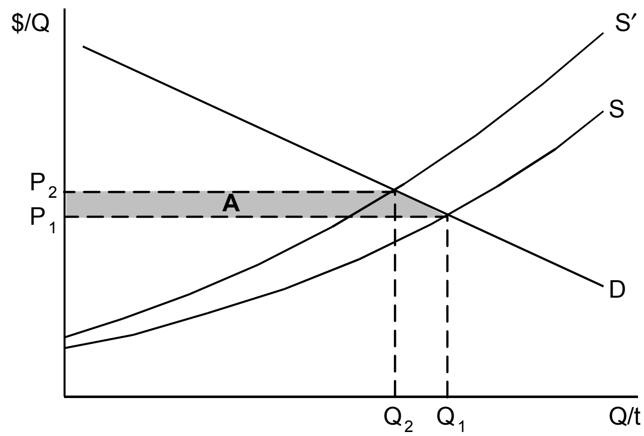
In Figure 10.2-8, baseline equilibrium occurs at the intersection of the demand curve, D, and supply curve, S. Price is P_1 with quantity Q_1. The increased cost of production with the regulation will cause the market supply curve to shift upward to S′. The new equilibrium price of the product is P_2. With a higher price for the product there is less consumer welfare, all else being unchanged. In Figure 10.2-8(a), area A represents the dollar value of the annual net loss in consumers' welfare associated with the increased price. The rectangular portion represents the loss in consumer surplus on the quantity still consumed due to the price increase, Q_2, while the triangular area represents the foregone surplus resulting from the reduced quantity consumed, $Q_1 – Q_2$.

In addition to the changes in consumers' welfare, there are also changes in producers' welfare with the regulatory action. With the increase in market price, producers receive higher revenues on the quantity still purchased, Q_2. In Figure 10.2-8(b), area B represents the increase in revenues due to this increase in price. The difference in the area under the supply curve up to the original market price, area C, measures the loss in producer surplus, which includes the loss associated with the quantity no longer produced. The net change in producers' welfare is represented by area B – C.

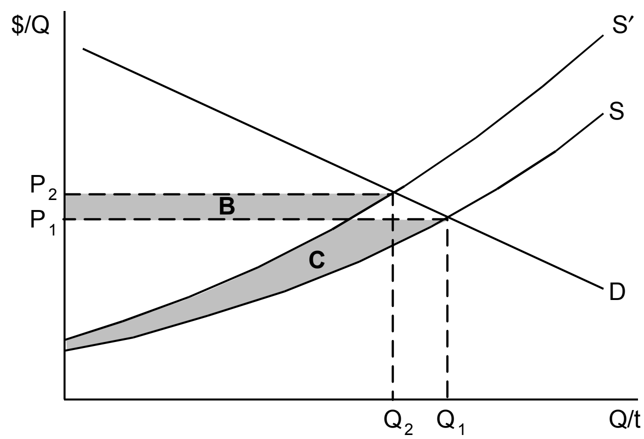
The change in economic welfare attributable to the compliance costs of the regulations is the sum of consumer and producer surplus changes, that is, – (A) + (B–C). Figure 10.2-8©) shows the net (negative) change in economic welfare associated with the regulation as area D.[J]

[J]However, it is important to emphasize that this measure does not include the benefits that occur outside the market, that is, the value of the reduced levels of air pollution with the regulations. Including this benefit may reduce the net cost of the regulation or even make it positive.

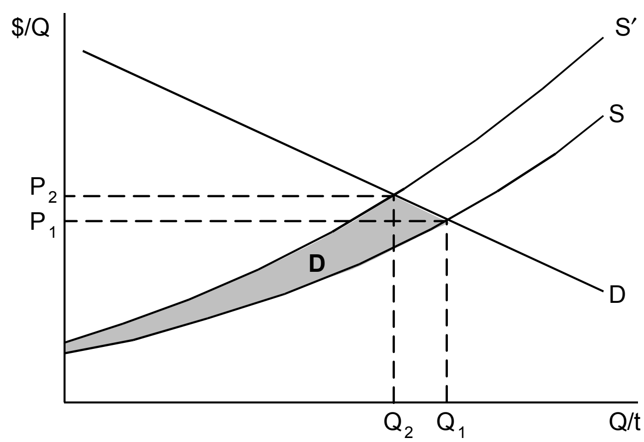
Figure 10.2-8
Market Surplus Changes with Regulation: Consumer and Producer Surplus



(a) Change in Consumer Surplus with Regulation



(b) Change in Producer Surplus with Regulation



(c) Net Change in Economic Welfare with Regulation

If not all the costs of the regulation are reflected in the supply shift, then the producer and consumer surplus changes reflected in Figure 10.2-5 will not capture the total social costs of the regulation. As discussed earlier, fixed R&D and capital costs are not included in the supply curve shift for the engine and equipment markets. The fixed costs in these instances are assumed to be borne totally by the producers in that none of these costs are passed on to consumers in the form of higher prices. The costs are added to the producer surplus estimates generated from the market analysis so that the accounting accurately reflects the total social cost of the regulation.

Operating savings are included in the total social cost estimates but not integrated into the market analysis. Operating savings are changes in operating costs are expected to be realized by diesel equipment users, for both existing and new equipment, as a result of the reduced sulfur content of nonroad diesel fuel. These include operating savings (cost reductions) due to fewer oil changes, which accrue to nonroad engines that are already in use as well as those that will comply with new emission standards. These savings (costs) also include any extra operating costs associated with the new PM emission control technology that may accrue to new engines that use this new technology. Operating savings are not included in the market analysis because some of the savings accrue to existing engines and because these savings are not expected to affect consumer decisions with respect to new engines (see Chapter 6). Operating savings are included in the social cost analysis, however, because they accrue to society. They are added into the estimated social costs as an additional savings to the application and transportation service markets, since it is the users of these engines and fuels that will see these savings. A sensitivity analysis was performed in which operating savings are included as inputs to the NDEIM market. The results of this analysis are presented in Appendix 10I.

10.3 NDEIM Model Inputs and Solution Algorithm

The NDEIM is a computer model comprising a series of spreadsheet modules. The model equations, presented in Appendix F to this chapter, are based on the economic relationships described in Section 10.2. The NDEIM analysis consists of four steps:

- Define the baseline characteristics of the supply and demand of affected commodities and specify the intermarket relationships.
- Introduce a policy "shock" into the model based on estimated compliance costs that shift the supply functions.
- Use a solution algorithm to estimate a new, with-regulation equilibrium price and quantity for all markets.
- Estimate the change in producer and consumer surplus in all markets included in the model.

This section describes the data inputs used to construct the model, the compliance costs used to shock it, and the algorithm used to solve it. The model results are presented in Appendices A through E.

10.3.1 Description of Product Markets

There are 60 integrated engine, equipment, fuel, transportation service, and application product markets included in the NDEIM.

10.3.1.1 Engine Markets

The engine markets are the markets associated with the production and consumption of engines. The producers in these markets are the engine manufacturers; the consumers are companies that make the nonroad equipment that use these engines. Seven engine markets are modeled, segmented by engine size (in horsepower).

- less than 25 hp
- 26 to 50 hp
- 51 to 75 hp
- 76 to 100 hp
- 101 to 175 hp
- 176 to 600 hp
- greater than 601 hp

The number of horsepower categories included in the NDEIM is larger than the number of nonroad engine standard horsepower categories. This allows more efficient use of the engine compliance cost estimates developed for this proposal. It also allows a more refined examination of economic impacts on equipment types.

The NDEIM distinguishes between “merchant” engines and “captive” engines. “Merchant” engines are produced for sale to another company and are sold on the open market to anyone who wants to buy them. “Captive” engines are produced by a manufacturer for use in its own nonroad equipment line (this equipment is said to be produced by “integrated” manufacturers). It is important to differentiate between merchant and captive engines because compliance costs affect them differently. All compliance costs for captive engines are absorbed into the equipment costs of integrated suppliers. In contrast, nonintegrated equipment suppliers who buy merchant engines pay only a portion of the engine compliance costs. As long as engine demand is not perfectly inelastic, the increased market price for merchant engines will reflect only a partial pass through of engine compliance costs. The rest of the compliance costs will be borne by the engine manufacturer.

10.3.1.2 Equipment Markets

The equipment markets are the markets associated with the production and consumption of equipment that use nonroad diesel engines. The producers in these markets are the equipment manufacturers; the consumers are companies that use this equipment to make goods sold in the application markets. Seven equipment markets are modeled:

- Construction

- Agricultural
- Pumps and compressors
- Generators and welder sets
- Refrigeration and air conditioning
- General industrial, and
- Lawn and garden.

Each of the 60 applications listed in the Power Systems Research OELink Sales Version 2002 (PSR) database were allocated to one of these categories to obtain a manageable number of equipment markets to be included in the NDEIM (Gallaher, 2003). The mapping is contained in Table 10.3-1. For each of these equipment types, up to seven horsepower size category markets are included in the model, for a total of 42 individual equipment markets.[K]

[K]There are seven horsepower/application categories that do not have sales in 2000 and are not included in the model. These are: agricultural equipment >600 hp; gensets & welders > 600 hp; refrigeration & A/C > 71 hp (4 hp categories); and lawn & garden >600 hp. Therefore, the total number of diesel equipment markets is 42 rather than 49.

Table 10.3-1
Mapping from PSR Equipment Categories to Equipment Markets

Application Markets	Equip Markets	Equipment Types
AGRICULTURE	AGRICULTURAL EQUIP	2-WHEEL TRACTORS
		AG TRACTORS
		BALERS
		COMBINES
		IRRIGATION SETS
		OTHER AG EQUIPMENT
		SPRAYERS
		WINDROWERS
CONSTRUCTION	CONSTRUCTION	AERIAL LIFTS
		BORE/DRILL RIGS
		CRANES
		CRAWLERS
		EXCAVATORS
		FINISHING EQUIPMENT
		FOREST EQUIPMENT
		GRADERS
		LT PLANTS/SIGNAL BDS
		MIXERS
		OFF-HWY TRACTORS
		OFF-HWY TRUCKS
		OTHER CONSTRUCTION
		PAVERS
		PLATE COMPACTORS
		ROLLERS
		S/S LOADERS
		SCRAPERS
		TAMPERS/RAMMERS
		TRACTR/LOADR/BCKHOES
		TRENCHERS
		WHEEL LOADERS/DOZERS
MANUFACTURING	GENERAL INDUSTRIAL	AIRCRFT SUPPRT EQUIP
		CHIPPERS/GRINDERS
		CONCRETE/IND SAWS
		CRUSH/PROC EQUIP
		DUMPERS/TENDERS
		FORKLIFTS
		OIL FIELD EQUIPMENT
		OTH MATERIAL HANDLNG
		OTHER GEN INDUSTRIAL
		RAILWAY MAINTENANCE
		ROUGH TRN FORKLFTS
		SCRUBBERS/SWEEPERS
		SPEC VEHICLES/CARTS
		SURFACING EQUIP
		TERMINAL TRACTORS
		UTILITY VEHICLES
	GENERATOR SETS & WELDERS	GENERATOR SETS

Application Markets	Equip Markets	Equipment Types
		WELDERS
	LAWN & GARDEN	COMMERCIAL MOWERS
		COMMERCIAL TURF
		LEAF BLOWERS/VACS
		LN/GDN TRACTORS
		OTHER LAWN&GARDEN
		TRIMMER/EDGER/CTTERS
	PUMPS & COMPRESSORS	AIR COMPRESSORS
		GAS COMPRESSORS
		HYD POWER UNITS
		PRESSURE WASHERS
		PUMPS
	REFRIGERATION/AC	REFRIGERATION/AC

Source: Gallaher (2003).

For the purpose of this analysis, nonroad diesel equipment is assumed to be a fixed factor of production in the application markets. Applying this assumption, a 1 percent decrease in agricultural output will lead to a 1 percent decrease in the demand for agricultural equipment (and fuel). The relationship between the percentage increase in equipment price and the percentage change in equipment demand (the elasticity of demand) is determined by the input share of diesel equipment relative to other inputs in the application markets and the supply and demand elasticities in the application markets.

10.3.1.3 Application Markets

The application markets are the markets associated with the production and consumption of goods that use the affected diesel engines, equipment, and fuel. The producers in these markets include farmers, ranchers, construction firms, industrial firms, and mines; consumers include other companies and households. Three application markets are modeled:

- Construction
- Agricultural
- Manufacturing

These three application markets created after considering various economic activity classification schemes, including the NAICS and SIC (Revelt, 2004; Gallaher, 2003). These three markets are included as separate groupings in each of those economic activity classification schemes. They are also the most significant categories of activities for which diesel engines, equipment, and fuel are most likely to be used, as suggested in the PSR data on which the equipment markets were chosen. Finally, they are a manageable number of markets to use in the NDEIM. Each of the 7 equipment markets listed above were allocated to one of these categories. The mapping is contained in Table 10.3-2.

Table 10.3-2
Mapping from Equipment Markets to Application Markets

Application Market	Equipment Market
Agricultural	Agricultural equipment
Construction	Construction equipment
Manufacturing	Pumps and compressors Gen sets and welding equipment Refrigeration Lawn and garden General industrial

One of the consequences of reducing economic activities that use diesel engines, equipment, and fuel into such a small number of application market categories is that seemingly unrelated activities are linked to aggregate trends and market responses. So, for example, if manufacturing application market production decreases by one percent, the demand for lawn and garden equipment, gen sets and welders, and forklifts will all decrease by the same one percent because they are all linked to the same application market. Similarly, forest equipment and signal boards are grouped with cranes and bulldozers in the construction application market. In addition, gen sets used in agricultural activities are considered to be used in the manufacturing application market. Unfortunately, this is a problem whenever a large number of different kinds of products or activities are reduced to a small number of categories. At the same time, most of the activity covered by each of the three categories, and thus most of the engines and equipment that are included in them, is directly related to the application category.

Analysis of the impacts on the three application markets is limited to market level changes. The results are reported in terms of average percent change for prices and quantities of goods sold in each of the three application markets. Changes in producer and consumer surplus at the market level are also reported. The economic impacts on suppliers or consumers in particular markets (e.g., farm production units or manufacturing or construction firms, or households and companies that consume agricultural goods, buildings, or durable or consumer goods) are not estimated.

10.3.1.4 Diesel Fuel Markets

The diesel fuel markets are the markets associated with the production and consumption of nonroad diesel fuel. Eight nonroad diesel fuel markets were modeled: two distinct nonroad diesel fuel commodities in four regional markets. The two fuels are:

- 500 ppm nonroad diesel fuel
- 15 ppm nonroad diesel fuel

The Department of Energy defines five Petroleum Administrative Districts for Defense (PADDs). For the purpose of this EIA, two of these PADDs are combined, giving four regional district fuel markets. These are:

- PADD 1 and 3
- PADD 2
- PADD 4
- PADD 5 (includes Alaska and Hawaii; California fuel volumes that are not affected by the program because they are covered by separate California nonroad diesel fuel standards are not included in the analysis)

PADD 1 and PADD 3 are combined because of the high level of interregional trade. Regional imports and exports across the remaining four regions included in the model are not included in the analysis.

Separate compliance costs are estimated for each 500 ppm and 15 ppm regional fuel market. As a result, the price and quantify impacts, as well as the changes in producer surplus, vary across the eight fuel markets.

As discussed in Section 10.2, the NDEIM is based on the assumption of perfect competition. Using this assumption, estimated social costs are obtained by using average per-unit variable compliance costs to shift the market supply curve (see Section 10.2.3.3). In the fuel market case, however, each regional supply curve is shifted by the average total (variable + fixed) regional cost of the regulation. This approach is used for the fuel market because, unlike for engines and equipment where the fixed costs are primarily for up-front R&D, most of the petroleum refinery fixed costs are for production hardware. This fuel market scenario (referred to as average total cost) is used when presenting disaggregated market results in Appendices 10.A through 10.D and sensitivity analysis results in Appendix 10I.

However, in some fuel regions, it may be more appropriate to let the “high cost” refinery’s compliance cost drive the new market price. If refiners' investment in desulfurization capacity is very close to that needed to satisfy demand for 15 ppm NRLM fuel, then refiners may have to often operate their equipment at a capacity beyond that which minimizes cost. For example, the temperature in the reactor can be increased, allowing greater fuel throughput. However, this speeds up catalyst deactiviation and shortens catalyst life. This effectively increases the operating cost per gallon of producing 15 ppm fuel. The long-term solution is for refiners not producing 15 ppm fuel to invest in desulfurization capacity. However, according to EPA's cost methodology, this incremental fuel would have a higher desulfurization cost than that experienced by those who have already invested. In order to justify this new 15 ppm fuel capacity, refiners have to anticipate not only covering their operating costs, but their capital costs as well. For this to occur, they would have to anticipates prices being at or above those of the "high cost" refineries as estimated here. Under this assumption it is the high cost producer’s dollars per gallon compliance cost increase that determines the new price. This is referred to as the max cost scenario and no longer reflects perfect competition because now individual firms have direct influence on market price. Two max cost scenarios are explored in the sensitivity analysis presented in Appendix 10I: one in which the high-cost refinery's total (variable + fixed) compliance costs determine price, and a second in which only the high-cost refinery's variable compliance costs determine price.

10.3.1.5 Locomotive and Marine Transportation Markets

The locomotive and marine sectors are affected by this rule through the limits on the sulfur content of fuel. These sectors provide inputs to a variety of end-use sectors in the form of transportation services. In this sense, their role is similar to other markets for intermediate goods already included in the NDEIM. For example, the equipment markets in the NDEIM are markets for intermediate goods that provide diesel-powered equipment to agriculture, construction, and manufacturing application markets. Using this analogy, locomotive and marine sectors are included in the NDEIM as two intermediate markets (see Figure 10.1-1). The intermediate goods/services in this context are the rail and water transportation services provided to end-use markets.

The U.S. Bureau of Economic Analysis (BEA) Industry Economic Program produces the input-output tables, which show how industries interact to provide input to, and take output from, each other. The data set can provide an appropriate measure transportation services purchased by the application markets included in NDEIM. The BEA data show that approximately 54 percent of rail and water transportation expenditures are made by the three application markets in the NDEIM (see Table 10.3-3). The remaining expenditures for these services are associated with explicitly modeled sectors not included in the model (e.g. electric utilities (transporting coal to electric power plants), nonmanufacturing service industries (public transportation), and governments). Costs flowing into these "other" sectors are included as a line item in the economic impact estimates but do not lead to changes in market prices or quantities.

Table 10.3-3
Distribution of Rail and Water Costs to Deliver Commodities by Industry: 1997

Application Market	Share of Rail Transportation Expenditures	Share of Water Transportation Expenditures
Agriculture	3.5%	2.5%
Construction	4.3%	8.3%
Manufacturing	45.9%	42.7%
Other	46.2%	45.5%

Source: U.S. Bureau of Economic Analysis (BEA). 1997 Benchmark I-O Supplementary Make, Use, and Direct Requirements Tables at the Detailed Level. Table 4. http://www.bea.gov/bea/dn2/i-o_benchmark.htm. Last updated November 24, 2003.

Locomotive and fuel costs were added only to the three application markets, even though equipment and engine manufacturers also use these services. This is a simplifying assumption and, is not expected to have an impact on the results of the market or social cost analysis because the share of these costs in total engine and equipment production is very small.

10.3.2 Market Linkages

In the national economy, the markets described above are connected in that changes in demand in one market will affect the supply of goods in a related market. For example, nonroad equipment manufacturers consume engines in their production processes in the sense that each piece of nonroad equipment has a nonroad engine. This equipment is then supplied to application market producers through the application markets. A decrease in the demand for equipment in the application market will lead to a decrease in the quantity of equipment produced, which will in turn lead to a decrease in the quantity of engines produced. Similarly, the fuel markets are also linked to the application markets, with the demand for No. 2 distillate being specified as a function of the production and consumption decisions made in the construction, agricultural, and manufacturer application markets. In the NDEIM, increased equipment costs decrease the demand for fuel, and increased fuel costs decrease the demand for equipment because both increase the costs of production in the application markets. This in turn leads to a decrease in production in the application markets and hence a decrease in the demand for inputs (fuel and equipment).

The linkages between the markets are illustrated in Figure 10.1-1. These interaction effects are accounted for by designing the model to derive the engine, equipment, transportation, and fuel market demand elasticities. The derived demand aspect of the model simulates connections between supply and demand among all the product markets and replicates the economic interactions between producers and consumers. Detailed specifications of the market model equations (supply and demand functions, equilibrium conditions) are provided in Appendix 10F.

10.3.3 Baseline Economic Data

This section describes the data used to define the baseline conditions in the model. These include baseline quantities and prices for the engines, equipment and fuel affected by the rule and for the transportation service sectors and application markets that use these engines, equipment, and fuel.

10.3.3.1 Baseline Quantities: Engines, Equipment and Fuel

Engines and Equipment: The NDEIM uses the same engine sales that are used in the engine and equipment cost analysis presented in Chapter 6. The engine sales are based on the Power Systems Research OELink Sales Version 2002 database, adjusted to eliminate stationary equipment and to maintain consistency with the 1998 Nonroad inventory model (see Chapter 8, Table 8.1-1 and related text). Sales data are used as a proxy for production data in the NDEIM because detailed production data by horsepower and equipment application are not available (modeling inventory decisions of engine and equipment manufacturers is beyond the scope of the NDEIM). The sales distribution by size and application is the same for equipment as for engines due to the assumption of a one-to-one relationship between engines and equipment. Engines and equipment are allocated to equipment type categories according to the PSR database categorization scheme (see Section 10.3.1.2 and Table 10.3-1, above). Table 10.3-4 lists sales data for affected diesel nonroad engines and equipment sold in the United States in 2000 by engine horsepower and equipment category.

Table 10.3-4
Engine/Equipment Sales in 2000

Engine Market	Agricultural Equipment	Construction	General Industrial	Generator Sets and Welders	Lawn and Garden	Pumps and Compressors	Refrigeration/ Air Condition	Grand Total
0<hp<25	13,195	17,043	3,173	54,971	17,118	4,980	8,677	119,159
25≤hp<50	38,303	30,233	6,933	32,540	10,323	4,254	10,394	132,981
50≤hp<75	19,156	30,919	7,074	13,234	1,456	3,930	18,145	93,914
75≤hp<100	11,788	30,146	14,204	5,567	2,722	4,238		68,665
100≤hp<175	35,226	49,503	17,757	7,313	1,556	985		112,340
175≤hp<600	41,678	42,126	8,327	1,813	509	1,494	—	95,947
hp > 600 hp	—	4,945	576	—	—	16	—	5,537
Grand Total	159,347	204,915	58,044	115,440	33,684	19,898	37,215	628,542

Source: Power Systems Research, OELink Sales Version, 2002.; see also Chapter 8, Table 8.1-1 and related text.

Fuel: Baseline nonroad, locomotive, and marine diesel fuel consumption is provided in Table 10.3-5. Fuel consumption is broken out by region (PADD) and application market (construction, agriculture, and manufacturing).

The fuel volumes used in NDEIM were developed from the information contained in Section 7.1 of Chapter 7 of the RIA. Only a brief summary of the methodology used to develop these volumes is contained here so the reader is directed to Chapter 7 of the RIA for a complete discussion. Demand volumes are first estimated for nonroad, locomotive and marine diesel fuel for 2001 for each PADD[L] and then grown to 2014. The analysis of varying regulatory scenarios always occurs using the 2014 estimated volumes. The three regulatory scenarios associated with the final rule are:

- NRLM meeting a 500 ppm sulfur standard in 2007 to 2010 exempting small refiners

- NR meeting a 15 ppm sulfur standard and LM meeting a 50 ppm sulfur standard in 2010 to 2012 exempting small refiners

- NRLM meeting a 15 ppm sulfur standard in 2010 to 2014 exempting some small refiners and allowing downgrade to meet demand except in PADD 1

- NRLM meeting a 15 ppm sulfur standard in 2014 which is fully phased in. The downgrade can be used in locomotive and marine diesel fuel except in PADD 1

The volume of pipeline downgrade and highway diesel fuel spillover are estimated and apportioned to nonroad, locomotive and marine diesel fuel depending on the distribution system constraints identified for each PADD and consistent with each regulatory scenario. After the downgrade and spillover are accounted for, the residual demands in each PADD are met by on-purpose production of low sulfur fuel.

The summary tables of 2014 volumes for each regulatory scenario are contained in Chapter 7. The volumes are summarized in Table 7.1.4-10 for the period from 2007 to 2010, Table 7.1.4-11 for the period from 2010 to 2012, Table 7.1.4-12 for the period from 2012 to 2014, and Table 7.1.4-13 for the period 2014 and thereafter.

The 2014 volumes are adjusted to estimated the volumes in each year from 2007 to 2040 using growth ratios compared to 2014 based on the growth rate factors in Tables 7.1.5-1 and 7.1.5-2. Each substream (i.e., spillover, downgrade, low sulfur fuel) within each fuel category is adjusted using the same growth factor.

The results of the volumes analysis are shown in Table 10.3-5. In the first column, the nonroad, locomotive and marine diesel fuel volume which must be desulfurized are summarized.

[L] Petroleum Administrative Districts for Defense.

The downgrade and spillover are aggregated together and shown in another column. Then a total is presented which represents the total of the two columns. The volumes are shown for PADDs 1 and 3 together, PADD 2, PADD 4 and PADD 5 without California, as well as a national total without California.

Table 10.3-5

Nonroad, Locomotive and Marine Diesel Fuel Consumption, 2007-2036 (million gallons)

	PADD I & III			PADD II			PADD IV			PADD V			Total		
Year	Nonroad, Locomotive, Marine	Highway Sulfur, Downgrade and Spillover	Total	Nonroad, Locomotive, Marine	Highway Sulfur, Downgrade and Spillover	Total	Nonroad, Locomotive, Marine	Highway Sulfur, Downgrade and Spillover	Total	Nonroad, Locomotive, Marine	Highway Sulfur, Downgrade and Spillover	Total	Nonroad, Locomotive, Marine	Highway Sulfur, Downgrade and Spillover	Total
2007	3,771	4,169	7,940	2,573	3,617	6,189	217	695	912	223	785	1,007	6,783	9,265	16,048
2008	6,592	1,503	8,095	4,503	1,817	6,319	380	551	931	390	639	1,029	11,864	4,510	16,374
2009	6,720	1,532	8,252	4,597	1,855	6,452	387	563	950	398	652	1,050	12,102	4,601	16,704
2010	7,008	1,405	8,412	4,392	2,195	6,587	337	633	970	420	652	1,072	12,158	4,883	17,041
2011	7,282	1,300	8,582	4,277	2,450	6,727	303	687	991	439	655	1,095	12,301	5,093	17,394
2012	7,414	1,323	8,737	4,359	2,498	6,857	309	700	1,010	448	669	1,116	12,530	5,189	17,719
2013	7,540	1,343	8,883	4,440	2,544	6,984	315	713	1,028	455	682	1,137	12,750	5,282	18,032
2014	7,669	1,365	9,034	4,521	2,591	7,111	321	725	1,046	553	605	1,158	13,064	5,286	18,350
2015	7,801	1,384	9,185	4,609	2,631	7,240	327	737	1,065	629	550	1,179	13,367	5,302	18,669
2016	7,932	1,403	9,336	4,696	2,673	7,369	334	749	1,083	641	560	1,200	13,603	5,385	18,988
2017	8,064	1,423	9,487	4,783	2,714	7,497	340	762	1,102	652	569	1,222	13,840	5,467	19,307
2018	8,200	1,442	9,643	4,871	2,753	7,625	347	773	1,120	664	579	1,243	14,083	5,548	19,630
2019	8,342	1,464	9,806	4,960	2,796	7,756	353	785	1,139	677	588	1,265	14,332	5,634	19,965
2020	8,545	1,411	9,956	4,934	2,948	7,882	353	804	1,157	688	598	1,286	14,520	5,760	20,280
2021	8,729	1,375	10,104	4,937	3,069	8,006	354	821	1,174	700	607	1,307	14,720	5,872	20,592
2022	8,872	1,395	10,266	5,022	3,114	8,137	360	833	1,193	712	616	1,329	14,966	5,958	20,925
2023	9,007	1,413	10,420	5,107	3,159	8,265	366	845	1,211	724	626	1,350	15,203	6,043	21,246
2024	9,145	1,432	10,577	5,191	3,204	8,395	372	857	1,230	736	636	1,371	15,445	6,128	21,573
2025	9,282	1,451	10,733	5,276	3,249	8,525	379	870	1,249	748	645	1,393	15,684	6,215	21,899
2026	9,420	1,469	10,889	5,360	3,294	8,653	385	882	1,267	759	655	1,414	15,924	6,300	22,224
2027	9,558	1,488	11,046	5,444	3,338	8,782	391	894	1,285	771	664	1,436	16,164	6,384	22,548
2028	9,696	1,506	11,203	5,528	3,382	8,910	397	907	1,304	783	674	1,457	16,405	6,469	22,874
2029	9,835	1,525	11,360	5,612	3,427	9,039	403	919	1,322	795	684	1,478	16,646	6,554	23,200
2030	9,974	1,544	11,518	5,697	3,472	9,168	410	931	1,341	807	693	1,500	16,887	6,640	23,527
2031	10,113	1,563	11,676	5,781	3,516	9,297	416	943	1,359	819	703	1,521	17,129	6,725	23,854
2032	10,253	1,582	11,835	5,865	3,561	9,427	422	956	1,377	831	712	1,543	17,371	6,811	24,182
2033	10,393	1,601	11,994	5,950	3,606	9,556	428	968	1,396	843	722	1,565	17,614	6,897	24,511
2034	10,534	1,620	12,154	6,034	3,651	9,686	434	980	1,414	855	732	1,586	17,857	6,983	24,840
2035	10,675	1,639	12,314	6,119	3,696	9,815	441	992	1,433	867	741	1,608	18,101	7,069	25,171
2036	10,816	1,659	12,475	6,204	3,742	9,945	447	1,005	1,452	879	751	1,630	18,345	7,156	25,501

10.3.3.2 Baseline Prices: Engines, Equipment and Fuel

Engines and Equipment: The baseline engine prices used in the NDEIM are the same as those contained in Table 6.2-5 in Chapter 6, above, sales weighting those values where appropriate. Table 10.3-6 provides the prices for the seven engine categories used in the model. The baseline equipment prices used in the NDEIM are contained in Table 10.3-7.[M] These were estimated by EPA using price data for the seven categories of equipment were complied from a variety of sources, including the U.S. General Services Administration and various websites. A relationship between price and horsepower was obtained using a linear interpolation method. The price estimates for the equipment were obtained using the sales weighted horsepower value for each power category and the corresponding linear equation (Guerra, 2004).

Table 10.3-6
Baseline Engine Prices

Power Range	Estimated Price
0<hp<25	$1,500
25≤hp<50	$2,900
50≤hp<75	$3,000
75≤hp<100	$4,000
100≤hp<175	$5,500
175≤hp<600	$20,000
hp > 600 hp	$80,500

Source: See also Chapter 6, Table 6.2-5.

[M]It should be noted that the equipment prices used in this analysis reflect current conditions and do not reflect any future price increases associated with EPA's nonroad Tier 3 standards.

Table 10.3-7
Baseline Prices of Nonroad Diesel Equipment[a]

Application	<25 hp	26-50 hp	51-75 hp	76-100 hp	101-175 hp	176-600 hp	>600 hp
Agricultural Equip	$6,900	$14,400	$22,600	$33,400	$69,100	$143,700	N/A
Construction Equip	$18,000	$29,700	$31,600	$57,900	$122,700	$312,900	$847,400
Pumps & Compressors	$6,000	$12,200	$10,600	$12,500	$23,800	$53,000	$88,000
GenSets & Welders	$6,800	$8,700	$8,300	$18,000	$21,400	$35,700	N/A
Refrigeration & A/C	$12,500	$27,000	$42,100	N/A	N/A	N/A	N/A
General Industrial	$17,300	$42,300	$56,400	$74,300	$116,900	$154,200	$345,700
Lawn & Garden	$9,300	$21,500	$33,100	$38,500	$29,900	$64,300	N/A

Source: Guerra, 2004.
[a] These equipment prices reflect current conditions and do not reflect any future price increases associated with EPA's nonroad Tier 3 standards.

Fuel Prices: The baseline fuel prices used in the NDEIM are the 2002 market prices for each PADD obtained from the U.S. Energy Information Administration's Petroleum Market Monthly. These prices are reported in Table 10.3-8 and are based on the average sales to end-users for high-sulfur diesel fuel.

Table 10.3-8
Average Market Prices for Diesel Fuel[a]: 2002

Market	Price ($/gallon)
PADD I&III	$0.91
PADD II	$0.94
PADD IV	$0.91
PADD V	$0.87

[a]High-Sulfur Diesel Fuel observation for December 2002.
Source: U.S. Energy Information Administration. 2004. Petroleum Marketing Monthly March 2004. Table 41.

10.3.3.3 Baseline Quantities and Prices for Transportation and Application Markets

For the three application markets, the NDEIM uses the values of production data reported by the U.S. Bureau of the Census and the U.S. Department of Agriculture. The Economic Census provides official measures of output for industries and geographic areas. It is the best publicly available data that measures market supply for the broadly defined application markets in the NDEIM, because its industrial classification system provides aggregate statistics for agriculture, constructing, and manufacturing. Trade data for agriculture and manufacturing is reported by the USDA and U.S. International Trade Commission (USITC)[N]. The NDEIM uses normalized commodities (e.g. price is one and value equals quantity) because of the great heterogeneity of products within each application market. To estimate production for future years, we applied average equipment growth rates to the value of output reported in Table 10.3-9 (see discussion of growth rates in Section 10.3.6).

Table 10.3-9
Baseline Data for NDEIM's Application Markets: 2000

Application Market	Value ($$10^9$)
Agriculture	Domestic Production: $ 219 Imports: $ 39
Construction	Domestic Production: $ 820
Manufacturing	Domestic Production: $ 4,209 Imports: $ 1,074

Sources: U.S. Department of Agriculture, National Agricultural Statistics Service (USDA-NASS). 2002. Agricultural Statistics 2002. Washington, DC: U.S. Department of Agriculture. Table 9-39 and Table 15-1. U.S. Census Bureau. 2003b. Value of Construction Put In Place: December 2002. C30/02-12. Washington, DC: U.S. Census Bureau. Table 1. U.S. Census Bureau. 2003a. Annual Survey of Manufactures. 2001 Statistics for Industry Groups and Industries. M01(AS)-1. Washington, DC: U.S. Census Bureau. Table 1. U.S. International Trade Commission. 2004. ITC Trade DataWeb. http://dataweb.usitc.gov/ As obtained March, 2004.

For the transportation service sectors, the NDEIM uses the latest service expenditure data reported by the U.S. Bureau of Economic Analysis. These values come from the 1997 Benchmark I-O Supplementary Make, Use, and Direct Requirements Tables at the Detailed Level." BEA's Industry Economic Program produces the input-output tables, which show how industries interact to provide input to, and take output from, each other. The data set can provide an appropriate measure transportation services purchased by the application markets included in NDEIM. Similar to the application markets, the model uses normalized commodities (e.g. price is one and value equals quantity). To estimate production for future years, we applied SO_2 growth rates for these sectors to the service expenditures reported in Table 10.3-10 (see discussion of growth rates in Section 10.3.6).

[N]International trade in construction is not significant.

Table 10.3-10
Baseline Data for NDEIM's Transportation Service Markets: 1997

Transportation Service Market	Value of Services Used by Application Markets Included in NDEIM ($$10^9$)
Locomotive	$19
Marine	$4

Source: U.S. Bureau of Economic Analysis (BEA). 1997 Benchmark I-O Supplementary Make, Use, and Direct Requirements Tables at the Detailed Level. Table 4. http://www.bea.gov/bea/dn2/i-o_benchmark.htm. Last updated November 24, 2003.

10.3.4 Calibrating the Fuel Spillover Baseline

The economic impact of the nonroad diesel rule is measured relative to the highway diesel rule. The highway rule is scheduled to be phased in prior to the nonroad rule. Thus, the effect of the highway rule must be incorporated into the baseline prior to modeling the impact of the nonroad rule. The main factor to be addressed is "spillover" fuel from the highway market. The Agency estimates that approximately one-third of nonroad equipment currently uses highway grade fuel because of access and distribution factors. Nonroad equipment currently using highway diesel will experience increased fuel costs as a result of the highway rule, but not as a result of the nonroad rule. These costs have already been captured in the highway rule analysis; thus, it is important to discount "spillover" fuel in the nonroad market to avoid double counting of cost impacts.

In this analysis, the baseline model is shocked by applying the compliance costs for the highway fuel requirements to the spillover fuel volumes included in Table 10.3-5. This provides an adjusted baseline for the nonroad economic impact analysis from which the incremental impact of the nonroad rule is estimated. When this adjustment is performed, increasing the cost of producing spillover fuel leads to a slight increase in the cost of producing goods and services in the application markets, and a decrease in application quantity ripples through the derived-demand curves of the equipment and engine markets, slightly reducing the baseline equipment and engine population. We assume that there are no substitutions between spillover diesel fuel consumption and nonroad diesel fuel consumption as prices change because demand is primarily driven by availability constraints.

10.3.5 Compliance Costs

The NDEIM uses the compliance cost estimates described in Chapters 6 and 7. These cost are summarized in Tables 10.3-13 through 10.3-15. The compliance cost per unit vary over time and by industry sector (engine, equipment, or fuel producer). All costs are presented in 2002 dollars.

For the reasons described in Section 10.1 and 10.2, the NDEIM does not handle all compliance costs in the same way. While all compliance costs are included in the economic welfare analysis to estimate the total social costs associated with the program, only some compliance costs are included in the market analysis to estimate changes in price and quantities of goods produced using the engines, equipment, and fuel affected by the rule. Table 10.3-11 identifies which compliance costs are used as shocks in the market analysis and which are added to the social cost estimates after changes in market prices and quantifies have been determined.

Table 10.3-11
How Compliance Costs are Accounted for in the Economic Analysis

Compliance Costs used to Shock the Market Model	Compliance Costs added after Market Analysis
• Variable costs for diesel engines • Variable costs for diesel equipment • Fixed and variable costs for nonroad diesel fuel	• Fixed costs for diesel engines • Fixed costs for diesel equipment • Changes in operating costs of diesel equipment

As noted above, marker costs for home heating fuel are included in the estimate of fixed and variable costs for nonroad diesel fuel (see Section 10.3.3.2, above).

10.3.5.1 Engine and Equipment Compliance Costs

For diesel engines, the projected compliance costs are largely due to using new technologies, such as advanced emissions control technologies and low-sulfur diesel fuel, to meet the proposed Tier 4 emissions standards. Compliance costs for engines are broken out by horsepower category and impact year. The method used to estimate these compliance costs is described in Section 6.4.3; the per unit compliance costs for the 175 to 600 hp range were estimated by sales weighting the 175 to 300 hp and the 300 to 600 hp per unit costs. The costs per unit change from year to year because engine standards are implemented differently in each power category. As shown in Table 10.3-13, the fixed cost per engine typically decreases after 5 years as these annualized costs are depreciated. The regulation's market impacts are driven primarily by the per-engine variable costs that remain relatively constant over time.

Because the estimated compliance costs for the rule are not directly proportional to engine price, the relative supply shift in each of the engine size markets is expected to vary.[O] As illustrated in Table 10.3-12, the ratio of variable engine compliance costs to market price ranges from 29 percent for engines 25 to 50 hp to 3 percent for engines above 600 hp. These different ratios lead to different relative shifts in the supply curves, and different impacts on the changes in market price and quantity for each market.

Table 10.3-12

[O]Fixed engine costs are not included in the supply shift; see Section 10.2.3.3.

Ratio of Variable Engine Compliance Costs to Engine Price

Power Range	Variable Engine Compliance Cost / Engine Price
0<hp<25	8.2%
25≤hp<50	29.3%
50≤hp<75	27.9%
75≤hp<100	28.3%
100≤hp<175	25.0%
175≤hp<600	8.5%
hp > 600 hp	2.8%

For nonroad equipment, the majority of the projected compliance costs are due to the need to redesign the equipment. The method used to estimate these compliance costs is described in Section 6.4.3. The fixed cost consists of the redesign cost to accommodate new emissions control devices. The variable cost consists of the cost of new or modified equipment hardware and of labor to install the new emissions control devices. The per unit compliance costs are weighted average costs within the appropriate horsepower range. The equipment sector compliance costs are broken out by horsepower category and impact year in Table 10.3-14. The majority of costs per piece of equipment are the fixed costs. The overall compliance costs per piece of equipment are less than half the overall costs associated with the same horsepower category engine.

Table 10.3-13
Compliance Costs per Engine[a]

HP Category	Cost Types	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0<hp<25	Variable	$129	$129	$123	$123	$123	$123	$123	$123	$123	$123
	Fixed	$33	$32	$31	$30	$30	$0	$0	$0	$0	$0
	Total	$162	$161	$154	$153	$152	$123	$123	$123	$123	$123
25≤hp<50	Variable	$147	$147	$139	$139	$139	$849	$849	$645	$645	$645
	Fixed	$49	$48	$47	$46	$45	$74	$73	$71	$70	$69
	Total	$196	$195	$187	$186	$185	$924	$922	$716	$715	$714
50≤hp<75	Variable	$167	$167	$158	$158	$158	$837	$837	$636	$636	$636
	Fixed	$50	$49	$49	$48	$47	$76	$75	$73	$72	$71
	Total	$217	$216	$206	$205	$205	$913	$912	$710	$709	$708
75≤hp<100	Variable	$0	$0	$0	$0	$1,133	$1,133	$1,122	$1,122	$1,122	$1,122
	Fixed	$0	$0	$0	$0	$80	$78	$108	$106	$104	$29
	Total	$0	$0	$0	$0	$1,213	$1,212	$1,229	$1,227	$1,226	$1,151
100≤hp<175	Variable	$0	$0	$0	$0	$1,375	$1,375	$1,351	$1,351	$1,351	$1,351
	Fixed	$0	$0	$0	$0	$78	$77	$106	$105	$103	$29
	Total	$0	$0	$0	$0	$1,453	$1,452	$1,457	$1,455	$1,454	$1,380
175≤hp<600	Variable	$0	$0	$0	$2,191	$2,190	$1,697	$2,137	$2,136	$2,136	$2,135
	Fixed	$0	$0	$0	$326	$321	$316	$437	$430	$122	$120
	Total	$0	$0	$0	$2,517	$2,511	$2,012	$2,574	$2,567	$2,258	$2,255
hp≥600hp	Variable	$0	$0	$0	$2,911	$2,910	$2,246	$2,733	$6,153	$6,153	$5,347
	Fixed	$0	$0	$0	$861	$848	$835	$1,083	$1,526	$705	$695
	Total	$0	$0	$0	$3,771	$3,758	$3,081	$3,817	$7,679	$6,857	$6,042

[a] 2002 dollars

(continued)

Table 10.3-13 (continued)
Compliance Costs per Engine[a]

HP Category	Cost Types	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
0<hp<25	Variable	$123	$123	$123	$123	$123	$123	$123	$123	$123	$123
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$123	$123	$123	$123	$123	$123	$123	$123	$123	$123
25≤hp<50	Variable	$645	$645	$645	$645	$645	$645	$645	$645	$645	$645
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$645	$645	$645	$645	$645	$645	$645	$645	$645	$645
50≤hp<75	Variable	$636	$636	$636	$636	$636	$636	$636	$636	$636	$636
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$636	$636	$636	$636	$636	$636	$636	$636	$636	$636
75≤hp<100	Variable	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122
	Fixed	$28	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$1,150	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122
100≤hp<175	Variable	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351
	Fixed	$29	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$1,380	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351
175≤hp<600	Variable	$2,134	$2,133	$2,132	$2,132	$2,131	$2,130	$2,130	$2,129	$2,128	$2,128
	Fixed	$119	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$2,253	$2,133	$2,132	$2,132	$2,131	$2,130	$2,130	$2,129	$2,128	$2,128
hp≥600hp	Variable	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347
	Fixed	$685	$433	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$6,032	$5,780	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347

[a] 2002 dollars

(continued)

Table 10.3-13 (continued)
Compliance Costs per Engine[a]

HP Category	Cost Types	2028	2029	2030	2031	2032	2033	2034	2035	2036
0<hp<25	Variable	$123	$123	$123	$123	$123	$123	$123	$123	$123
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$123	$123	$123	$123	$123	$123	$123	$123	$123
25≤hp<50	Variable	$645	$645	$645	$645	$645	$645	$645	$645	$645
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$645	$645	$645	$645	$645	$645	$645	$645	$645
50≤hp<75	Variable	$636	$636	$636	$636	$636	$636	$636	$636	$636
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$636	$636	$636	$636	$636	$636	$636	$636	$636
75≤hp<100	Variable	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122	$1,122
100≤hp<175	Variable	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351	$1,351
175≤hp<600	Variable	$2,127	$2,127	$2,126	$2,126	$2,125	$2,124	$2,124	$2,123	$2,123
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$2,127	$2,127	$2,126	$2,126	$2,125	$2,124	$2,124	$2,123	$2,123
hp≥600hp	Variable	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347	$5,347

[a] 2002 dollars

Table 10.3-14
Costs per Piece of Equipment[a]

HP Category	Cost Types	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0<hp<25	Variable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Fixed	$15	$15	$14	$14	$14	$13	$13	$13	$12	$12
	Total	$15	$15	$14	$14	$14	$13	$13	$13	$12	$12
25≤hp<50	Variable	$0	$0	$0	$0	$0	$20	$20	$16	$16	$16
	Fixed	$8	$8	$8	$7	$7	$42	$41	$40	$40	$39
	Total	$8	$8	$8	$7	$7	$62	$62	$57	$56	$55
50≤hp<75	Variable	$0	$0	$0	$0	$0	$21	$21	$17	$17	$17
	Fixed	$8	$8	$8	$8	$8	$44	$43	$42	$42	$41
	Total	$8	$8	$8	$8	$8	$65	$64	$59	$59	$58
75≤hp<100	Variable	$0	$0	$0	$0	$45	$45	$48	$48	$48	$48
	Fixed	$0	$0	$0	$0	$109	$107	$132	$130	$128	$126
	Total	$0	$0	$0	$0	$154	$152	$180	$178	$176	$174
100≤hp<175	Variable	$0	$0	$0	$0	$46	$46	$49	$49	$49	$49
	Fixed	$0	$0	$0	$0	$170	$168	$207	$204	$201	$197
	Total	$0	$0	$0	$0	$216	$213	$256	$253	$250	$246
175≤hp<600	Variable	$0	$0	$0	$75	$75	$60	$80	$80	$80	$80
	Fixed	$0	$0	$0	$378	$372	$366	$453	$446	$439	$433
	Total	$0	$0	$0	$453	$447	$426	$533	$526	$519	$513
hp≥600hp	Variable	$0	$0	$0	$57	$57	$46	$61	$123	$123	$111
	Fixed	$0	$0	$0	$690	$680	$670	$806	$1,404	$1,384	$1,365
	Total	$0	$0	$0	$748	$737	$716	$867	$1,527	$1,507	$1,475

[a] 2002 dollars

(continued)

Table 10.3-14 (continued)
Costs per Piece of Equipment[a]

HP Category	Cost Types	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
0<hp<25	Variable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
25≤hp<50	Variable	$16	$16	$16	$16	$16	$16	$16	$16	$16	$16
	Fixed	$32	$31	$31	$30	$30	$0	$0	$0	$0	$0
	Total	$48	$47	$47	$46	$46	$16	$16	$16	$16	$16
50≤hp<75	Variable	$17	$17	$17	$17	$17	$17	$17	$17	$17	$17
	Fixed	$33	$33	$32	$32	$31	$0	$0	$0	$0	$0
	Total	$50	$50	$49	$49	$48	$17	$17	$17	$17	$17
75≤hp<100	Variable	$48	$48	$48	$48	$48	$48	$48	$48	$48	$48
	Fixed	$124	$122	$120	$118	$24	$24	$0	$0	$0	$0
	Total	$172	$170	$168	$167	$72	$72	$48	$48	$48	$48
100≤hp<175	Variable	$49	$49	$49	$49	$49	$49	$49	$49	$49	$49
	Fixed	$194	$192	$189	$186	$37	$37	$0	$0	$0	$0
	Total	$243	$241	$238	$235	$86	$86	$49	$49	$49	$49
175≤hp<600	Variable	$80	$80	$79	$79	$79	$79	$79	$79	$79	$79
	Fixed	$427	$421	$415	$83	$82	$81	$0	$0	$0	$0
	Total	$506	$500	$494	$162	$161	$160	$79	$79	$79	$79
hp≥600hp	Variable	$111	$111	$111	$111	$111	$111	$111	$111	$111	$111
	Fixed	$1,346	$1,328	$1,310	$693	$684	$675	$540	$0	$0	$0
	Total	$1,457	$1,438	$1,421	$804	$795	$786	$650	$111	$111	$111

[a] 2002 dollars

(continued)

Table 10.3-14 (continued)
Costs per Piece of Equipment[a]

HP Category	Cost Types	2028	2029	2030	2031	2032	2033	2034	2035	2036
0<hp<25	Variable	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$0	$0	$0	$0	$0
25≤hp<50	Variable	$16	$16	$16	$16	$16	$16	$16	$16	$16
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$16	$16	$16	$16	$16	$16	$16	$16	$16
50≤hp<75	Variable	$17	$17	$17	$17	$17	$17	$17	$17	$17
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$17	$17	$17	$17	$17	$17	$17	$17	$17
75≤hp<100	Variable	$48	$48	$48	$48	$48	$48	$48	$48	$48
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$48	$48	$48	$48	$48	$48	$48	$48	$48
100≤hp<175	Variable	$49	$49	$49	$49	$49	$49	$49	$49	$49
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$49	$49	$49	$49	$49	$49	$49	$49	$49
175≤hp<600	Variable	$79	$79	$79	$79	$79	$79	$79	$79	$79
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$79	$79	$79	$79	$79	$79	$79	$79	$79
hp≥600hp	Variable	$111	$111	$111	$111	$111	$111	$111	$111	$111
	Fixed	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$111	$111	$111	$111	$111	$111	$111	$111	$111

[a] 2002 dollars

10.3.5.2 Nonroad Diesel Fuel Compliance Costs

The fuel compliance costs used in the NDEIM are the same as those described in Chapter 7. The NDEIM uses different compliance costs for each PADD, and for different fuel sulfur levels (15 and 500 ppm fuel). Thus, the compliance costs change when the fuel standards change, reflecting the phase-in of the fuel requirements. From 2007 to 2010, nonroad, locomotive, and marine diesel fuels are required to meet a 500 ppm sulfur cap. During this period small refiners can continue producing high sulfur distillate fuel (~3000 ppm) and sell it into the nonroad, locomotive and marine diesel fuel pool. In 2010, the sulfur standard for nonroad, locomotive and marine diesel fuel changes to a 15 ppm sulfur cap. From 2010 to 2014, small refiners can provide fuel complying with a 500 ppm sulfur cap to the nonroad, locomotive and marine diesel fuel pool, except in most of PADD 1 where 500 ppm small refiner fuel cannot be sold. After 2014, the program is fully phased-in when the small refinery provisions cease. Table 10.3-15 presents a summary of the compliance costs used in the model. It should be noted that these compliance costs are weighted averages of the separate compliance costs for each grade of fuel sold in that period.

In contrast to the engine and equipment compliance costs, the fuel compliance costs include fixed costs. They also include the marker costs described in Section 10.1.3.6. See Chapter 7 for a more detailed description of the components of the fuel compliance costs and how they are estimated. See Section 10.2..2.3 for a discussion of how fixed and variable costs are handled in the model.

Table 10.3-15
Fuel Compliance Costs, Locomotive, and Marine Diesel Fuel by PADD
Selected Years

Year[a]	Average Cost		Maximum Total Cost	
	500 ppm	15 ppm	500 ppm	15 ppm
PADD I and III				
2007-9	1.8	—	4.5	—
2010	1.86	5.7	4.57	9.4
2011	2.7	5.7	6.1	9.4
2014-13	2.7	6.0	6.1	9.6
2015	2.7	6.3	6.1	9.8
PADD II				
2007-9	2.5	—	3.8	—
2010	2.55	7.4	3.94	10.8
2011-13	3.5	7.4	5.9	10.8

Year[a]	Average Cost		Maximum Total Cost	
	500 ppm	15 ppm	500 ppm	15 ppm
2014	3.5	7.7	5.9	11.1
2015	3.5	7.9	5.9	11.2
PADD IV				
2007-9	3.5	—	6.1	—
2010	3.83	12.6	6.26	13.6
2011-13	9.2	12.6	9.2	13.6
2014	9.2	12.8	9.2	13.8
2015	9.2	13	9.2	13.9
PADD V[b]				
2007-9	1.5	—	1.5	—
2010	1.58	5.1	1.62	5.2
2011	3.7	5.1	4.4	5.2
2014-13	3.7	6.1	4.4	6.4
2015	3.7	6.9	4.4	7.3

[a]Note that the 500 ppm standard begins in 6/06 and the 15 ppm standard begins in 6/10

[b] Excludes diesel fuel sold for use in California which is regulated by California's regulations.

10.3.5.3 Changes in Operating Costs

As described in Section 6.2.3 of Chapter 6, changes in operating costs are expected to be realized by all diesel equipment users as a result of the reduced sulfur content of nonroad diesel fuel. These changes in operating costs include the change in maintenance costs associated with applying new emission controls to the engines; the change in maintenance costs associated with low-sulfur fuel such as extended oil-change intervals (extended oil change intervals results in maintenance savings); the change in fuel costs associated with the incrementally higher costs for low-sulfur fuel (see Chapter 7), and the change in fuel costs due to any fuel consumption impacts associated with applying new emission controls to the engines (e.g., cost is attributed to the CDPF and its need for periodic regeneration). Some of these changes in operating costs will accrue to users of existing as well as new equipment.

The expected changes in operating costs are not included in the market analysis. This is because, as explained in Chapter 6, these savings are not expected to affect consumer decisions with respect to new engines. Changes in operating costs are included in the social cost analysis, however, because they accrue to society. They are added into the estimated social costs as an additional savings to the application markets, since it is the users of these engines and fuels who will see these savings. Appendix 10I contains a sensitivity analysis in which operating cost savings are introduced into the market analysis as a downward shift in the application supply functions.

The operating savings in the social cost analysis were estimated by EPA using the estimated ¢/gallon operating savings estimates and the fuel volumes described in Chapter 6 and 7. Total annual operating savings were estimated for nonroad, locomotive, and marine fuel. The annual operating savings associated with nonroad fuel were allocated to the three application markets (i.e., the users of nonroad equipment) based on the number of gallons of nonroad diesel consumed in each of the agriculture (32.1 percent), construction (47.4 percent), and manufacturing sectors (20.5 percent). A different approach was followed for locomotive and marine fuel. This is necessary because not all locomotive and marine transportation services are provided to the three application markets included in the NDEIM (see Section 10.1.5). In this case, 54 percent of the locomotive and marine operating savings were allocated to the marine and locomotive transportation services included in the NDEIM and 46 percent were allocated to marine and locomotive transportation services provided for application markets not included in the NDEIM.

Table 10.3-16
Operating Cost Savings ($Millions)

Year	Nonroad	Locomotive	Marine	Total
2007	140	12	9	161
2008	246	21	15	282
2009	251	21	16	288
2010	266	22	17	305
2011	271	23	18	311
2012	261	23	18	302
2013	243	23	18	285
2014	257	17	19	293
2015	256	13	20	288
2016	241	13	20	274
2017	228	13	20	261
2018	216	13	20	249
2019	205	13	21	239
2020	192	13	22	227
2021	182	13	23	218
2022	176	14	23	213
2023	171	14	23	208
2024	167	14	23	204
2025	163	14	24	201
2026	160	14	24	198
2027	157	14	24	196
2028	156	14	25	195
2029	155	14	25	194
2030	154	15	25	194
2031	154	15	26	194
2032	154	15	26	195
2033	154	15	26	195
2034	154	15	27	196
2035	155	15	27	197
2036	156	15	27	198

Source: See Chapter 6 for an explanation of operating savings; the above values are based on the values reported in Table 6.4-3, applied to the relevant fuel volumes.

10.3.6 Growth Rates

The growth rates used in this analysis for engines and equipment are the same as those provided in Section 8.1. The growth rate for nonroad diesel fuel is from the Nonroad Model. The growth rates for locomotive, marine, heating oil, and highway diesel fuel are all from EIA's Annual Energy Outlook 2003.

Growth rates for the application markets are the average of the growth rates for equipment used in the relevant markets. They range from 1.8 percent (>600 HP) to 3.5 percent (<25 HP). This method was used over a method applying sales weighted averages because it does not overestimate the application growth rate by giving more weight to higher growth rates of small HP equipment. If a weighted average were used, the small engine growth rate would dominate because there are so many more small engines. Using such a weighted average would then overstate the growth rate for the larger engines. The difference between the two approach is about 0.2 percent (about 2.3 percent for unweighted and about 2.5 percent for weighted).

Finally, for the locomotive and marine sectors, growth is based on EPA's SO_2 inventory growth projections for marine diesel engines that use distillate fuel (typically engines with displacement less than 30 liters per cylinder), 50-state annual inventories, 1999-2003.

10.3.7 Market Supply and Demand Elasticities

To operationalize the market model, supply and demand elasticities are needed to represent the behavior adjustments that are likely to be made by market participants. The following parameters are needed:

- supply and demand price elasticities for application markets (construction, agriculture, and manufacturing),
- supply elasticities for equipment markets,
- supply elasticities for engine markets, and
- supply elasticities for diesel fuel markets.

Note that, for the equipment, engine, and diesel fuel markets, demand-specific elasticity estimates are not needed because they are derived internally as a function of changes in output levels in the applications markets.

Tables 10.3-17 and 10.3-18 provides a summary of the demand and supply elasticities used to estimate the economic impact of the proposed rule. Most elasticities were derived econometrically using publicly available data, with the exception of the supply elasticities for the construction and agricultural application markets and the diesel fuel supply elasticity, which were obtained from previous studies.[P] The general methodologies for estimating the supply and

[P]A supply function was estimated as part of the simultaneous equations approach used for the construction and manufacturing application markets. However, the supply elasticity estimates were not statistically significant and were negative, which is inconsistent with generally demand elasticities are discussed below. The specific regression results are presented in Appendix 10G. It should be noted that these elasticities reflect intermediate run behavioral changes. In the long run, supply and demand are expected to be more elastic since more substitutes may become available.

accepted economic theory. For this reason, literature estimates were used for the supply elasticities in the construction and manufacturing application markets.

Table 10.3-17
Summary of Market Demand Elasticities Used in the NDEIM

Market	Estimate	Source	Method	Input Data Summary
Applications				
Agriculture	–0.20	EPA econometric estimate	Productivity shift approach (Morgenstern, Pizer, and Shih, 2002)	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Construction	–0.96	EPA econometric estimate	Simultaneous equation (log-log) approach	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Manufacturing	–0.58	EPA econometric estimate	Simultaneous equation (log-log) approach.	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Transportation Services				
Locomotive		Derived demand	In the derived demand approach, • compliance costs increase prices and decrease demand for products and services in the application markets; • this in turn leads to reduced demand for diesel equipment, engines and fuel, which are inputs into the production of products and services in the application markets	
Marine		Derived demand		
Equipment				
Agriculture		Derived demand		
Construction		Derived demand		
Pumps/ compressors		Derived demand		
Generators and Welders		Derived demand		
Refrigeration		Derived demand		
Industrial		Derived demand		
Lawn and Garden		Derived demand		
Engines		Derived demand		
Diesel fuel		Derived demand		

Table 10.3-18
Summary of Market Supply Elasticities Used in the NDEIM

Markets	Estimate	Source	Method	Input Data Summary
Applications				
Agriculture	0.32	Literature-based estimate	Production-weighted average of individual crop estimates ranging from 0.27 to 0.55. (Lin et al., 2000)	Agricultural Census data 1991 – 1995
Construction	1.0	Literature-based estimate	Based on Topel and Rosen, (1988).[a]	Census data, 1963 – 1983
Manufacturing	1.0	Literature-based estimate	Literature estimates are not available so assumed same value as for Construction market	Not applicable
Transportation Services				
Locomotive	0.6	Literature-based estimate	Method based on Ivaldi and McCollough (2001)	Association of American Railroads 1978-1997
Marine	0.6	Literature-based estimate	Literature estimates not available so assumed same value as for locomotive market	Not applicable
Equipment				
Agriculture	2.14	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3523
Construction	3.31	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3531
Pumps/ compressors	2.83	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3561 and 3563
Generators/ Welder Sets	2.91	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3548
Refrigeration	2.83	EPA econometric estimate		Assumed same as pumps/compressors
Industrial	5.37	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3537
Lawn and Garden	3.37	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3524
Engines	3.81	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3519
Diesel fuel	0.24	Literature based estimate	Based on Considine (2002).[b]	From Energy Intelligence Group (EIG); 1987-2000[c]

[a] Most other studies estimate ranges that encompass 1.0, including DiPasquale (1997) and DiPasquale and Wheaton (1994).
[b] Other estimates range from 0.02 to 1.0 (Greene and Tishchishyna, 2000). However, Considine (2002) is one of the few studies that estimates a supply elasticity for refinery operations. Most petroleum supply elasticities also include extraction.
[c] This source refers to the data used by Considine in his 2002 study.

10.3.8 Model Solution

10.3.8.1 Computing Baseline and With-Regulation Equilibrium Conditions

To perform the economic impact analysis, the model compares the baseline equilibrium conditions and the counterfactual with-regulation equilibrium conditions produced under a changed policy regime. The assumption of an "observable" baseline equilibrium leads directly to the need for and construction of a data set that fulfills the equilibrium conditions for markets included in NDEIM. For this analysis, we examine the impacts of the rule for 29 years (2007 to 2036). As a result, we need to develop an observable baseline for each of these future years. This section describes the data and approach used to establish these baselines.

Developing a Baseline Equilibrium: In order to construct a baseline for each year, equilibrium market conditions without the rule were computed using the following three steps:

- Collect baseline prices and production data for the most recently available year (2000).

- Apply appropriate growth rates to estimate future production for markets included in NDEIM, and

- Incorporate the impact of increased fuel costs associated with the highway rule prior to analysis of the final nonroad rule. We incorporate the impact of the highway rule costs in the baseline because they have already been captured in the highway rule analysis; thus, we avoid double counting of cost impacts of the highway rule. In effect, our baseline market projections are "shocked" by the highway rule and a new set of baseline prices and quantities is estimated for all linked markets. This new baseline is the appropriate point of departure for analysis of the final nonroad rule.

It is important to note that the baseline analysis of each year does not incorporate the cumulative regulatory effects from the highway and nonroad rule in previous years. For example, the regulatory effects impacts from year 2007 do not affect the baseline conditions for the years 2008 through 2036. These dynamic interactions would reduce the estimated impact of the regulation but are beyond the scope of the modeling effort. As a result, the impact estimates may be viewed as conservative in that they likely over estimate impacts.

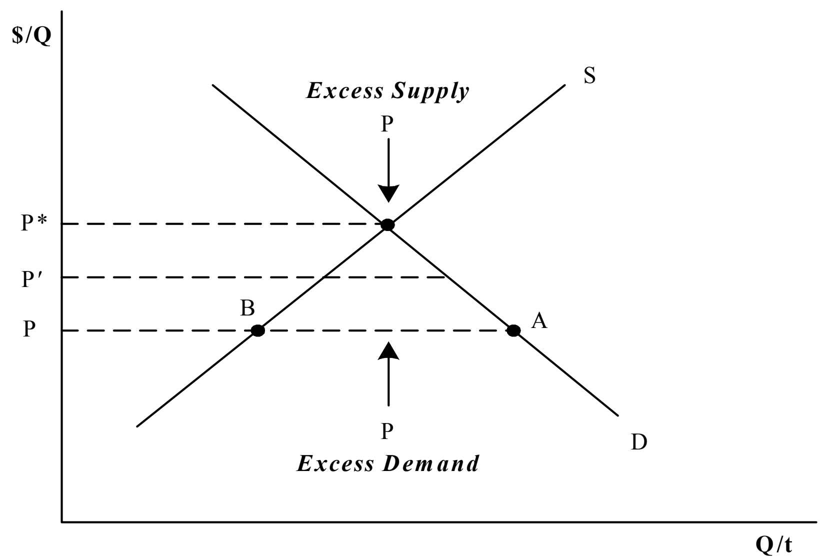
Shifting the Supply Function: The starting point for assessing the market impacts of a regulatory action is to incorporate the regulatory compliance costs into the production decision of the firm. In order to quantify this upward shift, the model the per-unit compliance cost estimates as the measure of additional cost per unit of producing output[Q]. Treatment of compliance costs in this manner is the conceptual equivalent of a unit tax on output.

[Q]We discuss the calculation of the appropriate per-unit compliance cost measure used in each market in Section 10.2.3.3 of the RIA.

Computing With-Regulation Equilibrium Conditions: The French economist Léon Walras proposed one early model of market price adjustment by using the following thought experiment. Suppose there is a hypothetical agent that facilitates market adjustment by playing the role of an "auctioneer." He announces prices, collects information about supply and demand responses (without transactions actually taking place), and continues this process until market equilibrium is achieved.

For example, suppose the auctioneer calls out a price (P) that is lower than the equilibrium price (P*) (see Figure 10.3-1). He then determines that the quantity demanded (A) exceeds the quantity supplied (B) and calls out a new (higher) price (P'). This process continues until P=P*. A similar analysis takes place when excess supply exists. The auctioneer calls out lower prices when the price is higher than the equilibrium price.

Figure 10.3-1.
For Prices Higher (Lower) than P*, Price Will Fall (Rise)



10.3.8.2 Solution Algorithm

Supply responses and market adjustments can be conceptualized as an interactive process. Producers facing increased production costs due to compliance are willing to supply smaller quantities at the baseline price. This reduction in market supply leads to an increase in the market price that all producers and consumers face, which leads to further responses by producers and consumers and thus new market prices, and so on. The new with-regulation equilibrium is the result of a series of iterations in which price is adjusted and producers and consumers respond, until a set of stable market prices arises where total market supply equals market demand. Market price adjustment takes place based on a price revision rule, described below, that adjusts price upward (downward) by a given percentage in response to excess demand (excess supply).

The NDEIM model uses a similar type of algorithm for determining with-regulation equilibria and the process can be summarized by six recursive steps:

1. Impose the control costs on affected supply segments, thereby affecting their supply decisions.

2. Recalculate the market supply in each market. Excess demand currently exists.

3. Determine the new prices via a price revision rule. We use a rule similar to the factor price revision rule described by Kimbell and Harrison (1986). P_i is the market price at iteration I, q_d is the quantity demanded, and q_s is the quantity supplied. The parameter z influences the magnitude of the price revision and speed of convergence. The revision rule increases the price when excess demand exists, lowers the price when excess supply exists, and leaves the price unchanged when market demand equals market supply. The price adjustment is expressed as follows:

$$P_{i+1} = P_1 \bullet \left(\frac{q_d}{q_s} \right)^z \qquad (10.1)$$

4. Recalculate market supply with new prices,

5. Compute market demand in each market.

6. Compare supply and demand in each market. If equilibrium conditions are not satisfied, go to Step 3, resulting in a new set of market prices. Repeat until equilibrium conditions are satisfied (i.e., the ratio of supply and demand is arbitrarily close to one). When the ratio is appropriately close to one, the market- clearing condition of supply equals demand is satisfied.

10.4 Estimating Impacts

Using the static partial equilibrium analysis, the NDEIM model loops through each year calculating new market equilibriums based on the projected baseline economic conditions and compliance cost estimates that shift the supply curves in the model. The model calculates price and quantity changes and uses these measures to estimate the social costs of the rule and partition the impact between producers and consumers. This approach follows the classical treatment of tax burden distribution in the public finance literature (e.g., Harberger, 1974).

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APPENDIX 10A: Impacts on the Engine Markets

This appendix provides the time series of impacts from 2007 through 2036 for the engine markets. Seven separate engine markets were modeled segmented by engine size in horsepower (the EIA includes more horsepower categories than the standards, allowing more efficient use of the engine compliance cost estimates developed for this rule):

- less than 25 hp
- 26 to 50 hp
- 51 to 75 hp
- 76 to 100 hp
- 101 to 175 hp
- 176 to 600 hp
- greater than 601 hp

Tables 10A-1 through 10A-7 provide the time series of impacts for the seven horsepower markets included in the analysis. Each table includes the following:

- average engine price
- average engineering costs (variable and fixed) per engine
  - Note that in the engineering cost analysis, fixed costs for engine manufacturers are recovered in the first five years (see Chapter 6)
- absolute change in the market price ($)
  - Note that the estimated absolute change in market price is based on variable costs only; see Appendix 10I for a sensitivity analysis including fixed costs as well
- relative change in market price (%)
- relative change in market quantity (%)
- total engineering (regulatory) costs for merchant engines ($)
- change in producer surplus from merchant engine manufacturers

As described in Section 10.3.3.1, approximately 65 percent of engines are sold on the market and these are referred to as “merchant” engines. The remaining 35 percent are consumed internally by integrated equipment manufacturers and are referred to as “captive” engines. The total engineering costs and changes in producer surplus presented in this appendix include only merchant engines because captive engines never pass through the engines markets. Fixed and variable engineering costs and changes in producer surplus associated with captive engines are included in equipment manufacture impact estimates presented in Appendix 10B.

All prices and costs are presented in $2002, and real engine prices are assumed to be constant. The engineering cost per engine typically decreases after 5 years as the annualized fixed costs are recovered. The price increase after that time is driven by the per-engine variable costs and remains relatively constant over time.

For all the engine size categories, the majority of the cost of the regulation is passed along through increased engine prices. Price increases in 2036 are estimated to be $123 (8.2 percent) for engines <25 hp, $645 (22.2 percent) for engines 26 to 50 hp, $636 (21.2 percent) for engines 51 to 75 hp, $1,121 (28 percent) for engines 76 to 100 hp, $1,350 (24.6 percent) for engines 101 to 175 hp, $2,122 (10.6 percent) for engines 176 to 600 hp, and $5,343 (6.6 percent) for engines above 601 hp.

While the cost per engine and market impacts (in terms of percentage change in price and quantity) stabilize in the later years of the regulation, the engineering costs and producer surplus changes continue to gradually increase because the projected baseline population of engines increases over time.

Table 10A-1. Impacts on the Engine Market and Engine Manufacturers: ≤25hp (Average Price per Engine = $1,500)[a]

	Engine (≤25Hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.001%	—	—
2008	$162	$129	8.6%	–0.002%	$20,017	–$4,043
2009	$161	$129	8.6%	–0.002%	$20,449	–$4,043
2010	$154	$123	8.2%	–0.004%	$20,007	–$4,044
2011	$153	$123	8.2%	–0.007%	$20,417	–$4,045
2012	$152	$123	8.2%	–0.009%	$20,827	–$4,047
2013	$123	$123	8.2%	–0.010%	$17,195	–$5
2014	$123	$123	8.2%	–0.011%	$17,605	–$6
2015	$123	$123	8.2%	–0.011%	$18,015	–$6
2016	$123	$123	8.2%	–0.011%	$18,425	–$6
2017	$123	$123	8.2%	–0.011%	$18,835	–$6
2018	$123	$123	8.2%	–0.011%	$19,245	–$6
2019	$123	$123	8.2%	–0.011%	$19,654	–$6
2020	$123	$123	8.2%	–0.011%	$20,064	–$7
2021	$123	$123	8.2%	–0.011%	$20,474	–$7
2022	$123	$123	8.2%	–0.011%	$20,884	–$7
2023	$123	$123	8.2%	–0.011%	$21,294	–$7
2024	$123	$123	8.2%	–0.011%	$21,704	–$7
2025	$123	$123	8.2%	–0.011%	$22,114	–$7
2026	$123	$123	8.2%	–0.011%	$22,524	–$7
2027	$123	$123	8.2%	–0.011%	$22,934	–$7
2028	$123	$123	8.2%	–0.011%	$23,344	–$8
2029	$123	$123	8.2%	–0.011%	$23,753	–$8
2030	$123	$123	8.2%	–0.011%	$24,163	–$8
2031	$123	$123	8.2%	–0.011%	$24,573	–$8
2032	$123	$123	8.2%	–0.011%	$24,983	–$8
2033	$123	$123	8.2%	–0.011%	$25,393	–$8
2034	$123	$123	8.2%	–0.011%	$25,803	–$8
2035	$123	$123	8.2%	–0.011%	$26,213	–$9
2036	$123	$123	8.2%	–0.011%	$26,623	–$9
NPV[b]					$370,428	–$17,043

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10A-2. Impacts on the Engine Market and Engine Manufacturers: 26–50hp (Average Price per Engine = $2,900)[a]

	Engine (26hp to 50hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.002%	—	–$1
2008	$196	$147	5.1%	–0.003%	$26,163	–$6,592
2009	$195	$147	5.1%	–0.003%	$26,589	–$6,592
2010	$187	$139	4.8%	–0.006%	$25,943	–$6,595
2011	$186	$139	4.8%	–0.011%	$26,347	–$6,600
2012	$185	$139	4.8%	–0.014%	$26,750	–$6,604
2013	$924	$849	29.3%	–0.015%	$136,464	–$10,981
2014	$922	$849	29.3%	–0.016%	$138,927	–$10,983
2015	$716	$645	22.2%	–0.016%	$110,004	–$10,983
2016	$715	$645	22.2%	–0.016%	$111,875	–$10,984
2017	$714	$645	22.2%	–0.016%	$113,746	–$10,984
2018	$645	$645	22.2%	–0.016%	$104,651	–$19
2019	$645	$645	22.2%	–0.016%	$106,522	–$19
2020	$645	$645	22.2%	–0.016%	$108,392	–$19
2021	$645	$645	22.2%	–0.016%	$110,263	–$20
2022	$645	$645	22.2%	–0.016%	$112,134	–$20
2023	$645	$645	22.2%	–0.016%	$114,005	–$20
2024	$645	$645	22.2%	–0.016%	$115,875	–$21
2025	$645	$645	22.2%	–0.016%	$117,746	–$21
2026	$645	$645	22.2%	–0.016%	$119,617	–$21
2027	$645	$645	22.2%	–0.016%	$121,488	–$22
2028	$645	$645	22.2%	–0.016%	$123,359	–$22
2029	$645	$645	22.2%	–0.016%	$125,229	–$22
2030	$645	$645	22.2%	–0.016%	$127,100	–$23
2031	$645	$645	22.2%	–0.016%	$128,971	–$23
2032	$645	$645	22.2%	–0.016%	$130,842	–$23
2033	$645	$645	22.2%	–0.016%	$132,712	–$24
2034	$645	$645	22.2%	–0.016%	$134,583	–$24
2035	$645	$645	22.2%	–0.016%	$136,454	–$24
2036	$645	$645	22.2%	–0.016%	$138,325	–$25
NPV[b]					$1,722,675	–$67,561

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table10.A-3. Impacts on the Engine Market and Engine Manufacturers: 51–75hp (Average Price per Engine = $3,000)[a]

	Engine (51hp to 75hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.002%	—	–$1
2008	$217	$167	5.6%	–0.004%	$18,388	–$4,259
2009	$216	$167	5.6%	–0.004%	$18,650	–$4,259
2010	$206	$158	5.3%	–0.006%	$18,102	–$4,261
2011	$205	$158	5.3%	–0.011%	$18,350	–$4,264
2012	$205	$158	5.3%	–0.014%	$18,597	–$4,267
2013	$913	$837	27.9%	–0.015%	$84,465	–$7,033
2014	$912	$837	27.9%	–0.017%	$85,780	–$7,035
2015	$710	$636	21.2%	–0.017%	$67,870	–$7,035
2016	$709	$636	21.2%	–0.017%	$68,869	–$7,035
2017	$708	$636	21.2%	–0.017%	$69,868	–$7,035
2018	$636	$636	21.2%	–0.017%	$63,844	–$13
2019	$636	$636	21.2%	–0.017%	$64,843	–$13
2020	$636	$636	21.2%	–0.017%	$65,842	–$13
2021	$636	$636	21.2%	–0.017%	$66,841	–$13
2022	$636	$636	21.2%	–0.017%	$67,840	–$13
2023	$636	$636	21.2%	–0.017%	$68,840	–$13
2024	$636	$636	21.2%	–0.017%	$69,839	–$14
2025	$636	$636	21.2%	–0.017%	$70,838	–$14
2026	$636	$636	21.2%	–0.017%	$71,837	–$14
2027	$636	$636	21.2%	–0.017%	$72,836	–$14
2028	$636	$636	21.2%	–0.017%	$73,835	–$14
2029	$636	$636	21.2%	–0.017%	$74,834	–$15
2030	$636	$636	21.2%	–0.017%	$75,833	–$15
2031	$636	$636	21.2%	–0.017%	$76,832	–$15
2032	$636	$636	21.2%	–0.017%	$77,832	–$15
2033	$636	$636	21.2%	–0.017%	$78,831	–$15
2034	$636	$636	21.2%	–0.017%	$79,830	–$16
2035	$636	$636	21.2%	–0.017%	$80,829	–$16
2036	$636	$636	21.2%	–0.017%	$81,828	–$16
NPV[b]					$1,052,492	–$43,432

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table10A-4. Impacts on the Engine Market and Engine Manufacturers: 76–100hp
(Average Price per Engine = $4,000)[a]

	Engine (76hp to 100hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.002%	—	–$1
2008	—	—	0.0%	–0.004%	—	–$1
2009	—	—	0.0%	–0.004%	—	–$2
2010	—	—	0.0%	–0.006%	—	–$3
2011	—	—	0.0%	–0.011%	—	–$6
2012	$1,213	$1,133	28.3%	–0.015%	$69,454	–$4,576
2013	$1,212	$1,133	28.3%	–0.016%	$70,577	–$4,577
2014	$1,229	$1,121	28.0%	–0.017%	$72,815	–$6,379
2015	$1,227	$1,121	28.0%	–0.017%	$73,926	–$6,379
2016	$1,226	$1,121	28.0%	–0.017%	$75,037	–$6,379
2017	$1,151	$1,121	28.0%	–0.017%	$71,580	–$1,812
2018	$1,150	$1,121	28.0%	–0.017%	$72,691	–$1,812
2019	$1,122	$1,121	28.0%	–0.017%	$72,001	–$11
2020	$1,122	$1,121	28.0%	–0.017%	$73,112	–$11
2021	$1,122	$1,121	28.0%	–0.017%	$74,223	–$11
2022	$1,122	$1,121	28.0%	–0.017%	$75,334	–$11
2023	$1,122	$1,121	28.0%	–0.017%	$76,445	–$12
2024	$1,122	$1,121	28.0%	–0.017%	$77,556	–$12
2025	$1,122	$1,121	28.0%	–0.017%	$78,667	–$12
2026	$1,122	$1,121	28.0%	–0.017%	$79,778	–$12
2027	$1,122	$1,121	28.0%	–0.017%	$80,889	–$12
2028	$1,122	$1,121	28.0%	–0.017%	$82,000	–$12
2029	$1,122	$1,121	28.0%	–0.017%	$83,111	–$13
2030	$1,122	$1,121	28.0%	–0.017%	$84,222	–$13
2031	$1,122	$1,121	28.0%	–0.017%	$85,333	–$13
2032	$1,122	$1,121	28.0%	–0.017%	$86,444	–$13
2033	$1,122	$1,121	28.0%	–0.017%	$87,555	–$13
2034	$1,122	$1,121	28.0%	–0.017%	$88,666	–$13
2035	$1,122	$1,121	28.0%	–0.017%	$89,777	–$14
2036	$1,122	$1,121	28.0%	–0.017%	$90,889	–$14
NPV[b]					$1,098,490	–$23,502

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10A-5. Impacts on the Engine Market and Engine Manufacturers: 101–175hp (Average Price per Engine = $5,500)[a]

	Engine (101hp to 175hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.003%	—	–$1
2008	—	—	0.0%	–0.004%	—	–$3
2009	—	—	0.0%	–0.004%	—	–$3
2010	—	—	0.0%	–0.007%	—	–$5
2011	—	—	0.0%	–0.013%	—	–$11
2012	$1,453	$1,375	25.0%	–0.017%	$90,913	–$4,892
2013	$1,452	$1,375	25.0%	–0.018%	$92,337	–$4,894
2014	$1,457	$1,350	24.6%	–0.019%	$94,162	–$6,885
2015	$1,455	$1,350	24.6%	–0.020%	$95,561	–$6,886
2016	$1,454	$1,350	24.6%	–0.020%	$96,960	–$6,886
2017	$1,380	$1,350	24.6%	–0.020%	$93,480	–$2,008
2018	$1,380	$1,350	24.6%	–0.020%	$94,879	–$2,009
2019	$1,351	$1,350	24.6%	–0.020%	$94,288	–$19
2020	$1,351	$1,350	24.6%	–0.020%	$95,687	–$19
2021	$1,351	$1,350	24.6%	–0.020%	$97,086	–$19
2022	$1,351	$1,350	24.6%	–0.020%	$98,485	–$19
2023	$1,351	$1,350	24.6%	–0.020%	$99,884	–$20
2024	$1,351	$1,350	24.6%	–0.020%	$101,283	–$20
2025	$1,351	$1,350	24.6%	–0.020%	$102,682	–$20
2026	$1,351	$1,350	24.6%	–0.020%	$104,081	–$21
2027	$1,351	$1,350	24.6%	–0.020%	$105,480	–$21
2028	$1,351	$1,350	24.6%	–0.020%	$106,879	–$21
2029	$1,351	$1,350	24.6%	–0.020%	$108,278	–$21
2030	$1,351	$1,350	24.6%	–0.020%	$109,677	–$22
2031	$1,351	$1,350	24.6%	–0.020%	$111,075	–$22
2032	$1,351	$1,350	24.6%	–0.020%	$112,474	–$22
2033	$1,351	$1,350	24.6%	–0.020%	$113,873	–$23
2034	$1,351	$1,350	24.6%	–0.020%	$115,272	–$23
2035	$1,351	$1,350	24.6%	–0.020%	$116,671	–$23
2036	$1,351	$1,350	24.6%	–0.020%	$118,070	–$23
NPV[b]					$1,431,405	–$25,444

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10A-6. Impacts on the Engine Market and Engine Manufacturers: 176–600hp (Average Price per Engine = $20,000)[a]

	Engine (176hp to 600hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Engine Manufacturers (10^3)
2007	—	—	0.0%	–0.003%	—	–$3
2008	—	—	0.0%	–0.004%	—	–$7
2009	—	—	0.0%	–0.004%	—	–$7
2010	—	—	0.0%	–0.008%	—	–$13
2011	$2,517	$2,191	11.0%	–0.014%	$101,112	–$13,109
2012	$2,511	$2,189	10.9%	–0.018%	$102,473	–$13,118
2013	$2,012	$1,696	8.5%	–0.019%	$83,408	–$13,121
2014	$2,574	$2,136	10.7%	–0.021%	$108,339	–$18,421
2015	$2,567	$2,135	10.7%	–0.021%	$109,668	–$18,423
2016	$2,258	$2,135	10.7%	–0.021%	$97,915	–$5,342
2017	$2,255	$2,134	10.7%	–0.021%	$99,244	–$5,342
2018	$2,253	$2,133	10.7%	–0.021%	$100,573	–$5,343
2019	$2,133	$2,132	10.7%	–0.021%	$96,607	–$48
2020	$2,132	$2,131	10.7%	–0.021%	$97,936	–$48
2021	$2,132	$2,131	10.7%	–0.021%	$99,265	–$49
2022	$2,131	$2,130	10.7%	–0.021%	$100,594	–$49
2023	$2,130	$2,129	10.6%	–0.021%	$101,923	–$50
2024	$2,130	$2,129	10.6%	–0.021%	$103,253	–$51
2025	$2,129	$2,128	10.6%	–0.021%	$104,582	–$51
2026	$2,128	$2,127	10.6%	–0.021%	$105,911	–$52
2027	$2,128	$2,127	10.6%	–0.021%	$107,240	–$53
2028	$2,127	$2,126	10.6%	–0.021%	$108,570	–$54
2029	$2,127	$2,126	10.6%	–0.021%	$109,899	–$54
2030	$2,126	$2,125	10.6%	–0.021%	$111,228	–$55
2031	$2,126	$2,124	10.6%	–0.021%	$112,557	–$56
2032	$2,125	$2,124	10.6%	–0.021%	$113,887	–$56
2033	$2,124	$2,123	10.6%	–0.021%	$115,216	–$57
2034	$2,124	$2,123	10.6%	–0.021%	$116,545	–$58
2035	$2,123	$2,122	10.6%	–0.021%	$117,874	–$58
2036	$2,123	$2,122	10.6%	–0.021%	$119,203	–$59
NPV[b]					$1,561,195	–$69,509

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10A-7. Impacts on the Engine Market and Engine Manufacturers: ≥601hp (Average Price per Engine = $80,500)[a]

	Engine (≥601hp)					
Year	**Engineering Cost/Unit**	**Absolute Change in Price**	**Change in Price (%)**	**Change in Quantity (%)**	**Total Engineering Costs (10^3)**	**Change in Producer Surplus for Engine Manufacturers (10^3)**
2007	—	—	0.0%	–0.002%	—	—
2008	—	–$1	0.0%	–0.004%	—	–$1
2009	—	–$1	0.0%	–0.004%	—	–$1
2010	—	–$1	0.0%	–0.007%	—	–$2
2011	$3,771	$2,908	3.6%	–0.013%	$6,156	–$1,409
2012	$3,758	$2,907	3.6%	–0.017%	$6,228	–$1,410
2013	$3,081	$2,242	2.8%	–0.017%	$5,182	–$1,411
2014	$3,817	$2,730	3.4%	–0.019%	$6,514	–$1,856
2015	$7,679	$6,149	7.6%	–0.020%	$13,296	–$2,649
2016	$6,857	$6,149	7.6%	–0.020%	$12,044	–$1,244
2017	$6,042	$5,343	6.6%	–0.020%	$10,761	–$1,244
2018	$6,032	$5,343	6.6%	–0.020%	$10,893	–$1,244
2019	$5,780	$5,343	6.6%	–0.020%	$10,582	–$800
2020	$5,347	$5,343	6.6%	–0.020%	$9,921	–$7
2021	$5,347	$5,343	6.6%	–0.020%	$10,054	–$7
2022	$5,347	$5,343	6.6%	–0.020%	$10,187	–$7
2023	$5,347	$5,343	6.6%	–0.020%	$10,319	–$8
2024	$5,347	$5,343	6.6%	–0.020%	$10,452	–$8
2025	$5,347	$5,343	6.6%	–0.020%	$10,584	–$8
2026	$5,347	$5,343	6.6%	–0.020%	$10,717	–$8
2027	$5,347	$5,343	6.6%	–0.020%	$10,850	–$8
2028	$5,347	$5,343	6.6%	–0.020%	$10,982	–$8
2029	$5,347	$5,343	6.6%	–0.020%	$11,115	–$8
2030	$5,347	$5,343	6.6%	–0.020%	$11,248	–$8
2031	$5,347	$5,343	6.6%	–0.020%	$11,380	–$8
2032	$5,347	$5,343	6.6%	–0.020%	$11,513	–$8
2033	$5,347	$5,343	6.6%	–0.020%	$11,646	–$9
2034	$5,347	$5,343	6.6%	–0.020%	$11,778	–$9
2035	$5,347	$5,343	6.6%	–0.020%	$11,911	–$9
2036	$5,347	$5,343	6.6%	–0.020%	$12,044	–$9
NPV[b]					$150,134	–$9,762

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

APPENDIX 10B: Impacts on Equipment Markets

This appendix provides the time series of impacts from 2007 through 2036 for the equipment markets. The equipment markets are the markets associated with the production and consumption of equipment that use nonroad diesel engines. Seven equipment types were modeled:

- agricultural
- construction
- pumps and compressors
- generators and welder sets
- refrigeration and air conditioning
- general industrial
- lawn and garden

Forty-two equipment markets were modeled, representing 7 horsepower categories within 7 application categories. There are 7 horsepower/application categories that did not have sales in 2000 and are not included in the model, so the total number of diesel equipment markets is 42 rather than 49.[R]

There are two sets of tables in this appendix. Tables 10B-1 through 10B-7 provide a summary of the time series of impacts for the seven equipment markets included in the analysis. Tables 10B-8 through 10B-49 provide the time series impacts for each equipment market by horsepower grouping. Each table includes the following:

- average equipment price
- average engineering costs (variable and fixed) per piece of equipment
  - Note that in the engineering cost analysis, fixed costs for equipment manufacturers are recovered in the first ten years (see Chapter 6)
- absolute change in the market price ($)
  - Note that the estimated absolute change in market price is based on variable costs only; see Appendix 10I for a sensitivity analysis including fixed costs as well
- relative change in the market price (%)
- relative change in the market quantity (%)
- total engineering (regulatory) costs associated with each market ($)
- change in producer surplus for all manufacturers in the market

As described in Section 10.3.3.1, approximately 65 percent of engines are sold on the market and these are referred to as “merchant” engines. The remaining 35 percent are consumed

[R]These seven equipment categories that did not have sales in 2000 are: agricultural equipment >600 hp; gensets & welders > 600 hp; refrigeration & A/C > 71 hp (4 hp categories); and lawn & garden >600 hp.

internally by integrated equipment manufacturers and are referred to as “captive” engines. The engineering costs and changes in producer surplus presented in this appendix include total equipment costs as well as captive engine costs. Because captive engines never pass through the engines markets, they therefore present an additional cost for integrated equipment producers.

All prices and costs are presented in $2002, and real equipment prices are assumed to be constant. The engineering cost per piece of equipment peak around 2014 as the fixed cost per equipment are phased in and then are depreciated over the next several years.

A greater percentage of the cost of the regulation is borne by the various equipment markets than is borne by the engine market. However, a substantial percentage of the cost is still passed along through increased equipment prices. For each equipment market as a whole, price increases range from an average increase of 1.31 percent in the general industrial equipment market to 5.4 percent in the pumps and compressors market. For specific types of equipment, the price increases range from 0.7 percent for construction <25, 176-600 and >600 hp, and general industrial equipment (<25 hp), to 9.4 percent for pumps and compressors 76-100 hp.

Even though the cost per piece of equipment and market impacts (in terms of percentage change in price and quantity) stabilize after the initial years of the regulation, the engineering costs and produce surplus changes continue to gradually increase because the projected baseline population of equipment increases over time.

Table 10B-1. Impacts on Agricultural Equipment Market and Manufacturers (Average Price per Equipment = $24,200)[a,b]

Year	Agricultural Equipment: Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	–$1	0.0%	–0.004%	—	–$114
2008	$94	$67	0.5%	–0.006%	$6,217	–$2,359
2009	$93	$67	0.5%	–0.006%	$6,304	–$2,364
2010	$89	$62	0.5%	–0.010%	$6,163	–$2,578
2011	$836	$630	0.9%	–0.019%	$136,011	–$36,021
2012	$1,278	$1,021	1.6%	–0.024%	$201,592	–$48,332
2013	$1,432	$1,158	3.1%	–0.025%	$205,681	–$51,844
2014	$1,611	$1,268	3.2%	–0.027%	$242,214	–$65,974
2015	$1,529	$1,191	2.7%	–0.027%	$238,948	–$65,991
2016	$1,448	$1,191	2.7%	–0.027%	$227,805	–$52,188
2017	$1,423	$1,191	2.7%	–0.027%	$227,549	–$49,273
2018	$1,390	$1,191	2.7%	–0.027%	$227,388	–$46,453
2019	$1,349	$1,190	2.7%	–0.027%	$223,284	–$39,690
2020	$1,347	$1,190	2.7%	–0.027%	$225,968	–$39,703
2021	$1,263	$1,190	2.7%	–0.027%	$209,555	–$20,621
2022	$1,230	$1,190	2.7%	–0.027%	$203,133	–$11,540
2023	$1,218	$1,190	2.7%	–0.027%	$203,137	–$8,884
2024	$1,190	$1,190	2.7%	–0.027%	$198,628	–$1,716
2025	$1,189	$1,189	2.7%	–0.027%	$201,312	–$1,740
2026	$1,189	$1,189	2.7%	–0.027%	$203,996	–$1,764
2027	$1,189	$1,189	2.7%	–0.027%	$206,680	–$1,788
2028	$1,189	$1,189	2.7%	–0.027%	$209,364	–$1,813
2029	$1,189	$1,189	2.7%	–0.027%	$212,048	–$1,837
2030	$1,189	$1,189	2.7%	–0.027%	$214,731	–$1,861
2031	$1,188	$1,188	2.7%	–0.027%	$217,415	–$1,885
2032	$1,188	$1,188	2.7%	–0.027%	$220,099	–$1,909
2033	$1,188	$1,188	2.7%	–0.027%	$222,783	–$1,933
2034	$1,188	$1,188	2.7%	–0.027%	$225,467	–$1,957
2035	$1,188	$1,188	2.7%	–0.027%	$228,151	–$1,982
2036	$1,188	$1,188	2.7%	–0.027%	$230,834	–$2,006
NPV[c]					$3,203,099	–$396,969

[a] Figures are in 2002 dollars.
[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.
[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-2. Impacts on Construction Equipment Market and Manufacturers (Average Price per Equipment = $128,100)[a,b]

Year	Construction Equipment					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	–$1	0.0%	–0.004%	—	–$227
2008	$82	$58	0.2%	–0.006%	$2,791	–$1,822
2009	$81	$58	0.2%	–0.006%	$2,819	–$1,831
2010	$77	$53	0.2%	–0.011%	$2,764	–$2,307
2011	$771	$567	0.4%	–0.021%	$129,258	–$41,345
2012	$1,342	$1,073	0.9%	–0.027%	$222,497	–$60,765
2013	$1,455	$1,172	1.6%	–0.028%	$215,758	–$64,049
2014	$1,621	$1,268	1.6%	–0.031%	$252,584	–$81,136
2015	$1,658	$1,285	1.4%	–0.032%	$277,706	–$87,572
2016	$1,574	$1,285	1.4%	–0.032%	$265,984	–$72,975
2017	$1,523	$1,266	1.4%	–0.032%	$260,346	–$68,895
2018	$1,495	$1,266	1.4%	–0.032%	$261,583	–$67,318
2019	$1,452	$1,266	1.4%	–0.032%	$257,237	–$60,158
2020	$1,440	$1,266	1.4%	–0.032%	$257,684	–$57,783
2021	$1,359	$1,265	1.4%	–0.032%	$237,148	–$34,427
2022	$1,323	$1,265	1.4%	–0.032%	$225,352	–$19,817
2023	$1,313	$1,265	1.4%	–0.032%	$225,367	–$17,019
2024	$1,285	$1,265	1.4%	–0.032%	$218,660	–$7,497
2025	$1,272	$1,265	1.4%	–0.032%	$217,689	–$3,712
2026	$1,272	$1,265	1.4%	–0.032%	$220,554	–$3,763
2027	$1,272	$1,265	1.4%	–0.032%	$223,419	–$3,814
2028	$1,272	$1,264	1.4%	–0.032%	$226,284	–$3,865
2029	$1,272	$1,264	1.4%	–0.032%	$229,149	–$3,915
2030	$1,272	$1,264	1.4%	–0.032%	$232,014	–$3,966
2031	$1,271	$1,264	1.4%	–0.032%	$234,880	–$4,017
2032	$1,271	$1,264	1.4%	–0.032%	$237,745	–$4,068
2033	$1,271	$1,264	1.4%	–0.032%	$240,610	–$4,119
2034	$1,271	$1,264	1.4%	–0.032%	$243,475	–$4,170
2035	$1,271	$1,264	1.4%	–0.032%	$246,340	–$4,221
2036	$1,271	$1,263	1.4%	–0.032%	$249,206	–$4,272
NPV[c]					$3,510,842	–$545,099

[a] Figures are in 2002 dollars.
[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.
[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-3. Impacts on Pumps and Compressor Equipment Market and Manufacturers (Average Price per Equipment = $13,700)[a,b]

	Pumps and Compressors					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$135	$98	1.1%	–0.001%	$176	–$177
2009	$134	$98	1.1%	–0.001%	$176	–$177
2010	$128	$93	1.1%	–0.001%	$176	–$177
2011	$340	$255	1.4%	–0.002%	$1,011	–$876
2012	$682	$563	3.6%	–0.003%	$2,102	–$1,668
2013	$952	$817	6.1%	–0.003%	$2,685	–$2,051
2014	$1,006	$847	6.1%	–0.003%	$3,136	–$2,432
2015	$923	$766	5.4%	–0.003%	$3,115	–$2,444
2016	$899	$766	5.4%	–0.003%	$3,126	–$2,444
2017	$878	$765	5.4%	–0.003%	$3,137	–$2,444
2018	$842	$765	5.4%	–0.003%	$2,971	–$2,268
2019	$826	$765	5.4%	–0.003%	$2,982	–$2,268
2020	$824	$765	5.4%	–0.003%	$2,993	–$2,268
2021	$800	$765	5.4%	–0.003%	$2,306	–$1,571
2022	$793	$765	5.4%	–0.003%	$1,526	–$779
2023	$780	$765	5.4%	–0.003%	$1,155	–$398
2024	$773	$765	5.4%	–0.003%	$785	–$17
2025	$772	$764	5.4%	–0.003%	$784	–$5
2026	$772	$764	5.4%	–0.003%	$795	–$5
2027	$772	$764	5.4%	–0.003%	$805	–$5
2028	$772	$764	5.4%	–0.003%	$816	–$5
2029	$772	$764	5.4%	–0.003%	$827	–$5
2030	$772	$764	5.4%	–0.003%	$838	–$5
2031	$772	$764	5.4%	–0.003%	$849	–$5
2032	$772	$764	5.4%	–0.003%	$860	–$5
2033	$772	$764	5.4%	–0.003%	$871	–$5
2034	$772	$764	5.4%	–0.003%	$882	–$5
2035	$772	$764	5.4%	–0.003%	$893	–$5
2036	$772	$764	5.4%	–0.003%	$904	–$6
NPV[c]					$27,665	–$17,056

[a] Figures are in 2002 dollars.

[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.

[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-4. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (Average Price per Equipment = $9,200)[a,b]

	Generator Sets and Welders					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$169	$123	1.6%	–0.001%	$7,721	–$2,899
2009	$168	$123	1.6%	–0.001%	$7,832	–$2,899
2010	$161	$117	1.5%	–0.001%	$7,677	–$2,902
2011	$202	$149	1.6%	–0.002%	$11,511	–$4,090
2012	$354	$285	2.3%	–0.003%	$25,652	–$7,014
2013	$631	$553	5.5%	–0.003%	$41,613	–$9,151
2014	$644	$558	5.5%	–0.003%	$43,801	–$10,345
2015	$563	$479	4.6%	–0.003%	$40,244	–$10,345
2016	$557	$479	4.6%	–0.003%	$40,403	–$9,992
2017	$548	$479	4.6%	–0.003%	$40,314	–$9,391
2018	$512	$479	4.6%	–0.003%	$37,930	–$6,496
2019	$507	$479	4.6%	–0.003%	$38,054	–$6,109
2020	$507	$479	4.6%	–0.003%	$38,566	–$6,109
2021	$502	$479	4.6%	–0.003%	$38,247	–$5,278
2022	$493	$479	4.6%	–0.003%	$36,440	–$2,959
2023	$481	$479	4.6%	–0.003%	$34,816	–$824
2024	$478	$479	4.6%	–0.003%	$34,523	–$19
2025	$478	$479	4.6%	–0.003%	$35,035	–$19
2026	$478	$479	4.6%	–0.003%	$35,547	–$19
2027	$478	$479	4.6%	–0.003%	$36,058	–$20
2028	$478	$478	4.6%	–0.003%	$36,570	–$20
2029	$478	$478	4.6%	–0.003%	$37,082	–$20
2030	$478	$478	4.6%	–0.003%	$37,594	–$21
2031	$478	$478	4.6%	–0.003%	$38,106	–$21
2032	$478	$478	4.6%	–0.003%	$38,618	–$21
2033	$478	$478	4.6%	–0.003%	$39,130	–$22
2034	$478	$478	4.6%	–0.003%	$39,642	–$22
2035	$478	$478	4.6%	–0.003%	$40,154	–$22
2036	$478	$478	4.6%	–0.003%	$40,666	–$23
NPV[c]					$563,662	–$69,507

[a] Figures are in 2002 dollars.

[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.

[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-5. Impacts on Refrigeration and Air-Conditioning Equipment Market and Manufacturers (Average Price per Equipment = $6,314)[a,b]

Year	Refrigeration and Air Conditioning					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$208	$152	0.6%	–0.001%	$447	–$449
2009	$206	$152	0.6%	–0.001%	$447	–$449
2010	$197	$144	0.6%	–0.001%	$447	–$452
2011	$196	$143	0.6%	–0.002%	$447	–$456
2012	$195	$143	0.6%	–0.003%	$447	–$459
2013	$768	$676	2.1%	–0.003%	$2,551	–$1,792
2014	$766	$676	2.1%	–0.003%	$2,565	–$1,793
2015	$610	$521	1.7%	–0.003%	$2,418	–$1,793
2016	$609	$521	1.7%	–0.003%	$2,429	–$1,793
2017	$607	$521	1.7%	–0.003%	$2,440	–$1,793
2018	$546	$521	1.7%	–0.003%	$2,005	–$1,347
2019	$546	$521	1.7%	–0.003%	$2,016	–$1,347
2020	$545	$521	1.7%	–0.003%	$2,027	–$1,347
2021	$545	$521	1.7%	–0.003%	$2,038	–$1,348
2022	$545	$521	1.7%	–0.003%	$2,049	–$1,348
2023	$522	$521	1.7%	–0.003%	$732	–$19
2024	$522	$521	1.7%	–0.003%	$743	–$20
2025	$522	$521	1.7%	–0.003%	$754	–$20
2026	$522	$521	1.7%	–0.003%	$765	–$20
2027	$522	$521	1.7%	–0.003%	$776	–$21
2028	$522	$521	1.7%	–0.003%	$787	–$21
2029	$522	$521	1.7%	–0.003%	$798	–$21
2030	$522	$521	1.7%	–0.003%	$810	–$21
2031	$522	$521	1.7%	–0.003%	$821	–$22
2032	$522	$521	1.7%	–0.003%	$832	–$22
2033	$522	$521	1.7%	–0.003%	$843	–$22
2034	$522	$521	1.7%	–0.003%	$854	–$23
2035	$522	$521	1.7%	–0.003%	$865	–$23
2036	$522	$521	1.7%	–0.003%	$876	–$23
NPV[c]					$22,468	–$12,722

[a] Figures are in 2002 dollars.
[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.
[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-6. Impacts on General Industrial Equipment Market and Manufacturers (Average Price per Equipment = $91,200)[a,b]

	General Industrial					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	$1
2008	$64	$46	0.1%	–0.001%	$557	–$287
2009	$63	$46	0.1%	–0.001%	$563	–$287
2010	$60	$44	0.1%	–0.001%	$552	–$294
2011	$516	$387	0.3%	–0.002%	$7,656	–$4,870
2012	$1,320	$1,101	1.1%	–0.003%	$27,925	–$11,353
2013	$1,429	$1,200	1.4%	–0.003%	$29,960	–$12,069
2014	$1,549	$1,260	1.4%	–0.003%	$33,740	–$15,024
2015	$1,537	$1,242	1.3%	–0.003%	$34,239	–$15,489
2016	$1,483	$1,242	1.3%	–0.003%	$34,263	–$15,216
2017	$1,431	$1,234	1.3%	–0.003%	$33,767	–$14,467
2018	$1,409	$1,234	1.3%	–0.003%	$33,729	–$14,131
2019	$1,372	$1,234	1.3%	–0.003%	$33,618	–$13,723
2020	$1,366	$1,234	1.3%	–0.003%	$33,896	–$13,705
2021	$1,313	$1,234	1.3%	–0.003%	$29,901	–$9,412
2022	$1,268	$1,234	1.3%	–0.003%	$24,474	–$3,688
2023	$1,260	$1,233	1.3%	–0.003%	$24,119	–$3,036
2024	$1,236	$1,233	1.3%	–0.003%	$21,873	–$493
2025	$1,231	$1,233	1.3%	–0.003%	$21,724	–$47
2026	$1,231	$1,233	1.3%	–0.003%	$22,021	–$47
2027	$1,231	$1,233	1.3%	–0.003%	$22,319	–$48
2028	$1,231	$1,233	1.3%	–0.003%	$22,616	–$48
2029	$1,231	$1,233	1.3%	–0.003%	$22,914	–$49
2030	$1,231	$1,233	1.3%	–0.003%	$23,212	–$50
2031	$1,230	$1,233	1.3%	–0.003%	$23,509	–$50
2032	$1,230	$1,233	1.3%	–0.003%	$23,807	–$51
2033	$1,230	$1,233	1.3%	–0.003%	$24,104	–$52
2034	$1,230	$1,232	1.3%	–0.003%	$24,402	–$52
2035	$1,230	$1,232	1.3%	–0.003%	$24,700	–$53
2036	$1,230	$1,232	1.3%	–0.003%	$24,997	–$54
NPV[c]					$401,039	–$102,642

[a] Figures are in 2002 dollars.
[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.
[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-7. Impacts on Lawn and Garden Equipment Market and Manufacturers (Average Price per Equipment = $17,700)[a,b]

	Lawn and Garden					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$164	$119	1.0%	–0.001%	$2,293	–$838
2009	$163	$119	1.0%	–0.001%	$2,331	–$838
2010	$156	$113	0.9%	–0.001%	$2,289	–$839
2011	$195	$144	1.0%	–0.002%	$2,604	–$1,074
2012	$361	$292	1.4%	–0.003%	$3,590	–$1,780
2013	$604	$530	2.5%	–0.003%	$5,759	–$2,097
2014	$616	$535	2.5%	–0.003%	$6,106	–$2,338
2015	$544	$465	2.2%	–0.003%	$5,667	–$2,338
2016	$539	$465	2.2%	–0.003%	$5,734	–$2,338
2017	$529	$465	2.2%	–0.003%	$5,801	–$2,338
2018	$496	$465	2.2%	–0.003%	$5,266	–$1,736
2019	$491	$465	2.2%	–0.003%	$5,333	–$1,736
2020	$491	$465	2.2%	–0.003%	$5,400	–$1,736
2021	$486	$465	2.2%	–0.003%	$5,234	–$1,503
2022	$479	$465	2.2%	–0.003%	$4,596	–$799
2023	$469	$465	2.2%	–0.003%	$4,113	–$249
2024	$467	$465	2.2%	–0.003%	$3,940	–$9
2025	$467	$465	2.2%	–0.003%	$4,007	–$9
2026	$467	$465	2.2%	–0.003%	$4,075	–$9
2027	$467	$465	2.2%	–0.003%	$4,142	–$10
2028	$467	$465	2.2%	–0.003%	$4,209	–$10
2029	$467	$465	2.2%	–0.003%	$4,276	–$10
2030	$467	$465	2.2%	–0.003%	$4,343	–$10
2031	$466	$465	2.2%	–0.003%	$4,410	–$10
2032	$466	$465	2.2%	–0.003%	$4,477	–$10
2033	$466	$465	2.2%	–0.003%	$4,544	–$10
2034	$466	$465	2.2%	–0.003%	$4,611	–$11
2035	$466	$465	2.2%	–0.003%	$4,678	–$11
2036	$466	$465	2.2%	–0.003%	$4,745	–$11
NPV[b]					$76,592	–$17,642

[a] Figures are in 2002 dollars.
[b] Average price per equipment for the market is a weighted average of the price of equipment by hp.
[c] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-8. Impacts on Agricultural Equipment Market and Manufacturers (<25 hp) (Average Price per Equipment = $6,900)[a]

	Agricultural Equipment (<25hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$1
2008	$177	$129	1.9%	–0.006%	$666	–$341
2009	$176	$129	1.9%	–0.006%	$675	–$341
2010	$168	$122	1.8%	–0.010%	$666	–$343
2011	$167	$122	1.8%	–0.019%	$674	–$348
2012	$166	$122	1.8%	–0.024%	$683	–$351
2013	$136	$122	1.8%	–0.025%	$608	–$269
2014	$136	$122	1.8%	–0.027%	$617	–$271
2015	$135	$122	1.8%	–0.027%	$625	–$271
2016	$135	$122	1.8%	–0.027%	$634	–$272
2017	$135	$122	1.8%	–0.027%	$642	–$272
2018	$123	$122	1.8%	–0.027%	$395	–$17
2019	$123	$122	1.8%	–0.027%	$404	–$18
2020	$123	$122	1.8%	–0.027%	$412	–$18
2021	$123	$122	1.8%	–0.027%	$421	–$18
2022	$123	$122	1.8%	–0.027%	$429	–$19
2023	$123	$122	1.8%	–0.027%	$437	–$19
2024	$123	$122	1.8%	–0.027%	$446	–$19
2025	$123	$122	1.8%	–0.027%	$454	–$20
2026	$123	$122	1.8%	–0.027%	$463	–$20
2027	$123	$122	1.8%	–0.027%	$471	–$21
2028	$123	$122	1.8%	–0.027%	$479	–$21
2029	$123	$122	1.8%	–0.027%	$488	–$21
2030	$123	$122	1.8%	–0.027%	$496	–$22
2031	$123	$122	1.8%	–0.027%	$505	–$22
2032	$123	$122	1.8%	–0.027%	$513	–$22
2033	$123	$122	1.8%	–0.027%	$522	–$23
2034	$123	$122	1.8%	–0.027%	$530	–$23
2035	$123	$122	1.8%	–0.027%	$538	–$24
2036	$123	$122	1.8%	–0.027%	$547	–$24
NPV[b]					$9,600	–$2,622

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-9. Impacts on Agricultural Equipment Market and Manufacturers (26-50 hp)
(Average Price per Equipment = $14,400)[a]

	Agricultural Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$7
2008	$204	$147	1.0%	–0.006%	$3,707	–$1,225
2009	$203	$147	1.0%	–0.006%	$3,762	–$1,225
2010	$194	$139	1.0%	–0.010%	$3,679	–$1,238
2011	$193	$138	1.0%	–0.019%	$3,731	–$1,268
2012	$192	$138	1.0%	–0.024%	$3,782	–$1,284
2013	$986	$868	6.0%	–0.025%	$20,616	–$3,639
2014	$984	$868	6.0%	–0.027%	$20,951	–$3,648
2015	$773	$660	4.6%	–0.027%	$17,064	–$3,649
2016	$771	$660	4.6%	–0.027%	$17,319	–$3,651
2017	$769	$660	4.6%	–0.027%	$17,575	–$3,653
2018	$693	$660	4.6%	–0.027%	$16,061	–$1,886
2019	$692	$660	4.6%	–0.027%	$16,316	–$1,887
2020	$692	$660	4.6%	–0.027%	$16,571	–$1,888
2021	$691	$660	4.6%	–0.027%	$16,826	–$1,890
2022	$691	$660	4.6%	–0.027%	$17,081	–$1,891
2023	$661	$660	4.6%	–0.027%	$15,546	–$103
2024	$661	$660	4.6%	–0.027%	$15,801	–$105
2025	$661	$660	4.6%	–0.027%	$16,057	–$107
2026	$661	$660	4.6%	–0.027%	$16,312	–$108
2027	$661	$660	4.6%	–0.027%	$16,567	–$110
2028	$661	$660	4.6%	–0.027%	$16,822	–$112
2029	$661	$660	4.6%	–0.027%	$17,077	–$114
2030	$661	$660	4.6%	–0.027%	$17,332	–$115
2031	$661	$660	4.6%	–0.027%	$17,587	–$117
2032	$661	$660	4.6%	–0.027%	$17,842	–$119
2033	$661	$660	4.6%	–0.027%	$18,097	–$121
2034	$661	$660	4.6%	–0.027%	$18,353	–$122
2035	$661	$660	4.6%	–0.027%	$18,608	–$124
2036	$661	$660	4.6%	–0.027%	$18,863	–$126
NPV[b]					$248,449	–$25,062

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-10. Impacts on Agricultural Equipment Market and Manufacturers (51-75 hp) (Average Price per Equipment = $22,600)[a]

	Agricultural Equipment (50≤hp<75)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$5
2008	$226	$167	0.7%	–0.006%	$1,844	–$582
2009	$225	$167	0.7%	–0.006%	$1,867	–$583
2010	$214	$157	0.7%	–0.010%	$1,818	–$592
2011	$213	$156	0.7%	–0.019%	$1,840	–$615
2012	$212	$155	0.7%	–0.024%	$1,863	–$627
2013	$978	$856	3.8%	–0.025%	$9,199	–$1,771
2014	$976	$856	3.8%	–0.027%	$9,326	–$1,778
2015	$769	$651	2.9%	–0.027%	$7,616	–$1,778
2016	$767	$651	2.9%	–0.027%	$7,713	–$1,780
2017	$765	$651	2.9%	–0.027%	$7,810	–$1,781
2018	$687	$651	2.9%	–0.027%	$7,086	–$961
2019	$686	$651	2.9%	–0.027%	$7,183	–$962
2020	$686	$651	2.9%	–0.027%	$7,280	–$963
2021	$685	$651	2.9%	–0.027%	$7,377	–$964
2022	$685	$651	2.9%	–0.027%	$7,474	–$965
2023	$653	$651	2.9%	–0.027%	$6,681	–$76
2024	$653	$651	2.9%	–0.027%	$6,777	–$77
2025	$653	$651	2.9%	–0.027%	$6,874	–$78
2026	$653	$651	2.9%	–0.027%	$6,971	–$79
2027	$653	$651	2.9%	–0.027%	$7,068	–$80
2028	$653	$651	2.9%	–0.027%	$7,165	–$81
2029	$653	$651	2.9%	–0.027%	$7,262	–$82
2030	$653	$651	2.9%	–0.027%	$7,359	–$84
2031	$653	$651	2.9%	–0.027%	$7,456	–$85
2032	$653	$651	2.9%	–0.027%	$7,553	–$86
2033	$653	$651	2.9%	–0.027%	$7,650	–$87
2034	$653	$651	2.9%	–0.027%	$7,747	–$88
2035	$653	$651	2.9%	–0.027%	$7,844	–$89
2036	$653	$651	2.9%	–0.027%	$7,941	–$90
NPV[b]					$108,842	–$12,491

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-11. Impacts on Agricultural Equipment Market and Manufacturers (76-100 hp) (Average Price per Equipment = $22,400)[a]

Year	Agricultural Equipment (70≤hp<100)					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$5
2008	—	–$1	0.0%	–0.006%	—	–$10
2009	—	–$1	0.0%	–0.006%	—	–$10
2010	—	–$1	0.0%	–0.010%	—	–$18
2011	—	–$3	0.0%	–0.019%	—	–$39
2012	$1,303	$1,175	3.5%	–0.024%	$13,727	–$2,422
2013	$1,302	$1,175	3.5%	–0.025%	$13,923	–$2,426
2014	$1,325	$1,166	3.5%	–0.027%	$14,767	–$3,146
2015	$1,324	$1,166	3.5%	–0.027%	$14,962	–$3,146
2016	$1,322	$1,166	3.5%	–0.027%	$15,157	–$3,147
2017	$1,247	$1,166	3.5%	–0.027%	$14,600	–$2,396
2018	$1,246	$1,166	3.5%	–0.027%	$14,796	–$2,397
2019	$1,218	$1,166	3.5%	–0.027%	$14,695	–$2,102
2020	$1,218	$1,166	3.5%	–0.027%	$14,890	–$2,102
2021	$1,218	$1,166	3.5%	–0.027%	$15,085	–$2,103
2022	$1,218	$1,166	3.5%	–0.027%	$13,661	–$485
2023	$1,218	$1,166	3.5%	–0.027%	$13,857	–$486
2024	$1,218	$1,166	3.5%	–0.027%	$13,635	–$70
2025	$1,218	$1,166	3.5%	–0.027%	$13,830	–$71
2026	$1,218	$1,166	3.5%	–0.027%	$14,026	–$72
2027	$1,218	$1,166	3.5%	–0.027%	$14,221	–$73
2028	$1,218	$1,166	3.5%	–0.027%	$14,416	–$74
2029	$1,218	$1,166	3.5%	–0.027%	$14,612	–$75
2030	$1,218	$1,166	3.5%	–0.027%	$14,807	–$76
2031	$1,218	$1,166	3.5%	–0.027%	$15,002	–$77
2032	$1,218	$1,166	3.5%	–0.027%	$15,198	–$78
2033	$1,218	$1,166	3.5%	–0.027%	$15,393	–$79
2034	$1,218	$1,166	3.5%	–0.027%	$15,588	–$80
2035	$1,218	$1,166	3.5%	–0.027%	$15,784	–$81
2036	$1,218	$1,166	3.5%	–0.027%	$15,979	–$82
NPV[b]					$206,738	–$18,829

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-12. Impacts on Agricultural Equipment Market and Manufacturers (101-175 hp) (Average Price per Equipment = $69,100)[a]

Year	Agricultural Equipment (100≤hp<175) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	–$1	0.0%	–0.004%	—	–$28
2008	—	–$1	0.0%	–0.006%	—	–$59
2009	—	–$1	0.0%	–0.006%	—	–$60
2010	—	–$3	0.0%	–0.010%	—	–$113
2011	—	–$6	0.0%	–0.019%	—	–$241
2012	$1,623	$1,414	2.0%	–0.024%	$50,277	–$9,980
2013	$1,619	$1,414	2.0%	–0.025%	$50,949	–$10,007
2014	$1,664	$1,391	2.0%	–0.027%	$53,852	–$12,849
2015	$1,659	$1,391	2.0%	–0.027%	$54,515	–$12,853
2016	$1,654	$1,391	2.0%	–0.027%	$55,178	–$12,859
2017	$1,577	$1,391	2.0%	–0.027%	$53,654	–$10,677
2018	$1,574	$1,391	2.0%	–0.027%	$54,317	–$10,684
2019	$1,542	$1,391	2.0%	–0.027%	$54,087	–$9,797
2020	$1,539	$1,391	2.0%	–0.027%	$54,750	–$9,800
2021	$1,537	$1,391	2.0%	–0.027%	$55,413	–$9,804
2022	$1,388	$1,391	2.0%	–0.027%	$48,590	–$2,324
2023	$1,387	$1,391	2.0%	–0.027%	$49,253	–$2,330
2024	$1,351	$1,391	2.0%	–0.027%	$48,004	–$424
2025	$1,351	$1,391	2.0%	–0.027%	$48,667	–$430
2026	$1,351	$1,391	2.0%	–0.027%	$49,330	–$436
2027	$1,351	$1,391	2.0%	–0.027%	$49,993	–$442
2028	$1,351	$1,391	2.0%	–0.027%	$50,656	–$448
2029	$1,351	$1,391	2.0%	–0.027%	$51,319	–$454
2030	$1,351	$1,391	2.0%	–0.027%	$51,982	–$460
2031	$1,351	$1,391	2.0%	–0.027%	$52,645	–$466
2032	$1,351	$1,391	2.0%	–0.027%	$53,308	–$472
2033	$1,351	$1,391	2.0%	–0.027%	$53,971	–$478
2034	$1,351	$1,391	2.0%	–0.027%	$54,634	–$484
2035	$1,351	$1,391	2.0%	–0.027%	$55,298	–$491
2036	$1,351	$1,391	2.0%	–0.027%	$55,961	–$497
NPV[b]					$741,939	–$81,965

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-13. Impacts on Agricultural Equipment Market and Manufacturers (176-600 hp) (Average Price per Equipment = $143,700)[a]

	Agricultural Equipment (175≤hp<600)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	–$1	0.0%	–0.004%	—	–$68
2008	—	–$3	0.0%	–0.006%	—	–$143
2009	—	–$3	0.0%	–0.006%	—	–$146
2010	—	–$6	0.0%	–0.010%	—	–$274
2011	$2,970	$2,255	1.6%	–0.019%	$129,766	–$33,510
2012	$2,958	$2,251	1.6%	–0.024%	$131,260	–$33,668
2013	$2,439	$1,741	1.2%	–0.025%	$110,384	–$33,733
2014	$3,107	$2,200	1.5%	–0.027%	$142,701	–$44,283
2015	$3,092	$2,199	1.5%	–0.027%	$144,166	–$44,293
2016	$2,777	$2,198	1.5%	–0.027%	$131,803	–$30,479
2017	$2,768	$2,197	1.5%	–0.027%	$133,268	–$30,494
2018	$2,759	$2,197	1.5%	–0.027%	$134,733	–$30,508
2019	$2,634	$2,196	1.5%	–0.027%	$130,600	–$24,924
2020	$2,627	$2,195	1.5%	–0.027%	$132,065	–$24,931
2021	$2,294	$2,194	1.5%	–0.027%	$114,433	–$5,842
2022	$2,292	$2,194	1.5%	–0.027%	$115,898	–$5,856
2023	$2,291	$2,193	1.5%	–0.027%	$117,363	–$5,870
2024	$2,209	$2,192	1.5%	–0.027%	$113,965	–$1,021
2025	$2,208	$2,191	1.5%	–0.027%	$115,430	–$1,035
2026	$2,208	$2,191	1.5%	–0.027%	$116,895	–$1,048
2027	$2,207	$2,190	1.5%	–0.027%	$118,360	–$1,062
2028	$2,206	$2,189	1.5%	–0.027%	$119,824	–$1,076
2029	$2,206	$2,189	1.5%	–0.027%	$121,289	–$1,090
2030	$2,205	$2,188	1.5%	–0.027%	$122,754	–$1,104
2031	$2,204	$2,187	1.5%	–0.027%	$124,219	–$1,118
2032	$2,204	$2,187	1.5%	–0.027%	$125,684	–$1,132
2033	$2,203	$2,186	1.5%	–0.027%	$127,149	–$1,145
2034	$2,203	$2,186	1.5%	–0.027%	$128,614	–$1,159
2035	$2,202	$2,185	1.5%	–0.027%	$130,079	–$1,173
2036	$2,202	$2,185	1.5%	–0.027%	$131,544	–$1,187
NPV[b]					$1,887,531	–$256,000

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-14. Impacts on Construction Equipment Market and Manufacturers (<25 hp) (Average Price per Equipment = $18,000)[a]

Year	Construction Equipment (<25hp) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	–0.004%	—	–$3
2008	$177	$129	0.7%	–0.006%	$370	–$343
2009	$176	$129	0.7%	–0.006%	$371	–$344
2010	$168	$122	0.7%	–0.011%	$370	–$350
2011	$167	$122	0.7%	–0.021%	$371	–$363
2012	$166	$121	0.7%	–0.027%	$372	–$371
2013	$136	$121	0.7%	–0.028%	$364	–$365
2014	$136	$121	0.7%	–0.031%	$365	–$370
2015	$135	$121	0.7%	–0.032%	$366	–$372
2016	$135	$121	0.7%	–0.032%	$367	–$373
2017	$135	$121	0.7%	–0.032%	$368	–$374
2018	$123	$121	0.7%	–0.032%	$39	–$46
2019	$123	$121	0.7%	–0.032%	$40	–$47
2020	$123	$121	0.7%	–0.032%	$41	–$48
2021	$123	$121	0.7%	–0.032%	$42	–$48
2022	$123	$121	0.7%	–0.032%	$42	–$49
2023	$123	$121	0.7%	–0.032%	$43	–$50
2024	$123	$121	0.7%	–0.032%	$44	–$51
2025	$123	$121	0.7%	–0.032%	$45	–$52
2026	$123	$121	0.7%	–0.032%	$46	–$53
2027	$123	$121	0.7%	–0.032%	$47	–$54
2028	$123	$121	0.7%	–0.032%	$47	–$55
2029	$123	$121	0.7%	–0.032%	$48	–$56
2030	$123	$121	0.7%	–0.032%	$49	–$57
2031	$123	$121	0.7%	–0.032%	$50	–$58
2032	$123	$121	0.7%	–0.032%	$51	–$59
2033	$123	$121	0.7%	–0.032%	$52	–$60
2034	$123	$121	0.7%	–0.032%	$52	–$61
2035	$123	$121	0.7%	–0.032%	$53	–$62
2036	$123	$121	0.7%	–0.032%	$54	–$63
NPV[b]					$3,325	–$3,348

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-15. Impacts on Construction Equipment Market and Manufacturers (26-50 hp) (Average Price per Equipment = $29,700)[a]

	Construction Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$8
2008	$204	$146	0.5%	–0.006%	$438	–$345
2009	$203	$146	0.5%	–0.006%	$440	–$345
2010	$194	$138	0.5%	–0.011%	$437	–$362
2011	$193	$137	0.5%	–0.021%	$439	–$397
2012	$192	$137	0.5%	–0.027%	$441	–$420
2013	$986	$867	2.9%	–0.028%	$3,293	–$1,864
2014	$984	$867	2.9%	–0.031%	$3,323	–$1,875
2015	$773	$659	2.2%	–0.032%	$3,006	–$1,882
2016	$771	$659	2.2%	–0.032%	$3,030	–$1,884
2017	$769	$659	2.2%	–0.032%	$3,053	–$1,885
2018	$693	$659	2.2%	–0.032%	$2,723	–$1,534
2019	$692	$659	2.2%	–0.032%	$2,747	–$1,536
2020	$692	$659	2.2%	–0.032%	$2,770	–$1,538
2021	$691	$659	2.2%	–0.032%	$2,794	–$1,540
2022	$691	$659	2.2%	–0.032%	$2,817	–$1,543
2023	$661	$659	2.2%	–0.032%	$1,428	–$132
2024	$661	$659	2.2%	–0.032%	$1,451	–$134
2025	$661	$659	2.2%	–0.032%	$1,475	–$137
2026	$661	$659	2.2%	–0.032%	$1,498	–$139
2027	$661	$659	2.2%	–0.032%	$1,521	–$141
2028	$661	$659	2.2%	–0.032%	$1,545	–$143
2029	$661	$659	2.2%	–0.032%	$1,568	–$145
2030	$661	$659	2.2%	–0.032%	$1,592	–$148
2031	$661	$659	2.2%	–0.032%	$1,615	–$150
2032	$661	$659	2.2%	–0.032%	$1,639	–$152
2033	$661	$659	2.2%	–0.032%	$1,662	–$154
2034	$661	$659	2.2%	–0.032%	$1,685	–$156
2035	$661	$659	2.2%	–0.032%	$1,709	–$159
2036	$661	$659	2.2%	–0.032%	$1,732	–$161
NPV[b]					$32,256	–$14,120

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-16. Impacts on Construction Equipment Market and Manufacturers (51-75 hp) (Average Price per Equipment = $31,600)[a]

	Construction Equipment ($50 \leq hp < 70$)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	–0.004%	—	–$8
2008	$226	$167	0.5%	–0.006%	$1,983	–$710
2009	$225	$167	0.5%	–0.006%	$2,007	–$711
2010	$214	$157	0.5%	–0.011%	$1,957	–$728
2011	$213	$156	0.5%	–0.021%	$1,980	–$764
2012	$212	$155	0.5%	–0.027%	$2,002	–$788
2013	$978	$856	2.7%	–0.028%	$10,288	–$2,484
2014	$976	$856	2.7%	–0.031%	$10,422	–$2,495
2015	$769	$650	2.1%	–0.032%	$8,629	–$2,502
2016	$767	$650	2.1%	–0.032%	$8,731	–$2,504
2017	$765	$650	2.1%	–0.032%	$8,834	–$2,505
2018	$687	$650	2.1%	–0.032%	$7,991	–$1,561
2019	$686	$650	2.1%	–0.032%	$8,093	–$1,563
2020	$686	$650	2.1%	–0.032%	$8,196	–$1,565
2021	$685	$650	2.1%	–0.032%	$8,298	–$1,567
2022	$685	$650	2.1%	–0.032%	$8,401	–$1,569
2023	$653	$650	2.1%	–0.032%	$7,067	–$134
2024	$653	$650	2.1%	–0.032%	$7,169	–$136
2025	$653	$650	2.1%	–0.032%	$7,272	–$138
2026	$653	$650	2.1%	–0.032%	$7,374	–$140
2027	$653	$650	2.1%	–0.032%	$7,477	–$142
2028	$653	$650	2.1%	–0.032%	$7,580	–$144
2029	$653	$650	2.1%	–0.032%	$7,682	–$146
2030	$653	$650	2.1%	–0.032%	$7,785	–$148
2031	$653	$650	2.1%	–0.032%	$7,887	–$150
2032	$653	$650	2.1%	–0.032%	$7,990	–$152
2033	$653	$650	2.1%	–0.032%	$8,092	–$154
2034	$653	$650	2.1%	–0.032%	$8,195	–$156
2035	$653	$650	2.1%	–0.032%	$8,297	–$158
2036	$653	$650	2.1%	–0.032%	$8,400	–$160
NPV[b]					$118,863	–$17,987

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-17 Impacts on Construction Equipment Market and Manufacturers (76-100 hp) (Average Price per Equipment = $57,900)[a]

Year	Construction Equipment ($70 \leq hp < 100$) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	–0.004%	—	–$15
2008	—	–$1	0.0%	–0.006%	—	–$30
2009	—	–$1	0.0%	–0.006%	—	–$31
2010	—	–$2	0.0%	–0.011%	—	–$62
2011	—	–$3	0.0%	–0.021%	—	–$127
2012	$1,303	$1,174	2.0%	–0.027%	$23,156	–$5,449
2013	$1,302	$1,174	2.0%	–0.028%	$23,465	–$5,460
2014	$1,325	$1,165	2.0%	–0.031%	$25,237	–$6,995
2015	$1,324	$1,164	2.0%	–0.032%	$25,545	–$7,007
2016	$1,322	$1,164	2.0%	–0.032%	$25,854	–$7,011
2017	$1,247	$1,164	2.0%	–0.032%	$25,024	–$5,875
2018	$1,246	$1,164	2.0%	–0.032%	$25,333	–$5,879
2019	$1,218	$1,164	2.0%	–0.032%	$25,192	–$5,434
2020	$1,218	$1,164	2.0%	–0.032%	$25,501	–$5,437
2021	$1,218	$1,164	2.0%	–0.032%	$25,809	–$5,440
2022	$1,218	$1,164	2.0%	–0.032%	$21,977	–$1,303
2023	$1,218	$1,164	2.0%	–0.032%	$22,285	–$1,306
2024	$1,218	$1,164	2.0%	–0.032%	$21,527	–$244
2025	$1,218	$1,164	2.0%	–0.032%	$21,836	–$247
2026	$1,218	$1,164	2.0%	–0.032%	$22,144	–$251
2027	$1,218	$1,164	2.0%	–0.032%	$22,452	–$254
2028	$1,218	$1,164	2.0%	–0.032%	$22,761	–$258
2029	$1,218	$1,164	2.0%	–0.032%	$23,069	–$262
2030	$1,218	$1,164	2.0%	–0.032%	$23,377	–$265
2031	$1,218	$1,164	2.0%	–0.032%	$23,686	–$269
2032	$1,218	$1,164	2.0%	–0.032%	$23,994	–$272
2033	$1,218	$1,164	2.0%	–0.032%	$24,303	–$276
2034	$1,218	$1,164	2.0%	–0.032%	$24,611	–$279
2035	$1,218	$1,164	2.0%	–0.032%	$24,919	–$283
2036	$1,218	$1,164	2.0%	–0.032%	$25,228	–$287
NPV[b]					$339,723	–$45,057

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-18. Impacts on Construction Equipment Market and Manufacturers (101-175 hp) (Average Price per Equipment = $122,700)[a]

Year	Construction Equipment (100≤hp<175) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	–$1	0.0%	–0.004%	—	–$51
2008	—	–$2	0.0%	–0.006%	—	–$105
2009	—	–$2	0.0%	–0.006%	—	–$107
2010	—	–$4	0.0%	–0.011%	—	–$215
2011	—	–$7	0.0%	–0.021%	—	–$438
2012	$1,623	$1,412	1.2%	–0.027%	$68,698	–$14,076
2013	$1,619	$1,411	1.2%	–0.028%	$69,612	–$14,114
2014	$1,664	$1,389	1.1%	–0.031%	$73,652	–$18,081
2015	$1,659	$1,388	1.1%	–0.032%	$74,553	–$18,122
2016	$1,654	$1,388	1.1%	–0.032%	$75,455	–$18,134
2017	$1,577	$1,388	1.1%	–0.032%	$73,387	–$15,171
2018	$1,574	$1,388	1.1%	–0.032%	$74,289	–$15,183
2019	$1,542	$1,388	1.1%	–0.032%	$73,979	–$13,984
2020	$1,539	$1,388	1.1%	–0.032%	$74,881	–$13,994
2021	$1,537	$1,388	1.1%	–0.032%	$75,783	–$14,004
2022	$1,388	$1,388	1.1%	–0.032%	$66,164	–$3,496
2023	$1,387	$1,388	1.1%	–0.032%	$67,065	–$3,508
2024	$1,351	$1,388	1.1%	–0.032%	$65,280	–$833
2025	$1,351	$1,388	1.1%	–0.032%	$66,182	–$844
2026	$1,351	$1,388	1.1%	–0.032%	$67,083	–$856
2027	$1,351	$1,388	1.1%	–0.032%	$67,985	–$868
2028	$1,351	$1,388	1.1%	–0.032%	$68,887	–$880
2029	$1,351	$1,388	1.1%	–0.032%	$69,788	–$891
2030	$1,351	$1,388	1.1%	–0.032%	$70,690	–$903
2031	$1,351	$1,388	1.1%	–0.032%	$71,592	–$915
2032	$1,351	$1,388	1.1%	–0.032%	$72,493	–$927
2033	$1,351	$1,388	1.1%	–0.032%	$73,395	–$939
2034	$1,351	$1,388	1.1%	–0.032%	$74,297	–$950
2035	$1,351	$1,388	1.1%	–0.032%	$75,198	–$962
2036	$1,351	$1,388	1.1%	–0.032%	$76,100	–$974
NPV[b]					$1,011,838	–$118,002

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-19. Impacts on Construction Equipment Market and Manufacturers (176-600 hp) (Average Price per Equipment = $312,900)[a]

Year	Construction Equipment (175≤hp<600)					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	–$2	0.0%	–0.004%	—	–$110
2008	—	–$5	0.0%	–0.006%	—	–$225
2009	—	–$5	0.0%	–0.006%	—	–$229
2010	—	–$9	0.0%	–0.011%	—	–$461
2011	$2,970	$2,248	0.7%	–0.021%	$103,262	–$30,609
2012	$2,958	$2,241	0.7%	–0.027%	$104,397	–$30,925
2013	$2,439	$1,731	0.6%	–0.028%	$88,557	–$31,005
2014	$3,107	$2,189	0.7%	–0.031%	$114,342	–$40,265
2015	$3,092	$2,187	0.7%	–0.032%	$115,456	–$40,352
2016	$2,777	$2,186	0.7%	–0.032%	$106,203	–$30,010
2017	$2,768	$2,185	0.7%	–0.032%	$107,317	–$30,022
2018	$2,759	$2,184	0.7%	–0.032%	$108,431	–$30,046
2019	$2,634	$2,184	0.7%	–0.032%	$105,349	–$25,874
2020	$2,627	$2,183	0.7%	–0.032%	$106,462	–$25,894
2021	$2,294	$2,182	0.7%	–0.032%	$88,274	–$6,612
2022	$2,292	$2,181	0.7%	–0.032%	$89,388	–$6,637
2023	$2,291	$2,181	0.7%	–0.032%	$90,502	–$6,661
2024	$2,209	$2,180	0.7%	–0.032%	$86,700	–$1,769
2025	$2,208	$2,179	0.7%	–0.032%	$87,814	–$1,793
2026	$2,208	$2,178	0.7%	–0.032%	$88,928	–$1,817
2027	$2,207	$2,178	0.7%	–0.032%	$90,042	–$1,841
2028	$2,206	$2,177	0.7%	–0.032%	$91,156	–$1,865
2029	$2,206	$2,176	0.7%	–0.032%	$92,270	–$1,889
2030	$2,205	$2,176	0.7%	–0.032%	$93,384	–$1,913
2031	$2,204	$2,175	0.7%	–0.032%	$94,498	–$1,936
2032	$2,204	$2,175	0.7%	–0.032%	$95,612	–$1,960
2033	$2,203	$2,174	0.7%	–0.032%	$96,726	–$1,984
2034	$2,203	$2,173	0.7%	–0.032%	$97,839	–$2,008
2035	$2,202	$2,173	0.7%	–0.032%	$98,953	–$2,032
2036	$2,202	$2,172	0.7%	–0.032%	$100,067	–$2,056
NPV[b]					$1,477,053	–$250,397

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-20. Impacts on Construction Equipment Market and Manufacturers (>600 hp) (Average Price per Equipment = $847,400)[a]

Year	Construction Equipment (≥600hp) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	–$6	0.0%	–0.004%	—	–$31
2008	—	–$11	0.0%	–0.006%	—	–$63
2009	—	–$11	0.0%	–0.006%	—	–$65
2010	—	–$22	0.0%	–0.011%	—	–$130
2011	$4,519	$2,923	0.4%	–0.021%	$23,207	–$8,646
2012	$4,496	$2,909	0.4%	–0.027%	$23,431	–$8,735
2013	$3,797	$2,230	0.3%	–0.028%	$20,179	–$8,757
2014	$4,684	$2,727	0.4%	–0.031%	$25,243	–$11,056
2015	$9,206	$6,205	0.8%	–0.032%	$50,150	–$17,335
2016	$8,364	$6,205	0.8%	–0.032%	$46,344	–$13,058
2017	$7,517	$5,387	0.7%	–0.032%	$42,363	–$13,061
2018	$7,489	$5,387	0.7%	–0.032%	$42,777	–$13,068
2019	$7,218	$5,387	0.7%	–0.032%	$41,837	–$11,720
2020	$6,767	$5,388	0.7%	–0.032%	$39,833	–$9,307
2021	$6,151	$5,388	0.7%	–0.032%	$36,149	–$5,214
2022	$6,142	$5,388	0.7%	–0.032%	$36,563	–$5,221
2023	$6,133	$5,388	0.7%	–0.032%	$36,978	–$5,227
2024	$5,997	$5,388	0.7%	–0.032%	$36,488	–$4,330
2025	$5,458	$5,388	0.7%	–0.032%	$33,066	–$500
2026	$5,458	$5,388	0.7%	–0.032%	$33,480	–$506
2027	$5,458	$5,388	0.7%	–0.032%	$33,895	–$513
2028	$5,458	$5,388	0.7%	–0.032%	$34,309	–$519
2029	$5,458	$5,388	0.7%	–0.032%	$34,724	–$526
2030	$5,458	$5,388	0.7%	–0.032%	$35,138	–$532
2031	$5,458	$5,388	0.7%	–0.032%	$35,552	–$539
2032	$5,458	$5,388	0.7%	–0.032%	$35,967	–$545
2033	$5,458	$5,388	0.7%	–0.032%	$36,381	–$551
2034	$5,458	$5,388	0.7%	–0.032%	$36,795	–$558
2035	$5,458	$5,388	0.7%	–0.032%	$37,210	–$564
2036	$5,458	$5,388	0.7%	–0.032%	$37,624	–$571
NPV[b]					$527,785	–$96,188

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-21. Impacts on Pumps and Compressor Equipment Market and Manufacturers (<25 hp)
(Average Price per Equipment = $6,000)[a]

	Pumps and Compressor Equipment (<25hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$177	$129	2.2%	–0.001%	$96	–$96
2009	$176	$129	2.2%	–0.001%	$96	–$96
2010	$168	$123	2.0%	–0.001%	$96	–$96
2011	$167	$123	2.0%	–0.002%	$96	–$97
2012	$166	$123	2.0%	–0.003%	$96	–$97
2013	$136	$123	2.0%	–0.003%	$96	–$97
2014	$136	$123	2.0%	–0.003%	$96	–$97
2015	$135	$123	2.0%	–0.003%	$96	–$97
2016	$135	$123	2.0%	–0.003%	$96	–$97
2017	$135	$123	2.0%	–0.003%	$96	–$97
2018	$123	$123	2.0%	–0.003%	—	–$1
2019	$123	$123	2.0%	–0.003%	—	–$1
2020	$123	$123	2.0%	–0.003%	—	–$1
2021	$123	$123	2.0%	–0.003%	—	–$1
2022	$123	$123	2.0%	–0.003%	—	–$1
2023	$123	$123	2.0%	–0.003%	—	–$1
2024	$123	$123	2.0%	–0.003%	—	–$1
2025	$123	$123	2.0%	–0.003%	—	–$1
2026	$123	$123	2.0%	–0.003%	—	–$1
2027	$123	$123	2.0%	–0.003%	—	–$1
2028	$123	$123	2.0%	–0.003%	—	–$1
2029	$123	$123	2.0%	–0.003%	—	–$1
2030	$123	$123	2.0%	–0.003%	—	–$1
2031	$123	$123	2.0%	–0.003%	—	–$1
2032	$123	$123	2.0%	–0.003%	—	–$1
2033	$123	$123	2.0%	–0.003%	—	–$1
2034	$123	$123	2.0%	–0.003%	—	–$1
2035	$123	$123	2.0%	–0.003%	—	–$1
2036	$123	$123	2.0%	–0.003%	—	–$1
NPV[b]					$752	–$760

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-22. Impacts on Pumps and Compressor Equipment Market and Manufacturers (26-50 hp)
(Average Price per Equipment = $12,200)[a]

	Pumps and Compressor Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$204	$147	1.2%	–0.001%	$41	–$41
2009	$203	$147	1.2%	–0.001%	$41	–$41
2010	$194	$139	1.1%	–0.001%	$41	–$41
2011	$193	$139	1.1%	–0.002%	$41	–$42
2012	$192	$139	1.1%	–0.003%	$41	–$42
2013	$986	$870	7.1%	–0.003%	$356	–$241
2014	$984	$870	7.1%	–0.003%	$359	–$241
2015	$773	$661	5.4%	–0.003%	$337	–$241
2016	$771	$661	5.4%	–0.003%	$339	–$241
2017	$769	$661	5.4%	–0.003%	$340	–$241
2018	$693	$661	5.4%	–0.003%	$301	–$200
2019	$692	$661	5.4%	–0.003%	$303	–$200
2020	$692	$661	5.4%	–0.003%	$305	–$200
2021	$691	$661	5.4%	–0.003%	$307	–$200
2022	$691	$661	5.4%	–0.003%	$309	–$200
2023	$661	$661	5.4%	–0.003%	$112	–$1
2024	$661	$661	5.4%	–0.003%	$113	–$1
2025	$661	$661	5.4%	–0.003%	$115	–$1
2026	$661	$661	5.4%	–0.003%	$117	–$1
2027	$661	$661	5.4%	–0.003%	$119	–$1
2028	$661	$661	5.4%	–0.003%	$121	–$1
2029	$661	$661	5.4%	–0.003%	$123	–$1
2030	$661	$661	5.4%	–0.003%	$124	–$1
2031	$661	$661	5.4%	–0.003%	$126	–$1
2032	$661	$661	5.4%	–0.003%	$128	–$1
2033	$661	$661	5.4%	–0.003%	$130	–$1
2034	$661	$661	5.4%	–0.003%	$132	–$1
2035	$661	$661	5.4%	–0.003%	$134	–$1
2036	$661	$661	5.4%	–0.003%	$135	–$1
NPV[b]					$3,189	–$1,673

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-23. Impacts on Pumps and Compressor Equipment Market and Manufacturers (51-75 hp)
(Average Price per Equipment = $10,600)[a]

Year	Pumps and Compressor Equipment (50≤hp<70) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	$226	$167	1.6%	–0.001%	$39	–$39
2009	$225	$167	1.6%	–0.001%	$39	–$39
2010	$214	$158	1.5%	–0.001%	$39	–$39
2011	$213	$158	1.5%	–0.002%	$39	–$39
2012	$212	$158	1.5%	–0.003%	$39	–$39
2013	$978	$858	8.1%	–0.003%	$328	–$222
2014	$976	$858	8.1%	–0.003%	$329	–$222
2015	$769	$653	6.2%	–0.003%	$309	–$222
2016	$767	$653	6.2%	–0.003%	$311	–$222
2017	$765	$653	6.2%	–0.003%	$312	–$222
2018	$687	$653	6.2%	–0.003%	$275	–$183
2019	$686	$653	6.2%	–0.003%	$276	–$183
2020	$686	$653	6.2%	–0.003%	$278	–$183
2021	$685	$653	6.2%	–0.003%	$279	–$183
2022	$685	$653	6.2%	–0.003%	$281	–$183
2023	$653	$653	6.2%	–0.003%	$99	–$1
2024	$653	$653	6.2%	–0.003%	$101	–$1
2025	$653	$653	6.2%	–0.003%	$102	–$1
2026	$653	$653	6.2%	–0.003%	$104	–$1
2027	$653	$653	6.2%	–0.003%	$105	–$1
2028	$653	$653	6.2%	–0.003%	$107	–$1
2029	$653	$653	6.2%	–0.003%	$108	–$1
2030	$653	$653	6.2%	–0.003%	$110	–$1
2031	$653	$653	6.2%	–0.003%	$111	–$1
2032	$653	$653	6.2%	–0.003%	$112	–$1
2033	$653	$653	6.2%	–0.003%	$114	–$1
2034	$653	$653	6.2%	–0.003%	$115	–$1
2035	$653	$653	6.2%	–0.003%	$117	–$1
2036	$653	$653	6.2%	–0.003%	$118	–$1
NPV[b]					$2,896	–$1,542

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-24. Impacts on Pumps and Compressor Equipment Market and Manufacturers (76-100 hp) (Average Price per Equipment = $12,500)[a]

	Pumps and Compressor Equipment (70≤hp<100)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	—	—	0.0%	–0.002%	—	—
2012	$1,303	$1,178	9.4%	–0.003%	$823	–$583
2013	$1,302	$1,178	9.4%	–0.003%	$827	–$583
2014	$1,325	$1,169	9.4%	–0.003%	$998	–$733
2015	$1,324	$1,169	9.4%	–0.003%	$1,003	–$733
2016	$1,322	$1,169	9.4%	–0.003%	$1,007	–$733
2017	$1,247	$1,169	9.4%	–0.003%	$1,011	–$733
2018	$1,246	$1,169	9.4%	–0.003%	$1,016	–$733
2019	$1,218	$1,169	9.4%	–0.003%	$1,020	–$733
2020	$1,218	$1,169	9.4%	–0.003%	$1,025	–$733
2021	$1,218	$1,169	9.4%	–0.003%	$1,029	–$733
2022	$1,218	$1,169	9.4%	–0.003%	$452	–$151
2023	$1,218	$1,169	9.4%	–0.003%	$456	–$151
2024	$1,218	$1,169	9.4%	–0.003%	$311	–$1
2025	$1,218	$1,169	9.4%	–0.003%	$315	–$1
2026	$1,218	$1,169	9.4%	–0.003%	$320	–$1
2027	$1,218	$1,169	9.4%	–0.003%	$324	–$1
2028	$1,218	$1,169	9.4%	–0.003%	$328	–$1
2029	$1,218	$1,169	9.4%	–0.003%	$333	–$1
2030	$1,218	$1,169	9.4%	–0.003%	$337	–$1
2031	$1,218	$1,169	9.4%	–0.003%	$342	–$1
2032	$1,218	$1,169	9.4%	–0.003%	$346	–$1
2033	$1,218	$1,169	9.4%	–0.003%	$351	–$1
2034	$1,218	$1,169	9.4%	–0.003%	$355	–$1
2035	$1,218	$1,169	9.4%	–0.003%	$360	–$1
2036	$1,218	$1,169	9.4%	–0.003%	$364	–$1
NPV[b]					$9,294	–$5,030

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-25. Impacts on Pumps and Compressor Equipment Market and Manufacturers (101-175 hp)
(Average Price per Equipment = $23,800)[a]

	Pumps and Compressor Equipment (100≤hp<175)					Change in Producer
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	—	—	0.0%	–0.002%	—	—
2012	$1,623	$1,421	6.0%	–0.003%	$266	–$210
2013	$1,619	$1,421	6.0%	–0.003%	$267	–$210
2014	$1,664	$1,399	5.9%	–0.003%	$325	–$263
2015	$1,659	$1,399	5.9%	–0.003%	$326	–$263
2016	$1,654	$1,399	5.9%	–0.003%	$327	–$263
2017	$1,577	$1,399	5.9%	–0.003%	$328	–$263
2018	$1,574	$1,399	5.9%	–0.003%	$329	–$263
2019	$1,542	$1,399	5.9%	–0.003%	$330	–$263
2020	$1,539	$1,399	5.9%	–0.003%	$331	–$263
2021	$1,537	$1,399	5.9%	–0.003%	$332	–$263
2022	$1,388	$1,399	5.9%	–0.003%	$124	–$54
2023	$1,387	$1,399	5.9%	–0.003%	$125	–$54
2024	$1,351	$1,399	5.9%	–0.003%	$72	—
2025	$1,351	$1,399	5.9%	–0.003%	$73	—
2026	$1,351	$1,399	5.9%	–0.003%	$74	—
2027	$1,351	$1,399	5.9%	–0.003%	$75	—
2028	$1,351	$1,399	5.9%	–0.003%	$76	—
2029	$1,351	$1,399	5.9%	–0.003%	$77	—
2030	$1,351	$1,399	5.9%	–0.003%	$78	—
2031	$1,351	$1,399	5.9%	–0.003%	$79	—
2032	$1,351	$1,399	5.9%	–0.003%	$80	—
2033	$1,351	$1,399	5.9%	–0.003%	$81	—
2034	$1,351	$1,399	5.9%	–0.003%	$82	—
2035	$1,351	$1,399	5.9%	–0.003%	$83	—
2036	$1,351	$1,399	5.9%	–0.003%	$84	—
NPV[b]					$2,796	–$1,807

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-26. Impacts on Pumps and Compressor Equipment Market and Manufacturers (176-600 hp)
(Average Price per Equipment = $53,000)[a]

Year	Pumps and Compressor Equipment (175≤hp<600) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	–$1	0.0%	–0.001%	—	—
2011	$2,970	$2,265	4.3%	–0.002%	$821	–$685
2012	$2,958	$2,264	4.3%	–0.003%	$823	–$685
2013	$2,439	$1,755	3.3%	–0.003%	$797	–$686
2014	$3,107	$2,216	4.2%	–0.003%	$1,010	–$860
2015	$3,092	$2,215	4.2%	–0.003%	$1,012	–$860
2016	$2,777	$2,214	4.2%	–0.003%	$1,015	–$860
2017	$2,768	$2,213	4.2%	–0.003%	$1,017	–$860
2018	$2,759	$2,212	4.2%	–0.003%	$1,019	–$860
2019	$2,634	$2,211	4.2%	–0.003%	$1,021	–$860
2020	$2,627	$2,210	4.2%	–0.003%	$1,023	–$860
2021	$2,294	$2,210	4.2%	–0.003%	$341	–$176
2022	$2,292	$2,209	4.2%	–0.003%	$343	–$176
2023	$2,291	$2,208	4.2%	–0.003%	$345	–$176
2024	$2,209	$2,207	4.2%	–0.003%	$173	–$1
2025	$2,208	$2,207	4.2%	–0.003%	$175	–$1
2026	$2,208	$2,206	4.2%	–0.003%	$177	–$1
2027	$2,207	$2,205	4.2%	–0.003%	$180	–$1
2028	$2,206	$2,205	4.2%	–0.003%	$182	–$1
2029	$2,206	$2,204	4.2%	–0.003%	$184	–$1
2030	$2,205	$2,203	4.2%	–0.003%	$186	–$1
2031	$2,204	$2,203	4.2%	–0.003%	$188	–$1
2032	$2,204	$2,202	4.2%	–0.003%	$190	–$1
2033	$2,203	$2,202	4.2%	–0.003%	$192	–$1
2034	$2,203	$2,201	4.2%	–0.003%	$195	–$1
2035	$2,202	$2,200	4.2%	–0.003%	$197	–$1
2036	$2,202	$2,200	4.2%	–0.003%	$199	–$1
NPV[b]					$8,508	–$6,048

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-27. Impacts on Pumps and Compressor Equipment Market and Manufacturers (>600 hp)
(Average Price per Equipment = $88,000)[a]

	Pumps and Compressor Equipment (≥600hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	–$1	0.0%	–0.001%	—	—
2009	—	–$1	0.0%	–0.001%	—	—
2010	—	–$2	0.0%	–0.001%	—	—
2011	$4,519	$2,965	3.4%	–0.002%	$15	–$14
2012	$4,496	$2,964	3.4%	–0.003%	$15	–$14
2013	$3,797	$2,287	2.6%	–0.003%	$14	–$14
2014	$4,684	$2,790	3.2%	–0.003%	$18	–$16
2015	$9,206	$6,271	7.1%	–0.003%	$32	–$29
2016	$8,364	$6,271	7.1%	–0.003%	$32	–$29
2017	$7,517	$5,453	6.2%	–0.003%	$31	–$29
2018	$7,489	$5,453	6.2%	–0.003%	$31	–$29
2019	$7,218	$5,453	6.2%	–0.003%	$32	–$29
2020	$6,767	$5,453	6.2%	–0.003%	$32	–$29
2021	$6,151	$5,453	6.2%	–0.003%	$18	–$16
2022	$6,142	$5,453	6.2%	–0.003%	$18	–$16
2023	$6,133	$5,453	6.2%	–0.003%	$18	–$16
2024	$5,997	$5,453	6.2%	–0.003%	$15	–$13
2025	$5,458	$5,453	6.2%	–0.003%	$3	—
2026	$5,458	$5,453	6.2%	–0.003%	$3	—
2027	$5,458	$5,453	6.2%	–0.003%	$3	—
2028	$5,458	$5,453	6.2%	–0.003%	$3	—
2029	$5,458	$5,453	6.2%	–0.003%	$3	—
2030	$5,458	$5,453	6.2%	–0.003%	$3	—
2031	$5,458	$5,453	6.2%	–0.003%	$3	—
2032	$5,458	$5,453	6.2%	–0.003%	$3	—
2033	$5,458	$5,453	6.2%	–0.003%	$3	—
2034	$5,458	$5,453	6.2%	–0.003%	$3	—
2035	$5,458	$5,453	6.2%	–0.003%	$3	—
2036	$5,458	$5,453	6.2%	–0.003%	$3	—
NPV[b]					$231	–$196

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-28. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (<25 hp)
(Average Price per Equipment = $6,800)[a]

	Generator Sets and Welding Equipment (<25hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$177	$129	1.9%	–0.001%	$3,795	–$1,615
2009	$176	$129	1.9%	–0.001%	$3,854	–$1,615
2010	$168	$123	1.8%	–0.001%	$3,794	–$1,616
2011	$167	$123	1.8%	–0.002%	$3,850	–$1,618
2012	$166	$123	1.8%	–0.003%	$3,906	–$1,619
2013	$136	$123	1.8%	–0.003%	$3,410	–$1,068
2014	$136	$123	1.8%	–0.003%	$3,466	–$1,069
2015	$135	$123	1.8%	–0.003%	$3,522	–$1,069
2016	$135	$123	1.8%	–0.003%	$3,578	–$1,069
2017	$135	$123	1.8%	–0.003%	$3,634	–$1,069
2018	$123	$123	1.8%	–0.003%	$2,627	–$6
2019	$123	$123	1.8%	–0.003%	$2,683	–$7
2020	$123	$123	1.8%	–0.003%	$2,739	–$7
2021	$123	$123	1.8%	–0.003%	$2,795	–$7
2022	$123	$123	1.8%	–0.003%	$2,851	–$7
2023	$123	$123	1.8%	–0.003%	$2,907	–$7
2024	$123	$123	1.8%	–0.003%	$2,963	–$7
2025	$123	$123	1.8%	–0.003%	$3,019	–$7
2026	$123	$123	1.8%	–0.003%	$3,075	–$7
2027	$123	$123	1.8%	–0.003%	$3,131	–$8
2028	$123	$123	1.8%	–0.003%	$3,187	–$8
2029	$123	$123	1.8%	–0.003%	$3,243	–$8
2030	$123	$123	1.8%	–0.003%	$3,299	–$8
2031	$123	$123	1.8%	–0.003%	$3,355	–$8
2032	$123	$123	1.8%	–0.003%	$3,411	–$8
2033	$123	$123	1.8%	–0.003%	$3,467	–$8
2034	$123	$123	1.8%	–0.003%	$3,523	–$9
2035	$123	$123	1.8%	–0.003%	$3,579	–$9
2036	$123	$123	1.8%	–0.003%	$3,634	–$9
NPV[b]					$58,866	–$10,712

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-29. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (26-50 hp)
(Average Price per Equipment = $8,700)[a]

	Generator Sets and Welding Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$204	$147	1.7%	–0.001%	$1,896	–$713
2009	$203	$147	1.7%	–0.001%	$1,922	–$713
2010	$194	$139	1.6%	–0.001%	$1,883	–$714
2011	$193	$139	1.6%	–0.002%	$1,907	–$715
2012	$192	$139	1.6%	–0.003%	$1,932	–$716
2013	$986	$870	10.0%	–0.003%	$10,977	–$2,502
2014	$984	$870	10.0%	–0.003%	$11,143	–$2,502
2015	$773	$661	7.6%	–0.003%	$9,227	–$2,502
2016	$771	$661	7.6%	–0.003%	$9,354	–$2,502
2017	$769	$661	7.6%	–0.003%	$9,481	–$2,502
2018	$693	$661	7.6%	–0.003%	$8,631	–$1,525
2019	$692	$661	7.6%	–0.003%	$8,758	–$1,525
2020	$692	$661	7.6%	–0.003%	$8,885	–$1,525
2021	$691	$661	7.6%	–0.003%	$9,012	–$1,525
2022	$691	$661	7.6%	–0.003%	$9,139	–$1,525
2023	$661	$661	7.6%	–0.003%	$7,746	–$5
2024	$661	$661	7.6%	–0.003%	$7,873	–$5
2025	$661	$661	7.6%	–0.003%	$8,000	–$5
2026	$661	$661	7.6%	–0.003%	$8,127	–$5
2027	$661	$661	7.6%	–0.003%	$8,254	–$5
2028	$661	$661	7.6%	–0.003%	$8,381	–$5
2029	$661	$661	7.6%	–0.003%	$8,508	–$5
2030	$661	$661	7.6%	–0.003%	$8,635	–$5
2031	$661	$661	7.6%	–0.003%	$8,762	–$5
2032	$661	$661	7.6%	–0.003%	$8,889	–$5
2033	$661	$661	7.6%	–0.003%	$9,017	–$6
2034	$661	$661	7.6%	–0.003%	$9,144	–$6
2035	$661	$661	7.6%	–0.003%	$9,271	–$6
2036	$661	$661	7.6%	–0.003%	$9,398	–$6
NPV[b]					$128,538	–$16,831

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-30. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (51-75 hp)
(Average Price per Equipment = $8,300)[a]

	Generator Sets and Welding Equipment (50≤hp<70)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$226	$167	2.0%	–0.001%	$2,029	–$570
2009	$225	$167	2.0%	–0.001%	$2,056	–$570
2010	$214	$158	1.9%	–0.001%	$2,000	–$570
2011	$213	$158	1.9%	–0.002%	$2,025	–$571
2012	$212	$158	1.9%	–0.003%	$2,051	–$571
2013	$978	$858	10.3%	–0.003%	$9,825	–$1,472
2014	$976	$858	10.3%	–0.003%	$9,966	–$1,472
2015	$769	$653	7.9%	–0.003%	$8,049	–$1,472
2016	$767	$653	7.9%	–0.003%	$8,157	–$1,472
2017	$765	$653	7.9%	–0.003%	$8,265	–$1,472
2018	$687	$653	7.9%	–0.003%	$7,518	–$617
2019	$686	$653	7.9%	–0.003%	$7,626	–$617
2020	$686	$653	7.9%	–0.003%	$7,734	–$617
2021	$685	$653	7.9%	–0.003%	$7,842	–$617
2022	$685	$653	7.9%	–0.003%	$7,950	–$617
2023	$653	$653	7.9%	–0.003%	$7,443	–$2
2024	$653	$653	7.9%	–0.003%	$7,551	–$2
2025	$653	$653	7.9%	–0.003%	$7,659	–$2
2026	$653	$653	7.9%	–0.003%	$7,767	–$2
2027	$653	$653	7.9%	–0.003%	$7,875	–$2
2028	$653	$653	7.9%	–0.003%	$7,983	–$2
2029	$653	$653	7.9%	–0.003%	$8,091	–$2
2030	$653	$653	7.9%	–0.003%	$8,199	–$2
2031	$653	$653	7.9%	–0.003%	$8,307	–$2
2032	$653	$653	7.9%	–0.003%	$8,415	–$2
2033	$653	$653	7.9%	–0.003%	$8,523	–$2
2034	$653	$653	7.9%	–0.003%	$8,631	–$2
2035	$653	$653	7.9%	–0.003%	$8,739	–$2
2036	$653	$653	7.9%	–0.003%	$8,847	–$2
NPV[b]					$118,426	–$9,648

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-31. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (76-100 hp)
(Average Price per Equipment = $18,000)[a]

Year	Generator Sets and Welding Equipment (70≤hp<100) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	—	—	0.0%	–0.002%	—	–$1
2012	$1,303	$1,178	6.5%	–0.003%	$2,241	–$842
2013	$1,302	$1,178	6.5%	–0.003%	$2,265	–$842
2014	$1,325	$1,169	6.5%	–0.003%	$2,527	–$1,069
2015	$1,324	$1,169	6.5%	–0.003%	$2,552	–$1,069
2016	$1,322	$1,169	6.5%	–0.003%	$2,576	–$1,069
2017	$1,247	$1,169	6.5%	–0.003%	$2,524	–$993
2018	$1,246	$1,169	6.5%	–0.003%	$2,548	–$993
2019	$1,218	$1,169	6.5%	–0.003%	$2,543	–$963
2020	$1,218	$1,169	6.5%	–0.003%	$2,567	–$963
2021	$1,218	$1,169	6.5%	–0.003%	$2,592	–$963
2022	$1,218	$1,169	6.5%	–0.003%	$1,851	–$198
2023	$1,218	$1,169	6.5%	–0.003%	$1,876	–$199
2024	$1,218	$1,169	6.5%	–0.003%	$1,703	–$2
2025	$1,218	$1,169	6.5%	–0.003%	$1,727	–$2
2026	$1,218	$1,169	6.5%	–0.003%	$1,752	–$2
2027	$1,218	$1,169	6.5%	–0.003%	$1,776	–$2
2028	$1,218	$1,169	6.5%	–0.003%	$1,801	–$2
2029	$1,218	$1,169	6.5%	–0.003%	$1,825	–$2
2030	$1,218	$1,169	6.5%	–0.003%	$1,849	–$2
2031	$1,218	$1,169	6.5%	–0.003%	$1,874	–$2
2032	$1,218	$1,169	6.5%	–0.003%	$1,898	–$2
2033	$1,218	$1,169	6.5%	–0.003%	$1,923	–$2
2034	$1,218	$1,169	6.5%	–0.003%	$1,947	–$2
2035	$1,218	$1,169	6.5%	–0.003%	$1,971	–$2
2036	$1,218	$1,169	6.5%	–0.003%	$1,996	–$2
NPV[b]					$30,552	–$7,004

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-32. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (101-175 hp)
(Average Price per Equipment = $21,400)[a]

	Generator Sets and Welding Equipment (100≤hp<175)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	–$1
2011	—	—	0.0%	–0.002%	—	–$1
2012	$1,623	$1,421	6.6%	–0.003%	$11,755	–$2,081
2013	$1,619	$1,421	6.6%	–0.003%	$11,915	–$2,081
2014	$1,664	$1,399	6.5%	–0.003%	$12,544	–$2,692
2015	$1,659	$1,399	6.5%	–0.003%	$12,702	–$2,692
2016	$1,654	$1,399	6.5%	–0.003%	$12,860	–$2,692
2017	$1,577	$1,399	6.5%	–0.003%	$12,493	–$2,167
2018	$1,574	$1,399	6.5%	–0.003%	$12,651	–$2,168
2019	$1,542	$1,399	6.5%	–0.003%	$12,595	–$1,953
2020	$1,539	$1,399	6.5%	–0.003%	$12,753	–$1,953
2021	$1,537	$1,399	6.5%	–0.003%	$12,911	–$1,953
2022	$1,388	$1,399	6.5%	–0.003%	$11,515	–$399
2023	$1,387	$1,399	6.5%	–0.003%	$11,673	–$399
2024	$1,351	$1,399	6.5%	–0.003%	$11,434	–$2
2025	$1,351	$1,399	6.5%	–0.003%	$11,591	–$2
2026	$1,351	$1,399	6.5%	–0.003%	$11,749	–$3
2027	$1,351	$1,399	6.5%	–0.003%	$11,907	–$3
2028	$1,351	$1,399	6.5%	–0.003%	$12,065	–$3
2029	$1,351	$1,399	6.5%	–0.003%	$12,223	–$3
2030	$1,351	$1,399	6.5%	–0.003%	$12,381	–$3
2031	$1,351	$1,399	6.5%	–0.003%	$12,539	–$3
2032	$1,351	$1,399	6.5%	–0.003%	$12,697	–$3
2033	$1,351	$1,399	6.5%	–0.003%	$12,855	–$3
2034	$1,351	$1,399	6.5%	–0.003%	$13,013	–$3
2035	$1,351	$1,399	6.5%	–0.003%	$13,171	–$3
2036	$1,351	$1,399	6.5%	–0.003%	$13,329	–$3
NPV[b]					$174,772	–$16,116

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-33. Impacts on Generator Sets and Welding Equipment Market and Manufacturers (176-600 hp)
(Average Price per Equipment = $21,400)[a]

Year	Generator Sets and Welding Equipment (175≤hp<600)					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	$2,970	$2,266	6.3%	–0.002%	$3,728	–$1,185
2012	$2,958	$2,265	6.3%	–0.003%	$3,767	–$1,185
2013	$2,439	$1,756	4.9%	–0.003%	$3,221	–$1,186
2014	$3,107	$2,216	6.2%	–0.003%	$4,154	–$1,540
2015	$3,092	$2,215	6.2%	–0.003%	$4,192	–$1,540
2016	$2,777	$2,214	6.2%	–0.003%	$3,877	–$1,187
2017	$2,768	$2,214	6.2%	–0.003%	$3,916	–$1,187
2018	$2,759	$2,213	6.2%	–0.003%	$3,954	–$1,187
2019	$2,634	$2,212	6.2%	–0.003%	$3,850	–$1,044
2020	$2,627	$2,211	6.2%	–0.003%	$3,888	–$1,044
2021	$2,294	$2,210	6.2%	–0.003%	$3,096	–$213
2022	$2,292	$2,210	6.2%	–0.003%	$3,134	–$213
2023	$2,291	$2,209	6.2%	–0.003%	$3,173	–$213
2024	$2,209	$2,208	6.2%	–0.003%	$3,000	–$1
2025	$2,208	$2,207	6.2%	–0.003%	$3,038	–$1
2026	$2,208	$2,207	6.2%	–0.003%	$3,077	–$1
2027	$2,207	$2,206	6.2%	–0.003%	$3,115	–$1
2028	$2,206	$2,205	6.2%	–0.003%	$3,154	–$1
2029	$2,206	$2,205	6.2%	–0.003%	$3,192	–$1
2030	$2,205	$2,204	6.2%	–0.003%	$3,231	–$1
2031	$2,204	$2,203	6.2%	–0.003%	$3,269	–$1
2032	$2,204	$2,203	6.2%	–0.003%	$3,308	–$1
2033	$2,203	$2,202	6.2%	–0.003%	$3,346	–$1
2034	$2,203	$2,202	6.2%	–0.003%	$3,385	–$1
2035	$2,202	$2,201	6.2%	–0.003%	$3,423	–$1
2036	$2,202	$2,201	6.2%	–0.003%	$3,462	–$1
NPV[b]					$52,508	–$9,195

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-34. Impacts on Refrigeration and Air-Conditioning Equipment Market and Manufacturers (<25 hp)
(Average Price per Equipment = $12,500)[a]

	Refrigeration and Air-Conditioning Equipment (<25hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$177	$129	1.0%	–0.001%	$168	–$168
2009	$176	$129	1.0%	–0.001%	$168	–$168
2010	$168	$123	1.0%	–0.001%	$168	–$168
2011	$167	$123	1.0%	–0.002%	$168	–$169
2012	$166	$123	1.0%	–0.003%	$168	–$169
2013	$136	$123	1.0%	–0.003%	$168	–$169
2014	$136	$123	1.0%	–0.003%	$168	–$170
2015	$135	$123	1.0%	–0.003%	$168	–$170
2016	$135	$123	1.0%	–0.003%	$168	–$170
2017	$135	$123	1.0%	–0.003%	$168	–$170
2018	$123	$123	1.0%	–0.003%	—	–$2
2019	$123	$123	1.0%	–0.003%	—	–$2
2020	$123	$123	1.0%	–0.003%	—	–$2
2021	$123	$123	1.0%	–0.003%	—	–$2
2022	$123	$123	1.0%	–0.003%	—	–$2
2023	$123	$123	1.0%	–0.003%	—	–$2
2024	$123	$123	1.0%	–0.003%	—	–$2
2025	$123	$123	1.0%	–0.003%	—	–$2
2026	$123	$123	1.0%	–0.003%	—	–$2
2027	$123	$123	1.0%	–0.003%	—	–$2
2028	$123	$123	1.0%	–0.003%	—	–$2
2029	$123	$123	1.0%	–0.003%	—	–$2
2030	$123	$123	1.0%	–0.003%	—	–$2
2031	$123	$123	1.0%	–0.003%	—	–$2
2032	$123	$123	1.0%	–0.003%	—	–$2
2033	$123	$123	1.0%	–0.003%	—	–$3
2034	$123	$123	1.0%	–0.003%	—	–$3
2035	$123	$123	1.0%	–0.003%	—	–$3
2036	$123	$123	1.0%	–0.003%	—	–$3
NPV[b]					$1,310	–$1,340

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-35. Impacts on Refrigeration and Air-Conditioning Equipment Market and Manufacturers (26-50 hp)
(Average Price per Equipment = $27,000)[a]

	Refrigeration and Air-Conditioning Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$204	$147	0.5%	–0.001%	$100	–$101
2009	$203	$147	0.5%	–0.001%	$100	–$101
2010	$194	$139	0.5%	–0.001%	$100	–$102
2011	$193	$139	0.5%	–0.002%	$100	–$103
2012	$192	$139	0.5%	–0.003%	$100	–$104
2013	$986	$869	3.2%	–0.003%	$871	–$590
2014	$984	$869	3.2%	–0.003%	$876	–$590
2015	$773	$661	2.4%	–0.003%	$823	–$590
2016	$771	$661	2.4%	–0.003%	$827	–$591
2017	$769	$661	2.4%	–0.003%	$832	–$591
2018	$693	$661	2.4%	–0.003%	$736	–$490
2019	$692	$661	2.4%	–0.003%	$740	–$490
2020	$692	$661	2.4%	–0.003%	$745	–$490
2021	$691	$661	2.4%	–0.003%	$749	–$490
2022	$691	$661	2.4%	–0.003%	$754	–$490
2023	$661	$661	2.4%	–0.003%	$273	–$5
2024	$661	$661	2.4%	–0.003%	$277	–$5
2025	$661	$661	2.4%	–0.003%	$281	–$5
2026	$661	$661	2.4%	–0.003%	$286	–$5
2027	$661	$661	2.4%	–0.003%	$290	–$5
2028	$661	$661	2.4%	–0.003%	$295	–$5
2029	$661	$661	2.4%	–0.003%	$299	–$5
2030	$661	$661	2.4%	–0.003%	$304	–$5
2031	$661	$661	2.4%	–0.003%	$308	–$6
2032	$661	$661	2.4%	–0.003%	$313	–$6
2033	$661	$661	2.4%	–0.003%	$317	–$6
2034	$661	$661	2.4%	–0.003%	$322	–$6
2035	$661	$661	2.4%	–0.003%	$326	–$6
2036	$661	$661	2.4%	–0.003%	$331	–$6
NPV[b]					$7,790	–$4,126

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10B-36. Impacts on Refrigeration and Air-Conditioning Equipment Market and Manufacturers (51-75 hp)
(Average Price per Equipment = $42,100)[a]

	Refrigeration and Air-Conditioning Equipment (50≤hp<70)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$226	$167	0.4%	–0.001%	$179	–$180
2009	$225	$167	0.4%	–0.001%	$179	–$180
2010	$214	$158	0.4%	–0.001%	$179	–$182
2011	$213	$157	0.4%	–0.002%	$179	–$184
2012	$212	$157	0.4%	–0.003%	$179	–$187
2013	$978	$858	2.0%	–0.003%	$1,512	–$1,032
2014	$976	$858	2.0%	–0.003%	$1,521	–$1,033
2015	$769	$653	1.6%	–0.003%	$1,428	–$1,033
2016	$767	$653	1.6%	–0.003%	$1,434	–$1,033
2017	$765	$653	1.6%	–0.003%	$1,441	–$1,033
2018	$687	$653	1.6%	–0.003%	$1,269	–$855
2019	$686	$653	1.6%	–0.003%	$1,276	–$855
2020	$686	$653	1.6%	–0.003%	$1,282	–$855
2021	$685	$653	1.6%	–0.003%	$1,289	–$855
2022	$685	$653	1.6%	–0.003%	$1,295	–$855
2023	$653	$653	1.6%	–0.003%	$459	–$12
2024	$653	$653	1.6%	–0.003%	$466	–$13
2025	$653	$653	1.6%	–0.003%	$472	–$13
2026	$653	$653	1.6%	–0.003%	$479	–$13
2027	$653	$653	1.6%	–0.003%	$486	–$13
2028	$653	$653	1.6%	–0.003%	$492	–$13
2029	$653	$653	1.6%	–0.003%	$499	–$13
2030	$653	$653	1.6%	–0.003%	$506	–$14
2031	$653	$653	1.6%	–0.003%	$512	–$14
2032	$653	$653	1.6%	–0.003%	$519	–$14
2033	$653	$653	1.6%	–0.003%	$526	–$14
2034	$653	$653	1.6%	–0.003%	$532	–$14
2035	$653	$653	1.6%	–0.003%	$539	–$15
2036	$653	$653	1.6%	–0.003%	$546	–$15
NPV[b]					$13,368	–$7,255

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-37. Impacts on General Industrial Equipment Market and Manufacturers (<25 hp)
(Average Price per Equipment = $17,300)[a]

Year	General Industrial Equipment (<25hp) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	$177	$129	0.7%	–0.001%	$61	–$61
2009	$176	$129	0.7%	–0.001%	$61	–$61
2010	$168	$123	0.7%	–0.001%	$61	–$61
2011	$167	$123	0.7%	–0.002%	$61	–$62
2012	$166	$123	0.7%	–0.003%	$61	–$62
2013	$136	$123	0.7%	–0.003%	$61	–$62
2014	$136	$123	0.7%	–0.003%	$61	–$62
2015	$135	$123	0.7%	–0.003%	$61	–$62
2016	$135	$123	0.7%	–0.003%	$61	–$62
2017	$135	$123	0.7%	–0.003%	$61	–$62
2018	$123	$123	0.7%	–0.003%	—	–$1
2019	$123	$123	0.7%	–0.003%	—	–$1
2020	$123	$123	0.7%	–0.003%	—	–$1
2021	$123	$123	0.7%	–0.003%	—	–$1
2022	$123	$123	0.7%	–0.003%	—	–$1
2023	$123	$123	0.7%	–0.003%	—	–$1
2024	$123	$123	0.7%	–0.003%	—	–$1
2025	$123	$123	0.7%	–0.003%	—	–$1
2026	$123	$123	0.7%	–0.003%	—	–$1
2027	$123	$123	0.7%	–0.003%	—	–$1
2028	$123	$123	0.7%	–0.003%	—	–$1
2029	$123	$123	0.7%	–0.003%	—	–$1
2030	$123	$123	0.7%	–0.003%	—	–$1
2031	$123	$123	0.7%	–0.003%	—	–$1
2032	$123	$123	0.7%	–0.003%	—	–$1
2033	$123	$123	0.7%	–0.003%	—	–$1
2034	$123	$123	0.7%	–0.003%	—	–$1
2035	$123	$123	0.7%	–0.003%	—	–$1
2036	$123	$123	0.7%	–0.003%	—	–$1
NPV[b]					$479	–$487

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-38. Impacts on General Industrial Equipment Market and Manufacturers (26-50 hp) (Average Price per Equipment = $42,300)[a]

Year	General Industrial Equipment (25≤hp<50) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	$204	$147	0.3%	–0.001%	$83	–$71
2009	$203	$147	0.3%	–0.001%	$83	–$71
2010	$194	$139	0.3%	–0.001%	$83	–$72
2011	$193	$139	0.3%	–0.002%	$83	–$72
2012	$192	$139	0.3%	–0.003%	$83	–$73
2013	$986	$870	2.1%	–0.003%	$664	–$400
2014	$984	$869	2.1%	–0.003%	$670	–$400
2015	$773	$661	1.6%	–0.003%	$616	–$400
2016	$771	$661	1.6%	–0.003%	$620	–$400
2017	$769	$661	1.6%	–0.003%	$624	–$400
2018	$693	$661	1.6%	–0.003%	$555	–$326
2019	$692	$661	1.6%	–0.003%	$559	–$327
2020	$692	$661	1.6%	–0.003%	$563	–$327
2021	$691	$661	1.6%	–0.003%	$567	–$327
2022	$691	$661	1.6%	–0.003%	$571	–$327
2023	$661	$661	1.6%	–0.003%	$251	–$3
2024	$661	$661	1.6%	–0.003%	$256	–$3
2025	$661	$661	1.6%	–0.003%	$260	–$3
2026	$661	$661	1.6%	–0.003%	$264	–$3
2027	$661	$661	1.6%	–0.003%	$268	–$3
2028	$661	$661	1.6%	–0.003%	$272	–$3
2029	$661	$661	1.6%	–0.003%	$276	–$3
2030	$661	$661	1.6%	–0.003%	$280	–$3
2031	$661	$661	1.6%	–0.003%	$284	–$3
2032	$661	$661	1.6%	–0.003%	$289	–$3
2033	$661	$661	1.6%	–0.003%	$293	–$3
2034	$661	$661	1.6%	–0.003%	$297	–$3
2035	$661	$661	1.6%	–0.003%	$301	–$3
2036	$661	$661	1.6%	–0.003%	$305	–$3
NPV[b]					$6,249	–$2,785

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-39. Impacts on General Industrial Equipment Market and Manufacturers (51-75 hp) (Average Price per Equipment = $56,400)[a]

	General Industrial Equipment (50≤hp<70)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$226	$167	0.3%	–0.001%	$413	–$150
2009	$225	$167	0.3%	–0.001%	$418	–$150
2010	$214	$158	0.3%	–0.001%	$408	–$150
2011	$213	$158	0.3%	–0.002%	$412	–$151
2012	$212	$157	0.3%	–0.003%	$417	–$151
2013	$978	$858	1.5%	–0.003%	$2,167	–$532
2014	$976	$858	1.5%	–0.003%	$2,195	–$533
2015	$769	$653	1.2%	–0.003%	$1,824	–$533
2016	$767	$653	1.2%	–0.003%	$1,845	–$533
2017	$765	$653	1.2%	–0.003%	$1,867	–$533
2018	$687	$653	1.2%	–0.003%	$1,687	–$332
2019	$686	$653	1.2%	–0.003%	$1,708	–$332
2020	$686	$653	1.2%	–0.003%	$1,730	–$332
2021	$685	$653	1.2%	–0.003%	$1,751	–$332
2022	$685	$653	1.2%	–0.003%	$1,772	–$332
2023	$653	$653	1.2%	–0.003%	$1,465	–$3
2024	$653	$653	1.2%	–0.003%	$1,486	–$3
2025	$653	$653	1.2%	–0.003%	$1,507	–$4
2026	$653	$653	1.2%	–0.003%	$1,529	–$4
2027	$653	$653	1.2%	–0.003%	$1,550	–$4
2028	$653	$653	1.2%	–0.003%	$1,571	–$4
2029	$653	$653	1.2%	–0.003%	$1,592	–$4
2030	$653	$653	1.2%	–0.003%	$1,614	–$4
2031	$653	$653	1.2%	–0.003%	$1,635	–$4
2032	$653	$653	1.2%	–0.003%	$1,656	–$4
2033	$653	$653	1.2%	–0.003%	$1,677	–$4
2034	$653	$653	1.2%	–0.003%	$1,699	–$4
2035	$653	$653	1.2%	–0.003%	$1,720	–$4
2036	$653	$653	1.2%	–0.003%	$1,741	–$4
NPV[b]					$24,870	–$3,615

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-40. Impacts on General Industrial Equipment Market and Manufacturers (76-100 hp)
(Average Price per Equipment = $74,300)[a]

Year	General Industrial Equipment (75≤hp<100) Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	–$1
2009	—	—	0.0%	–0.001%	—	–$1
2010	—	—	0.0%	–0.001%	—	–$2
2011	—	—	0.0%	–0.002%	—	–$4
2012	$1,303	$1,178	1.6%	–0.003%	$8,518	–$2,336
2013	$1,302	$1,178	1.6%	–0.003%	$8,625	–$2,337
2014	$1,325	$1,169	1.6%	–0.003%	$9,382	–$2,990
2015	$1,324	$1,169	1.6%	–0.003%	$9,489	–$2,990
2016	$1,322	$1,169	1.6%	–0.003%	$9,596	–$2,990
2017	$1,247	$1,169	1.6%	–0.003%	$9,325	–$2,611
2018	$1,246	$1,169	1.6%	–0.003%	$9,432	–$2,611
2019	$1,218	$1,169	1.6%	–0.003%	$9,390	–$2,462
2020	$1,218	$1,169	1.6%	–0.003%	$9,497	–$2,462
2021	$1,218	$1,169	1.6%	–0.003%	$9,604	–$2,462
2022	$1,218	$1,169	1.6%	–0.003%	$7,760	–$511
2023	$1,218	$1,169	1.6%	–0.003%	$7,867	–$511
2024	$1,218	$1,169	1.6%	–0.003%	$7,471	–$9
2025	$1,218	$1,169	1.6%	–0.003%	$7,578	–$9
2026	$1,218	$1,169	1.6%	–0.003%	$7,685	–$9
2027	$1,218	$1,169	1.6%	–0.003%	$7,792	–$10
2028	$1,218	$1,169	1.6%	–0.003%	$7,899	–$10
2029	$1,218	$1,169	1.6%	–0.003%	$8,006	–$10
2030	$1,218	$1,169	1.6%	–0.003%	$8,113	–$10
2031	$1,218	$1,169	1.6%	–0.003%	$8,220	–$10
2032	$1,218	$1,169	1.6%	–0.003%	$8,327	–$10
2033	$1,218	$1,169	1.6%	–0.003%	$8,434	–$10
2034	$1,218	$1,169	1.6%	–0.003%	$8,541	–$10
2035	$1,218	$1,169	1.6%	–0.003%	$8,648	–$11
2036	$1,218	$1,169	1.6%	–0.003%	$8,756	–$11
NPV[b]					$122,225	–$18,884

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-41. Impacts on General Industrial Equipment Market and Manufacturers (101-175 hp)
(Average Price per Equipment = $116,900)[a]

Year	General Industrial Equipment (100≤hp<175)					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	–$2
2009	—	—	0.0%	–0.001%	—	–$2
2010	—	—	0.0%	–0.001%	—	–$5
2011	—	–$1	0.0%	–0.002%	—	–$8
2012	$1,623	$1,420	1.2%	–0.003%	$11,708	–$4,156
2013	$1,619	$1,420	1.2%	–0.003%	$11,833	–$4,160
2014	$1,664	$1,399	1.2%	–0.003%	$13,023	–$5,276
2015	$1,659	$1,399	1.2%	–0.003%	$13,147	–$5,276
2016	$1,654	$1,399	1.2%	–0.003%	$13,272	–$5,276
2017	$1,577	$1,399	1.2%	–0.003%	$13,025	–$4,905
2018	$1,574	$1,399	1.2%	–0.003%	$13,150	–$4,905
2019	$1,542	$1,399	1.2%	–0.003%	$13,123	–$4,754
2020	$1,539	$1,399	1.2%	–0.003%	$13,247	–$4,754
2021	$1,537	$1,399	1.2%	–0.003%	$13,371	–$4,755
2022	$1,388	$1,399	1.2%	–0.003%	$9,722	–$981
2023	$1,387	$1,399	1.2%	–0.003%	$9,846	–$981
2024	$1,351	$1,399	1.2%	–0.003%	$9,007	–$18
2025	$1,351	$1,399	1.2%	–0.003%	$9,131	–$18
2026	$1,351	$1,399	1.2%	–0.003%	$9,256	–$18
2027	$1,351	$1,399	1.2%	–0.003%	$9,380	–$18
2028	$1,351	$1,399	1.2%	–0.003%	$9,504	–$19
2029	$1,351	$1,399	1.2%	–0.003%	$9,629	–$19
2030	$1,351	$1,399	1.2%	–0.003%	$9,753	–$19
2031	$1,351	$1,399	1.2%	–0.003%	$9,878	–$19
2032	$1,351	$1,399	1.2%	–0.003%	$10,002	–$20
2033	$1,351	$1,399	1.2%	–0.003%	$10,127	–$20
2034	$1,351	$1,399	1.2%	–0.003%	$10,251	–$20
2035	$1,351	$1,399	1.2%	–0.003%	$10,375	–$20
2036	$1,351	$1,399	1.2%	–0.003%	$10,500	–$21
NPV[b]					$159,307	–$34,647

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-42. Impacts on General Industrial Equipment Market and Manufacturers (176-600 hp)
(Average Price per Equipment = $154,200)[a]

	General Industrial Equipment (175≤hp<600)					Change in Producer
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	–$1
2009	—	—	0.0%	–0.001%	—	–$1
2010	—	–$1	0.0%	–0.001%	—	–$3
2011	$2,970	$2,265	1.5%	–0.002%	$6,434	–$4,061
2012	$2,958	$2,264	1.5%	–0.003%	$6,470	–$4,063
2013	$2,439	$1,755	1.1%	–0.003%	$5,975	–$4,065
2014	$3,107	$2,215	1.4%	–0.003%	$7,625	–$5,135
2015	$3,092	$2,214	1.4%	–0.003%	$7,662	–$5,135
2016	$2,777	$2,213	1.4%	–0.003%	$7,457	–$4,894
2017	$2,768	$2,213	1.4%	–0.003%	$7,494	–$4,895
2018	$2,759	$2,212	1.4%	–0.003%	$7,530	–$4,895
2019	$2,634	$2,211	1.4%	–0.003%	$7,469	–$4,797
2020	$2,627	$2,210	1.4%	–0.003%	$7,506	–$4,798
2021	$2,294	$2,209	1.4%	–0.003%	$3,727	–$982
2022	$2,292	$2,209	1.4%	–0.003%	$3,763	–$982
2023	$2,291	$2,208	1.4%	–0.003%	$3,799	–$982
2024	$2,209	$2,207	1.4%	–0.003%	$2,864	–$11
2025	$2,208	$2,206	1.4%	–0.003%	$2,901	–$11
2026	$2,208	$2,206	1.4%	–0.003%	$2,937	–$11
2027	$2,207	$2,205	1.4%	–0.003%	$2,974	–$11
2028	$2,206	$2,204	1.4%	–0.003%	$3,010	–$11
2029	$2,206	$2,204	1.4%	–0.003%	$3,046	–$11
2030	$2,205	$2,203	1.4%	–0.003%	$3,083	–$12
2031	$2,204	$2,203	1.4%	–0.003%	$3,119	–$12
2032	$2,204	$2,202	1.4%	–0.003%	$3,156	–$12
2033	$2,203	$2,201	1.4%	–0.003%	$3,192	–$12
2034	$2,203	$2,201	1.4%	–0.003%	$3,229	–$12
2035	$2,202	$2,200	1.4%	–0.003%	$3,265	–$12
2036	$2,202	$2,200	1.4%	–0.003%	$3,302	–$12
NPV[b]					$76,149	–$35,032

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-43. Impacts on General Industrial Equipment Market and Manufacturers (>600 hp) (Average Price per Equipment = $345,700)[a]

	General Industrial Equipment (≥600hp)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	–$1	0.0%	–0.001%	—	—
2009	—	–$1	0.0%	–0.001%	—	—
2010	—	–$2	0.0%	–0.001%	—	—
2011	$4,519	$2,964	0.9%	–0.002%	$665	–$512
2012	$4,496	$2,963	0.9%	–0.003%	$667	–$512
2013	$3,797	$2,287	0.7%	–0.003%	$634	–$513
2014	$4,684	$2,789	0.8%	–0.003%	$783	–$629
2015	$9,206	$6,270	1.8%	–0.003%	$1,439	–$1,095
2016	$8,364	$6,270	1.8%	–0.003%	$1,410	–$1,061
2017	$7,517	$5,452	1.6%	–0.003%	$1,371	–$1,061
2018	$7,489	$5,452	1.6%	–0.003%	$1,375	–$1,061
2019	$7,218	$5,452	1.6%	–0.003%	$1,369	–$1,050
2020	$6,767	$5,452	1.6%	–0.003%	$1,355	–$1,031
2021	$6,151	$5,452	1.6%	–0.003%	$881	–$554
2022	$6,142	$5,452	1.6%	–0.003%	$886	–$554
2023	$6,133	$5,452	1.6%	–0.003%	$890	–$554
2024	$5,997	$5,452	1.6%	–0.003%	$789	–$449
2025	$5,458	$5,452	1.6%	–0.003%	$346	–$2
2026	$5,458	$5,452	1.6%	–0.003%	$351	–$2
2027	$5,458	$5,452	1.6%	–0.003%	$355	–$2
2028	$5,458	$5,452	1.6%	–0.003%	$359	–$2
2029	$5,458	$5,452	1.6%	–0.003%	$364	–$2
2030	$5,458	$5,452	1.6%	–0.003%	$368	–$2
2031	$5,458	$5,452	1.6%	–0.003%	$372	–$2
2032	$5,458	$5,452	1.6%	–0.003%	$377	–$2
2033	$5,458	$5,452	1.6%	–0.003%	$381	–$2
2034	$5,458	$5,452	1.6%	–0.003%	$385	–$2
2035	$5,458	$5,452	1.6%	–0.003%	$390	–$2
2036	$5,458	$5,452	1.6%	–0.003%	$394	–$2
NPV[b]					$11,760	–$7,192

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-44. Impacts on Lawn and Garden Equipment Market and Manufacturers (<25 hp) (Average Price per Equipment = $9,300)[a]

	Lawn and Garden Equipment (<25hp)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	$177	$129	1.4%	–0.001%	$1,805	–$629
2009	$176	$129	1.4%	–0.001%	$1,836	–$629
2010	$168	$123	1.3%	–0.001%	$1,804	–$629
2011	$167	$123	1.3%	–0.002%	$1,834	–$630
2012	$166	$123	1.3%	–0.003%	$1,864	–$630
2013	$136	$123	1.3%	–0.003%	$1,597	–$333
2014	$136	$123	1.3%	–0.003%	$1,627	–$333
2015	$135	$123	1.3%	–0.003%	$1,657	–$333
2016	$135	$123	1.3%	–0.003%	$1,687	–$333
2017	$135	$123	1.3%	–0.003%	$1,717	–$333
2018	$123	$123	1.3%	–0.003%	$1,417	–$2
2019	$123	$123	1.3%	–0.003%	$1,447	–$2
2020	$123	$123	1.3%	–0.003%	$1,477	–$2
2021	$123	$123	1.3%	–0.003%	$1,507	–$3
2022	$123	$123	1.3%	–0.003%	$1,537	–$3
2023	$123	$123	1.3%	–0.003%	$1,568	–$3
2024	$123	$123	1.3%	–0.003%	$1,598	–$3
2025	$123	$123	1.3%	–0.003%	$1,628	–$3
2026	$123	$123	1.3%	–0.003%	$1,658	–$3
2027	$123	$123	1.3%	–0.003%	$1,688	–$3
2028	$123	$123	1.3%	–0.003%	$1,718	–$3
2029	$123	$123	1.3%	–0.003%	$1,749	–$3
2030	$123	$123	1.3%	–0.003%	$1,779	–$3
2031	$123	$123	1.3%	–0.003%	$1,809	–$3
2032	$123	$123	1.3%	–0.003%	$1,839	–$3
2033	$123	$123	1.3%	–0.003%	$1,869	–$3
2034	$123	$123	1.3%	–0.003%	$1,900	–$3
2035	$123	$123	1.3%	–0.003%	$1,930	–$3
2036	$123	$123	1.3%	–0.003%	$1,960	–$3
NPV[b]					$29,853	–$3,868

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-45. Impacts on Lawn and Garden Equipment Market and Manufacturers (26-50 hp) (Average Price per Equipment = $21,500)[a]

	Lawn and Garden Equipment (25≤hp<50)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$204	$147	0.7%	–0.001%	$474	–$194
2009	$203	$147	0.7%	–0.001%	$480	–$194
2010	$194	$139	0.6%	–0.001%	$471	–$195
2011	$193	$139	0.6%	–0.002%	$477	–$196
2012	$192	$139	0.6%	–0.003%	$482	–$196
2013	$986	$870	4.0%	–0.003%	$2,817	–$742
2014	$984	$870	4.0%	–0.003%	$2,858	–$742
2015	$773	$661	3.1%	–0.003%	$2,391	–$742
2016	$771	$661	3.1%	–0.003%	$2,422	–$742
2017	$769	$661	3.1%	–0.003%	$2,453	–$742
2018	$693	$661	3.1%	–0.003%	$2,228	–$485
2019	$692	$661	3.1%	–0.003%	$2,259	–$485
2020	$692	$661	3.1%	–0.003%	$2,290	–$485
2021	$691	$661	3.1%	–0.003%	$2,321	–$486
2022	$691	$661	3.1%	–0.003%	$2,353	–$486
2023	$661	$661	3.1%	–0.003%	$1,901	–$3
2024	$661	$661	3.1%	–0.003%	$1,933	–$3
2025	$661	$661	3.1%	–0.003%	$1,964	–$3
2026	$661	$661	3.1%	–0.003%	$1,995	–$3
2027	$661	$661	3.1%	–0.003%	$2,026	–$3
2028	$661	$661	3.1%	–0.003%	$2,057	–$4
2029	$661	$661	3.1%	–0.003%	$2,089	–$4
2030	$661	$661	3.1%	–0.003%	$2,120	–$4
2031	$661	$661	3.1%	–0.003%	$2,151	–$4
2032	$661	$661	3.1%	–0.003%	$2,182	–$4
2033	$661	$661	3.1%	–0.003%	$2,213	–$4
2034	$661	$661	3.1%	–0.003%	$2,245	–$4
2035	$661	$661	3.1%	–0.003%	$2,276	–$4
2036	$661	$661	3.1%	–0.003%	$2,307	–$4
NPV[b]					$32,380	–$5,037

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-46. Impacts on Lawn and Garden Equipment Market and Manufacturers (51-75 hp) (Average Price per Equipment = $33,100)[a]

	Lawn and Garden Equipment (50≤hp<75)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	$226	$167	0.5%	–0.001%	$14	–$14
2009	$225	$167	0.5%	–0.001%	$14	–$14
2010	$214	$158	0.5%	–0.001%	$14	–$15
2011	$213	$158	0.5%	–0.002%	$14	–$15
2012	$212	$157	0.5%	–0.003%	$14	–$15
2013	$978	$858	2.6%	–0.003%	$121	–$83
2014	$976	$858	2.6%	–0.003%	$122	–$83
2015	$769	$653	2.0%	–0.003%	$115	–$83
2016	$767	$653	2.0%	–0.003%	$115	–$83
2017	$765	$653	2.0%	–0.003%	$116	–$83
2018	$687	$653	2.0%	–0.003%	$102	–$68
2019	$686	$653	2.0%	–0.003%	$102	–$68
2020	$686	$653	2.0%	–0.003%	$103	–$68
2021	$685	$653	2.0%	–0.003%	$103	–$68
2022	$685	$653	2.0%	–0.003%	$104	–$68
2023	$653	$653	2.0%	–0.003%	$37	–$1
2024	$653	$653	2.0%	–0.003%	$37	–$1
2025	$653	$653	2.0%	–0.003%	$38	–$1
2026	$653	$653	2.0%	–0.003%	$38	–$1
2027	$653	$653	2.0%	–0.003%	$39	–$1
2028	$653	$653	2.0%	–0.003%	$40	–$1
2029	$653	$653	2.0%	–0.003%	$40	–$1
2030	$653	$653	2.0%	–0.003%	$41	–$1
2031	$653	$653	2.0%	–0.003%	$41	–$1
2032	$653	$653	2.0%	–0.003%	$42	–$1
2033	$653	$653	2.0%	–0.003%	$42	–$1
2034	$653	$653	2.0%	–0.003%	$43	–$1
2035	$653	$653	2.0%	–0.003%	$43	–$1
2036	$653	$653	2.0%	–0.003%	$44	–$1
NPV[b]					$1,072	–$577

[a] Figures are in 2002 dollars.

[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-47. Impacts on Lawn and Garden Equipment Market and Manufacturers (76-100 hp) (Average Price per Equipment = $38,500)[a]

	Lawn and Garden Equipment (70≤hp<100)					Change in Producer Surplus for Equipment Manufacturers (10^3)
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	—	—	0.0%	–0.002%	—	–$1
2012	$1,303	$1,178	3.1%	–0.003%	$529	–$375
2013	$1,302	$1,178	3.1%	–0.003%	$531	–$375
2014	$1,325	$1,169	3.0%	–0.003%	$641	–$471
2015	$1,324	$1,169	3.0%	–0.003%	$644	–$471
2016	$1,322	$1,169	3.0%	–0.003%	$647	–$471
2017	$1,247	$1,169	3.0%	–0.003%	$650	–$471
2018	$1,246	$1,169	3.0%	–0.003%	$653	–$471
2019	$1,218	$1,169	3.0%	–0.003%	$655	–$472
2020	$1,218	$1,169	3.0%	–0.003%	$658	–$472
2021	$1,218	$1,169	3.0%	–0.003%	$661	–$472
2022	$1,218	$1,169	3.0%	–0.003%	$290	–$98
2023	$1,218	$1,169	3.0%	–0.003%	$293	–$98
2024	$1,218	$1,169	3.0%	–0.003%	$200	–$1
2025	$1,218	$1,169	3.0%	–0.003%	$202	–$1
2026	$1,218	$1,169	3.0%	–0.003%	$205	–$1
2027	$1,218	$1,169	3.0%	–0.003%	$208	–$2
2028	$1,218	$1,169	3.0%	–0.003%	$211	–$2
2029	$1,218	$1,169	3.0%	–0.003%	$214	–$2
2030	$1,218	$1,169	3.0%	–0.003%	$217	–$2
2031	$1,218	$1,169	3.0%	–0.003%	$220	–$2
2032	$1,218	$1,169	3.0%	–0.003%	$222	–$2
2033	$1,218	$1,169	3.0%	–0.003%	$225	–$2
2034	$1,218	$1,169	3.0%	–0.003%	$228	–$2
2035	$1,218	$1,169	3.0%	–0.003%	$231	–$2
2036	$1,218	$1,169	3.0%	–0.003%	$234	–$2
NPV[b]					$5,970	–$3,244

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-48. Impacts on Lawn and Garden Equipment Market and Manufacturers (101-175 hp)
(Average Price per Equipment = $29,200)[a]

	Lawn and Garden Equipment (100≤hp<175)					
Year	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	Change in Producer Surplus for Equipment Manufacturers (10^3)
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	—	0.0%	–0.001%	—	—
2011	—	—	0.0%	–0.002%	—	—
2012	$1,623	$1,421	4.8%	–0.003%	$420	–$331
2013	$1,619	$1,421	4.8%	–0.003%	$421	–$331
2014	$1,664	$1,399	4.7%	–0.003%	$514	–$416
2015	$1,659	$1,399	4.7%	–0.003%	$515	–$416
2016	$1,654	$1,399	4.7%	–0.003%	$517	–$416
2017	$1,577	$1,399	4.7%	–0.003%	$518	–$416
2018	$1,574	$1,399	4.7%	–0.003%	$520	–$416
2019	$1,542	$1,399	4.7%	–0.003%	$521	–$416
2020	$1,539	$1,399	4.7%	–0.003%	$523	–$416
2021	$1,537	$1,399	4.7%	–0.003%	$525	–$416
2022	$1,388	$1,399	4.7%	–0.003%	$195	–$85
2023	$1,387	$1,399	4.7%	–0.003%	$197	–$85
2024	$1,351	$1,399	4.7%	–0.003%	$114	–$1
2025	$1,351	$1,399	4.7%	–0.003%	$116	–$1
2026	$1,351	$1,399	4.7%	–0.003%	$117	–$1
2027	$1,351	$1,399	4.7%	–0.003%	$119	–$1
2028	$1,351	$1,399	4.7%	–0.003%	$120	–$1
2029	$1,351	$1,399	4.7%	–0.003%	$122	–$1
2030	$1,351	$1,399	4.7%	–0.003%	$124	–$1
2031	$1,351	$1,399	4.7%	–0.003%	$125	–$1
2032	$1,351	$1,399	4.7%	–0.003%	$127	–$1
2033	$1,351	$1,399	4.7%	–0.003%	$128	–$1
2034	$1,351	$1,399	4.7%	–0.003%	$130	–$1
2035	$1,351	$1,399	4.7%	–0.003%	$131	–$1
2036	$1,351	$1,399	4.7%	–0.003%	$133	–$1
NPV[b]					$4,418	–$2,856

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10.B-49. Impacts on Lawn and Garden Equipment Market and Manufacturers (176-600 hp)
(Average Price per Equipment = $64,300)[a]

Year	Lawn and Garden Equipment (175≤hp<600)					Change in Producer Surplus for Equipment Manufacturers (10^3)
	Engineering Cost/Unit	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs (10^3)	
2007	—	—	0.0%	0.000%	—	—
2008	—	—	0.0%	–0.001%	—	—
2009	—	—	0.0%	–0.001%	—	—
2010	—	–$1	0.0%	–0.001%	—	—
2011	$2,970	$2,265	3.5%	–0.002%	$279	–$233
2012	$2,958	$2,264	3.5%	–0.003%	$280	–$233
2013	$2,439	$1,755	2.7%	–0.003%	$271	–$233
2014	$3,107	$2,216	3.4%	–0.003%	$344	–$293
2015	$3,092	$2,215	3.4%	–0.003%	$345	–$293
2016	$2,777	$2,214	3.4%	–0.003%	$346	–$293
2017	$2,768	$2,213	3.4%	–0.003%	$346	–$293
2018	$2,759	$2,212	3.4%	–0.003%	$347	–$293
2019	$2,634	$2,211	3.4%	–0.003%	$348	–$293
2020	$2,627	$2,210	3.4%	–0.003%	$349	–$293
2021	$2,294	$2,210	3.4%	–0.003%	$116	–$60
2022	$2,292	$2,209	3.4%	–0.003%	$117	–$60
2023	$2,291	$2,208	3.4%	–0.003%	$118	–$60
2024	$2,209	$2,207	3.4%	–0.003%	$59	—
2025	$2,208	$2,207	3.4%	–0.003%	$60	—
2026	$2,208	$2,206	3.4%	–0.003%	$60	—
2027	$2,207	$2,205	3.4%	–0.003%	$61	—
2028	$2,206	$2,205	3.4%	–0.003%	$62	—
2029	$2,206	$2,204	3.4%	–0.003%	$63	—
2030	$2,205	$2,203	3.4%	–0.003%	$63	—
2031	$2,204	$2,203	3.4%	–0.003%	$64	—
2032	$2,204	$2,202	3.4%	–0.003%	$65	—
2033	$2,203	$2,202	3.4%	–0.003%	$66	—
2034	$2,203	$2,201	3.4%	–0.003%	$66	—
2035	$2,202	$2,200	3.4%	–0.003%	$67	—
2036	$2,202	$2,200	3.4%	–0.003%	$68	–$1
NPV[b]					$2,898	–$2,060

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

APPENDIX 10C: Impacts on Application Markets

This appendix provides the time series of impacts from 2007 through 2036 for the application markets and the transportation service markets included in the model.

There are 3 application markets: construction, agriculture, and manufacturing.

There are 2 transportation service markets: locomotive and marine.

Tables 10C-1 through 10C-5 provide the time series of impacts for these markets. Each table includes the following:

- relative change in market price (%)
- relative change in market quantity (%)
- change in producer and consumer surplus for each application market

For the three application markets, prices are expected to increase 0.02 percent in the manufacturing sector, 0.1 percent in the agricultural sector, and 0.5 percent in the construction sector. Price increase are highest in about 2015, and decrease thereafter. Quantity decreases stabilize in about 2015 as well.

For the transportation service markets, prices are expected to increase 0.03 percent in the locomotive sector and 0.006 percent in the marine sector. Price increases and quantity decreases stabilize in about 2015.

Table 10C-1. Impacts on Agricultural Application Market[a]

Year	Agriculture		Change in Producer and Consumer Surplus ($$10^3$)
	Change in Price (%)	Change in Quantity (%)	
2007	0.030%	0.000%	–$35,860
2008	0.050%	–0.001%	–$75,265
2009	0.050%	–0.001%	–$76,967
2010	0.104%	–0.002%	–$144,827
2011	0.142%	–0.003%	–$309,684
2012	0.139%	–0.004%	–$394,695
2013	0.136%	–0.005%	–$429,981
2014	0.147%	–0.005%	–$478,692
2015	0.154%	–0.005%	–$484,874
2016	0.152%	–0.005%	–$493,522
2017	0.150%	–0.005%	–$502,205
2018	0.148%	–0.005%	–$510,901
2019	0.146%	–0.005%	–$519,570
2020	0.143%	–0.005%	–$524,291
2021	0.140%	–0.005%	–$530,035
2022	0.138%	–0.005%	–$538,585
2023	0.136%	–0.005%	–$547,123
2024	0.134%	–0.005%	–$555,669
2025	0.132%	–0.005%	–$564,198
2026	0.130%	–0.005%	–$572,713
2027	0.128%	–0.005%	–$581,228
2028	0.127%	–0.005%	–$589,742
2029	0.125%	–0.005%	–$598,257
2030	0.123%	–0.005%	–$606,770
2031	0.121%	–0.005%	–$615,284
2032	0.119%	–0.005%	–$623,797
2033	0.118%	–0.005%	–$632,309
2034	0.116%	–0.005%	–$640,821
2035	0.114%	–0.005%	–$649,333
2036	0.113%	–0.005%	–$657,844
NPV[b]			–$8,180,632

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10C-2. Impacts on Construction Application Market[a]

Year	Construction		Change in Producer and Consumer Surplus (10^3)
	Change in Price (%)	Change in Quantity (%)	
2007	0.105%	–0.001%	–$47,524
2008	0.176%	–0.001%	–$97,113
2009	0.174%	–0.001%	–$99,303
2010	0.382%	–0.002%	–$199,991
2011	0.526%	–0.004%	–$409,111
2012	0.517%	–0.005%	–$548,053
2013	0.508%	–0.006%	–$584,333
2014	0.553%	–0.006%	–$650,082
2015	0.587%	–0.006%	–$689,966
2016	0.579%	–0.006%	–$702,193
2017	0.573%	–0.006%	–$709,196
2018	0.568%	–0.006%	–$721,412
2019	0.565%	–0.006%	–$733,610
2020	0.559%	–0.006%	–$744,027
2021	0.554%	–0.006%	–$754,910
2022	0.550%	–0.006%	–$767,057
2023	0.544%	–0.006%	–$779,171
2024	0.539%	–0.006%	–$791,302
2025	0.533%	–0.006%	–$803,409
2026	0.527%	–0.006%	–$815,495
2027	0.522%	–0.006%	–$827,581
2028	0.517%	–0.006%	–$839,668
2029	0.512%	–0.006%	–$851,754
2030	0.507%	–0.006%	–$863,841
2031	0.502%	–0.006%	–$875,929
2032	0.497%	–0.006%	–$888,016
2033	0.492%	–0.006%	–$900,104
2034	0.487%	–0.006%	–$912,193
2035	0.482%	–0.006%	–$924,281
2036	0.478%	–0.006%	–$936,370
NPV[b]			–$11,525,673

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10C-3. Impacts on Manufacturing Application Market[a]

Year	Manufacturing		Change in Producer and Consumer Surplus (10^3)
	Change in Price (%)	Change in Quantity (%)	
2007	0.007%	–0.003%	–$40,523
2008	0.015%	–0.004%	–$104,885
2009	0.015%	–0.004%	–$106,956
2010	0.028%	–0.007%	–$190,735
2011	0.059%	–0.013%	–$289,933
2012	0.074%	–0.016%	–$382,352
2013	0.079%	–0.017%	–$482,357
2014	0.086%	–0.019%	–$519,105
2015	0.086%	–0.019%	–$517,361
2016	0.086%	–0.019%	–$525,764
2017	0.086%	–0.019%	–$533,562
2018	0.086%	–0.019%	–$542,061
2019	0.086%	–0.019%	–$550,840
2020	0.086%	–0.019%	–$557,759
2021	0.085%	–0.018%	–$564,953
2022	0.085%	–0.019%	–$573,644
2023	0.085%	–0.019%	–$582,045
2024	0.085%	–0.019%	–$590,571
2025	0.085%	–0.019%	–$599,072
2026	0.085%	–0.019%	–$607,560
2027	0.085%	–0.019%	–$616,061
2028	0.085%	–0.019%	–$624,576
2029	0.085%	–0.019%	–$633,104
2030	0.085%	–0.019%	–$641,646
2031	0.086%	–0.019%	–$650,201
2032	0.086%	–0.019%	–$658,771
2033	0.086%	–0.019%	–$667,355
2034	0.086%	–0.019%	–$675,953
2035	0.086%	–0.019%	–$684,566
2036	0.086%	–0.019%	–$693,194
NPV[b]			–$8,722,570

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10C-4. Impacts on the Locomotive Transportation Market[a]

Year	Manufacturing		Change in Producer and Consumer Surplus ($$10^3$)
	Change in Price (%)	Change in Quantity (%)	
2007	0.003%	–0.004%	–$44
2008	0.005%	–0.006%	–$234
2009	0.005%	–0.006%	–$240
2010	0.010%	–0.011%	–$519
2011	0.020%	–0.021%	–$970
2012	0.027%	–0.027%	–$1,314
2013	0.028%	–0.028%	–$1,579
2014	0.031%	–0.031%	–$1,739
2015	0.032%	–0.032%	–$1,773
2016	0.032%	–0.032%	–$1,813
2017	0.032%	–0.032%	–$1,850
2018	0.032%	–0.032%	–$1,892
2019	0.032%	–0.032%	–$1,936
2020	0.032%	–0.032%	–$1,973
2021	0.032%	–0.032%	–$2,013
2022	0.032%	–0.032%	–$2,059
2023	0.032%	–0.032%	–$2,106
2024	0.032%	–0.032%	–$2,155
2025	0.032%	–0.032%	–$2,204
2026	0.032%	–0.032%	–$2,255
2027	0.032%	–0.032%	–$2,306
2028	0.032%	–0.032%	–$2,359
2029	0.032%	–0.032%	–$2,413
2030	0.032%	–0.032%	–$2,469
2031	0.032%	–0.032%	–$2,525
2032	0.032%	–0.032%	–$2,583
2033	0.032%	–0.032%	–$2,643
2034	0.032%	–0.032%	–$2,704
2035	0.032%	–0.032%	–$2,766
2036	0.032%	–0.032%	–$2,829
NPV[b]			–$31,271

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10C-3. Impacts on the Marine Transportation Market[a]

Year	Manufacturing: Change in Price (%)	Manufacturing: Change in Quantity (%)	Change in Producer and Consumer Surplus ($$10^3$)
2007	0.001%	0.000%	–$32
2008	0.001%	–0.001%	–$132
2009	0.001%	–0.001%	–$135
2010	0.002%	–0.001%	–$289
2011	0.004%	–0.002%	–$549
2012	0.005%	–0.003%	–$744
2013	0.006%	–0.003%	–$876
2014	0.006%	–0.003%	–$967
2015	0.006%	–0.003%	–$996
2016	0.006%	–0.003%	–$1,019
2017	0.006%	–0.003%	–$1,038
2018	0.006%	–0.003%	–$1,062
2019	0.006%	–0.003%	–$1,087
2020	0.006%	–0.003%	–$1,108
2021	0.006%	–0.003%	–$1,131
2022	0.006%	–0.003%	–$1,157
2023	0.006%	–0.003%	–$1,184
2024	0.006%	–0.003%	–$1,211
2025	0.006%	–0.003%	–$1,239
2026	0.006%	–0.003%	–$1,267
2027	0.006%	–0.003%	–$1,296
2028	0.006%	–0.003%	–$1,326
2029	0.006%	–0.003%	–$1,357
2030	0.006%	–0.003%	–$1,388
2031	0.006%	–0.003%	–$1,420
2032	0.006%	–0.003%	–$1,452
2033	0.006%	–0.003%	–$1,486
2034	0.006%	–0.003%	–$1,520
2035	0.006%	–0.003%	–$1,555
2036	0.006%	–0.003%	–$1,591
NPV[b]			–$17,569

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

APPENDIX 10D: Impacts on the Nonroad Fuel Market

This appendix provides the time series of impacts from 2007 through 2036 for the nonroad diesel fuel market. Eight nonroad diesel fuel markets were modeled: 2 sulfur content levels (15 ppm and 500 ppm) for each of 4 PADDs (PADDs 1&3, PADD 2, PADD 4, and PADD 5). Note that PADD 5 includes Alaska and Hawaii but excludes California fuel volumes that are not affected by the program because they are covered by separate California nonroad diesel fuel standards.

Tables 10D-1 through 10D-4 provide the time series of impacts for the diesel fuel market for the four regional fuel markets. Each table includes the following:

- average price per gallon
- average engineering costs (variable and fixed) per gallon
- absolute change in the PADDs' nonroad diesel price ($)
  - Note that the estimated absolute change in market price is based on average variable and fixed costs; see Appendix 10I for sensitivity analyses reflecting maximum total costs and maximum variable costs
- relative change in the PADDs' nonroad diesel price (%)
- relative change in the PADDs' nonroad diesel quantity (%)
- total engineering (regulatory) costs associated with each PADD's fuel market ($)
- change in producer surplus for all fuel producers

In 2001, about 68 percent of high-sulfur diesel fuel was consumed in nonroad diesel equipment and about 32 percent was consumed in marine equipment and locomotive engines.[S] The engineering costs and changes in producer surplus presented in this appendix include both of these diesel fuel segments.

All prices and costs are presented in $2002, and the real per-gallon prices are assumed to be constant within each regional fuel market. For each regional fuel market, the majority of the cost of the regulation is passed along through increased fuel prices.

[S]These percentages exclude heating oil; if high-sulfur heating oil is included, then about 35 percent of high-sulfur fuel was consumed in nonroad diesel equipment and about 17 percent was consumed in marine equipment and locomotive engines.

Table 10D-1. Impacts on the Nonroad Fuel Market in PADD 1&3
(Average Price per Gallon = $0.91)[a]

Year	Engineering Cost/Unit 15ppm	Engineering Cost/Unit 500ppm	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs ($10^3^)	Change in Producer Surplus for Fuel Producers ($10^3^)
2007	—	$0.02	$0.01	1.0%	–0.002%	$56,985	–$54
2008	—	$0.02	$0.02	1.8%	–0.004%	$99,743	–$613
2009	—	$0.02	$0.02	1.8%	–0.004%	$101,806	–$629
2010	$0.06	$0.02	$0.04	4.1%	–0.007%	$236,629	$65
2011	$0.06	$0.03	$0.05	5.7%	–0.013%	$339,851	–$2,313
2012	$0.06	$0.03	$0.05	5.7%	–0.017%	$346,465	–$3,292
2013	$0.06	$0.03	$0.05	5.6%	–0.018%	$352,867	–$3,624
2014	$0.06	$0.03	$0.06	6.1%	–0.019%	$390,537	–$4,187
2015	$0.06	$0.03	$0.06	6.5%	–0.020%	$421,492	–$4,532
2016	$0.06	$0.03	$0.06	6.5%	–0.020%	$429,036	–$4,625
2017	$0.06	$0.03	$0.06	6.5%	–0.020%	$436,616	–$4,689
2018	$0.06	$0.03	$0.06	6.5%	–0.020%	$444,324	–$4,783
2019	$0.06	$0.03	$0.06	6.5%	–0.020%	$452,220	–$4,877
2020	$0.06	$0.03	$0.06	6.5%	–0.020%	$462,196	–$5,027
2021	$0.06	$0.03	$0.06	6.6%	–0.020%	$471,507	–$5,164
2022	$0.06	$0.03	$0.06	6.6%	–0.020%	$479,447	–$5,259
2023	$0.06	$0.03	$0.06	6.6%	–0.020%	$487,125	–$5,353
2024	$0.06	$0.03	$0.06	6.6%	–0.020%	$494,924	–$5,448
2025	$0.06	$0.03	$0.06	6.6%	–0.020%	$502,671	–$5,542
2026	$0.06	$0.03	$0.06	6.6%	–0.020%	$510,413	–$5,636
2027	$0.06	$0.03	$0.06	6.6%	–0.020%	$518,166	–$5,730
2028	$0.06	$0.03	$0.06	6.6%	–0.020%	$525,932	–$5,824
2029	$0.06	$0.03	$0.06	6.6%	–0.020%	$533,710	–$5,918
2030	$0.06	$0.03	$0.06	6.6%	–0.020%	$541,500	–$6,012
2031	$0.06	$0.03	$0.06	6.6%	–0.020%	$549,303	–$6,106
2032	$0.06	$0.03	$0.06	6.6%	–0.020%	$557,119	–$6,200
2033	$0.06	$0.03	$0.06	6.6%	–0.020%	$564,948	–$6,294
2034	$0.06	$0.03	$0.06	6.6%	–0.020%	$572,789	–$6,388
2035	$0.06	$0.03	$0.06	6.6%	–0.020%	$580,644	–$6,482
2036	$0.06	$0.03	$0.06	6.6%	–0.020%	$588,512	–$6,576
NPV[b]						$7,422,281	–$76,083

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

Table 10D-2. Impacts on the Nonroad Fuel Market in PADD 2
(Average Price per Gallon = $0.94)[a]

Year	Engineering Cost/Unit 15ppm	Engineering Cost/Unit 500ppm	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs ($10^3)	Change in Producer Surplus for Fuel Producers ($10^3)
2007	—	$0.02	$0.01	1.5%	–0.003%	$57,852	$64
2008	—	$0.02	$0.02	2.6%	–0.005%	$101,359	–$544
2009	—	$0.02	$0.02	2.6%	–0.005%	$103,564	–$558
2010	$0.07	$0.03	$0.05	5.0%	–0.008%	$204,945	$578
2011	$0.07	$0.03	$0.06	6.7%	–0.015%	$281,683	–$932
2012	$0.07	$0.03	$0.06	6.7%	–0.019%	$287,389	–$1,649
2013	$0.07	$0.03	$0.06	6.7%	–0.021%	$293,011	–$1,903
2014	$0.08	$0.03	$0.07	7.3%	–0.022%	$323,985	–$2,523
2015	$0.08	$0.03	$0.07	7.7%	–0.023%	$349,620	–$2,889
2016	$0.08	$0.03	$0.07	7.7%	–0.023%	$356,353	–$2,957
2017	$0.08	$0.03	$0.07	7.7%	–0.023%	$363,096	–$3,012
2018	$0.08	$0.03	$0.07	7.7%	–0.023%	$369,869	–$3,083
2019	$0.08	$0.03	$0.07	7.7%	–0.023%	$376,682	–$3,151
2020	$0.08	$0.03	$0.07	7.5%	–0.023%	$374,491	–$2,895
2021	$0.08	$0.03	$0.07	7.4%	–0.023%	$374,573	–$2,733
2022	$0.08	$0.03	$0.07	7.4%	–0.023%	$381,107	–$2,791
2023	$0.08	$0.03	$0.07	7.4%	–0.023%	$387,586	–$2,849
2024	$0.08	$0.03	$0.07	7.4%	–0.023%	$394,090	–$2,907
2025	$0.08	$0.03	$0.07	7.4%	–0.023%	$400,582	–$2,964
2026	$0.08	$0.03	$0.07	7.4%	–0.023%	$407,040	–$3,021
2027	$0.08	$0.03	$0.07	7.4%	–0.023%	$413,500	–$3,079
2028	$0.08	$0.03	$0.07	7.4%	–0.023%	$419,963	–$3,136
2029	$0.08	$0.03	$0.07	7.4%	–0.023%	$426,429	–$3,194
2030	$0.08	$0.03	$0.07	7.4%	–0.023%	$432,896	–$3,251
2031	$0.08	$0.03	$0.07	7.4%	–0.023%	$439,367	–$3,308
2032	$0.08	$0.03	$0.07	7.5%	–0.023%	$445,840	–$3,366
2033	$0.08	$0.03	$0.07	7.5%	–0.023%	$452,315	–$3,423
2034	$0.08	$0.03	$0.07	7.5%	–0.023%	$458,794	–$3,480
2035	$0.08	$0.03	$0.07	7.5%	–0.023%	$465,275	–$3,537
2036	$0.08	$0.03	$0.07	7.5%	–0.023%	$471,758	–$3,594
NPV[b]						$6,075,867	–$42,383

[a] Figures are in 2001 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2030 time period.

Table 10D-3. Impacts on the Nonroad Fuel Market in PADD 4
(Average Price per Gallon = $0.91)[a]

Year	Engineering Cost/Unit 15ppm	Engineering Cost/Unit 500ppm	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs ($10^3^)	Change in Producer Surplus for Fuel Producers ($10^3^)
2007	—	$0.04	$0.02	2.0%	–0.003%	$6,826	$34
2008	—	$0.04	$0.03	3.4%	–0.005%	$11,955	–$34
2009	—	$0.04	$0.03	3.4%	–0.005%	$12,214	–$35
2010	$0.13	$0.04	$0.07	6.8%	–0.009%	$24,781	$432
2011	$0.13	$0.09	$0.09	9.1%	–0.016%	$33,824	$459
2012	$0.13	$0.09	$0.09	9.1%	–0.020%	$34,500	$401
2013	$0.13	$0.09	$0.09	9.1%	–0.021%	$35,166	$390
2014	$0.13	$0.09	$0.09	9.9%	–0.023%	$39,254	$324
2015	$0.13	$0.09	$0.10	10.6%	–0.024%	$42,621	$273
2016	$0.13	$0.09	$0.10	10.6%	–0.024%	$43,461	$276
2017	$0.13	$0.09	$0.10	10.6%	–0.024%	$44,301	$280
2018	$0.13	$0.09	$0.10	10.6%	–0.024%	$45,142	$281
2019	$0.13	$0.09	$0.10	10.6%	–0.024%	$45,982	$284
2020	$0.13	$0.09	$0.10	10.4%	–0.024%	$45,886	$322
2021	$0.13	$0.09	$0.10	10.3%	–0.024%	$46,029	$349
2022	$0.13	$0.09	$0.10	10.3%	–0.024%	$46,840	$352
2023	$0.13	$0.09	$0.10	10.3%	–0.024%	$47,652	$356
2024	$0.13	$0.09	$0.10	10.3%	–0.024%	$48,463	$359
2025	$0.13	$0.09	$0.10	10.4%	–0.024%	$49,275	$363
2026	$0.13	$0.09	$0.10	10.4%	–0.024%	$50,081	$366
2027	$0.13	$0.09	$0.10	10.4%	–0.024%	$50,886	$369
2028	$0.13	$0.09	$0.10	10.4%	–0.024%	$51,692	$373
2029	$0.13	$0.09	$0.10	10.4%	–0.024%	$52,498	$376
2030	$0.13	$0.09	$0.10	10.4%	–0.024%	$53,304	$379
2031	$0.13	$0.09	$0.10	10.4%	–0.024%	$54,109	$383
2032	$0.13	$0.09	$0.10	10.4%	–0.024%	$54,915	$386
2033	$0.13	$0.09	$0.10	10.4%	–0.024%	$55,721	$390
2034	$0.13	$0.09	$0.10	10.4%	–0.024%	$56,527	$393
2035	$0.13	$0.09	$0.10	10.4%	–0.024%	$57,333	$397
2036	$0.13	$0.09	$0.10	10.4%	–0.024%	$58,138	$400
NPV[b]						$742,250	$5,626

[a] Figures are in 2001 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2030 time period.

Table 10D-4. Impacts on the Nonroad Fuel Market in PADD 5
(Average Price per Gallon = $0.87)[a]

Year	Engineering Cost/Unit 15ppm	Engineering Cost/Unit 500ppm	Absolute Change in Price	Change in Price (%)	Change in Quantity (%)	Total Engineering Costs ($$10^3$)	Change in Producer Surplus for Fuel Producers ($$10^3$)
2007	—	$0.01	$0.01	0.5%	–0.003%	$3,004	–$24
2008	—	$0.01	$0.01	0.9%	–0.005%	$5,266	–$68
2009	—	$0.01	$0.01	0.9%	–0.005%	$5,382	–$70
2010	$0.05	$0.02	$0.02	1.8%	–0.008%	$11,146	–$44
2011	$0.05	$0.04	$0.03	2.8%	–0.015%	$17,727	–$171
2012	$0.05	$0.04	$0.03	2.8%	–0.019%	$18,083	–$287
2013	$0.05	$0.04	$0.03	2.8%	–0.020%	$18,428	–$322
2014	$0.06	$0.04	$0.04	4.4%	–0.022%	$29,541	–$321
2015	$0.07	$0.04	$0.06	5.9%	–0.023%	$40,159	–$377
2016	$0.07	$0.04	$0.06	5.9%	–0.023%	$40,915	–$385
2017	$0.07	$0.04	$0.06	5.9%	–0.023%	$41,678	–$390
2018	$0.07	$0.04	$0.06	5.9%	–0.023%	$42,453	–$398
2019	$0.07	$0.04	$0.06	5.9%	–0.023%	$43,236	–$406
2020	$0.07	$0.04	$0.06	5.9%	–0.023%	$44,001	–$413
2021	$0.07	$0.04	$0.06	5.9%	–0.023%	$44,768	–$420
2022	$0.07	$0.04	$0.06	5.9%	–0.023%	$45,551	–$428
2023	$0.07	$0.04	$0.06	5.9%	–0.023%	$46,317	–$436
2024	$0.07	$0.04	$0.06	5.9%	–0.023%	$47,090	–$444
2025	$0.07	$0.04	$0.06	5.9%	–0.023%	$47,859	–$452
2026	$0.07	$0.04	$0.06	5.9%	–0.023%	$48,627	–$460
2027	$0.07	$0.04	$0.06	5.9%	–0.023%	$49,396	–$468
2028	$0.07	$0.04	$0.06	5.9%	–0.023%	$50,166	–$476
2029	$0.07	$0.04	$0.06	5.9%	–0.023%	$50,936	–$485
2030	$0.07	$0.04	$0.06	5.9%	–0.023%	$51,707	–$493
2031	$0.07	$0.04	$0.06	5.9%	–0.023%	$52,478	–$501
2032	$0.07	$0.04	$0.06	5.9%	–0.023%	$53,251	–$509
2033	$0.07	$0.04	$0.06	5.9%	–0.023%	$54,024	–$517
2034	$0.07	$0.04	$0.06	6.0%	–0.023%	$54,797	–$525
2035	$0.07	$0.04	$0.06	6.0%	–0.023%	$55,572	–$533
2036	$0.07	$0.04	$0.06	6.0%	–0.023%	$56,347	–$541
NPV[b]						$647,478	–$6,343

[a] Figures are in 2001 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2030 time period.

APPENDIX 10E: Time Series of Social Cost

This appendix provides a time series of the rule's estimated social costs from 2007 through 2036. Costs are presented in 2002 dollars.

Table 10E-1. Time Series of Market Impacts

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Engine Producers Total	**$0.0**	**$14.9**	**$14.9**	**$14.9**	**$29.4**	**$38.9**	**$42.0**	**$51.6**	**$52.4**	**$37.9**
Equipment Producers Total	**$0.3**	**$8.8**	**$8.8**	**$9.6**	**$88.7**	**$131.4**	**$143.1**	**$179.0**	**$186.0**	**$156.9**
Construction Equipment	$0.2	$1.8	$1.8	$2.3	$41.3	$60.8	$64.0	$81.1	$87.6	$73.0
Agricultural Equipment	$0.1	$2.4	$2.4	$2.6	$36.0	$48.3	$51.8	$66.0	$66.0	$52.2
Industrial Equipment	$0.0	$4.6	$4.7	$4.7	$11.4	$22.3	$27.2	$31.9	$32.4	$31.8
Application Producers & Consumers Total	**$123.9**	**$277.3**	**$283.2**	**$535.6**	**$1,008.7**	**$1,325.1**	**$1,496.7**	**$1,647.9**	**$1,692.2**	**$1,721.5**
Total Producer	*$45.5*	*$108.4*	*$110.8*	*$216.5*	*$418.5*	*$553.0*	*$620.9*	*$685.2*	*$706.4*	*$718.6*
Total Consumer	*$78.4*	*$168.8*	*$172.4*	*$319.1*	*$590.2*	*$772.1*	*$875.7*	*$962.7*	*$985.8*	*$1,002.8*
Construction	$47.5	$97.1	$99.3	$200.0	$409.1	$548.1	$584.3	$650.1	$690.0	$702.2
Agriculture	$35.9	$75.3	$77.0	$144.8	$309.7	$394.7	$430.0	$478.7	$484.9	$493.5
Manufacturing	$40.5	$104.9	$107.0	$190.7	$289.9	$382.4	$482.4	$519.1	$517.4	$525.8
Fuel Producers Total	**$0.2**	**$1.7**	**$1.7**	**–$0.2**	**$4.7**	**$7.2**	**$8.0**	**$9.6**	**$10.5**	**$10.7**
PADD 1 & 3	$0.1	$0.7	$0.7	$0.1	$2.6	$3.7	$4.1	$4.7	$5.1	$5.2
PADD 2	$0.0	$0.8	$0.8	–$0.1	$1.9	$2.9	$3.3	$4.0	$4.4	$4.5
PADD 4	$0.0	$0.1	$0.1	–$0.3	–$0.2	$0.0	$0.0	$0.1	$0.2	$0.2
PADD 5	$0.0	$0.1	$0.1	$0.1	$0.4	$0.6	$0.6	$0.7	$0.7	$0.8
Transportation Services, Total	**$18.9**	**$33.1**	**$33.5**	**$71.5**	**$102.0**	**$103.6**	**$104.9**	**$95.5**	**$88.3**	**$89.2**
Locomotive	$0.0	$0.2	$0.2	$0.5	$1.0	$1.3	$1.6	$1.7	$1.8	$1.8
Marine	$0.0	$0.1	$0.1	$0.3	$0.5	$0.7	$0.9	$1.0	$1.0	$1.0
Application Markets Not Included in	$18.9	$32.7	$33.1	$70.7	$100.5	$101.6	$102.4	$92.8	$85.5	$86.4
Operating Savings	**–$160.9**	**–$281.9**	**–$288.0**	**–$304.6**	**–$311.4**	**–$302.2**	**–$284.7**	**–$293.0**	**–$288.0**	**–$273.6**
Total	**–$17.6**	**$53.9**	**$54.2**	**$326.7**	**$922.3**	**$1,304.0**	**$1,510.0**	**$1,690.5**	**$1,741.3**	**$1,742.6**

(continued)

Table 10E-1. Time Series of Market Impacts (continued)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Engine Producers Total	**$28.4**	**$10.4**	**$0.9**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**
Equipment Producers Total	**$148.6**	**$139.7**	**$125.0**	**$122.7**	**$74.2**	**$40.9**	**$30.4**	**$9.8**	**$5.6**	**$5.6**
Construction Equipment	$68.9	$67.3	$60.2	$57.8	$34.4	$19.8	$17.0	$7.5	$3.7	$3.8
Agricultural Equipment	$49.3	$46.5	$39.7	$39.7	$20.6	$11.5	$8.9	$1.7	$1.7	$1.8
Industrial Equipment	$30.4	$26.0	$25.2	$25.2	$19.1	$9.6	$4.5	$0.6	$0.1	$0.1
Application Producers & Consumers Total	**$1,745.0**	**$1,774.4**	**$1,804.0**	**$1,826.1**	**$1,849.9**	**$1,879.3**	**$1,908.3**	**$1,937.5**	**$1,966.7**	**$1,995.8**
Total Producer	*$728.2*	*$740.5*	*$752.9*	*$762.2*	*$772.3*	*$784.6*	*$796.8*	*$809.0*	*$821.2*	*$833.4*
Total Consumer	*$1,016.8*	*$1,033.9*	*$1,051.1*	*$1,063.8*	*$1,077.6*	*$1,094.7*	*$1,111.6*	*$1,128.5*	*$1,145.5*	*$1,162.4*
Construction	$709.2	$721.4	$733.6	$744.0	$754.9	$767.1	$779.2	$791.3	$803.4	$815.5
Agriculture	$502.2	$510.9	$519.6	$524.3	$530.0	$538.6	$547.1	$555.7	$564.2	$572.7
Manufacturing	$533.6	$542.1	$550.8	$557.8	$565.0	$573.6	$582.0	$590.6	$599.1	$607.6
Fuel Producers Total	**$10.9**	**$11.1**	**$11.3**	**$11.2**	**$11.2**	**$11.5**	**$11.7**	**$11.9**	**$12.1**	**$12.3**
PADD 1 & 3	$5.3	$5.4	$5.5	$5.6	$5.8	$5.9	$6.0	$6.1	$6.2	$6.3
PADD 2	$4.6	$4.7	$4.8	$4.6	$4.5	$4.5	$4.6	$4.7	$4.8	$4.9
PADD 4	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2
PADD 5	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.8	$0.9	$0.9	$0.9
Transportation Services, Total	**$90.2**	**$91.3**	**$92.6**	**$95.6**	**$98.1**	**$99.5**	**$100.5**	**$101.7**	**$102.9**	**$104.1**
Locomotive	$1.8	$1.9	$1.9	$2.0	$2.0	$2.1	$2.1	$2.2	$2.2	$2.3
Marine	$1.0	$1.1	$1.1	$1.1	$1.1	$1.2	$1.2	$1.2	$1.2	$1.3
Application Markets Not Included in	$87.3	$88.3	$89.6	$92.6	$95.0	$96.2	$97.2	$98.4	$99.4	$100.6
Operating Savings	**–$260.8**	**–$249.4**	**–$239.3**	**–$227.4**	**–$218.2**	**–$212.8**	**–$208.1**	**–$204.2**	**–$200.7**	**–$198.0**
Total	**$1,762.2**	**$1,777.6**	**$1,794.6**	**$1,828.3**	**$1,815.3**	**$1,818.5**	**$1,843.0**	**$1,856.9**	**$1,886.6**	**$1,919.9**

(continued)

Table 10E-1. Time Series of Market Impacts (continued)

	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Engine Producers Total	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.1**	**$0.2**	**$0.2**	**$0.2**
Equipment Producers Total	**$5.7**	**$5.8**	**$5.9**	**$5.9**	**$6.0**	**$6.1**	**$6.2**	**$6.2**	**$6.3**	**$6.4**
Construction Equipment	$3.8	$3.9	$3.9	$4.0	$4.0	$4.1	$4.1	$4.2	$4.2	$4.3
Agricultural Equipment	$1.8	$1.8	$1.8	$1.9	$1.9	$1.9	$1.9	$2.0	$2.0	$2.0
Industrial Equipment	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1
Application Producers & Consumers Total	***$2,024.9***	***$2,054.0***	***$2,083.1***	***$2,112.3***	***$2,141.4***	***$2,170.6***	***$2,199.8***	***$2,229.0***	***$2,258.2***	***$2,287.4***
Total Producer	*$845.6*	*$857.8*	*$870.0*	*$882.2*	*$894.4*	*$906.6*	*$918.8*	*$931.1*	*$943.3*	*$955.5*
Total Consumer	*$1,179.3*	*$1,196.2*	*$1,213.1*	*$1,230.1*	*$1,247.0*	*$1,264.0*	*$1,280.9*	*$1,297.9*	*$1,314.9*	*$1,331.9*
Construction	$827.6	$839.7	$851.8	$863.8	$875.9	$888.0	$900.1	$912.2	$924.3	$936.4
Agriculture	$581.2	$589.7	$598.3	$606.8	$615.3	$623.8	$632.3	$640.8	$649.3	$657.8
Manufacturing	$616.1	$624.6	$633.1	$641.6	$650.2	$658.8	$667.4	$676.0	$684.6	$693.2
Fuel Producers Total	**$12.5**	**$12.7**	**$13.0**	**$13.2**	**$13.4**	**$13.6**	**$13.8**	**$14.0**	**$14.2**	**$14.5**
PADD 1 & 3	$6.4	$6.5	$6.6	$6.7	$6.8	$6.9	$7.0	$7.1	$7.2	$7.3
PADD 2	$5.0	$5.1	$5.2	$5.2	$5.3	$5.4	$5.5	$5.6	$5.7	$5.8
PADD 4	$0.2	$0.2	$0.2	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3
PADD 5	$0.9	$0.9	$0.9	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0
Transportation Services, Total	**$105.3**	**$106.5**	**$107.8**	**$109.0**	**$110.3**	**$111.6**	**$112.9**	**$114.2**	**$115.6**	**$116.9**
Locomotive	$2.3	$2.4	$2.4	$2.5	$2.5	$2.6	$2.6	$2.7	$2.8	$2.8
Marine	$1.3	$1.3	$1.4	$1.4	$1.4	$1.5	$1.5	$1.5	$1.6	$1.6
Application Markets Not Included in	$101.7	$102.8	$104.0	$105.2	$106.3	$107.5	$108.8	$110.0	$111.2	$112.5
Operating Savings	**–$196.0**	**–$194.9**	**–$194.3**	**–$194.1**	**–$194.3**	**–$194.8**	**–$195.4**	**–$196.1**	**–$197.1**	**–$198.4**
Total	**$1,952.5**	**$1,984.2**	**$2,015.5**	**$2,046.4**	**$2,076.9**	**$2,107.2**	**$2,137.4**	**$2,167.5**	**$2,197.3**	**$2,227.0**

[a] Figures are in 2002 dollars.
[b] Net present values are calculated using a social discount rate of 3 percent over the 2004 to 2036 time period.

APPENDIX 10F: Model Equations

To enhance understanding of the economic model EPA used in this report, additional details about the model's structure are provided in this appendix. The equations describing supply, final demand, and intermediate (i.e., derived) demand relationships are presented below along with a brief description of the solution algorithm.

10F.1 Model Equations

A constant-elasticity functional form was selected for all supply and final demand functions. The general form and description of these equations are presented below:

$$\text{Supply Equation: } Q_x = a(P_x - \Delta c - \Delta c_y)^{\varepsilon} \quad (10F.1)$$

$$\text{Final Demand Equation: } Q_x = aP_x^{\eta} \quad (10F.2)$$

where

- x = production output,
- y = production input,
- Q_x = quantity of output (x) supplied or demanded,
- P_x = market price for output (x),
- a = constant,
- Δc = direct supply shift ($/$Q_x$),
- Δc_y = indirect supply shift resulting from change in the price of input y, and
- ε,η = these parameters can be interpreted as the own-price elasticity of supply/demand for the economic agent (see Tables 10.3-12 and 10.3-13 for values of these parameters).

With this choice of functional form, the supply and demand elasticities are assumed to remain constant over the range of output affected by the regulation. This can be demonstrated by applying the definition of own-price elasticity of demand:

$$\frac{dq}{dp} \bullet \frac{p}{q} = \text{E}ap^{(1-\varepsilon)} \bullet \frac{p^{(1-\varepsilon)}}{a} = \varepsilon . \quad (10F.3)$$

The intermediate input (Q_y) demands is specified within the supply chain as a function of output (Q_x). The subscript "0" denotes baseline and the subscript "1" denotes with regulation.

$$\text{Derived Demand Equation: } Q_y = f(Q_x) \quad (10F.4a)$$

$$Q_{y1} = Q_{y0}(1+\Delta Q_x/Q_x) \quad (10F.4b)$$

Computing Supply/Demand Function Constants. Using the baseline price, quantity, and elasticity parameter, the value of the constants can be computed. For example, supply function constants can be calculated as follows:

$$\text{Constant Calibration: } a = \frac{Q_{x0}}{(P_{x0})^{\varepsilon}} \quad (10F.5)$$

Direct Supply Shift (Dc). The direct upward shift in the supply function is calculated by using the annualized compliance cost estimates provided by the engineering cost analysis. Computing the supply shift in this manner treats the compliance costs as the conceptual equivalent of a unit tax on output.

Indirect Supply Shift (Dc_y). The indirect upward shift in the supply function is calculated by using the change in input (y) prices (i.e., engines, equipment, and/or fuel) that result from the direct compliance costs introduced into the model. Only two types of suppliers are affected by these changes: equipment producers that use diesel engines and application markets that use equipment with diesel engines and diesel fuel. The term Dc_y is computed as follows:

$$\Delta c_y = \frac{\Delta P_y \bullet Q_{y0}}{Q_{x0}}. \qquad (10F.6)$$

10F.2 Engine Markets

As described in Section 10.3.3.1, seven separate engine markets were modeled segmented by engine size in horsepower (the EIA includes more horsepower categories than the standards, allowing more efficient use of the engine compliance cost estimates developed for this rule):

- less than 25 hp
- 26 to 50 hp
- 51 to 75 hp
- 76 to 100 hp
- 101 to 175 hp
- 176 to 600 hp
- greater than 601 hp

In each of these engine markets, there are three types of suppliers: captive suppliers (engines are consumed internally by integrated equipment manufacturers), merchant suppliers (engines are sold on the open market), and foreign suppliers. These supply segments are represented by upward-sloping supply functions. On the demand side, consumers of engines include integrated and nonintegrated equipment manufacturers[T] and are represented by derived demand functions (Eqs. [10F-4a] and [10F.4b]).

Captive Domestic Supply Equation: $S_{engcap} = a_1(p - c)^{\varepsilon}$ (10F.7)

Merchant Domestic Supply Equation: $S_{engmer} = a_2(p - c)^{\varepsilon}$ (10F.8)

Import Supply Equation: $M_{eng} = a(p - c)^{\varepsilon}$ (10F.9)

Integrated Demand Equation: $D_I = S\ (S_{equip})$ (10F.10)

Nonintegrated Demand Equation: $D_{NI} = S(S_{equip})$ (10F.11)

Market Clearing Condition: $S_{engcap} + S_{engmer} + M_{eng} = D_I + D_{NI}$ (10F.12)

10F.3 Equipment Markets

As described in Section 10.3.3.2, integrated and nonintegrated equipment manufacturers supply their products into a series of 42 equipment markets (7 horsepower categories within 7 application categories; there are 7 horsepower/application categories that did not have sales in 2000 and are not included in the model, so the total number of diesel equipment markets is 42, not 49).[U] The equipment types are:

[T]Note that engines sold to foreign equipment manufacturers are not included in the domestic engine market because they are subject to different (foreign) environmental regulations and hence are considered different products.

[U] These are: agricultural equipment >600 hp; gensets & welders > 600 hp; refrigeration & A/C > 71 hp (4 hp categories); and lawn & garden >600 hp.

- agricultural
- construction
- refrigeration
- generators and welder sets
- lawn and garden
- pumps and compressors
- general industrial

Each individual equipment market is comprised of two aggregate suppliers groups: (1) domestic integrated suppliers that produce and consume their own engines (captive engines) and (2) domestic nonintegrated suppliers that purchase engines from the open market to be used in their equipment (merchant engines).

On the demand side, each of the 42 equipment markets is linked to one of three application markets (agricultural, construction, and manufacturers) is represented by derived demand functions (Eq. [10F.4a and 10F.4b])

Domestic Integrated Supply Equation: $$S_{eqI} = a(p - c)^{\varepsilon} \qquad (10F.13)$$

Domestic Nonintegrated Supply Equation: $$S_{eqNI} = a(p - c - c_y)^{\varepsilon} \qquad (10F.14)$$

Domestic Demand Equation: $$D_{eq} = \sum Q_{eq}\left(1 + \frac{\Delta Q_{qpp}}{Q_{qpp0}}\right) \qquad (10F.15)$$

Market Clearing Condition: $$S_{eqI} + S_{eqNI} = D_{eq} \qquad (10F.16)$$

10F.4 Application Markets

As described in Section 10.3.3.3, there are three application markets that supply products and services to consumers:

- agricultural
- construction
- manufacturing

The supply in each of these three application markets is the sum of a domestic supply and an foreign (import) supply. The consumers in the application markets are represented by a domestic demand and a foreign (export) demand function.

Supply Equation: $$S_{app} = a(p_{app} - c - \beta\Delta p)^{E_{kS}} \qquad (10F.17)$$

Foreign (Import) Supply Equation: $$S_{app} = ap_{app}{}^{E} \qquad (10F.18)$$

Domestic Demand Equation: $$D_{app} = ap^{\eta} \qquad (10F.19)$$

Foreign (Export) Demand Equation: $$X_{app} = ap^{\eta} \qquad (10F.20)$$

Market Clearing Condition: $$S_{app} + M_{app} = D_{app} + X_{app} \qquad (10F.21)$$

β_0, $\beta_{1,}$ and β_2 are the baseline input shares of equipment, fuel, and transportation services.

10F.5 Fuel Markets

As described in Section 10.3.3.4, eight nonroad diesel fuel markets were modeled: two distinct nonroad diesel fuel commodities in four regional markets. The two fuels are:

- 500 ppm nonroad diesel fuel, and
- 15 ppm nonroad diesel fuel.

The four regional nonroad diesel fuel markets are

- PADD 1 and 3
- PADD 2
- PADD 4
- PADD 5 (includes Alaska and Hawaii; California fuel volumes that are not affected by the program because they are covered by separate California nonroad diesel fuel standards are not included in the analysis)

The supply and demand for nonroad diesel fuel is specified for the model for four regional diesel fuel markets. Derived demand of diesel fuel comes from three application markets. The equations for PADD district j are specified below:

Supply Equation: $$S_j = a(P_j - \Delta c)\varepsilon \qquad (10F.22)$$

Derived Demand Equation: $$D_j = \Sigma Q_{j0}\left(1 + \frac{\Delta Q_{app}}{Q_{app0}}\right) \qquad (10F.23)$$

Market Clearing Condition: $$S_j = D_j \qquad (10F.24)$$

10F.6 Locomotive and Marine Transportation Markets

There are two transportation service markets that supply services to the application markets:

- locomotive
- marine

The supply in each of these three application markets is the sum of a domestic supply

Supply Equation: $$S_{trans} = a(p_{trans} - c - \beta\Delta p_{fuel})^{E_{ks}} \qquad (10F.25)$$

Market Clearing Condition: $$S_{trans} = D_{trans} \qquad (10F.26)$$

β is the baseline input share of fuel $\left(\frac{Q_{fuel0}}{Q_{app0}}\right)$.

10F.7 Market-Clearing Process and Equations

Supply responses and market adjustments can be conceptualized as an interactive process. Producers facing increased production costs due to compliance with the control program are willing to supply smaller quantities at the baseline price. This reduction in market supply leads to an increase in the market price that all producers and consumers face, which leads to further responses by producers and consumers and thus new market prices, and so on. The new with-regulation equilibrium is the result of a series of iterations in which price is adjusted and producers and consumers respond, until a set of stable market prices arises where total market supply equals market demand.

Market-Clearing Equation: Total Supply = Total Demand. (10F.27)

The algorithm for determining with-regulation equilibria can be summarized by six recursive steps:

1. Impose the control costs on affected supply segments, thereby affecting their supply decisions.

2. Recalculate the market supply in each market. Excess demand currently exists.
3. Determine the new prices via a price revision rule. A rule similar to the factor price revision rule described by Kimbell and Harrison (1986) is used. P_i is the market price at iteration i, q_d is the quantity demanded, and q_s is the quantity supplied. The parameter z influences the magnitude of the price revision and speed of convergence. The revision rule increases the price when excess demand exists, lowers the price when excess supply exists, and leaves the price unchanged when market demand equals market supply. The price adjustment is expressed as follows:

$$P_{i+1} = P_1 \bullet \left(\frac{q_d}{q_s}\right)^z \quad (10F.26)$$

4. Recalculate market supply with new prices.
5. Compute market demand in each market.
6. Compare supply and demand in each market. If equilibrium conditions are not satisfied, go to Step 3, resulting in a new set of market prices. Repeat until equilibrium conditions are satisfied (i.e., the ratio of supply and demand is arbitrarily close to one).

APPENDIX 10G: Elasticity Parameters for Economic Impact Modeling

The Nonroad Diesel Economic Impact Model (NDEIM) relies on elasticity parameters to estimate the behavioral response of consumers and producers to the regulation and its associated costs. To operationalize the market model, supply and demand elasticities are needed to represent the behavioral adjustments that are likely to be made by market participants. The following parameters are needed:

- supply and demand elasticities for application markets (agriculture, construction, and manufacturing)
- supply elasticities for equipment markets
- supply elasticities for engine markets
- supply elasticities for diesel fuel markets
- supply elasticities for locomotive and marine transportation markets

Note that demand elasticities for the equipment, engine, diesel fuel, and transportation markets are not estimated because they are derived internally in the model. They are a function of changes in output levels in the applications markets.

Tables 10G-1 and 10G-2 contain the demand and supply elasticities used to estimate the economic impact of the rule. Two methods were used to obtain the supply and demand elasticities used in the NDEIM. First, the professional literature was surveyed to identify elasticity estimates used in published studies. Second, when literature estimates were not available for specific markets, established econometric techniques were used to estimate supply and demand elasticity parameters directly. Specifically, the supply elasticities for the agricultural and construction application markets and the supply elasticity for the diesel fuel market were obtained from the literature. The supply elasticity for the manufacturing market is assumed to be the same as for the construction market. The supply elasticities for all of the application markets and for equipment and engine markets were estimated econometrically.

This appendix discusses the literature for elasticities based on existing studies and presents the data sources and estimation methodology and regression results for the econometric estimation.

Finally, it should be noted that these elasticities reflect intermediate run behavioral changes. In the long run, supply and demand are expected to be more elastic since more substitutes may become available.

Table 10G-1
Summary of Market Demand Elasticities Used in the NDEIM

Market	Estimate	Source	Method	Input Data Summary
Applications				
Agriculture	–0.20	EPA econometric estimate	Productivity shift approach (Morgenstern, Pizer, and Shih, 2002)	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Construction	–0.96	EPA econometric estimate	Simultaneous equation (log-log) approach	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Manufacturing	–0.58	EPA econometric estimate	Simultaneous equation (log-log) approach.	Annual time series from 1958 – 1995 developed by Jorgenson et al. (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987)
Transportation Services				
Locomotive		Derived demand	In the derived demand approach, • compliance costs increase prices and decrease demand for products and services in the application markets; • this in turn leads to reduced demand for diesel equipment, engines and fuel, which are inputs into the production of products and services in the application markets	
Marine		Derived demand		
Equipment				
Agriculture		Derived demand		
Construction		Derived demand		
Pumps/ compressors		Derived demand		
Generators and Welders		Derived demand		
Refrigeration		Derived demand		
Industrial		Derived demand		
Lawn and Garden		Derived demand		
Engines		Derived demand		
Diesel fuel		Derived demand		

Table 10G-2
Summary of Market Supply Elasticities Used in the NDEIM

Markets	Estimate	Source	Method	Input Data Summary
Applications				
Agriculture	0.32	Literature-based estimate	Production-weighted average of individual crop estimates ranging from 0.27 to 0.55. (Lin et al., 2000)	Agricultural Census data 1991 – 1995
Construction	1	Literature-based estimate	Based on Topel and Rosen, (1988).[a]	Census data, 1963 – 1983
Manufacturing	1	Literature-based estimate	Literature estimates are not available so assumed same value as for Construction market	Not applicable
Transportation Services				
Locomotive	0.6	Literature-based estimate	Method based on Ivaldi and McCollough (2001)	Association of American Railroads 1978-1997
Marine	0.6	Literature-based estimate	Literature estimates not available so assumed same value as for locomotive market	Not applicable
Equipment				
Agriculture	2.14	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3523
Construction	3.31	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3531
Pumps/ compressors	2.83	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3561 and 3563
Generators/ Welder Sets	2.91	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3548
Refrigeration	2.83	EPA econometric estimate		Assumed same as pumps/compressors
Industrial	5.37	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3537
Lawn and Garden	3.37	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3524
Engines	3.81	EPA econometric estimate	Cobb-Douglas production function	Census data 1958-1996; SIC 3519
Diesel fuel	0.24	Literature based estimate	Based on Considine (2002).[b]	From Energy Intelligence Group (EIG); 1987-2000[c]

[a] Most other studies estimate ranges that encompass 1.0, including DiPasquale (1997) and DiPasquale and Wheaton (1994).
[b] Other estimates range from 0.02 to 1.0 (Greene and Tishchishyna, 2000). However, Considine (2002) is one of the few studies that estimates a supply elasticity for refinery operations. Most petroleum supply elasticities also include extraction.
[c] This source refers to the data used by Considine in his 2002 study.

10G.1 Application Markets - Demand Elasticities

There are three application markets in the NDEIM: agricultural, construction, and manufacturing. Demand elasticities for the construction and manufacturing application markets were estimated using a simultaneous equation (two-stage least squares) method. This approach was also investigated for the agricultural application market; however, the estimated demand elasticity parameter for that market was not statistically significant. For this reason, a production function approach (Morgenstern, Pizer and Shih, 2002) was employed for the agricultural application market. Publicly available data developed by Dale Jorgenson and his associates (Jorgenson, 1990; Jorgenson, Gollop, and Fraumeni, 1987) were used in the regression analysis. A time series of 38 observations, from 1958 to 1995, was used to estimate the demand elasticities in both the two-stage least squares and production function approach. Both of these techniques are described below.

10G.1.1 Construction and Manufacturing Demand Elasticities

10G.1.1.1 Description of Simultaneous Equation Method

The demand elasticities for the construction and manufacturing application markets were estimated using a simultaneous equation (two-stage least squares) approach. The methodology is described below and the individual regression results are presented in Appendix 10F.

In a partial equilibrium model, supply and demand are represented by a series of simultaneous interdependent equations, in which the price and quantity produced of a product are simultaneously determined by the interaction of producers and consumers in the market. In simultaneous equations models, where one variable feeds back in to the other equations, the error terms are correlated with the endogenous variable. As a result, estimating parameter values using the ordinary least squares (OLS) regression method for each individual equation yields biased and inconsistent parameter estimates. Therefore, OLS is not an appropriate estimation technique.

Instead, a simultaneous equations approach is used. In the simultaneous equations approach both the supply and demand equations for the market are specified and parameters for the two-equation system are estimated simultaneously.

The log-log version of the model is specified as follows:

$$\text{Supply: } Q_{ts} = a_0 + a_1P_t + a_2PL_t + a_3PK_t + a_4PM_t + e_t \quad (10G.1a)$$

$$\text{Demand: } Q_{td} = b_0 + b_1P_t + b_2HH_t + b_3I_t + v_t \quad (10G.1b)$$

where

Q_t = log of quantity of the market product in year t
P_t = log of price of the market product in year t
PL_t = log of cost of labor inputs in year t

PK_t = log of cost of capital inputs in production in year t
PM_t = log of cost of material inputs in production in year t
HH_t = log of number of households in year t
I_t = average income per household in year t
e_t, v_t = error terms in year t

The parameter estimates $\hat{a}_1$ and $\hat{b}_1$ are the estimated price elasticity of supply and price elasticity of demand, respectively.

The first equation defines quantity supplied in each year as a function of the product price and the cost of inputs: labor, capital and materials. The second equation defines the quantity demanded in each year as a function of the production price, the number of households, and the average income per household. The equilibrium condition is that supply equals demand

$$\text{equilibrium: } Q_{ts} = Q_{td}$$

Application of this two-stage least square regression approach was successful for estimating the demand elasticity parameters for use here but was unsuccessful for estimating the supply elasticities. The supply elasticity estimates were negative and not statistically significant. Therefore, as noted above, literature estimates were used for the supply elasticities for the three application markets in the NDEIM.

To estimate the demand elasticities using this two-stage least squares approach, it is necessary to first estimate the reduced-form equation for price using OLS. The reduced-form equation expresses price as a function of all exogenous variables in the system:

$$P_t = fn(PL_t , PK_t , PM_t , HH_t , I_t)$$

The results of this regression are used to develop fitted values of the dependent price variable P_t (this is a new instrumental variable for price). The fitted values by construction will be independent of error terms in the demand equation. In the second stage regression, the fitted price variable P_t (the instrumental variable) is used as a replacement for P_t, in the demand equation. An OLS is performed on this equation, which produces a consistent, unbiased estimate of the demand elasticity b_1.

10G.1.1.2 Construction Application Market Demand Elasticity

The results of the simultaneous equation method for the construction demand elasticity are presented in Table 10G-3. The estimated demand elasticity is −0.96 and is statistically significant with a t-statistic of –3.83. This inelastic estimate implies that a 1 percent increase in price will lead to a 0.96 percent decrease in demand for construction, and means that the quantity of goods and services demanded is expected to be fairly insensitive to price changes.

Table 10G-3. Construction Demand Elasticity

Number of Observations = 29
R squared = 0.78
Adjusted R squared = 0.75

Variable	Estimated Coefficients	t-statistic
intercept	18.83	5.19
ln price	–0.96	–3.83
ln number of households	–1.73	–3.37
ln average income per household	–1.67	5.34

10G.1.1.3 Manufacturing Application Market Demand Elasticity

The results of the simultaneous equation method for the manufacturing market are presented in Table 10G-4. The estimated demand elasticity is −0.58 and is statistically significant with a t-statistic of –2.24. This inelastic estimate implies that a 1 percent increase in price will lead to a 0.58 percent decrease in the demand for manufactured products, and means that the quantity of goods and services demanded is expected to be fairly insensitive to price changes.

Table 10G-4. Manufacturing Demand Elasticity

Number of Observations = 29
R squared = 0.83
Adjusted R squared = 0.81

Variable	Estimated Coefficients	t-statistic
intercept	6.16	0.84
ln price	–0.58	–2.24
ln number of households	0.19	0.23
ln average income per household	0.62	1.49

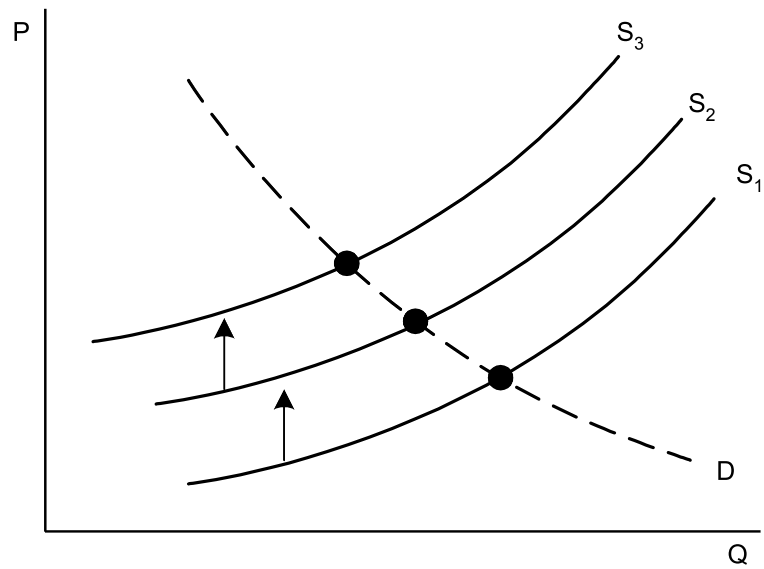
10G.1.2 Agricultural Application Market Demand Elasticity

10G.1.2.1: Description of Productivity Shift Approach

When the simultaneous equation method was attempted for the agricultural application market, the resulting demand elasticity parameter estimate was not statistically significant. Thus, the demand elasticity for the agricultural market was estimated using the productivity shift approach. This is a technique that regresses historical data for aggregate output on industry productivity (Morgenstern, Pizer, and Shih, 2002).

As shown in Figure 10G-1, changes in industry productivity represent shifts in the supply curve. The supply curve shifts in conjunction with the known output values trace-out the demand curve and enables the estimation of the demand elasticity. Because the agricultural sector is relatively small compared to the entire economy, it is reasonable to assume that the productivity changes do not shift the demand curve through income effects.

Figure 10G-1
Productivity Shifts Trace-Out Demand Curve



The demand elasticity (ξd) is estimated through a simple regression of the annual change in the natural log of outputs on change in the natural log of productivity:

$$\Delta \ln output_t = \xi_d \Delta \ln prod_t + \varepsilon_t$$

where
$output_t$ = output t is the industry output in year t
$prod_t$ = industry productivity in year t
ε_t = random error term

The change in the natural log of productivity is computed as the log difference between the annual change in input price and the annual change in output price:

$$\Delta \ln prod_t = \sum_{sh} \frac{(\upsilon_{sh,t}+\upsilon_{sh,t-1})}{\partial} (\ln P_{sh,t} - \ln P_{sh,t-1}) - (\ln PO_t - \ln PO_{t-1}) \qquad (10.G\text{-}2)$$

where
P = input prices
PO = output prices
υ = input shares

Eq. (10G.2) is a similar to a standard quantity-based definition of productivity (output divided by input), but expressed in terms of input and output prices. Under a competitive market with zero-profit assumptions, revenue equals cost, and the price of output must equal the price of input divided by the standard definition of productivity:

$$P_O = P_I (Q_I / Q_O)$$

Thus,

$$P_I / P_O = Q_O / Q_I$$

where

Q_O = quantity of output
Q_I = quantity of input

Since Q_O / Q_I is a quantity based productivity, P_I / P_O is an equivalent measure of productivity according to the above equation. The difference in logged changes in P_I and P_O is a valid measure of productivity growth (Pizer, 2002).

10G.1.2.2 Agricultural Application Market Demand Elasticity

The results of the estimated agricultural model are presented in Table 10G-5. The demand elasticity estimate is −0.20 and is statistically significant with a t-statistic of 2.31. This implies that a 1 percent increase in price will lead to a 0.2 percent decrease in demand, and means that the quantity of goods and services demanded is expected to be fairly insensitive to price changes.

Table 10G-5. Agricultural Demand Elasticity

Number of Observations = 38
R squared = 0.13
Adjusted R squared = 0.11

Variable	Estimated Coefficients	t-statistic
intercept	0.02	3.49
ln productivity t	–0.20	2.31

10G.2 Application Market - Supply Elasticities

Professional literature sources were used to obtain supply elasticity estimates for the applications markets. These literature sources used are described below.

It should be noted that both of the econometric estimation methods described above, the simultaneous equation approach and the production function approach, were also attempted for the supply elasticities. However, because of the great variety of the production processes in these aggregate industry sectors (heterogeneity), parameter estimates were either not statistically significant or did not conform with standard microeconomic theory (i.e., estimates were not upward sloping).

10G.2.1 Agricultural Application Market Supply Elasticity

Obtaining reasonable estimates of supply response in agriculture has been a persistent problem since the inception of farm price support programs in the 1930s. The nonrecourse marketing loans, deficiency payments, and conservation set-asides that make up the current farm price support system distort equilibrium prices to the point that any econometric estimates are difficult to formulate or support.

A recent study by economists at the USDA's Economic Research Service provides an approach to estimating agricultural demand elasticities (Lin et al., 2000). Taking into account recent changes in the 1996 Farm Bill, the authors measure nationwide acreage price elasticity values for the seven major agricultural crops, obtaining values ranging from 0.269 for soybeans to 0.550 for sorghum. Although a composite number for all farm output is not reported, an average value of 0.32 can be obtained by weighting the reported values by the acreage planted for each crop. This value was used for the supply elasticity in the agriculture application market. This estimated elasticity is inelastic, which means that the quantity of goods and services supplied is expected to be fairly insensitive to price changes.

Although the literature estimates vary, this estimate conforms closely to historical evidence and economic theory of small but positive supply elasticities. This determination of price having little impact on supply (referred to as inelastic supply) is consistent with a historical observation that total acreage cultivated varies little from year to year. Between 1986 and 2001, for instance, U.S. cropland harvested has ranged from 289 to 318 million acres, with an average of 305 million acres over that 15-year period. A low supply elasticity is also supported by the fact that there are few alternative uses (except in the very long run) for cropland, capital, and labor employed in farming. Abandonment or redeployment of farm assets is an often irreversible decision, and one not greatly affected by annual price swings.

10G.2.2 Construction Application Market Supply Elasticity

Although the construction market does not suffer from government-induced distortions to prices and quantities, the evidence on supply elasticity is even more varied than that for agriculture. Estimates of supply elasticity ranging from near zero to infinity have been reported in credible papers on housing construction published during the past 20 to 30 years. A literature survey paper by DiPasquale (1997) describes the methodological issues that have led to this variety of responses. A key issue is the conceptual problem of distinguishing between increases in the stock the of housing (or other structures) through new construction and changes in the flow of housing services, which can also include renovation, apartment or condominium conversion, and abandonment.

DiPasquale cites a number of published studies that suggest that a value of 1.0 for supply elasticity is appropriate. In the study that most closely matches the analysis for this regulation, Poterba (1984) estimated elasticity of new construction with respect to real house prices ranging from 0.5 to 2.3, depending on the specification. A study by Topel and Rosen investigating asset-markets and also found a short-run elasticity value of 1.0 (Topel and Rosen, 1988). Finally, DiPasquale cites one of her own papers that estimated values of 1.0 to 1.2 for the price elasticity of construction (DiPasquale and Wheaton, 1994). Based on these studies, a value of 1.0 was used for the supply elasticity in the construction application market. This unit elastic elasticity means that the quantity supplied is expected to vary directly with changes in prices.

Estimates of supply response for other portions of the construction market, namely nonresidential buildings and nonbuilding (roads and bridges, water and sewer systems, etc.), are not available in the literature. However, the similarity between technologies employed in construction of residential and other nonindustrial buildings suggests that supply elasticities should be comparable. In addition, residential construction accounts for a significant portion of construction activity. According to the Census Bureau's most recent Annual Value of Construction Put in Place report, residential and nonindustrial buildings accounted for about 77 percent of the $842 billion in construction spending in 2001, with new residential housing making up about 33 percent (U.S. Census Bureau, 2002).

10G.2.3 Manufacturing Application Market Supply Elasticity

No supply elasticity estimates were available in the professional literature for the aggregate manufacturing sector. For this reason, a unitary supply elasticity of 1.0 was used in the model. This unit elastic elasticity means that the quantity supplied is expected to vary directly with changes in prices. A sensitivity analysis for this assumed elasticity is presented in Appendix 10I.

10G.3 Engine and Equipment Markets Supply Elasticity

Published sources for the price elasticity of supply for diesel engine and diesel equipment markets were not available. Therefore, the supply elasticities used in the model were estimated econometrically using a production function cost minimization approach.

10G.3.1 Production Function Cost Minimization Approach

The production function cost minimization approach for econometrically estimating the supply elasticities is based on the cost-minimizing behavior of the firm subject to production function constraints. The production function describes the relationship between output and inputs. For this analysis, a Cobb-Douglas, or multiplicative form, was used as the functional form of the production function:

$$Q_t = A\, k_t^{\alpha k}\, L_t^{\alpha L}\, M_t^{\alpha k}\, t^{\lambda} \qquad (10G\text{-}3)$$

where

Q_t = output in year t

K_t = real capital consumed in production in year t[V]
L_t = quantify of labor used in year t
M_t = material inputs in year t
t = a time trend variable to reflect technology changes

This equation can be written in linear form by taking the natural logarithms of each side of the equation. The parameters of this model, α_K, α_L, α_M, can then be estimated using linear regression techniques:

$$\ln Q_t = \ln A + \alpha_k \ln k_t + \alpha \ln L_t + \alpha_m \ln M_t + \lambda \ln t.$$

Under the assumptions of a competitive market and perfect competition, the elasticity of supply with respect to the price of the final product can be expressed in terms of the parameters of the production function:

$$\text{Supply Elasticity} = (\alpha_l + \alpha_m) / (1 - \alpha_l - \alpha_m) \qquad \text{(10G-4)}$$

This underlying relationship is derived from the technical production function and the behavioral profit maximization conditions. The derivation for equation (10G-4) is provided in Appendix 10H.

In a competitive market, a firm will supply output as long as the marginal cost (MC) of producing the next unit does not exceed the marginal revenue (MR, i.e., the price). In a short-run analysis, where capital stock is assumed to be fixed (or a sunk cost of production), the firm will adjust its variable inputs of labor and material to minimize the total cost of producing a given level of output.

The supply function is estimated by minimization, subject to the technical constraints of the production function, and then setting the MC = P to determine the quantity produced as a function of market price. To maintain the desired properties of the Cobb-Douglas production function, it is necessary to place restrictions on the estimated coefficients. For example, if $\alpha_L + \alpha_M = 1$, then the supply elasticity will be undefined. Alternatively, if $\alpha_L + \alpha_M > 1$, this yields a negative supply elasticity. Thus, a common assumption is that $\alpha_K + \alpha_L + \alpha_M = 1$. This implies constant returns to scale, which is consistent with most empirical studies.

10G.3.2 Data for Estimating Engine and Equipment Supply Elasticities

The data for the supply elasticity estimation were obtained from the National Bureau of Economic Research-Center for Economic Studies (NBER-CES). All nominal values were deflated into $1987, using the appropriate price index. The following variables were used:

- value of shipments

[V]Capital consumed is defined as the value added minus labor expenditures, divided by the price index for capital.

- price index of value shipments
- production worker wages
- implicit GDP deflators
- cost of materials
- price index for materials
- real capital stock
- investment
- price index for investment
- value added
- price index for capital

The capital (k) variable used in the Cobb-Douglas regression analysis is calculated as:

K = (Value Added – Labor Costs) / Price Index for Capital

This provides a measure of capital consumed as opposed to using a measure of total capital stock in place at the firm.

10G.3.3 Engine Supply Elasticity Regression Results

The results of the estimated production function is presented in Table 10G-6. All parameter estimates are statistically significant at the 95 percent confidence level and the supply elasticity is calculated to be 3.81. This elastic elasticity estimate means that the quantities supplied in this market are expected to be very responsive to price changes.

Table 10G-6. Engine Supply Elasticity

Supply Elasticity = 3.81
Number of Observations = 33
R-squared = 0.9978
Goldfeld-Quandt F = 1.88
Note: F(14,14) = 2.46.

Variable	Estimated Coefficients	t-statistic
Intercept	0.954	24.76
ln K	0.2081	4.77
ln T	0.0215	2.37
ln M	0.5909	13.4
ln L	0.201	5.55

10G.3.4 Equipment Supply Elasticity Regression Results

The results of the estimated production functions are presented in Tables 10G-7 through 10G-12. The supply elasticities are calculated from the estimated coefficients for lnM and lnL as described in Equation G10-4. The supply elasticities range from approximately 1.0 for refrigeration to 5.4 for general industrial equipment. The average supply elasticity is 3.6. These elastic elasticity estimates means that the quantities supplied in this market are expected to be responsive to price changes.

Table 10G-7. Agricultural Supply Elasticity

Supply Elasticity = 2.14
Number of Observations = 33
R-squared = 0.9969
Goldfeld-Quandt F = 2.01
Note: F(14,14) = 2.46

Variable	**Estimated Coefficients**	**t-statistic**
Intercept	1.1289	20.81
ln K	0.3189	11.12
ln T	–0.0241	–3.10
ln M	0.4952	10.29
ln L	0.1858	4.64

Table 10G-8. Construction Supply Elasticity

Supply Elasticity = 3.31
Number of Observations = 33
R-squared = 0.9926
Goldfeld-Quandt F = 1.76
Note: F(14,14) = 2.46

Variable	**Estimated Coefficients**	**t-statistic**
Intercept	1.172	28.54
ln K	0.2318	5.83
ln T	–0.0617	–7.08
ln M	0.1511	4.54
ln L	0.6172	13.97

Table 10G-9. Industrial Supply Elasticity

Supply Elasticity = 5.37
Number of Observations = 33
R-squared = 0.9949
Goldfeld-Quandt F = 1.23
Note: F(14,14) = 2.46

Variable	Estimated Coefficients	t-statistic
Intercept	0.6927	18.29
ln K	0.157	3.47
ln T	–0.00739	–0.76
ln M	0.0412	0.96
ln L	0.8018	21.9

Table 10G-10. Garden

Supply Elasticity = 3.37
Number of Observations = 33
R-squared = 0.9963
Goldfeld-Quandt F = 1.18
Note: F(14,14) = 2.46

Variable	Estimated Coefficients	t-statistic
Intercept	0.6574	13.34
ln K	0.2287	3.75
ln T	0.0413	2.78
ln M	0.0644	1.72
ln L	0.7069	11.23

Table 10G-11. Gensets

Supply Elasticity = 2.91
Number of Observations = 33
R-squared = 0.9909
Goldfeld-Quandt F = 1.16
Note: F(14,14) = 2.46

Variable	Estimated Coefficients	t-statistic
Intercept	1.1304	11.09
ln K	0.2557	3.6
ln T	0.0325	2.73
ln M	0.3797	4.67
ln L	0.3646	4.51

Table 10G-12. Pumps

Supply Elasticity = 2.83
Number of Observations = 33
R-squared = 0.9979
Goldfeld-Quandt F = 1.40
Note: F(14,14) = 2.46

Variable	Estimated Coefficients	t-statistic
Intercept	0.9367	19.01
ln K	0.2608	4.45
ln T	–0.207	–1.74
ln M	0.0891	1.57
ln L	0.6501	14.48

10G.4 Diesel Fuel Supply Elasticity: Literature Estimate

Very few studies have attempted to quantify supply responsiveness for individual refined products, such as diesel fuel. For example, a study for the California Energy Commission stated “There do not seem to be credible estimates of gasoline supply elasticity” (Finizza, 2002). However, sources agree that refineries have little or no ability to change output in response to price: high fixed costs compel them to operate as close to their capacity limit as possible. The Federal Trade Commission (FTC) analysis made this point explicitly (FTC, 2001).

Greene and Tishchishyna (2000) reviewed supply elasticity estimates available in the literature. The supply elasticity values cited in most of these studies were for “petroleum” or “oil” production in the United States, which includes exploration, distribution and refining activities. The lowest short-term numbers cited were 0.02 to 0.05, with long-run values ranging from 0.4 to 1.0. It seems likely that these extremely low numbers are influenced by the limited domestic supply of crude petroleum and the difficulty of extraction.

A recent paper by Considine (2002) provides one of the few supply elasticity estimates for refining production (excluding extraction and distribution) based on historical price and quantity data. In this study, Considine estimates a refining production supply elasticity of 0.24. This estimate is for aggregate refinery production and includes distillate and nondistillate fuels. Because petroleum products are made in strict proportion and refineries have limited ability to adjust output mix in the short to medium run, it is reasonable to assume that supply is relatively inelastic and similar across refinery products. This value of 0.24 was used for the supply elasticity for this market. This estimated elasticity is inelastic, which means that the quantity of goods and services supplied is expected to be fairly insensitive to price changes.

10G.4 Locomotive and Marine Supply Elasticities: Literature Estimate

Over the past three decades, several studies have empirically estimated railroad cost functions (see for example Braeutigam, 1999). One of the most recent studies by Ivald and McCullough (2001) estimated a multi-product cost function for railroad services using data from the Association of American Railroads (1978 to 1997). They report cost elasticities for which we can derive a supply elasticity parameter for rail transportation services[W]. The supply parameters are slightly elastic (1.6), suggesting a one percent change in the market price of the services would induce producers increase service supply more than one percent.

Similar studies for marine transportation services are generally restricted to the study of the liner shipping industry (see for example Klein and Kyle, 1997). However, these ocean carrier services are not directly comparable to commercial marine services in the Great Lakes and Inland River Ports in the United States. Instead, they are more likely to be consistent with on-land transportation services provided by the railroad sector. As a result, we have assumed the supply elasticity parameter for best characterizes the supply responses of the marine transportation market included in NDEIM.

[W]Under the assumption of perfect competition, supply elasticities can be derived by taking the inverse of the reported cost elasticities. Therefore, Invalid and McCullough's cost elasticity of 0.6 is used to compute a supply elasticity of 1/0.6 = 1.6.

APPENDIX 10H: Derivation of Supply Elasticity

This appendix derives the underlying relationship for the supply elasticity used in the production function approach described in Appendix 10G.

Cobb-Douglas:

$Q = L^{\alpha} k^{1-\alpha}$ where Q = output
L = labor input
k = capital input

Cost Minimization:

Marginal Revenue Product of Labor = Wage Rate

$MRP_L = P \cdot MP_L = w$

$$MP_L = \frac{\partial Q}{\partial L} = \alpha L^{\alpha-1} k^{1-\alpha}$$

$$P \cdot MP_L = P\alpha\, L^{\alpha-1} k^{1-\alpha} = w$$

$$L^{\alpha-1} = \frac{w}{P\alpha k^{1-\alpha}}$$

$$L^{1-\alpha} = \frac{P\alpha k^{1-\alpha}}{w}$$

$$L = \left(\frac{P\alpha k^{1-\alpha}}{w}\right)^{\frac{1}{1-\alpha}} = \left(\frac{P\alpha}{w}\right)^{\frac{1}{1-\alpha}} k$$

Substitute Back into Cobb-Douglas:

$$y = \left[\left(\frac{P\alpha}{w}\right)^{\frac{1}{1-\alpha}} k\right]^{\alpha} k^{1-\alpha}$$

$$y = \left(\frac{P\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}} k = p^{\frac{\alpha}{1-\alpha}} \left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}} k$$

$$\ln y = \frac{\alpha}{1-\alpha} \ln P + \frac{\alpha}{1-\alpha} \ln\left(\frac{\alpha}{w}\right) + \ln k$$

$$\boxed{\frac{\partial \ln y}{\partial \ln P} = \frac{\alpha}{1-\alpha} = \text{Supply Elasticity}}$$

APPENDIX 10I: Sensitivity Analysis

The Economic Impact Analysis presented in this Chapter 10 is based on the Nonroad Diesel Economic Impact Model (NDEIM) developed for this analysis. The NDEIM reflects certain assumptions about behavioral responses (modeled by supply and demand elasticities) and how costs are treated by producers. This appendix presents a sensitivity analysis for several model components by varying how they are treated. Five model components are examined:

- Scenario 1: alternative market supply and demand elasticity parameters
- Scenario 2: alternative ways to treat fuel market costs
- Scenario 3: alternative way to treat operating costs
- Scenario 4: alternatives way to treat engine and equipment fixed costs
- Scenario 5: alternative discount rates

The results of these sensitivity analyses are presented below. All of the results are presented for 2013 only. The results for the application and transportation service markets do not include the operating savings. Instead, operating savings are added into the total social costs as a separate item.

In general, varying the model parameters does not significantly change the results of the economic impact assessment analysis presented above. Total social costs are about the same across all sensitivity analysis scenarios, $1,510 million. In addition, varying these model parameters does not significantly affect the way the social costs are borne. In all cases, the application markets bear the majority of the burden (about 83 percent), although there are small differences in the way the costs are borne among the scenarios. The exception is Scenario 2, the fuel cost scenario. In the maximum total cost scenario, the share of the social costs borne by the application market exceeds the social costs of the rule ($2,029 million versus $1,510.9 million for the rule), indicating that refiners will gain from the rule (about $526 million). In the maximum variable cost scenario, the share of the social costs borne by the application market also exceeds the social costs of the rule ($1,584 million versus $1,510.9 million for the rule), indicating that refiners would gain from the rule in this scenario as well (about $79 million). There are also differences in the way the application market costs are shared among producers and consumers in that market, especially for Scenario 1.

With regard to the market analysis, expected percentage changes for price and price and quantity for each market are about the same as in the base case. Prices are expected to increase about 2.14. 2.9, and 6 percent for the engine, equipment, and fuel markets respectively, while quantities. These engine and equipment percentage price increases are stable across scenarios except in Scenario 4, in which engine and equipment fixed costs and included in the model. In this case, the expected engine price increase goes up from about 21.4 percent to 23.0 percent and the expected equipment price increase goes up from about 2.9 percent to 3.4 percent. The fuel percentage price increases are also stable across scenarios, with the exception of Scenario 2, in which a price increase of 11 percent is expected in the maximum total cost scenario and a 7 percent increase is expected in the maximum variable cost scenario.

Percentage decreases in the quantities produced in the markets are also relatively stable across the scenarios with decreases of 0.01, 0.02, and 0.02 percent expected for the engine, equipment, and fuel markets respectively. There is some variation in absolute quantities across the scenarios, but these are negligible when compared to the total output of each market. The largest change in absolute quantity of output is associated with Scenario 1, when supply elasticities are varied. The largest decline is 107 engines, 189 equipment units, and 3.25 million gallons of fuel; the smallest is 44 engines, 74 equipment units, and 1.29 million gallons of fuel. This is in comparison to 79 engines, 139 equipment units, and 2.38 million gallons of fuel in the base case.

For the application market, the expected price increase remains stable across the scenarios at about 0.1 percent, and the expected quantity decrease at about 0.02. Prices in the transportation service markets are expected to increase about 0.0.01 percent and quantity to decrease about 0.01 percent.

10I.1 Model Elasticity Parameters

Key model parameters include supply and demand elasticity estimates used by the model to characterize behavioral responses of producers and consumers in each market.

Consumer demand and producer supply responsiveness to changes in the commodity prices are referred to by economists as "elasticity." The measure is typically expressed as the percentage change in quantity (demanded or supplied) brought about by a percent change in own price. A detailed discussion regarding the estimation and selection of the elasticities used in the NDEIM are discussed in Appendix 10G. This component of the sensitivity analysis examines the impact of changes in selected elasticity values, holding other parameters constant. The goal is to determine whether alternative elasticity values significantly alter conclusions in this report.

10I.1.1 Application Markets (Supply and Demand Elasticity Parameters)

The choice of supply and demand elasticities for the *application market* is important because changes in quantities in the application markets are the key drivers in the derived demand functions used to link impacts in the engine, equipment, and fuel markets. In addition, the distribution of regulatory costs depends on the *relative supply and demand elasticities* used in the analysis. For example, consumers will bear less of the regulatory burden if they are more responsive to price changes than producers.

Table 10I-1 reports the upper- and lower-bound values of the application market elasticity parameters (supply and demand) used in the sensitivity analysis. The variation in estimates reported in the literature were used for supply elasticity ranges. For the manufacturing market, an assumed elasticity of 1.0 was used. For the purpose of this sensitivity analysis, the same upper and lower bounds were used as for the construction market. For demand elasticity values, a 90 percent confidence interval was computed using the coefficient and standard error values reported in the econometric analysis (see Appendix 10G).

Table 10I-1. Sensitivity Analysis of the Supply and Demand Elasticities for the Application Markets

Parameter/Market	Elasticity Source	Upper Bound	Base Case	Lower Bound
Supply elasticity				
Agriculture	Literature estimate	0.55	0.32	0.027
Construction	Literature estimate	2.3	1	0.5
Manufacturing	Assumed value	2.3	1	0.5
Demand elasticity				
Agriculture	EPA estimate	–0.35	–0.20	–0.054
Construction	EPA estimate	–1.39	–0.96	–0.534
Manufacturing	EPA estimate	–1.02	–0.58	–0.140

Note: For literature estimates, the variations in estimates reported were used to develop elasticity ranges. In contrast, EPA computed upper- and lower-bound estimates using the coefficient and standard error values associated with its econometric analysis and reflect a 90 percent confidence interval.

The results of the NDEIM using these alternative elasticity values for the application markets are reported in Tables 10I-2 and 10I-3. As can be seen in those tables, market prices are stable across the upper- and lower-bound sensitivity scenarios. Absolute quantities vary but the percentage changes in output are negligible for the two scenarios.

The change in total social surplus for 2013 also remains nearly unchanged across all scenarios and is approximately the same as for the rule ($1,510 million). However, consumers in the application market bear a *smaller* share of the social costs when they are more responsive to price changes relative to producers (supply lower bound and demand upper bound scenarios). As shown, consumers bear approximately 34.5 and 46.5 percent, respectively, in these scenarios compared to 58.5 percent in the base case. In contrast, they bear a *higher* share (up to 78.5 percent) when they are less responsive to price changes relative to producers (supply upper bound and demand lower bound scenarios). While the burden of the fuel market changes slightly, it always remain below 1 percent of the social costs.

Table 10I-2. Application Market Sensitivity Analysis for Supply Elasticities[a,b]

Scenario	Base Case		Supply Upper Bound		Supply Lower Bound	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Application Markets						
Price ($/q)	NA	0.10%	NA	0.11%	NA	0.05%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.01%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$1,113	NA	$520	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	$377	NA	$985	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,490	NA	$1,505	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$973	2.9%	$977	2.9%
Quantity (gal/yr)	–139	–0.02%	–189	–0.02%	–74	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$145	NA	$141	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.4%	$821	21.4%
Quantity (gal/yr)	–79	–0.01%	–107	–0.02%	–44	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–3.25	–0.03%	–1.29	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	$12	NA	$3	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$3	NA	$2	NA
Applications Not Included in NDEIM ($$10^6$/yr)	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,509.9	NA	$1,510.1	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

Table 10I-3. Application Market Sensitivity Analysis for Demand Elasticities[a,b]

Scenario	Base Case		Demand Upper Bound		Demand Lower Bound	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Application Markets						
Price ($/q)	NA	0.10%	NA	0.08%	NA	0.12%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.01%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$695	NA	$1,181	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	$798	NA	$323	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,493	NA	$1,503	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$974	2.9%	$977	2.9%
Quantity (gal/yr)	–139	–0.02%	–170	–0.02%	–88	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$144	NA	$142	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.4%	$821	21.4%
Quantity (gal/yr)	–79	–0.01%	–96	–0.02%	–50	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–2.89	–0.02%	–1.54	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	$10	NA	$4	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	0.00%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$3	NA	$1	NA
Applications Not Included in NDEIM ($$10^6$/yr)	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,509.9	NA	$1,510.0	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

10I.1.2 Equipment, Engine and Diesel Fuel Markets (Supply Elasticity Parameters)

Sensitivity analysis was also conducted for the engine, equipment, and diesel fuel market supply elasticities. The range of supply elasticity values evaluated for each market are provided in Table 10I-4. The engine and equipment market supply elasticities are derived econometrically. Therefore, the upper and lower bound values were computed using the coefficient and standard error values associated with the econometric analysis and reflect a 90 percent confidence interval (see Appendix 10G).

The fuel market supply elasticity was obtained from the literature. The value for the lower bound for the sensitivity analysis is based on the range of available estimates. The value for the upper bound was derived from a set of regulatory studies of the petroleum refining industry that were conducted using a techno-economic method to estimate supply costs at the individual refinery level (EPA, 2000; CRA/BOB, 2000; MathPro, 2002). Synthetic industry supply curves (i.e., marginal cost curves) were developed from these studies and yielded supply elasticities ranging from 0.2 to 2.0. Therefore, the sensitivity analysis uses 2.0 as an upper bound for the supply elasticity of nonroad diesel fuel.

Three sets of sensitivity results are presented in Tables 10I-5, 10I-6, and 10I-7, where supply elasticities are changed in the equipment, engines, and fuel markets, respectively.

Table 10I-4
Engine, Equipment, and Diesel Fuel Market Sensitivity Analysis for Supply Elasticity Parameters

Market	Elasticity Source	Upper Bound	Base Case	Lower Bound
Supply				
Engines	EPA Estimate	7.64	3.81	2.33
Equipment				
Agriculture	EPA Estimate	3.72	2.14	1.31
Construction	EPA Estimate	6.06	3.31	2.09
Refrigeration	EPA Estimate	5.62	2.83	1.62
Industrial	EPA Estimate	12.93	5.37	2.9
Garden	EPA Estimate	7.96	3.37	1.82
Generator	EPA Estimate	12.14	2.91	1.12
Pumps	EPA Estimate	5.62	2.83	1.62
Diesel fuel	Literature Estimate	2	0.2	0.04

Note: For literature estimates, the variations in estimates reported were used to develop elasticity ranges. In contrast, EPA computed upper- and lower-bound estimates using the coefficient and standard error values associated with its econometric analysis and reflect a 90 percent confidence interval.

Tables 10I-5 and 10I-6 contain the results of varying the engine and equipment supply elasticities. When these elasticities are allowed to vary, all quantitative estimates for both market impacts (price and quantity changes) and social impacts (how the burden is shared across markets) remain nearly unchanged when compared with the rule, across both the upper and lower bound supply elasticity scenarios for equipment and engines. These results imply that the results presented in Section 10.1 are not sensitive to the supply elasticity values used in the engine and equipment markets, because the derived demand for engines and equipment is highly inelastic (it is a function of the inelastic demand and supply in the application markets), and so almost all of the compliance costs are passed on to the application markets through price increases.

Table 10I-7 contains the results of varying the fuel supply elasticity. The results for the upper bound is nearly identical to the base case. However, in the case of the lower bound (producers are less sensitive to price changes), the expected percentage change in the price of fuel decreases from 6 percent in the base case to 5.6 percent. There is a reallocation of surplus loss from the application markets to the fuel markets. In the base case, the application markets are expected to bear about 83 percent of the social costs ($1,497 million), while the fuel market is expected to bear about 0.5 percent ($8 million). When the lower bound of the supply elasticity for the fuel market is used, the share of the application markets decreases to 80 percent ($1,436 million) while the share of the fuel markets increases to about 4 percent ($70 million). The total welfare losses are stable, however, at $1,510.

The demand elasticities for the equipment and engine diesel fuel markets are derived as part of the model, and therefore sensitivity analysis was not conducted on those parameters.[X] In other words, the change in the application market quantities determines the demand responsiveness in the engine, equipment, and diesel fuel markets. As a result, the demand sensitivity analysis for these markets is indirectly shown in Table 10I-2. Nonroad diesel equipment and fuel expenditures are relatively small shares of total production costs for the application markets. Therefore changes in these input prices do not significantly alter input demand (i.e., demand in these markets is highly inelastic).

[X]For a discussion of the concept of derived demand, see Section 10.2.2.3 Incorporating Multimarket Interactions.

Table 10I-5. Equipment Market Supply Elasticity Sensitivity Analysis[a,b]

Scenario	Base Case		Supply Upper Bound		Supply Lower Bound	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Application Markets						
Price ($/q)	NA	0.10%	NA	0.10%	NA	0.10%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.02%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$877	NA	$874	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	$622	NA	$620	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,499	NA	$1,494	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$977	2.9%	$972	2.9%
Quantity (q/yr)	–139	–0.02%	–139	–0.02%	–139	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$141	NA	$146	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.4%	$821	21.4%
Quantity (q/yr)	–79	–0.01%	–76	–0.01%	–79	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–2.39	–0.02%	–2.38	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	$8	NA	$8	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$2	NA	$2	NA
Applications Not Included in NDEIM ($$10^6$/yr)	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,510.0	NA	$1,510.0	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

Table 10I-6. Engine Market Supply Elasticity Sensitivity Analysis[a,b]

Scenario	Base Case		Supply Upper Bound		Supply Lower Bound	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Application Markets						
Price ($/q)	NA	0.10%	NA	0.10%	NA	0.10%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.02%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$876	NA	$876	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	$621	NA	$621	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,497	NA	$1,497	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$975	2.9%	$975	2.9%
Quantity (q/yr)	–139	–0.02%	–139	–0.02%	–139	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$143	NA	$143	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.4%	$821	21.4%
Quantity (q/yr)	–79	–0.01%	–79	–0.01%	–77	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–2.38	–0.02%	–2.38	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	$8	NA	$8	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$2	NA	$2	NA
Applications Not Included in NDEIM ($$10^6$/yr)	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,510.0	NA	$1,510.0	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

Table 10I-7. Fuel Market Supply Elasticity Sensitivity Analysis[a,b]

	Base Case		Supply Upper Bound		Supply Lower Bound	
Scenario	**Absolute**	**Relative**	**Absolute**	**Relative**	**Absolute**	**Relative**
Application Markets						
Price ($/q)	NA	0.10%	NA	0.10%	NA	0.09%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.01%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$878	NA	$839	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	$623	NA	$597	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,501	NA	$1,436	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$975	2.9%	$975	2.9%
Quantity (q/yr)	–139	–0.02%	–140	–0.02%	–134	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$143	NA	$143	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.4%	$821	21.4%
Quantity (q/yr)	–79	–0.01%	–78	–0.01%	–75	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.06	6.0%	$0.05	5.6%
Quantity (q/yr)	–2.38	–0.02%	–2.39	–0.02%	–2.31	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	–$2	NA	$70	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$2	NA	$3	NA
Applications Not Included in NDEIM ($$10^6$/yr)	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,510.6	NA	$1,510.6	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

10.I.2 Fuel Market Supply Shift Alternatives

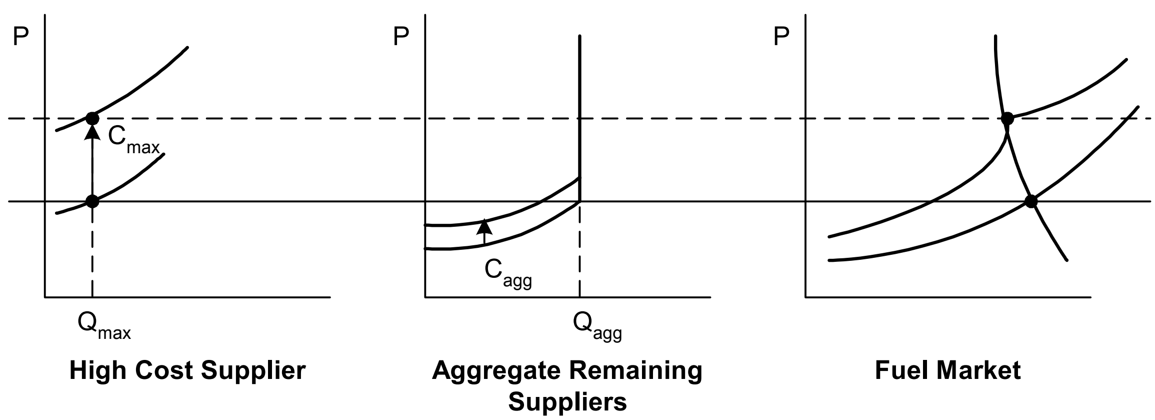
Section 10.2 discusses alternative approaches to shifting the supply curve in the market model. Three alternatives for the fuel market supply shift are investigated in this sensitivity analysis:

- Total average (variable + fixed) cost shift—the results presented in Section 10.1 and the appendices are generated using this cost shift.
- Total maximum (variable + fixed) cost shift
- Variable maximum cost shift

To model the total and variable maximum cost scenarios, the high-cost producer is represented by a separate supply curve as shown in Figure 10I-1. The remainder of the market is represented as a single aggregate supplier. The high-cost producer's supply curve is then shifted by C_{max} (either total or variable), and the aggregate supply curve is shifted by C_{agg}. Using this structure, the high-cost producer will determine price as long as

- the decrease in market quantity does not shut down the high-cost producer, and
- the supply from aggregate producers is highly inelastic (i.e., remaining producers are operating close to capacity); thus, the aggregate producers cannot expand output in response to the price increase.

Figure 10I-1
High Cost Producer Drives Price Increases



Note that the aggregate supply curve is no longer shifted by the average compliance costs but slightly less than the average because the high-cost producer has been removed. The adjusted average aggregate cost shift (C_{agg}) is calculated from the following:

$$C_{ave} * Q_{tot} = C_{max} * Q_{max} + C_{agg} * Q_{agg} \quad (10I.2)$$

where C_{ave} is the average control cost for the total population; Q_{max}, C_{max}, and Q_{agg}, C_{agg} are the baseline output and cost shift for the maximum cost producer; and the baseline output and cost shift for the remaining aggregate producers, respectively.

The results of this sensitivity analysis are reported in Table 10I-8.

Table 10I-8
Sensitivity Analysis to Cost Shifts in the Diesel Fuel Market

	Average Total Scenario		Maximum Total Scenario		Maximum Variable Scenario	
Scenario	**Absolute Change**	**Relative Change (%)**	**Absolute Change**	**Relative Change (%)**	**Absolute Change**	**Relative Change (%)**
Application Markets						
Price ($/q)	NA	0.10%	NA	0.14%	NA	0.10%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%	NA	–0.02%
Change in Consumer Surplus ($$10^6$/yr)	$876	NA	$1,176	NA	$919	NA
Change in Producer Surplus ($$10^6$/yr)	$621	NA	852	NA	665	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$2,029	NA	$1,584	NA
Equipment Markets						
Price ($/q)	$975	2.9%	$973	2.9%	$975	2.9%
Quantity (q/yr)	–139	–0.02%	–177	–0.02%	–138	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$143	NA	$145	NA	$143	NA
Engine Markets						
Price ($/q)	$821	21.4%	$821	21.0%	$821	21.0%
Quantity (q/yr)	–79	–0.01%	–100	–0.02%	–78	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$42	NA	$42	NA	$42	NA
Fuel Markets						
Price ($/q)	$0.06	6.0%	$0.10	11.0%	$0.06	7.0%
Quantity (q/yr)	–2.38	–0.02%	–3.02	–0.02%	–2.36	–0.02%
Change in Producer Surplus ($$10^6$/yr)	$8	NA	–$526	NA	–$79	NA
Transportation Services						
Price ($/q)	NA	0.01%	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%	NA	–0.01%
Change in Producer Surplus ($$10^6$/yr)	$2	NA	$4	NA	$3	NA
Applications Not Included in NDEIM	$102.4	NA	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,510.9	NA	$1,510.9	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

The total and variable maximum cost shift scenarios lead to different conclusions for two important variables: the estimated market price increase for diesel fuel and the estimated welfare impact for affected refineries. Under the base case (total average cost scenario), refiners pass most of the average compliance costs on to the application markets, and the net decrease in producer surplus for refiners is relatively small (about $7.8 million, or 0.6 percent of total social costs), and prices are expected to increase about 6.0 percent. Note that these are industry averages, and individual refiners will gain or lose because compliance costs vary across individual refineries.

In the total maximum cost scenario, the highest operating cost refinery determines the new market price through the impacts on both fixed and variable costs. This refinery has the highest per-unit supply shift, which leads to a higher price increase relative to the average cost scenario. As a result, all refiners except the highest cost refiner are expected to benefit from the rule, by about $526 million, because the change in market price exceeds the additional per-unit compliance costs for most of the refineries (i.e., most refiners have costs less than the costs for the highest operating cost refinery). Consequently, in this scenario the producers and consumers in the application market are expected to bear a larger share of the total cost of the program: $2,029 million compared to $1,497 million, out of total social costs of about $1,510 million for the welfare costs of the rule without considering the operating savings.

The variable maximum cost scenario is similar to the total maximum cost scenario because the highest cost refinery determines the with-regulation market price. However, the variable maximum cost scenario leads to an expected price increase that is smaller than the total maximum cost scenario because the refiner supply shift includes only variable compliance costs. In other words, the refiners do not pass along any fixed costs; they absorb the fixed costs. However, the refinery industry still experiences a small net surplus gain ($79 million) because the change in market price (driven by the maximum variable cost) exceeds the additional per-unit compliance costs for many of the refineries (i.e., many refiners still have total costs less than the costs for the highest operating cost refinery in this scenario).[Y] The net surplus gain for refiners is smaller than the total maximum scenario ($79 million compared to $596 million) because refiners absorb fixed costs, and the projected market price increase is smaller. Again, consumers and producers in the application markets are expected to bear a larger share of the total cost of the program, about $1,584 million.

The results of this sensitivity analysis suggest that the expected impacts on producers and consumers in the application markets and on refiners is affected by how refinery costs are modeled. The NDEIM models these costs based on the average (variable + fixed) cost scenario, reflecting a competitive market situation in all regional markets. However, if the highest cost refinery drives the new market price, then prices are expected to increase more, with a larger contraction in output. In this case, consumers and producers in the application market are expected to bear more than the cost of the rule. When the highest cost refinery's variable costs drive the new market price, then prices will increase slightly more that the base case (from 6 percent to 7 percent), producers and consumer will again bear more of the burden of the rule, and refiners bear less than in the base case.

[Y]Also, see Table 7.6-1 and related text in Chapter 7 regarding the possible diesel fuel price increases for the maximum operating cost scenario

10I.3 Operating Cost Scenario

In the base case analysis presented in Chapter 10, operating savings are not included in the market analysis. As explained in Section 10.3.5.3, this approach is used because these operating savings are not expected to affect consumer decisions with respect to new engines and equipment. However, these operating savings accrue to society and so they are added to social costs after changes in price and quantity are estimated. In the analysis for 2013, $284.7 million in operating savings are applied to the application markets; these savings are expected to accrue to producers in these markets. Specifically, $265.5 million are applied to the social costs for the three application markets and for the transportation services providers ($243.2 million and $22.3 million, respectively) and $19.2 million are applied to the social costs for those markets not included in NDEIM.[Z] The results of this base case analysis are set out in Table 10.1-4. In the summary presented in Table 10I-9, all of the operating savings are presented as a separate item.

In this sensitivity analysis, we modify the analysis to include operating savings in the market analysis. This scenario considers the possibility that some portion of the operating savings realized by users of nonroad engines, equipment, and fuel can be transmitted to consumers through the market relationships specified in the model, thereby affecting prices and output. The operating savings are modeled as a cost reduction (benefit) for producers in the application markets and service providers in the locomotive and marine sectors.[AA] Specifically, they are treated as negative supply shift for the supply curves in these markets. Treating operating savings like this reduces the size of the supply shift and illustrates how operating savings may be shared among producers and consumers in these markets.

The results of this sensitivity analysis are included in Table I-9. In this scenario, the price increase and quantity decrease in the application markets are expected to be smaller (0.08 percent compared to 0.10 percent for price, and -0.01 percent compared to -0.02 percent for quantity). This is a direct result of the smaller supply shift. Although the estimated total social costs associated with the rule are comparable for both scenarios, $1,510.1 million compared to $1.510.0 million in the base case, there are two important *distributional* consequences associated with including operating savings in the market analysis. First, almost all of the locomotive and marine savings ($22 million) are now directly passed to the application markets in the form of lower prices. As a result, the application markets benefit from operating savings in transportation services and they bear 80.6 percent of the total social costs instead of 83.4 percent (the change in total application market surplus decreases from $1,254 to $1,234 million). Second, a portion of the operating savings is now distributed to consumers in application markets. In 2013, the change in consumer surplus in the application markets decreases from $876 million to $709 million. The change in producer surplus is smaller, and decreases from

[Z] See Section 10.3.5.3 for a description of how the operating savings are estimated.

[AA] We only consider cost savings for market included in NDEIM (the three application markets and the transportation service markets). This amounts to $265 million, or 93 percent of the operating savings. The remaining $19 million is added as a line item to the social costs for application markets not included in NDEIM.

$621 to $525 million.

Table 10I-9
Operating Savings Included in the Market Analysis[a,b]

Scenario	Base Case (2013) Absolute Change	Base Case (2013) Relative Change (%)	Adding Operating Savings To App Absolute Change	Adding Operating Savings To App Relative Change (%)
Application Markets				
Price ($/q)	NA	0.10%	NA	0.08%
Quantity (q/yr)	NA	–0.02%	NA	–0.01%
Change in Consumer Surplus	$876	NA	$709	NA
Change in Producer Surplus	$621	NA	$525	NA
Change in Total Surplus ($$10^6$/yr)	$1,497	NA	$1,234	NA
Equipment Markets				
Price ($/q)	$975	2.9%	$976	2.9%
Quantity (q/yr)	–139	–0.02%	–93	–0.01%
Change in Producer Surplus	$143	NA	$142	NA
Engine Markets				
Price ($/q)	$821	21.4%	$821	21.4%
Quantity (q/yr)	–79	–0.01%	–53	–0.01%
Change in Producer Surplus	$42	NA	$42	NA
Fuel Markets				
Price ($/q)	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–1.57	–0.01%
Change in Producer Surplus	$8	NA	$6	NA
Transportation Services				
Price ($/q)	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%
Change in Producer Surplus	$2	NA	$2	NA
Applications Not Included in	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$19.2	NA
Total Social Cost	$1,510.0	NA	$1,510.1	NA

a Sensitivity analysis is presented for 2013.
b Figures are in 2002 dollars.

10I.4 Engine and Equipment Fixed Cost Shift Scenario

As discussed in Section 10.3 only the variable costs are used to shift the supply curve in the engines and equipment markets. Fixed costs are assumed to be R&D costs that are absorbed by engine and equipment markets over a 5-year period and hence do not affect market prices or quantities. As a result, producers are not able to pass any of these costs on and bear all fixed costs as a decrease in producer surplus.

In this scenario, the supply shift for engine producers includes the fixed and variable compliance costs. The results are presented in Table 10I-10. In this scenario, engine producers are able to pass along the majority of the fixed compliance costs to the downstream markets rather than absorb them as a one-to-one reduction in profits. As expected, this scenario leads to a higher projected price increases for the engine and equipment markets (from 2.9 percent in the baseline case to 3.4 percent for equipment markets and from 21.4 percent in the baseline case to 23.0 percent for engine markets), and the share of the social costs borne by these markets decreases from 9.5 percent to 0.2 percent for the equipment markets, and from 2.8 percent to 0 percent for the engine markets. These costs are passed on to the application markets, and their expected share of the compliance burden increases from 83 percent to 93 percent. However, the total social costs of the regulation are not expected to change measurably as the higher prices lead to almost no change in the demand for equipment and engines.

Table 10I-10 Fixed Costs Added to Supply Shift in Engine and Equipment Markets[a,b]

	Base Case (2013)		Shocking Engine and Equipment Markets by Total Costs	
Scenario	Absolute Change	Relative Change (%)	Absolute Change	Relative Change (%)
Application Markets				
Price ($/q)	NA	0.10%	NA	0.11%
Quantity (q/yr)	NA	–0.02%	NA	–0.02%
Change in Consumer Surplus	$876	NA	$978	NA
Change in Producer Surplus	$621	NA	$697	NA
Change in Total Surplus	$1,497	NA	$1,675	NA
Equipment Markets				
Price ($/q)	$975	2.9%	$1,192	3.4%
Quantity (q/yr)	–139	–0.02%	–156	–0.02%
Change in Producer Surplus	$143	NA	$5	NA
Engine Markets				
Price ($/q)	$821	21.4%	$898	23.0%
Quantity (q/yr)	–79	–0.01%	–87	–0.02%
Change in Producer Surplus	$42	NA	$0	NA
Fuel Markets				
Price ($/q)	$0.06	6.0%	$0.06	6.0%
Quantity (q/yr)	–2.38	–0.02%	–2.67	–0.02%
Change in Producer Surplus	$8	NA	$9	NA
Transportation Services				
Price ($/q)	NA	0.01%	NA	0.01%
Quantity (q/yr)	NA	–0.01%	NA	–0.01%
Change in Producer Surplus	$2	NA	$3	NA
Applications Not Included in	$102.4	NA	$102.4	NA
Operating Savings ($$10^6$/yr)	–$284.7	NA	–$284.7	NA
Social Costs ($$10^6$/yr)	$1,510.0	NA	$1,509.9	NA

[a] Sensitivity analysis is presented for 2013.
[b] Figures are in 2002 dollars.

10I.5 Alternative Social Discount Rates

Future benefits and costs are commonly discounted to account for the time value of money.

The market and economic impact estimates presented in Section 10.1 calculate the present value of economic impacts using a social discount rate of 3 percent, yielding a total social cost of $27.2 billion. The 3 percent discount rate reflects the commonly used substitution rate of consumption over time. An alternative is the OMB-recommended discount rate of 7 percent that reflects the commonly used real private rate of investment. Table 10I-11 shows the present value calculated over 2004 to 2030 using both the 3 and 7 percent social discount rates. With the 7 percent social discount rate, the present value of total social costs decreases to $13.9 billion.

Table 10I-11. Net Present Values[a]

	NPV (3%)			NPV (7%)		
	Market Surplus (10^6)	Operating Cost Savings (10^6)	Total	Market Surplus (10^6)	Operating Cost Savings (10^6)	Total
Engine Producers Total	$256		$256	$180		$180
Equipment Producers Total	$1,162		$1,162	$740		$740
Construction Equipment	$545		$545	$343		$343
Agricultural Equipment	$397		$397	$255		$255
Industrial Equipment	$220		$220	$141		$141
Application Producers & Consumers Total	$28,429	–$3,757	$24,672	$14,663	–$2,309	$12,354
Total Producer	$11,838			$6,096		
Total Consumer	$16,591			$8,567		
Construction	$11,526	–$1,779	$9,746	$5,922	–$1,093	$4,829
Agriculture	$8,181	–$1,208	$6,973	$4,222	–$742	$3,480
Manufacturing	$8,723	–$770	$7,953	$4,519	–$473	$4,046
Fuel Producers Total	$169		$169	$86		$86
PADD 1 & 3	$85		$85	$43		$43
PADD 2	$69		$69	$35		$35
PADD 4	$3		$3	$1		$1
PADD 5	$12		$12	$6		$6
Transportation Services Total	$1,653		$973	$900		$508
Locomotive	$31	–$160	–$129	$16	–$97	–$82
Marine	$18	–$204	–$187	$9	–$113	–$104
Application Markets Not Included in NDEIM	$1,604	–$315	$1,288	$875	–$182	$693
Total	$31,669	–$4,437	$27,232	$16,569	–$2,701	$13,868

[a] Figures are in 2001 dollars.
[b] Figures are in 2002 dollars.