Innovations

for

Tomorrow's

Transportation

Issue 1

May 2009

Acknowledgements

This first issue of Innovations for Tomorrow's Transportation is a result of research conducted for and discussed at a workshop held on January 9, 2009. The workshop included a diverse group of leaders in the transportation research field, who are listed below. Without the valuable contributions and insight of this group, this issue would not have been possible.

Workshop Participants

- Ken Adler, EPA
- Jennifer Ahlin, VDOT
- Sherri Alston, FHWA
- Victor Aragonés, FRA
- Paul Argyropoulos, EPA
- Jack Basso, AASHTO
- Paul Bingham, Global Insight
- Ken Boyer, Michigan State University
- Dan Brand, Charles River Associates
- Joe Bryan, Halcrow
- David Carlson, FHWA
- Bill Cowart, Cambridge Systematics, Inc.
- Cindy Essenmacher, FHWA
- Cristiano Facanha, ICF
- Jonathan Gifford, George Mason University
- Bruce Griesenbeck, Sacramento Area Council of Governments
- Ben Hawkinson, FHWA
- Damon Hill, ENO Foundation
- Michael Johnsen, FMCSA
- Robert Kafalenos, FHWA
- Anthony Kane, AASHTO
- Peter Kissinger, AAA Foundation for Traffic Safety
- David Kuehn, FHWA
- Michael Lawrence, Jack Faucett, Joung Lee, AASHTO
- William Linde, FHWA
- Steve Lockwood, PB Americas
- Becky Lupes, FHWA
- April Marchese, FHWA
- Gary Maring, Cambridge Systematics, Inc.
- Regina McElroy, FHWA
- Michael Onder, FHWA
- Mary Phillips, FHWA
- Ben Pierce, Battelle
- Robert Poole, Reason Foundation
- Jeff Price, FHWA
- Sherry Riklin, FTA
- Ben Ritchey, Battelle
- Mark Sarmietto, FHWA
- Craig Secrest, High Street Consulting
- Darren Timothy, FHWA
- Mary Lynn Tischer, VDOT
- Diane Turchetta, FHWA
- Jack Wells, DOT
- Porter Wheeler, Maryland Transportation Authority
- Karen White, FHWA

The workshop was facilitated by the presentation and guidance of six workshop participants, each of whom prepared one of the briefing papers included in this issue of Innovations. A brief biography for each speaker is provided below.

Steve Lockwood provides a unique combination of policy, finance, program, and technology knowledge and over 35 years of applications experience. He has special expertise in transportation-related institutional development and serves as consultant to state governments and associations. Prior to joining PB Americas, he served for three years as the senior Federal Highway Administration Policy Officer, two years as Director of the Transportation 2020 Coalition and over 15 years as a principal-in-charge leading highway and transit planning projects.

Paul Argyropoulos is a Senior Policy Advisor in EPA's Office of Transportation and Air Quality. He is responsible for providing advice and analysis to the Office Director on a broad range of transportation program issues with a focus on fuels. He chaired EPA's intra-agency work group for the first renewable fuels standard program and currently chairs the workgroup responsible for developing the new renewable fuels standard rule required under the Energy Independence and Security Act of 2007.

Christiano Facanha is a transportation engineer with 10 years of experience in the freight transportation industry. Most of his work focuses on transportation modeling to evaluate the energy and environmental impacts of freight transportation. Dr. Facanha currently is employed by ICF International where he has evaluated emission models to better quantify emissions from freight transportation.

Bruce Griesenbeck has 20 years of experience in transportation planning and travel demand modeling, working directly for public agencies. He is currently the Principal Transportation Analyst for the Sacramento Area Council of Governments (SACOG), and leads the transportation forecasting and analysis team and the transportation monitoring team. Over the last three years, he has led the development and implementation of SACOG's regional activity-based travel demand model, the first such model to be based on parcel-level land use data.

Joe Bryan is a Vice President for the surface freight transportation practice of Halcrow in Boston, MA, with over 25 years of experience in the field. He possesses broad practical experience in freight carrier management in multiple modes and has been a substantial contributor to the development of public and public-private freight planning in the United States. Mr. Bryan is an author of the original AASHTO Freight Rail Bottom Line Report and has contributed to subsequent series on logistics and multi-modal freight.

Dan Brand is a Senior Consultant to CRA International and has chaired three TRB standing committees: Passenger Travel Demand Forecasting, New Transportation Systems and Technology, and ITS. Mr. Brand has provided assistance in travel demand forecasting and planning to agencies in nearly every major city in the United States and cities in Europe and Asia. Prior to his 30 year career at CRA, Mr. Brand was the Massachusetts Undersecretary of Transportation.

In This Issue

Foreword

Karen White, FHWA Office of Transportation Policy Studies

In the early 1990s, the Office of Policy and Governmental Affairs embarked on a research journey entitled "Searching for Solutions, A Policy Discussion Series." These 17 reports included areas that, at the time, were exploratory and advanced. The wide-ranging and forward-thinking topics included congestion pricing, public-private partnerships, public and private sector roles in intelligent vehicle highway systems, productivity and the infrastructure, air quality, productivity measures, bond financing, land use and transportation, life-cycle cost analysis, North American trade, cost allocation, and the personal transportation survey. New topics have not been added to the series for almost 10 years, and the time has come to bring focus and attention into the policy challenges of the future.

The transportation system is facing new challenges to deliver and implement passenger and freight systems that meet the needs of mobility and economic growth. To synthesize the multifaceted issues facing highway transportation, the Office of Transportation Policy Studies is initiating this new series of Transportation Policy Discussions. As its predecessor did, this series will examine challenges and solutions across a broad range of topics including: (1) implementation issues for vehicle miles traveled (VMT) based user fees; (2) issues and options with respect to infrastructure banks; (3) achieving intermodal interoperability; (4) optimal fees for commercial motor vehicles; (5) financial structures for mega-region projects; (6) implications of alternative fuels; (7) meeting the needs of the aging population; (8) role of the Federal Government in solving urban transportation congestion; and (9) other topics. However, rather than being strictly defined by these initial topics, the series is expected to encompass policy discussions covering a wide range of topics over the course of the next five years.

This first issue of Innovations for Tomorrow's Transportation is the result of the effort of many transportation leaders' input, insight, and discussion. It provides an encompassing framework outlining transportation research needs in six policy areas. Future discussions and workshops will bring experts and government officials together for other topics of interest. Many of these topics will provide useful input into future surface transportation legislation by providing a forum for researchers and stakeholders to discuss future directions of highway delivery. These future topics include implementation issues and options for a VMT-based user-fee system and issues and options related to infrastructure banks.

We look forward to the continuation of this series!

At A Glance

On January 9, 2009, a compendium of U.S. Department of Transportation (DOT), State, and Local transportation officials, as well as industry experts, convened to discuss six existing and emerging crucial transportation topics. This diverse group of transportation experts heard background briefings on each topic and engaged in detailed dialogue and discussions to identify critical research needs needed to support the surface transportation legislative reauthorization. The six topics highlighted for consideration by meeting participants consisted of:

1. Future markets for public-private partnerships
2. Implications of alternative fuels on transportation
3. Policies to reduce greenhouse gas (GHG) emissions associated with freight movements
4. Linking transportation and land use
5. Achieving intermodal interoperability for freight movements
6. Impacts of higher fuel costs.

For each topic, a background briefing paper was prepared, distributed, and presented to meeting participants prior to any detailed discussions. These background papers were designed not only to provide a common backdrop, but also to provoke discussion on emerging research needs. These briefing papers are presented in detail in this issue of Innovations for Tomorrow's Transportation. Following each presentation, meeting participants were organized into multidisciplinary and multi-organizational discussion groups to exchange ideas and to identify areas where existing research does not adequately address the current or emerging issues.

Despite the breadth of research topics considered, several common themes were identified by participants of the various targeted discussion groups. For example, workshop participants clearly identified the need for, and benefits of, increased public involvement and outreach and consistently stressed the need for DOT to continue and enhance existing education and outreach activities. Other cross-topic research areas were identified including research regarding a mileage-based or VMT-based tax and intermodal operability.

In the transportation community, it is widely understood that the current revenue streams are not sufficient to sustain the highway system in the United States. Many, including the Congressionally mandated National Surface Transportation Infrastructure Financing Commission, suggest that moving to a VMT-based tax is one avenue that should be considered[1]. Prior to adoption of this alternative approach, workshop participants identified that research is needed on the role of public-private partnerships in administering a vehicle miles traveled fee and understanding travel behavior changes as a result of implementing a VMT-based tax.

Intermodal operability continues to be a focus of research and investigation by DOT and others, and is an area for further research within the context of reducing GHG emissions, transportation and land use, the impact of alternative fuels, and within the general area of interoperability itself.

[1] National Surface Transportation Infrastructure Financing Commission, Final Report, "Paying our Way: A New Framework for Transportation Finance," February 2009.

Overall, workshop participants identified more than 34 different research needs among the six topic areas. These research needs are listed below. Additional details are provided in the main body of this issue of Innovations for Tomorrow's Transportation.

Future Markets for Public-Private Partnerships (PPPs)

- Public sector "comparator" model
- Procurement risks to private sector for public-private partnerships
- Outsourcing operations and maintenance on a broad system-wide basis
- Model concession agreements
- Tolling on the interstate highway system
- Implementation of a mileage-based user fee
- Best markets for public-private partnerships
- Multi-state public-private partnerships
- The impact of the current financial climate on public-private partnerships

Policies to Reduce Greenhouse Gas (GHG) Emissions Associated with Freight Movements

- Imposing pricing mechanisms to promote fuel efficiency gains in the freight system
- Improving truck fleet fuel efficiency
- Encouraging mode shifts to more fuel-efficient modes
- Understanding the effects of congestion on truck fuel efficiency and GHG emissions

Impacts of Higher Fuel Costs

- Investigation of VMT leveling in 2004
- Impact of gasoline price volatility
- Impact of low oil prices
- Impacts of fuel prices on travel behavior
- Guidance on forecasts of vehicle operating costs
- Impacts of fuel price increases on the financing capacity of states

Implications of Alternative Fuels on Transportation

- Impacts of alternative fuels on safety
- Impact of production and distribution of alternative fuels on infrastructure
- Characterization and prioritization of collective alternative fuels public policy goals
- Assigning a dollar value to impacts
- Impact of alternative fuels on highway revenue

Achieving Intermodal Interoperability for Freight Movements

- Examination of improvements through information technology
- Role of governments in facilitation of common asset pools
- Adaptive solutions for improving interoperability
- Incentives for innovation in interoperability
- The effect of interoperability improvements on system capacity
- Case studies of system change

Linking Transportation and Land Use

- Enhance commercial vehicle modeling and analysis capabilities for local Jurisdictions
- Assessing the feasibility of sustaining projects combining transportation and land use
- Enhanced household travel surveys
- Macro versus micro characterization of land uses

Future Markets for Public-Private Partnerships

Steve Lockwood, PB Americas

Introduction

Public-Private Partnerships (PPP) have long been part of the highway development process – starting with outsourced design, construction, and routine maintenance. The evolving context for highway development offers expanding opportunities to systematically capitalize on private resources – financial, management, and technical. As discussed below, these go well beyond public-private toll projects that have received considerable attention to include other areas that are not as clearly addressed in highway policy or related policy research.

These are not new challenges. At the November 1991 post-ISTEA FHWA Policy Seminar "Exploring Key issues in Public- Private Partnerships for Highway Development" – part of the *Searching for Solutions* series – the current author noted: "*Provisions of [the Intermodal Surface Transportation Efficiency Act of 1991] ISTEA, together with new technology, may make toll financing and public private partnerships an attractive option by which states can capitalize on private sector resources such as new capital source, user charge options and innovation in design construction and operations, However, there remain significant issues …which require systematic review."*[1]

That we are still having a conversation on this topic 17 years later is testimony to the challenge of change in a complex institutional context, barring significant external pressures.

21st Century Challenges

The owners of the nation's highway system face daunting challenges in maintaining and improving service. A combination of resource limits on new capacity despite increased travel demand and an increase in the financial burden of the maturing infrastructure has indicated the need for more efficient development and management of the highway assets – both in terms of maintenance and operations – and additional investment resources to supplement constrained taxes. A series of evolving national and regional program initiatives under discussion offer additional challenges including the need to improve basic infrastructure networks, respond to environmental and energy imperatives, and an increased political demand for performance and investment accountability. At the same time, many state and local highway entities are constrained by the current recession-related agency downsizing and the challenges of evolving new technology. The current financial crisis adds to these constraints. It seems clear that new approaches, including changes in the roles of the players, are called for to meet the challenges.

1. Excerpt from Introduction: "Exploring Key issues in Public-Private Partnerships for Highway Development" No. 2 in the FHWA series *Searching for Solutions,* FHWA Office of Policy Development, 11/21/1991

A gradual rationalization of highway-related responsibilities for efficiency purposes among agencies, jurisdictions and sectors that includes downsizing, devolution, and new public-public and public-private partnerships is already under way. Figure 1 illustrates this evolution.

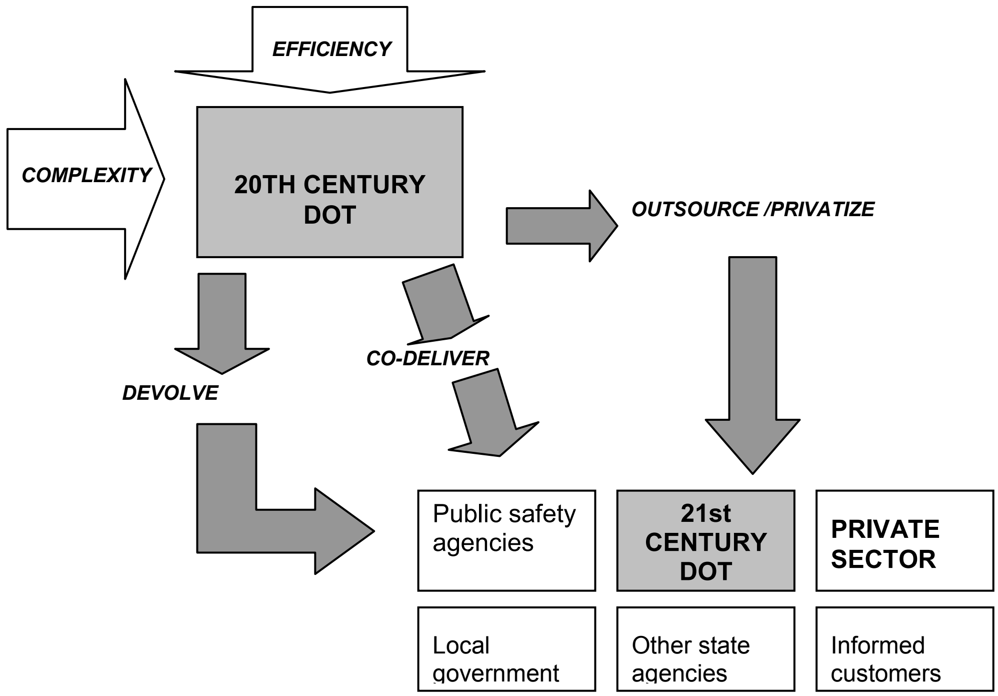


Figure 1. The 21st Century State DOT

The Private Sector Potential

The private sector dominates the $1T highway transportation systems and services sector with the exception of the 10% comprised of infrastructure. The contrast between the public and private sector roles in transportation compared to utilities and communications is striking as highway infrastructure is the only remaining major public sector infrastructural monopoly in the United States. At the same time, however, private sector entities possess technology, management, and financial capabilities that are increasingly relevant for efficient and effective highway infrastructure programs such as project management, ITS development and systems operations, asset management, toll road finance and development, and vehicle-related information systems and services. The potential of the private sector is based on the flexibility of the private sector to provide experienced management and specialized technology, access to innovative finance, the experience, market and customer responsiveness, and the potential for competition-driven performance. Key service areas include:

- Project management expertise
- Access to private capital and innovative financial expertise
- Flexibility to provide varied asset management resources efficiently
- Complex systems development expertise and real-time systems operations experience
- Customer-based service development and market responsiveness

- Potential for innovative alliances to provide new products and services.

Both public sector constraints and private sector opportunities indicate the potential for a new allocation of public versus private sector roles, together with related risks and rewards. Such an evolution already has taken place in many of the other advanced economies.

The potential new and/or enlarged roles for the private sector cover the complete range of highway development and services activities – and can be (and have been) bundled into several possible packages for new partnership arrangements as shown in Figure 2. These partnerships are based on a range of business models including fixed price or fee procurement of services, product acquisition, leasing, concessions, or privatization.

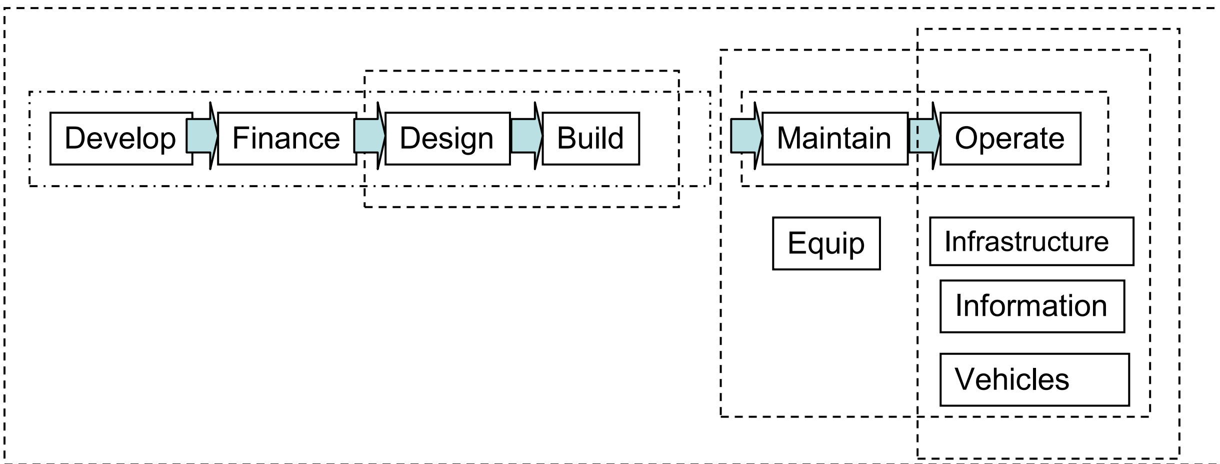


Figure 2. Range of Scopes for Public-Private Partnerships

Areas for Public-Private Partnerships

The capital focus of the federal aid program has resulted in, at the federal level, the focus of major PPPs on finance and private toll roads. While this is understandable, the potential roles of PPPs are considerably broader – and, from the state and local DOT perspectives – equally important. The discussion below focuses on five principal arenas:

- Design-Build fixed-price contracting
- Outsourcing network-level maintenance and/or operations for a fee
- Private toll roads via leases and concessions based on toll revenues
- Manage VMT/pricing systems administration for a fee
- Vehicle-Infrastructure Integration based on service revenues.

These opportunities are discussed below in terms of service focus of the PPPs as well as the current and future trends.

Design-Build Fixed-Price Contracting

Focus – Design-build (D-B) contracting offers the opportunity to capitalize on private design/construction management expertise and incentives in order to streamline project development -- especially for large projects that strain DOT staff resources and that have a modest track record for cost and schedule control. It also shifts responsibility and risks for project cost and schedule slippage to private entities that are incentivized to eliminate them by the fixed-price contract. D-B is the international convention for infrastructures development and is commonly used on all toll projects in the United States. However, its advantages also relate to conventional highway development. Since the inception of SAFTEA-LU, many of the significant federal constraints have been eliminated (project size, NEPA, and procurement) via federal rules. Over one-half of the states have highway D-B legislation and it is being used on more than 700 major and minor projects nationwide.

Future Trends/Market – The market for D-B will continue to increase as state DOTs and other highway agencies are downsized. Major projects are increasingly an exception rather than the rule in transportation agencies; therefore, agency staff cannot be maintained for these projects. D-B contracting could grow to as much as 50% of highway expenditures for capacity (or 10-15% of total highway expenditures.) From the industry side, the mergers and acquisitions activity in the construction industry will encourage this trend.

Significance/Federal Role – Improving project delivery is important to gaining public confidence in the highway program. FHWA has substantially deregulated D-B.

Outsourcing Network-Level Maintenance and/or Operations for a Fee

Focus – Given the increase in both recurring and non-recurring (incidents) congestion, it is apparent that maintaining current levels of service is substantially dependent on aggressive, real-time operational management of the highway network such as incident management, ramp metering, and work zone traffic control. These functions require the deployment of intelligent transportation systems (ITS) infrastructure and the acquisition of operations capabilities, which strain current DOT capabilities and resources. The few state DOTs with strong systems operations programs also are utilizing outsourcing for systems operations that include ITS and field activities (TMC operations, SSP, 511, probe data). Motivations include staffing limitations, time for procurement, and ease of change in the level of investment.

Systematic maintenance programs in the form of "asset management systems" are being increasingly deployed by DOTs to more effectively cope with their increasing maintenance burden. Legislative mandates, lack of equipment, a need for specialized expertise or equipment, downsizing and retirements, and perceived cost savings have encouraged some states to undertake outsourced system-level asset management/maintenance. System-level asset management outsourcing is common in the UK, Australia, Canada and the United States, and has been utilized by a few states such as Virginia, Florida, Texas, and Tennessee. Although early results on costs and performance have been mixed, it appears that states are gaining experience with scoping and performance management to gain the intended advantages. In addition, the competition for asset management is developing and growing as opportunities are perceived.

Future Trends/Market – Small contractors and labor union concerns have constrained the rate of asset management outsourcing, together with the slow rate of state DOT efforts to fully institutionalize asset management approaches. Staffing and investment efficiency pressures are likely to lead to additional system-level outsourcing. Outsourcing is still ad hoc and limited, but operations and maintenance costs range from 25% (average) to 50% of total highway expenditures. Outsourcing is closely tied to further performance-driven mainstreaming congestion-management initiatives with real-time operations.

Significance/Federal Role – System management, both assets and operations, provide significant opportunities for performance improvements. The interest in outsourcing will be directly proportional to the pressure for increased performance accountability in an environment of agency staff and resource limitations.

Private Toll Roads via Leases and Concessions Based on Toll Revenues

Focus – Toll roads have maintained their 5% to 6% share of total highway finance as overall investment has increased. Most of these facilities are public authority facilities using tax-exempt finance and authority credit. Private involvement as developer/financer/owner/operator of toll roads is a major development. PPP toll roads have focused primarily on creating new capacity as new roads or upgrading existing highways, but in a few cases have undertaken "take over" and upgrading of existing roads via concessions.

Since the inception of ISTEA, there is growing experience with tapping private finance in the form of equity and debt as well as creative financing to supplement conventional highway finance. Currently, 25 states have some kind of PPP authority. Within the realm of financing, there is a broad array of approaches available for consideration that range from full privatization via leases and concessions to a variety of financing mixes involving the combination of private debt and/or equity with public funds and public credit support to the private financing. Over the last 15 years, FHWA has developed a range of financing credit support (TIFIA, PAB) to encourage and support private investment. At the same time, there has been important standardization in procurement and contracting approaches through the experiences in Texas and Virginia.

Current PPP toll roads include SR 91 and SR 125 in California, the Dulles Greenway and Pocahontas Parkway in Virginia, Texas SH 130, and the Virginia Beltway High Occupancy Toll (HOT) lanes that are currently under construction. In fact, according to a current survey conducted by Parsons Brinkerhoff for FHWA, there have been 53 toll projects creating new centerline miles and an additional five projects that have extended or widened existing toll roads since ISTEA was enacted. Additionally, there have been 11 HOT projects. Looking to the future, there are another 106 toll projects and 58 HOT projects in various stages of design, finance, or NEPA clearance. Ten new PPP toll projects (new centerline miles) have been opened since ISTEA was enacted (including some very small projects) and there are another 12 PPP projects committed in eight states with another 26 projects (including six additional states) that are currently under consideration.

In addition to tolls being used to create new capacity, major interest has been spurred by the concession model involving sale and/or conversion of existing roads in return for a major up-front payment. Three major multi-billion dollar concessions have been let (Indiana, Chicago, Dallas), providing significant funds to DOTs for transportation and other purposes. In addition, there has been innovation in privately financed roads without tolls – using "availability payments" from conventional public resources rather than tolls. A recent federal rule clarifies the framework for concessions let on existing federal aid facilities.

Future Trends/Market – The toll projects survey indicates both the increased utilization of tolling in more states in general and an increased focus on the potential of the PPP approaches. The PPP toll projects, currently in various stages of development nationwide, indicate a $57B level of investment. While the current demise of investment banks and debt uncertainty clouds the short-run level of interest in toll PPP, it also suggests a stronger role for equity.

Significance/Federal Role – Toll roads will make up an increasing component of new capacity that could rise potentially to 30% nationally during the next decade provided the projects currently being developed move forward. At $6B per year, PPP investments would amount to roughly 15% of total new capacity investment at current levels. For rapidly growing larger states such as California, Texas, Florida, and Virginia, tolls already are playing an even larger role in capacity development as they represent as much as 50% of the investment. This level of investment may continue to increase.

Concessions with up-front payments are attractive to state DOTs for their revenue redistribution potential as evidenced by continuing interest in Pennsylvania and New Jersey. A major inhibitor to toll road development has been resistance to conversion of free roads, especially the Interstate facilities, which are located in the major toll markets. Deregulation of the Interstate, accompanied by federal regulation of rates, competition, use of resources, and returns, will have a major impact and substantially increase project development velocity.

Manage VMT/pricing systems administration for a fee

Focus – While pricing is not necessarily dependent on a PPP framework, the politics of pricing may favor the private sector as implementer – given the increased public acceptability of pricing by private entities. The interest in peak-period pricing is increasing. At present, there are five public highways and/or HOT facilities and two bridges with peak-period pricing. However, there is only one operating PPP with pricing (Dulles Greenway), although CA SR 91 was originally developed and operated as a PPP-priced facility.

Private sector involvement could take on greater significance if there is a national program that uses vehicle miles traveled (VMT) fees as a major source of highway revenues. In particular, private sector involvement could serve as a mechanism for optional pricing evolution to VMT. This already has begun to occur in the International Arena. For example, the German truck road-pricing program has been developed and administered by a private consortium.

Future Trends/Market – VMT pricing concepts and technology are in the research and development stage. Significant piloting may emerge in the next reauthorization of the federal aid program. Several private entities have proprietary technologies that need to be evaluated and considered prior to national implementation.

Significance/Federal Role – A VMT-based funding mechanism represents a major change in the administration of the federal aid program. As such, there are a large number of conceptual, legal, technological, institutional, marketing, deployment, and management issues that still need to be examined and resolved.

Vehicle-Infrastructure Integration Based on Service Revenues

Focus – The advances in GPS and high-speed wireless communications together have resulted in systems being developed that provide the potential for collision avoidance, probe-based mobility information, and a range of in-vehicle services relating to information regarding infrastructure conditions and weather, roadside services, vehicle warranty and maintenance, etc. Capitalizing on these technologies for their full safety benefits involves connecting vehicles to signals, vehicles to other vehicles and to off-road data and analysis systems. The technologies for vehicle-infrastructure integration (VII) are currently under development as a formal PPP involving the private vehicle manufacturers, communications and service providers, and federal and state transportation agencies.

Future Trends/Market – The VII program is in a state of development and is impacted by the current status of both the federal highway program and the automotive industry. Certain features inherent in the VII concept – such as improved vehicle to roadside communications for commercial purposes are already in the market via after-market devices and for fleet applications. Federal research on key safety systems and technology options continues.

Significance/Federal Role – From a public sector point of view, such vehicle-to-infrastructure integration can significantly impact fatality and accident reduction. In addition, it provides the basis for network-wide "perfect" highway conditions information system for congestion management. From a private sector point of view, introduction of V2V and V2I systems has the potential to provide a wide range of vehicle and in-vehicle commercial services. Taken together, VII represents a key step on the way to highway automation and a radical transformation of vehicles into electronic service platforms – with consequent impact on the entire highway arena. The federal role in VII and the nature of the relevant PPP for VII currently is being reviewed in the context and recognition of financial constraints, the state of the automotive industry, and the potential of various technologies and systems to be organized into an evolutionary framework, supported by federal research and standards.

Public-Private Partnerships in the Future

Overall, PPPs will continue to increase in significance as infrastructure programs increasingly focus on maintenance and systems operations. Figure 3, based on the discussion above, suggests the scale of the potential private role in the near future.

PPP Arena	Percentage of Total Annual National Highway Expenditures	Effectiveness/ Leverage	Federal Role
D-B Fixed Price Contracting	*10-15%*	*Low but widespread*	*Established*
Outsourcing of Maintenance & Operations	*10%*	*Modest and concentrated*	*Promotion*
Private Toll Roads	*10%*	*Modest and concentrated*	*Legislation/Promotion/ Regulation/ Support*
VMT/Pricing Program Management	*2%*	*High and widespread*	*Legislation/Promotion/ Regulation/ Support*
VII	*25%*	*High and widespread*	*Legislation/Promotion/ Regulation/ Support*

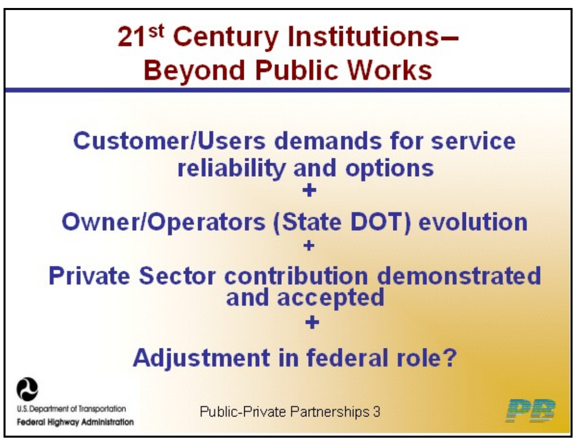
Figure 3: The Market for Public-Private Partnerships

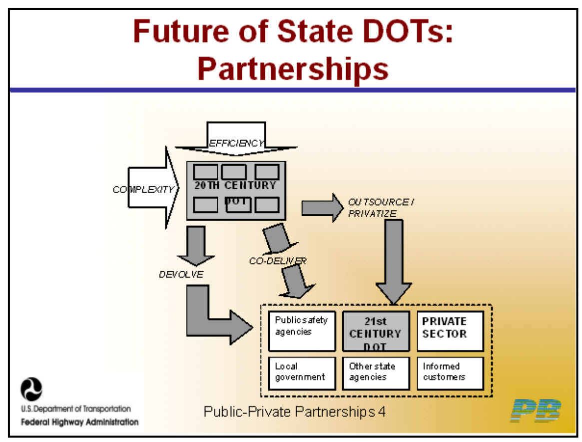
As indicated in Figure 3, the potential arena for private involvement in investment terms is not insignificant at 30% to 40% excluding the private roles in entirely new service enterprises such as VMT charging and VII. The nexus of complex program management, innovative finance, real-time operations, and market-responsive challenges plays to the obvious strength of the sophisticated private sector, which is located substantially outside the traditional highway transportation sector. Current trends in levels of service offered by the existing highway system make it clear that the traditional sectoral roles and institutional arrangements will not support an increasing mobile, complex, high-tech economy. As suggested in Figure 1, both network and services improvements will depend on a 21st Century transportation institutional framework that capitalizes on the respective strengths and responsibilities of the sectors and institutions within them.

The long-term implications of PPPs in the highway sector may be expected to evolve in directions consistent with other infrastructure-based public utilities and services such as power, water, telecommunications, etc. The “mobility corporation” concept would combine the complete range of functions discussed as PPP opportunities in this paper. It would involve private enterprise-type ownership and management, providing highway infrastructure-based services on a metropolitan or corridor scale. The corporations would own (by long-term lease) the network, improve and maintain it and provide a range of related operations and customer-convenience services for passenger and freight movement. It might be expected that special pricing, priority, and design features would be developed for specific user markets.

The public sector (state and local) would play a role similar to a public utilities commission for highways, regulating minimum service levels, prices, and general managerial audit, as well as developing a comparator or re-bid approach to ensure competitive service. The federal role at this point would be to provide FCC-type oversight and coordination to ensure that national interests are met.

Workshop Presentation





New Roles for Private Sector

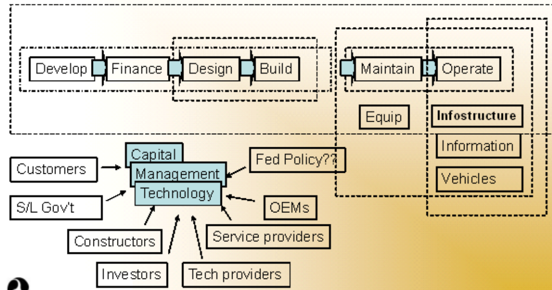
Private sector contribution: Capitalize on competition/innovation via:

- Developing projects efficiently
- Tapping asset value, augmenting taxes
- Incentivizing life-cycle investment
- Managing congestion
- Operating systems
- Improving safety

Also = business opportunities

U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 5

Roles & Resources, Partners & Program Scopes



U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 6

What: Private D/B Fixed Price Contracting

Why: Reduces unaccounted project cost & schedule creeps

How: Shifts risks/rewards to private entity

Who: Major Constructors

- *Status*
  - Utilized in larger projects with significant risk reduction
  - Widely accepted – over 700 D/B projects today
  - Federal constraints minimized (final rule)
- *Potential & Federal Role*
  - All major projects
  - Program performance comparisons

U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 7

What: Outsourcing of Network-Maintenance and/or Operations

Why: Improve Facility Network Efficiency/ Effectiveness

How: Performance contracting for incentivized aggressive high tech operations

Who: Specialized service providers

- *Status*
  - Supplements constrained agency staff
  - Operations outsourcing (TMC, SSP, 511, AM) increasing in larger states
  - Asset management contracts in several states
- *Potential & Federal Role*
  - Impact of downsizing and performance challenges
  - Market up to 30% of total expenditures in some states

U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 8

What: Private Toll Roads

Why: Supplement conventional finance and development/management skills

How: Leases and concessions tapping private investment

Who: Financial institutions, equity funds and constructors

- *Status*
  - 7% of revenues, but key to new capacity in growth states
  - 10 PPP toll roads – range of models (some small)
  - Interest in concession up-front payments
- *Potential & Federal Role*
  - Future PPP potential: 38 of 79 toll roads under development = $60B
  - Pricing policy, credit support
  - Deregulation of Interstate

U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 9

PPP Toll Project (Survey)

- **Toll Activity**
  - Total toll "facilities" opened since ISTEA = 53
  - Total toll "facilities" currently in development = 79
  - HOT lane "projects" currently in development = 58
- **Percent of total highway capacity investment represented by tolls going forward**:
  - Total value of toll/HOT projects currently in "development" = $126B
  - Total tax funded Highway annual capacity investment (current rate) = $40B/year
  - Potential toll % all future capacity investment = +/-30 % (more in some states)
- **PPP toll projects**:
  - Total PPP toll/HOT projects opened since ISTEA (7 states):10 = $2B (only)
  - PPP toll/HOT projects committed (8 states): 12 = $19B
  - PPP toll/HOT projects "possible"(6 add'l states): 26 = $38B
  - Potential rate of PPP investment/year = $6B/yr over 10 years
  - Total potential PPP investment of all future capacity = +/-15% (big uncertainty)

U.S. Department of Transportation Federal Highway Administration — Public-Private Partnerships 10

What: VMT Fees/Pricing Administration

Why: New fee collection system nationwide supplementing fuel taxes (& managing demand)

How: General application – upper level system

Who: (new) Private program management entities

- *Status*
  - Tax-raising resistance
  - State testing of technology
  - Congressional interest
- *Potential & Federal Role*
  - Legislation and standardization
  - Pilot programs and transition
  - PPP as program manager

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 11

What: Vehicle-Infrastructure Integration

Why: Major Reduction in vehicle crashes

How: V2V and V2I communications and controls

Who: OEMs, Communications, Service providers

- *Status*
  - Concepts & technology in proof of concept
  - Limited after-market services available
  - Uncertainty in both public and private commitment level
- *Potential & Federal Role*
  - Radical improvements in safety, mobility, information and services
  - Small fed investment X huge multiplier in business/benefits
  - Complex institution relationships to be worked out

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 12

The Markets for PPP

- $1T+ Highway Transportation Sector (infrastructure, services, vehicles) is already 90% private
- Reallocate remaining public $150-200B to achieve objectives
- Realistic comparators of efficiency and effectiveness
- New federal policy challenge:

Deregulate/facilitate vs. public interests

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 13

Potential Market Value of PPPs

PPP Arena	Potential % Total Highway Expenditure	Effectiveness/ Leverage	Federal Role
D/B Fixed Price Contracting	10-15%	Low but widespread	Established
Outsourcing of Maintenance & Ops	10%	Modest and concentrated	Promotion
Private Toll Roads	10%	Modest and concentrated	Legislation/ Promotion/ Regulation/ Support
VMT/Pricing Program Management	2%	High and widespread	Legislation/ Promotion/ Regulation/ Support
VII	25%	High and widespread	Legislation/ Promotion/ Regulation/ Support

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 14

Long-Term Evolution

- **Private Mobility Corporations**
  - Utility model with paying customers
  - Private investor ownership (like utilities)
  - Metro and corridor-level entities
  - Combine infra, operations, information, services (VII+)
  - New mobility products (transp-comms tradeoffs?)
- **State DOTs become PUCs to regulate**
  - Preservation of competition via corridors, rebids
  - Minimum LOS requirements

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 15

Federal Role in PPP Market Development

Reorganize F-A program to accommodate expansion of partnering

- Increase flexibility (deregulation of applications, mix, environmental review)
- Expand credit support (TIFIA, PAB)
- Promote innovation, demonstration
- Accommodate variation

- Regulate re national network interest protection
- Alternative Regulatory Models

U.S. Department of Transportation Federal Highway Administration

Public-Private Partnerships 16

Implications of Alternative Fuels on Transportation

Paul Argyropoulos, EPA[1]

Introduction

There are obvious links between the U.S. Department of Transportation and the U.S. Environmental Protection Agency just as there are linkages between fuel and the movement of people and goods. Without the highways, vehicles cannot travel with ease and, without the fuels, the vehicles cannot travel at all. While DOT's focus is on the transportation system, EPA's focus is on the environment, though again these two worlds come together in the form of the need for fuels and the vehicle emissions that result from the use of those fuels.

This paper is based on EPA's Office of Transportation and Air Quality's (OTAQ's) perspective. OTAQ's mission is to provide guidance and regulation on emissions from anything that uses fuel to move and some things that don't move including emissions from vehicles both heavy- and light-duty, on-road and non-road, and anything from hand-held equipment to power generation equipment, etc. As part of this mission, OTAQ regulates fuels and requires registration of fuels for compliance purposes. OTAQ requires information about the composition, toxicity, and emissions effects of fuels, and how this use would equate to meeting current emission standards.

The strategy that EPA began to develop and deploy back in the late 80s and early 90s was a systems approach. This approach recognizes that regulations may affect a range of stakeholders, all of whom are sensitive to the possible effects of EPA regulations on the cost structure of their industry. Stakeholders are naturally reluctant to incur new costs that would result in additional costs to consumers. EPA realized that stakeholders need to work together and develop a systems approach so that new regulations are based on common sense and also provide greatest amount of flexibility to the stakeholders with the least amount of impact, while still realizing that not every stakeholder will be happy with the final result. However, EPA believes that this approach yields a larger segment of satisfied stakeholders than would result from unilateral decisions and associated regulations. In keeping with this philosophy, EPA has designed programs to transition the industry into new regulations and provide flexibility, training, and banking programs with development of more stringent programs so that fuels are helping new technologies to be deployed. It makes the technologies easier to meet the emission standards and ultimately saves costs. Another dimension to EPA's systems approach is to consider, to the extent possible, not only the direct effects of regulations, but the indirect effects as well. In the case of fuels, this means that EPA may consider not only the emissions resulting from the use of the fuel, but also the emissions resulting from the production of the fuel.

Turning to alternative fuels, any discussion must start by defining what this term really means and how it is defined. For example, is this a fuel that is different than what we have now, a non-petroleum based fuel, a bio fuel, or a gaseous fuel? From EPA's perspective, "alternative fuels" are any fuels that are used in motor vehicles that differ from the existing fuels, which may

[1] Extracted from Oral Presentation by Battelle Staff.

include conventional petroleum fuels that have been modified by a change in formulation or it may be a completely different fuel type.

A New Renewable Fuels Standard

One of the major recent government actions was the passage of the Energy Independence and Security Act of 2007[2], which has the goals of reducing the U.S. dependency on foreign imports of oil and reducing the environmental footprint and greenhouse gas (GHG) emissions though utilization of new fuels and fuel blends. The Policy Act of 2005 had set forth national standards of renewable fuels of 7.5 billion gallons by 2012. The new Energy Independence and Security Act (EISA) changed this goal by significantly increasing this target to 36 billion gallons of renewable fuel by 2022. Currently, EPA is engaged in developing all of the new requirements that will be needed to meet all of the objectives of EISA. In particular, there are new categories for replacement of gasoline that have been expended beyond the on-road sector to the off-road sector to permit credit generation into some other pools as well. However, to be in compliance, there are a number of critical provisions that need to be met.

For a fuel to be used as a renewable product, it has to have been made from an approved renewable biomass and has to come from lands that have been previously cultivated. This criteria has far reaching implications for biofuels, including the need to conduct a life-cycle assessment to follow the distribution and refinement of feed stocks into renewable fuel including tracking where the feed stock originated, what land was it grown on, etc. Each fuel category has an associated standard that must be met with the exception that corn ethanol has been "grandfathered." Generally speaking, if it is a new fuel from a new facility, it has to meet a 20% GHG reduction over the fuel it is replacing, which was established in the Act as the 2005 petroleum-based fuel. Congress included provisions in the Act to provide for the situation where the new technology does not work or come on line as quickly as projected and the standards cannot be reached. In this case, EPA was granted the authority to issue waivers to the standards.

The proposed rulemaking for the second Renewable Fuels Standard (RFS 2)[3] requires that some renewable fuels must achieve GHG emissions reductions compared with the gasoline and diesel fuels they displace. To receive credit toward meeting the new standards, refiners must meet these requirements. For each fuel pathway, the proposed rulemaking takes into account GHG emissions produced over the full life cycle of the fuel. This includes production and transport of the feedstock, land-use change, production, distribution, blending of the renewable fuel, and use. The resulting life-cycle GHG emission level is then compared with the life-cycle GHG emissions of 2005 petroleum baseline fuels that are displaced by the renewable fuel. For renewable fuels to quality for RFS 2, they must meet or exceed the minimum GHG reduction thresholds. The thresholds for the four categories of renewable fuels are as follows:

- 20 percent less GHG emissions for renewable fuels produced from new facilities;
- 50 percent less for biomass-based diesel;
- 50 percent less for advanced biofuels; and
- 60 percent less for cellulosic biofuels.

[2] http://www.govtrack.us/congress/bill.xpd?bill=h110-6
[3] http://www.epa.gov/otaq/renewablefuels/

Ultimately, the implication of this Act is that there will be a shift in the distribution of fuels with renewable fuels obtaining a much higher volume than ever before. Under EPA's original Renewable Fuels Standard (RFS 1)[4], alternative fuels were only anticipated to displace 1%-1.5% of conventional fuels in the U.S. by 2012. However, under ESIA the expected change is much more dramatic with an anticipated 16% replacement by 2022. Further, within the transportation sector, petroleum-based liquid consumption is expected to be flat, replaced in part by bio-fuels.

Examining the projected distribution of biomass liquids in 2022, it is still expected that a large component of alternative fuel will be based on corn ethanol, bio diesel, bio-butanol, or a renewable fuel feed stock. There is a tremendous amount of technology that is currently in existence that has the potential to turn feedstock into a product that is very similar to conventional gasoline and diesel. It is clear that transportation will still be utilizing a type of liquid transportation fuel well into the future. However, how quickly technology develops, market penetration, and shifts in purchasing are still somewhat unknown. The recent drop in cost of crude oil has affected the price of gasoline and diesel. However, despite this reduction in price there continues to be a shift in the type of vehicles that the public is purchasing, with movement toward smaller, more fuel efficient vehicles. With changes in technology and shifts in the vehicle fleet, will come changes in GHG emissions.

The reduction of GHG emissions appears to be a priority for the new administration, although many have been working on this issue for a long time. The reality is we are going to see a shift in the change in the mix of types of energy sources – more in broad sector perspective rather than transportation sector. For example, we are still going to see a lot of the transportation sector GHG emissions associated with the shift into electricity, because the energy source for production of electricity is unknown. Quantifying this shift will be big factor in the evaluations of the impacts of GHG emission from the transportation sector. Again, if demand shifts, there could be a shift in types of vehicles utilized by the public and a resulting change in the mix of energy sources used for transportation. So, projections of reduced GHG emissions result partly from reduced travel demand, partly from increased vehicle efficiency, and partly from a shift from petroleum to other alternative fuels, such as renewable fuels, which may have lower associated carbon dioxide emissions.

Research Needs

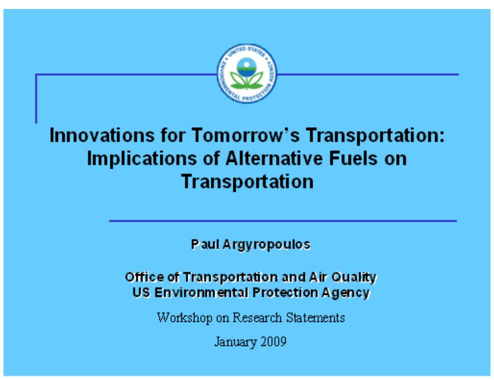
There are a number of different areas where further research is needed, some of which are included below. One key area of future research will be to conduct a closer examination of the projected changes in fuel use as a result of EISA. Historical trends can provide some insight into whether these projections are reasonable, but there have been many changes in recent months that may impact these projections. New research is needed to incorporate these changes and assess the impact of these changes on the EISA projections.

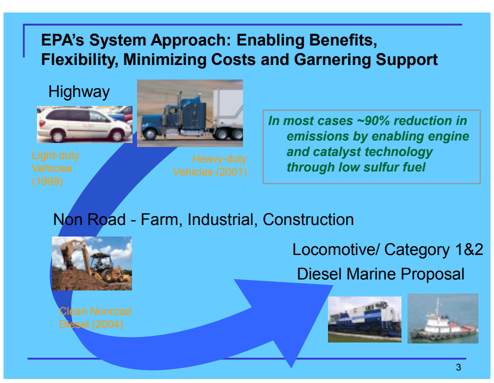
[4] http://epa.gov/otaq/renewablefuels/index.htm

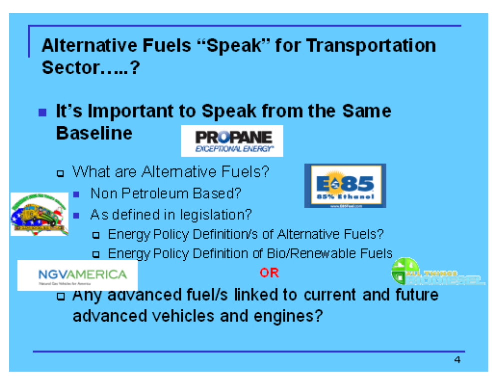
Additional research is needed on several other topics, including continuing discussions on the costs and benefits of energy security and independence, the importance of maintaining gains in public protection regarding emission controls, and others. One emerging question on sustainability that warrants research is to quantify the trade-off between the use of crop-based feedstocks for transportation fuel versus for food production. For example, ethanol requires a large quantity of corn for production, which necessarily competes against the use of the same corn for livestock and poultry feed.

The area of public policy and market drivers is another area for additional research. Public policy is the center of everything, but there are so many things now are affecting these policies. Climate change is a significant policy issue, but there are so many other factors, including the economy, that ultimately are going to factor into whether a consistent and balanced public policy can be developed that simultaneously meets the needs of a variety of stakeholders and of potentially conflicting viewpoints. Finally, research is needed to understand the infrastructure needs for alternative fuels. There are infrastructure issues associated with alternative fuels that need to be studied, including the need to haul biomass to a refinery, and the associated infrastructure requirements for this activity. This research needs to address questions such as pipelines, highways, etc. that will be needed.

Workshop Presentation

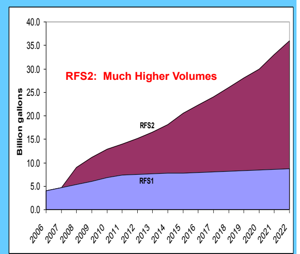






One Important Giant Step?: Energy Independence & Security Act – Renewable Fuels Standard

- Modifies Current RFS program beginning in 2008
- Volumes increase to 9 Bgal/yr in 2008 – escalating to 36 Bgal/year by 2022
- Establishes new renewable fuel categories and eligibility requirements, including GHG reduction thresholds!
- Provides new waivers and paper credit provisions
- Includes new obligation for fuels
- Includes new studies and reports



5

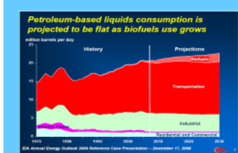
Baseline Perspectives / Projections
(For General Reflection)

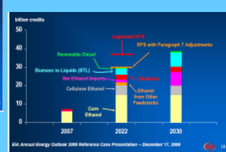
AEO Early Release - 2009

6

Renewable Fuel Displacement of Conventional Fuels

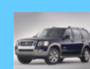
- Under RFS 1 – In 2012 renewable fuels would displace 0.8 to 1.6 percent of the petroleum that would otherwise be used by the transportation sector
- Under RFS 2 – Projections are ~16 percent displacement in 2022

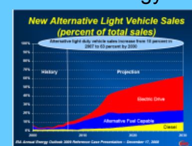


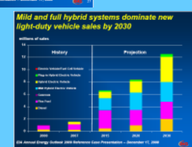


7

Vehicle Mix and Technology Flip

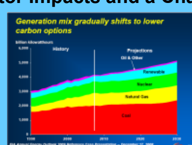


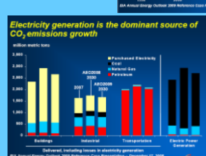


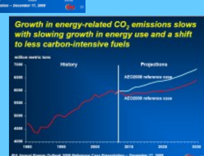


8

GHG's: Sector Impacts and a Changing Mix

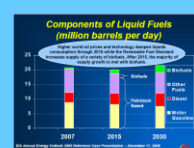




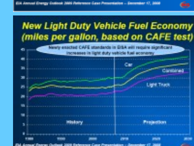


9

Projections for Liquid Transportation Fuels



At the same time, efficiency is expected to rise



10

A Couple Initial Questions

- Are projections accurate?
- Based on real or theoretical technology?
  - Fuels and Vehicles
- What could change & drive a shift or redirection in transportation market or public policy?
  - Reflection on 2008 energy market and economy

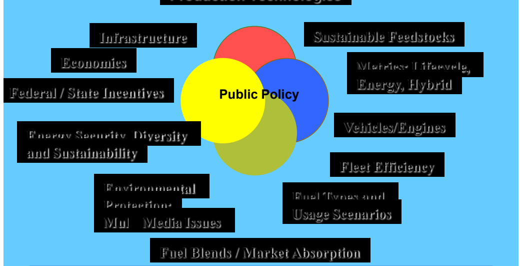
11

Key Goals and Challenges in the Policy Debates – All requiring additional or new research……….

- Energy Security
- Energy Independence
- Protect Public Health and Environment
- Control Climate Change
- Sustainability for Food, Fuel and Resources
- Sound Economics
- ………………………………….

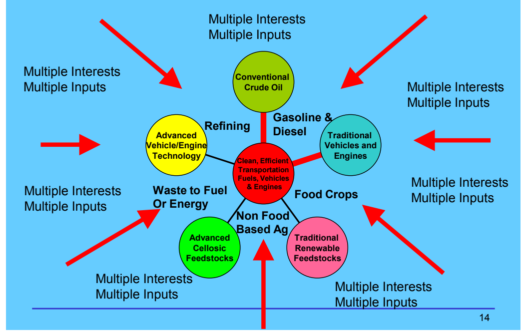
12

Public Policy and Market Drivers: Multiple Inputs -- Multiple Parties -- Multiple Perspectives -- Varying Interests



13

Dawning of New Age of Programs and Analysis for Sustainable Transportation ---- (Fuels, Vehicles and Engines)



14

Sustainability Criteria

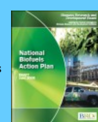
Market Factors

Production

Public Policy Goals

Metrics

Energy Security



What Information / Research is Needed to Address the Issues?

Environment

Economic

Market Demand and Ability to Consume

Technology

Authority

Emerging Markets

Global Influences

15

Thoughts for Further Discussion: Implications of "Alternative" Transportation Fuels on Transportation

When will Alt fuels make a significant difference in GHG emissions?
- **EPAct / EISA, Other Policies – Timing / impacts on energy security and GHG**
  - Assessing GHG impacts from Fuels and Vehicle System

Federal Roles for Fuels (Energy) and Vehicles?
- **Fuels / Energy - Pro's and Con's of potential energy sources considering fuel / vehicle systems**
  - **Liquid fuels? Gaseous Fuels? Electricity?**
    - Current infrastructure? Future needs / access?
    - Current / Future Fleet (near, mid and long term) / Technology
    - Energy value – equivalency (mpue/mpg) , safety, health and environmental impacts?
      - Fuel Properties – relation to emissions
      - Other issues related feedstock and fuel production, usage impacts?
      - Economics, Volume / energy needs to meet demand – near, mid and long term?
- **Vehicles - Pro's and Con's of potential transportation unit options considering fuel / vehicle systems**
  - **Options – near, mid and long term**
    - Advance gasoline / diesel designs (direct injections, Homogeneous Charge Compression Ignition, etc.)
    - Hybrid – gasoline and diesel hybrids / electric
    - Electric – Plug in Hybrids
    - Fuel cells

Should federal policies guide "Transportation for Tomorrow" or should markets?
- **Historical Perspective – Both have and expect both will continue to influence direction.**
  - **Energy security, environmental, safety, economics, innovation, etc.**
    - Market demands
    - Policy driven
    - Technology forcing

16

Policies to Reduce Greenhouse Gas Emissions Associated with Freight Movements

Cristiano Façanha, ICF International
Jeff Ang-Olson, ICF International

Introduction

This paper summarizes policies to support a reduction in greenhouse gas (GHG) emissions from freight movements. This paper starts with a brief description of the current freight activity in the United States and its associated effects on GHG emissions. The suggested policies to support a reduction in freight GHG emissions are divided into seven categories: (1) carbon taxes and other pricing mechanisms, (2) improvements in trucking fleet fuel efficiency, (3) improvements in railroad fuel efficiency, (4) improvements in fuel efficiency of other modes, (5) alternative fuels, (6) mode shift, and (7) congestion mitigation. This paper concludes with a brief analysis of the combined effects of these policies.

Freight Fuel Consumption and Greenhouse Gas Emissions – Current Activity

GHG emissions from freight transportation are tied closely to freight energy use. Both are growing because energy efficiency improvements in the freight sector have not kept pace with growth in demand. The transportation sector in total is responsible for 28% of all U.S. GHGs, as reported in the U.S. Environmental Protection Agency's (EPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks (Figure 1). Within the transportation sector, freight movement accounts for 27% of transportation GHG emissions, with the majority of emissions generated by trucking.

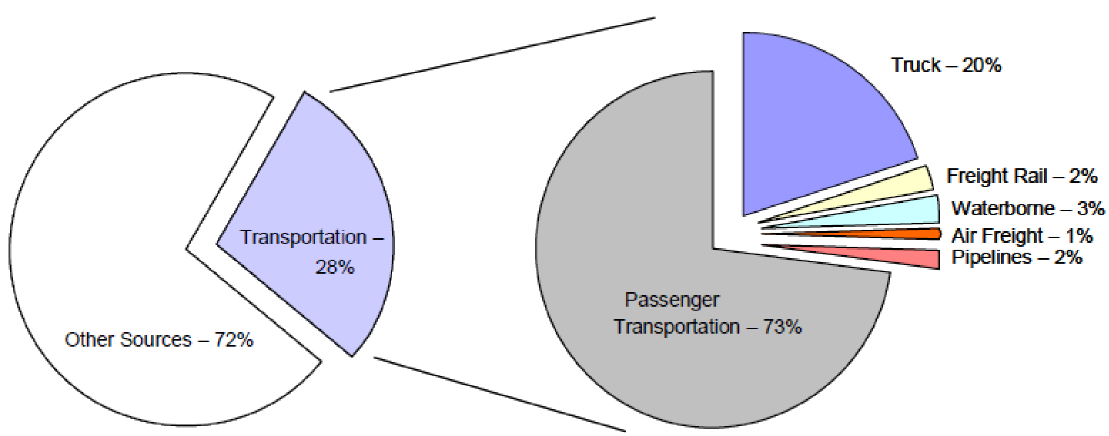


Figure 1. GHG Emissions by Source and Transportation Mode (2005)[1]

[1] ICF International Based on U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

Energy use and GHG emissions from freight transportation have grown at roughly twice the rate of passenger transportation emissions over the last 15 years. The causes are robust growth in freight demand coupled with an overall decline in energy efficiency within the freight sector. With the exception of pipelines, GHG emissions from all freight modes have increased over the last 15 years (Figure 2). Freight-truck GHG emissions increased by 69% from 1990 to 2005 and accounted for almost 90% of the increase in freight GHGs. Freight-rail emissions increased by 29% during this period and air freight emissions increased by 15%.

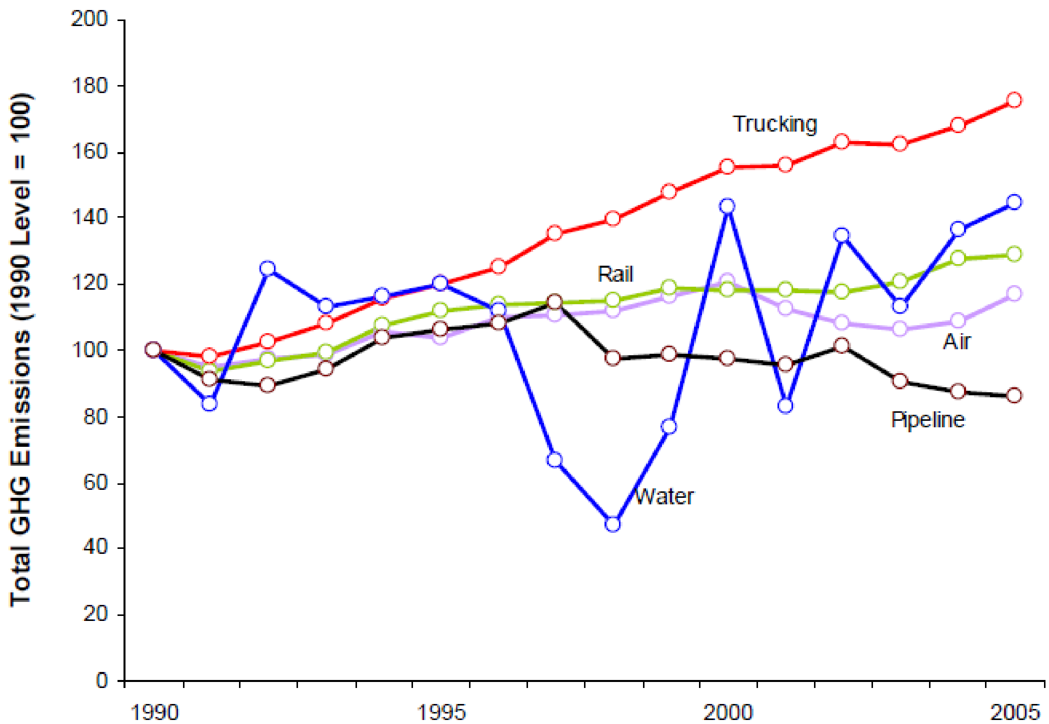


Figure 2. GHG Emissions by Transportation Model (1990-2005)

The rapid growth in freight GHGs and the overall decline in freight energy efficiency reflect a growing reliance on freight modes – particularly truck and air – that provide faster, more reliable service but have higher energy intensity. The notable exception to freight's growing energy intensity can be seen in rail shipments. Rail ton-miles grew by 62% between 1990 and 2005, exceeding the growth rate for truck and air cargo, but rail energy efficiency also has improved.

In contrast, freight-truck energy efficiency declined between 1990 and 2005. The reasons for this drop are not well understood, but are likely related to market demand for more powerful engines, requirements for advanced emission control devices that also may have compromised fuel efficiency, a decline in operational efficiency, and the elimination of mandatory highway speed limits. However, the recent spike in diesel prices has focused attention on truck fuel efficiency and is likely to slow or even reverse this trend. Between 2000 and 2005, freight-truck energy efficiency was essentially flat.

Looking ahead, freight-transportation energy use and GHG emissions are expected to grow modestly over the next three decades, led again by the trucking sector. Total domestic freight transportation GHG emissions are projected to increase 74% by 2035, an increase of about 1.8% annually. Trucking will still account for the vast majority of domestic freight GHG emissions.

Current environmental regulations will significantly reduce truck and locomotive particulate and NOx emissions, but do little to reduce GHG emissions. Curtailing GHG emissions will be a major challenge for the freight transportation industry. Improved engine efficiency and alternative fuels will be the most important contribution within the freight transportation sector to a more sustainable climate policy and energy security but addressing highway congestion and achieving modal shifts also will be important to reducing freight energy consumption and emissions.

Policies to Reduce GHG Emissions from Freight Movements

Government regulation and complementary support for research and development as well as deployment can help advance technologies and strategies that reduce freight transportation fuel use and emissions. Key elements would involve:

- Imposing carbon taxes or similar fuel pricing signals
- Improving trucking fleet fuel efficiency
- Improving rail fuel efficiency
- Improving fuel efficiency of other modes
- Expanding use of alternative fuels
- Encouraging mode shifts to more fuel-efficient modes
- Mitigating congestion.

1. Imposing carbon taxes or similar fuel pricing signals

Reducing freight transportation fuel use and GHG emissions can best be achieved when the cost of fuel use and GHG emissions are accurately reflected in the price of freight transportation shipments and passed along to manufacturers, retailers, and final consumers who purchase freight transportation.

Transportation will be expected to help meet the 60% to 80% reduction targets for 2050 GHG emissions that currently are being discussed in proposed state and federal legislation. To have a substantial impact, truck GHG emissions must be greatly reduced. Some freight can be shifted to rail and waterborne freight transportation, but truck vehicle miles traveled (VMT) cannot be reduced significantly without affecting logistics costs for businesses and industries and driving up the cost of goods and services for consumers. This points toward the need to price diesel fuel – the primary fuel for truck and rail engines – to encourage fuel efficiency and adoption of alternative fuels while providing sufficient vehicle-miles of travel to support economic activity.

One approach for using market mechanisms to reduce freight GHGs would be a cap-and-trade-style approach for diesel fuel. Most of the GHG cap-and-trade bills introduced in the 2007-2008

Congress included transportation among the capped sectors through an upstream cap on the CO_2 content of petroleum fuels, implemented at the refinery.

Oak Ridge National Laboratory has developed several scenario forecasts of truck fuel economy using the National Energy Modeling System (NEMS). The "advanced" scenario assumes that there is a national sense of urgency to improve efficiency and reduce carbon emissions, and that some increase in direct costs of fuel and carbon emissions (up to $50 per truck) could be passed to customers to meet energy and environmental goals. Under this scenario, long-haul combination truck fuel economy would rise from approximately 5.6 mpg today to 9 mpg by 2020.

2. Improving trucking fleet fuel efficiency

Currently, a variety of strategies are available to improve the fuel efficiency of trucking operations, including tractor and trailer aerodynamic improvements, use of single-wide tires, automatic tire inflation systems, options to reduce extended truck idling, and driver training programs. Full market penetration of these strategies could reduce fuel use by more than seven billion gallons and eliminate 75 tons of GHG emissions annually. The U.S. EPA's SmartWay Transport Partnership is helping to promote these types of strategies by offering recognition and rewards for participating carriers.

High fuel prices and consumer demand for "green" products already are encouraging companies to adopt fuel savings strategies on their own. Wal-Mart, for example, has set a goal of doubling the fuel economy of its truck fleet by 2015, and already has achieved a 25% fleet-wide improvement as of 2008.

New and emerging technologies can potentially lead to greater fuel efficiency gains. Hybrid-electric powertrains are one of the most promising technological developments for trucks. Current hybrid technology is most appealing for stop-and-go driving typical of parcel delivery operations; both FedEx and UPS are now using some hybrid trucks for city deliveries. According to a report prepared for the National Commission on Energy Policy, hybridization of trucks in truck-size classes 3 to 5 can increase fuel economy by 71% in city driving. Several reports suggest that hybrid engines will not be cost effective for typical intercity combination trucks; however, some truck operators and engine manufacturers are researching and testing hybrid powertrains in heavy-duty combination trucks. Wal-Mart and ArvinMeritor currently are developing a hybrid version of the International ProStar class-8 tractor, powered by a Cummins engine. Eaton and PACCAR, the maker of Kenworth and Peterbilt trucks, have announced plans to develop a hybrid heavy-duty truck and bring it to market by 2009. Volvo also has developed a hybrid with a reported 35% improvement in fuel economy.

3. Improving rail fuel efficiency

There are a number of technology opportunities to improve rail efficiency. New locomotive designs are likely to reduce fuel use by capturing wasted energy and using more efficient fuel sources. Hybrid-electric and Generator-Set ("Genset") switcher locomotives already are in use in many locations. Union Pacific, for example, has more than 150 Genset locomotives working in California and Texas. Advanced hybrid-electric and fuel-cell locomotives are in the research and development stage.

Locomotive information technology can reduce fuel use by optimizing train operation. Onboard computers can monitor engine performance and other characteristics (e.g., train tonnage, grade, speed) to optimize engine speeds, brake use, and fuel consumption. Electronically controlled pneumatic brakes save fuel by eliminating unnecessary braking and acceleration. When combined with satellite navigation, onboard computers can determine optimum speeds to ensure an on-time arrival, while maximizing fuel efficiency.

Another promising development is "positive train control," which allows central dispatchers to control train operations in order to optimize network behavior. Current efforts to develop positive train control are focused on developing interoperable communication protocols, with limited systems currently in the research and development stage. The long-term fuel and emission reduction benefits of these technologies are uncertain. A goal is to match the fuel economy benefits of the last 30 years, which saw a doubling of U.S. railroad ton-miles per gallon. If this trajectory were to continue (equivalent to a 2.4% annual improvement in fuel efficiency), it would reduce diesel fuel consumption in 2035 by 3.6 billion gallons and eliminate 39 million metric tons of GHG emissions in that year.

4. Improving fuel efficiency of other modes

R&D efforts have explored the potential for improvements in ship fuel efficiency. Design improvements could be achieved through optimizing the hull shape, air lubrication, selection of appropriate propeller, diesel-electric propulsion (e.g., pop propulsion), and use of alternative fuels. Combined, these strategies could improve the fuel efficiency of new ships by up to 30%. Maintenance strategies or retrofit in existing ships also could improve fuel efficiency by about 20%. Other technological improvements include ship power improvements (through alternative types of energy), and alternative non-toxic coatings and active removal systems to remove marine organisms from the ships' hull (to smooth the hull's surface). Operational strategies also can improve fuel performance by adjusting ship routes to avoid poor weather conditions and improving port operations to reduce hotelling times.

Although aviation accounts for a small share of freight GHG emissions, energy efficiency gains can still be achieved through more fuel efficient engines, design innovations in the aircraft body, use of lighter materials, and improvements in airport operations. All of these strategies are being explored by the airlines and aircraft manufacturers in an effort to reduce aviation fuel costs. But, as with other modes, there may be opportunities for government to accelerate their development and deployment.

5. Expanding use of alternative fuels

Alternative fuels such as biodiesel represent an emerging fuel source for heavy-duty trucks. Some states, especially in the Midwest, have mandated the blending of small fractions of biodiesel in all diesel sold. In other cases, individual truck operators are using B5 (5%

biodiesel and 95% diesel) or B20 (20% biodiesel and 80% diesel). Some uncertainties remain as to the net GHG benefits from alternative fuels when life-cycle effects (land-use changes, production, distribution, and use) are taken into account. Current Department of Energy models suggest that using biodiesel from soy results in approximately half the GHG emissions of conventional diesel on a life-cycle basis.

6. Encouraging mode shifts to more fuel-efficient modes

Environmental benefits can be realized by shifting freight to cleaner modes. In general, rail and water transportation are associated with lower emissions (on a ton-mile basis) than truck transportation, although these benefits depend on details such as the length of haul and the use of drayage trucks to access intermodal facilities. Emission rates for new trucks will drop significantly in the coming years, which may offset the environmental advantages of rail in some instances.

7. Mitigating congestion

Congestion can affect freight fuel consumption to the extent that it requires vehicles to accelerate and decelerate more often to adapt to network traffic levels. Because fuel consumption is significantly higher in acceleration mode than while traveling at constant speed, fuel consumption typically is higher in congested scenarios.

There has not been much published research to date on the effects of congestion on fuel consumption nationwide. The 2007 Urban Mobility Study makes an attempt to do so, but it does not single out the effects of congestion on freight movements. An assessment of freight bottlenecks on highways has estimated delay incurred by heavy-duty trucks[2]. Internal ICF estimates indicate that about 135 million gallons of fuel are spent annually by heavy-duty trucks on congested roads, which translates into roughly 1.4 million metric tons of CO_2. Because congestion degrades the fuel performance of heavy-duty trucks more heavily than light-duty vehicles, it is important to have a better understanding of congestion effects on freight movements.

Combined Effects of Policies

Figure 3 illustrates how a combination of these strategies might cut GHG emissions from truck and rail freight transport by more than half in 2035.

[2] Cambridge Systematics (2005): An Initial Assessment of Freight Bottlenecks on Highways, Prepared for FHWA.

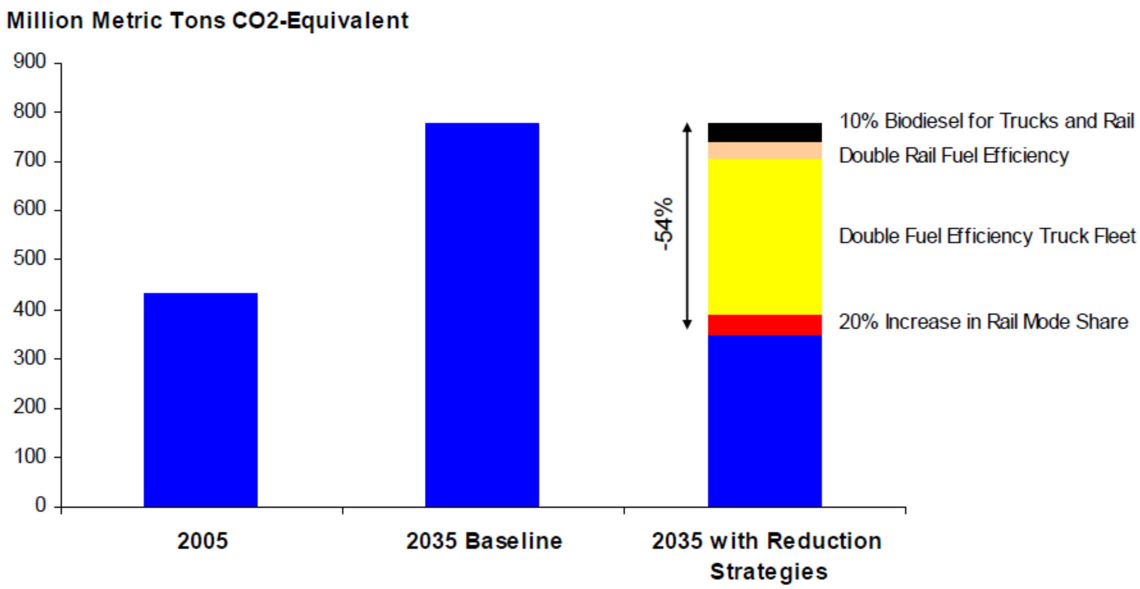
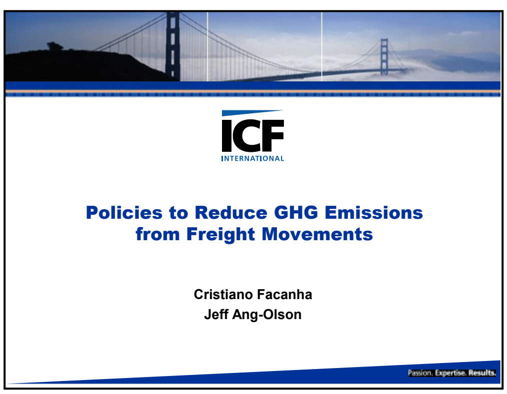
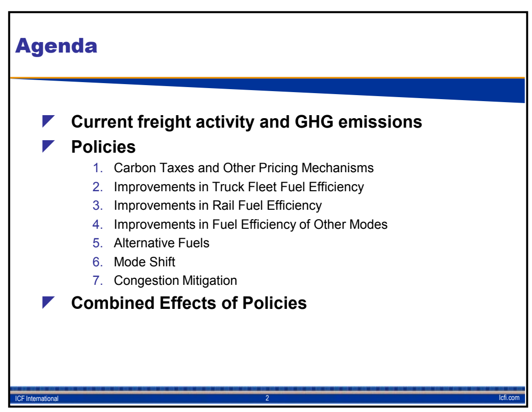


Figure 3. Impact of Potential Truck and Rail GHG Reduction Strategies[3]

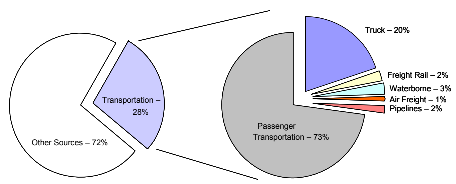
Workshop Presentation





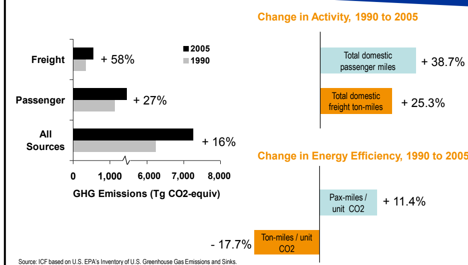
[3] ICF International.

Current Freight-Related GHG Emissions



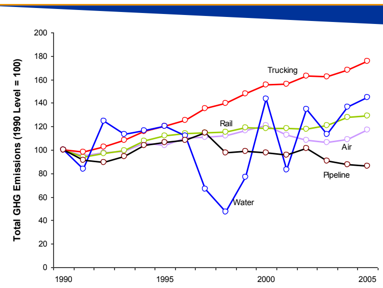
Source: ICF based on U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

Freight in the Context of GHG Emissions



Source: ICF based on U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

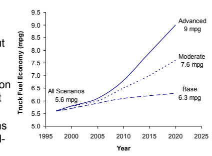
GHG Growth by Freight Mode



Source: ICF based on U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

1. Carbon Taxes and Pricing

- Reducing freight GHG emissions can best be achieved when the cost of fuel use and GHG emissions are accurately reflected in the transportation price.
- Transportation will be expected to help meet the 60-80% reduction targets for 2050 GHG emissions that currently are being discussed in proposed state and Federal legislation.
- To have a substantial impact, truck GHG emissions must be greatly reduced.
- Some freight can be shifted to rail and waterborne freight transportation, but truck VMT cannot be reduced significantly without affecting logistics costs.
- This points toward the need to price diesel fuel to encourage fuel efficiency and adoption of alternative fuels while providing sufficient VMT to support economic activity.
- One approach for using market mechanisms to reduce freight GHGs would be a cap-and-trade style approach for diesel fuel.

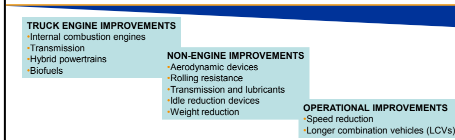


Source: ORNL (2000): Scenarios for a Clean Energy Future

2. Truck Efficiency Improvements

- **Because trucking represents the most sizeable source of freight-related GHG emissions, it is also the most important source for potential improvements.**
- **External factors affecting future truck fuel efficiency:**
  - Diesel and energy prices
  - Future changes in traffic mix
  - Future changes in network utilization and congestion
  - EPA emissions regulations
  - Anti-idling policies

2. Truck Efficiency Improvements



- **Full market penetration of these strategies could reduce fuel use by more than seven billion gallons and reduce 75 tons of GHG emissions annually.**
- **The U.S. EPA's SmartWay Transport Partnership is helping to promote these types of strategies by offering recognition and rewards for participating carriers.**
- **Higher fuel costs have encouraged private industry to invest in research.**

3. Rail Efficiency Improvements

- **External factors affecting future rail fuel efficiency:**
  - Diesel and energy prices
  - Future changes in mix of commodities and equipment
  - Future changes in traffic volume relative to capacity
  - EPA environmental regulations
- **There are numerous technological and operational opportunities to improve rail fuel efficiency. Those can generally be divided in:**
  - Single-unit Developments
  - Complete Train or Line-segment Developments
  - System-Wide Developments

3. Rail Efficiency Improvements

Short-term

- Train simulation programs
- On-board information technology
- Automatic shutdown devices

- Employee Training
- Scheduled operations
- Train composition for improved aero
- Enforcing no-Idling policies
- Speed limits

LOCOMOTIVE
- Diesel engine technology
- Electrical traction systems
- Hybrid locomotives
- Truck, brakes, and adhesion controls

CAR-LEVEL
- High-capacity cars
- Lightweight materials
- Steering or radial trucks
- Low friction bearings
- Improved car aero

TRAIN-LEVEL
- Electrically-controlled brakes
- Distributed power
- Rail-wheel lubrication

SYSTEM-LEVEL
- ECP
- Integrated monitoring and inspection systems
- Distributed power
- Rail-wheel lubrication

Long-term

- Rail electrification
- Fuel cell locomotives
- Automated operations
- Dedicated high performance corridors

4. Efficiency Improvements of Other Modes

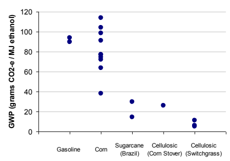
- R&D efforts have explored the potential for improvements in ship fuel efficiency.
- Design improvements could be achieved through:
  - Optimization of hull shape
  - Air lubrication
  - Selection of appropriate propeller
  - Diesel-electric propulsion (e.g., pop propulsion)
  - Use of alternative fuels
- Combined use of these strategies could improve the fuel efficiency of new ships by up to 30%.
- Maintenance strategies or retrofit of existing ships could also improve fuel efficiency by about 20%.
- Other technological improvements include:
  - Ship power improvements (through alternative types of energy)
  - Alternative non-toxic coatings and active removal systems to remove marine organisms from the ships' hull (to smooth the hull's surface).
- Operational strategies can also improve fuel performance by adjusting ship routes to avoid poor weather conditions and improving port operations to reduce hotelling times.

4. Efficiency Improvements of Other Modes

- Aviation efficiency gains can still be achieved through:
  - More fuel efficient engines
  - Design innovations in the aircraft body
  - Use of lighter materials
  - Improvements in airport operations.
- All of these strategies are being explored by the airlines and aircraft manufacturers in an effort to reduce aviation fuel costs. But, as with other modes, there may be opportunities for government to accelerate their development and deployment.

5. Alternative Fuels

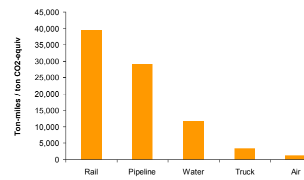
- Alternative fuels represent an emerging fuel source for heavy-duty trucks.
- There remain some uncertainties as to the net GHG benefits from alternative fuels when life-cycle effects.
- Current DOE models suggest that using biodiesel from soy results in approximately half the GHG emissions of conventional diesel on a life-cycle basis.



Source: ICF

6. Mode Shift

- Environmental benefits can be realized by shifting freight to cleaner modes.

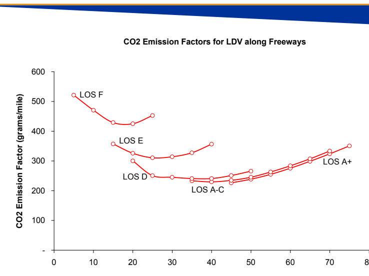


Source: ICF based on U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks.

6. Mode Shift

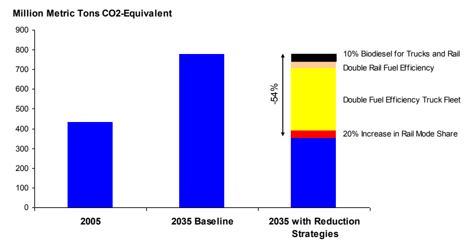
- However…
  - There is a wide variation in environmental benefits depending on the lane, equipment type, and service offering. Rail-truck fuel efficiency ratio can range from about 1.5 to over 5.
  - Planned fuel efficiency improvements will affect different modes in very different ways.

7. Congestion Relief



Source: ICF

Combined Effects of Policies



Source: ICF

Questions & Answers

- Cristiano Facanha – cfacanha@icfi.com

Linking Transportation and Land Use

Mike McKeever, Sacramento Area Council of Governments
Bruce Griesenbeck, Sacramento Area Council of Governments

Introduction

Linking transportation and land use refers to the process of guiding development and expansion of communities with the goal of better coordination of land use and transportation that accommodates pedestrian and bike safety, mobility, enhances public transportation service, improves road network connectivity, and includes a multi-modal approach to transportation. Typically, this is accomplished through supporting land-use development patterns to create a variety of transportation options.

Under increasing pressure from population expansion, development of large tracks of open lands into residential subdivisions or strip-style commercial shops is occurring in communities throughout the United States. At the same time that roads are being widened and new roads are being constructed, the facets of transportation such as bike trails, sidewalks, and other facilities that link activities and users are lagging. The objective of linking transportation and land use is to define and manage this growth of communities in a fashion that balances land use and transportation needs. To achieve this objective, there are a number of important resources that need to be available to planners. The following discusses four priority areas where federal research is needed to support the linkage between transportation and land use.

Improved Data and Modeling Capacity to Support Integrated Scenario Planning

Metro, the Portland (Oregon) regional government, adopted a long-range growth vision in the mid 1990s[1]. That action spawned a number of regional-scale scenario planning exercises around the country, starting in Utah with Envision Utah, and most recently becoming a statewide Blueprint Planning program sponsored by the California Department of Transportation for all of the regions throughout that large state. The process became popular enough in California that this Fall the state legislature passed and the Governor signed SB375, a landmark law that requires regional planning agencies to integrate climate change, transportation, land use, and housing planning[2]. There are several initiatives to advocate for inclusion of some of the concepts in SB375 in the new Federal Transportation bill, which is just starting the re-authorization process. FHWA has actively encouraged Metropolitan Planning Organizations (MPOs) to

---

[1] 2040 Growth Concept, Portland Regional Government Metro Council, 1995.
[2] California Senate Bill 375, Signed into California Law September 30, 2008.

engage in scenario planning activities that integrate transportation, land use, and air quality decisions.

Most of the regional scenario planning initiatives share the following characteristics:

- They use more and more sophisticated data, models, and analysis to estimate the trade offs and impacts of growth decisions on a broadening array of variables, including travel behavior, air emissions, water quality, demand and supply, habitat and natural resources, agriculture, infrastructure costs, floodplains, environmental justice, affordable housing, economic development, and even health.

- They almost always result in adopted growth strategies that use compact development, mixed use, transit and pedestrian-oriented design, and other smart principles to reduce per capita vehicle miles traveled and air emissions (including greenhouse gases), increase non-auto trips (transit, walk, bike), and reduce the impact of urbanization on agricultural, habitat, and natural resource lands.

- The planning processes educate large numbers of citizens and stakeholders about complex technical planning issues, and engage the participants in hands-on, interactive mapping exercises (sometimes aided by the use of laptop computers "live" in public meetings) that help citizens understand the full range of impacts of planning choices and build consensus across usually disparate interests and groups.

The Metropolitan Planning Region (MPO) is the most cost-effective scale to build that data, and create modeling and analysis tools necessary to adequately support serious planning. The local level is too small and costly, the state level often is too big and unwieldy in the Western states and too small in the Eastern states. While the MPO is the right scale to build a parcel-level geographic information system, forecasting tools, scenario building models (including three-dimensional visualization capability), and travel and air emissions forecasting models, it still takes money and management-level commitment to make it happen. Many of the technical tools and methods should not be different from one region to another. Some standardization would help cut costs, increase the reliability of results, and support good inter-regional planning to address the cross-border impacts.

Longitudinal Household Travel and Activity Survey

Household travel surveys have advanced in recent years to include important information on the activities that people engage in during the course of the day. Additional data and collection procedures are needed to provide a robust dataset of the transportation and land-use characteristics that influence travel choices. The resulting data set will serve as a cost-effective basis to develop a transferable protocol for activity-based travel models throughout the country.

Traditionally, the surveys were concerned only with the number and location of vehicle and transit trips, then walk and bicycle trips were added. These surveys focused on the primary purpose of the trip as discrete decisions made by travelers, then linking trips into tours was examined to begin to understand how people and households decide on a set of activities and their relative importance.

The locations of trips traditionally was concerned only with the Travel Analysis Zone (TAZ) of the trip, then exact addresses and locations were collected as research pointed out that travel decisions for transit and non-motorized trips depended on very small units of distance and time (i.e., feet not miles, and small not large numbers of minutes).

The surveys traditionally did not collect any information about the location of trips other than TAZ, then research concluded that geographic information about each destination is important to understanding why that location was chosen. The land-use and travel-choice characteristics that influence location choices include street pattern, density and mix of surrounding uses, transit and pedestrian system characteristics, and safety and security among other features.

Originally, the surveys were conducted for only 1 or 2 days for each respondent, but household activities are often scheduled across a week or more for some important mandatory and discretionary trips. Only one survey (in the Puget Sound region) has conducted a multi-year longitudinal survey. By tracking changes in travel and activity over years the long-term behavioral patterns can be analyzed and incorporated into models.

Traditionally, no information was collected on the health of the respondents. More recently, the relationship between land use, transportation system, and health has been examined. Health data include the amount of physical activity, especially walking, exposure to air toxics from vehicles, and personal safety.

Conducting surveys has become more difficult for several reasons. People are more wary of surveys because telemarketers and criminals have used the primary recruitment for household surveys, which are telephone calls to the home. Also, cell phones are now a common, if not the predominate, communication device that makes random household selection within the survey area more difficult. With more attention to detailed spatial data have come concerns about privacy. The surveys have had a requirement that the person and household's private information was not released. Now that it is possible to know the exact address of each trip of each person, attaching the person's name and other vital information is more likely.

Revising the protocols for household travel surveys would address each of these issues in meeting its objectives of a comprehensive survey of urban travel behavior; such a study currently is being planned in California. Key features of the California study include:

- A five or more year survey, with a week of data collected from each respondent each year. The activity and travel data would be collected with both a diary format and with a handheld GPS unit with capability of menu-based data entry. An interview would be done each year that includes data on demographics (including health data), housing, economic information, and travel costs. Stated preference data would be collected on travel and activity choices that are related to options available but not chosen, such as alternate shopping and recreation locations, or travel response to different costs of travel.

- The survey would be repeated to the same households each year for 5+ years. A replacement protocol would be used for households that drop out of the survey.

- The survey would be conducted in 3-5 urban areas that represent a range of urban and suburban development patterns and transportation systems with at least 1,000 households per area.

- Each trip location would be examined for the land use and travel characteristics near it. Land-use density and mix, street pattern, transit service level, and pedestrian system data would be collected for ¼- and ½-mile radius around each location.

Transportation Cost and Pricing Research

An improved travel survey could be used in conjunction with activity-based travel models to better understand the long- and short-term impacts of costs in travel choices.

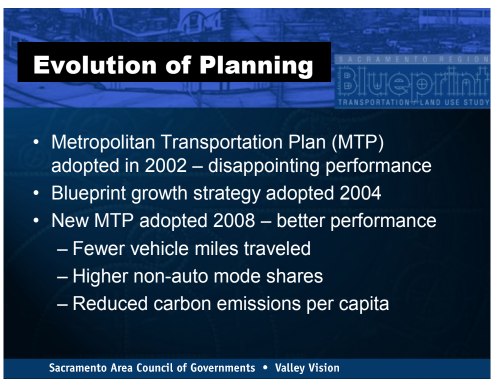
Part 1 – Exogenous Costs: Vehicle acquisition, disposition, and use study. Using the first wave or two of the longitudinal study described above, estimate model of vehicle acquisition, disposition, and use. This would make it possible to capture the full range of operating costs of different vehicle types, plus the intra-household dynamics of who uses what vehicle for what trips. This would make it possible to actually model the true costs of vehicle transportation (rather than single-point averages), and it would net significant data on vehicle activity by type of vehicle for use in emissions modeling.

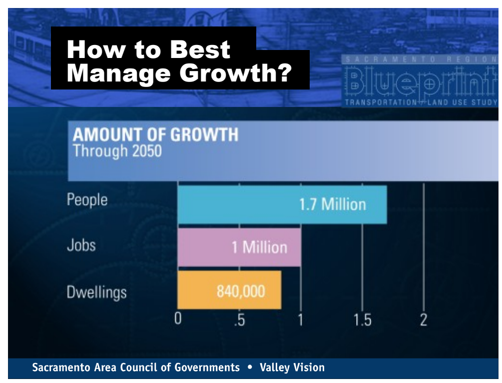
Part 2 – Pricing Policy: Modifications to travel models to allow for evaluation of pricing (HOT lanes, toll roads, parking pricing, road pricing). Parts 1 and 2 together would provide the first comprehensive treatment of true transportation costs using an activity-based modeling system for household-based travel.

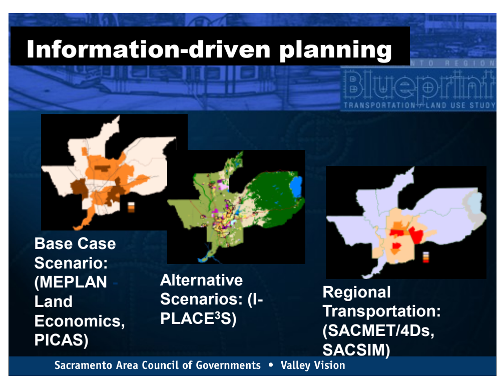
Commercial Vehicle Activity Model Transfer

This would be a unique research effort focused on the transferability of a commercial vehicle/freight activity model from one region to another. The "donor" region would be Calgary, Alberta, Canada. Research would focus on model structural modification and calibration to fit in the Sacramento test region and any other test regions in the country. By implementing this model, SACOG would have the first true activity-based demand simulation model for both household- and commercial-based travel.

Workshop Presentation



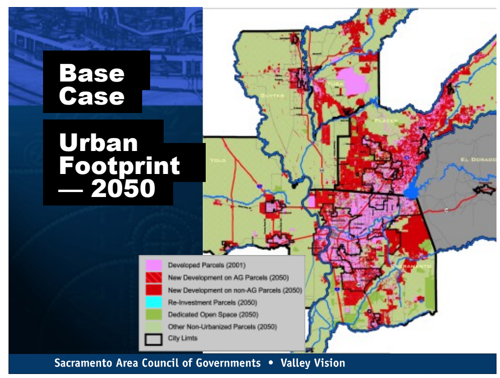


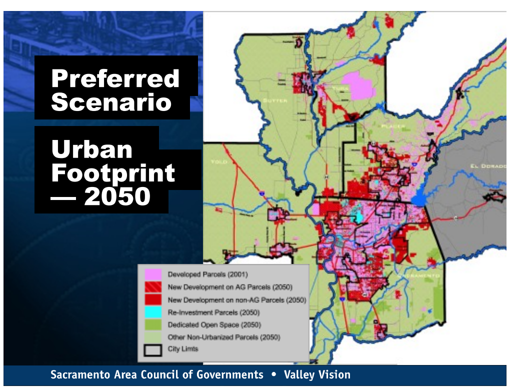


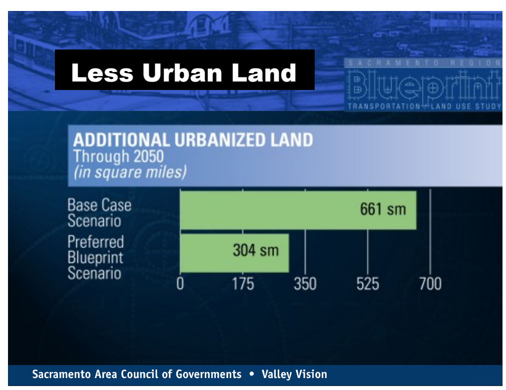

Citizen Input — Over 5,000 participants at workshops and forums (PLACE³S modeling)
SACRAMENTO REGION
Blueprint
TRANSPORTATION LAND USE STUDY
Sacramento Area Council of Governments • Valley Vision


Regional Forum 2004 – 1400 people
SACRAMENTO REGION
Blueprint
TRANSPORTATION LAND USE STUDY
Sacramento Area Council of Governments • Valley Vision

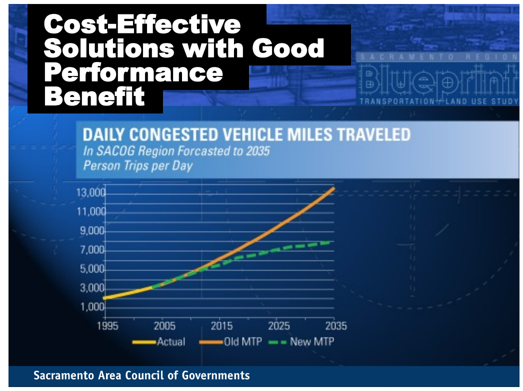

Elected Officials Summit – Oct. 2004
SACRAMENTO REGION
Blueprint
TRANSPORTATION LAND USE STUDY
Sacramento Area Council of Governments • Valley Vision

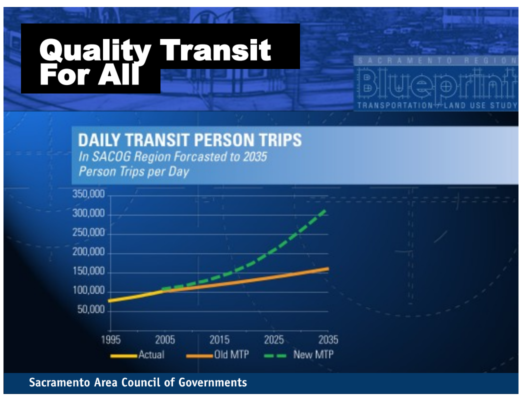

Base Case
Urban Footprint — 2050
Developed Parcels (2001)
New Development on AG Parcels (2050)
New Development on non-AG Parcels (2050)
Re-Investment Parcels (2050)
Dedicated Open Space (2050)
Other Non-Urbanized Parcels (2050)
City Limits
Sacramento Area Council of Governments • Valley Vision

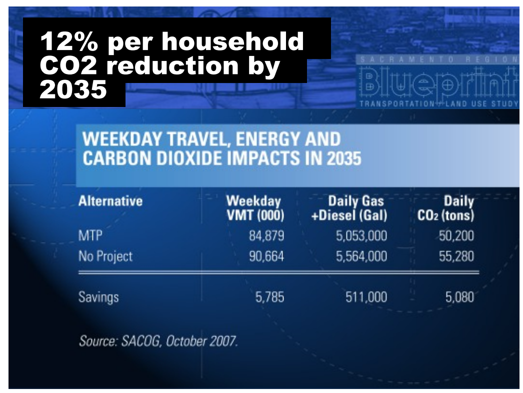

Preferred Scenario
Urban Footprint — 2050
Developed Parcels (2001)
New Development on AG Parcels (2050)
New Development on non-AG Parcels (2050)
Re-Investment Parcels (2050)
Dedicated Open Space (2050)
Other Non-Urbanized Parcels (2050)
City Limits
Sacramento Area Council of Governments • Valley Vision

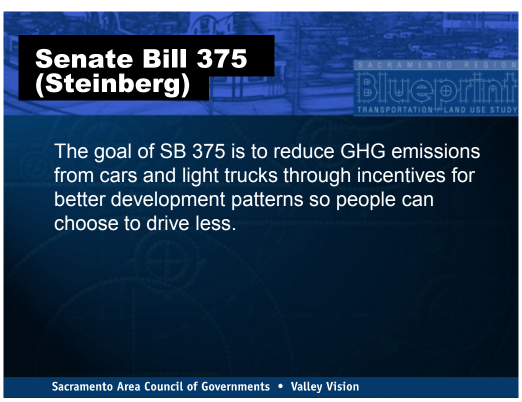

Less Urban Land
SACRAMENTO REGION
Blueprint
TRANSPORTATION LAND USE STUDY
ADDITIONAL URBANIZED LAND
Through 2050
(in square miles)
Base Case Scenario
661 sm
Preferred Blueprint Scenario
304 sm
0
175
350
525
700
Sacramento Area Council of Governments • Valley Vision

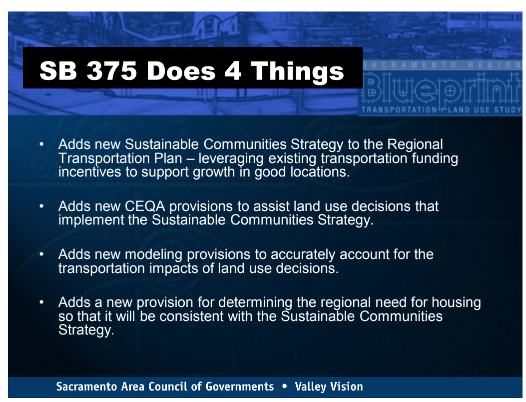

HOUSING CHOICE
(in percent)
New Housing Stock in:
2050 Basecase
2050 Preferred Scenario
2035 MTP Projections
2004-06 Built Units
2007 Units for Sale/ Under Constructions
20% 80%
69% 31%
62% 38%
34% 61%
67% 33%
0 10 20 30 40 50 60 70 80 90 100
Small Lot / Attached
Large Lot


Cost-Effective Solutions with Good Performance Benefit
DAILY CONGESTED VEHICLE MILES TRAVELED
In SACOG Region Forcasted to 2035
Person Trips per Day
13,000
11,000
9,000
7,000
5,000
3,000
1,000
1995 2005 2015 2025 2035
Actual
Old MTP
New MTP
Sacramento Area Council of Governments

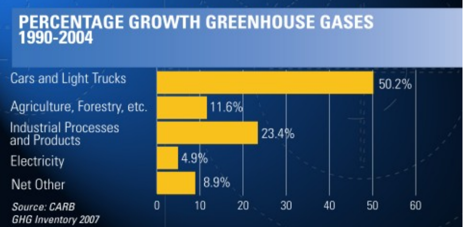

Quality Transit For All
DAILY TRANSIT PERSON TRIPS
In SACOG Region Forcasted to 2035
Person Trips per Day
350,000
300,000
250,000
200,000
150,000
100,000
50,000
1995 2005 2015 2025 2035
Actual
Old MTP
New MTP
Sacramento Area Council of Governments


12% per household CO2 reduction by 2035
WEEKDAY TRAVEL, ENERGY AND CARBON DIOXIDE IMPACTS IN 2035
Alternative
Weekday VMT (000)
Daily Gas +Diesel (Gal)
Daily CO2 (tons)
MTP 84,879 5,053,000 50,200
No Project 90,664 5,564,000 55,280
Savings 5,785 511,000 5,080
Source: SACOG, October 2007.


Senate Bill 375 (Steinberg)
The goal of SB 375 is to reduce GHG emissions from cars and light trucks through incentives for better development patterns so people can choose to drive less.
Sacramento Area Council of Governments • Valley Vision

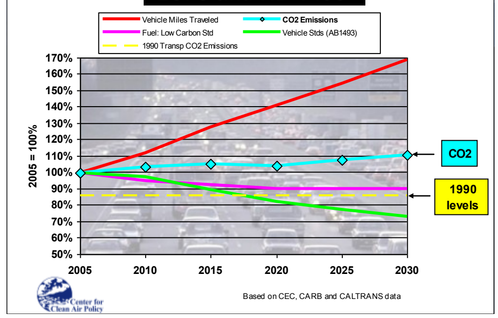

SB 375 Does 4 Things
Adds new Sustainable Communities Strategy to the Regional Transportation Plan – leveraging existing transportation funding incentives to support growth in good locations.
Adds new CEQA provisions to assist land use decisions that implement the Sustainable Communities Strategy.
Adds new modeling provisions to accurately account for the transportation impacts of land use decisions.
Adds a new provision for determining the regional need for housing so that it will be consistent with the Sustainable Communities Strategy.
Sacramento Area Council of Governments • Valley Vision

Percentage Growth Greenhouse Gases 1990-2004



Sacramento Area Council of Governments • Valley Vision

Growth in VMT will overwhelm savings from LCFS and AB 1493



Travel Demand Models

- SACMET is traditional 4-step model
  - Based on 1533 traffic analysis zones
  - Households cross-classified (persons, workers, income)
  - TP+ software platform
  - Developed 1994
  - Used, improved since then
  - 3 MTP's adopted (1996, 1999, 2002)
  - 2 FTA New Starts
  - Basis for many city/county models

Sacramento Area Council of Governments • Valley Vision

Travel Demand Models (cont'd)

- SACSIM is Activity-based tour model
  - Based on parcel/point land use data
  - Synthetic population (includes age, gender, FT/PT worker, student status)
  - Custom software (DAYSIM) w/in a TP+ shell
  - Developed 2006
  - First application: analysis of 2008 MTP

Sacramento Area Council of Governments • Valley Vision

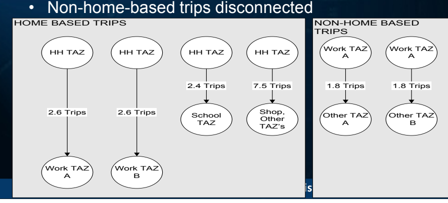
Difference in Unit of Analysis

- SACMET = TAZ and Trip
  - Geographic area with number of people, jobs, etc.
  - Trips are "disembodied" and treated as a "gravitational" event
- SACSIM = Persons and Tours
  - Population represents variety of people in a "real" way
  - Travel is a an outgrowth of activities—a way of stringing activities together

Sacramento Area Council of Governments • Valley Vision

SACMET Representation of Travel

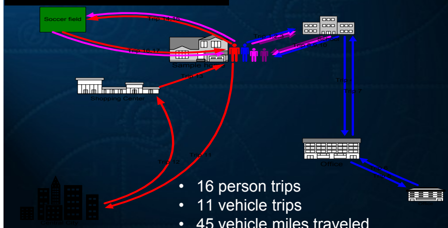
- Trips to/from TAZ, not Households
- Trip rates = averages
- Mode of trips unrelated
- Non-home-based trips disconnected



SACSIM Representation of Travel

- People represented (1 FT worker, 1 PT worker, 2 school-age kids)
- "Tours" for each person generated
  - Tour = chain of trips beginning and ending at home
  - Tours defined by activities (work, school, shop, meal, etc)
- Mode prior mode choice affects later mode choice on tour
- Non-home-based travel "attached" to person
- Characteristics of people and place of residence retained through all activities and travel

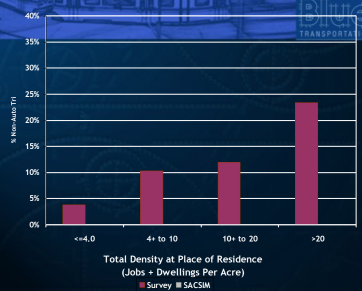
Typical Weekday Travel for 4-Person Household



- 16 person trips
- 11 vehicle trips
- 45 vehicle miles traveled

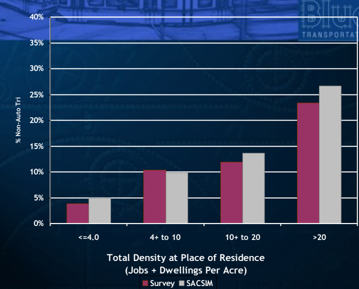
Sacramento Area Council of Governments • Valley Vision

Density and Non-Auto Travel



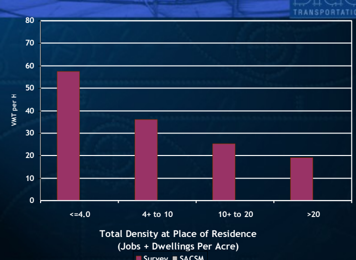
Sacramento Area Council of Governments • Valley Vision

Density and Non-Auto Travel



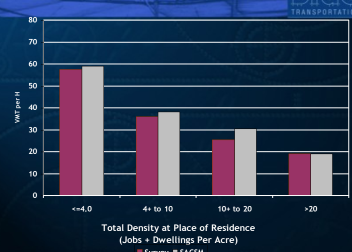
Sacramento Area Council of Governments • Valley Vision

Density and VMT



Sacramento Area Council of Governments • Valley Vision

Density and VMT



Sacramento Area Council of Governments • Valley Vision


Research Priorities
Blueprint
• Improved data and modeling capacity to support integrated scenario planning
• Longitudinal household travel and activity survey
• Transportation cost and pricing research
• Commercial vehicle activity model transfer
Sacramento Area Council of Governments • Valley Vision

Achieving Intermodal Interoperability for Freight Movements

Joe Bryan, Halcrow

The Issue

Interoperability is the ability of diverse systems and organizations to work together well. In freight transportation, the question of interoperability most often is between modes, but it can be between information systems, or between jurisdictions when standards or regulations differ. In transportation, the crucial question is about the compatibility of networks and their ability to function as one. The importance of this is threefold: first, for the achievement of network economies; second, for the related standardization of fleets; and third, for the provision of rapid and reliable service to markets, ranging from regional to global. Interoperability is a visible issue in the aspiration of services to be "seamless" and the stress placed on transportation performance measured door to door. The delays and diseconomies that come from incompatibility add to asset requirements, traffic congestion, fuel consumption, and emissions.

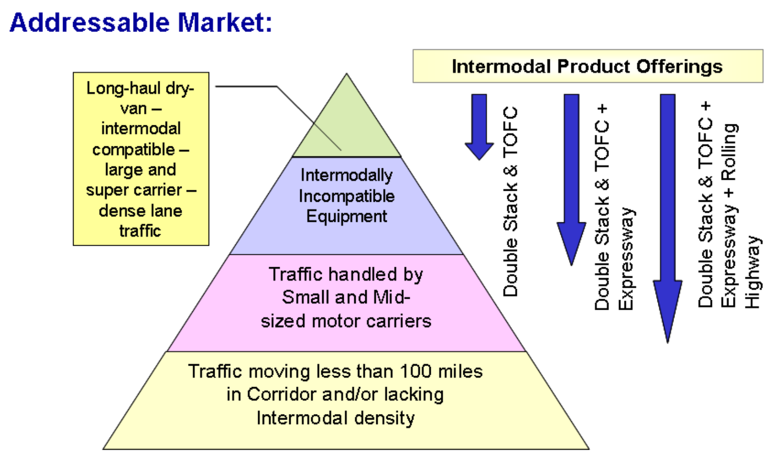
Several of the more prominent interoperability issues in the United States lie with operating equipment: trucks, railcars, trailers, containers, and such. In one case, regulatory nonalignment affects the configuration of equipment allowed to travel between domestic jurisdictional regions and across the NAFTA borders. Nonalignment also extends to other elements governing operations, like driver rules and cabotage laws. The operating constraint here is not due to the regulations per se, but rather to their differences, and the resulting effect on the free flow of fleets across boundaries. Once again, the fundamental limitation from restricted interoperability occurs in the network, which encounters diseconomies and loss of mobility.

This paper will review two further issues of equipment interoperability, one in rail-highway intermodal and the other in container ship to inland. It will consider why they occur and persist, the implications for the transportation network, and the kinds of policies that might prompt a more efficient and integrated system.

Rail-Highway Intermodal

The dominant form of commercial truck equipment on the nation's highways is a wheeled trailer, with dry vans being the most common type. On the nation's rail intermodal network, the dominant form of equipment is an unwheeled container, with dry vans being almost the exclusive type. The network is not geared to removing trucks directly from the highway; it is geared first to moving international containers long distances inland and second to moving freight from the small set of domestic operators who own and can substitute containers for trailers. The incompatibility of highway with intermodal equipment has a sound logic, based in the need for trains to have high revenue-bearing capacity and to run on a capital-intensive network of controlled scale. To manage capital intensity, the system of rail infrastructure has been reduced over decades to a viable size. The financial return on that now-limited capacity can be measured in its revenue utilization per foot of train. The highest intermodal revenue per foot comes from containers moving stacked atop one another, which means they cannot have wheels. This operating configuration has persuasive economies in dense lanes that can keep trains full. It is a linehaul and not a pickup-and-delivery economy, so it has its greatest effect at long distances, and railroads have invested heavily to exploit it. Trailers – normally reinforced for rail lifting – continue to be carried in intermodal service, but railroads no longer own them, and, in most cases, trailer trains are neither the leading product nor the impetus for private investment.

This lack of interoperable equipment between the highway and the intermodal networks restricts the size of the market rail services address. A 2003 study for the Commonwealth of Virginia looked at this problem along the I-81 corridor, and with railroad cooperation attempted to resolve it[1]. A graphic from that study appears at left, illustrating the way that adoption of different railcar technologies increases the size of the addressable rail market, by deepening intermodal penetration among highway equipment types and the truck lines operating them. The key technology was the Expressway railcar platform used by Canadian Pacific (CP) Rail in Canada, which is able to handle virtually any type of trailer on the road without modification. By eliminating the barrier of interoperability for most motor carriers (including smaller and private ones), their utilization of rail services could be expected to go up and highway diversions increase, which in turn became part of the logic for public investment in rail. The subsequent result of that study is instructive. The railroad went ahead with investments and new service development along the corridor, but stayed with conventional railcar technology. Their reasoning is that the quantity of new business they can attract conventionally seems sufficient to them, and still appears to warrant public support. A second reason may be that the economies of the new technology are in terminals and pickup and delivery, which favors shorter distances and less revenue per foot. The technology in question presented its own challenges of interoperability within the railroad, in that it required either utilization in fixed corridors or an expensive, broader roll out in order to achieve network balance. In Canada, where it remains in service, the first solution has been adopted over a relatively short distance route.[2]



---

[1] The Northeast – Southeast – Midwest Corridor Marketing Study, Examining The Potential To Divert Highway Traffic From Interstate 81 To Rail Intermodal Movement: Final Report to Virginal Department of Rail and Public Transportation, Reebie Associates, 2003

[2] CP Rail invested $52M in Expressway's introduction, primarily for equipment and terminals. Originally hoped to spur a public-private partnership to finance double tracking of the Montreal-Detroit corridor, the heavy public investment did not occur.

Implications – There are two obstacles to interoperability in rail-highway intermodal. The first is the constraint of capacity, which then must be devoted only to the most beneficial uses. In the absence of public investment, the measure of benefit will be private financial returns, and it will favor and should favor long-haul stack trains. The second obstacle is the inertia of equipment and systems in place. Much capital has been sunk into railcars and rail yards designed to optimize on a limited network. Even if that limitation were lifted, a different and parallel technology would have to develop its own set of operational economies. Continuance of the status quo means that railroads may take on less traffic than the public may like, with consequences for roadway congestion, national energy consumption, carbon management, shipping costs, and the cost of goods.

Container to Ship Inland

The principal international marine container is a 40-foot dry box, without wheels. Containers of 20 feet and 45 feet exist, as well as isotainers to handle certain bulks, but the 40-foot box is the dominant form of equipment used in U.S. foreign trade and around the world. Container ships and handling systems are designed to optimize its transport, and while a larger container can be managed above decks, irregularity can challenge efficiency. This equipment is owned or leased primarily by steamship lines, which also provide a wheeled chassis to transport the box in pickup and delivery.

By domestic standards, the 40-foot box is an inferior good: it offers roughly two-thirds less cubic carrying capacity than the 53-foot trailer normally run by a U.S. truck line and its chassis doesn't have use in ordinary domestic service. Moreover, the ship lines make an understandable effort to control their assets and keep them tied to their ports, by limiting the time allowed for pickup-and-delivery service and charging demurrage fees on a rising scale for overage. The consequence is that the carriage networks for international and domestic goods are separate. The average dray distance for most ports is well within the overnight distance for a single truck driver, and dray carriers typically do not operate as network fleets that interlink and balance many lanes. Instead, pricing normally is based on 100% empty return, which carriers portray as operationally factual; export lanes are not the reverse of import in any case, while time, ownership, and cube all work against triangulation with domestic freight. Even allowing for the higher degree of imbalance characteristic of shorter haul distances, this is poor utilization. By comparison, national average empty returns for all dry vans appear in the table below, and they show a far more efficient pattern: the worst empty factor is 31%, not 100%.[3]

Length of Loaded Haul - Dry Vans				
0-50 Miles	51-100	101-200	201-500	501+
Length of Empty Repositioning				
6.6 Miles	17.3	30.4	55.2	105.0
Length of Empty Repositioning as % Loaded Miles				
31%	27%	20%	18%	11%

Based on 1997 VIUS

[3] VIUS (the since-discontinued federal Vehicle Inventory and Use Survey) relied on operator reporting, the figures are ten years old, and the conversion of distances to percentages is estimated. It also is possible for load factors to be lighter on "backhaul" segments. However, dry vans are the most versatile of equipment, and the pattern is clear: van carriers do not normally run half their miles empty.

The problem of inland interoperability has additional repercussions. First, the separation of the wheel set from the box creates a parallel group of assets to be managed and matched, and this is further complicated by the relegation of both components of equipment to use by the owning ship lines – a prescription for inefficiency that chassis pools are just beginning to address. Next, the arrangement where trucking companies contribute only tractors and none of the trailing equipment is unique to the United States and is otherwise rare in U.S. common carriage; for the operator best able to improve utilization, it diminishes the incentive to do so, contributing to cross-hauling and excess vehicle miles traveled (VMT). Last, the transloading of goods from marine containers to domestic equipment arose partly as a solution to the disconnected networks, and partly for reasons of consolidation and supply chain management. To the extent that the former is a motivation, it is an extra step and an extra cost.

Implications – The chief obstacles to interoperability in container ship to inland are the dimensions of the equipment and the motivations of ownership. The misalignment of international containers with domestic service is more importantly a matter of cubic capacity than of chassis requirement. In any case, the latter is a necessary corollary of ship loading, where the former is not – as the photograph at left illustrates for 53-foot top loading. The problem of ownership is that marine operators have every reason to maintain a standard box and keep it close to shore, while the groundside operators have little reason and some disincentive to improve the productivity of someone else's asset. In this sense, it wouldn't matter if container leasing companies introduced bigger equipment, because of the party to whom they would offer it. The ground carrier doesn't bear the burden of the lease and the obligation to make it lucrative; the ship line does, but considers it for a portable unit of vessel capacity. Economic interests thus prevent the marine and land networks from meshing.

The situation may be reminiscent of the rail intermodal industry 20 years ago. To assure service, railroads at that time supplied trailing equipment to draymen, which ran balkanized operations with low utilization around rail ramps. When the railroads withdrew the equipment because the business had matured, groundside operators who had or could develop networks to support their own assets stepped up. Interestingly, this also stimulated development of railcars that could fully accommodate 53-foot domestic boxes. Steamship lines are not likely to stop supplying containers, but ground carriers with fleets might alter the situation from the land side. Meanwhile, continuance of the status quo brings excessive repositioning of too much equipment and with it higher ground costs, land requirements, traffic volumes, fuel consumption, and emissions of carbon and other substances.

Policy Options

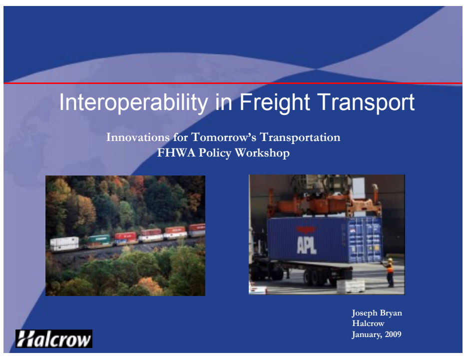
Limitations to interoperability bring with them a mixture of private handicaps and public burdens. Drawbacks on the private side may not involve inefficiencies: the rail position for highway diversion is about accepting less market share for less risk. It is productive on its own terms, and it is satisfactory to railroads that have seen the downside of the fixed costs of infrastructure. Thus, drawbacks may be tolerable to the existing private interests: port draymen aren't bothered by high empty returns they can charge for, and ship lines want their carrying equipment back. If problems of interoperability are most importantly a disconnect between networks, then one source of difficulty can be that players are happy in their parts, and the public interest in the whole either has to be asserted on its own, or borne by new or evolving players with system ambitions. To the public sector, the value of solutions lies in the matters cited above: management of congestion and roadway costs, economic competitiveness, land use, energy requirements, air quality, and carbon control. Policy responses to promote interoperability can include direct investment and eligibility requirements, multijurisdictional programs, pricing and incentives, setting or encouragement of standards, pursuit of consistent regulation - and keeping an informed eye on markets as they sort themselves out.

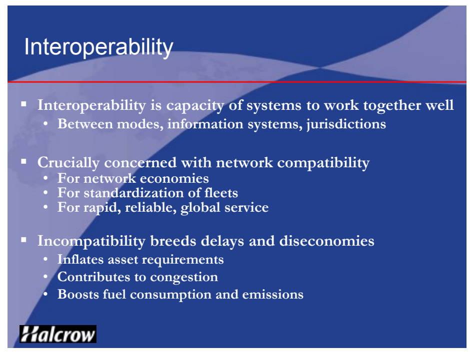
One useful development from a policy perspective is the rise of intermodal corridors linking gateways to distribution hubs - the Heartland Corridor between Norfolk and Columbus is an example of this. Because they are intended as integrated intermodal products, and the promoters want public support, public agencies can seek the inclusion of desirable features. An example might be additional capacity to foster domestic trailer service on the corridor, or on a different route; another would be incorporation of an initiative for domestic size containers in overseas trade. Linkage of these corridors into larger networks is essential; system plans could be stipulated as a condition for rail investment, and core freight routes that also accommodate drayage could be required in the transportation plans of involved communities. Corridor applications are one of the central arguments for multijurisdictional programs; the furtherance of such programs is consistent with interoperability goals because they help integrate networks, so support for them as a matter of policy makes sense.

Pricing tools may become more diverse in the next few years. If fuel taxes are increased or freight user fees are imposed, reductions could be allowed for trucks in intermodal service, provided they met certain, perhaps escalating, standards for empty returns. Should carbon monetization be introduced, it could substantially change the calculus for interoperability. Higher cube containers might acquire greater value, and better equipment utilization might earn better credits. Conceivably, it could make shorter distance rail lanes more attractive to railroads simply by adding another element to profitability, which could in turn boost operating models that are focused on terminal and pickup-and-delivery efficiency.

As a final point, it is worth noting that players with committed capital and entrenched interests may support the status quo, and that change may come from outside with new players possessing different objectives. One of the real improvements to interoperability in recent years occurred in information technology. The conventional effort to stitch together legacy information systems with electronic data interchange was transformed by the arrival of web-based platforms, which were simpler, more effective, and much more accessible. (Transformation in this realm will continue; for example, as the technology communicating terminal and road conditions moves from passive information pools to proactive streams, it will reach deeper into user environments and sharpen operating decisions.) Public policy generally may favor standing out of the way of innovation, but it also can see to it that competition is allowed, and the path to new developments is not blocked.

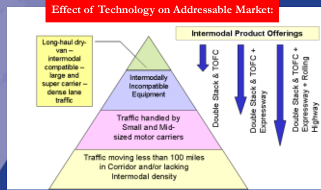
Workshop Presentation





Trial Solution: I-81 Corridor

Effect of Technology on Addressable Market:



Outcome: Corridor investment with standard railcars
Reason: Ample new business without new technology

Halcrow

Implications

Two Obstacles:

☑ Constraint of capacity
☑ Inertia of equipment & systems in place

- Status Quo means:
  - Railroads accept less market share for less risk
  - Diminished access to public benefits of rail

Halcrow

Container Ship to Inland

- Marine network geared to 40-foot container
  - Box & chassis owned or leased by ship lines
  - Demurrage (rent) ties equipment to shore
- Domestically, 40-foot container is inferior good
  - Much lower cube
  - Truckers don't buy them
- Reason for 40-foots is sensible:
  - Global marine standard
  - Owned as portable ship capacity
- Result:
  - Good utilization in marine service
  - Poor utilization in inland service
  - ➡ Barrier to interoperability

Halcrow

Inland Utilization

Compare marine container 100% empty return to US average:

Length of Loaded Haul - Dry Vans				
0-50 Miles	51-100	101-200	201-500	501+
Length of Empty Repositioning				
6.6 Miles	17.3	30.4	55.2	105.0
Length of Empty Repositioning as % Loaded Miles				
31%	27%	20%	18%	11%

Based on 1997 VIUS

Outcome:
- Excess VMT and cross-hauling
- Draymen aren't network carriers
- Chassis management & transloading requirements

Halcrow

Implications

Two Obstacles:

☑ Equipment dimensions
☑ Motivations of ownership (and disincentives)

- Status Quo means higher:
  - Ground costs and land requirements
  - Traffic volumes
  - Fuel consumption and emissions
- Intermodal history suggests a precedent

Halcrow

Policy Perspective

If interoperability problems are a disconnect between networks:

- Difficulty may be players happy in their parts
  - Public interest in the whole must be asserted on its own, or
  - Borne by new or evolving players
- Solutions have substantial value to public:
  - Management of congestion & roadway costs
  - Economic competitiveness
  - Land use
  - Energy requirements
  - Air quality & carbon control

Halcrow

Policy Options

- Promote interoperability through:
  - Investment and eligibility
  - Standards and consistent regulations
  - Informed eye on markets
- Intermodal corridor products a useful trend
  - Public can trade support for features
  - Application for multijurisdictional programs
- Pricing tools becoming diverse
  - Create incentives as well as fees
  - Carbon monetization potentially powerful
- Allow for change from outside
  - Example: web vs. EDI

Halcrow

Impacts of Higher Fuel Costs

Dan Brand, CRA International

Introduction and Objective

This is a brief paper on the impacts of higher fuel costs on the demand for surface passenger transportation in the United States. It outlines what generally is known about how surface transportation will change or be changed by sustained higher fuel costs based on a scan of recent literature and national data.

Some Recent Events and Data

The most recent concern motivating an examination of the impacts of higher fuel prices is their recent extreme volatility. The per-barrel price of oil on world markets has decreased from about $140 to around $40, just in the last six months! The average price at the pump for unleaded regular gasoline was $4.09 a gallon in July, and was below $1.70 in December 2008! A year earlier, in July 2007, the average price per gallon was $2.96, for an increase of 38% from July 07 to July 08[1]. For the months of August, September, and October, from 07 to 08, the percent price increases were 36%, 32%, and 12%. These price increases resulted in the largest monthly, year-over-year declines in U.S. vehicle miles traveled (VMT) since record keeping began in 1942. The VMT declines in 2008 over 2007 have been 3.6% in July, 5.6% in August, 4.4% in September, and 3.5% in October. For the year 2008 through October, the latest month for which FHWA Traffic Volume Trends data are available, the decline has been 3.5% or about 90 billion vehicle miles[2]. These declines are widely distributed across the country; 48 states experienced VMT declines in September 2008 as compared to September 2007. Whether these declines continued as gas prices declined so rapidly in November and December is a very interesting question. Presumably, the current economic slowdown and rising unemployment will offset part of the effect of declining gas prices.

A positive result of these VMT declines is a small decline in traffic congestion in the United States. The average gas price increase of 28% in the first half of 2008 over 2007 "influenced a 3% reduction in the Travel Time Index (the ratio of peak period travel time to free flow travel time) for the nation as a whole, slightly below 2006 levels. Ninety six of the nation's top 100 markets (by population) had drops in traffic congestion in the first half of 2008 compared to 2007."[3]

Another important result of these VMT declines is that fuel consumption also is down. Energy Information Administration (EIA) data for all of 2008 show that motor gasoline consumption

[1] Energy Information Administration, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp.
[2] FHWA Traffic Volume Trends, http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm.
[3] INREX National Traffic Scorecard Special Report "The Impact of Fuel Prices on Consumer Behavior and Traffic Congestion".

declined by 3.3%, compared to 2007[4]. For the last two months of 2008, VMT declines have been slightly less than in previous months in 2008, and still less due to fuel price increases and more due to the economic decline that accelerated in the last two months of 2008[5]. Thus, we may postulate that gasoline consumption for the year 2008 through October is down about 4% due to gas price increases. This drop in gas consumption shows that not only are Americans driving less, but they also are switching to transit, buying more fuel efficient cars, and in multicar households, shifting to their more fuel efficient cars.

Annual transit ridership has increased by about 420 million passengers in the last year, or about 4% to 10.6 billion passengers[6]. The increase is widespread, with 86% of transit agencies reporting ridership increases. However, comparing this increase of 420 million passenger trips to the decline of 90 billion VMT on our streets and highways means that only a small fraction of highway travel has diverted to transit (5% or less). In the major cities where transit is more available, highway traffic was down more than the national VMT declines. For example, in New York City, traffic on the Lincoln and Holland Tunnels fell 6.3% in September compared with 2007, and more than 7% in October on the four MTA controlled bridges and tunnels.

The impacts of recent oil and gasoline price swings notwithstanding, the huge impacts of transportation on U.S. energy independence and global warming are continuing primary concerns affecting national transportation policy. Transportation consumes more than 70% of all oil used in North America, and there is evidence "that oil consumption is set to become increasingly concentrated in the transportation sector."[7] Ninety nine percent of all energy consumed in transportation (all modes) currently is oil based, and 58% of that energy is used by light duty vehicles (LDVs). This means that more than 40% of all oil used in the United States is used by LDVs on highways. Because we import about 60% of our oil, this means we are using the equivalent of all our domestically produced oil for highway passenger transportation! Importing the remaining 60% of our domestic consumption, much of it from quite unfriendly countries, has annual costs for the United States in the hundreds of billions of dollars in transfers of wealth, price shocks, military costs in blood and treasure, and other costs such as for the Strategic Petroleum Reserve. The current economic situation has shown that adding these costs annually to our national debt may be unsustainable.

Finally, global warming is a huge and still emerging concern, both for its consequences and the costs of measures to mitigate it. As long as carbon-based fuels are used to provide the basic energy used in transportation, whether oil based or for electric power generation, greenhouse gas production will continue to increase with increased energy consumption in transportation. Currently, the United States emits a little less than a quarter of global carbon dioxide emissions, and transportation is the single largest source of these emissions, emitting 32% of the U.S. total[8].

---

[4] Energy Information Administration, http://tonto.eia.doe.gov/dnav/pet/pet_cons_psup_dc_nus_mbblpd_a.htm.
[5] FHWA Traffic Volume Trends, http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm.
[6] American Public Transportation Association web-site, http://www.apta.com/media/facts.cfm#hw02.
[7] OECD ITF Joint Transport Research Centre Paper "Oil Dependence: Is Transport Running out of Affordable Fuel?" February 2008, http://www.sourceoecd.org/10.1787/235517712500.
[8] Energy Information Administration, "Greenhouse Gases, Climate Change, and Energy" May 2008.

Short- and Long-Run Travel Behavior Changes: Some Analysis

Developing policies to respond to the impacts of higher fuel prices in the most effective and equitable manner requires a better understanding of the causes and components of the VMT and fuel consumption behaviors described above. As one published paper puts it: "Understanding the sensitivity of gasoline demand to changes in prices and income has important implications for policies related to climate change, optimal taxation and national security, to name only a few."[9] I begin by computing the price elasticities implied by the recent VMT and gasoline consumption changes described above, compare them with values in the recent literature, and then use both to better understand whose travel and fuel consumption is being affected.

Travel and Gasoline Price Elasticities from the Above Data

The short-run VMT price elasticities computed from the above changes from 2007 to 2008 are -0.17 for the four-month period July to October, and about -0.12 (=3.5% VMT decline/30% price increase) for 2008 through October. The short-run gasoline price elasticity for the year through October is only slightly larger at -0.13 (=4% gas decline/30% price increase).

However, these price elasticities do not account for the "but for" effect of the long-term secular trends of VMT and gas consumption in the United States. FHWA data for the increase in VMT in the United States between 1983 and 2004 when nominal gas prices fluctuated between about 80 cents and $1.70 a gallon for unleaded regular gas indicate a fairly steady average annual VMT increase of about 2.9%. EIA Petroleum Supply Monthly data over the same period show the annual average gasoline consumption growth to be 1.2%. If we assume the "but for" cases to be a 2.9% VMT increase and a 1.2% fuel consumption increase between 2007 and 2008, the VMT and fuel consumption price elasticities increase to levels more consistent with values quoted in the literature. The short-run VMT fuel price elasticity adjusted for the secular trends for the four months of July through October 2008 versus 2007 is about -0.30, and for the first ten months of 2008 versus 2007 it is -0.21. The 10-month fuel consumption price elasticity increases to about -0.17.

Travel and Gasoline Consumption Price Elasticities from the Literature

The range of VMT fuel price elasticities reported in the literature is certainly wide: "The short-term elasticity of traffic with respect to price is about -0.15; the long-term is about -0.30."[10] "The (long run) elasticity of household VMT with respect to gasoline prices ranges from -0.19 to -0.32."[11] The short-run VMT price elasticity estimates in the literature are a little lower than those computed with the recent data above. However, there also is evidence that the elasticity

---

[9] Jonathan E. Hughes, Christopher R. Knittel, and Daniel Sperling, "Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand", National Bureau of Economic Research, Working Papers number 12530, 2006.

[10] Daniel J. Graham and Stephen Glaister, "The Demand for Automobile Fuel: A Survey of Elasticities," Journal of Transport Economics and Policy, Volume 36, Part 1, January 2002.

[11] Paul Schimek, "Trends in Personal Motor Vehicle Ownership and Use: Evidence from the Nationwide Personal Transportation Survey", 1998.

increases as the before and after prices move higher: “$4 per gallon appears to be a significant breakpoint for many respondents, both in terms of curbing single occupancy vehicle (SOV) commuting and making hybrid engine vehicle (HEV) ownership a popular investment.”[12] Also, we need to understand that our elasticities computed above may be somewhat high because the early effect of the current economic downturn is included in the data.

There appears to be a larger literature on fuel consumption price elasticities than on VMT fuel price elasticities. Our computed short-run gas price elasticity of about -0.17 is less than the range reported in the literature: “When we use….1-year lags as other studies have used, we obtain elasticity estimates in the range of -0.35.”[13] “Typically, short-term (fuel consumption) price elasticities are in the region of -.3 and long-term elasticities are between -0.6 and -0.8.”[10] A possible reason for our low fuel consumption price elasticities is the contradictory evidence on changes in fuel consumption between 2008 and 2007. U.S. Treasury data on gas tax receipts for the two years show a negligible decline, while EIA data show the modest decline referred to above. The VMT declines from their secular trends suggest the possibility that the gasoline consumption decline is larger than that reported by either agency.

Finally, an interesting note here is that the aggregate cross elasticity of transit ridership with respect to gas price that we can compute from the above data is right on the mark with at least one reported result in the literature. Our gas price cross elasticity is +0.13 (= 4% ridership increase/30% price increase over the first ten months of 2008 versus 2007). “Research in 2007 established that for every 10% increase in gas prices, U.S. transit demand has increased by 1.2%, a cross elasticity of demand to gas prices (e) of +0.12”[14].

The Components of the Behavioral Changes

The impacts of gas price changes on specific behaviors of the population as a whole, as well as on sub groups of the population, are key to developing transportation policies that mitigate negative impacts and increase benefits. Without accounting for the long-term secular (“but for”) trends, our aggregate data above suggests that in the short term, the reduction in VMT contributes much more to the reduction in gas consumption than switching to vehicles with higher gas mileage. The reduction in VMT has been 3.5% for 2008 through October, while the gas consumed has declined by about 4%. While the two behavior changes are very similar in size, this agrees with a finding in the literature that “households respond to price changes by adjusting VMT more than composite miles per gallon in the year after a price change.”[13] However, in the long run, there is general agreement in the literature that “about two thirds of this (fuel consumption decline) results from the purchase of more fuel efficient vehicles and only about a third results from reduced travel.”[15] “So motorists do find ways of economizing on their

---

[12] Bomberg, Kockelman, “Traveler Response to 2005 Gas Price Spike”, TRB 2007.
[13] Steven L. Puller, Lorna A. “Greening, Household adjustment to gasoline price change: an analysis using 9 years of US survey data,” Energy Economics, 21 (1999).
[14] Graham Currie, “Understanding Links Between Transit Ridership and Auto Gas Prices - US and Australian Evidence”, TRB, 2008.
[15] Todd Litman, “Changing Transportation Trends and Their Implications for Transport Planning”, TRB 2008.

use of fuel, given time to adjust. Raising fuel prices will therefore be more effective in reducing the quantity of fuel used than in reducing the volume of traffic."[10]

However, the consequences of reducing traffic volumes on congestion may still be large. We know from traffic engineering that small changes in traffic volumes on congested highways make a big difference in travel speeds. An indication of this is given above in the data section in which the average gas price increase of 28% over the first half of 2008 over 2007 resulting in about a 3% reduction in VMT over 2007 "influenced a 3% reduction in the Travel Time Index for the nation as a whole."[16] This one-to-one correspondence of VMT reduction to travel time reduction is an important finding.

The impact of higher fuel costs on the automotive industry is another important concern in the current economy, particularly for the domestic car manufacturing industry. There is again, a wide range of fleet fuel economy fuel price elasticities, but with a strong central tendency in the 0.5 to 0.6 range[17]. This is consistent with the long-run fuel consumption price elasticity range of -0.6 to -0.8 reported above, with the greatest impact of fuel price increases being increases in fleet fuel economy rather than decreases in VMT. Charlie Wilson's old saying, "what's good for GM is good for the country" doesn't hold these days. Instead, what's good for the country may not be good for GM. The country is demanding fuel-efficient, low-polluting, economical cars these days. We can only hope that the domestic auto industry meets this challenge.

A cautionary note on the long-run demand for fuel-efficient cars is that "the long run income elasticity of fuel demand is typically found to fall in the range of 1.1 to 1.3."[10] This also includes the effects of increasing travel as income increases. "The implication is that fuel prices must rise faster than the rate of income growth, even to stabilize consumption at existing levels." [10] However, in the current economy, income growth isn't the major concern.

There is important evidence from the literature that the distributional impacts of fuel price increases on households extends well beyond simply income effects. "Urban households in general are more price elastic than rural households. Urban multiple vehicle, multiple wage earner households are the most (fuel consumption) price responsive (-0.577), whereas single earner, single vehicle rural households are the least responsive (-0.091). It is therefore clearly evident that the price elasticity of different types of households can be very different."[18] Trip chaining as a response to higher gas prices is strongly suggested by various studies, meaning that neighborhoods with multiple opportunities for satisfying household needs lend themselves more easily to VMT decreases. Multiple wage earner households also have more flexibility in rearranging their travel patterns.

Single- or no-wage earner rural and exurban households have the least flexibility to adjust their travel patterns, and the least opportunity to engage in trip chaining. That they have been hit the hardest by the recent round of gas price spikes is consistent with recent housing price declines in areas populated by long-distance commuters. For example, the two worst hit areas in the country

---

[16] American Public Transportation Association, "Rising Fuel Costs: Impacts on Transit Ridership and Agency Operations, follow-up to September 2008 report.

[17] Don Pickrell, Report to the Presidential Commission on Greenhouse Gas Reduction, 1995.

[18] Wadud, Graham and Noland, "Gasoline Demand with Heterogeneity in Household Responses," TRB 2008.

during the first three quarters of 2008 were Stockton and Merced, CA, each with price declines over 32%.[19]

Some papers "suggest that urban form, more than demographics, dictates the behavioral responses (to spikes in gas prices, and)…..higher gas prices may cause people to select better planned neighborhoods, with more mixed land uses and more transit- and pedestrian-friendly travel options."[12] This can put a positive spin on policies to keep gas prices high as is discussed in the final section of this brief paper. Indeed, social commentators are calling for transportation policies that would "encourage clustering,…. bringing Americans together in new ways. It would help maintain the social capital that's about to be decimated by the economic downturn."[20]

Implications for Transportation Policies

This brief paper is intended to summarize the issues and current knowledge about the impacts of higher fuel prices on the demand for surface transportation in the United States. It is intended to help workshop participants avoid spending time discussing what has already been researched in order to more efficiently identify important research needs for information to evaluate policies and procedures to foster or prevent certain changes from occurring to our transportation system.

The research findings summarized in this paper do indicate that America`s surface transportation system will change with sustained high fuel prices. We can look forward to much more fuel-efficient cars and other LDVs, shorter highway commutes to work, more use of public transportation, more clustering of urban activities with shorter trip lengths and more opportunities for ridesharing matches, but also to the potential for more isolation of rural populations, particularly the rural poor. To the extent that urban densities increase, the market for public transportation will increase, probably offsetting their higher fuel costs. However, as the commuting population thins out in distant suburbs and rural areas, serving them economically with higher cost public transportation will be much more problematic. On the other hand, high-speed intercity surface transportation – true high-speed rail with travel times competitive with airlines trips between 180 and 350 miles – will find a ready market as air travel costs increase dramatically due to the sustained fuel price increases under this scenario.

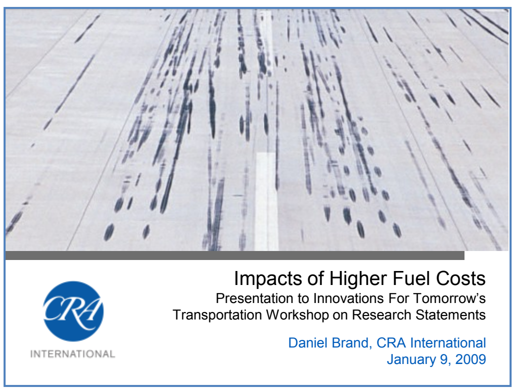
In preparation for the January 9 workshop, it is useful to lay out some ground rules for considering the kinds of policies the nation may consider in responding to a high fuel price scenario. First, it's regulatory and investment decisions need to be based on a systematic analysis of economic benefits to ensure that scarce resources are flowing to projects with the most net public benefits. In this regard, we may want to consider early sayings of President-elect Barack Obama. He stated on Meet the Press, December 7: "We need to provide incentives for fuel efficient cars." However, when asked: "what about a tax that brings gas up to $4 a gallon?", Obama replied, "People are suffering, they can't afford $4 a gallon." This is consistent with the general finding that mandating fuel economy standards is "politically more feasible than (raising)

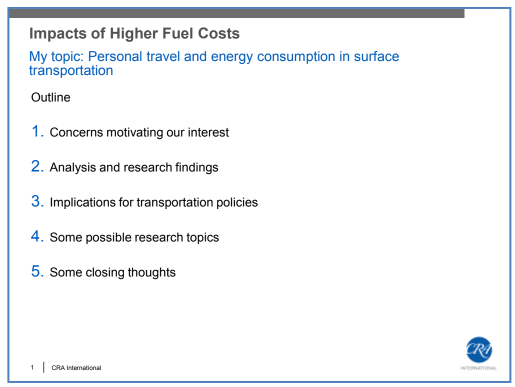
[19] Zillow.com.
[20] David Brooks, op ed, NYTimes, December 9, 2008.

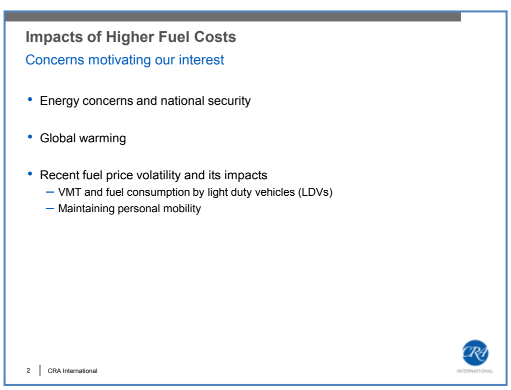
taxes. In the U.S. polls show broad popular support for standards but much less support for taxation."[21]

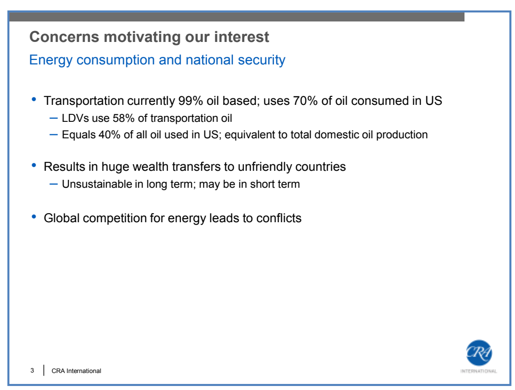
On the other hand, there is a current outpouring of support for major gas tax increases by prominent commentators from all sides of the political spectrum, and by acknowledged experts. On the "left", "Thomas Friedman in The NY Times, "Win, Win, Win, Win, Win,…"[22] and on the right, Charles Krauthammer in the Weekly Standard, "The Net Zero Gas Tax,"[23] both argue passionately and eloquently for major gas tax increases. Daniel Sperling and Deborah Gordon, noted transportation energy researchers, argue for a variable gas tax, which produces a $3.50 a gallon floor gas price.[24]

Workshop Presentation









[21] Clerides and Zachariadis, "The Effect of Standards and Fuel Prices on Automobile Fuel Economy: An International Analysis", Energy Economics 30 (2008).
[22] NY Times 12/28/08.
[23] Weekly Standard 01/05/09.
[24] NY Times, "How High Gas Prices Can Save the Car Industry," 11/16/08.

Concerns motivating our interest

Global warming

- US produces nearly one-fourth of global CO_2
- Transportation produces nearly one-third of US CO_2
- LDVs are the largest transportation source of GHG

4 | CRA International

Concerns motivating our interest

Recent fuel price volatility and its impacts

- Recent price decrease
  - July 2008: oil > $140/barrel; December 2008 < $40/barrel
  - Gasoline > $4/gallon; now < $1.70/gallon
- National gas price up 30%, comparing the first ten months of 2008 with the same period in 2007
  - 2008 through October, vs. 2007 through October: ≈ 30% gas price increase
- Understanding price sensitivity of gasoline demand is key to policies on global warming, energy and national security, optimal taxation and regulations, etc.
  - AND to impacts on personal mobility

5 | CRA International

Concerns motivating our interest

Impacts of recent 30% gas price increase

- National VMT down 3.5%, comparing the first ten months of 2008 with the same period in 2007
  - Largest drop since record keeping began in 1942
  - Widespread: down in nearly all states
- Government gas tax receipts down 9%
- Not all bad news
  - Traffic congestion down 3%
  - Transit use up 4%

6 | CRA International

Impacts of Higher Fuel Costs

Analysis and research findings

- Implied short-run demand elasticities from 2007-2008 US fuel price increase:
  - VMT price elasticity = -0.12; fuel consumption = -0.30
- Corrected for "but for" 2.9% annual average secular increases:
  - VMT = -0.21; fuel consumption = -0.40
- Transit ridership cross-elasticity = +0.13
- Congestion fuel price elasticity ≈ VMT fuel price elasticity

7 | CRA International

Impacts of Higher Fuel Costs

Analysis and research findings

- Elasticities from literature:
  - Short-run: VMT ≈ -0.15; fuel consumption ≈ -0.35
  - Long-run: VMT ≈ -0.25; fuel consumption ≈ -0.70
    - Our short-run elasticities are slightly higher due to economic downturn in US and $4+ gas prices
  - Transit ridership cross-elasticity = +0.12 (close match!)
  - Long-run fuel consumption income elasticity ≈ +1.2
  - Long-run fleet fuel economy fuel price elasticity ≈ +0.5 to +0.6

8 | CRA International

Analysis and research findings

Components of behavior changes

- Aggregate VMT vs. switch to FEVs:
  - Short-run about equal; Long-run FEV switch >> Δ VMT
- Important VMT distributional impacts:
  - Urban multiple wage earner multicar HH most responsive
  - Rural single car HH least responsive
- Urban HH responses
  - Short-run: trip chaining, switch to FEVs and transit, less leisure travel to rural areas
  - Long-run: land value/travel cost tradeoff changes
- Rural HH responses:
  - Few chaining and transit opportunities available
  - More isolation of rural poor

9 | CRA International

Analysis and research findings

Passenger transportation system impacts of higher *sustained* fuel costs

- Much more fuel efficient LDV fleet
- Less VMT:
  - More clustering of urban activities and trip chaining
  - Shorter highway commutes and more commuter rail/bus and transit use
  - Reduced long distance commuting by all modes
- Potential for increased isolation of rural poor
  - Economical rural transit service more problematic
- Potential for increased intercity HSR benefits from increased (fuel) cost of air travel

Analysis and research findings

Economic and security impacts of sustained higher fuel costs

- Doing nothing:
  - Continued huge wealth transfers to unfriendly countries
  - Unsustainable borrowing and lower standard of living
  - Competition for oil with our creditor nations
  - Increased rate of global warming
  - Doing nothing not an option; there *will* be changes, including losses of mobility

Impacts of Higher Fuel Costs

Implications for transportation policies

- Available policy levers:
  - Taxes and rebates
  - Regulations
  - Technology changes
- Prospects for each?
  - Impacts on travel demand determine much of their effectiveness, costs, and benefits
  - Macroeconomic, global finance, and national security analyses determine the remainder
- Problem is huge, but "you should never let a crisis go to waste."

Impacts of Higher Fuel Costs

Some possible research topics

- Behavioral changes over time as fuel prices change (longitudinal panel surveys)
  - How trip making behavior changes
  - How purchase and use of cars and other LDVs change
- Impacts of pricing/rebate incentives on car and other LDV demand
- How to implement various tax policies
  - VMT vs. fuel-based taxes
  - Possible carbon tax and cap-and-trade schemes
  - How to implement CAFE and alternative fuel mandates
- Effectiveness of tax vs. regulatory policies
- Impacts on FHWA program delivery

Impacts of Higher Fuel Costs

Some closing thoughts

- Sensitivity of LDV fuel demand to price fairly well known, including impacts of taxes to support high price floors
- Government regulatory role huge now in financial sector – becoming huge in auto industry
  - Can CAFE and emission mandates be far behind?
- The credit bubble – living beyond our means
  - We thought we could, and so did the world
- We led the financial crisis – made in America and exported around the world
  - The energy price collapse quickly followed
  - Can we lead now?
- Some combination of regulation and taxes is required
  - Low energy prices may BE the problem
  - And we know the impacts of these, and doing nothing

Daniel Brand
Senior Consultant
Transportation Consulting
(617) 425-3310
dbrand@crai.com

www.crai.com

Compendium of Identified Research Needs

The following research topics were identified during the workshop as needing further research either to extend current research or as new areas of investigation. Therefore, these needs do not represent the view of a single individual or even the workshop participants as a whole. They are presented in order of discussion and are not ranked in any other order. Regardless, these research needs do provide insight and guidance to FHWA, DOT, and others on the current state of the research and the emerging issues that likely will need to be addressed.

Future Markets for Public-Private Partnerships

The following research needs were identified by workshop participants as priority needs within the realm of Public-Private Partnerships.

Public Sector "Comparator" Model A key issue in public-private partnerships is the ability to compare the relative costs of public versus private development and implementation of a given project on a comprehensive and even-handed basis that accounts for the complete range of costs—and makes the comparison based on a carefully defined common alternative. The Europeans, Australians, and Canadians have perfected a standardized template for analyzing costs on both a direct and indirect model that is a PPP comparative model. One key feature of the comparator approach is the systematic incorporation of risk (construction, financial, revenue, environmental, etc.) and how these risks are borne by public or private sector. The new U.S. DOT Fair Market Value Rule would enable such a tool to be utilized in the United States. One research need is to develop a "U.S. version" of the comparator.

Procurement Risks to Private Sector for Public-Private Partnerships Potential PPP project proposal process – solicited or unsolicited – is very expensive to private entities. Without a clear competitive procurement process – or a commitment to move ahead with the project, these risks can discourage private initiatives. In the case of Virginia, there has been the development over time of a highly organized, transparent approach – in which there appears to be a high degree of industry confidence. In other cases such as Pennsylvania, a highly politicized process substantially increased the risk to the private entity. Research needs to be conducted, both domestic and international, on the procurement process and how it has dealt with issues such as transparency and compensation to insure an attractive process to mitigate risk and entice private entities to engage in PPPs.

Outsourcing Operations and Maintenance on a Broad System-Wide Basis
The business models of various state DOTs vary widely with regard to activities carried out with in-house staff versus private sector contractors and service suppliers. There is a wide range of experience on outsourcing (beyond design and routine maintenance). Florida and Virginia are on the leading edge in the outsourcing of a broad array of functions related to both maintenance (asset management contracts on a network basis) and systems operations functions (TMC operations, traveler information, safety service patrol, etc.). There is difference between the two states and even districts within the states as to how this is operated. Key issues include the development of a performance-driven approach both to procurement and contract management.

Best practice needs to be compiled and reported and key management issues need to be identified.

Model Concession Agreements Workshop participants agreed that there isn't a single best model for concessions. A few states such as Texas, Florida, and Virginia have had considerable experience and learning in concession agreements. In particular, there may be different models for different types of PPP projects including variable terms, up-front payments, and public sector competition. Research is needed to understand the relative pros and cons to the various concession models, particularly variable terms versus a fixed-concession agreement.

Tolling on the Interstate Highway System Interstate facilities are the location of major traffic congestion and preservation needs. Currently, tolling of existing interstates is highly constrained by FHWA regulations. Tolling presents an opportunity for both generating revenue and congestion pricing. The workshop participants discussed the implications of tolling on the interstates to interstate commerce. There have been several proposals for "rules" regarding future interstate tolling, from the Finance Commission and Congress. A quick turnaround pre-legislative white paper, with pros and cons reported on as needed because this issue is clearly going to be dealt with in the next surface transportation reauthorization legislation.

Implementation of a Mileage-Based User Fee Research is needed to assess the role of the private sector versus the public sector in the implementation of a mileage-based (VMT-based) user fees. In particular, one key question that has to be addressed is whether the implementation of VMT-based user fee collection system has to be performed as a public service – or would contracting the services (as in the case of Germany) make sense. For example, in the private sector, there are systems such as the Easy-Pass system that could be considered for administration of such a fee, with the trade-off being issues associated with privacy. Research is needed to understand all of the options, tradeoffs, and issues that should be considered when determining the appropriate mechanism for implementing a mileage-based user fee.

Best Markets for Public-Private Partnerships The type of projects that are most appropriate for PPP (Brownfields versus Greenfield) is an important consideration for state programs – both with regard to the revenue potential and the need for mixed funding – and with regard to revenue risks. Certain types of PPP arrangements shift the revenue risk in various ways – such as the Availability and Lane Rental approaches. There needs to be a better understanding of the best markets and risk transfer aspects. What are the aspects of the different markets and the implications for PPPs?

Multi-State Public-Private Partnerships Increasingly, the U.S. DOT has recognized the corridors of the future such as I-95 and the I-70 truck lanes where projects will be operating in multiple states. One model for multi-jurisdiction operation is the Easy-Pass model. However, what are other models for multi-state environments and what are the institutional mechanisms?

The Impact of the Current Financial Climate on Public-Private Partnerships
The current condition of the credit market and VMT growth has thrown many of the PPP

projects under development into an uncertain context. Previous estimates of project velocity need to be revisited. New models of PPP with different financial structures need to be reviewed.

Implications of Alternative Fuels on Transportation

Impacts of Alternative Fuels on Safety Safety, specifically personal safety, includes consumer safety for fueling and operating/riding in alternatively fueled vehicles. Consumers need to have information that demonstrates that if their vehicle operates on a different fuel that the vehicle will be at least as safe as a vehicles operated on conventional fuels, such as gasoline and diesel. More broadly, research is needed to assess whether there are safety issues emerging from the distribution of alternative fuels or of the feedstocks used to produce alternative fuels. From the distribution standpoint, research is needed to determine what changes may be necessary to the distribution system to safely accommodate new fuels or fuel additives. Further, consideration needs to be made for safe collection, distribution, and storage of feedstocks, in consideration of where these feed stocks are grown, turned into fuels, and ultimately used.

Impact of Production and Distribution of Alternative Fuels on Infrastructure
Research is needed to assess whether the manufacture of alternative fuels will require a greater demand for new or expanded modes to distribute and consume the fuels. For example, will the existing transportation infrastructure support a change in how fuel for alternatively fueled vehicles is transported? Will increased transportation needs ultimately result in increased emissions due to an increase in freight that may offset potential gains in passenger vehicles? More broadly, research is needed to assess whether there are specific infrastructure issues emerging from the distribution of alternative fuels or of the feedstocks used to produce alternative fuels. From the distribution standpoint, research is needed to determine what changes may be necessary to the distribution system to efficiently and cost effectively/competitively accommodate new fuels or fuel additives, including consideration to infrastructure needs for collection, distribution, and storage of feedstocks, in consideration of both where these feed stocks are grown, turned into fuels, and ultimately used.

Characterization and Prioritization of Collective Alternative Fuels Public Policy Goals Cross-agency research is needed to determine what the collective public policy goals are with respect to alternative fuels (i.e., is the term alternative broadly applied to all feedstock and fuel sources, or is it restricted, for example, to renewable fuels) and what the priority of objectives is across the Federal Government. Currently, the primary policy focus is on reducing energy dependence to foreign entities and other objectives have a secondary focus. This has consequences with respect to the ability of the government to meet multiple objectives. Research and collaboration is needed across the Federal Government to determine the collective goals and the impacts of policy decisions and mandates on the fuels that are currently in use or those new fuels that may be pushed more into the mainstream.

Assigning a Dollar Value to Impacts Assigning a dollar value can be difficult. Consideration of costs and/or benefits, such as those for addressing climate, safety, energy security, etc., certainly will enhance the ability of the government to optimize future policy and support a more informed debate and decisions on how alternative fuels should be utilized in the future. Research is needed to develop tools and metrics to make these dollar assessments.

Impact of Alternative Fuels on Highway Revenue Research is needed to assess the current impacts of alternative fuels on federal aid or the financing programs in the future because there are different taxes, incentives, etc. In particular, research is needed to investigate various options for informing future policies as they pertain to fuels/energy use in the transportation, including non-liquid fuels such as electricity.

Policies to Reduce Greenhouse Gas Emissions Associated with Freight Movements

Imposing Pricing Mechanisms to Promote Fuel Efficiency Gains in the Freight System The objective of this research project is to determine which fuel pricing mechanisms should be developed and implemented to encourage fuel efficiency gains in the freight transportation system. Reducing freight transportation fuel use and greenhouse gas (GHG) emissions can best be achieved when the cost of fuel and GHG emissions are accurately reflected in the price of freight transportation shipments and passed along to manufacturers, retailers, and final consumers who purchase freight transportation. Transportation will be expected to help meet the 60% to 80% reduction targets for 2050 GHG emissions that currently are being discussed in proposed state and federal legislation. To have a substantial impact, truck GHG emissions, which represent over 80% of all freight GHG emissions, must be greatly reduced. Some freight can be shifted to rail and waterborne freight transportation, but truck vehicle-miles of travel cannot be reduced significantly without affecting logistics costs for businesses and industries and driving up the cost of goods and services for consumers. This points toward the need to price freight transportation to encourage fuel efficiency and adoption of alternative fuels while providing sufficient service levels to support economic activity.

One approach for using pricing mechanisms to reduce freight GHGs would be a cap-and-trade-style approach for diesel fuel (the primary fuel for truck and rail engines). Most of the GHG cap-and-trade bills introduced in the 2007-2008 Congress included transportation among the capped sectors through an upstream cap on the CO_2 content of petroleum fuels, implemented at the refinery. Alternate market-based approaches, such as carbon taxes, also could help encourage fuel efficiency gains in the freight system. A low-carbon fuel standard, such as that being implemented in California, is another type of market-based approach; it will require fuel providers to reduce the carbon intensity of transportation fuels and most likely will include diesel. There are also other forms of pricing that could encourage reduction in fuel use, including an increase in diesel taxes or variations in state weight-distance fees for trucks.

The analysis should evaluate the effects of different pricing mechanisms on the fuel efficiency of the freight system, including trucking, rail, marine, air, and pipelines. Fuel efficiency improvements could be derived from technological or operational improvements, and they could be associated with a single mode or due to the shift to a more fuel-efficient mode. The development of pricing mechanisms needs to take into account that different types of fuels are used in different modes (e.g., diesel fuel for truck and rail, bunker fuel for marine, and jet fuel for air cargo), so pricing mechanisms might be applicable to a single mode or multiple modes depending on how they are configured (i.e., if pricing mechanisms are applied to crude oil, then all modes would be affected). For those cases in which different pricing mechanisms affect modes in different ways, the analysis should determine how the implementation of such mechanisms would affect mode shift.

Because the implementation of such schemes could encourage the development of alternative fuels and technologies, the analysis should be on a well-to-wheels basis. Because a shift toward electric-powered vehicles or alternative fuels (e.g., biofuels) is possible, the energy associated with land-use changes, harvest processes, fuel refining and distribution, as well as electricity generation and transmissions, should be taken into account.

Improving Truck Fleet Fuel Efficiency The objective of this research project is to determine and evaluate policies to encourage the implementation of fuel-saving strategies for heavy-duty trucks. Government regulation, market-based approaches, voluntary programs, and complementary support for research and development as well as deployment can help advance technologies and strategies that reduce fuel use and emissions from trucking. Previous research indicated that transportation will be expected to meet between 60% and 80% of GHG emissions reduction targets for 2050 that currently are being discussed in proposed state and federal legislation. Improving the fuel efficiency of heavy-duty trucks will play a significant role in achieving such targets. With the doubling of truck fuel efficiency between 2005 and 2035, it would be possible to reduce 2035 freight-related GHG emissions to 2005 levels. Oak Ridge National Laboratory has developed several scenario forecasts of truck fuel economy using the National Energy Modeling System (NEMS). In their most aggressive scenario, long-haul combination truck fuel economy would rise from approximately 5.6 mpg today to 9 mpg by 2020. However, such improvements will only materialize if the right set of incentives and regulations are in place to encourage the adoption and ensure the successful implementation of fuel-saving strategies.

A variety of strategies currently are available to improve the fuel efficiency of trucking operations, including the introduction of alternative engine technologies, tractor and trailer aerodynamic improvements, use of single-wide tires, use of alternative fuels, automatic tire inflation systems, options to reduce extended truck idling, improvements in truck routing and utilization, and driver training programs.

Many players could be involved in the implementation of fuel-saving strategies. Governmental agencies could provide support for research development and equipment testing, possibly subsidies for new technologies, as well as the development of regulations. Equipment manufacturers would have to accelerate the development and deployment of fuel-saving technologies, while carriers would have to adapt to a new framework where regulations and incentives would be in place to promote a faster adoption of more fuel-efficient trucks. Finally, manufacturers and end consumers might need to accept higher transportation costs as a result of investment in fuel-saving technologies.

Programs to promote the implementation of fuel-saving strategies for heavy-duty trucks fall into four categories: (1) support for research, development, and deployment of fuel-saving strategies, (2) market-based approaches (e.g., carbon taxes, cap and trade systems), (3) regulatory programs (e.g., fuel economy standards), and (4) voluntary programs (e.g., U.S. EPA’s SmartWay Transport Partnership).

Encouraging Mode Shifts to more Fuel-Efficient Modes The objective of this research project is to determine and evaluate policies to encourage mode shifts to more fuel-efficient modes. More aggressive mode shifts to more fuel-efficient modes, especially from trucking to rail, could play an important role in achieving the necessary GHG emissions reduction targets for 2050 that currently are being discussed in proposed state and federal regulation. In general, rail and water transportation are associated with lower emissions (on a ton-mile basis) than truck transportation, although these benefits depend on the length of haul, equipment, and the use of drayage trucks to access intermodal facilities. However, there are constraints to increasing rail and water transportation mode shares due to supply chain configuration, service requirements (i.e., speed, travel-time reliability, damage), logistics costs, and mode capacity. This research should point to policies that could encourage mode shifts beyond those created by "business-as-usual" market conditions.

Understanding the Effects of Congestion on Truck Fuel Efficiency and GHG Emissions The objective of this research project is to understand the effects of congestion on fuel efficiency and GHG emissions from heavy-duty trucks. Congestion can affect truck fuel consumption (and consequently GHG emissions) to the extent that it requires vehicles to accelerate and decelerate more often to adapt to network traffic levels. Because fuel consumption is significantly higher in acceleration mode than while traveling at constant speed, fuel consumption is typically higher in congested roadways. There has not been much published research to date on the effects of congestion on fuel consumption nationwide. The 2007 Urban Mobility Study makes an attempt to do so, but it does not single out the effects of congestion on freight movements. An assessment of freight bottlenecks on highways has estimated delay incurred by heavy-duty trucks.[1] However, there has been no published research assessing the effects of congestion on fuel efficiency of heavy-duty trucks.

This research project will examine how fuel or emissions models consider traffic inputs that could characterize congestion levels. A methodology to quantify the congestion experienced by heavy-duty trucks in current and future years, as well as traffic inputs (to fuel and emissions models) that properly characterize congestion, will need to be developed.

Linking Transportation and Land Use

Enhance Commercial Vehicle Modeling and Analysis Capabilities for Local Jurisdictions Participants of the workshop felt that there was a need for research to be conducted to improve commercial vehicle modeling and analysis capability for jurisdictions that are making land-use decisions regarding commercial vehicles and their emissions. Also, this research needs to include a focus on some of the new data collection technologies and sources for information on commercial vehicle movements within metro area regions.

Assessing the Feasibility of Sustaining Projects Combining Transportation and Land Use Research is needed to understand the likelihood that the visions of projects

[1] Cambridge Systematics (2005): An Initial Assessment of Freight Bottlenecks on Highways. Prepared for Federal Highway Administration.

like the blueprint planning and smart growth can be realized at a national level. Additional research is needed to define how the success of those smart growth visions can be monitored over time to create a template for regions to follow.

Enhanced Household Travel Surveys Current travel surveys, particularly the National Household Travel Survey (NHTS), are not longitudinal in nature, which makes their use for land-use planning more limiting. Research should be conducted to investigate the feasibility of enhancing the NHTS by making it a longitudinal survey and including more information on land-use contacts for survey respondents to link land-use context to travel behavior. Alternatively, household travel surveys planned for regional implementation should be modified to include a longitudinal component.

Macro versus Micro Characterization of Land Uses In assessing the effectiveness of influencing travel behavior through land-use planning, one basic issue is: at what level of detail are land use data available for use in doing planning or analysis? Definitions of very basic land-use characteristics like density can vary widely, according to the geographic scale of data available. The oft-quoted chestnut that "Los Angeles is denser than New York" is only true if you expand the geographic scale to include the entire metro area—the developed, urbanized areas of New York are far denser than Los Angeles. As micro-level (i.e., parcel or small grid-cell) land-use databases become more common around the country, there is a growing realization that characteristics of land use at micro level are far more predictive of variation in travel behavior than are macro-level characteristics. The devil (or angel) is in the details. Research is needed to address the geographic scale of land-use data, which is optimal in terms of capturing major variations in travel behavior, and provide guidance for development of future travel-demand models.

Achieving Intermodal Interoperability for Freight Movements

Examination of Improvements Through Information Technology

Interoperability of information technology systems is important in itself for the management of supply chains, as well as for the facilitation of physical and market functions. The difficulties of linking legacy and proprietary systems are an established barrier to interoperability that the advent of the internet, and the more recent development of web service environments, has begun to break down. Information networks and resources developed for one purpose – such as highway management for passenger mobility – could be sharpened, extended, and reconceived for mobility in the freight sub-system. A variety of research has been done in information technology; what are the most promising ways it can aid freight interoperability, and which ways would be most useful for improving supply chain performance? What role should government play, what can be expected from private players, and what connections could be cultivated between the two from the grass-roots level on up? Research would be valuable to a) reconsider the existing body of literature from the perspective of interoperability opportunities; b) delineate the opportunities in terms of their achievability and their importance; c) explore the roles and interrelations of the public and private sector, including the possible functions of government as a demonstrator of systems, a convener of participants, and a short term spur to longer range programs.

Role of Governments in Facilitation of Common Asset Pools Asset owners want asset control, yet proprietary fleets forego some opportunities for utilization efficiency. Industry groups sometimes are formed to overcome this, such as the TTX equipment cooperative in the railroad business. In circumstances where utilization inefficiency imposes a marked penalty on public systems – such as the congestion effects of container cross-hauling in port cities – there may be a rationale for public action at the federal or some more local level. The options are various: there may be reason to encourage more efficient patterns of private ownership, there could be performance standards that only pools could reach, or there could be an outright federal or coordinated government program. Research would be useful to clarify the public interest and the range of policy choices that could serve it.

Adaptive Solutions for Improving Interoperability Equipment differences are a common and often entrenched barrier to interoperability. Overcoming them would be best, but more rapid benefits may be available from improving the interoperation of the current assets. For example, 40' marine containers are unattractive to domestic users and ship lines keep them close to ports when demand is healthy. Nevertheless, the public pays a price in emissions and congestion when high proportions of these containers return empty to portside markets. Are there pricing mechanisms that could encourage a different result, or operating configurations (like an LCV) that might be permitted for the sake of better utilization? These are possible ways to make do with what exists, and support a better result. Research is called for to a) explore options for make-do improvements to interoperation; b) analyze benefits, costs, institutional friction, probabilities of adoption, and the actions required in the public and private sectors; c) recommend polices consonant with these findings.

Incentives for Innovation in Interoperability Pricing mechanisms could be employed to prompt adaptive solutions; they could also be directed toward innovation. GHG emission charges would fall more heavily on poorly utilized equipment, and could cause owners to operate differently. Alternately, the incentive system and performance goals built into a program like EPA's SmartWay could be generalized to incorporate utilization factors, and to reflect positively or negatively upon the supply chain customers the operators hope to attract. How could direct or indirect economic prices like these two examples be employed as a market mechanism, charging for the externalities the public bears and encouraging the markets to create solutions? Research would be useful to identify a) the types of incentives that could be employed; b) the behaviors desirable and undesirable they could help bring about, and the risks they might pose; c) the best policy recommendations in light of these findings.

The Effect of Interoperability Improvements on System Capacity Limitations to interoperability between modal networks inflate asset requirements and highway VMT. How large is the effect on available transportation system capacity; how much capacity could be released if certain types of limitations were removed? While capacity assessments are complex, their results would be informative for transportation policy, and the benefits should accrue to passenger as well as to freight uses. Research would be valuable to determine a) methods to measure the amount and types of capacity restriction imposed by certain kinds of interoperability limitations (types would include intercity, urban, and gateway, for passenger and freight sub-systems); b) estimates of capacity restriction using one or more of those methods; c) policy implications based on the magnitude and form of capacity that interoperability improvements could make free.

Case Studies of System Change A substantial obstacle to interoperability gains is the satisfaction of industry players with their conventional roles. A drayman, for example, will never buy an asset that someone else will provide for him, and consequently will never be much concerned for its utilization. Some of the radical improvements in intermodal freight operations in fact have come from the outside, from new players with a different set of objectives and incentives. Stack trains were an innovation of steamship lines, not railroads; similarly, the entry of the JB Hunt fleet to the domestic intermodal market allowed railroads eventually to require all players to bring their own equipment. What lessons can be taken from examples like these? Are there ways that new entrants could transform the interoperability of freight operations in some sectors, and should their entry be monitored, encouraged or supported? Research is called for to analyze a) examples of historical shifts, and the conditions under which they; b) the motivations of the prime movers; c) the process by which change spread in the industry; d) the applicability of historical lessons to current challenges in interoperability; and e) policy options derived from these conclusions.

Impacts of Higher Fuel Costs

Further Investigation of the Leveling of Vehicle Miles Traveled Further research is needed to understand the factors that caused vehicle miles traveled (VMT) to level off in 2004. Currently, the root cause of this leveling is not well understood. This research also should be expanded to better understand the causes of changes in VMT between 2007 and 2008.

This research follows up on prior research. There are some published papers that investigate VMT elasticities using 2004 and more recent VMT data. However, the published studies do not use data on the rapid rise in gas prices that took place in the first six months of 2008, nor do they take into account “the full efflorescence of the economic decline” since August/September 2008.[2] Gas prices in the United States fluctuated between about 80 cents and $1.70 a gallon for unleaded regular gas between 1983 and 2004, accompanied by a fairly steady increase in annual average VMT increase of about 2.9%. However, 2004 marked the beginning of a gradual price rise above these levels, culminating in the rapid rise in gas prices to over $4 a gallon in mid 2008. We are clearly living in a different world of volatile and higher gas prices. We also need better information to help evaluate possible national policies like cap and trade that would purposely increase gas prices to respond to energy conservation, energy security, and global warming concerns. A systematic explanation of the VMT leveling since 2004 and the VMT declines from 2007 to 2008 also is needed to inform essentially all of the other six research areas identified and discussed below. Research in this area also will benefit from the research results in the second identified research area discussed next.

Impact of Gasoline Price Volatility Research is needed to better understand the impact of gasoline price volatility as opposed to the price effects themselves. There is a need to develop

[2] March 30, 2009 New Yorker Article, p.21.

better information on price elasticities and the impact of the volatility versus long-run changes in price. The rapid run up in gas prices in 2008 without the long gas lines of 1973 and 1979 is unique. The quick decline during the rest of 2008 from their very high July/August price levels also is unique, and has resulted in our new recognition that the volatility of prices itself is probably playing a role. Modeling the effect of fuel price volatility can test many hypotheses such as the presence of hystereses or "stickiness," which causes lags in the response of travelers to changes in fuel prices, especially volatile changes. The interaction of this volatility with socioeconomic factors also is important, as evidenced by the current slowness of VMT levels to resume their historic gradients. There needs to be a market segmentation of travelers in estimating the impact of volatility because price elasticities have been shown to change with time, income levels, household car ownership and other socioeconomic characteristics, and importantly, location with respect to trip purpose opportunities (rural versus suburban versus urban) and other transportation services (e.g., transit and ridesharing opportunities). Including volatility may help narrow the current wide range of elasticity estimates.

Impact of Low Oil Prices Additional research is needed to assess the *overall* impact of low oil prices across a wide spectrum of areas including transportation, national energy dependence, security, etc. Dollar values need to be assigned to the difficult-to-measure objectives so that trade-off analyses can be made to understand how a change in policy by one branch of the government may impact the ability of another branch to reach its goals. There are two components to this research need. First, research is needed to understand the environmental and economic impacts of low fuel prices. Several articles and opinion editorial (op ed) pieces from all sides of the political spectrum argue passionately for setting a floor under fuel prices to mitigate the damaging impacts of continuing our policy of low fuel prices. There is a large body of literature on these impacts of low fuel prices because we have lived through decades of them. However, there is an urgency now to take these impacts very seriously because we have seen that these impacts can be mitigated by higher fuel prices, and recent international developments have caused us to view these impacts as having very high costs.

The second component to this research need is the need to do new research on the dollar values of the physical impacts of low fuel prices. There is a fairly large body of literature on the dollar values of the national security cost of a gallon of gasoline, or a pound of CO_2 emission, but times are changing, and a new full cost accounting of the cost of national policies to keep fuel prices low needs to be made. For example, currently, the cost of externalities in the market price of gasoline in not routinely included, but the time has come to update these costs of changing government policies by various branches of government. We also will be better able to conduct trade-off analyses to understand how a change in policy by one branch of the government may impact the ability of another branch to reach its goals. For example, in transportation, one goal could be to reduce VMT and congestion and another could be to increase highway revenue. Conversely, the Departments of Commerce and Labor may have a different focus and priority of wanting to increase auto sales. Better information that can be used to quantify the trade offs is needed to be able to make these tradeoffs in the public and national interest.

Understanding the Impacts of Fuel Prices on Travel Behavior Research is needed to understand the impacts that changes in the fuel tax or movement to a VMT-based tax would have on travel behavior and resulting requirements of the transportation system. In particular, this research needs to address the impacts on travel behavior by making big changes in fixed versus marginal costs on highway travel. This is a new focus of research as it extends the discussion to the impact of VMT-based fees on travel behavior and the long-term impacts on land use and demographics.

Substantial increases in fuel taxes increase the price of fuel as perceived by the consumers of transportation. However, a VMT-based tax would mark a significant change from a less to a more transparent cost of driving. It could potentially make a big change in *the perceptions of* fixed versus marginal costs of highway travel. The State of Oregon has carried out experiments assessing the full marginal cost of highway travel, and data are available from those trials. However, given the current consumer awareness and probable sensitivity to higher costs of driving, new research with refined and expanded methods is needed. There also are a variety of low-to-high tech methods of recording mileage and collecting the tax. Research on the consumer perceptions of these methods could ease the transition and reduce the opposition to implementing a VMT-based tax.

Guidance on Forecasts of Vehicle Operating Costs Current modeling and planning efforts typically have assumed that vehicle operating costs stay relatively constant in real terms, but this may not be an appropriate assumption for future planning efforts. Research is needed to provide guidance to state and regional planners on appropriate assumptions for future operating costs of a personal vehicle. This research would build upon prior DOE research and work by others in the private sector that makes a living advising on futures in the oil market. However, the recent price increases and volatility in fuel prices highlights the need to revisit this research area.

Forecasts of highway and transit use in current modeling and planning work can vary in important ways depending on the inputs assumed for future fuel prices and the resulting vehicle operating costs. Fairness in distributing discretionary federal funds for highway and transit projects requires a level playing field in the vehicle operating costs used to forecast the benefits and costs of projects competing for discretionary funds. Also, the increase in public-private partnerships as a method of financing transportation projects with user revenues mandates due diligence and some kind of accepted consensus in fuel costs to minimize the liability from inaccurate user revenue forecasts. The guidance needs to take advantage of important advances in risk analysis and risk minimization methods now commonly used in the private sector, including the real options approach just now being investigated for use in transportation analyses.

Impacts of Fuel Price Increases on the Financing Capacity of States As fuel prices increase, there may be a resulting decrease in vehicular travel that would result, under the current scheme, in reductions of funding available to states. This reduced funding level may ultimately affect state bond rates, Grant Anticipation Revenue Vehicles (GARVEE) bonds, etc. Research is needed to better understand the connectivity between increased fuel prices and state financing and the ultimate impact of reductions in state financing capacity.

Knowing the impact of fuel price increases on both fuel consumption and VMT would enable research on the revenue implications to the states of various financing methods. This research area is assuming much greater importance as states and toll road authorities, both public and private, are having their bonds downgraded or put on watches by the rating agencies due to recent declines in revenue from fuel taxes and toll revenue. This drives up borrowing costs, in some cases well outside transportation facility financing. The increase in negative ratings by the rating agencies is not only due to revenue shortfalls in transportation, but to their well-publicized recent mistakes in rating other types of securities. While we know that fuel consumption and VMT are far from elastic with respect to fuel price increases, and that we are far from the break point between increased revenue due to higher fuel taxes and decreased revenue from decreases in fuel consumption and VMT, the political break point is much more sensitive. In the long term, confidence in the sustainability of the existing gas tax is weaker than in the short term. Therefore, because increases in user fees take a long time to pass political tests, and even longer to change collection methods (e.g., from fuel taxes to mileage fees), work in this research area should be carried out now.

Public Outreach on Fuel Taxes There was a consensus among workshop participants that the general public is relatively uninformed on the purpose of the existing gasoline tax. The workshop participants recommended that FHWA consider undertaking a public outreach campaign to better inform the public on the need and purpose of the gasoline tax and how this money ultimately is used. The need for this research is best summarized by the constant repetition in the media of this statement by ordinary citizens in many states now attempting to raise their state gas tax: “If I knew the gas tax increase was going to fix our roads, I’d be for it!” The need for public outreach is, of course, not new! However, it is needed now more than ever for several reasons (1) the public is not well informed on the purpose of the existing gas tax, (2) the public is uninformed on the consequences of not raising the gas tax, (3) the public is uninformed on *alternatives* to the existing gasoline tax, and (4) based on the state of the highway trust fund, we need to be able to test the acceptability of new concepts for raising revenue. The last point can extend to highly controversial concepts like road pricing. Methods for estimating the effects of advertising and public outreach campaigns are well developed. These campaigns generally emphasize the importance of the benefits from the proposed action, and portray very negative consequences of doing nothing. Political viability can change over time and what was once considered unacceptable can become quite acceptable after some change in circumstances, including appropriate public education efforts.

Conclusions

The FHWA Office of Policy has a long history of supporting the policy decision making efforts of DOT through research and policy analysis studies. In particular, the Office of Highway Policy Information collects, analyzes, and distributes highway-related data from Federal, State, and local sources. The Office of International Programs leads FHWA's efforts to serve the U.S. road community's access to international sources of information on road-related technologies and markets, and to provide technical assistance on road transportation issues to developing countries and economies in transition. The Office of Legislation and Strategic Planning provides support and assistance to the Federal Highway Administration, Department of Transportation, and Congress on policy development and execution; including coordination of the Agency's legislative program and designs, implements and evaluates national studies; including conditions and performance (C & P) reports. The Office of Transportation Policy Studies develops analytical tools and data systems for policy development and studies; conducts analyses and studies to support the formulation of transportation policy and legislative initiatives; prepares major reports to Congress on highway policy issues; and monitors and forecasts economic, demographic, and personal/commercial travel trends.

Ongoing or planned research within the Office of Policy includes aspects of several of the research needs identified by workshop participants. For example, in support of the National Surface Transportation Policy and Revenue Study Commission and the National Surface Transportation Infrastructure Financing Commission, the FHWA Office of Policy sponsored several research efforts related to travel behavior, mileage-based tax, public private partnerships, and other topics. However, findings from this unique workshop, which consisted of transportation policymakers as well as senior technical and industry leaders, provide FHWA with information on priorities and specific direction for additional research.

As stated in the National Surface Transportation Policy and Revenue Study Commission, "The surface transportation system of the United States is at a crossroads." The current Surface Transportation Funding Authorization, commonly referred to as SAFETEA-LU (Safe, Accountable, Flexible, and Efficient Transportation Equity Act-A Legacy for Users) expires in 2009 and a new surface transportation bill will need to be drafted and introduced in the 111th Congress. This legislation will authorize funding for most of the nation's transportation infrastructure investments for the next six years and will, therefore, serve as a foundation for the emergence of transportation policy and research for many years to come. Collectively, the research needs identified through this process highlight several critical areas where research is needed so that informed decisions can be made as part of the authorization process. In particular, many of the research needs are directly or indirectly related to current government policies regarding energy independence, climate change, and dependence on foreign oil. Implementing the research identified in this issue of Innovations will provide FHWA with increased insight and ability to assist Congress in considering options for the Authorization Bill, as well as the future direction of the transportation system in the United States.