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Exam Preview:

1. Wholesale biodiesel from virgin oils can cost up to four times more than conventional No. 2 diesel; biodiesel from recycled grease is less expensive but still costs considerably more than conventional diesel.
   a. True
   b. False
2. According to the reference material, In 1999, 87%of RFG contained MTBE, a number reduced to about __% in 2004, according to EPA.
   a. 39
   b. 46
   c. 53
   d. 87
3. According to the reference material, the American Jobs Creation Act provides a tax credit of up to $_____ per gallon for the sale and use of "agri-biodiesel" — biodiesel from virgin agricultural products.
   a. .75
   b. 1.00
   c. 1.50
   d. 1.75
4. According to the reference material, before amendment by the Energy Policy Act of 2005, the Clean Air Act required that RFG contain at least __% oxygen by weight.
   a. 1
   b. 1.5
   c. 2
   d. 3
5. According to the reference material, P.L. _____ stablishes a renewable fuels standard requiring the use of 7.5 billion gallons of renewable fuel in gasoline by 2012.

a. 105-98
b. 109-55
c. 109-58
d. 108-59

6. Because of lower production costs and the availability of government incentives, ethanol prices in Brazil and some other countries can be significantly lower than in the United States. To offset the U.S. tax incentive that all ethanol (imported or domestic) receives, most imports are subject to a tariff of $0.75 per gallon.
    a. True
    b. False
7. The Energy Policy Act of 1992 established mandatory alternative fuel vehicle purchase requirements for various vehicle fleets. Under the law, __% of the passenger vehicles purchased by federal and state vehicle fleets must be capable of operating on alternative fuels.
    a. 25
    b. 50
    c. 75
    d. 100
8. In the Energy Independence and Security Act of 2007 (P.L. 110-140), which raised fuel economy standards for the first time in several decades, Congress established the $50 billion Advanced Technology Vehicles Manufacturing program. It has supported technological development by automakers, including at Ford, Tesla, and Nissan plants.
    a. True
    b. False
9. According to the reference material, in the January 2003 State of the Union address, President ush announced the Hydrogen Fuel Initiative, which increased federal spending on hydrogen fuel and stationary fuel cell R&D. This initiative requested ___ billion dollars between 2004-2008 for the initiative.
    a. 1.1
    b. 1.3
    c. 1.5
    d. 1.8
10. The cost barriers for biodiesel production have generated interest in providing tax incentives for biodiesel, in the form of either a production tax credit or an excise tax exemption, or both.
    a. True
    b. False

Alternative Fuels and Advanced Technology Vehicles:

Summary

Alternative fuels and advanced technology vehicles are seen by proponents as integral to improving urban air quality, decreasing dependence on foreign oil, and reducing emissions of greenhouse gases. However, major barriers — especially economics — currently prevent the widespread use of these fuels and technologies. Because of these barriers, and the potential benefits, there is continued congressional interest in providing incentives and other support for their development and commercialization.

In the 109th Congress, alternative fuels and advanced technology vehicles have received a good deal of attention, especially in the debate over omnibus energy legislation. High fuel prices, especially in response to hurricanes along the Gulf Coast and high petroleum prices, have increased that attention. Major topics of congressional interest include tax incentives for alternative fuel production; the future of ethanol and the fuel additive MTBE, including the establishment of a renewable fuels standard (RFS); and research and development of hydrogen fuel and fuel cells. Other topics include government vehicle purchase requirements, tax credits for vehicle purchases, promotion of biodiesel fuel, and incentives for hybrid electric vehicles.

The Energy Policy Act of 2005 (P.L. 109-58, H.R. 6) contains many provisions relevant to alternative fuels and advanced technology vehicles. Among its provisions, the act expands existing tax incentives for the purchase of advanced vehicles, authorizes R&D funding for hydrogen fuel and fuel cells, and requires that the nationwide gasoline supply contain a minimum amount of ethanol or other renewable fuel. H.R. 6 was signed by President Bush on August 8, 2005.

In the fall of 2005, hurricanes along the Gulf Coast led to disruptions in refining capacity and oil supply, which then led to higher gasoline and diesel prices. Since then, some Members of Congress have been seeking ways to reduce the vulnerability of the fuel system. Several bills have been introduced to promote further development of alternative fuels and advanced technology vehicles or to mandate their sale and use. High crude oil and gasoline prices in spring and summer 2006 have further increased interest in moving away from a petroleum-based transportation system.

Some energy tax provisions, including tax credits for ethanol and biodiesel, were inserted into the conference report of the American Jobs Creation Act of 2004 (P.L. 108-357). Among other provisions, the law replaced an existing ethanol tax exemption with a tax credit and established tax credits for biodiesel.

This report replaces CRS Issue Brief IB10128, *Alternative Fuels and Advanced Technology Vehicles: Issues in Congress*, by Brent D. Yacobucci. It will be updated as events warrant.

Alternative Fuels and Advanced Technology Vehicles:

Introduction

High crude oil and gasoline prices since autumn 2005 have led to increased interest in the U.S. fuel supply. Recent congressional interest has focused on alternatives to petroleum, ways to improve the efficiency of the U.S. transportation sector, and ways to improve the stability and security of the petroleum supply and refining sectors.[1] High global oil prices (spurred by high demand), a transition from winter to summer gasoline, and the phase-out of the gasoline additive MTBE have pushed U.S. gasoline pump prices to historic highs.

Key components of federal policies to reduce fuel consumption include the promotion of alternatives to petroleum fuels and the promotion of more efficient vehicles. This report provides an overview of current issues surrounding alternative fuels[2] and advanced technology vehicles[3] — issues discussed in further detail in other CRS reports referred to in each section.

Most Recent Developments

Crude oil and gasoline prices have remained high since autumn 2005 due to hurricanes in the Gulf Coast, political instability in the Middle East, and a transition away from the gasoline additive MTBE.

On August 10, 2005, President Bush signed the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (P.L. 109-59, H.R. 3), which reauthorizes major highway and transit programs. Among other provisions, the act provides funding for alternative fuel transit buses and establishes a tax credit for the sale of alternative fuels.

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[1] For more information on petroleum supply and prices, see CRS Report RL32530, *World Oil Demand and its Effect on Oil Prices*, by Robert Pirog. For more information on legislative proposals to help mitigate high gasoline prices, see CRS Report RL33521, *Gasoline Prices: New Legislation and Proposals*, by Carl E. Behrens and Carol Glover.

[2] Alternative fuels are fuels produced from sources other than petroleum, including natural gas, coal-derived fuels, agriculture-based ethanol and biodiesel, and hydrogen.

[3] Advanced technology vehicles are vehicles that use technologies other than (or in addition to) an internal combustion engine, including electric vehicles, fuel cell vehicles, and hybrids.

On August 8, 2005, President Bush signed the Energy Policy Act of 2005 (P.L. 109-58, H.R. 6), an omnibus energy bill. The act contains provisions on renewable fuels, hydrogen R&D, and alternative fuel fleet requirements. Among other provisions, P.L. 109-58 establishes a renewable fuels standard requiring the use of 7.5 billion gallons of renewable fuel in gasoline by 2012. It also provides for MTBE cleanup, authorizes hydrogen R&D, and provides tax credits for the purchase of advanced vehicles.

Background and Analysis

Congressional Interest

Legislative Background. A combination of issues — the oil crises of the 1970s, the rise in awareness of environmental issues, concerns over energy security, increasing vehicle emissions, and high gasoline prices — spurred interest in moving the United States away from petroleum fuels for transportation and toward alternative fuels and advanced vehicle technologies.[4]

The Energy Policy Act of 1992. The 102nd Congress passed the Energy Policy Act of 1992 (EPAct 1992, P.L. 102-486). Among other provisions, this law requires the purchase of alternative fuel vehicles by federal agencies, state governments, and alternative fuel providers. Under EPAct 1992, a certain percentage — which varies by the type of fleet — of new passenger vehicles purchased for a federal or state agency or alternative fuel provider fleets must be capable of operating on alternative fuels, including ethanol, methanol, natural gas, or propane. EPAct 1992 established a tax credit for the purchase of electric vehicles, as well as tax deductions for the purchase of alternative fuel and hybrid vehicles.

The Energy Policy Act of 2005. There was little congressional action on energy policy through the late 1990s. In light of high fuel prices in the early 2000s, continued growth in domestic and global petroleum demand, and other energy policy concerns, Congress has been working on comprehensive energy legislation since 2001. In the 107th Congress, an energy bill stalled in conference. The 108th Congress continued the debate over energy legislation. The conference report (H.Rept. 108-375) included provisions on vehicle tax credits, amendments to vehicle purchase requirements under the Energy Policy Act of 1992, a requirement that gasoline contain ethanol or other renewable fuels, and tax credits for ethanol and biodiesel fuels. However, this bill also stalled. Many of these topics were addressed in the 109th Congress by the Energy Policy Act of 2005 (EPAct 2005, P.L. 109-58, H.R. 6), which was signed by President Bush on August 8, 2005.

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[4] For background on alternative fuels, including legislative history, see CRS Report RL30758, *Alternative Transportation Fuels and Vehicles: Energy, Environment, and Development Issues*, by Brent D. Yacobucci. For background on advanced vehicle technologies, see CRS Report RL30484, *Advanced Vehicle Technologies: Energy, Environment, and Development Issues*, by Brent D. Yacobucci.

Other Legislation. Other laws affecting alternative fuel and advanced technology vehicles include the Energy Policy and Conservation Act (P.L. 94-163), which established fuel economy standards for passenger cars and light trucks; the 1990 Amendments to the Clean Air Act (P.L. 101-549), which require cities with significant air quality problems to promote low emission vehicles; highway authorization bills, including P.L. 109-59 and P.L. 105-178, which established and reaffirmed tax incentives for ethanol and other fuels; and numerous laws that authorize federal research and development on alternative fuels, advanced technologies, and enabling infrastructure, such as alternative fuel pumps.

Current Issues. Recent events have renewed interest in alternative fuels and advanced vehicles. For example, high pump prices for gasoline and diesel fuel have raised concerns over fuel conservation and energy security, including U.S. dependency on oil imports. In light of this, there is growing interest in more efficient vehicles or vehicles that abandon the use of petroleum altogether. This is especially true as the rapid growth in the sales of light trucks — these include sport utility vehicles (SUVs), mini-vans, and pickups, which tend to have lower fuel economy than passenger cars — has lowered the overall fuel economy of the new vehicle fleet.

Furthermore, ongoing technological developments in hybrid vehicles, fuel cells, and hydrogen fuel have raised key policy questions. These questions include whether more generous tax incentives for hybrid and/or fuel cell vehicles should be established, the costs associated with production of hydrogen as a major transportation fuel, and whether research and development funds should be focused on such potentially high-risk technologies as fuel cells or on near-term, conventional technologies, such as hybrids.

Hurricanes along the Gulf Coast in the fall of 2005 led to fuel supply disruptions and high retail prices, raising congressional interest in alternatives to petroleum. In addition, in spring 2006, high crude prices, issues with refining capacity, and concerns about ethanol supply led to high pump prices, further raising concerns about the United States' ability to supply fuel to the transportation sector.

Fuel Tax Incentives

There are three key tax incentives for alternative fuels: (1) a tax credit for ethanol of $0.51 per gallon, (2) a tax credit for biodiesel of $1.00 per gallon ($0.50 for biodiesel made from recycled products), and (3) a credit of $0.50 per gallon for the retail sale of alternative fuels other than ethanol and biodiesel (e.g., LPG). In addition, there are tax credits for small ethanol and biodiesel producers ($0.10 per gallon).[5]

There is ongoing interest in tax incentives for the production and purchase of alternative fuels. Supporters of this approach argue that the market favors conventional fuels, and that the widespread infrastructure and nearly ubiquitous use of conventional fuels in automobiles makes it difficult for alternative fuels to

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[5] For more information on the ethanol tax incentives, see CRS Report RL32979, *Alcohol Fuels Tax Incentives*, by Salvatore Lazzari.

compete without economic incentives. The American Jobs Creation Act of 2004 (P.L. 108-357) replaced a previous excise tax exemption for ethanol-blended fuels with a tax credit of $0.51 per gallon. This credit will expire at the end of 2010.

In addition to the credit for ethanol-blended gasoline, there has been interest in promoting biodiesel fuel. P.L. 108-357 provides a tax credit of $1.00 per gallon for the sale and use of "agri-biodiesel" — biodiesel produced from virgin agricultural products such as soybean or canola oil. There is a smaller credit of $0.50 per gallon for biodiesel produced from recycled grease. Under P.L. 108-357 the biodiesel credit would have expired at the end of 2006, four years before the expiration of the ethanol credit; the Energy Policy Act of 2005 (P.L. 109-58) extends the biodiesel tax credit through 2008.

Ethanol and MTBE

Outside of tax incentives, ethanol has been of key interest in recent Congresses, especially in its role as an alternative to MTBE (methyl tertiary butyl ether).[6] MTBE and ethanol were used (among other purposes) to meet Clean Air Act requirements that reformulated gasoline (RFG), sold in the nation's worst ozone nonattainment areas, contain at least 2% oxygen (by weight), to improve combustion. Under the RFG program, areas with "severe" or "extreme" ozone pollution (90 counties with a combined population of 64.8 million) must use reformulated gas; areas with less severe ozone pollution may opt into the program as well, and many have. In all, portions of 17 states and the District of Columbia use RFG, and about 30% of the gasoline sold in the United States is RFG, according to the Environmental Protection Agency (EPA).[7]

Before amendment by the Energy Policy Act of 2005, the Clean Air Act required that RFG contain at least 2% oxygen by weight.[8] Refiners met this requirement by adding a number of ethers or alcohols, any of which contains oxygen and other elements. Until recently, the most commonly used oxygenate was MTBE because it was cheaper and easier to use than competing oxygenates. In 1999, 87% of RFG contained MTBE, a number reduced to about 46% in 2004, according to EPA. MTBE has also been used since the late 1970s in non-reformulated gasoline as an octane enhancer, at lower concentrations. As a result, gasoline with MTBE has been used throughout the United States, whether or not an area has been subject to RFG requirements.

MTBE contamination creates taste and odor problems in water at very low concentrations, and some animal studies indicate MTBE may pose a cancer risk to

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[6] For additional background on the MTBE issue, see CRS Report RL32787, *MTBE in Gasoline: Clean Air and Drinking Water Issues*, by James E. McCarthy and Mary Tiemann. For information on ethanol, see CRS Report RL33290, *Fuel Ethanol: Background and Public Policy Issues*, by Brent D. Yacobucci.

[7] U.S. Environmental Protection Agency (EPA), Office of Transportation Air Quality (OTAQ), *Staff White Paper: Study of Unique Gasoline Blends ("Boutique Fuels"), Effects on Fuel Supply and Distribution and Potential Improvements*, October 2001.

[8] In the case of MTBE, this equates to roughly 11% by volume.

humans. MTBE leaks, generally from underground gasoline storage tanks, have been implicated in numerous incidents of ground water contamination. For these reasons, 25 states have taken steps to ban or limit its use, according to the Renewable Fuels Association.[9] The most significant of the bans (in California and New York) took effect at the end of 2003, leading many to suggest that Congress revisit the issue to modify the oxygenate requirement and set more uniform national requirements regarding MTBE and its potential replacements, principally ethanol.

Support for eliminating the oxygenate requirement on a nationwide basis was widespread among states, the petroleum industry, and some environmental groups. In general, these stakeholders concluded that gasoline can meet the same low-emission performance standards as RFG without the use of oxygenates. But agricultural interests presented a potential obstacle to enacting legislation to remove the oxygen requirement. According to the U.S. Department of Agriculture, roughly 20% of the nation's corn crop is used to produce the competing oxygenate, ethanol.[10] If MTBE use were reduced or phased out, but the oxygen requirement remained in effect, ethanol use would have soared, increasing demand for corn. Conversely, if the oxygen requirement were repealed, not only would MTBE use decline, but so, likely, would demand for ethanol. Thus, some Members of Congress and governors from corn-growing states took a keen interest in MTBE legislation and related oxygenate requirements.

To help promote the market for ethanol if the oxygen standard were eliminated, a renewable fuels standard (RFS) was suggested. This would require that all gasoline contain ethanol or other renewable fuel. This concept was supported by agricultural interests, the oil industry, and some environmental groups. Opponents included states that do not produce ethanol, due to fears that the mandate could raise gasoline prices.

The Energy Policy Act of 2005 (P.L. 109-58) contains numerous MTBE and ethanol provisions. It repeals the Clean Air Act requirement to use MTBE or other oxygenates. In place of this requirement, the law establishes a renewable fuels standard. Under the RFS, annual gasoline supply is required to contain 7.5 billion gallons of ethanol or other renewable fuel by 2012. To prevent "backsliding" on air quality, the law requires that reductions in emissions of toxic substances achieved by RFG be maintained, and it authorizes funds for MTBE cleanup.[11]

Issues in the Spring/Summer of 2006: MTBE Phase-Out and Ethanol Supply. As a result of P.L. 109-58, the oxygen requirement for RFG was eliminated on May 6, 2006. This requirement — which gasoline suppliers asserted

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[9] Renewable Fuels Association, "New Jersey Bans MTBE," *Ethanol Report*, Issue #226, July 15, 2005.

[10] U.S. Department of Agriculture, Economic Research Service, *Feed Outlook*, June 13, 2006.

[11] For a detailed comparison of the renewable fuels legislation, see CRS Report RL32865, *Renewable Fuels and MTBE: A Comparison of Selected Provisions in the Energy Policy Act of 2005 (H.R. 6)*, by Brent D. Yacobucci, Mary Tiemann, James E. McCarthy, and Aaron M. Flynn.

was a de facto mandate to use MTBE — was cited by gasoline suppliers as a defense against liability for MTBE contamination. Therefore, although P.L. 109-58 actually gives the industry more flexibility, the industry moved quickly to eliminate MTBE from the gasoline supply in spring 2006. Because MTBE accounted for 11% of the volume of RFG in areas it was used, the elimination of MTBE increased pressure on already tight refining capacity. The loss in volume and energy from eliminating MTBE increased demand for gasoline as well as ethanol. Exacerbating the problem was the fact that the industry was making the transition from winter gasoline to more stringent summertime specifications, which adds competition for the highest-quality gasoline components. These pressures, along with historically high crude oil prices, have led to historically high gasoline prices. Further, some localized areas (e.g., Norfolk, VA) faced short-term supply disruptions as refineries made the transition.

Ethanol Imports

Corn growers and ethanol producers are supportive of the renewable fuels standard because of its implications for higher corn and ethanol prices. However, concern over ethanol imports is growing among some stakeholders. Because of lower production costs and the availability of government incentives, ethanol prices in Brazil and some other countries can be significantly lower than in the United States. To offset the U.S. tax incentive that all ethanol (imported or domestic) receives, most imports are subject to a tariff of $0.54 per gallon. This tariff effectively negates the tax incentive for covered imports and has been a significant barrier to fuel ethanol imports.

However, under certain conditions imports of ethanol from Caribbean Basin Initiative (CBI) countries are granted duty-free status.[12] This is true even if the ethanol was produced in a non-CBI country. In this scenario, the ethanol is produced in another country (historically Brazil or a European country), dehydrated in a CBI country, then shipped to the United States. This avenue for imported ethanol to avoid the tariff has been criticized by some stakeholders, including some Members of Congress. In the spring and summer of 2004, two companies announced plans to construct new dehydration facilities in CBI countries and to process ethanol from Brazil. With the establishment of a renewable fuel standard, as well as high U.S. gasoline and ethanol prices, there may be more interest in importing ethanol, either through CBI countries or directly from ethanol producers.

Vehicle Purchase Requirements

The Energy Policy Act of 1992 established mandatory alternative fuel vehicle purchase requirements for various vehicle fleets.[13] Under the law, 75% of the passenger vehicles purchased by federal and state vehicle fleets must be capable of

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[12] For more information on ethanol imports from CBI countries, see CRS Report RS21930, *Ethanol Imports and the Caribbean Basin Initiative*, by Brent D. Yacobucci.

[13] For purposes of compliance with EPAct 1992, a vehicle fleet is all of the passenger vehicles operated by an agency or company.

operating on alternative fuels; 90% of the vehicles purchased by alternative fuel providers[14] must be alternative fuel vehicles.[15]

The alternative fuel vehicle provisions of EPAct have been criticized as ineffective because, while EPAct requires the purchase of vehicles, it did not mandate the use of alternative fuels. In most cases, the vehicles purchased to meet the requirement are dual-fuel vehicles (i.e., they can operate on either a conventional fuel or an alternative fuel). Those vehicles are primarily fueled using gasoline, because gasoline tends to be less expensive and more widely available than alternative fuels since the infrastructure to provide alternative fuels is limited compared with the existing infrastructure for gasoline and diesel fuel.

In addition, despite the vehicle purchase mandate, many agencies have failed to meet their statutory obligation. As a result, in 2002 the Center for Biological Diversity filed a lawsuit with the U.S. District Court for the Northern District of California. In July 2002, the court ruled that several federal agencies failed to meet their quotas and ordered those agencies to prepare reports on their compliance with EPAct, which those agencies have completed.[16]

The Energy Policy Act of 2005 (Section 701) modified the requirements for EPAct 1992 compliance. All dual-fuel vehicles purchased to meet the EPAct quotas are required to operate on alternative fuels, unless an agency is granted a waiver by the Secretary of Energy. In addition, the Secretary of Energy is required to conduct a study of the effectiveness of the EPAct requirements.

In addition to the requirements for federal, state, and fuel provider fleets, EPAct grants the Department of Energy (DOE) the authority to extend the requirements to local government and private fleets. However, as of 2002, DOE had not made a determination on requirements for local and private fleets. As part of the above lawsuit, the Center for Biological Diversity also asked the court to force DOE to promulgate new rules. In ruling on the above case, the U.S. District Court for the Northern District of California ordered DOE to establish a timeline for a new rulemaking. DOE compiled a timeline and, on March 4, 2003, it issued a rulemaking determining that such a program would not promote the goals of EPAct, neither reducing dependence on foreign oil nor leading to greater use of alternative fuel vehicles (68 *Federal Register* 10319).

Vehicle Purchase Tax Incentives

Some supporters of alternative fuel and advanced technology vehicles argue that tax incentives for the purchase of vehicles and fuels are more effective than any purchase mandate. In addition to the mandatory purchase requirements, EPAct 1992

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[14] Alternative fuel providers are businesses that sell or distribute alternative fuels.

[15] For more information on vehicle purchase requirements, see CRS Report RL30758, *Alternative Transportation Fuels and Vehicles: Energy, Environment, and Development Issues*, by Brent D. Yacobucci.

[16] *Center for Biological Diversity v. Abraham, N.D. Cal., No. CV-00027.*

established tax incentives for the purchase of electric vehicles and "clean-fuel vehicles," including alternative fuel and hybrid vehicles. The Energy Policy Act of 2005 (Section 1341) significantly expands and extends the vehicle purchase incentives, establishing tax credits for the purchase of fuel cell, hybrid, alternative fuel, and advanced diesel vehicles. For passenger vehicles, the credit is worth as much as $3,400 for hybrids and advanced diesels, and as much as $4,000 for alternative fuel vehicles, depending on vehicle attributes. The expiration date for the incentives also varies depending on the technology. In the case of hybrid and advanced diesel vehicles, the number of vehicles eligible for the credits is limited for each vehicle manufacturer.[17]

Biodiesel

Biodiesel is a synthetic diesel fuel produced from oils, including soybean and canola oils, animal fats, and recycled cooking grease.[18] It can be blended with conventional diesel fuel and used in diesel engines with few or no modifications. Further, with some engine modifications, it can be used in a nearly pure form. Because biodiesel can displace conventional diesel without the use of new (and in many cases costly) vehicles, there is growing interest in its use. Further, because it can be produced from agricultural products, farmers (especially soybean and canola farmers) and some environmentalists have a keen interest in its development as a way to promote rural economies, reduce agricultural wastes, and limit greenhouse gas emissions. However, biodiesel production is currently expensive: wholesale biodiesel from virgin oils can cost up to two times more than conventional No. 2 diesel; biodiesel from recycled grease is less expensive but still costs considerably more than conventional diesel.

The cost barriers for biodiesel production have generated interest in providing tax incentives for biodiesel, in the form of either a production tax credit or an excise tax exemption, or both. Further there is interest in developing new technologies to help reduce production costs. However, the organic oils used as raw materials are one of the largest costs in production. Therefore, to significantly reduce biodiesel production costs, the costs of soybean oil and other oils would need to decrease substantially.

As was stated above, the American Jobs Creation Act provides a tax credit of up to $1.00 per gallon for the sale and use of "agri-biodiesel" — biodiesel from virgin agricultural products. The credit is $0.50 per gallon for biodiesel from recycled grease. In addition, the law provides an excise tax credit for biodiesel blends (i.e. biodiesel and conventional diesel). Producers are eligible for one credit or the other, but not both (see "Fuel Tax Incentives," above). These credits were set to expire at the end of 2006; the Energy Policy Act of 2005 (P.L. 109-58) extends

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[17] For more information on vehicle tax incentives, see CRS Report RS22351, *Tax Incentives for Alternative Fuel and Advanced Technology Vehicles*, by Brent D. Yacobucci.

[18] For more information on biodiesel, see CRS Report RL32712, *Agriculture-Based Renewable Energy Production*, by Randy Schnepf, and CRS Report RL30758, *Alternative Transportation Fuels and Vehicles: Energy, Environment, and Development Issues*, by Brent D. Yacobucci.

these credits through 2008. Further, EPAct 2005 established a credit of $0.10 per gallon for small agri-biodiesel producers.

Hydrogen and Fuel Cells

Over the past few years, interest has grown substantially in hydrogen fuel and fuel cells.[19] Hydrogen fuel can be produced using any energy source, and has thus been touted as a way to limit dependence on energy imports. Further, when hydrogen is used in a fuel cell (a device that produces electricity by converting hydrogen to water), mostly heat and water are produced, drastically reducing or eliminating vehicle emissions. However, hydrogen fuel production is currently very expensive, as are fuel cells. In addition, depending on the original fuel source, overall fuel-cycle emissions can be a key concern.[20]

Because of the potential benefits from hydrogen and fuel cells, and because of the existing technical and cost barriers to their commercialization, the Bush Administration has strongly supported research and development (R&D). In January 2002, the Administration announced the FreedomCAR initiative, which promotes cooperative R&D between the "Big Three" American auto manufacturers (DaimlerChrysler, Ford, and General Motors) and the federal government. While the partnership is conducting research on many technologies, hydrogen and fuel cell vehicles are a key focus. Further, in his January 2003 State of the Union address, President Bush announced the Hydrogen Fuel Initiative, which increased federal spending on hydrogen fuel and stationary fuel cell R&D. Overall, the President is requesting $1.8 billion between FY2004 and FY2008 for both initiatives, including a $720 million increase in funding from earlier appropriations.[21]

Opponents of the initiatives argue that hydrogen fuel and fuel cells may never be commercialized and that the initiatives draw funding away from near-term technologies such as hybrid vehicles. Further, some argue that research and development alone will not reduce petroleum dependence and that Congress should instead consider tightening fuel economy standards for all vehicles.

Congress agreed to increase funding for hydrogen and fuel cell research from $185 million in FY2003 to $231 million in FY2004, $254 million in FY2005, and $258 million in FY2006. The Energy Policy Act of 2005 authorizes a total of $3.3 billion through FY2010 for fuel cell and hydrogen R&D.

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[19] For background information on hydrogen and fuel cells, see CRS Report RL32196, *A Hydrogen Economy and Fuel Cells: An Overview*, by Brent D. Yacobucci and Aimee E. Curtright.

[20] For example, depending on the technology used, processing coal into hydrogen could lead to significantly higher emissions of toxic compounds and carbon dioxide.

[21] For more information on the Administration's initiatives, see CRS Report RS21442, *Hydrogen and Fuel Cell Vehicle R&D: FreedomCAR and the President's Hydrogen Fuel Initiative*, by Brent D. Yacobucci.

Hybrid Vehicles

Hybrid gasoline/electric (and diesel/electric) vehicles are becoming increasingly popular in the United States. Hybrids combine a gasoline (or diesel) engine with an electrical motor system to improve efficiency.[22] If their use becomes more widespread, they could help improve the overall efficiency of the vehicle fleet and could help limit oil consumption. Further, they could do so without significant changes to existing infrastructure, which has been a key barrier to the expanded use of alternative fuel vehicles. By the end of 2006, Ford, DaimlerChrysler, General Motors, Honda, Nissan, and Toyota will offer vehicles with hybrid powertrains. At the present time, only hybrid passenger cars, SUVs, and pickups are available in the United States, but hybrid versions of other vehicle models and classes are expected in the near future.

Because of their energy and environmental benefits, some states have provided drivers of hybrid vehicles an exemption from high occupancy vehicle (HOV) lane requirements. Under TEA-21 (which expired on September 30, 2003), states had the authority to grant HOV exemptions for so-called "Inherently Low Emission Vehicles" (ILEVs). The ILEV standard requires that a vehicle have no evaporative emissions, a standard that is not met by any current hybrid. However, because of the reduced emissions and improved fuel economy of hybrid vehicles, there has been congressional interest in explicitly granting states the right to exempt them from HOV lane requirements. While not addressing hybrids directly, the final version of the highway reauthorization act (P.L. 109-59) permits states to exempt certain high-efficiency vehicles from HOV restrictions.

Further, as was stated above, the Energy Policy Act of 2005 expanded the incentives for the purchase of hybrid vehicles (see "Vehicle Purchase Tax Incentives," above).

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[22] For more information on hybrid vehicles, see CRS Report RL30484, *Advanced Vehicle Technologies: Energy, Environment, and Development Issues*, by Brent D. Yacobucci.

Electrification May Disrupt the Automotive Supply Chain

The global market for vehicle electrification is expanding. In 2018, more than 1.7 million plug-in and battery electric vehicles were sold worldwide, a nearly 40% increase over 2017. These account for about 2% of all passenger vehicle sales, both worldwide and in the United States. Demand for electric vehicles is expected to continue to grow, as some industrial countries have called for a complete shift away from sales of new fossil-fuel-powered vehicles by 2030. The shift to electric vehicles and away from internal combustion engines is likely to have significant consequences for the U.S. automobile assembly and parts manufacturing industries. A widespread shift to electric vehicles has the potential to eliminate large numbers of jobs in vehicle and parts production, even if the vehicles are assembled in the United States. Congress may wish to explore these possible economic impacts and consider steps to mitigate them.

The EV Market

Electric vehicles come in two basic varieties. Plug-in hybrids use both an electric motor and an internal combustion engine; battery electric vehicles use only batteries. Both draw electricity from an external source.

The first contemporary electric vehicle models came to market in 2010, but demand grew slowly: 157,000 were sold in the United States in 2016. Sales were limited due both to price—battery-powered vehicles cost far more than gasoline-powered vehicles of similar size—and to car buyers' concerns about "range," the distance a vehicle can travel between battery charges. However, the costs of producing electric vehicles appear to be falling as manufacturers achieve greater scale, and networks of high-speed charging stations are being installed in a number of U.S. urban areas and along major Interstate Highway corridors to allay drivers' fear of running out of power. Recent actions by several auto manufacturers indicate they believe electric vehicles are becoming a mainstream product.

Now, nearly all global automakers manufacture both plug-in hybrid and battery electric vehicles. McKinsey, a business consulting firm, forecasts global production of 3.5 million battery electric vehicles in 2020 and 14.8 million by 2025. China leads in both electric vehicle production and sales. Of the 42 different electric vehicle models sold in the United States in 2018, 10 were made at seven U.S. plants. U.S. sales of electric vehicles rose by 80% from 2017 to 2018, led by Tesla and Toyota. More than one million plug-in hybrid and battery electric vehicles are now on U.S. roads.

At the time of its November 2018 announcement that it may shutter five assembly plants, General Motors (GM) said that it would introduce 20 new battery electric vehicles by 2023. Ford has indicated that it is doubling its investment in electrification and plans to produce 16 fully electric vehicles by 2022. Volkswagen Group has announced plans to build electric vehicles in Tennessee starting in 2022.

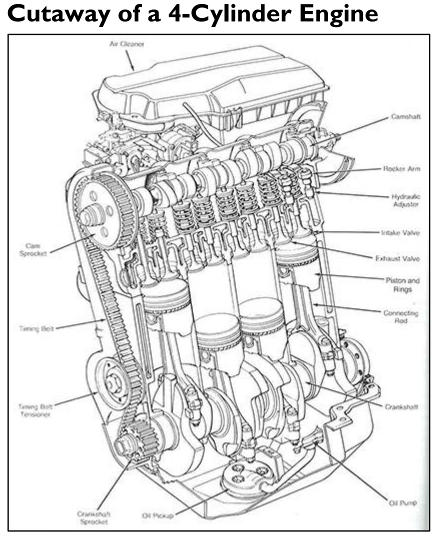
The Powertrain Difference

The powertrain, the system that propels the vehicle, is significantly different in conventional and electric vehicles. As a result, production of an electric vehicle is likely to require far less labor than production of a similar vehicle with either a gasoline or diesel engine.

In a conventional vehicle, the powertrain includes the engine, the drivetrain—the components and system that provide power to the wheels—as well as other associated components, such as the transmission, engine cooling and exhaust systems, and emissions control. Most passenger vehicles on the road today have an internal combustion engine, fueled by gasoline or diesel.

It has been estimated that the powertrain adds more value to a vehicle than any of its other systems. The engine and transmission are two of the most complex components in a gasoline-powered vehicle. A cutaway of a passenger car engine illustrates the many parts that are manufactured for this part of the powertrain (**Figure 1**). Most of these parts are made of metals that can withstand temperatures of 2,000 degrees Fahrenheit generated through internal combustion.

Figure 1. Cutaway of a 4-Cylinder Engine



Source: John B. Heywood, "Engine Types and Their Operation," in *Internal Combustion Fundamentals*, 2nd ed. (New York: McGraw Hill Education, 2018), p. 12. With permission of the publisher.

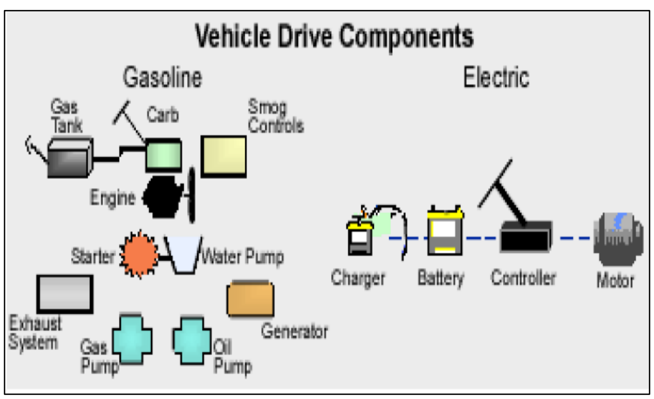
The powertrain is an essential feature because it is responsible for vehicle performance—getting driver and passengers to their destinations—and also differentiates vehicles. For example, the large engine in a Chevrolet Corvette gives the vehicle much different speed and acceleration than the smaller engine typically installed in a Chevrolet Sonic. Powertrain components are manufactured by the large automakers as well as supplier firms, usually in plants separate from those that assemble cars and trucks. The production facilities are generally located near the major assembly plants in the Midwest and South.

Ernst & Young has estimated that vehicles with conventional powertrains have as many as 2,000 components in their powertrains. That number rises when parts used for engine cooling and exhaust and sensors used in emissions control systems are considered. Of the nearly 590,000 U.S. employees engaged in motor vehicle parts manufacturing, about one-quarter—nearly 150,000—make components for internal combustion powertrains.

Electric vehicle powertrains differ substantially from those in conventional vehicles. Instead of the hundreds of moving parts built into a conventional powertrain, an electric vehicle powertrain has only a few. For example, Tesla has said its drivetrain has 17 moving parts, including two in the motor.

The other powertrain parts in a battery-powered vehicle are a very large lithium ion battery pack, which supplies the energy to run the vehicle; a controller that governs speed and acceleration and keeps batteries from overheating; and a converter that distributes power to accessories such as windshield wipers. Software is also a key component in managing battery cooling and connecting the power source to vehicle applications. No emissions are generated, so all-electric vehicles do not have exhaust systems, mufflers, catalytic converters and tailpipes (**Figure 2**). Electric vehicle powertrains are also cheaper to maintain and, unlike many internal combustion engines that may deteriorate over time, electric vehicle motors may have lower maintenance costs.

Figure 2. Comparison of Gasoline and Electric Powertrains



Source: Idaho National Laboratory, *How Do Gasoline & Electric Vehicles Compare?*, https://avt.inl.gov/sites/default/files/pdf/fsev/compare.pdf.

Should electric powertrains displace those used by gasoline over the next decade and beyond, it is likely that both production and engineering jobs will be affected. Electric vehicle powertrains, if built domestically and not imported, would generate production employment, but fewer employees may be needed than at present because vehicle battery packs have relatively few components and are less complicated to assemble than internal combustion engine powertrains. Electric vehicles utilize a large number of electronic sensors, but these devices require little labor to produce and assemble.

Much of the mechanical and materials engineering work undertaken by automobile and parts manufacturers could be replaced by jobs requiring different skillsets such as chemical, battery, and software engineering or by imports of lithium ion batteries. Few U.S. universities offer degrees in battery engineering, a skill set that is in short supply even today.

U.S. Policy Choices

Congress may address through hearings and legislation the supply-chain transition from internal combustion engines to electric batteries and motors. Congress has in the past demonstrated a strong interest in encouraging the domestic development and production of advanced technology vehicles, including electric and hybrid passenger cars. Recent precedents include the following:

- In the Energy Independence and Security Act of 2007 (P.L. 110-140), which raised fuel economy standards for the first time in several decades, Congress established the $25 billion Advanced Technology Vehicles Manufacturing program. It has supported technological development by automakers, including at Ford, Tesla, and Nissan plants. The $16 billion remaining authority could be focused on converting internal combustion engine capacity to electric vehicle capacity.

- The American Recovery and Reinvestment Act of 2009 (P.L. 111-5) provided grants of $2.4 billion to support the establishment of U.S. lithium-ion battery manufacturing facilities. These grants anticipated a more rapid acceptance of electric vehicles, and the capacity they envisioned has not been fully utilized. Similar investments today may find wider applicability.

Congress could address changing skills needs through the existing Workforce Innovation and Opportunity Act (P.L. 113-128), which makes grants to the states to identify workforce needs at the local level. Workers who today manufacture parts for gasoline or diesel engines could be retrained to make parts for electric vehicle motors and the lithium-ion batteries that power them, although there may be significantly fewer such jobs than exist in automotive supply chains today.

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