Commission Briefing Paper 4C-02

Implications of Potential Petroleum Scarcity on Surface Transportation in the Short and Long Term

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper examines the potential implications of scarcity of petroleum on surface transportation. Impact areas include consumers' vehicle purchase decisions, trends in manufacturing and trucking industries' technology deployment and practices, as well as market penetration of alternative fuels.

Background and Key Findings

About 95 percent of the transportation sector's energy source is petroleum. Transportation accounts for about 65 percent of U.S. crude oil consumption and gasoline accounts for about 67 percent of the total crude oil used for transportation. Given the transportation sector's high dependence on petroleum, this sector may be strongly affected by scarcity of petroleum both in the short and long term. The on-going changes in demand and supply of oil impact the general motoring public, the vehicle manufacturing industry, and the trucking industry in different ways. These impacts are reflected in both behavioral and financial trends. These include technology advancements in the vehicle manufacturing industry, consumer choice in vehicle purchase and fuel types, and driving habits and patterns. The following are some key findings.

- Consumers tend to shift to smaller and more fuel efficient vehicles during periods of sustained high oil prices. Sales of Honda Civics grew 37 percent between 2005 and 2006. During the same period, Honda reported a 25-percent sales increase in the gasoline-electric hybrid version of the Civic. Sales of hybrids[1] are projected to reach 2 million per year by 2030, accounting for about 10 percent of light vehicle sales. Increasing fuel prices were quoted as a major contributing factor to declining sales of heavy-duty trucks.

- The motor vehicle manufacturing industries increasingly deploy advanced technologies to improve fuel and performance efficiency (e.g., hybrids, valve lift, electrically driven power steering pumps, and advanced electronic transmission control).

[1] http://www.eia.doe.gov/oiaf/aeo/pdf/earlyrelease.pdf

- Average annual vehicle miles traveled (VMT) generally do not fluctuate with crude oil price changes based on data between 1975 and 2005. However, travel demand for light-duty vehicles is expected to grow at a reduced rate of 1.9 percent per year (down from 3 percent in the last 20 years) through 2030 due to high energy prices.[2]

- Alternative fuels and biofuel consumption have increased in volume and share over the past several years, and there is momentum for some continued growth. Alternative fuels were projected to displace 207,000 barrels of oil equivalent per day in 2010 and 280,500 barrels per day in 2025, in response to current (i.e., assuming no new incentives or programs are enacted) environmental and energy legislation intended to reduce oil use.[3]

- The U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) have initiated studies develop technologies to reduce diesel truck engine idle in order to reduce emissions and fuel consumption from long-haul trucks at truck stops.

- Urban buses use the same engine types as heavy duty trucks, and they have tested and implemented a variety of alternative fuels and hybrid-electric configurations. (One quarter of current bus sales are for CNG buses, for example, and hybrid electric bus sales are rising.) Since urban bus engines represent at most 3 percent of heavy duty engine sales, there is significant potential for fuel economy gains from existing technology in the trucking sector.

Transportation Energy

Transportation uses over a quarter of the energy in the U.S., which is the second highest amount after industrial sector. While the other sectors use a mix of at least three primary energy sources, about 95 percent of the transportation sector's energy source is petroleum.[4] According to estimates by the Energy Information Administration (EIA), energy demand for transportation was projected to grow from 27.1 quadrillion British Thermal Units (BTU) in 2003 to 40.4 quadrillion BTU in 2025. Motor gasoline use was also projected to increase by 1.7 percent per year from 2003 to 2025. During the same period, the U.S. population and gross domestic product (GDP) are projected to increase at an annual rate of 0.8% and 3% respectively. An assessment of the world energy[5] indicates that oil demand for transport increases linearly with GDP at a rate similar to the population growth rate. Based on this relationship and assuming an annual rate of increase of 0.8% (i.e., projected population growth rate), the estimated transportation energy demand would be about 50 BTU by 2050.

Alternative fuels were projected to displace 207,000 barrels of oil equivalent in 2010 and 280,500 barrels per day in 2025, in response to current environmental and energy legislation intended to reduce oil use.[6]

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[2] http://www.eia.doe.gov/oiaf/aeo/pdf/earlyrelease.pdf -- - *Annual Energy Outlook 2007 (AEO2007)* Overview.
[3] http://www.eia.doe.gov/oiaf/aeo/demand.html
[4] http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/demand_text.htm #Measuring%20Oil%20Consumption
[5] World Energy Outlook: Energy and CO_2 Emissions Trends in the Transport Sector. Cozzi., L. 2005,
[6] http://www.eia.doe.gov/oiaf/aeo/demand.html

EIA estimates that after 2015, real prices of world crude oil will begin to rise as demand continues to grow and higher cost supplies are brought to market. In 2030, the average real price of crude oil is projected to be above $59 per barrel in 2005 dollars, or about $95 per barrel in nominal dollars.[7] According to U.S. DOE 1997 estimates, conventional oil reserves total about 1 trillion (10^7) barrels. At a world annual consumption rate of about 27 billion barrels per year, the reserve to production ratio was estimated to be 37 years, i.e., about 27 years from 2007. U.S. oil imports are projected to reach about 65 percent of supply by 2020.[8]

Impact Areas

The potential impacts of scarcity of petroleum on surface transportation are discussed under impact areas that are directly affected by petroleum prices. The discussions are based on analysis of information and data from previous studies that link oil price to various vehicle fleet characteristics.

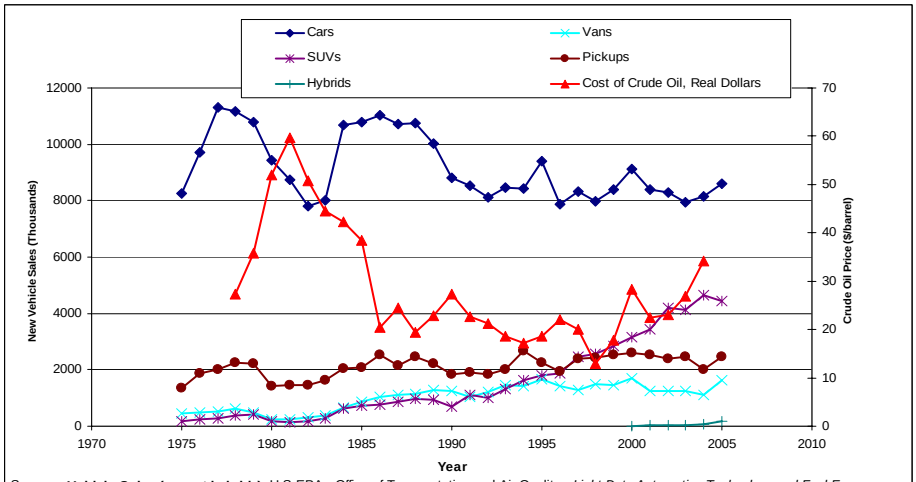
Vehicle sales

Consumers' choice of vehicles is influenced by several attributes including the price of petroleum. Figure 1 illustrates the pattern of light vehicle sales over the last 30 years between 1975 and 2005, and Figure 2 shows the trend for medium and heavy vehicles for the same period. There is some correlation with oil prices, but generally there was a lag time between the time that oil prices peaked and the time that the numbers of vehicles sold reached a low. For example, in 1981 the real price of crude oil peaked at $59.60 per barrel, but passenger car sales did not reach a low of 7,007,000 sales until 1982.[9]

It is also noted in Figure 1 that sport utility vehicle (SUV) sales increased sharply after 1990. Between 1990 and 2004, the market share of SUV sales rose from 6% to 29%. During the same period the market share of passenger car sales declined from 66% to 47%. This can be explained in part by the fact that SUVs had a lower CAFÉ standard than passenger cars, so the higher-profit margin SUV could be sold with many power options that could not be introduced in passenger cars without affecting their CAFÉ compliance. The decline in SUV sales for model year 2005 seems to suggest that consumers are becoming more sensitive to the impacts of low fuel efficiency of SUVs and the high price of fuel in 2004 and 2005 on their driving costs.

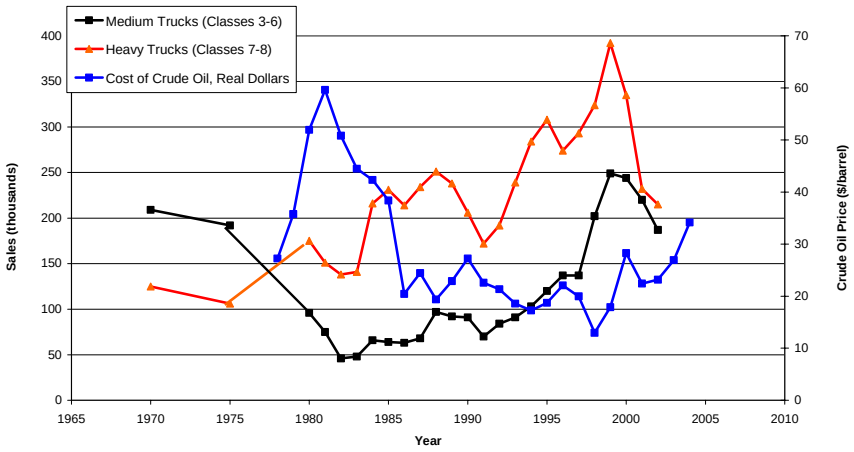
A recent news article[10] reported that spiking gasoline prices stalled light truck sales in September 2005 as consumers shifted toward more fuel-efficient vehicles. According to the article, General Motors Corporation reported a sales drop of 24 percent compared with the same month a year

[7] Annual Energy Outlook 2007 Overview. Energy Information Administration.
[8] U.S. Department of Energy (DOE). Annual Energy Review 1997. DOE/EIA-0384(97). U.S. DOE Energy Information Administration. Washington DC 1998.
[9] This lag in purchaser effect may be due in part to the proportion of petroleum-based automobile components, which also rise in price as the cost of oil increases. This cost increase is delayed by the manufacturing process itself.
[10] Columbus Dispatch, "Climbing gas prices hammer SUV, truck sales. Tuesday October 04, 2005



Sources: **Vehicle Sales (except hybrids):** U.S.EPA. Office of Transportation and Air Quality. *Light Duty Automotive Technology and Fuel Economy Trends: 1975 through 2005.* Appendix E. July 2005. Available: http://www.epa.gov/otaq/fetrends.htm
Hybrid Vehicle Sales: Electric Drive Transportation Association. "Hybrid Vehicle Sales Information." Available: http://www.electricdrive.org/index.php?tg=articles&idx=Print&topics=7&article=692
Crude Oil: USDOE, EIA, Petroleum Marketing Monthly, August 2005, Washington DC, Table 1.
Note: 2005 hybrid vehicle sales projected based on rate of sales from January -June 2005. Real Dollars in chained (2000) dollars, calculated by using gross domestic product implicit price deflators from Table D1 of Annual Energy Review.

Figure 1 – U.S. New Vehicle Sales (Light Vehicles)



Sources: **Truck Sales:** Davis, Stacy C. U.S. Department of Energy, Center for Transportation Analysis, Oak Ridge National Laboratory. Transportation Energy Data Book. Edition 24. Table 5.3: New Retail Truck Sales by Gross Vehicle Weight.
Crude Oil: US Department of Energy, Energy Information Administration, Petroleum Marketing Monthly, August 2005, Washington DC, Table 1.
Note: Real Dollars in chained (2000) dollars, calculated by using gross domestic product implicit price deflators from Table D1 of Annual Energy Review.
Notes: Truck Sales data from 1970 is based on new truck registrations. Truck sales data up to and including 1985 are only for domestic sales and import data are not available. Truck sales from 1986 and later include domestic and import sales.

Figure 2 – U.S. New Vehicle Sales (Medium and Heavy Trucks)

ago. Overall sales of trucks, minivans, and SUVs dropped 30 percent. Ford Motor Company's sales declined 20 percent. Sales of Ford's large SUVs including Ford Explorer and Expedition and Lincoln Navigator declined by more than 55 percent each. The big Japanese automakers reported strong U.S. sales in September 2005 with most posting increases of 10 to 12 percent

from the same month in 2004 as consumers shifted to Japanese brand passenger cars and smaller trucks – a market shift that repeated the first such shift during the oil crisis of 1973-75. It was also noted that consumers are buying the few hybrid cars on the market as well as smaller cars and smaller SUVs from import companies. Sales of the Honda Civic grew 37 percent from a year ago. Honda reported a 25 percent sales increase in the gasoline-electric hybrid version of the Civic. Sales of the hybrid Toyota Prius nearly doubled, to 8,193 for the month of September 2005. Currently, hybrids account for only 1 percent of U.S. automobile sales. It is estimated that hybrids will triple or even quadruple their share of the automobile sales over the next 3 years. It is predicted that hybrids will account for 3 percent of the light vehicle share by 2008.

According to a compilation of survey data by the National Renewable Energy Laboratory (NREL)[11] on consumer preferences when purchasing a new vehicle and the relationship to fuel prices, among the attributes that consumers indicated were most important to them when choosing their next vehicle, fuel economy tends to have higher responses when oil prices are higher, such as in 1980. Dependability had the highest response in every year except 1980 when fuel economy was the top response. The second most popular response was low vehicle price in the 1980s and safety in the 1990s and 2000s. In the 1990s, fuel economy was the fourth or fifth response, while in 2004 it was the third most popular response.

A recent issue of Transport Topics[12] noted that orders for heavy-duty vehicles were declining. Increasing fuel prices were quoted as a major contributing factor. Trucking consumes about 665 million gallons of diesel fuel per week. The trucking industry spent about $2.09 billion for its diesel fuel in the first week of October 2005. This represents more than $725 million above what was spent in the corresponding week a year ago. Obviously there is growing concern in the trucking industry with the increasing fuel prices.

Driving patterns and mode choice

Fuel price affects road users' mode choice as well as driving patterns. For example, the September 30, 2005 issue of *The Urban Transportation Monitor*[13] reported that motorists nationwide are increasingly turning to public transit and carpooling/vanpooling to meet their commuting needs. There is little hard data but much anecdotal evidence supporting a direct link between fuel prices and changes in commuting habits. Commuter and telecommuting associations have also reported increased interests in their services. In a survey of employees from over 1000 companies nationwide, 17 percent said they would change the way they commute if gas prices continue to rise (5 percent would opt for public transportation; 4 percent for carpooling; and 8 percent for telecommuting) and 44 percent said they would prefer to, but cannot.

A recent internet survey conducted in August 2005[14] addressed the question "has the price of gas forced you to change your spending habits?" Out of over 1,000 respondents 39 percent said they

[11] Steiner, E. *Consumer Views on Transportation and Energy. Technical Report.* National Renewable Energy Laboratory (NREL). Golden, CO. August 2003. NREL/TP-620-34468.
[12] Transport Topics. Weekly Newspaper of Freight and Transportation. Week of October 10, 2005 Pg. 6- Editorial
[13] *The Urban Transportation Monitor,* September 30, 2005 Issue. P 4.
[14] http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2005/08/14/OIL.TMP

cut down on driving while 11 percent said they cut back on expenses in other areas and 4 percent said they traded in their SUVs.

In the short term, increasing fuel prices invariably impact road users' choice of mode and driving habits. It is important to note that behavioral changes can also be influenced by economic factors other than fuel prices.

In terms of price elasticity, a recent study[15] observed that a 10% increase in fuel price causes fuel consumption to decline by 5 to 6%, indicating that roughly half of the long-term effect of higher fuel prices consists of reduced consumer benefits from motorists forced to purchase smaller vehicles and reduce their vehicle travel.

Annual vehicle miles traveled

Average annual vehicle miles traveled (VMT) is used a surrogate to measure the impacts of crude oil prices on driving habits especially for freight vehicles. For all vehicle categories (including passenger cars, SUVs, pickup trucks, vans, combination trucks, and single unit trucks), VMT appeared to increase steadily with time and did not fluctuate with crude oil price changes between 1975 and 2005. Some studies (e.g., Dahl et al, 1993[16], Goodwin et al, 2004[17]) concluded that elasticities are very small, while others found no significant response to price change. Output was determined to be the predominant driver of medium and heavy truck travel.

Vehicle manufacturing industry reaction

Manufacturers are required to meet the Corporate Average Fuel Economy (CAFE) standards for their fleets of passenger cars or light trucks of less than 8,500 lbs gross vehicle weight. Fuel efficiencies for both new passenger cars and new light trucks increased with the CAFE standards from 1980 to 1985, and leveled off thereafter. Slight variations within 2 mpg of the CAFE standard occurred from 1985 to 2004. However, these variations do not appear to correspond with the price of oil. This suggests that manufacturers do not respond to increasing oil prices by producing fuel efficient vehicles. Instead, they respond to the government fuel economy regulations by attaining an average fuel efficiency that is slightly better than the regulatory requirement.

In general, emerging and advanced technologies (e.g., engines with variable valve timing and more sophisticated fuel injection, transmissions with lockup torque converters or that are continuously variable, and brakes that reduce sliding friction) have been directed to other aspects of vehicle performance, such as higher acceleration or more electronic amenities.[18] Technological progress continues to expand the potential for improving the efficiency of conventional vehicles. In European and Japanese markets, Japanese manufacturers have

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[15] Appropriate Responses to Rising Fuel Prices: Citizens Should Demand, "Raise My Prices Now!". Littman, T. VTI. 2005

[16] A Survey of Energy Demand Elasticities in Support of the Development of the NEMS. Dahl, Carol, Colorado School of Mines. October 19, 1993.

[17] "Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review," Goodwin, Phil, Joyce Dargay and Mark Hanly, *Transport Reviews*, Vol. 24, No. 3, May 2004.

[18] United States Environmental Protection Agency. Office of Transportation and Air Quality. Light Duty Automotive Technology and Fuel Economy Trends: 1975 through 2005. Appendix E. July 2005. Available: http://www.epa.gov/otaq/fetrends.htm

introduced lean-burn gasoline direct injection engines, which improve fuel efficiency on the order of 20 percent[19]. Technologies directed at improving fuel efficiency include hybrid electric technology where hybrid powertrains combine a conventional combustion engine with electric drive components, and those directed at promoting the use of alternative motor fuels, and fuel-cell powered vehicles. Hybrid vehicles became available in the United States in 2000 with the introduction of the Honda Insight and the Toyota Prius.

While the Ford Escape is currently the only domestically manufactured hybrid, American car manufacturing companies have plans to expand their selection of hybrid vehicles. Fuel efficiency for heavy trucks improved about 35 percent (i.e., 2 mpg) over the 25-year period between 1977 and 2002, while for medium trucks fuel efficiency increased by about 34 percent (i.e., 2.5 mpg) over a 15-year period between 1987 and 2002. There appears to be no correlation between oil prices and the fuel efficiency of medium and heavy trucks.

High fuel costs and concerns about dependence on foreign oil in the last several years have resulted in increased interest in various alternative fuel sources and propulsion systems for public transportation. It is estimated that in the next 10 years, hybrid-electric systems in heavy-duty transit vehicles represent the most likely fuel/propulsion technology to significantly penetrate and benefit public transportation.[20]

Trucking industry practices

The practice of long-haul trucks idling their engines overnight at rest stops is very common in order to heat and cool the cab while the driver is sleeping, mask noises, keep fuel warm in the winter, and avoid cold starting. Long-duration truck idling consumes approximately 960 million gallons of diesel annually.[21] The practice of truck engine idling overnight not only wastes fuel but it also produces unnecessary emissions of various pollutants.

The U.S. Department of Energy (DOE) initiated a study of diesel truck engine idle reduction technologies as part of its Advanced Vehicle Testing Activity (AVTA).[22] Three demonstration projects have been sponsored under this study to gather data on the implementation of several available and near-term technologies.

In one of these demonstration projects for which some preliminary results are available, Schneider National Inc. installed Cab Cooler cooling systems on 19 Freightliner trucks and self-contained diesel-fueled heating systems on 100 trucks. Preliminary results indicated that the Cab Cooler reduced idle time to about 15 percent on average over the summer evaluation period. However, this reduction did not result in increased fuel economy compared with the control trucks. The expected payback period for this technology would exceed the industry accepted 2-year maximum. With regards to the performance of the heating systems, preliminary results

[19] Energy and Transportation Beyond 2000. Greene, D. L. and DeCicco, J.M. TRB Committee on Transportation Energy.

[20] New and Emerging Information technologies for Public Transportation. TCRP Draft Final Report. Battelle, TranSystens, Coogan, M. and E-Squared Engineering. December 2006

[21] U.S. EPA, Idling Reduction: national Transportation Idle-Free Corridors.

http://www.epa.gov/SmartwayLogistics/transport/where-you-work/idle-tsemap.htm

[22] Proc, Ken. U.S. Department of Energy. National Renewable Energy Laboratory. *Idle Reduction Technology Demonstrations.* November 2004.

indicated that control trucks used for comparison during the evaluation period averaged 22 percent idle time while the test trucks averaged 9 percent idle time. Payback period based on fuel savings alone was estimated to be less than 4 years. However, at higher fuel prices, the payback period could be less than 2 years[21].

The U.S. Environmental Protection Agency (EPA) is also addressing truck idling as part of its Smartway Transport Partnership. These programs are intended to reduce emissions and fuel consumption for long-haul trucks at truck stops by implementing alternatives to idling, such as electrification and auxiliary power units. In June 2003 the EPA launched its National Transportation Idle-Free Corridors project.[23] Under the authority of the Clean Air Act the EPA has also funded several idle reduction demonstration projects in various locations around the country. No results from these demonstration projects are currently available. Therefore, the impacts of oil prices on the use of idle reduction technologies cannot be evaluated. It is, however, expected that, as oil prices continue to rise, the trucking industry is more likely to turn to fuel saving technologies such as idling reduction technologies.

One other potential for fuel economy may come from the urban bus sector. Urban buses use the same engine sets as heavy duty trucks. Urban buses have also tested and implemented a wide variety of alternative fuels and hybrid-electric drive trains. Since urban buses represent less than 3 percent of the heavy duty engine market, the potential for heavy truck fuel economy is significant.

Use of alternative fuels

Changes in fuel prices and energy policy, combined with technological advances, are gradually altering the landscape for alternative motor fuels. The evolution of alternative-fuel vehicles (AFVs) and alternative motor fuels to date has been driven almost entirely by government policy aimed at meeting energy security (reducing oil imports) and/or environmental goals (reduction of criteria pollutants). These policies have taken the shape of mandates and/or financial incentives at the federal, state, or local government level. Some of these evolving policy changes—in particular, the next round of tailpipe emission standards for heavy-duty vehicles—could ultimately curtail further penetration of current-generation (e.g., natural gas or liquefied petroleum gas (LPG)) AFVs. Already, such policy evolution has helped stall the further penetration of AFVs in the light-duty vehicle segment.

Transit agencies are purchasing increasing numbers of AFVs instead of diesel vehicles for several reasons including: reducing dependence on foreign oil, and (ii) recent price increases in oil used to produce diesel fuels. Policy options to increase the use of alternative fuels in transit include (i) defer action, (ii) mandate the use of alternative fuels, and (iii) create new or enhance existing incentive programs.[24] However, the potential benefits from creating new or enhancing existing incentive programs should be generated in a much larger market than public transportation.

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[23] Environmental Protection Agency. "Idling Reduction: Demonstration Projects." 14 December 2004.

Available: http://www.epa.gov/SmartwayLogistics/transport/what-smartway/idling-reduction-demo-projects.htm

[24] Alternative Fuel Study: A Report to Congress in Policy Options for Increasing the Use of Alternative Fuels in Transit vehicles. FTA, 2006

Future Trends of Potential Impacts

The doubling of oil prices between 2003 and 2005 is an indication that oil production is approaching its peak. As petroleum production peaks, geopolitics and market economics will cause even more significant price increases and security risks.[25] According to a recent U.S. DOE report, when world peaking will occur is not known with certainty. The study indicated that peaking may occur within 20 years[26].

In general, as fuel prices continue to rise, the motoring public would react to the scarcity of petroleum in various ways. Some of the impacts described above are observed in the short term while others are not. The short-term reactions of commuters shifting to public transportation and buying more fuel-saving vehicle models are expected to stabilize in the long term. In the long term, it is expected that there will be increased penetration of hybrid-electric, smaller, more fuel efficient, and technologically advanced vehicles on the roadways. AEO2007[27] predicts growing market penetration by unconventional vehicle technologies, such as flex-fuel, hybrid, and diesel vehicles. Sales of hybrids are projected to reach 2 million per year by 2030, accounting for about 10 percent of total light-duty vehicles sales.

The use of hybrid-electric and other fuel efficient technologies on transit buses is expected to increase in the long term, although the potential for increasing use of biofuels (bio-diesel and soy or corn-based fuels) remains uncertain due to complex market realities in the agricultural sector. The feasibility and benefits of hybrid-electric buses have been well established in field deployments and these have moved beyond demonstration into commercial production.[28] However, for commercial production to continue (and possibly affect the heavy duty truck sector as well), the major challenges associated with hybrid-electrics need to be addressed (e.g., high capital costs for the vehicles [60 to 80 percent higher than comparable diesel buses] and the high cost and uncertain life-span of batteries). Furthermore, fuel cell technologies, which are being tested on urban buses, are still at least five years away from commercial production. Their likely prices or market viability cannot be calculated at this time. Many fuel cell tests are using petroleum-based fuels.

The manufacturing industry will continue to deploy advanced technologies that eventually will improve performance and fuel efficiencies of vehicles of all classes. Deployment of engine idling technologies in the trucking industry is expected to result in significant savings in fuel cost to the industry and reduced emissions.

Strategies for the Future

As petroleum prices continue to rise, several policy and behavioral changes are required to meet the challenges imposed. The potential short- and long-term impacts of the scarcity of petroleum are discussed in the foregoing sections. The following are some potential strategies for consideration from the regulatory standpoint.

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[25] "Oil or Not? Do we know enough to make decision" Landrio, G.E. Stone Consulting & Design Inc.
[26] Peaking of World Oil Production: Impacts, Mitigation, & risk Management. Hirsch, R.L., Bezdek, R., & Wending, R. Report for U.S. DOE. February 2005.
[27] Annual Energy Outlook 2007 Overview. Energy Information Administration.
[28] "Hydrogen Reality Check". Kevin Bullis, Technology Review (online) MIT. May 05, 2005

An assessment of the world energy outlook identified the following as potential policy options for transport:[29]

- Improved vehicle fuel efficiency
- Increased sales of AFVs and alternative motor fuels
- Increased sales of hybrid and fuel-cell powered vehicles
- Mode switching (transit, high-speed rail).

Promotion of the use AFVs and alternative motor fuels is considered a practical strategy. Alternative motor fuel is used in a broad sense to include all categories of alternative fuels (e.g., liquefied petroleum gas, methanol, ethanol, coal-derived liquid fuels, natural gas, biodiesel, etc.). A GAO report[30] identified the following as the most critical impediments to the use of AFVs and alternative motor fuels in the U.S.

- Relatively low price of conventional fuel
- Insufficient availability of alternative fuel refueling infrastructure
- Relatively higher cost of certain AFVs.

In order to promote increased use of alternative fuels in the transportation sector, Congress supported and enacted certain tax incentives, including federal tax exemptions, credits, and deductions. Similar tax incentives extended to the manufacturers would help reduce the cost of production of AFVs, hybrid, and other more fuel-efficient vehicles.

Bioenergy is an increasingly important alternative source of energy to supplement future demands. It is projected that by 2030, the biofuel share of the transportation fuel demand in the U.S. will be about 20% compared to 1% in 2004.[31]

A recent U.S. DOE report[32] on the impacts of world oil production peaking also identified a number of mitigation scenarios. These include physical mitigation defined as (i) implementation of technologies that can substantially reduce the consumption of liquid fuels (improved fuel efficiency) while still delivering comparable service and (ii) the construction and operation of facilities that yield large quantities of liquid fuels. The report also noted that a number of near-commercial substitute fuel production technologies are currently available for deployment. Therefore, the production of large amounts of substitute liquid fuels is feasible with existing technology. The report concluded that technologies exist to mitigate the challenges and uncertainties associated with peaking of world conventional oil production.

Implications of Potential Petroleum Scarcity on Surface Transportation in the Short and Long Term

[29] World Energy Outlook: Energy and CO_2 Emissions Trends in the Transport Sector. Cozzi., L. 2005,
[30] Alternative Motor Fuels and vehicles: Impacts on the Transportation Sector. GAO-01-957T. GAO, 2001
[31] Bioenergy: Biofuels in Europe- Visions for Transport. Sipila, K., OECD – Scientific Challenges for Energy Research. Paris, 2006
[32] Peaking of World Oil Production: Impacts, Mitigation, & risk Management. Hirsch, R.L., Bezdek, R., & Wending, R. Report for U.S. DOE. February 2005.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS - PAPER 4C-02

One reviewer commented as follows:

- On page1, there does not seem to be any technical support given to the assumption that oil demand for transportation increases at a rate similar to the population growth rate. An annual growth rate of .8% between 2005 and 2050 seems too low.

- On page 2, why does EIA think that the real price of crude oil won't begin to rise until 2015? At $95 per barrel in nominal dollars by 2030 seems way too low.

- On page 5, if fuel prices were driving heavy-duty truck sales, sales of heavy-duty trucks would not be declining because the latest models are significantly more fuel efficient than the five + year old trucks they would be replacing.

- On page 6, the energy crises of 1973, 1978, and even 2006 were rather short-term in nature and fuel prices did not rise much over $2.00/gallon. In a long-term shortage, brought about by political instability in the world, fuel prices probably would be dramatically higher and the crisis could be longer term. This would lead to freight modal shifts, especially given the other problems in the trucking industry, i.e., driver shortages, congestion, higher insurance costs, etc.

Another reviewer commented as follows:

Background and Key Findings set the stage and are right on target. I take exception with only one statement: "Given transportation sector's high dependence on petroleum, this sector MAY be strongly affected by scarcity of petroleum in both the short and long term." This reviewer believes it ought to have said "WILL" be strongly affected. That is the opinion of many in the petroleum field.

Key Findings agree with what this reviewer has read in the popular press and transportation magazines.

- Alternative fuels and bio-fuels are discussed and quantities per day given. It would have helped if a percent were shown to illustrate how little is projected by 2025.
- Urban buses….. "Since urban bus engines represent at most 3% of heavy duty engine sales, there is significant potential for fuel economy gains from existing technology in the trucking sector." This was poorly worded. It might have been better to have been: Since urban bus engines represent at most 3% of heavy duty engine sales, there is little potential for savings, but since trucking represents 97% of heavy duty engine sales, there is significant potential for savings in the trucking sector."

"Transportation uses over a quarter of the energy in the US, which is the second highest amount after industrial sector. While the other sectors use a mix of at least three primary energy sources, about 95% of the transportation sector's energy source is petroleum". This is well put.

An assessment of world energy indicates that oil demand for transport increases linearly with GDP at a rate similar to the population growth rate. Annual population growth in the US is expected to continue at 0.8%/yr.

Impact areas are discussed under each specific area.

- Vehicle sales of large vehicles such as SUV's has declined and sales of compact cars and hybrids has increased and this is expected to continue. This reviewer would note that there is anecdotal evidence is that unsold large SUV's and light pick up trucks are crowding dealers' lots; large rebates are being offered to sell them.)
- The paper quoted that Ford's large vehicle sales has dropped 55% (prompting recent layoffs and plant closings that occurred after the paper was written.)
- Driving patterns were described indicating that only 5% of motorists were opt for public transportation while 44% said they would prefer to, but could not do so (presumably because there was no service to where and/or when they wanted to go.) Most respondent motorists said they have cut down on driving."

In terms of price elasticity a recent study observed that a 10% increase in price caused a 5 to 6% reduction in use of petroleum products indicating that roughly half of the long-term effect of higher fuel prices consists of reduced consumer benefits from motorists forced to (1) by smaller vehicles and/or (2) drive less.

Annual vehicle miles traveled did not vary much with price. (Motorists bought smaller cars and drove just as far.)

Various efforts to meet government Corporate Average Fuel Economy standards were described. A very important finding was: "In general, emerging and advanced technologies have been directed to other aspects of vehicle performance such as higher acceleration or more electronic amenities". Progress in fuel economy in Europe and Japan was described.

Another key finding was: "There appears to be no correlation between oil prices and fuel efficiency of medium and heavy trucks."

Another key finding was that within public transportation, which uses about 3% of heavy engines sold, that: "It is estimated that in the next 10 years, hybrid-electric systems in heavy duty transit vehicles represents the most likely fuel/propulsion technology to significantly penetrate and benefit public transportation." (Comment: As way of explanation, the stop/go duty of urban transit vehicles provides much opportunity for regenerative braking. Long haul trucking has little opportunity for regenerative braking, although in mountainous territory it may have some benefits, so that hybrid vehicles do not offer anything of benefit to the trucking industry.)

Trucking industry practices are described, especially idling engines over long periods of time. Mitigation efforts are described such as electric plug in services at truck stops to keep HVAC operating and engines warm. Cold starting a diesel is difficult and in some cases not possible. (Comment: Such efforts are well within the state of the art and can be done quickly and widely

given incentives to do so. The paper indicated a 4 year payback at present fuel prices and as little as 2 yrs with increased fuel prices.)

"The doubling of oil prices between 2003 and 2005 is an indication that oil production is approaching its peak. As petroleum production peaks, geopolitics and market economics will cause even more significant price increases and security risks. According to a recent USDOE report, when world peaking will occur is not known with certainty. The study indicated that peaking may occur within 20 years." (Comment: A report that your reviewer received after the paper was prepared indicated that world production did reach a peak in December 2005, and has declined since. One might observe that there are still oil fields yet to be discovered, but literature indicates that the easy sources have been found, and what is to be discovered with be much more difficult and costly to recover. It might have been better to have reported that cheap oil production peaked in December 2005. In any event, all indications are that petroleum prices will continue to go up reflecting increasing world demand. How rapidly it increases will be the result of supply and demand, as usual, with supply possibly being constrained by producing nations for their own benefit.).

Strategies for the future are suggested on pages 9-10, both short term and long term. Most are already in use or have been recommended.

- Improved vehicle fuel efficiency
- Increased sales of alternative fuel vehicles
- Increased sales of hybrid and fuel cell vehicles
- Mode switching (transit, high speed rail)

Promotion of AFV's and alternative motor fuels is considered a practical strategy. (Comment, and is happening with E85 production). Following are the most critical impediments in the US market:

- Relative low price of conventional fuel
- Insufficient availability of alternative fuel infrastructure
- Relatively higher cost of AFV's

Congress did enact tax incentives for hybrids, AFV's and other more fuel efficient vehicles. (COMMENT; This is a double edged sword that will decrease fuel tax collections if such vehicles are adopted in large numbers.) Bio-energy by 2030 can be an important source. It can be 20% by 2030 compared with 1% in 2004.

The final paragraph ends with an optimistic note: "Therefore the production of large amounts of substitute liquid fuels is feasible with existing technology. The report concluded that technologies exist to mitigate the challenges and uncertainties associated with peaking of world conventional oil production."

This reviewer believes this is a good report on the situation as it is presently known.