Commission Briefing Paper 4C-05

Implications of Higher Energy Costs/Energy Scarcity on Transportation Mode Splits

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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 presents information on the relationship between energy costs or scarcity and the transportation modal choice of passengers and freight.

Background and Key Findings

- DOE estimates short run motor gasoline price elasticity at -0.056 percent average elasticity representing the change in demand associated with a one percent change in price. This is a very low elasticity, but is actually a somewhat higher elasticity than those DOE estimates for other fuels, since much more highway travel is adjustable than are some other uses of fuels.

- Cambridge Energy Research Associates noted in December 2006 that the consumption of gasoline rose about one percent in the first eleven months of 2006 compared to 2005, despite an increase in gasoline price as reported by EIA of 13.4 percent for 2006 compared to 2005. They noted that gasoline demand was increasing 1.6 percent per year through 2004, so a decrease in growth to one percent was highly consistent with DOE's elasticity estimate.

- The percentage price change in gasoline price from 2004 to 2005 was 22.7 percent. Cambridge Energy Research Associates noted a growth of gasoline consumption of only 0.3 percent in 2005, again highly consistent with DOE's price elasticity.

- Cambridge Energy Research Associates also notes that spending on petroleum products makes up only 3.8 percent of the household budget in 2006.

- The American Public Transit Association (APTA) reports ridership increases of 1.3 percent for 2005 and 3.2 percent for the first six months of 2006. These figures are both higher than the figures for gasoline consumption in those periods (one percent higher for

2005 and two percent higher for 2006), but do not seemingly reflect a very major shift to public transportation on a national level.

- However, freight modal shifts are likely to be very minor. The freight services provided by 3,000,000 long haul trucks versus 20,000 locomotives are highly distinct. Rail simply cannot serve the origins and destinations served by trucking. Many of the most important studies relating to modal usage and energy were conducted in the late 1970s and early 1980s because that was a period of major concern about energy costs and energy scarcity. The studies from the 1970s and 1980s primarily concluded that responses to energy prices and energy scarcity were not predominantly changes in mode choice but rather changes in total travel, changes in vehicle purchase patterns, and overall changes in consumer spending.

- In the longer run, shifts to more fuel efficient modes could be strengthened by higher energy prices or energy scarcity. There is no past long term trend information that would provide evidence for the impacts of rising energy prices. However, research that indicates much higher long term elasticities for gasoline use with regard to price points to the likelihood of an impact of higher energy prices on mode shifts.

Evidence from Recent Rise in Fuel Costs

There are several theoretical responses to an upsurge in energy costs or to energy scarcity. These responses could include one or more of the following:

1. Reduction in travel/use of all transportation modes.
2. Modal switch from those passenger transportation options where energy prices are absorbed by the user (such as the automobile), to those where energy prices are absorbed by another party such as a transit operator.
3. Modal switch from those freight transportation options that have very high energy costs to those where there may be fuel efficiency gains (e.g., trucking to rail).
4. Development or greater use of alternative fuel sources that are less costly.
5. Development or greater use of vehicles that use energy in a more efficient manner.

This briefing paper focuses on the modal usage responses, which are items 2 and 3 above. This is not to indicate that the other responses are less important. Most likely, the other responses are more important than the potential for modal shifts.

The US Department of Energy (DOE) Energy Information Administration provides the most definitive source of information on these topics. The DOE EIA maintains a regional short term energy model (RSTEM) which they have calibrated to provide elasticities of fuel usage with regard to price, for highway use of motor fuel and for other fuels. EIA concludes that "overall, net price elasticities of demand in RSTEM over a 2-year horizon tend to be small because of the limited substitution possibilities available for most fuels and sectors" (Costello, Dave, "*Reduced Form Energy model Elasticities from EIA's Regional Short-Term Energy Model (RSTEM),* May 9, 2006). Motor gasoline price elasticity is estimated at -0.056 percent average elasticity representing the change in demand associated with a one percent change in price. This is a very

low elasticity but is actually a somewhat higher elasticity that for other fuels, since much more highway travel is adjustable than are some other uses of fuels.

Secondary and supportive information includes a recently released study from "Energy and the American People" (November 2006, Cambridge Energy Resource Associates (CERA). CERA, a private energy consultancy which also specializes in producing energy research and data. Cambridge Energy Research Associates noted in December 2006 that the consumption of gasoline rose about one percent in the first eleven months of 2006 compared to 2005, despite an increase in gasoline price as reported by EIA of 13.4 percent for 2006 compared to 2005. They noted that gasoline demand was increasing 1.6 percent per year through 2004, so a decrease in growth to one percent was highly consistent with DOE's elasticity estimate.

The percentage price change in gasoline price from 2004 to 2005 was 22.7 percent. Cambridge Energy Research Associates noted a growth of gasoline consumption of only 0.3 percent in 2005, again highly consistent with DOE's price elasticity. Cambridge Energy Research Associates also notes that spending on petroleum products makes up only 3.8 percent of the household budget in 2006. Therefore, households have been able to absorb higher prices by making overall adjustments in their spending which while perhaps onerous, are definitively doable. Lower income households with higher proportions of their budgets spent on petroleum are of course hit higher than these averages suggest.

EIA's short term energy outlook also summarizes the annual energy expenditures as a percentage of the entire GDP. Energy expenditures were nearly 14 percent of GDP in 1980, and then declined to around 8 percent by the late 1980s, and have generally still remained around this number. Thus, the economy is less energy dependent than it was twenty years ago, which was just after the most difficult period of rapid increases in energy prices.

The longer term energy forecasts by EIA (*Report #:DOE/EIA-0383(2007) released date December 2006*) indicate that through 2030, motor fuel consumption by both light duty vehicles and freight trucks is expected to increase. Fuel efficiency for vehicles of both types is forecast by EIA to increase slightly and constantly through 2030. EIA's forecasts of new light duty fuel fleets efficiency increase from 25.7 mpg in 2006 to 29.2 mpg in 2030, with freight trucks increasing from 6.0 mpg to 6.7 mpg. EIA's forecasts of bus energy usage increases from 0.26 quadrillion btu to 0.30 quadrillion btu. Indicating that little if no change to modal usage is expected in the EIA base case assumptions.

APTA Ridership Statistics

One theoretical response of higher energy prices could be an increase in the amount of passengers using public transportation. This is a logical response since the energy costs are generally borne by the transit operator instead of the passenger. Therefore, passengers previously absorbing the costs of higher energy through increased gasoline prices may be convinced to switch to public transportation in order to lessen the burden of higher energy costs.

The American Public Transit Association (APTA) reports ridership increases of 1.3 percent for 2005 and 3.2 percent for the first six months of 2006. These figures are both higher than the figures for gasoline consumption in those periods (one percent higher for 2005 and two percent higher for 2006), but do not seemingly reflect a very major shift to public transportation on a national level. Ridership changes on specific transit systems vary. One of the primary reasons why responses may not have been higher is that in many systems, transit services could not be expanded in response to energy prices, because operating dollars remained limited. In order to take advantage of the potential for transit to respond to energy cost or scarcity impacts, there must be an expansion of service.

Freight Transportation

Freight transportation will also respond to changes in energy prices or to energy scarcity. However, freight modal shifts are likely to be very minor. The freight services provided by 3,000,000 long haul trucks versus 20,000 locomotives are highly distinct. Rail simply cannot serve the origins and destinations served by trucking. Trucking firms, although highly concerned about energy prices, also responded by altering their business practices to include fuel contingencies in their contracts, thus spreading the impacts of fuel price changes throughout the economy rather than concentrating the price impacts on the carriers themselves.

There is some likely response to higher energy prices however, in terms of a strengthening of intermodal shipments. This sector, involving carrying containers or trucks on line haul rail has been growing rapidly, so it may be difficult to conclude that any particular part of recent growth is due to energy prices rather than to other factors. Unfortunately, there is no current data on long haul trucking for 2005 or 2006 in the series compiled by BTS, so it is not possible to make an informed estimate of changes resulting from higher fuel costs.

In the longer term, sustained high energy costs are likely to result in a reorganization of intermodal freight to reflect fuel-efficiency differentials between modes. This may take years as freight forwarders seek the lowest through cost possible, and carriers reorganize their warehousing and connection points. One significant factor affecting this equation is the prominence of "just-in-time" product delivery, which generally reduces the time spent, and the need for, warehousing. In essence, the time in-vehicle substituted for warehouse cost. Significant or persistent increases in fuel cost may force a re-examination of the economics of just-in-time delivery and modal share.

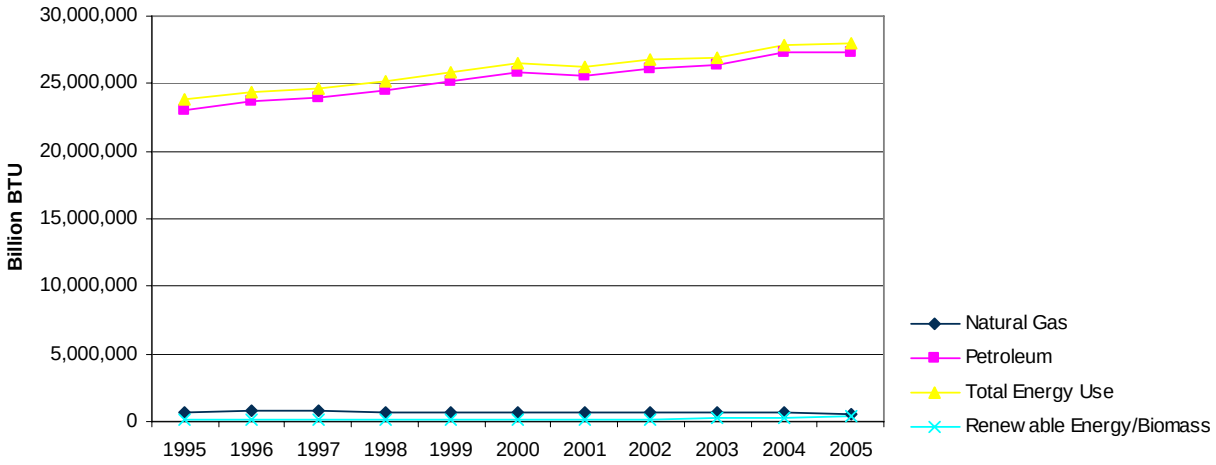
Department of Energy Transportation Consumption and Costs Data

Available evidence suggests that there has been a slight leveling off of the total amount of energy consumed in the United States transportation sector, between 2004 and 2006. As shown in Figure 1 below, the amount of energy consumed in the U.S. has been climbing fairly steadily since 1995, though with leveling off points in 2000-2001 and again in 2002-2003. [1] These levelings were likely due to economic factors rather than prices, which remained low. It is not possible of course, to conclude definitively that the 2004-2006 slowing was due to the higher energy prices

[1] United States Department of Energy, Energy Information Administration. http://www.eia.doe.gov/emeu/aer/consump.html

or due to some other economic or demographic factors. The data on gasoline consumption for 2004 to 2006 is, as noted, consistent with the elasticities estimated by DOE for price responses. However, it is true that the relative percentages of the types of energy consumed as a percent of total energy consumption have remained steady. Petroleum captures the majority of the total transportation energy use, and fluctuates proportionally to total energy consumption. Natural gas and Renewable energy sources both capture a relatively small percentage of total transportation energy consumption, and have not fluctuated dramatically in the past ten years.

Figure 1: U.S. Transportation Sector Energy Consumption 1995-2005

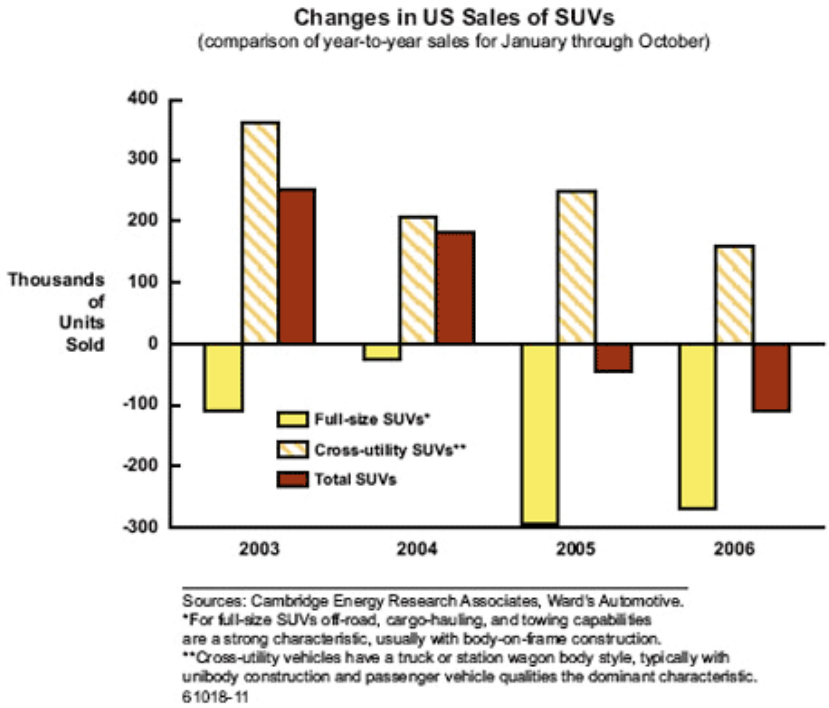


Other Research Findings

The CERA report by a private energy consultancy also concludes the following:

- For the first time in 25 years, motorists' average mileage went down in 2005.
- New purchases of light trucks, SUVs and minivans declined in 2005 and 2006 for the first time since 1990. This trend is shown below in Figure 2.

Figure 2: Changes in US Sales of SUVs 2002-2006



Literature Review of Previous Studies

Many of the most important studies relating to modal usage and energy were conducted in the late 1970s and early 1980s because that was a period of major concern about energy costs and energy scarcity. The studies from the 1970s and 1980s primarily concluded that responses to energy prices and energy scarcity were not predominantly changes in mode choice but rather changes in total travel, changes in vehicle purchase patterns, and overall changes in consumer spending. The most comprehensive study of the interrelationships of energy and passenger modes was "Transit and Energy" (October 1979, prepared for the urban Mass Transportation Administration by System Design Concepts, Inc.). The Transit and Energy study estimated the energy impacts of alternative transit actions, which provides information that answers the question of whether and how much energy transit will save. If transit actions do not save energy, then they are not an effective response to higher energy prices or to energy scarcity. Conversely, the more energy saved by a particular transit action, then the more that type of transit action can contribute to responses to higher energy costs or energy scarcity.

The UMTA study estimated energy savings in terms of btus (british thermal units) per dollar spent. Transit was found to save btus per dollar invested in several categories of new services or service adjustments. New express bus service was predicted to save 118,204 btus per dollar and new light rail and new heavy rail services to save 2,137 and 2,142 btus per dollar. Reducing peak fares was found to save 11,766 btus per dollar spent for conventional bus and 11,180 btus per dollar spent for express bus. Doubling peak service frequencies was found to save 22,395 btus per dollar for conventional bus and 11,097 btus per dollar for heavy rail. Doubling of off peak services were found to be energy inefficient (more energy would be used than would be used by the number of passengers attracted from autos, due to low transit occupancies off-peak.)

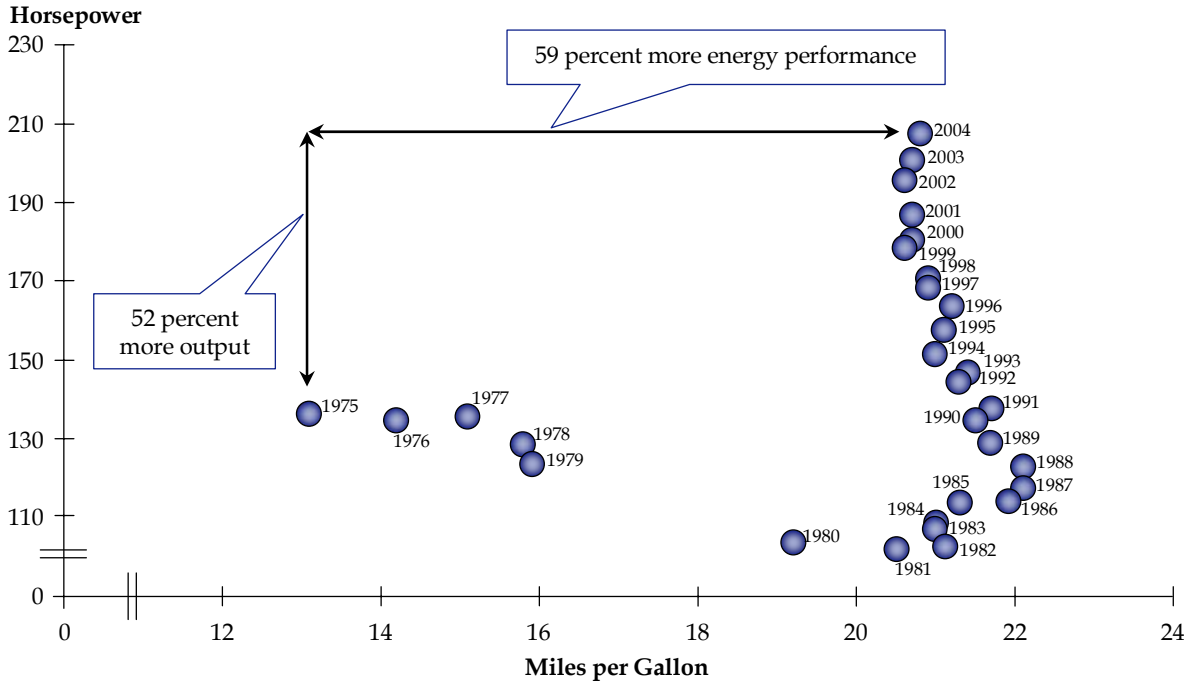
For comparison purposes, the petroleum btus per passenger mile used in 1976 were 11,000 for autos, 2,610 for conventional bus, 2,310 for express bus, 1,875 for light rail, and 1,270 for heavy rail. Transit still maintains an energy advantage even after the fuel efficiency gains of the 1975 to current period.

A 1976 study, "Energy, the Economy, and Mass Transit" (prepared for the Office of Technology Assessment, United States Congress, by System Design Concepts, Inc.) provided an analysis of the relationships between energy availability and energy prices and mode splits for passenger travel. In terms of modal changes, the analysis in Energy, the Economy and mass Transit concluded that the average percentage of transit passengers who would have been auto drivers diverted by transit service improvements would be 34 percent, and the average vmt diverted per new transit passenger would be 2.4 miles. This limits the impact of transit improvements on fuel savings. Energy, the Economy, and Mass Transit concluded that transit could play a positive role in replacing mobility that might be lost due to energy costs or energy scarcity, but concluded that the maximum achievable would be about a doubling of transit usage. Since energy savings would only be proportional to transit use, and a doubling would take transit from 3 percent to 6 percent of personal travel, the modal substitution effect would be limited in terms of impacts on total energy consumption. The costs of doubling transit usage on an annual basis will be somewhat more than a doubling of current transit costs, according to the 2002 AASHTO Report "*Transportation: Invest in America: The Bottom Line*".

An NCHRP Project "State Transportation Finance in the Context of Energy Constraints" was completed in 1981 by System Design Concepts, Inc. and provided a methodology for estimating the revenue impacts of a wide variety of actions that influence travel and energy usage. A major contribution of this report was to estimate that fuel prices would have to be extremely high in relation to 1977 real prices to impact on fleet fuel efficiency over and above the CAFÉ standards. The pricing points were not reached during the 1980s and 1990s. This conclusion was borne out by the experience through 2006 with auto and light truck fuel efficiency. EPA figures in figure 3 (C.2) show that the combined auto and truck fuel efficiency by model year has been relatively stable since 1985, meeting the CAFÉ standards but not increasing due to any other factors.

The NCHRP study reviewed and compiled the literature and modeling of fuel price demand and elasticities, which was very extensive in the late 1970s. A comprehensive world market study (Pindyck, Robert, "The Structure of World Energy Demand", The MIT Press, 1979) provided estimates of U.S. Motor gasoline elasticities by year, increasing from -.111 in year one to -.217 in year two to -.490 in year five to -.818 in year ten to -1.17 in year twenty. This illustrated the likelihood of stronger and stronger adjustments to demand over time. As with freight, fuel price impacts over time would also strengthen the role of public transportation, although as with freight, the supply of public transportation services will need to be expanded to serve the increased demand. In the short term of recent years of 2004 to 2006, the supply of public transportation services was not increasing as fuel prices were rising.

Figure C.2 Sales-Weighted Horsepower and On-Road Fuel Economy for New Light-Duty Vehicles
1975-2004 Model Years



Source: Environmental Protection Agency, Fuel Economy Trends, 2004.

A 1980 study for the Office of the Secretary (Development of VMT Forecasting Model, Model Development and Forecasts, COMSIS Corporation) provided estimates of the total net fuel price elasticity for intercity trucking including both the direct elasticity and the rail truck cross elasticity. For a variety of scenarios, the elasticities were around -.0.03 to -0.01, indicating that trucking fuel consumption was fairly inelastic with regard to price.

Conclusions

Overall, the data and research suggest that, similar to the case in the 1970's, the current rise in energy prices is not causing a substantial passenger modal switch (i.e. people leaving behind the automobile in lieu of public transportation, or freight being diverted from trucks to rail). Some changes of these types do occur but the primary response to higher fuel prices has been to alter overall consumption patterns at the household level and to pass on fuel price changes within the freight sector. There does exist some evidence to suggest that higher energy prices are causing people to switch to more fuel efficient vehicles and reduce the amount of vehicle miles traveled, thereby reducing the amount of energy that must be consumed. Similarly, freight does not appear to be shifting from truck to rail. The longer term presents a somewhat altered likelihood, since higher fuel prices can strengthen mode shifts to more fuel efficient modes for both passenger and freight.