The Nexus of Energy, Environment and the Economy
A WIN, WIN, WIN OPPORTUNITY

A study prepared for the Institute of Transportation Engineers
January 2009

Introduction

The present economic situation is buffeted by sharp downturns in consumer demand and housing values. At least in part, this was precipitated by the energy shocks of 2007 and 2008 with fuel costs crossing $3.00 a gallon in 2007 and then $4.00 a gallon by mid 2008. Beyond cost, there is the concern about the integrity of future supplies of petroleum fuels and the nation's energy security in a very uncertain world. At the same time there is growing world-wide concern for the effects of the burning of carbon-based fuels and the GHG emissions it produces. At the nexus of these three intersecting concerns there are the possibilities for a win, win, win situation. Many aspects of these driving forces act in parallel and addressing them can yield benefits in all three areas. Amory Lovins said it well in a recent Wall Street Journal policy piece.

> *Making our energy supplies affordable, secure and climate-safe all require exactly the same actions – mainly energy efficiency – so it doesn't matter which of them you care most about."*[1]

Because transportation is so heavily dependent on petroleum fuels it is at the center of the US energy security issue, and it is also a significant factor in GHG concerns as well. The following reviews at a relatively broad level the directions that might be taken by ITE utilizing its expertise and unique position in helping to achieve a triple win.

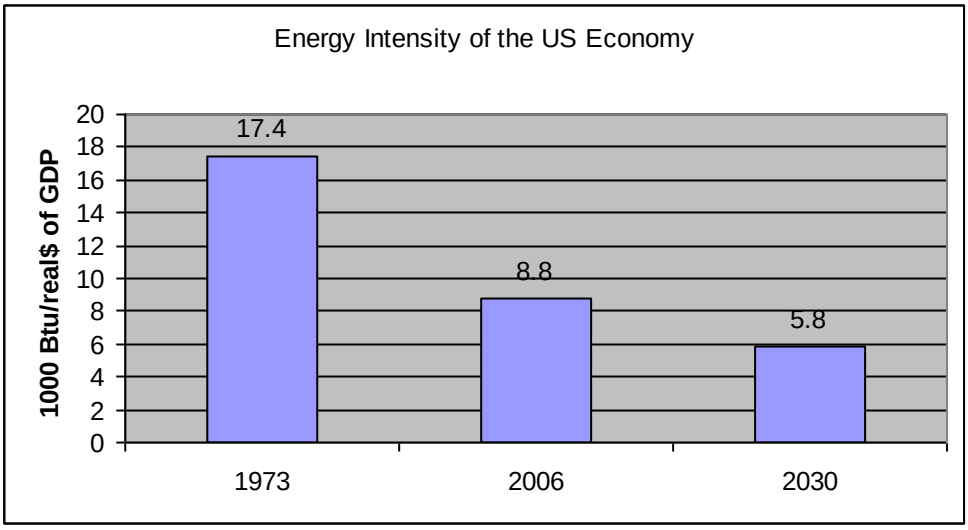
A Factual Base

There is a tendency to paint a rather dire portrait of US energy and GHG emissions trends, but in fact there are many positive aspects of the trends in the energy and GHG picture that need to be recognized up front. Perhaps the two most significant measures of important trends are energy use per unit of GDP and energy use per capita.

[1] Energy – the Journal Report, Wall Street Journal, November 17, 2008

The trend picture (figure 1) shows that our national energy intensity has been cut in half since the first energy crisis in 1974. This is in part due to energy efficiency gains and in great part due to the shifts away from energy intensive industries (e.g., steel-making) to non-intensive industries (services). This trend is expected to continue into the future as show in the figure.

Figure 1 Energy Intensity of the US Economy

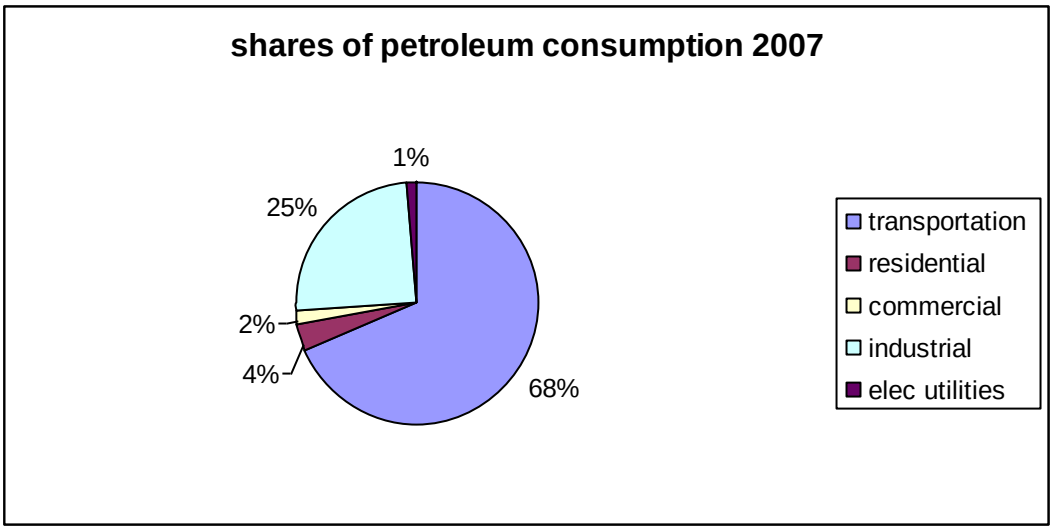


Source: Annual Energy Outlook 2008, US DOE

An equally significant pattern is seen in energy intensity per capita. This does not exhibit quite so dramatic a downward trend, but shows a stable or slightly declining level of circa 350 million Btu per capita since the first energy crisis in 1974.

If these patterns are examined more closely by economic sector, transportation seems to emerge as the main culprit, exhibiting an increasing share of national petroleum consumption since the 70's. What has happened should not be surprising; with the dramatic increases in petroleum costs in the period, those sectors of the economy that could shift away from petroleum use did so. For example, the percentage of homes heated with oil dropped from 32% in 1973 to 17% by 1997; and the share of electricity generated by petroleum dropped from 16% to less than 3% in the same period. Transportation, far more dependent on an easily portable, high energy density per pound and per cubic foot energy source, has had to stay with petroleum.

Figure 2 Petroleum Shares 2007



Source: The Energy Data Book, Edition 27; USDOE

As a consequence, transportation consumption of petroleum grew by about 1.3% a year in the period from 1973 to 2007, while residential use declined at 2.1% a year, commercial use at 2.4% and electricity generation at 4.8%. Only industrial uses grew slightly, at .4% per year. This has led to a situation where transportation today, 95% dependent on petroleum just as it was in 1973, accounts for more than two-thirds of petroleum use and with only industrial uses at 25% still consuming a significant share. (Figure 2)

This puts transportation at about 28% of all energy consumption in the US and, consequently, at a similar share of Green House Gas emissions. So as a factor in green house gas emissions transportation is an important, but not an absolutely critical factor, especially when measured on a scale looking at cost-effective opportunities for improvements. In terms of energy security, however, transportation must be the centerpiece of the discussion.

Finally, when the longer term is considered the picture is less tranquil and transportation again becomes a critical player in GHG emissions. Technologically, it can be seen that in the mid-term transportation can realize upwards of 30% improvements, particularly in surface transportation vehicles. Coupled with the demographically-determined lower growth prospects in vmt, a more stable transportation energy and GHG condition can be envisaged. But in the longer term (2050 for example), as transportation becomes the major energy user in our economy

and world-wide, and as travel growth continues, particularly in freight and air travel, something very close to the complete de-carbonization of ground transport will be required.

The recent enactment of the Energy Independence and Security Act of 2007 (EISA) established new café standards of 35 mpg for cars and light trucks by 2020. This forecast a 40% improvement in fuel efficiency which reduces dependence on petroleum by over 2 million barrels per day in 2030. The 2008 Annual Energy Outlook of DOE, indicates a 14% increase in energy use by transportation by that year and a decline in overall petroleum dependence in transportation from 96% to 88%. In terms of both energy security and GHG emissions this would have to be seen as a very real challenge, particularly in the years beyond 2030.

Recent trends

The dominant factor in recent trends has been the extreme volatility in gasoline prices. In November of 2007, gasoline prices moved beyond the threshold of $3.00 a gallon – not surprisingly that was the first month in which national-level vmt declines were measured. In retrospect it seems it was as much a function of sticker-shock as were the actual costs. By June 2008 prices crossed the even more sticker-shocking level of $4.00, only staying there for about eight weeks. Although it applied for a very short period it is significant how strong an impact the $4.00 price threshold had on our national perspective. At this writing (December 2008) a barrel of oil is down to below $50 a barrel well below half of what it was in July of 2008, but neither vmt nor auto sales have recovered.

There are several important facets to the declining vmt trend that go well beyond fuel prices:

- All functional levels of the highway system and all parts of the country were affected (Figure 3). In August of 2008, the peak summer travel month, no state showed positive vmt growth.
- Rural facilities were far more affected than were urban, with typical levels of reduction more than twice that of urban facilities, indicating that it was business travel and tourism being affected as well as lower income rural populations with their typically longer trip distances for all trip purposes.

- These trends are attributable to more than just fuel prices. The housing mortgage crises and the economic down turn have affected travel very substantially.
- This is all happening in a demographic context in which vmt growth levels have declined steadily over five decades (Figure 4, 5). Even with the return to a more stable economy and more affordable fuel prices annual vmt growth levels beyond the one to two percent range should not be expected in the future.

Figure 3 Monthly Percent Decline in VMT by Facility Type 2008 vs 2007

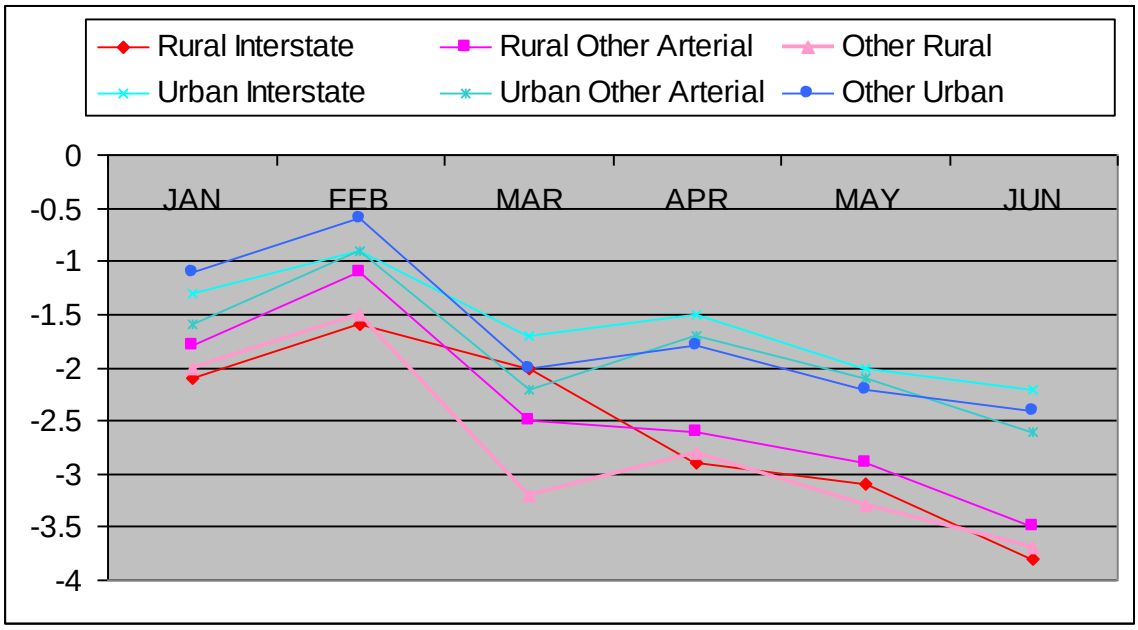


Figure 4. VMT trends by Age and Gender 1990 – 2001

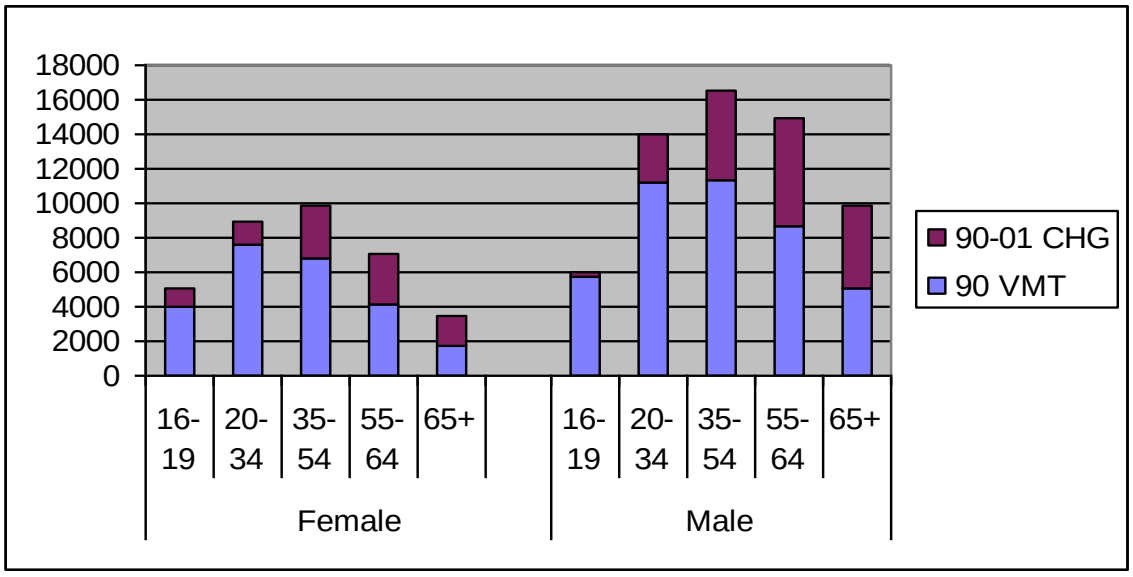
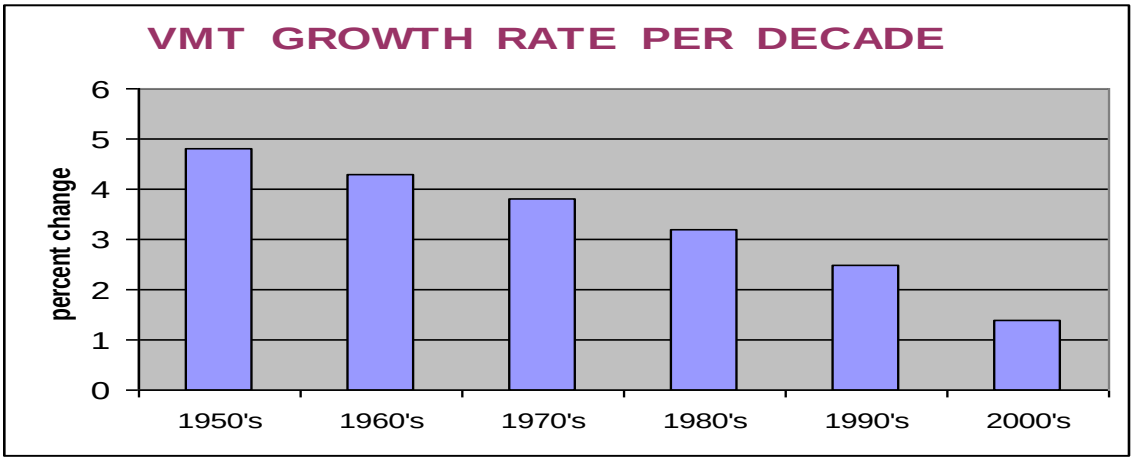


Figure 5 VMT Growth Rate per Decade



A measure of the conflicting attitudes in our society today was the public reactions to reports on the decline of vmt. Too many, with a note of glee, were delighted and thought those suburbanites in their SUV's had it coming. Just about every reporter in the country wrote about a "tipping point" where the fuel prices had at last reached the levels where everyone would move back to the city and walk to work a la 1908. Others recognized that vmt equals trips with economic and social transactions of value to the society, and their suppression at this time was not what the economy needed. Sadly, too many of our public officials saw the vmt decline only in terms of its impact on their revenues, without any apparent interest or concern for national economic or societal repercussions, or the very real impact on households.

A little better sense of scale is needed, something that many reporters seem to lack. If vmt is down by 3.5% this year that comes out to something like this: last year I drove three hundred miles a week; this year I drove 290 – which effectively equals a 5 mile trip from home dropped per week. (When I gave reporters this take on the story they preferred to report that the amount of vmt lost was equal to 586 trips to the moon – a very helpful transportation metric)

Along with a requisite better sense of scale is a better sense of history. We went through similar declines in vmt in both of the previous energy shocks of 1974 and 1979, each time very quickly recovering to previous vmt growth levels. In those cases fuel prices did not drop but rather with time, with some inflation, and the purchase of the "econo-boxes" of the period the society came through reasonably well. In our present case, even at the prices in the neighborhood of $4.00, we were really quite comparable to 1980 or 1981. If we adjust for inflation, the price of fuel in 1981, in 2007 dollars, is about $3.10 per gallon against the average price in 2007 of $2.85. If this is divided by the average fuel efficiencies of the period then we are far better off in terms of cost per mile than we were in 1981, as shown in Table 1. Moreover, this fails to recognize that as a society we are approximately 20% wealthier today. Because petroleum is far less significant in our economy today than then, it would take oil at $145/bbl in today's dollars to equal the economic impact on our economy of the early eighties.

TABLE 1 Cost Per Mile 2007 vs 1981

	Cost/ gallon	Avg. fuel efficiency	Cost/mile
1981 (in 2007$)	$3.09	16.4	18.8 cents
2007	$2.85	22.4 (2006)	12.7 cents
2008 approximation	$4.00	22.4 (2006)	17.8 cents

Where did all that vmt really go? It is something of an indictment of our system monitoring practices and our overall data collection processes in the US today that we really don't know. Some surmises:

- More cuts in rural trip-making than urban areas with very negative impacts on rural economies.
- Declines in summer discretionary travel – "Sorry Grandma, we're not coming this year!"
- Some payoff from trip chaining; packaging one's itinerary to reduce travel
- Some carpooling; both work and non-work related; e.g. soccer moms – "I'll take your kids today and you take mine tomorrow."
- Small trip length reductions – "let's go to that closer restaurant!"
- Trips curtailed – "let's forget going to the movies and watch TV!"
- Walking/biking – "let's give it a try; we need the exercise!"
- Transit obviously saw substantial increases and reporters tended to equate it with the declines in vmt – the scale thing again – in reality, at most maybe 2% of the vmt decline can be explained by shifts to transit.
- Considerable fleet (bus and truck) reorganizing of routes and loads. Those fuel users that can pass thru their rising costs tend to be more immune to cost increases.

State Of The Practice

There has been an explosion of studies in this area and a similar explosion in the numbers of organizations weighing in on the topic. For the most part this has been beneficial and is a part of the process of educating ourselves in this relatively new area. In the US there have been a great number of important studies and at least as many abroad. Because so many of the European countries were ahead of us in these concerns their research and experience can provide very helpful guidance. Standing out among these have been the UK studies which have had broad significance around the world. These include the Stern Review of the economics of climate change; the Eddington study examining the links between transportation and the economy; and the King Study reviewing low carbon fuel opportunities for surface transportation.[2] Taken together they encompass many of the key issues challenging the world today in transportation, the economy, energy and environment. In the US the studies of the National Commission on Energy Policy, the Institute for 21st Century Energy of the US Chamber of Commerce, and the Energy Security Leadership Council have all examined the threats and the prospective solutions. Also influential has been the so-called McKinsey Study which addressed the relative cost-effectiveness of alternative approaches to GHG emissions.

Gleaned from these studies are some key observations that can provide guidance:

- The transportation role of increasing access to labor force and to markets is central to our economic well-being. (Eddington Study)
- There are two major functions of transport investment – assuring connectivity within a country and overcoming congestion in our major metropolitan areas (Eddington Study)
- A nation today operates in a world market and its future depends on its success in that world, (Eddington Study)
- There is a strong need to address GHG emissions and to do so cost-effectively. (The Stern review)

[2] See reading list

- Highly positive on transportation opportunities, citing the prospect of a 50% reduction in carbon fuels used by 2030, and the potential for complete de-carbonization of surface transportation by 2050. (The King report)
- Heavily emphasizes that emissions saved now are more valuable than those saved later. (The King report)

Overall, there is strong recognition that this problem is technological in nature and can be meaningfully addressed by technology. The world is burgeoning with good ideas about responses. This is even more true than were the challenges of air pollution.

I often ask audiences what percent of the solution to air quality issues in America was attributable to changes in vehicle and fuel technology versus changes in people's behavior. Audiences agree that it is at least 95% technology (some say 105%) and yet we still persist in seeking to modify behavior as if the public were our patients rather than our customers. There seems to be a greater recognition of the fact that the GHG emissions challenge is even more of a technological question and yet we will persist in attacking behavior first. Whether this is due to our lack of understanding of sometimes esoteric technologies, or regulations that diminish the potential application of technologies, perhaps the lack of appreciation of the difficulties of moving public behavior in any direction in a pluralistic society, or just that some people like to tell others how to live, is unclear.

A further factor that reinforces the technological approach is that the potential changes are real improvements that create parallel motivations in the public and among regulators. The McKinsey study points out that many technological changes will reduce fuel costs without loss of the consumer surplus the auto provides in terms of flexibility, speed and other amenities.

A final observation derived from the literature is that these challenges need to be addressed in stages. As the King report states, the nature of GHG emissions is that they are cumulative and represent an increasing threat over time. This argues for staged responses with near term, mid term, and longer term perspectives. It also argues for something like a present-worth analysis where immediate actions are far more valuable than actions with very long lead times.

Modeling and data development are moving ahead in this new area but there will clearly be gaps in our knowledge and ability to monitor and model trends. The nature of the issues will be focused on understanding trends and their implications. Support for the ability to monitor system performance and to conduct cost-effectiveness and cost-benefit studies will be critical. Most of the issues will be in developing cost relationships per ton of carbon reduced and the performance metrics that surround that. One of the gaps in the metropolitan and state air quality processes was often their inability to effectively incorporate technological opportunities. This will be even more critical in regard to GHG emissions. Economic considerations will be key, and stronger metropolitan and state abilities in the economic analysis arena will be very important. Closer coordination between vehicle and fuel designers and the planning and engineering professions will be critical, as will better training for transportation planners and engineers in regard to technologies. The planning process may well have to learn about the energy costs and GHG emissions embedded in the fabrication and construction of transportation infrastructure. These must be incorporated into any analysis of potential options. Much of transportation infrastructure is immensely energy intensive – steel, aluminum, concrete, asphalt, tunneling, etc. There will need to be extensive research on less energy intensive methods and applications.

Policy Issues And Expectations

Efficiency vs Equity One of the fundamental conflicts that emerges in any regulatory process is that of efficiency versus equity. Efficiency means cost effectiveness – generating the greatest benefits at the lowest cost first and then moving on to more difficult and more expensive options, thus solving more of the problem per dollar. The whole cap and trade philosophy is premised on an efficiency argument. This often conflicts with a sense of equity in which the view is that all should share in the gain or pain in proportion to their share of the problem. Using an equity argument, if air travel constitutes roughly 9% of the emissions problem it should be responsible for 9% of the solution. On cost effectiveness grounds that would be absurd, aviation is the most dependent of any economic sector on a high energy density per pound and per cubic foot portable fuel, and therefore likely to be the most difficult and costly to remediate. It would be far wiser to use our resources to, for example, reduce an equivalent amount of GHG by shifting the production of electricity to non-carbon sources. Further, one would expect that aviation has already wrung as much efficiency out of their equipment designs and operations as possible given fuel's high relative costs and weight and would eagerly adopt any new technology that promises greater efficiency. Most transportation shares the same challenge of the weight, volume and cost of fuels as aviation, but at a lesser degree. The quintessential cost-effectiveness question is: "*what share of my problem am I resolving with what share of my resources*."

The equity – efficiency issue will have two parts: an intra-transport issue where trade-offs among modes may be significant; and perhaps more importantly an inter-sectoral issue where trade-offs between transportation and electric power generation or residential, commercial, agricultural and industrial capabilities will need to be pursued. The transportation industry will need to be prepared to represent transportation interests on the side of being most responsive to cost-effective opportunities. If it is agreed that global warming and energy security are linked serious problems, then it is critical that solutions be approached in a quantitative and economically sound way.

Alignment of Interests There is a strong alignment of interests between consumers of transportation and the goals of reduced GHG emissions and of energy security. Direct fuel savings that reduce operating costs as well as reduce emissions and the need for imported fuels represent a win-win-win situation. This is quite different from the air quality technology changes to vehicles in past decades where costs were added to the vehicle and the only benefit perceived by consumers was a rather broad and amorphous future improvement in air quality. In the present case it must be recognized that all of these forces are moving together in the right direction. There well may be

trade-offs to be recognized as there were in the early eighties where compromises of power and safety were significant, but current technologies seem to promise that consumer benefits can be sustained as improvements are made.

Timing Questions A real distinction from air quality approaches is the cumulative nature of GHG emissions. Many of the statistical treatments by the DOE show both emissions generated per year and cumulative emissions over a period of study. This places a premium on early actions and suggests a time-discounted value approach to options. Recognizing the distinctions in the short to long term options will be key. Some examples:

Short Term 1 to 5 years

- attack current congestion;
- focus on operations, speeds, and traffic flow;
- modify work schedules, greater flexibility
- generate and disseminate public information on eco-driving
- non-construction mode-shifts to carpooling, use of current transit and non-motorized modes, expanded work at home
- trip planning and trip chaining
- re-direct research and analysis to operations and energy saving construction approaches

Mid Term 5 to 20 years

- new vehicle technologies and infrastructure
- changes in sources of electricity
- changes in scale and nature of movements of energy products
- incorporate new PMT/VMT effects in demographic trends
- recognition of embedded energy and GHG in construction processes
- recognize non-transportation energy improvements in other sectors – agriculture, commercial services, housing, electricity generation.

Long Term 30 to 50 years

- substitutes for mobile fuels
- substitutes for carbon-based fuels
- long term life style trend changes
- changes in productivity keyed to energy
- changes in energy intensive and non-intensive industries
- ultimately the issues will come down to how we produce electricity

Distinctions from Air Quality There are important differences between the treatment of GHG emissions and historical air quality approaches that need to be recognized in any attack on the current problems. Already noted is that the time frames are different – almost diametrically opposed. The emphasis on near term responses in GHG emissions argues for a cost-effectiveness based process with emphasis on present-worth kinds of approaches where a solution today is far more valuable than a solution some-time off in the future. Long-term options such as major infrastructure construction and reorganization of land uses need to be severely discounted. The nature of the solutions in GHG emissions will be even more technologically determined than air quality has been. More importantly, responses to GHG emissions will largely be nation-wide and even world-wide, as contrasted to the metropolitan scale of air quality approaches. The project-based approach typical of air quality remediation will be much less of a factor in regard to energy reductions and emissions. But perhaps the most important distinction is that in the present instance the interests of the consumer and the regulators are aligned and there will be far fewer cost-based conflicts as a result. If engineers and planners can provide transportation capabilities, most specifically personal vehicles, with lower fuel use and lower emissions while not forcing unacceptable trade-offs in safety and utility, public support will be assured.

Emissions or VMT It must be agreed that the target is fuel use and related emissions not the existence of transportation services per se. Therefore, passenger miles of travel and ton miles of travel should not be the surrogate targets for reductions. For example, in the cross-sectoral concerns cited earlier, transportation appears to be the only sector in which output – passenger miles and ton miles – are targeted for reduction, rather than their emissions or fuel consumption. No one has proposed parallel cuts in agricultural or industrial outputs proportionate to their emissions, or reductions in the amount of housing or commercial activity. Perhaps it is that transportation, being a means to other ends, makes it easier to be more casual about reductions without a real sense of what is being lost. It may be reflective of other agendas at work. Many of the state pronouncements on GHG targets specifically targeting VMT, can be seen as mostly aspirational, often with little or no foundation or understanding of the social or economic implications of their actions. It is clear that transportation expertise and experience were not engaged in these expressions of sentiments. The Chairman of the President's (GWBush) Council on Environmental Quality had it right when he stated: "There is a stunning degree of innumeracy when it comes to the numbers surrounding climate change legislation." An important role for transportation professionals is to replace that innumeracy with something more substantive.

The four-legged stool -- Operations An almost standard conceptual tool today in this subject is the four-legged stool, with the four legs: Vehicles, Fuels, vmt/land use, and operations. It is the latter two that need to be further addressed here. It is a pleasant surprise that the usual three-legged stool has added a leg called operations, clearly an area of strength of ITE. Operations is a powerful player in this arena for a substantial number of sound reasons. The first is that it is, at least relatively, an immediate action program, not subject to most of the long term planning and review delays of capital intensive approaches. The GHG emissions issue places great emphasis on early action placing operations in an important light. Beyond what might be called traditional operations; congestion response – deriving the maximum service levels from existing facilities – there are other operational aspects of interest. These include the operation of vehicles – eco-driving is the term of use in Europe – training drivers to handle their machines in an energy-effective manner, and managing facilities to assure efficient flow speeds. This could extend to vehicle routing, trip chaining, load factors and fleet optimization. All non-motorized transportation would also fall under this rubric. The second key element in operations as illustrated by many of the above elements is that there is no heavily embedded energy or GHG in the construction of the tools employed such as would be the case in the development of new roadways or transit systems. An important third positive factor regarding operations is that it represents a no-regrets approach with little down-side. All of the above-mentioned tools and others provide positive pay-offs even were the concerns re energy and GHG to be obviated.

The four legged stool – Land Use Just as strong as the operations case is, the almost opposite applies to prospective land use solutions. There is little in the way of pay-offs in the immediate near term. Most land use pay-off potentials are in the long term future and studies to date place the potential pay-offs even there as limited.[3] This is even more true today with immense housing hang-overs across the country. Moreover, from a demographic perspective today's population doubling rate is on the order of 100 years contrasted to about 50 years back in the fifties. Also an aging population tends to be a more sedentary population with moving rates far lower than younger age groups. The second differing aspect is the embedded energy nature of the high density land use approach – it would require substantial new construction with all that entails in terms of embedded energy. This is not to suggest there are no opportunities here but to make certain that such opportunities are addressed in a realistic light. As housing construction continues in the future it should be assured that there are no regulatory or market impediments to building in ways that the public wants or that builders are willing to provide – whether high density or low. This suggest that the policy should be a "let it

[3] Growing Cooler ULI, 2007

happen" rather than a "make it happen" policy approach. A coercive approach that forces the public to live in ways that some find efficient is fundamentally bankrupt, founded on way too little knowledge. We need to be more modest in our prescriptions. The American public has no obligation to live in ways that makes it convenient for us to serve them. Given the existing distribution of land uses in any metropolitan area today, the potential exists for the public to "optimize" their travel rather dramatically if they choose. They can live nearer to work if the work trip is more important to them than other amenities. They can live nearer shopping or other opportunities as they prefer. The fact that they do not tells us something – at a minimum it tells us that the situation is a bit more complex and multifaceted than our often simplistic analyses reveal. Monitoring future trip lengths as a measure of the public's real interest in such opportunities/amenities should be a part of our quantitative approach.

RECOMMENDATIONS

In many respects ITE and its members are ideally situated to play a substantial roles in these areas of interacting concern. Many of the central issues facing the nation fit well the professional skills and experience of its world wide membership. Perhaps the most crucial is whether the decisions that we must address will be made based on quantitative decision-making or on political grounds among battling advocacies. I would argue that this set of challenges is even more oriented to quantitative analyses than the challenges of air quality. This plays to the strengths of the profession. The profession must focus its thinking and its proposals around data, around modeling capabilities, and around cost-effectiveness or cost-benefit approaches. It must help guide the decision-making ahead of us toward a strongly quantitative process – to everyone's benefit. It must be a champion for substantive, sound analysis.

Often when a subject area is as new, as global climate change or energy security is to many, there is a very salutary emphasis on educating ourselves. Because it is new it becomes acceptable for decision-makers to admit their ignorance and to pursue ways in which to seek expertise and to learn more. ITE members can be the great educators in the field, working in their communities and states, and at the national level, becoming a trusted source of sound advice and understanding regarding many of the interrelated factors involved. In these early stages, just as in the first energy crises of the mid and late seventies, political advocacy will lose out to more sound quantitative reasoning only if there is a strong trusted professional resource.

Working Where The Light Is Good

ITE professionals can take on the role of strongly advancing those areas where their expertise is undisputed. Some of these areas are:

Promote Enhanced Operations – ITE must become the central advocate for expanded utilization of improved operations capabilities to reduce fuel consumption and GHG emissions through improved traffic flow. This activity and the promotion of eco-driving, discussed below, have the great reward of being low cost, immediate action opportunities with immediate rewards in all sectors of concern. This will take action by members at all levels – communities, metropolitan areas, states as well as in Washington.

Promote Eco-Driving – this approach, focused on the driver's behavior is a natural fit with Enhanced Operations, utilizing the best of the experience being tested in other countries, where savings of up to 10% have been observed. It will take operations knowledge and public information capabilities.

An Extensive Public Information Program – one of the great disappointments of the recent surge in fuel costs has been the failure of governments at all levels to address the public's concerns and to assist them in responding. Such public recommendations as traveling at slower speeds, assuring correct tire inflation, fewer start-stop cycles, could have been responsive and helpful. More broadly the promotion of carpooling, of working at home and revised work schedules could have had immediate benefits to travelers and to society but were almost totally un-discussed. ITE membership can undertake that role going into the future, documenting the strong and immediate benefits of such approaches.

Advance a more Effective Planning Process – it is a given today that the planning process is too slow and clumsy for current and future needs. ITE can play a very effective role in assuring that prospective legislation and subsequent regulation recognizes the need for a rigorous, professional, quantitative process conducted in a timely fashion. A major part of that will be a shared sense of need for performance measurement and performance-based decisions.

Advance Progress in Infrastructure Adaptation – it is recognized that adapting our existing Infrastructure and operations to changing weather patterns will be an important facet of our concerns in transportation. In many of these areas, and particularly with respect to emergency management, the profession will have a powerful role to play.

Advancing the Research Agenda – many of the areas of concern identified here are areas of weakness in understanding and experience. A strong research agenda must be defined, justified, funded and managed. ITE is a natural player in this arena. Its members must be very active participants in the research process.

An Educated Participant

There are other critical areas where, although not within the traditional strengths of ITE and its members, they can still play an educated and knowledgeable role:

Taxation – It is recognized that public investment revenues are grossly inadequate. ITE can play a significant role in making the case for effective mechanisms of revenue-raising that can produce the needed revenues. The coming months will see an

astonishing array of revenue devices being proposed. Sound criteria for judging these revenue devices will be needed including traditional revenue tools and new ones such as stimulus packages, cap and trade, carbon taxes, etc.

Vehicle Efficiency and Fuel Technologies – perhaps the central transportation issue of the current era will be how fast, and with what effects, can we turn over the nation's vast fleet of about 250 million vehicles. One important aspect will be which vehicles with which technologies and fuels are to be promoted. Finally the system implications of these new vehicle fleets need to be assessed, including their traffic implications and safety consequences.

More effective Legislation and Regulation – because transportation is not properly appreciated in public policy, ITE must be a leader in making the case for the value and importance of transportation. A large part of this will be in being prepared to demonstrate the value of transportation to the society in both economic and social terms. If our transportation goals can be met by everyone staying home and goods not moving, we need to rethink our goals. The profession can provide the leadership at all levels of government in making that case.

Were our resources great and were the problem not serious we could perhaps afford a business as usual approach with funding of advocates in proportion to noise level and a unhealthy dollop of earmarks. But if, the problem is serious – and it is, and if our resources are limited – and they are, then we must address these challenges in more quantitative and substantive ways, founded on sound information and analytical methods. ITE has an immensely important role to play in assuring that approach.