Reformulated Gasoline Use Under the 8-Hour Ozone Rule

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On June 17, 2002, Senator Jeff Bingaman, Chairman of the Senate Committee on Energy and Natural Resources, requested that the Energy Information Administration (EIA) provide analysis of eight factors related to the Senate-passed fuels provisions of H.R. 4, the Energy Policy Act of 2002.[1] In response, EIA has prepared a series of analyses discussing the market impacts of each of these factors.

Because of the rapid delivery time requested by Sen. Bingaman, each requested factor related to the Senate-passed bill was analyzed separately, that is, without analyzing the interactions among the various provisions. In addition, assumptions about State actions, such as their implementation and timing of MTBE bans, influence the results. Discussions about some of these interactions have been included in order to explain the interconnected nature of such issues.

EIA's projections are not statements of what will happen but what might happen, given known technologies, technological and demographic trends, and current laws and regulations. The *Annual Energy Outlook 2002 (AEO2002*) is used in these analyses to provide a policy-neutral Reference Case that can be used to analyze energy policy initiatives. EIA does not propose, advocate or speculate on future legislative or regulatory changes. Laws and regulations are assumed to remain as currently enacted or in force in the Reference Case; however, the impacts of emerging regulatory changes, when clearly defined, are reflected.

The analyses involve simplified representations of reality because reality is complex. Projections are highly dependent on the data, methodologies, and assumptions used to develop them. Because many of the events that shape energy markets are random and cannot be anticipated (including severe weather, technological breakthroughs, and geopolitical disruptions), energy market projections are subject to uncertainty. Further, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. These uncertainties are addressed through analysis of alternative cases in the *AEO2002*.

Introduction

This paper responds to Sen. Bingaman's inquiry on "[the] impact on gasoline price and supply when many additional ozone non-attainment areas come under the new 8-hour ozone standard;…" This new standard would change the ambient air standard for ozone from 0.12 parts per million (ppm) averaged over a 1-hour period to a new 0.08 ppm standard averaged over 8 hours.

In 1997, the United States Environmental Protection Agency (EPA) announced new national ambient air quality standards (NAAQS) for ground-level ozone, the primary component of smog. The replacement of the existing 1-hour NAAQS standard with the

[1] Letter from Sen. Bingaman to Mary Hutzler, dated June 17, 2002.

proposed 8-hour standard was delayed by legal challenges, but is now in the process of being implemented. Although the Final Rule on the implementation of these standards has not yet been promulgated, designation of the 8-hour nonattainment areas is expected to occur in 2004, States may begin providing State Implementation Plans for attainment in 2006, and some States must meet the limit in 2007.[2]

In 1991, 98 areas in the United States were in nonattainment of the 1-hour ozone standard, according to the EPA. By 2000, only 36 were still designated nonattainment areas.[3] Thirty of the 36 were among the original 98; six were new. EPA has identified approximately 329 counties that are failing to meet the new 8-hour standards according to 1999-2000 data. Based on EPA projections for 2007, the number of counties failing the 8-hour NAAQS is expected to be cut in half,[4] as a result of low-sulfur gasoline requirements for light-duty highway vehicles (referred to as ``Tier 2'' standards) that become effective in 2004, and as a result of ozone control programs already in place such as those affecting power plants.

The purpose of this analysis is to determine the potential impact of the implementation of the 8-hour standard on the reformulated gasoline (RFG) requirements that are currently tied to nonattainment of the 1-hour standard. In general, this analysis identified limited potential for increasing the RFG market as a result of the change in NAAQS standards, and concluded that States are more likely to look to low Reid vapor pressure (RVP) fuels and changes in diesel fuel programs to resolve lingering ozone problems than to increase reliance on RFG, because these are lower-cost alternatives.

Ozone Formation and Trends

Ozone (O_3) is a gas composed of three oxygen atoms. Ozone is formed by the reaction of volatile organic compounds (VOC's) and nitrogen oxides (NO_x) in the presence of heat and sunlight. Ground-level ozone forms readily in the atmosphere, usually during hot summer weather. VOC's are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products, and other industrial sources. Nitrogen oxides are emitted from motor vehicles, power plants, and other sources of combustion.

Peak ozone levels typically occur during hot, dry, stagnant summertime conditions. The length of the ozone season varies from one area of the United States to another. Southern and Southwestern states may have an ozone season that lasts nearly the entire year.

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[2] U.S. Environmental Protection Agency, *Potential Schedule for Implementing the 8-Hour Ozone NAAQS and Related Actions*, (Washington, DC, February 4, 2002).

[3] U.S. Environmental Protection Agency, *1998-2000 Ozone and 1999-2000 Carbon Monoxide Air Quality Update*, (Washington, DC, March 25, 2002).

[4] EIA estimate based on U.S. EPA spreadsheet for 8-Hour Ozone NAAQS: Projected 2007 attainment/nonattainment for the Eastern U.S. Based on Heavy-Duty Diesel Rule AZ Modeling and assuming counties failing to meet the 8-hour NAAQS with 1998-2000 data for Western States for which no projections are available.

EPA is increasingly focusing its efforts on tracking and controlling ground-level ozone, a key component of smog. Of the six tracked pollutants, progress has been slowest for ground-level ozone. In the southern and north central regions of the United States, ozone levels have actually worsened from 1991 to 2000, though they have improved in other parts of the country.[5] The highest ambient ozone concentrations are typically found at suburban sites, consistent with the downwind transport of emissions from urban centers. For the more recent 10-year period, urban sites show decreases of approximately 12 percent and suburban sites show 11 percent decreases. However, at rural monitoring locations national improvements have been slower. One-hour ozone levels for 2000 are 6 percent below 1991 levels. In 2000, for the third consecutive year, rural 1-hour ozone levels are greater than the levels observed for the urban sites, but they are still lower than levels observed at suburban sites.

Much of this ozone trend is due to increased emissions in NO_x, a family of chemicals that can spread ozone hundreds of miles downwind. Between 1970 and 2000, NO_x emissions in the United States have increased almost 20 percent (and 3 percent increase from 1991 to 2000). The majority of this increase is attributed to growth in emissions from non-road engines (like construction and recreation equipment), diesel vehicles, and power plants.

NAAQS for Ozone

In 1997, EPA revised the national ambient air quality standards for ozone, which had been in place since 1979. Implementation has been delayed by a legal challenge to the Clean Air Act, which was resolved by the U.S. Supreme Court in favor of the constitutionality of the Act on February 27, 2001.

In the 1979 standards, EPA set the 1-hour O_3 standard at 0.12 ppm daily maximum 1-hour average concentration not to be exceeded more than once per year on average. Compliance with the 1-hour ozone standard is judged on the basis of the most recent 3 years of ambient air quality monitoring data. The 1-hour ozone standard is not met at a monitoring site if the average number of estimated exceedances of the ozone standard is greater than 1.0 (1.05 rounds up). A site would be in compliance, for example, if it had 2 days failing in the first year, none in the second year, and one in the third year.

In 1997 EPA set a new, stricter 8-hour O_3 NAAQS at 0.08 ppm to protect against longer exposure periods. The 8-hour O_3 standard is not met if the 3-year average of the annual 4th highest daily maximum 8-hour O_3 concentration is greater than 0.08 ppm (0.085 rounds up). EPA changed the form of the standard from an expected-exceedance form to a concentration-based form because it more directly relates to ozone concentrations associated with health effects; and it avoids exceedances, regardless of size, from being counted equally in the attainment tests.

[5] U.S. Environmental Protection Agency, *Latest Findings on National Air Quality: 2000 Status and Trends*, (Washington, DC, September 2001).

The 0.12-ppm 1-hour standard will not be revoked in a given area until that area has achieved 3 consecutive years of air quality data meeting the 1-hour standard. The purpose of retaining the current 1-hour standard is to ensure a smooth, legal, and practical transition to the new standard.

The final rule on implementation of the 8-hour ozone rule is scheduled in 2003. The 8-hour ozone nonattainment areas are scheduled to be designated in 2004. Marginal areas must meet the standard in 2007; moderate areas in 2010; serious areas in 2013; and severe areas in 2019-2021. Two, 1-year extensions are possible for each area.

Pending Changes in Gasoline and Diesel Formulation

Some of the strategies for reducing ground-level ozone include:

- Reducing NO_x emissions from power plants and industrial combustion sources;
- Introducing low-emission cars and trucks;
- Using "cleaner" fuels; and
- Improving vehicle inspection programs.

As part of the EPA's effort to reduce ozone, consumers will begin to use significantly cleaner gasoline in 2004 and significantly cleaner diesel fuel in 2006.

Gasoline

Starting in 2004, all gasoline will be required to have a much-reduced sulfur level in order to ensure the effectiveness of emissions control technologies that will be needed to meet the Tier 2 emissions targets of the Clean Air Act Amendments of 1990. This low-sulfur gasoline requirement will tap almost all of the potential NO_x reduction from gasoline.

Compared to average U.S. gasoline sulfur levels outside of California of 268 ppm in 1998,[6] sulfur levels in gasoline will be reduced to 30 ppm in 2004, greatly reducing NO_x in all States. Average gasoline sulfur content has already declined somewhat due to tighter NO_x restriction on RFG that began in 2000 (Phase 2 RFG).

In February 2000, EPA published its Final Rule on "Tier 2" Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements for light-duty vehicles.[7] In 2004,

[6] U.S. Environmental Protection Agency, *Regulatory Impact Analysis--Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Control Requirements,* EPA420-R-99-023 (Washington, DC, December 1999), Chapter 4.

[7] U.S. Environmental Protection Agency, *Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Control Requirements*, 40 CFR Parts 80, 85, and 86 (Washington, DC, February 10, 2000).

manufacturers must begin producing vehicles that are cleaner than those being sold today. The standards would also be extended to light-duty trucks, minivans, and sport utility vehicles (SUV's), which currently pollute three to five times more than cars. This is the first time that the same set of emissions standards will be applied to all passenger vehicles. In its Final Rule, EPA notes that the single set of standards is appropriate given the increasing use of light trucks for personal transportation and the increasing number of vehicle-miles traveled by light trucks. The same standards will be applied to vehicles operated on any fuel.

Because automotive emissions are linked to the sulfur content of motor fuels, the Final Rule also requires a reduction in average gasoline sulfur levels nationwide. Sulfur reduces the effectiveness of the catalyst used in the emission control systems of advanced technology vehicles, increasing their emissions of hydrocarbons, CO, and NO_x. The sulfur content of gasoline must be reduced to an annual average of 30 parts per million (ppm), and a maximum 80 ppm in any gallon, to accommodate the new emissions control systems and meet the Tier 2 standards. The new Federal standard is equivalent to the current standard for gasoline in California at about one-fourth the sulfur content in areas currently using reformulated gasoline and about one-tenth the current sulfur content of conventional gasoline.

Because the standard will require refiners to invest in sulfur-removing processes, it will be phased in between 2004 and 2007 and, initially, will allow less stringent standards for small refiners. To encourage reductions before 2004, refiners will receive credits for sulfur reductions below a baseline level. The credits can be used later as “allotments,” which will allow a refiner to exceed the new sulfur standard by a given amount. Gasoline produced by most refiners will be required to meet corporate average sulfur contents of 120 ppm in 2004 and 90 ppm in 2005. The corporate average will be phased out by 2006. Beginning in 2005, most refiners must meet a refinery-level average of 30 ppm. Refiners producing most of their gasoline for the Rocky Mountain region will also be allowed a more gradual phase-in because of less severe ozone pollution in the area; they will be required to meet a refinery average of 150 ppm in 2006 and must meet the 30 ppm requirement in 2007. Small refiners will not be required to meet the 30-ppm standard until 2007.

In its final Tier 2 gasoline rule, EPA stated that in 1996, cars and light trucks comprised 21 percent of the NO_x emissions from human sources in the United States. EPA projected that based on the available ozone modeling and other information, there were 26 metropolitan areas, which would be unable to attain and maintain the NAAQS, in the absence of additional reductions. These 26 areas are those that have current violations of the 1-hour ozone NAAQS and are predicted by ozone modeling to still be in violation without a new Federal vehicle program in 2007. EPA projected nationwide Tier 2/gasoline sulfur control NO_x reductions from cars and light trucks of approximately 1.0 million tons per year in 2007, reducing emissions of ozone precursors from cars and light trucks greatly.

On-Road Diesel Fuel

Starting in 2006, most on-road diesel fuel will be required to have a much-reduced sulfur level in order to ensure the effectiveness of emissions control in new diesel engines. This low-sulfur diesel requirement will significantly reduce NO_x emissions from diesel engines.

Compared to average U.S. diesel sulfur levels outside California and Alaska of 340 ppm in 1996,[8] sulfur levels in on-road diesel fuel will be reduced to 15 ppm starting in 2006, reducing NO_x in most parts of the United States.

In July 2000, the EPA finalized new regulations to reduce emissions for new heavy-duty trucks and buses in model years 2004 and later. The standards for all diesel vehicles over 8,500 pounds will reduce NO_x emissions by more than 40 percent through reductions in hydrocarbons beginning in 2004.[9] New test procedures and compliance requirements will begin in the 2007 model year, and on-board diagnostic systems will be required for engines in vehicles between 8,500 and 14,000 pounds, with a phase-in period covering the 2005 through 2007 model years. New standards for heavy-duty gasoline engines and vehicles will reduce both hydrocarbons and NO_x for all vehicles above 8,500 pounds not covered in the Tier 2 light duty vehicle standards, beginning in 2005. In 1998, the EPA signed consent decrees with several heavy-duty engine manufacturers, stating that the 2004 emission standards would be met by October 2002.

In December 2000, EPA published additional standards for on-road heavy-duty diesel engines that would take effect beginning in model year 2007.[10] These standards will require stricter control of NO_x emissions. The new standards apply to diesel-powered vehicles with gross vehicle weight (GVW) of 14,000 pounds or more. The NO_x standards are to be phased in at 50 percent of new vehicle sales in model years 2007 through 2009. In 2010, all new on-road vehicles will be required to meet the NO_x standards. For years 2007 through 2009, the EPA allows diesel engine manufacturers flexibility in meeting the NO_x standards. Engine manufacturers are provided the option of producing all diesel engines to meet an average of 2004 and 2007 NO_x emission standards.

In order to enable diesel engine technology to meet tighter emissions standards, EPA issued new standards for diesel fuel quality in December 2000, which will become effective in mid-2006.[11] The standards will cap diesel fuel sulfur content at 15 ppm starting June 1, 2006, from the current maximum standard of 500 ppm. Diesel meeting the new specification will be required at terminals by July 15, 2006, and at retail stations and wholesalers by September 1, 2006. All 2007 and later model year diesel-fueled vehicles must be refueled with this new low sulfur diesel fuel. Under a "temporary

[8] U.S. Environmental Protection Agency, *Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Requirements*, EPA420-R-00-026 (Washington, DC, December 2000, Chapter IV.

[9] U.S. Environmental Protection Agency, *Final Emission Standards for 2004 and Later Model Year Highway Heavy-Duty Vehicles and Engines*, EPA420-F-00-026 (Washington, DC, July 2000).

[10] U.S. Environmental Protection Agency, *Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements: Final Rule*, 40 CFR Parts 69, 80, and 86 (Washington, DC, January 18, 2001).

[11] Ibid.

compliance option" (phase-in), up to 20 percent of on-road diesel fuel produced may continue to meet the current 500-ppm sulfur limit through May 2010; the remaining 80 percent of the on-road diesel fuel produced must meet the new 15-ppm maximum.

In the Final On-Road Diesel Rule, EPA states that heavy-duty vehicles contribute about 15 percent to the national NO_x inventory for all sources in 2007. The standards should result in close to a 90 percent reduction in NO_x from new engines. In 2007, EPA estimates that the rule will reduce NO_x emissions by 58,000 tons and 1.82 million tons by 2020.[12] For the 37 areas in the East for which EPA's modeling predicted exceedances in 2007, 2020, and/or 2030 and current 1-hour design values are above the standard or within 10 percent of the standard, EPA's modeling results indicated that there will be substantial reductions in the number of exceedances and the magnitude of high ozone concentrations in both 2020 and 2030 due to this Rule.

State Options for Mitigation

The Clean Air Act requires each State with air quality problems to have an approved State Implementation Plan (SIP) that shows how an area plans to meet its air quality obligations, including achieving and then maintaining attainment of all of the National Ambient Air Quality Standards (NAAQS), such as those for ozone. EPA is expected to promulgate regulations for implementing the 8-hour ozone standards in 2003. Some States are expected to start providing State Implementation Plans for the 8-hour standard in 2006. Since SIP's will be provided after the implementation of "Tier 2" low-sulfur gasoline requirements in 2004, which will result in substantial NO_x reduction across the country, they are not likely to make plans based solely on data from 1998 to 2000. Instead they would rely on future data or emissions projections that would take into account the air quality improvement from Tier 2 gasoline and other ongoing ozone improvement programs. EIA estimates that the current number of counties failing to meet the 8-hour NAAQS may be cut in half by the first effective date of 2007, based on EPA projections for Eastern States and current nonattainment status for Western States where no projections were available.

Although the EPA's authority to apply the 8-hour National Ambient Air Quality Standards (NAAQS) was upheld by the courts, there is still considerable uncertainty about how the NAAQS standards will be implemented and what their impact might be. Among the options States have to reduce ozone is further adoption of RFG, low-RVP[13] gasoline, or ultra-low-sulfur diesel fuel. In deciding whether or not to require a fuel

[12] Ibid.

[13] Summer gasoline requires a lower Reid Vapor Pressure (RVP) than winter gasoline and summer is the time of highest demand. RVP measures the tendency of a material to evaporate, and thus its tendency to produce volatile organic compounds (VOC's). It is measured in pounds per square inch (psi), sometimes just referred to in "pounds." Adding ethanol to gasoline increases the RVP and requires that further refining adjustments be made, particularly when producing RFG and low-RVP conventional gasolines. The low-RVP requirement in the summer adds more complications to using ethanol during this season than during the winter, in addition to summer being the period of highest demand.

change as part of their SIP's, States are likely to compare the relative cost and benefit to other measures such as tightening emissions from industry, power plants, or vehicles.

Reformulated Gasoline

Current participation in the Federal RFG program is based on noncompliance with the existing 1-hour ozone standard. Under the Clean Air Act Amendments of 1990 (CAAA), areas classified as "severe" or "extreme" nonattainment were required to use RFG and other less severe nonattainment areas were able to opt-into the program. Even though many of these areas have since come into attainment of the 1-hour standard, they are expected to continue to use RFG as part of their maintenance plan (Table 1).

Ten of the areas with the worst ozone pollution currently are required to use RFG under the provisions of CAAA. Areas with less severe ozone problems in 12 States and the District of Columbia have opted to use RFG as part of their attainment strategies. When reformulated gasoline first came into use in 1995, it represented about 28 percent of total gasoline sales. In 2001, 33.6 percent of gasoline was reformulated. The Baton Rouge, Louisiana, area currently uses low-RVP gasoline, but will be required to switch to RFG within the next year or two, because its nonattainment status was recently reclassified from "serious" to "severe." The addition of Baton Rouge to the RFG area is expected to increase the RFG market by two-tenths of a percentage point to 33.8 percent.

From 1995 to 1999 Phase I of the reformulated gasoline program reduced VOC emissions by 17 percent and NO_x emissions by 2 percent, according to EPA.[14] A more stringent Phase II of the program beginning in 2000 was designed to make additional reductions.

Reformulated gasoline has the same components as conventional gasoline. However, the components that contribute most to air pollution are further processed and refined. RFG is made in a way that prevents it from evaporating as much as conventional gasoline, has fewer toxic components, and contains chemical oxygen, known as oxygenate, to improve combustion.

[14] U.S. Environmental Protection Agency, *Phase II Reformulated Gasoline: The Next Major Step Toward Cleaner Air*, EPA 420-F-99-042, (Washington, DC, November 1999)

Table 1. Existing RFG Areas, 1-hour and 8-hour Attainment/Nonattainment Status

Required RFG Areas – Designated "Extreme" or "Severe"	Designated Nonattainment Of 1-Hour NAAQS In 1991	Continued Failure of 1-Hour NAAQS 1998-2000 Data	Failure of 8-Hour NAAQS 1998-2000 Data
Baltimore, MD	X	X	X
Chicago-Gary-Lake County, IL-IN-WI	X		
Hartford-New Haven-Waterbury, CT	X		X
Houston-Galveston-Brazoria, TX	X	X	X
Los Angeles-Anaheim-Riverside, CA	X	X	X
Milwaukee-Racine, WI	X	X	X
New York-Northern New Jersey-Long Island, NY-NJ-CT	X	X	X
Philadelphia-Wilmington, Trenton, PA-MD-NJ	X	X	X
Sacramento, CA	X	X	X
San Diego, CA	X	X	X
Soon to be Required RFG Areas/ Areas Redesignated "Severe"			
San Joaquin, CA	X	X	X
Baton Rouge, LA	X	X	X
Opt-In RFG Areas –less severe classifications			
Connecticut (rest of State)	X	X	X
Delaware (rest of State)	X		X
District of Columbia	X	X	X
Kentucky			
Cincinnati-Hamilton (KY portion)	X		
Louisville (KY portion)	X		X
Maryland			
Washington DC (MD portion)	X	X	X
Kent & Queen Anne's Cos.	X		
Massachusetts- entire State	X		X
Missouri			
St. Louis	X		X
New Hampshire			
Boston-Lawrence-Worcester (NH portion)	X		
New Jersey-entire State	X		X
New York			
Essex & Dutchess Cos.	X		X
Rhode Island–entire State	X		X
Texas			
Dallas-Fort Worth	X		X
Virginia			
Washington DC (VA portion)	X	X	X
Richmond	X	X	X
Norfolk	X		X

Sources: United States Environmental Protection Agency, *U.S. EPA 1998-2000 Ozone and 1999-2000 Carbon Monoxide*, online: http//www.epa.gov/oar/aqtrnd00/carboz00.html, June 21, 2002. United States Environmental Protection Agency, *List of Reformulated Gasoline Program Areas*, online: http://www.epa.gov/otaq/rfgarea.htm, August 6, 2002.

Relative to conventional gasoline, RFG provides reductions of NO_x and VOC emissions, both of which contribute to ozone formation, and also of air toxics emissions benefits. However, compared to Tier 2 low-sulfur gasoline, which will come into use in 2004, RFG provides only a VOC and air toxics benefit. Only the VOC emissions benefit contributes to less ozone formation. Areas that have ongoing VOC problems may be more likely to look to low-RVP gasoline as an option for ozone improvement, than RFG because low-RVP gasoline is less costly to produce.

Areas that switch from conventional to reformulated gasoline are very likely to pay higher prices. In the Central Atlantic States, for example, where significant amounts of both RFG and conventional gasoline are consumed, the 2001 average of weekly regular RFG prices exceeded the average of conventional prices by 5.3 cents per gallon.[15] Low-RVP gasoline prices are generally closer to conventional gasoline prices than to RFG.

There is no legal obligation for areas that are in nonattainment of the 8-hour ozone standards to use reformulated gasoline (RFG). Requiring the use of RFG may be an option for States, although there is currently no clear statutory mechanism for joining the RFG program based on nonattainment of the 8-hour standard.

Areas that are still projected to fail 8-hour ozone in 2007 would have little incentive to choose RFG over a low-RVP gasoline. Even if a renewable fuel standard is enacted requiring the use of relatively high-RVP ethanol, areas that meet the standard with low-RVP gasoline could buy ethanol credits.

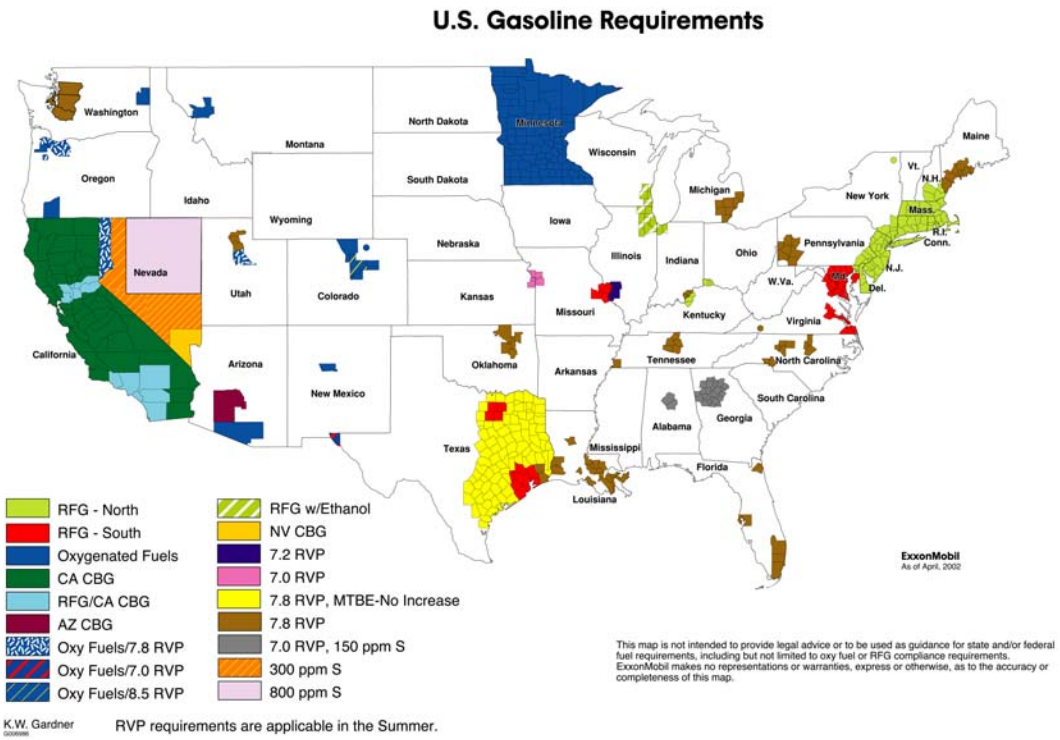
Low-RVP Gasoline

As States developed their State Implementation Plans (SIP's) to improve air quality, many found they could achieve the VOC reduction benefits of RFG by requiring a cheaper low-RVP conventional gasoline. Production costs for low-RVP conventional fuels can be less than for RFG, because blending is less complex.

Low-RVP gasoline, defined as conventional gasoline with an RVP of less than or equal to 7.8 pounds per square inch (psi), is currently required in 20 States (Figure 1). RVP restrictions as low as 7.0 psi are required in parts of Alabama, Georgia, Kansas, and Missouri.

[15] Calculated from http://www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_history.html

Figure 1.



As noted above, the introduction of low-sulfur gasoline in 2004 means that most of the potential NO_x reduction from changes to gasoline quality will already be achieved. Areas that have ongoing VOC problems may be more likely to look to low-RVP gasoline as an option for ozone improvement than RFG, because low-RVP gasoline is less costly to produce.

However, low-RVP gasoline is more difficult to produce if ethanol must be one of the components, because ethanol has a relatively high RVP. If the renewable fuel standard and ethanol credit trading provisions of the proposed energy bills are passed, areas with low-RVP gasoline requirements may find it more economical to trade ethanol credits.

Diesel Fuel

Implementation of clean diesel fuel and engines is expected to be key to ozone compliance programs. Given that the areas projected to be out of 8-hour ozone compliance will already be using low-sulfur gasoline and that many of these areas are already using RFG or low-RVP gasoline, potential ozone improvement through further VOC controls on gasoline is minor compared to potential gains from diesel programs.

The Texas SIP issued in 2000 required, for example, that diesel sulfur levels in certain counties decline to 500 ppm with 10 percent aromatic hydrocarbons, and a 48 cetane

minimum, for both on- and non-road use beginning this year, with further reductions to 15 ppm on June 1, 2006.[16] The areas affected are Houston-Galveston, Dallas-Fort Worth, Beaumont-Port Arthur, and 95 central and eastern counties. The SIP regulates non-road diesel in these counties where no Federal regulations exist, and the 2006 Texas regulations are imposed slightly earlier than the Federal regulations. Federal regulations allow the producer to choose between meeting a minimum cetane number of 40 or a maximum aromatic hydrocarbon content of 35 percent by volume.

The Texas Natural Resource Conservation Commission concluded that modeling demonstrated significant emission reductions could be achieved by using a low aromatic hydrocarbon/high cetane diesel fuel as specified by the Commission's fuel requirements. By the year 2007, the Texas diesel fuel program is expected to reduce statewide NO_x emissions from on-road vehicles and non-road equipment by 30 tons per day, of which 6.67 tons per day of reductions will be achieved in the Houston-Galveston 1-hour ozone nonattainment area.

EIA Study

By 2007, further NO_x reductions from motor vehicles will become increasingly costly, because gasoline and diesel sulfur reduction programs will have already dramatically reduced NO_x emissions from vehicles. States with continuing VOC emissions problems are likely to address them with low-RVP gasoline, rather than more-costly RFG. Therefore, it is unlikely that the 8-hour ozone rule will lead to much of an increase in RFG consumption.

However, at the request of Committee staff, an "upper bound" case was developed for increased RFG consumption as a result of the transition from the 1-hour to the 8-hour ozone rule. This "upper bound" case must be considered to have a small probability.

Assumptions

EIA's analysis of the impact of the 8-hour NAAQS takes into account the national requirement for "Tier 2" low-sulfur gasoline in 2004 that will substantially reduce NO_x emissions for all gasoline in the United States. Analysis of 8-hour nonattainment for the Eastern part of the country, including States in Petroleum Allocation Defense District's (PADD's) I through III, is based on EPA's projections for the attainment status of counties in 2007 which accounts for Tier 2 gasoline and other ongoing ozone reduction measures.[17] These projections do not distinguish among marginal, moderate, severe, and serious nonattainment areas. Since similar projections were not available for Western

[16] Texas Natural Resource Conservation Commission, Chapter 114 - Control of Air Pollution from Motor Vehicles, Rule Log Number 2000-011D-114-AI

[17] U.S. EPA spreadsheet, "8-Hour Ozone NAAQS: Projected 2007 Attainment/Nonattainment for the Eastern U.S. Based on Heavy Duty Diesel Rule AQ Modeling" transmitted from Office of Air Quality Planning and Standards.

states, EIA's analysis assumes nonattainment/attainment status of counties in PADD's IV and V based on 1999-2000 NAAQS data.[18]

EIA developed an "Upper Bound-RFG" case by identifying counties and their associated Metropolitan Statistical Areas (MSA's) that would be the most likely candidates to switch to RFG as a direct result of the new 8-hour standards. The "Upper Bound-RFG" case is based on the following assumptions.

- Projected 8-hour non-attainment areas that are currently using RFG are expected to continue to use RFG.

- Projected 8-hour non-attainment areas that currently use low-RVP fuels continue to use these blends. This assumption is based on the premise that areas currently using RVP restricted gasoline are doing so to address local summertime VOC problems. Given that virtually all of the potential NO_x reduction from gasoline will be achieved through Tier 2 gasoline requirements, the VOC problems in areas currently using low-RVP gasoline are assumed to continue to be addressed through RVP restrictions.

- Projected nonattainment counties that are currently using conventional gasoline without volatility restrictions (9.0 psi areas) were assumed to be the most likely to switch to RFG because the emissions benefit would be the greatest in these areas. Attainment counties in the same MSA as any of these nonattainment counties were also assumed to be likely to switch to RFG, because areas are likely to make common plans to reduce ozone.

- Areas that had previously opted-out of the RFG program were assumed to have a predisposition against RFG and were not assumed to switch to RFG.

In addition to the counties already using RFG, the 16 projected nonattainment counties included in the "Upper Bound RFG" case are shown in the right-hand column of Table 2, titled "Most Likely to Switch." The actual 8-hour "nonattainment areas" have not yet been designated but these areas are generally the larger metropolitan areas that the failing county is associated with. The "Upper Bound RFG" case reflects both the counties projected to fail the 8-hour NAAQS, and 32 other counties in the associated metropolitan areas shifting to RFG in 2007. As a result of these assumptions, the national market share for reformulated gasoline is assumed to rise from 33.8 percent under the 1-hour rule to 38.0 percent under the 8-hour rule.

These State fuel choices are assumed to occur in 2007, regardless of whether a county is in marginal, moderate, serious, or severe nonattainment. In reality, areas with moderate, serious, or severe ozone problems may choose not to switch to RFG until years after 2007. The "Upper Bound RFG" case represents the shortest possible time period for counties using conventional gasoline to switch to RFG. Thus, the case represents an "upper bound" to what is expected to occur.

[18] Current nonattainment areas in AZ and CO: U.S. EPA 1998-2000 Ozone and 1999-2000 Carbon Monoxide, Table 3, online: http//www.epa.gov/oar/aqtrnd00/carboz00.html, June 21, 2002.

The “Upper Bound RFG” case is believed to be a reasonable upper bound on the number of areas that would shift to RFG solely as a result of the new 8-hour NAAQS. As shown in Table 2, four of the counties assumed to switch to RFG in the “Upper Bound RFG” case are currently out of attainment for the 1-hour NAAQS. The fact that these areas did not choose RFG as a compliance option for the 1-hour NAAQS leads to the assumption that they will to choose to use RFG only as a “last resort” as a means of complying with the 8-hour standard. Thus, the case represented here is an “upper bound” to what is expected to occur.

Table 2. Counties Projected to Fail 8-Hour NAAQS in 2007 That Are Not Already Using RFG

State	County	Greater Metropolitan Statistical Area	Summertime RVP Limit Pounds per square inch (psi)	Previously Opted-out of RFG Program	Currently Nonattainment for 1-Hour NAAQS	Most Likely to Switch to RFG
AZ	Maricopa	Phoenix	7.0[1]	X		
CO	Jefferson	Denver	9.0[2]			X
FL	Escambia	Pensacola	9.0			X
GA	Bibb	Macon	9.0		X	X
	DeKalb	Atlanta	7.0		X	
	Douglas	Atlanta	7.0		X	
	Fayette	Atlanta	7.0		X	
	Fulton	Atlanta	7.0		X	
	Gwinnett	Atlanta	7.0		X	
	Rockdale	Atlanta	7.0		X	
IN	Clark	Louisville	7.8			
	Hamilton	Indianapolis	9.0			X
LA[3]	Calasieuu	Lake Charles	7.8		X	
	Iberville	NA	7.8			
MI	Allegan	Grand Rapids-Muskegon-Holland	9.0			X
	Berrien	Benton Harbor	9.0			X
	Lenawee	Ann Arbor	9.0			X
	Macomb	Detroit	7.8			
	Muskegon	Grand Rapids-Muskegon-Holland	9.0			X
MS	Jackson	Jackson	9.0			X
NC	Mecklenburg	Charlotte-Gastonia-Rock Hill, NC-SC	7.8		X	
	Wake	Raleigh-Durham-Chapel Hill	7.8		X	
NV	Clark	Las Vegas	9.0[4]			
OH	Lake	Cleveland-Lorain-Elyria	9.0			X
PA	Allegheny	Pittsburgh	7.8	X		
	Armstrong		9.0	X		
	Lancaster	Lancaster	9.0	X		
	Lehigh	Allentown-Bethlehem-Easton	9.0	X		
	Monroe	Scranton	9.0	X		
	North Hampton	Allentown-Bethlehem-Easton	9.0	X		
	Washington	Pittsburgh	7.8	X		
TN	Blount	Knoxville	9.0		X	X
	Knox	Knoxville	9.0		X	X
	Shelby	Memphis	7.8		X	
	Sumner	Nashville	7.8		X	
TX	Gregg	Longview-Marshall	7.8			
	Jefferson	Beaumont-Port Arthur	9.0			X
WI	Door	NA	9.0			X
	Kewaunee	NA	9.0			X

	Sheboygan	Sheboygan	9.0		X	X

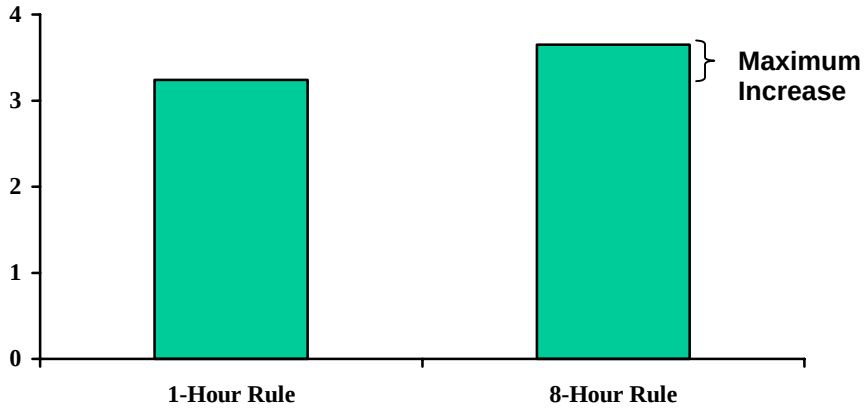
[1]Arizona Cleaner Burning Gasoline.
[2] Voluntary 8.5 psi program.
[3] East Baton Rouge is also projected to fail 8-Hour NAAQS but is not included here because it will be switched to RFG due to reclassification of Baton Rouge as a "severe" nonattainment area for the 1-Hour NAAQS.
[4]Nevada Cleaner Burning Gasoline does not restrict RVP.
Note: Counties "Most Likely to Switch to RFG" represent an upper bound.
Sources: Projected 2007 from nonattainment areas in FL, GA, IN, LA, MI, MS, NC, OH, PA, TN, TX, and WI: U.S. EPA spreadsheet. Current nonattainment areas in AZ and CO: U.S. EPA 1998-2000 Ozone and 1999-2000 Carbon Monoxide, Table 3, online: http//www.epa.gov/oar/aqtrnd00/carboz00.html, June 21, 2002.

The price changes in this scenario are relative to a case that includes the fuel-related provisions of H.R. 4, as amended by the Senate. This case includes an 87-percent MTBE ban starting in 2006, a renewable fuel standard of 5 billion gallons by 2012, the elimination of the current oxygen requirement on RFG, and the 1-hour ozone nonattainment rule.[19]

Results

The "Upper Bound RFG" case results in a maximum 12.6 percent increase in the volume of RFG consumed in 2007 (Figure 2). RFG consumption is projected to be 3.24 million

Figure 2. Reformulated Gasoline Consumption Under Two Cases, 2007 (million barrels per day)



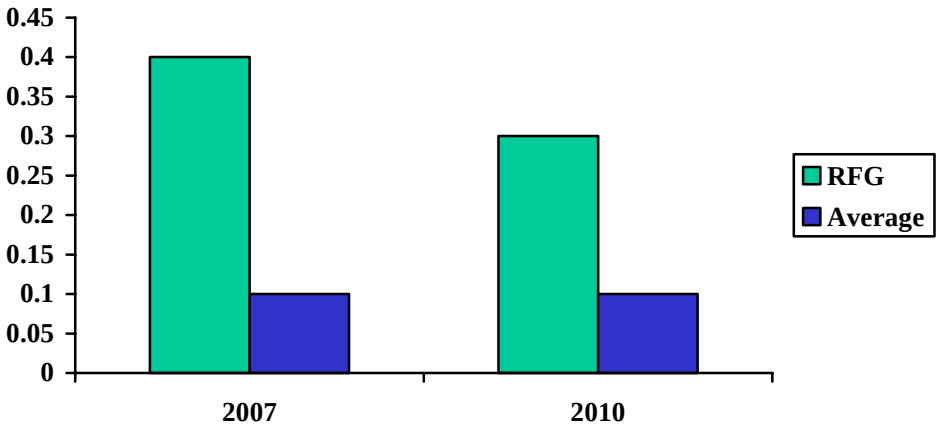
Note: The 8-hour rule results represent an upper bound on the amount of RFG consumed. Both cases assume an 87-percent MTBE ban.
Source: Energy Information Administration, National Energy Modeling System runs BingBasX.d062602a and BingBasK.d080502a

[19] Energy Information Administration, *Impact of Renewable Fuels Standard/MTBE Provisions of S. 517 Requested by Senators Daschle and Murkowski,* (Washington, DC, April 15, 2002). The legislation does not specify an 87-percent ban; the scenario assumes that a State like Texas would seek a waiver from the ban.

barrels per day under the 1-hour ozone case and a maximum of 3.65 million barrels per day under the 8-hour ozone case in 2007. Total gasoline consumption is almost exactly the same in the two cases; increased RFG consumption in the 8-hour case replaces conventional gasoline consumption in the 1-hour case.

National average annual RFG pump prices are up to 0.4 cents per gallon higher in the Upper Bound case (Figure 3) than a case with the H.R. 4 provisions, as amended by the Senate. Average U.S. gasoline prices are projected to increase by 0.1 cent per gallon.

Figure 3. Maximum Gasoline Price Increases Resulting from 8-Hour Ozone Rule Under an "Upper Bound" Case, 2007 and 2010 (cents per gallon)



Note: The Upper Bound case assumes that projected nonattainment counties that are currently using conventional gasoline without volatility restrictions are the most likely to switch to RFG.
Source: Energy Information Administration, National Energy Modeling System runs BingBasX.d062602a and BingBasK.d080502a

Price increases shrink over time, as the industry adds new processing equipment to meet the new RFG demand.

Because States have other options for improving ozone, it is highly unlikely that all the projected nonattainment areas currently using conventional gasoline would switch to RFG and that they would switch to RFG in 2007. Therefore, EIA considers the "Upper Bound RFG" case as a high-end case in terms of both the volume of gasoline that would switch to RFG and the associated price impact.

Relation to Previous Work

Previous work on H.R. 4, as amended by the Senate, showed that reformulated gasoline prices are expected to rise about 8 cents per gallon from today's levels, while national

average gasoline prices are 3-3.5 cents higher than today.[20] The effects of the 8-hour ozone rule would be on top of these increments, but the results presented would be an upper bound on the average annual incremental price increase.

Conclusion

The potential for increasing the RFG market as a result of the change in NAAQS standards is expected to be limited to a maximum of 0.4 million barrels per day. States are more likely to look to low-RVP fuels and changes in diesel fuel programs to resolve lingering ozone problems than to increase reliance on RFG, because of its higher cost. The 8-hour ozone rule could increase average national RFG prices by no more than 0.4 cents per gallon and average national gasoline prices by up to 0.1 cent per gallon over those projected for H.R. 4, as amended by the Senate.

[20] Ibid.

Appendix A:

Letter of Request from Senator Jeff Bingaman, June 17, 2002.

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510-6150
ENERGY.SENATE.GOV

June 17, 2002

Dr. Mary Hutzler
Acting Administrator
Energy Information Administration
1000 Independence Avenue SW
Washington, DC 20585

Dear Acting Administrator Hutzler:

The Senate passed version of H.R.4 contains a number of provisions affecting fuels markets that require additional analysis prior to final conference decisions. First, the oxygenate requirement for RFG would be eliminated and the states would be allowed to ban the use of MTBE beginning in 2004, a national phase out would follow. Also beginning in 2004, a certain portion of all gasoline sold in the U.S. will have to be from "renewable fuels", this requirement will affect all refiners and gasoline markets. The combination of these two factors alone has the potential to significantly impact US motor fuels markets.

As we all know too well, every previous significant change to fuel formulations has resulted in severe price volatility in various US motor fuels markets. Each time, the Committee on Energy & Natural Resources has held hearings to review the problems in an effort to avoid or at least mitigate future recurrence of such dislocations. The Energy Information Administration (EIA) has also investigated and reported on these various transitions. We should be able to apply what we have learned from these past market transition experiences to ease the implementation of these various changes that will start to take effect in 2004.

Therefore, I am requesting that the EIA analyze the potential market implications of the Senate-passed fuels provisions in H.R.4 combined with known and anticipated regulatory changes. This should include specific analysis of the following factors:

1. The expected volumetric shortfall in fuels supplies with an effective MTBE ban in 2004;
2. Actual renewable fuels production capacity, supply, and constraints and the effect on price;
3. Inter-regional transportation issues and associated costs for renewable fuels;

4. The potential effect of operating the mandate on a fiscal year, (i.e. beginning in October) vs. calendar year basis;
5. The environmental impact of the simultaneous implementation of the low sulfur and Mobile Source Air Toxic (MSAT) gasoline regulations and a national ethanol mandate;
6. The impact on gasoline price and supply when many additional ozone non-attainment areas come under the new 8-hour ozone standard;
7. The potential cost and supply impacts associated with individual states seeking to protect air quality through the removal of the one-pound vapor pressure waiver for gasoline blended with ethanol;
8. The potential effect/role of implementation of a national menu of fuels to address the proliferation of boutique fuels.

As earlier requests have noted, it would be helpful to have this study completed as soon as possible. Should you have any questions, regarding this request, please contact Jennifer Michael at the Committee, at (202)224-7143. I thank you in advance for your assistance.

Sincerely,

Jeff Bingaman
Chairman, Senate Committee on
Energy & Natural Resources

cc: file