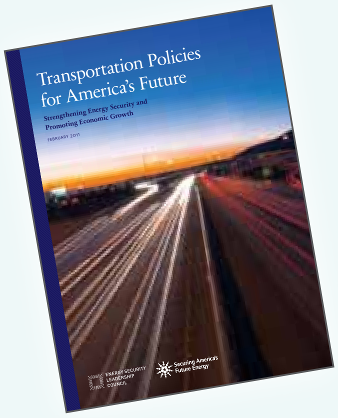
Congestion in America

A Growing Challenge to U.S. Energy Security

JANUARY 2012

Securing America's
Future Energy

Introduction



In February 2011, the Energy Security Leadership Council released a report entitled *Transportation Policies for America's Future.* The report examined the challenges facing the U.S. transportation system in the 21st century and provided a vision and accompanying recommendations for a more efficient, analytically-thorough, and market-driven approach to national transportation policy. Most importantly, it emphasized the crucial interaction between transportation policy decisions and the energy security challenge posed by U.S. oil dependence.

TRANSPORTATION POLICYMAKING, CONGESTION, AND RECOMMENDATIONS FOR REAUTHORIZATION

The United States accounts for more than one-fifth of the world's daily oil consumption. This heavy dependence on a commodity whose price is both high and volatile imposes a tremendous burden on the U.S. economy. Excessive reliance on oil also constrains the totality of U.S. foreign policy, and encumbers the U.S. military, which stands constantly ready as the protector of vulnerable energy infrastructure and supply routes across the globe.

In 1970, approximately 50 percent of total U.S. oil consumption was attributable to the transportation sector. Then, the sector consumed 8 million barrels of oil per day. Today, the sector is responsible for 70 percent of total U.S. oil consumption—more than 13 million barrels of oil per day.[1]

Notwithstanding recent progress to improve the fuel efficiency of our cars and trucks and efforts to shift towards alternative fuels, the vehicles that power the American economy will remain dependent on oil for many decades. Despite this linkage, transportation and energy policy have historically been debated in two entirely separate spheres. In fact, since the construction of the interstate highway system, a coherent, unified strategy for the federal surface transportation system has largely been absent. Characterized by indirect fees, misaligned incentives, overburdening regulations, and inefficient capital investments, the system currently faces major funding and performance challenges.

Despite covering only a small percentage of total U.S. land, metropolitan areas account for 90 percent of U.S. gross domestic product (GDP), contain more than 80 percent of the nation's population, and experience two-thirds of total vehicle miles traveled (VMT).[2]

Road traffic congestion today is a significant challenge to transportation system performance in major U.S. cities—and increasingly in smaller cities as well—resulting in wasteful oil consumption and severely threatening the potential future oil-saving benefits associated with more efficient vehicles and alternative fuels. In 2010, drivers in U.S. urban areas were estimated to have wasted 1.9 billion gallons of fuel—equivalent to approximately four entire days of highway petroleum consumption—idling in traffic for 4.8 billion hours. Over the past decade, the total costs of this waste and delay reach almost $1 trillion.[3]

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[1] U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE), *Transportation Energy Data Book (TEDB),* Table 1.12, June 2011

[2] U.S. Department of Commerce, Bureau of Economic Analysis (BEA), *Economic Accounts*; U.S. Census Bureau, Population Estimates, *Metropolitan and Micropolitan Statistical Areas*; and U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA), *Traffic Volume Trends*

[3] David Schrank, Tim Lomax, and Bill Eisele, Texas Transportation Institute (TTI), *Urban Mobility Report 2011*, at 1, September 2011

Unlike many other industrialized countries, the United States is expected to experience population growth over the next 20 years, from 310 million people to more than 370 million people.[4] Highway VMT is expected to increase almost twice as fast as the population over this period and VMT per licensed driver is also forecast to rise from approximately 13,000 per year to more than 15,000 per year.[5] The rate of urbanization also remains positive—estimated at 1.2 percent per annum through 2015.[6]

Despite being necessary, ambitious policymaking today remains elusive, and with limited funding available, the prospects for a rapid near-term expansion of the U.S. transportation system appear weak. The use of alternatives to single-occupancy vehicle travel remains a small minority of the total travel demanded, and also shows little sign of rapid near-term growth. From both a supply and demand perspective, the current outlook for addressing congestion remains bleak.

As such, the situation faced by cities is expected to worsen substantially in the absence of proactive and effective public policy intervention. Estimates suggest 29 and 65 percent increases in wasted fuel and equally large increases in travel delays by 2015 and 2030 respectively.[7]

To effectively address traffic congestion across the country, increase traveler mobility, and reduce wasted time and fuel, transportation infrastructure policies must be flexible and multi-dimensional. Some may be well-suited for widespread implementation, others less so, and still others may simply not be practical given local or regional conditions. The broad range of options available to policymakers can be grouped into four primary categories:

- Pricing and other flow management techniques to reduce or eliminate recurring congestion
- Accident/incident management for mitigating the likelihood and effect of non-recurring congestion
- Improved public transit service and other alternatives to single-occupancy vehicle travel
- Strengthened long-term urban planning and development initiatives

Each of these policy options can play a role in comprehensive plans aimed at reducing congestion in U.S. cities. However, expanded transit services, dynamically-tolled lanes, restrictions on downtown parking, or any number of myriad options rarely form part of a city-wide congestion-mitigation strategy. While individual strategies are not ineffective in themselves, they will achieve the greatest impact on U.S. oil consumption when designed and deployed in a cohesive and complementary fashion which emphasizes the use of suitable technology, appropriately streamlined review processes, and rigorous cost-benefit analysis.

Reducing the quantity of fuel wasted across the nation while enhancing the efficiency of the U.S. transportation system is a vital mission. To meaningfully reduce U.S. oil dependence, existing congestion-mitigation efforts must be strengthened and new initiatives begun in earnest.

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[4] U.S. Census Bureau, U.S. Population Projections, *National Population Projections 2008*

[5] Energy Information Administration (EIA), *Annual Energy Outlook (AEO) 2011*, Table 60, April 2011

[6] Central Intelligence Agency (CIA), *The World Factbook*, United States

[7] TTI, *Urban Mobility Report 2011*, at 1

PART I

Energy Security

Oil

Rapidly increasing demand for mobility in the developing world is reshaping the global oil market.

Oil demand growth in emerging market economies averaged 3.5 percent annually over the past decade, resulting in an addition to global demand of 11.8 million barrels per day between 2001 and 2010.[8] Oil demand in the developed world actually shrunk over the same period.[9] Looking to the future, fully 100 percent of the increase in global oil demand through 2035 is expected to come from developing nations—almost all of it from transportation.[10]

Conventional oil production within the world's most developed nations peaked in 1997, and has declined by more than 3 million barrels per day since.[11] Globally, more than 90 percent of conventional oil supplies are owned by state-run national oil companies (NOCs).[12] While a limited number of these NOCs operate like private firms at the technological frontier of the industry, the majority function essentially as a branch of their respective central governments, depositing oil revenues in the treasury, from which they are often diverted to other programs rather than being reinvested in new energy projects.

Meanwhile, the fraction of global oil reserves that is accessible to international oil companies (IOCs) is becoming increasingly complex and costly to produce. In addition to the typical costs for pipelines, tankers, and refineries, IOCs must now invest significant additional capital per barrel of oil produced for specialized drilling equipment and oversized offshore platforms. As a result, the cost of production for non-OPEC oil reserves has increased rapidly in recent years.

Between 2003 and 2008, tightened supply-demand dynamics resulted in a nearly unprecedented run-up in global oil prices. After averaging approximately $30 per barrel in 2003, oil prices climbed each year thereafter, ultimately spiking to an inflation-adjusted historical record of $147 per barrel in July 2008.[13]

The global financial crisis and subsequent recession resulted in a sharp retraction in oil prices and weakened demand for petroleum fuels. However, this has proven to be temporary. Oil prices averaged nearly $80 per barrel in 2010, and once again exceeded $100 per barrel in 2011. Demand is rising again in many economies, and global consumption of petroleum returned to, and exceeded, pre-crisis levels in 2010.

Oil consumption in China and India combined increased by more than five million barrels per day over the past decade.

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[8] BP, *Statistical Review of World Energy 2011*, at 9

[9] Id.

[10] International Energy Agency (IEA), *World Energy Outlook (WEO) 2011*, Table 3.1

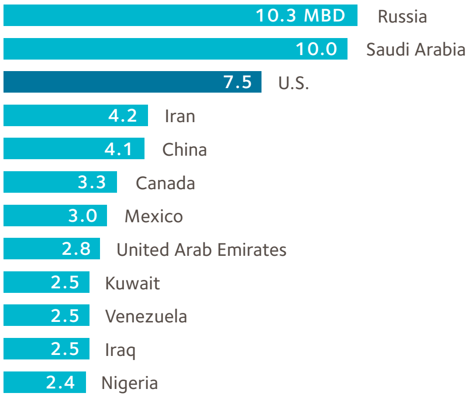
[11] BP, *Statistical Review of World Energy 2011*, at 8

[12] IEA, *WEO 2008*, Table 14.1

[13] EIA, *Petroleum Navigator*

FIGURES I.1 & I.2

Top Global Oil Producers, 2010



Top Global Oil Consumers, 2010

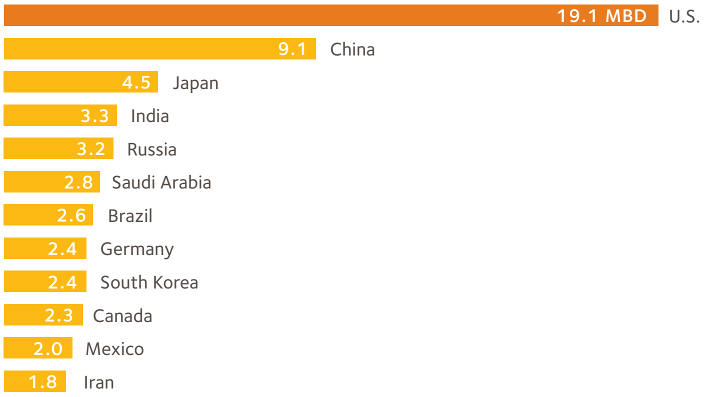
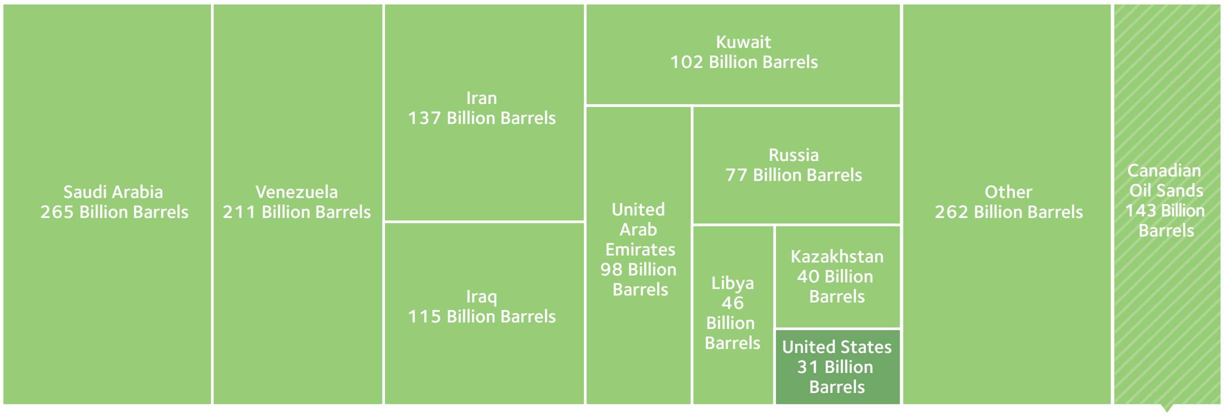


FIGURE I.3

Holders of Proved Conventional Reserves, 2010



Not conventional; shown for context

Source: BP

The United States is the world's largest oil consumer. Almost 40 percent of the nation's total primary energy demands are met by this single commodity, giving it an economic significance unmatched by any other fuel.[14] Over the five-year period from 2005 through 2009, American oil consumption averaged 20.1 million barrels per day, about one fourth of the global total.[15] In 2010, U.S. households and businesses spent approximately $750 billion on petroleum fuels—about 5 percent of GDP.[16]

Although the United States also remains a major oil producer, demand growth has far outpaced supply growth for many decades. Net petroleum imports, once a small fraction of total supplies, now meet more than half of total U.S. oil demand. Between 2005 and 2010, net imports averaged 57 percent of petroleum fuels supplied.[17] However, high oil prices and improved drilling technologies have recently unlocked substantial new resources, and in 2009 and 2010 the nation witnessed consecutive annual increases in domestic oil production for the first time since 1984 to 1985. Access to these unconventional oil sands, shale oil, and ultra-deepwater resources has arrested the aggregate decline in production in the world's developed nations, and offers the possibility of a return to growth in the future.

While high oil prices and increasingly stringent automotive fuel-economy standards appear likely to promote a beneficial reduction in the oil intensity of the U.S. economy, the Department of Energy nonetheless forecasts oil consumption to increase by 3 million barrels per day between 2010 and 2035.[18] Thus the United States is expected to remain heavily dependent on petroleum for the foreseeable future.

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[14] BP, *Statistical Review of World Energy 2011*, at 41

[15] Id., at 9

[16] EIA, *Annual Energy Review (AER) 2011*, Table 3.5; EIA, *Short Term Energy Outlook (STEO)*; BEA, *National Income and Product Accounts*, Table 1.1.5

[17] EIA, *AER 2011*, Table 5.1a

[18] EIA, *AEO 2011*, Table 11

Economic Security

American businesses and consumers are estimated to have spent almost $1 trillion on gasoline, diesel, and other refined products in 2011—up from less than $600 billion in 2009.

In 2008, when oil prices peaked, the U.S. sent $386 billion—55 percent of the total trade deficit—overseas for crude oil and petroleum products. This year, net expenditures on petroleum imports are again expected to exceed $300 billion.[19] With oil prices averaging nearly $100 per barrel, the Department of Energy forecasts OPEC net export revenues to exceed $1 trillion in real terms in 2011—their highest level ever.[20] Looking forward, OPEC is expected to provide more than half of the world's oil supplies by 2035 significantly increasing the net oil trade surplus in the Middle East.[21]

Direct wealth transfer is but one of the many economic costs of U.S. oil dependence. Researchers at the Oak Ridge National Laboratories (ORNL) have shown that significant economic costs stem from the temporary misallocation of resources that occurs as a result of sudden price changes. Specifically, budgeting and financial decisions for both businesses and households become more difficult, affecting long-term economic activity. They have also shown that the existence of an oligopoly inflates oil prices above their free-market cost, which reduces economic activity by forcing the diversion of resources to cover the higher cost of oil.

In total, they have calculated that oil dependence cost the nation more than $5 trillion between 1970 and 2010. Since 2006, these costs, which include wealth transfers, potential GDP loss, and macroeconomic adjustments, have risen to an average of more than $350 billion a year, and topped $500 billion in 2008.[22] This burden is simply unsustainable.

Notably, every recession over the past 40 years has been preceded by—or coincided with—an oil price spike. In general, recessions are caused by a myriad of factors and are damaging to nearly all sectors of the economy. And yet, oil price spikes tend to exact a particularly heavy toll on fuel-intensive industries like commercial airlines and shipping companies. Automobile manufacturers suffer disproportionately as well, as consumers scale back large purchases.

The most fundamental impact is on consumer spending. When oil prices spike, consumers must spend more on gasoline, leaving them less to spend on everything else. Because consumer spending accounts for approximately 70 percent of U.S. economic activity,[23] sharp increases in the price of petroleum therefore represent a significant threat to the health of the U.S. economy.

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[19] U.S. Census Bureau, *International Trade in Goods and Services*

[20] EIA, *OPEC Revenues Fact Sheet*

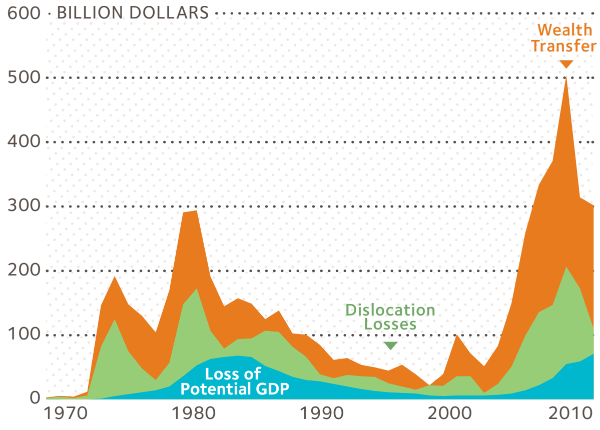
[21] IEA, *WEO 2011*, at 103

[22] David Greene, Roderick Lee, and Janet Hopson, ORNL, *OPEC and Costs to the U.S. Economy of Oil Dependence: 1970-2010*, 2011

[23] BEA, *National Income and Product Accounts*, Table 1.1.5

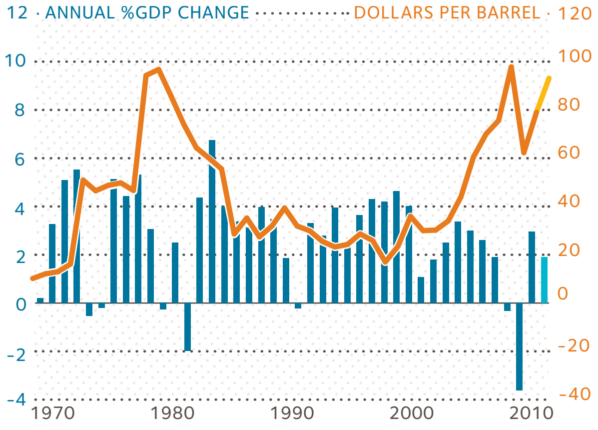
FIGURES 1.4 & 1.5

Economic Costs of U.S. Oil Dependence



Source: ORNL

Oil Prices and Economic Growth



Source: EIA, BEA, BP

National Security

Throughout the 20th century and into the 21st, the United States remains the only nation with the capacity to protect vulnerable energy infrastructure and supply routes.

This capability, combined with the critical importance of oil to the U.S. and global economy, has forced the nation to accept the burden of securing the world's oil supply. This can constrain U.S. foreign policy, requiring the nation to accommodate hostile governments with which it shares neither common values nor goals.

Much of the infrastructure that delivers oil to the world market each day is exposed and susceptible to attack and/or other form of forced closure in unstable regions. The events that unfolded across the Middle East and North Africa throughout much of 2011 only serve to underscore this vulnerability. In Libya for example, oil production collapsed from approximately 1.6 million barrels per day in January to effectively zero by April as civil war ravaged the country.[24]

More than 50 percent of the world's oil supplies must transit through one of six maritime chokepoints, narrow shipping channels like the Strait of Hormuz between Iran and Oman.[25] Even a failed attempt to close one of these strategic passages could cause global oil prices to rise rapidly from current levels. A successful and extended closure could result in severe economic consequences.

To mitigate this risk, U.S. armed forces expend enormous resources patrolling oil transit routes and protecting chronically vulnerable infrastructure in hostile corners of the globe. This engagement benefits all nations, but comes primarily at the expense of the American military and ultimately the American taxpayer. A 2009 study by the RAND Corporation placed the cost of this defense burden at between $67.5 billion and $83 billion annually, plus an additional $8 billion in military operations.[26] In proportional terms, these costs suggest that between approximately 11 and 13 percent of the current defense budget is devoted to guaranteeing the free flow of oil.[27] And that is to say nothing of the grave responsibility of putting American military personnel in harm's way.

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[24] IEA, *Oil Market Report*, OPEC Crude Production, Monthly Data

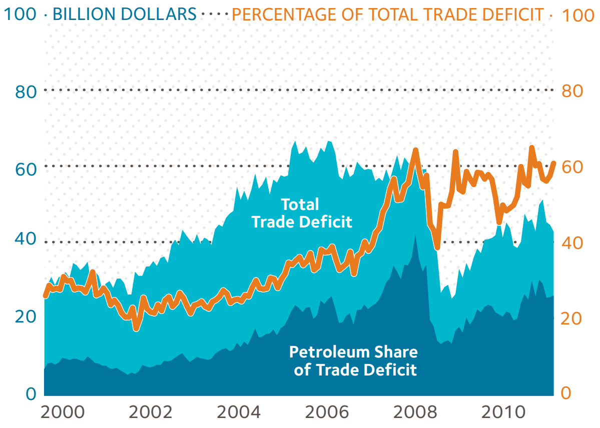
[25] EIA, *World Oil Transit Chokepoints*

[26] RAND Corporation, *Imported Oil and U.S. National Security*, at 71, 2009

[27] U.S. Department of Defense, *Fiscal Year 2012 Budget Request*, Figure 1-1, FY 2011 CR

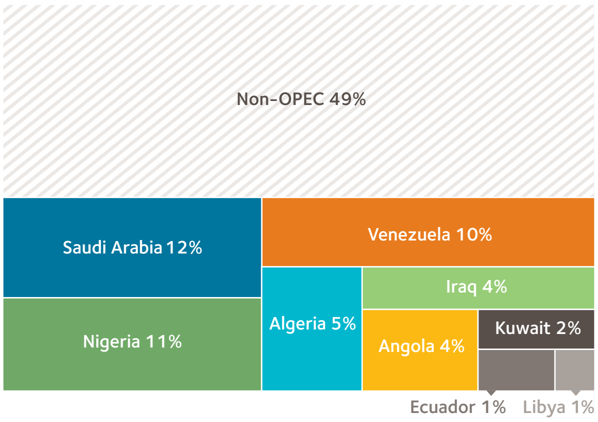
FIGURES 1.6 & 1.7

Share of Petroleum in U.S. Trade Deficit



Source: Census Bureau

U.S. Oil Imports by Origin



Source: EIA

PART 2

Congestion

Road Traffic Congestion Primer

Highway congestion, very simply, is caused when traffic (demand) approaches or exceeds the available space (supply) afforded for travel by the highway system.

In any given location, congestion can vary significantly from day to day because both travel demand and available highway capacity are constantly changing. The time of day, day of the week, season of the year, emergencies, recreational travel, and special events are all factors in determining traffic demand. On the supply side of the equation, accidents/incidents, adverse weather, and other events all cause variation in available highway capacity.[28]

Congestion is classified as either recurring or non-recurring. Recurring congestion is typically the result of peaks in demand (common "rush hour"-style congestion), while non-recurring congestion is caused by a variety of often unpredictable factors affecting (reducing) the available quantity of highway capacity or clogging the system with surges in travel demand.[29]

Congestion is strongly non-linear. That is, once traffic volumes are at capacity, additional demand can lead to significant increases in delay, and vice versa. As traffic volumes approach system capacity, stop-and-go driving conditions form bottlenecks. This also results in lower effective system capacity because fewer vehicles can move through a given bottleneck due to the extra turbulence.[30]

Since the 1980s, physical highway capacity in the United States has remained essentially unchanged while total miles traveled on the system have almost doubled. With few sizable and significant programs to make the demand side of the equation more efficient, congestion—by every measure—has increased substantially. Congestion is worse in urban areas of every size, worse in rural areas, worse on weekends, affects more time of the day, and disrupts more personal trips and freight movements.

Traffic incidents—including crashes, stalled vehicles, and debris on the road—are responsible for approximately 25 percent of congestion problems.

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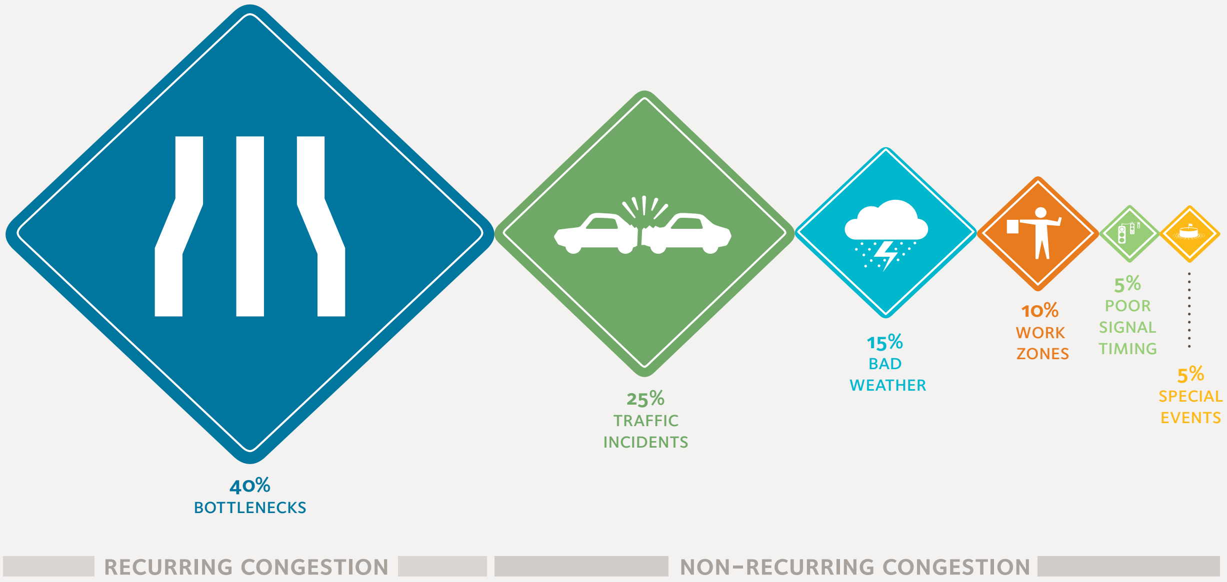
[28] FHWA, *Focus on Congestion Relief, Describing the Congestion Problem.*

[29] Recurring and non-recurring congestion account for approximately 40 percent and 60 percent of total highway congestion respectively.

[30] Cambridge Systematics for FHWA, *Traffic Congestion and Reliability: Linking Solutions* to Problems, at 2-1, July 2004

Sources of Traffic Congestion

FIGURE 2.1



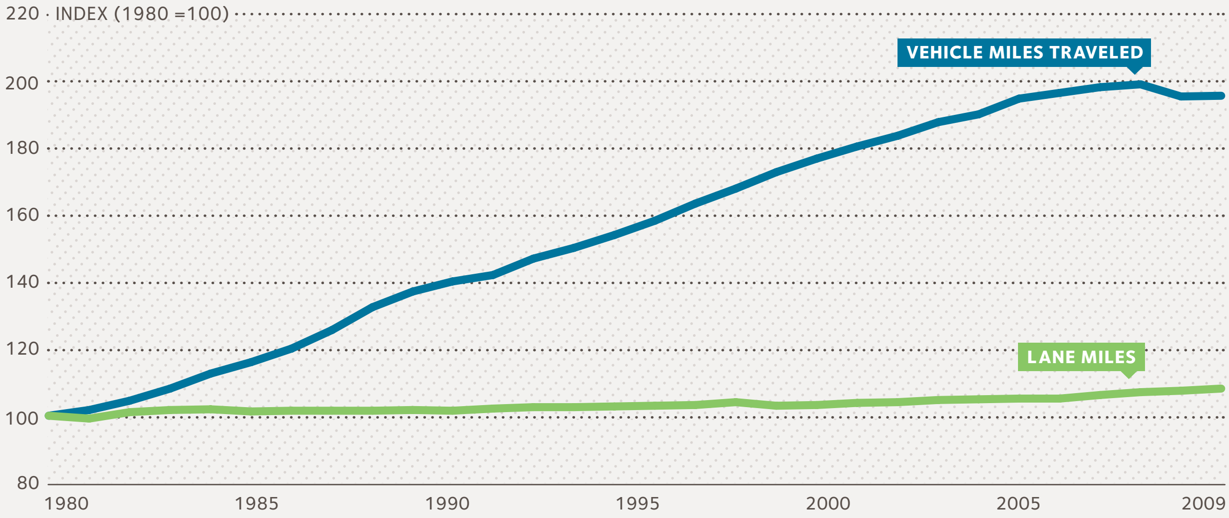
Annual Costs of Congestion

FIGURE 2.2

34 Hours	WASTED PER AUTO COMMUTER	4.8 Billion	TOTAL HOURS WASTED
14 Gallons	FUEL WASTED PER AUTO COMMUTER	1.9 Billion	TOTAL GALLONS OF FUEL WASTED
$713	AVERAGE COST PER AUTO COMMUTER	$101 Billion	TOTAL COST

U.S. Lane Miles and Vehicle Miles Traveled

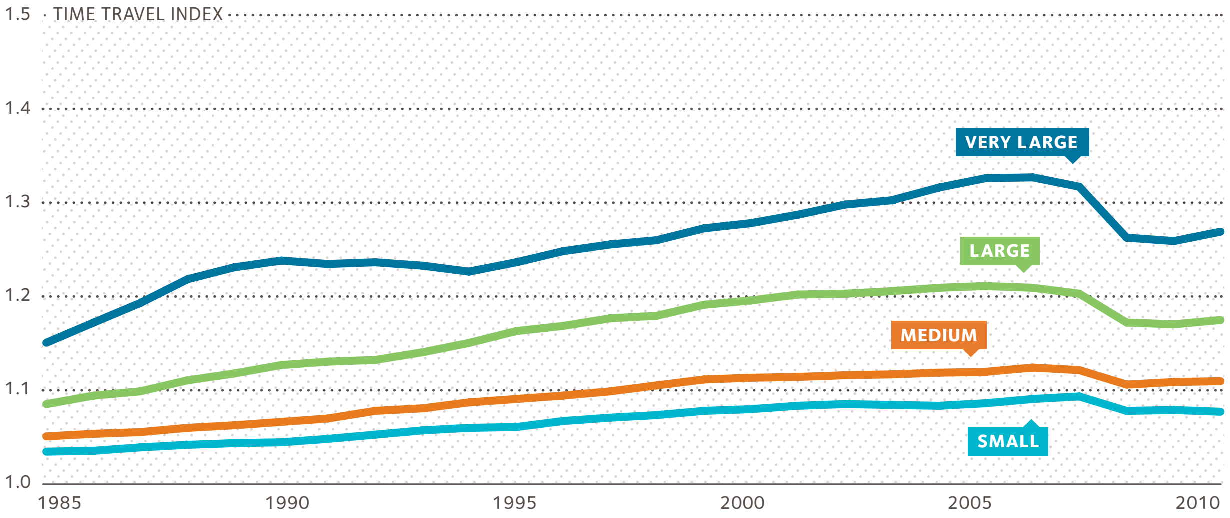
FIGURE 2.3



Sources: Figure 2.1— FHWA; Figure 2.2—Texas Transportation Institute; Figure 2.3— FHWA

FIGURES 2.4

Peak Period Congestion Trends by Population Area Size



Source: Texas Transportation Institute

Highly uncertain variation in daily traffic volume has also rendered travel times increasingly unreliable, necessitating greater planning and travel time allocation for all system users.[31] These 'buffers' are largest in peak periods when average congestion levels are already at their height. They are estimated to have a significant additional effect on travel times. For example, the average Time Travel Index (TTI) calculated for Los Angeles, Pittsburgh, and Chicago were 1.47, 1.28, and 1.48 respectively, but to ensure an on-time arrival for drivers, they revised these numbers upward to 1.92, 1.70, and 2.07.[32] The calculations show that a 30-minute uncongested trip in Chicago increases to 44 minutes in average conditions, and more than doubles to 62 minutes in the worst conditions.[33]

Time Travel Index

The Time Travel Index (TTI) is the ratio of travel time in the peak period to travel time in uncongested (free-flowing) conditions. A TTI of 1.50 indicates that a trip which takes an average of 30 minutes during the peak period takes 20 minutes during uncongested conditions.

Ultimately, time is money, and delays negatively affect both commercial and personal travel. Congestion is thus a substantial cost to all those demanding mobility on the highway system. This cost can manifest itself in many forms. With respect to personal travel it could be the negative effect on health and personal well-being of increasingly stressful and time-consuming commutes. With respect to commercial travel and for shippers specifically, it could be the efficient and effective use of inventory prevented by unpredictable delays. Congestion also challenges the effective functioning of emergency medical, police, and fire services.

The increases in monetary and non-monetary costs have a clear negative impact on the U.S. economy and society overall. Estimates of delay and associated increased fuel costs reach $101 billion annually.[34] Delays and extra fuel consumed reach 34 hours of travel time and 14 gallons per urban resident respectively, for an average congestion cost of $713 per commuter.[35]

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[31] David Schrank, Tim Lomax and Shawn Turner, TTI, *Urban Mobility Report 2010*, at 21, December 2010

[32] TTI, *Urban Mobility Report 2011*, at B-54, 2007 data

[33] Id.

[34] Truck congestion includes only the value of wasted time, fuel and truck operating costs, and the negative effects of uncertain or longer delivery times, missed meetings, business relocations, and other congestion-related effects are not included.

[35] TTI, *Urban Mobility Report 2011*, at 1

Transportation Sector Oil Consumption

The U.S. transportation sector consumes approximately 2.7 and 8.9 million barrels per day of diesel and gasoline respectively.

In 2010, the transportation sector accounted for 70 percent of total U.S. oil consumption.[36] At approximately 13 million barrels per day, this quantity is larger than that consumed by any other national economy for all purposes and sectors.[37] Highway vehicles—including cars, motorcycles, buses, and light-, medium-, and heavy-duty trucks—are responsible for more than 85 percent of this quantity.[38]

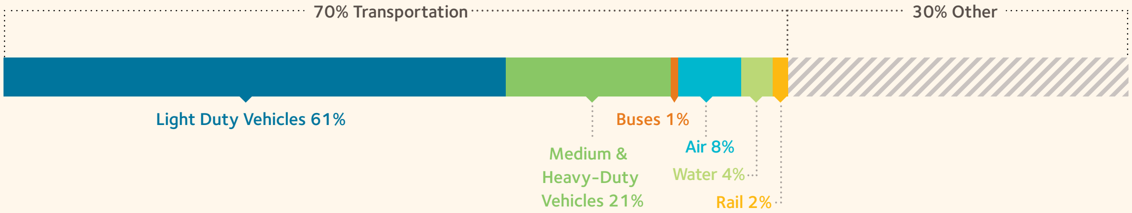
The U.S. highway system, U.S. transportation sector, and the nation as a whole will remain dependent on petroleum for many decades despite impressive anticipated improvements in vehicle fuel efficiency and the wider use of alternative fuels.

Alone, these two components remain insufficient for addressing the demand-side challenge of U.S. oil dependence in the short-to-medium term, and will be undermined to a rising degree by an increasingly strained, inefficient, and deteriorating U.S. transportation infrastructure. This infrastructure is the third component—complementing and facilitating gains from the other two—of a comprehensive strategy to reduce U.S. oil consumption.

Imbalances between traffic demand and available highway capacity has created widespread vehicular congestion across America's metropolitan areas. The resulting gridlock, results in billions of hours of delay annually, and affects both private and commercial traffic. It negatively impacts quality of life, adversely affects business activity, substantially distorts development patterns, reduces urban air quality, and importantly, wastes considerable quantities of fuel.

U.S. Oil Consumption By Sector and Mode

FIGURE 2.5



Source: Transportation Energy Data Book

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[36] DOE, EERE, *TEDB*, Table 1.12

[37] China places a distant, but rapidly growing, second, consuming more than 9 million barrels per day in 2010.

[38] DOE, EERE, *TEDB*, Table 1.15

Wasted Fuel

From the early 1980s through 2007, the quantity of congestion-related fuel waste increased steadily.

Over the same time period, total highway fuel consumption also increased—by approximately 60 percent.[39] Notably, however, the wasted fuel due to congestion grew at a much faster rate—tripling from a quantity equivalent to approximately 0.3 percent of total highway fuel consumption, to a quantity equivalent to more than 1 percent.

In 2010, drivers in metropolitan areas wasted 1.9 billion gallons of fuel. This equates to more than 125,000 barrels of wasted fuel per day (by way of context, less than 1 percent of the oil wells in the United States produced more than even 200 barrels of oil per day in 2009).[40]

The nation's fifteen largest metropolitan areas (those with more than 3 million inhabitants) accounted for 70 percent of the total fuel wasted. Areas with more than 1 million inhabitants (47 in total) are responsible for 90 percent of this wasted fuel. The cities of Los Angeles, New York, Chicago, Dallas, and Washington D.C. are each estimated to experience more than 80 million gallons of fuel waste per year.[41]

ECONOMIC RECESSION, HIGH OIL PRICES AND CONGESTION LEVELS

It is important to recognize that although the lowest levels of congestion in recent times were observed in 2008, this was due to the unique circumstances surrounding the 2007-2009 economic recession. Prior to the slowdown congestion levels had been rising steadily higher for at least two decades.

Average fuel prices increased substantially through the early- and mid-2000s before reaching a peak in the summer of 2008—at which time average retail gasoline prices exceeded $4 per gallon. This helped depress levels of household disposable income and decrease demand for other goods and services as Americans allocated greater proportions of their budgets to energy. Businesses suffered as a result, and shipping rates declined. Unemployment also rose rapidly, from 4.6 percent in 2007 to 9.3 percent in 2009.[42] Job losses result in fewer commuters on U.S. roads. Both features prompt changes in travel decisions including fewer household vehicle trips, the chaining of trips, carpooling, use of public transit, and other alternatives to individual driving.

Similar congestion declines in the 1980s and 1990s quickly reversed as the economy recovered from recessions in those periods.[43] Congestion levels and associated fuel waste did begin to rise once again in 2009 and 2010, and traffic conditions are expected to worsen further as the economy strengthens and grows, and population, the number of licensed drivers, VMT, and VMT per driver all steadily increase.[44]

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[39] DOE, EERE, *TEDB*, Table 1.13

[40] EIA, *Distribution of Wells by Production Rate Bracket 2009*

[41] TTI, *Urban Mobility Report 2011*, at 24

[42] U.S. *Department of Labor, Labor Force Statistics from the Current Population Survey*

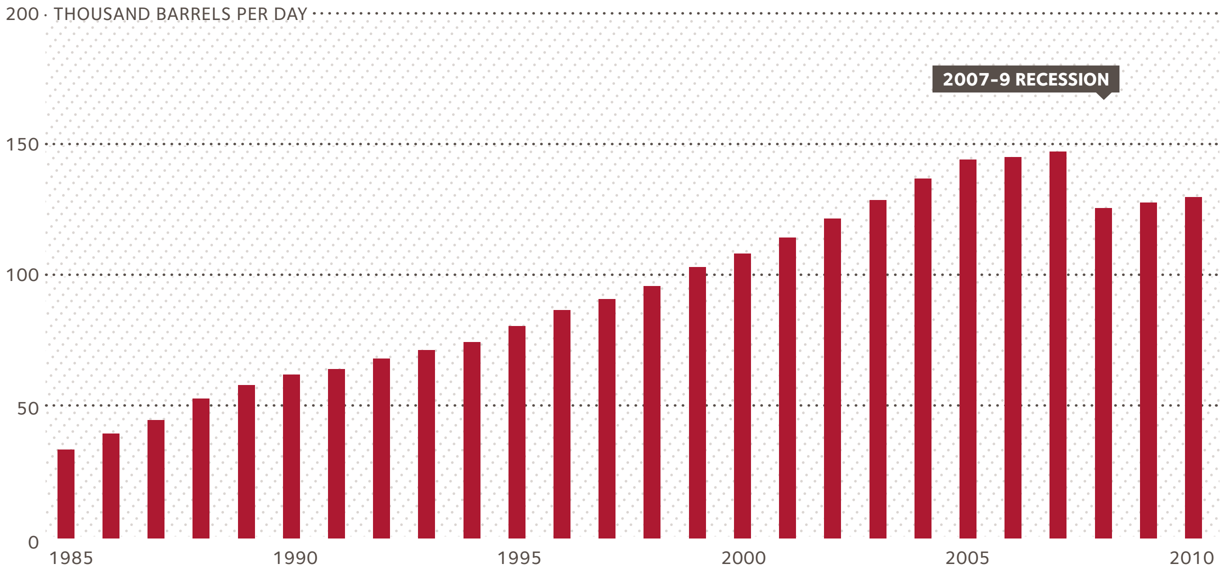
[43] TTI, *Urban Mobility Report 2011*, at 6

[44] EIA, *AEO 2011*, Table 60

In 2010, drivers in U.S. metropolitan areas wasted more than 1.9 billion gallons of fuel as a result of congestion.

Total Fuel Wasted as a Result of Urban Area Congestion

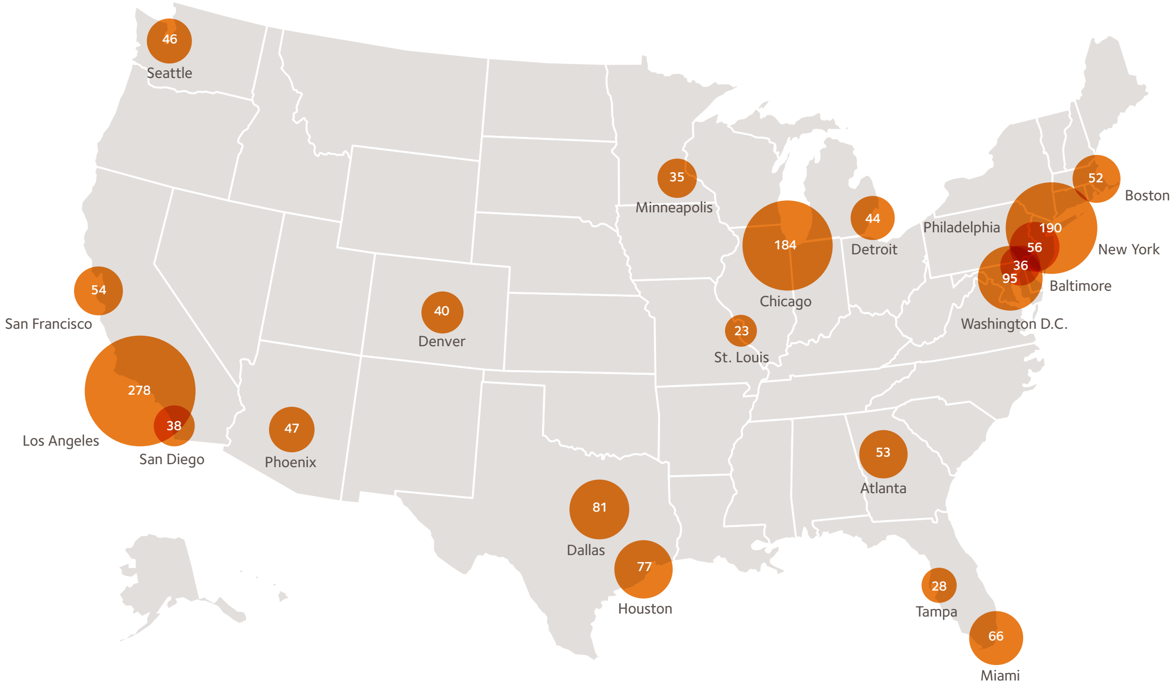
FIGURE 2.6



Top 20 Urban Areas by Wasted Fuel, 2010

FIGURE 2.7

ALL FIGURES IN MILLIONS OF GALLONS



The total annual cost of congestion is estimated at more than $1 billion in each of the cities identified. Together, they account for 78 percent of the total fuel wasted nationally.

Sources: Figures 2.6, 2.7—Texas Transportation Institute

Future Prospects

Congestion's most direct causes—including population and economic growth, as well as rising surface mobility demand, measured in vehicle miles traveled—are expected to increase.

The total U.S. population, for example, is forecast to rise from approximately 310 million people to almost 375 million people over the next twenty years.[45] An economic growth rate of 3.5 percent would double U.S. GDP from today's level over the same period of time.[46] Most notably, highway VMT is expected to increase almost twice as fast as population.[47]

Congestion is thus expected to increase in cities of all sizes, widen geographically, and deepen in intensity. Traffic in the country's small- and medium-sized urban areas is forecast to resemble what currently exists in large and very large urban areas, while the largest urban areas are expected to face gridlock patterns unseen thus far in the United States.

Despite the inherent uncertainties in projecting future congestion levels accurately, it is instructive to note that numerous studies paint a bleak picture of U.S. congestion trends going forward. In 2006, the Reason Foundation related congestion trends to population and traffic density forecasts and estimated that 58 urban areas and 59,700 lane miles will encounter congestion levels considered severe by 2030, up from 28 urban areas and 39,500 lane miles respectively in 2003.[48,49] According to the study, traffic density in the nation's largest cities will increase by almost 20 percent over the same period. Notably, these forecasts took planned road capacity additions into account.[50]

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[45] U.S. Census Bureau, U.S. Population Projections, *National Population Projections 2008*

[46] The average rate of GDP growth for the past 20 years was 2.5 percent.

[47] EIA, *AEO 2011*, Table 7

[48] 'Severe' congestion is defined as peak-hour traffic volume which exceeds the peak-hour capacity of the facility to carry it

[49] Sam Staley and Adrian Moore, *Mobility First: A New Vision for Transportation in a Globally Competitive Twenty-First Century*, 2009; and David Hartgen and Gregory Fields, *Building Roads to Reduce Traffic Congestion in America's Cities: How Much and at What Cost?* at 8 and 9, August 2006

[50] David Hartgen and Gregory Fields, *Building Roads to Reduce Traffic Congestion in America's Cities: How Much and at What Cost?* at 4, August 2006

FIGURE 2.8 Urban-Area Congestion Forecasts for 2030

Urban Area	TTI		30 Minute Trip Time		Increase in Delay
By City	2003	2030	2003	2030	2003–2030
Los Angeles-Long Beach	1.75	1.94	53	58	25%
Chicago	1.57	1.88	47	56	54%
Washington	1.51	1.87	45	56	71%
San Francisco-Oakland	1.54	1.86	46	56	59%
Atlanta	1.46	1.85	44	56	85%
Miami	1.42	1.84	43	55	100%
Denver-Aurora	1.40	1.80	42	54	100%
Seattle-Tacoma	1.38	1.79	41	54	108%
Las Vegas	1.39	1.79	42	54	103%
Minneapolis-St. Paul	1.34	1.76	40	53	124%
Baltimore	1.37	1.75	41	53	103%
Portland	1.37	1.75	41	53	103%
By City Size	2003	2030	2003	2030	2030
Small (pop. 250,000-500,000)	1.11	1.15	33	35	36%
Medium (pop. 500,000-1,000,000)	1.18	1.36	35	41	100%
Large (pop. 1,000,000-3,000,000)	1.28	1.53	38	46	89%
Very Large (pop. 3,000,000+)	1.48	1.76	44	53	58%

Source: Reason Foundation, Texas Transportation Institute

Challenges of Forecasting Congestion

Exact levels of congestion are unpredictable and vary based upon the complex interactions of numerous factors. Just how much congestion will worsen is a topic of considerable debate and uncertainty. The challenge of accurate prediction stems from four main factors:

Traffic Dynamics	Travel times increase more rapidly than travel densities, as each additional vehicle exacts a greater strain on highway resources. Phrased differently, as the numbers of vehicles and miles traveled increases linearly, congestion delays increase logarithmically in response. While expectations of averages can be determined, much like day-to-day fluctuations, long-term conditions are challenging to predict.
Economic Growth and Fuel Prices	Economic growth is an important factor to consider when estimating long-term changes in urban-area congestion. Typically, positive growth encourages greater vehicle movement of both personal- and business-related travel. Yet simultaneously, congestion constrains growth by causing delays and wasting fuel. High fuel prices are also a substantial contributor. In the mid-2000s, congestion levels plateaued as prices rose to unsustainable levels and aggregate VMT declined. Both economic growth rates and fuel prices are subject to considerable uncertainty over the long term (and the short term also).
Future Policy and Technological Advances	Drivers, businesses, and cities are all aware of the impact congestion can have on their success. Deteriorating road conditions may force government action. Congestion-reduction policies are ultimately to be expected in some form at all levels with the private sector likely providing some supporting services and expertise. Customer demand may also promote the development of innovative solutions. It is unknown at present how widespread, comprehensive, or effective, such programs will be.
Traveler Preferences	Increasing demand for reliable travel times is likely to push travel in urban areas towards alternatives to personal vehicles as congestion worsens further. Those with the flexibility to change trip start/end times, take other routes, or find other alternatives will ultimately do so. Urban freight traffic dominated by trucks (and inherently less mode flexible than personal travel) will also be challenged to adapt and optimize delivery routes and schedules.

More recent estimates from ORNL predict stop-and-go conditions to increase from nearly 12,000 miles in 2007 to more than 20,000 miles by 2040. ORNL expects the total length of congested segments with traffic flowing below the speed limit to increase from nearly 7,000 miles to more than 39,000 miles over the same period.[51]

For both travel delays and wasted fuel, Los Angeles is the nation's most gridlocked city. With more than 500 million hours of delay and almost 300 million gallons of wasted fuel in 2010, the estimated cost reached $11 billion.[52] Most freeways have segments on which traffic moves at less than 35 miles per hour for at least two hours every day, and many bottlenecks are congested for at least four hours per day.[53] The Reason Foundation's 2006 analysis estimated that by 2030, 11 additional urban areas will experience congestion levels comparable to or worse than Los Angeles (which had a TTI in 2003 of 1.75).[54]

Notably, however, estimates of time travel are based on average speeds. The variability in travel times will grow proportionately to trip distance and can be exacerbated further as average speeds decrease (and average travel times increase). Ultimately, this lack of reliability necessitates more planning and forces drivers to adjust their travel times to account for longer journeys and the possibility of additional, unexpected delays. This phenomenon is already experienced by users of the nation's roadways, but it is likely to intensify as traffic conditions worsen in the future.

Freight traffic is expected to become an increasingly

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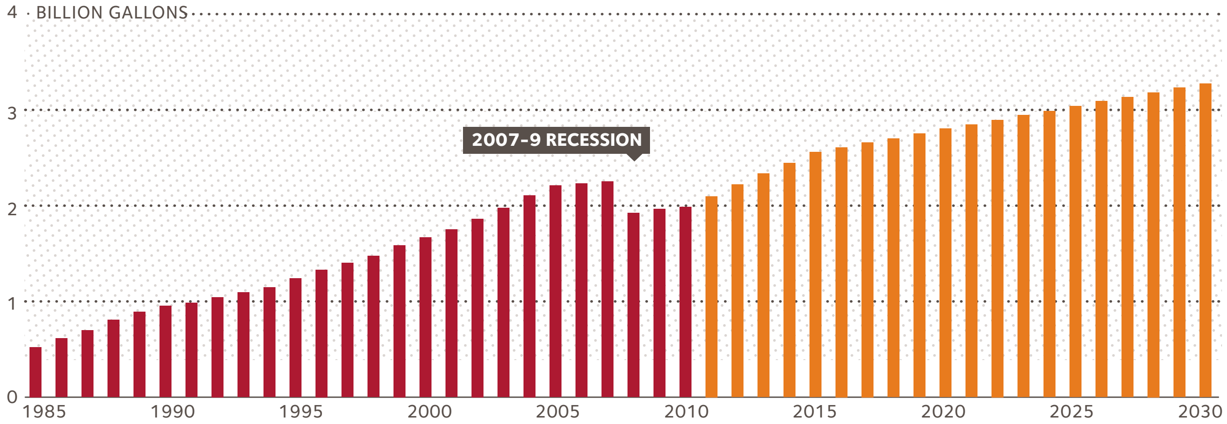
[51] Oak Ridge National Laboratory (ORNL), *Freight Analysis Framework Version 3 (FAF3)*, Key Statistics

[52] TTI, *Urban Mobility Report 2011*, at 24

[53] Paul Sorensen, New Geography, *Reducing Traffic Congestion and Improving Travel Options in Los Angeles*, January 2010

[54] Sam Staley and Adrian Moore, *Mobility First: A New Vision for Transportation in a Globally Competitive Twenty-First Century*, 2009

FIGURE 2.9 Total Fuel Wasted as a Result of Congestion, Historical and Forecast



Source: Texas Transportation Institute

important component of the cost of congestion. While trucks only accounted for 6 percent of the miles traveled in urban areas in 2010, they are estimated to incur 26 percent of the total congestion cost.[55] In addition, a significant share of the $23 billion in higher freight costs due to congestion was passed onto consumers in the form of higher prices.[56] Going forward, the cost of freight congestion, both in aggregate and as a proportion of the total, is likely to increase. Truck VMT has increased considerably over the past several decades, and is forecast to increase by a further 55 percent between 2010 and 2035.[57] In fact, light-, medium-, and heavy-duty trucks have accounted for 100 percent of the increase in U.S. transport-related oil demand since 1973.[58]

All these factors combine to suggest that wasted fuel and the other adverse impacts caused by congested road conditions are likely to worsen in the future. The recent slowdown has provided only temporary relief. Even if the increase in wasted fuel rises at the average annual rate observed between 2000 and 2009—even with the substantial decrease in 2008 of15 percent it will reach 2.9 billion gallons by 2030.[59]

Projections from the Texas Transportation Institute estimate slightly more aggressive annual growth. They forecast that the average commuter will see an additional three hours of delay by 2015 and seven hours by 2020. Wasted fuel will increase to 2.5 billion gallons by 2015 and 3.2 billion gallons by 2030—29 and 65 percent increases respectively. Under this scenario, the total wasted annual fuel would likely exceed its historical high (observed in 2007) by 2013.[60]

TOWARDS SOLUTIONS

Many cities have begun planning efforts, and others have already started implementing solutions, aimed at reducing traffic congestion. However, even some of the most ambitious plans only offer expectations of minor improvements in congestion levels over the long term, and others offer only the possibility that congestion will be held at levels similar to those observed today rather than any reasonable hope of improved travel conditions.

In Chicago, for example, the Metropolitan Agency for Planning (CMAP) developed its GO TO 2040 plan that includes such strategies as congestion and parking pricing. It estimates that city residents spend 1.8 million hours in congestion every day.[61] It forecasts that a larger population will spend the same number of hours in congestion in 2040.[62] In fact, the stated goal is to "maintain our level of congestion," something which they would consider "an achievement." Indeed, that would be an achievement; congestion is already a huge problem facing the nation's urban areas, and the general outlook is not positive. Even if Chicago's goal is reached, the costs of congestion will remain significant. Similar challenges exist in cities nationwide.

It is clear that without widespread implementation of comprehensive policies targeted at not only slowing the growth of congestion but ultimately reducing it, adverse impacts will continue to rise. Innovative solutions are urgently needed.

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[55] TTI, *Urban Mobility Report 2011*, at 8

[56] Id., at 10

[57] EIA, *AEO 2011*, Table 7

[58] DOE, EERE, *TEDB*, Tables 1.13, 1.14, and 1.15

[59] TTI, *Urban Mobility Report 2011*, at 3; and SAFE Analysis

[60] Id.

[61] Chicago Metropolitan Agency for Planning, *GO TO 2040*, Figure 54, at 258

[62] Id.

Congestion and Freight

In 2007, the U.S. transportation system moved an average of 51 million tons of freight worth $45 billion each day.[63,64] After declines in freight movement observed in 2008 and 2009, annual tonnage estimates started to grow again to growth in 2010. From 2010 to 2040, tonnage is projected to increase 1.6 percent per year, reaching 27.1 billion tons, a total increase of 61 percent.[65]

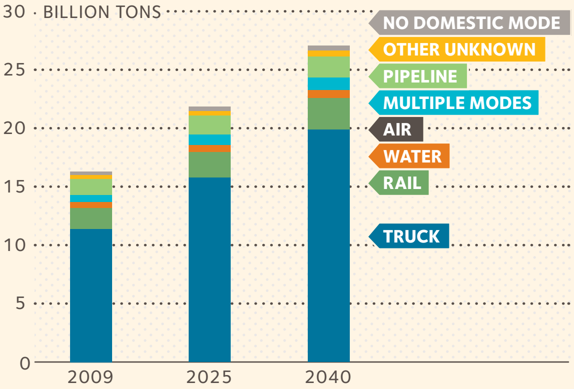
Transportation by truck accounts for approximately 72 percent of freight by total tonnage and 71 percent of freight by value, in addition to much of the 4 percent and 12 percent respectively that moves by multiple modes.[66] Assuming that average truck payloads and the modal shares for each type of commodity remain constant, the forecasted increase in tonnage will cause truck travel to increase almost 80 percent by 2040.[67]

Moreover, globalization has caused international trade to grow considerably faster than the overall economy. Partly due to the increasing share of foreign trade in U.S. GDP, freight transport growth at the nation's gateways and internal networks has been strained by the increasing demand for the movement of goods.

It is estimated that highway bottleneck delays accrue more than 220 million hours annually.[68] At an estimated delay cost of $32.15 per hour, this equates to a direct user cost of approximately $7 billion per year.[69,70] The vast majority of these bottlenecks occur at interchanges, lane drops, steep grades, and signalized intersections. Ninety-one percent of bottleneck delays are found in urban areas.[71] Federal Highway Administration (FHWA) data shows that congestion increased at 61 of the 100 identified freight bottlenecks between 2009 and 2010.[72] After years of decline, logistics costs today are found to be generally increasing amidst delays and volatile fuel costs.[73]

FIGURE 2.10

Growth of Freight Tonnage, Historical and Forecast



Source: FHWA

Freight operators are affected by many of the same negative consequences of congestion felt by individual travelers, including fuel waste, vehicle wear-and-tear, (pickup and delivery) delays and unreliability. In some instances, the effects are subtly different. For example, much as congestion might limit an individual's choice of employment location, it also limits the geographic coverage of a given fleet vehicle. As a result, more vehicles and more drivers may be required, perhaps in addition to extended hours of operation. Other adverse and secondary effects include lower rates of vehicle utilization that can negatively affect capital investment payback periods and the need by firms that rely on on-time deliveries to maintain higher levels of inventory.

Ultimately, the productivity of all businesses that rely on shipping is weakened by congested system conditions. The added cost is absorbed by participants throughout the supply chain, including the end purchaser. Sometimes this cost is manifested simply above and beyond higher prices. It might also be felt as a direct delay in receiving an item, or even a lower quality product (e.g. perishable consumables held too long in inventory).

System congestion also puts businesses operating in the United States at a disadvantage to less congested areas around the globe. This is especially relevant in major port cities and other gateways where the negative impacts of congestion on freight activity can reach well beyond that limited jurisdiction.

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63 Freight shipped through pipelines is not included

64 ORNL, *Freight Analysis Framework Version 3 (FAF3)*, October 2011 data

65 Id.

66 Id.

67 Id., Key Statistics

68 Cambridge Systematics for FHWA, *Estimated Cost of Freight Involved in Highway Bottlenecks*, November 2008

69 $32.15 is the conservative value used by the FHWA's Highway Economic Requirements System model

70 Other researchers have suggested higher rates, typically between $60 and $70 per hour, implying total direct costs of at least $13.2 billion.

71 Cambridge Systematics for FHWA, *Estimated Cost of Freight Involved in Highway Bottlenecks*, November 2008

72 FHWA, Press Release, *New Freight Traffic Data Point to More Congestion on Key Highways*, September 2011

73 Congressional Research Service, William J. Mallet, *Surface Transportation Congestion: Policy and Issues*, February 2008

FIGURE 2.11

Congestion Around The World

Traffic congestion is a global problem. Some international cities experience crippling conditions that eclipse the gridlock observed in even the busiest American cities. Such conditions are likely to intensify further as car ownership rates increase in rapidly-growing emerging markets. Many cities are already taking reactive steps to today's challenges and implementing new and innovative strategies to mitigate the long-term impacts of rising travel demand.

New York City, United States

A 2008 congestion pricing proposal gained diverse and substantial support from the mayor, governor, city council, major business groups, and the U.S. Department of Transportation. However, it ultimately failed to pass into law in the New York State Assembly.[4]

Annual excess fuel consumption for the greater metro area amounts to almost 200 million gallons annually. The cost of wasted time and fuel is estimated at $9.8 billion in 2010.[5]

High population density, narrow streets, and huge volumes of both commuters and tourists make New York one of the busiest and most crowded cities in the world.

With 468 stations, the subway system is the world's largest, and is used by 5.1 million people every weekday. [6]

Los Angeles, United States

In 2010, the city experienced more than half a billion hours of travel delay and experienced fuel waste of almost 300 million gallons.[1]

Population densities are high, segments of freeways experience traffic flowing at just 35 miles per hour, and many bottlenecks are congested for several hours each day.[2]

The average driver in Los Angeles suffers through 72 hours of delay every year.[3]

Mexico City, Mexico

The average commuter spends 4 hours in traffic every day, on winding streets littered with 10,000 makeshift speed bumps installed by safety conscious residents.[7]

Frequent protests block the city's arteries several times a month. A single protest in 2006 caused a backup of half a million vehicles.[8]

The city ranked worst globally in IBM's 2011 Global Commuter Pain Survey. [9]

Sao Paulo, Brazil

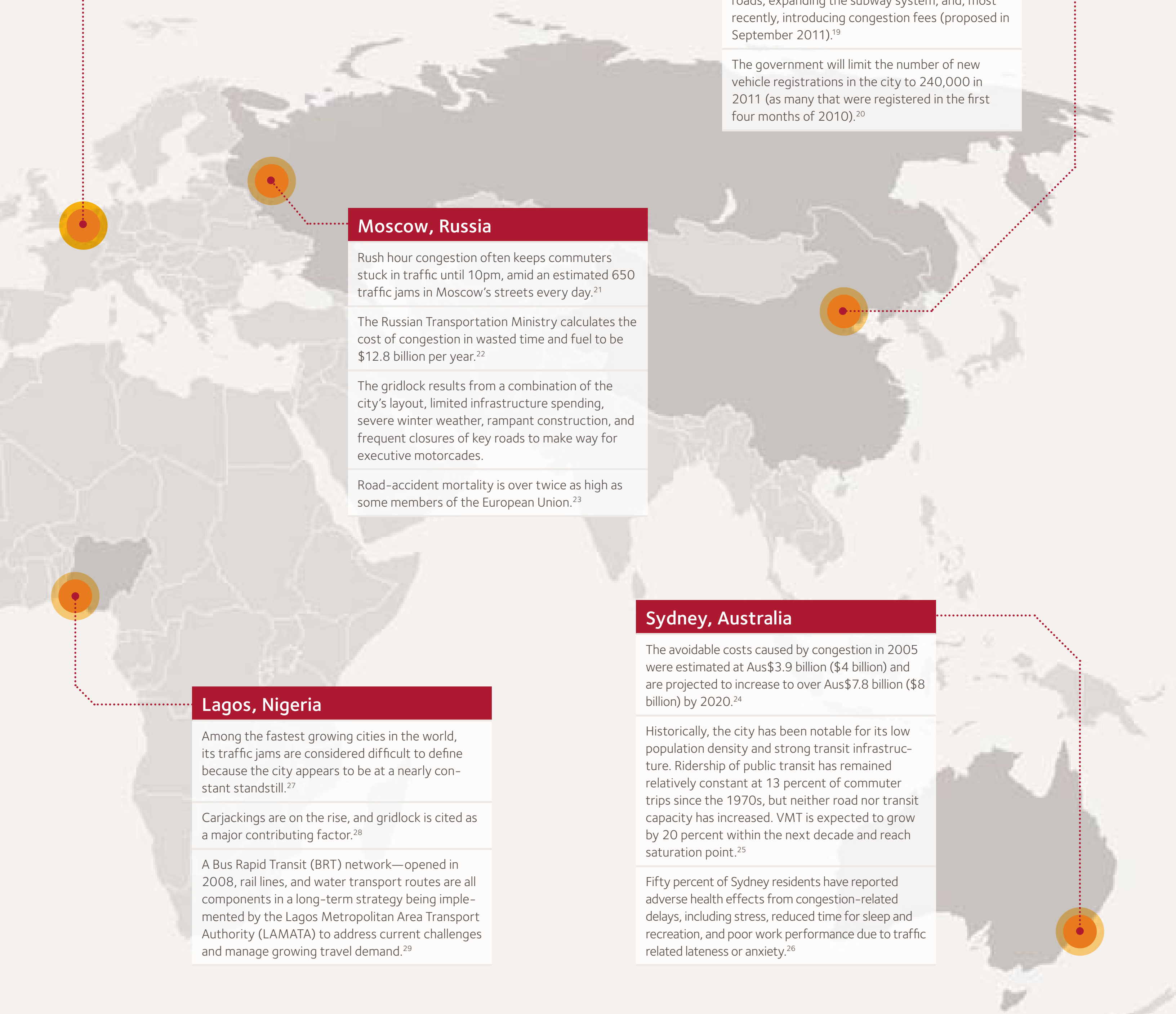
It is common for city residents to spend three to four hours in traffic jams extending longer than 100 miles.[10]

Unable to tolerate the delays, the wealthy are resorting to travelling by helicopter. In fact, with more than 400 private helicopters in operation, the city is considered the helicopter capital of the world ahead of both New York and Tokyo.[11]

A traffic control program known as rodizio restricts vehicle usage one day a week based on the last digit of the number plate.[12]

Sao Paulo has an immense fleet of buses numbering 10,000 units (by comparison, the New York Metropolitan Transportation Authority operates approximately 6,000 buses).[13]

1 TTI, *Urban Mobility Report 2011*, at 24. 2 Paul Sorensen, New Geography, *Reducing Traffic Congestion and Improving Travel Options in Los Angeles*, January 2010. 3 Id. 4 New York Times, *Congestion Pricing Plan Fails in Albany*, April 2008. 5 TTI, *Urban Mobility Report 2011*, at 24. 6 New York City Metropolitan Transit Authority, *Subway and Bus Ridership*, 2010. 7 Foreign Policy, *The World's Worst Traffic*, August 2010. 8 Id. 9 IBM Corporation, *Frustration Rising: IBM 2011 Commuter Pain Survey*, 2011. 10 Foreign Policy, *The World's Worst Traffic*, August 2010. 11 Id. 12 Companhia de Engenharia de Tráfego, Rodízio Municipal. 13 São Paulo Turismo, *Transportation, Bus.* 14 The Independent, *Brussels tops European traffic congestion hotspots*, 2011. 15 OECD Economic Surveys: Belgium, Fiscal Problems of the Brussels-Capital Region, 2009. 16 IBM Corporation, *Frustration Rising: IBM 2011 Commuter Pain Survey*, 2011. 17 Foreign Policy, *The World's Worst Traffic*, August 2010.



Brussels, Belgium

Has been ranked as the most congested city in Europe due to the intense concentration of government buildings and resulting traffic flow on the city center's narrow roads.[14]

The city itself has a small population of 1 million residents, but half a million additional commuters travel into the city each weekday from neighboring areas.[15]

Motorcades of visiting dignitaries also frequently cause extensive and prolonged road closures, exacerbating impediments to general mobility.

Beijing, China

Sixty-nine percent of motorists report giving up mid-journey as a result of traffic congestion.[16]

In 2010, construction on a major highway caused a ten-day, 60-mile traffic jam.[17]

Today, there are approximately 30 million passenger vehicles in China—a number expected to increase nearly 10-fold by 2030.[18]

Since hosting the Olympics in 2008, city officials have implemented several measures to address traffic congestion, including restricting car purchases, increasing parking fees, widening roads, expanding the subway system, and, most recently, introducing congestion fees (proposed in September 2011).[19]

The government will limit the number of new vehicle registrations in the city to 240,000 in 2011 (as many that were registered in the first four months of 2010).[20]

Moscow, Russia

Rush hour congestion often keeps commuters stuck in traffic until 10pm, amid an estimated 650 traffic jams in Moscow's streets every day.[21]

The Russian Transportation Ministry calculates the cost of congestion in wasted time and fuel to be $12.8 billion per year.[22]

The gridlock results from a combination of the city's layout, limited infrastructure spending, severe winter weather, rampant construction, and frequent closures of key roads to make way for executive motorcades.

Road-accident mortality is over twice as high as some members of the European Union.[23]

Lagos, Nigeria

Among the fastest growing cities in the world, its traffic jams are considered difficult to define because the city appears to be at a nearly constant standstill.[27]

Carjackings are on the rise, and gridlock is cited as a major contributing factor.[28]

A Bus Rapid Transit (BRT) network—opened in 2008, rail lines, and water transport routes are all components in a long-term strategy being implemented by the Lagos Metropolitan Area Transport Authority (LAMATA) to address current challenges and manage growing travel demand.[29]

Sydney, Australia

The avoidable costs caused by congestion in 2005 were estimated at Aus$3.9 billion ($4 billion) and are projected to increase to over Aus$7.8 billion ($8 billion) by 2020.[24]

Historically, the city has been notable for its low population density and strong transit infrastructure. Ridership of public transit has remained relatively constant at 13 percent of commuter trips since the 1970s, but neither road nor transit capacity has increased. VMT is expected to grow by 20 percent within the next decade and reach saturation point.[25]

Fifty percent of Sydney residents have reported adverse health effects from congestion-related delays, including stress, reduced time for sleep and recreation, and poor work performance due to traffic related lateness or anxiety.[26]

[18] IEA, *WEO 2009*, Figure 1.7, at 83.
[19] BBC News, *Beijing Places 'Congestion Charge' to ease traffic woes*, September 2011.
[20] The Independent, *Beijing to cut car registrations to ease gridlock*, December 2010.
[21] Wall Street Journal, *From Bumper to Bummer, Traffic in Moscow Tails the Economy*, March 2009.
[22] Foreign Policy, *The World's Worst Traffic*, August 2010.
[23] Id.
[24] Government of Australia, Department of Transport and Regional Services, *Estimating Urban Traffic and Congestion Cost Trends for Australian Cities*, 2007.
[25] Id.
[26] IBM Corporation, *Frustration Rising: IBM 2011 Commuter Pain Survey.*
[27] Foreign Policy, *The World's Worst Traffic*, August 2010.
[28] Punch, *Tensions as carjackings rise in Lagos*, August 2011.
[29] Lagos Metropolitan Area Transport Authority (LAMATA), *BRT (Bus Rapid Transit) and The Strategic Transport Master Plan*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PART 3

Solutions

Overview

There is no single best solution. To effectively overcome the congestion that plagues America's cities and achieve meaningful fuel savings, transportation infrastructure policies must be flexible and multi-dimensional to properly address local and/or regional conditions.

While some broad solutions such as pricing might be successful when applied widely, each road/system pricing project must be carefully tailored to individual locations. Some solutions may be well suited for widespread use, others less so, and still others may simply not be practically implementable given local conditions.

Policymakers are not (always) constrained in the number of options that they have available to consider. In fact, the diverse nature of our cities and our surface transportation system can present many possibilities for addressing the growing gridlock. The solutions that follow, falling into four primary categories, reflect this breadth. These categories are: pricing and other flow management strategies for reducing/eliminating recurring congestion; accident/incident management for reducing the likelihood and effects of non-recurring congestion; public transit and alternatives to single-occupancy vehicle travel; and long-term urban planning and development.

FIGURE 3.1 Comprehensive Solutions

Road Traffic Management

Aligning supply and demand for travel using pricing and other strategies in addition to flow management techniques and technologies

Accident/Incident Resolution

Preventing and responding to unexpected and highly variable incidents that can result in immediate, severe, and long-lasting road congestion

Each of these solutions can play a role in a comprehensive plan aimed at reducing congestion in U.S. cities. In some locations, efforts to combat congestion using such solutions have begun. However, whether this has taken the form of expanded transit services, dynamically-tolled lanes, restrictions on downtown parking, or any number of myriad options, these initiatives rarely form part of a city-wide congestion-mitigation strategy. While individual strategies are not ineffective in themselves, they will bring greatest overall value when used in a complementary fashion. A simple example would be to implement both some form of road pricing and an accident/incident response program in order to address the two types of traffic congestion (recurring and non-recurring).

Today's limited federal legislative capacity—which is shaped by budget constraints and political opposition to increasing government spending and raising taxes, requires more than ever that the nation's transportation strategy focus on policies that are low in cost and high in efficiency and effectiveness. Policymakers must therefore carefully consider the various solutions available and consolidate the most applicable and cost-effective into a tailored strategy that addresses the specific congestion issues their region faces.

There must be a strong focus on the use of advanced technology to help achieve higher system efficiencies. Returning to the simple example above, the use of travel speed monitoring technologies for the purpose of setting dynamic road pricing can also be used to identify the sudden reductions in average speeds caused by incidents and help inform appropriate response efforts. Such complementary solutions will ultimately be crucial to maximizing the effectiveness of congestion-mitigation efforts nationwide.

Collective and aggressive action to address the challenge is urgently needed. Existing efforts must be strengthened and new initiatives must begin in earnest on both the practical short-term options and proposals with longer-term benefits.

Public Transit & Other Alternatives

Raising load factors and improving efficiency and coverage of high-quality transit where local conditions warrant, plus non-road based solutions

Urban Planning & Development

Increasing physical system capacity and promoting higher density urban infrastructure development

Road Traffic Management

Market-based road pricing initiatives and other flow management techniques that help align travel demand and supply are critical tools for addressing recurring traffic congestion.

ALIGNING ROAD SUPPLY AND DEMAND

Effectively addressing travel demand is a crucial exercise. Several strategies can be implemented to manage existing urban transportation infrastructure with a higher level of efficiency. These involve shifting and/or reducing demand for travel at the most congested times, and improving the flow of traffic through the urban system in order to alleviate pressure on the most overburdened points. Direct road pricing is primary among the options. Secondary options include reversible lanes and other non-pricing based flow-management techniques.

ROAD PRICING

Road pricing remains an underutilized, though proven, near-term tool for reducing urban-area congestion. By providing drivers highly visible market-based incentives to switch to times, routes, or modes of transportation that are less congested, road pricing encourages drivers to use the available road capacity more efficiently, helping to reduce the peaks and valleys that characterize the system absent such incentives.[74] Prices can be varied to capture the different costs imposed by drivers on the system (and each other) based upon congestion levels at a given time. At times when traffic is heavy, drivers are charged higher prices, and at times when traffic is light, they are charged lower prices (known as 'dynamic' pricing).[75]

Cordon Pricing

Under this pricing system each vehicle is charged a fixed toll when it passes through the specified cordon surrounding the designated area targeted for congestion reduction, typically the central area(s) of a city.

Road pricing takes one of two primary forms; cordon (or area) pricing and tolls. Cordon charges apply to all roadways within a designated zone, typically a city center. Charging methods vary widely. In London, for example, drivers are charged between £9 and £12 ($15 and $20) to enter the city between 7am and 6pm Monday through Friday.[76,77] Some, such as emergency vehicles, motor cycles, and taxis are automatically exempted, while others, including electric vehicles, can qualify for a 100 percent discount.[78] Stockholm's cordon system is similar, charging drivers a lower 10 to 20 SEK ($1.30 to $2.60), variable amount based upon when they enter the zone. The pricing operates between 6:30am and 6:30pm on weekdays and the maximum charge is 60 SEK per day ($7.80).[79]

Tolls are more individually targeted and typically applied to either all or part of a congested facility (such as a specific highway or bridge). Again, significant variation exists in the manner such tolls are implemented. High-occupancy toll (HOT) lanes for example, typically offer fee exemptions to vehicles carrying more than one passenger. This in itself promotes ride sharing and carpooling and reduces the number of single-occupant vehicles using the road system during the most congested travel periods.

The reversible lane is the most common type of separated lane high-occupancy vehicle (HOV) / HOT

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[74] Congressional Budget Office (CBO), *Using Pricing to Reduce Congestion*, at VII, March 2009

[75] The extent to which congestion pricing systems are 'dynamic' can vary. For example, in the most dynamic systems, real-time traffic data updates the charge regularly to maintain consistent traffic flow. In other less dynamic systems, charges may vary simply by time-of-day based upon historical traffic data (although revisions may be made every few months).

[76] Transport for London (TfL), Congestion Charge, *Maps and Times*

[77] While based upon historical traffic flows and congestion levels, the London Congestion Charge would not be considered 'dynamic' (the charge is the same whether one enters the zone at 8am—when traffic flow is very heavy—or 1pm—when traffic flow is much lighter).

[78] TfL, Congestion Charge, *Discounts and Exemptions*

[79] Magnus Carle, Head of Congestion Charge Secretariat, City of Stockholm, *Congestion Charging in Stockholm*, Presentation; and City of Stockholm website

facility—thus they are not always priced. The direction of travel on these lanes changes depending on the time of day, typically enabling greater inflow to the urban area during morning peak hours and greater outflow during afternoon peak hours.

For priced facilities—including cordon pricing and tolling—prices are adjusted in an effort to maintain a steady flow of traffic rather than the stop-and-go conditions typical of congested roads.[80] Ultimately, such market-based pricing enables the existing road capacity to carry more traffic at the same or a better level of performance simply by moving some portion of it out of the most congested (peak) periods. An essential aspect of practical implementation is technology such as the E-ZPass that allow vehicles to pay charges electronically while traveling at highway speeds.

Road pricing that reduces congestion enhances system efficiency. The Department of Transportation has estimated that this could reduce the amount of funding required to maintain the highway system, at its current physical condition and operational performance, by more than 25 percent.[81]

Notably, road pricing can be effective without requiring major shifts in travel patterns. Because traffic congestion scales non-linearly, reductions in peak-period highway traffic volumes by as little as 10 percent can all but eliminate recurring system congestion.[82] Pricing also need not eliminate the least inelastic demand—those that might be considered the 'most important' trips being made during peak periods—such as daily commutes. The majority of rush hour trips in both the morning (56 percent) and evening (69 percent) are today made by non-commuters.[83]

Most congestion pricing in U.S. cities has not taken place on a majority of the road network, but rather on single facilities in congested corridors. In fact, the Congressional Budget Office has highlighted the prevalence of HOV lanes—unpriced—as an opportunity to reduce traffic congestion through conversion to HOT lanes.[84] However, while these projects are meritorious, the more extensive geographic coverage of cordon pricing will more effectively reduce urban-area traffic congestion. This type of pricing has been used successfully in a number of cities around the world. The pricing programs in London, Stockholm, and Singapore, for example, have resulted in reductions of 10 to 30 percent or more of traffic in their priced zones and have sustained these reductions over time.[85] These programs have realized societal economic benefits greater than their costs.[86] They are also viewed in a generally favorable way by the public (and acceptability has been observed to increase over time as initial skepticism and concern are addressed).[87]

BETTER FLOW MANAGEMENT

Mechanisms that do not use direct pricing can also be effective in managing urban road traffic flow. As they relate specifically to roadways suffering from recurring congestion, these mechanisms are numerous, but they focus primarily on the application of advanced traffic signaling.

Flow-focused solutions improve the efficiency with which the systems functions, again enabling a higher rate of utilization with a fixed quantity of capacity. For example, applying real-time traffic data to traffic lights can improve traffic flow substantially, reducing stops by as much as 40 percent, travel times by as much as 25 percent and fuel consumption by up to 10 percent.[88]

High-Occupancy Vehicle / Toll Lanes

High Occupancy Vehicle (HOV) lanes are exclusive road or traffic lanes reserved for the use of buses, vanpools, carpools, and emergency vehicles, usually located next to regular or unrestricted lanes. High Occupancy Toll (HOT) lanes make HOV lanes accessible to vehicles not meeting the minimum occupancy requirement by paying a toll.

More isolated signal projects, such as ramp meters that time the entry of vehicles onto heavily-trafficked highways can also reduce travel times, congestion, and fuel consumption associated with stop-and-go conditions, and significantly improve travel time predictability/reliability.

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[80] Typically, Level of Service C (at or near free-flowing conditions).

[81] CBO, *Using Pricing to Reduce Congestion*, at 11

[82] Transportation Research Board (TRB), *Highway Capacity Manual 2000*

[83] FHWA, National Household Travel Survey, *Congestion: Who is Traveling in the Peak?*, August 2007

[84] CBO, *Using Pricing to Reduce Congestion*, at 10

[85] FHWA, *Lessons Learned From International Experience in Congestion Pricing: Final Report*, at i, August 2008

[86] Id., at ii

[87] Id., at 2-9, 2-10, 2-17, 2-18, 2-23, and 2-24

[88] National Transportation Operations Coalition, *National Traffic Signal Report Card: Technical Report 2007*, at 21, October 2007

CASE STUDY A

DYNAMIC TOLLING / MNPASS

Antennae positioned on I-394 monitor the speed of traffic and vary the cost of express lane use accordingly, and enable drivers to make payments directly from their MnPASS account.

WHAT IS IT?

Dynamic tolling is a market-based strategy to manage lane traffic flow by charging drivers higher prices when and where travel demand is strong and low prices when demand is weak.

MNPASS

MnPASS enables solo drivers to use the HOV lanes during peak hours by paying an electronic toll.[89] Minnesota converted HOV lanes into the state's first HOT lanes in 2005.[90] On sections of the ten-mile stretch on I-394, the HOT lanes are separated from unpriced lanes by a double white line. As the road approaches downtown, the lanes are combined into a reversible expressway. This expressway is separated from unpriced lanes by a concrete barrier. The HOT lanes remain free to HOVs and motorcyclists during peak hours, and are free to all users in off-peak periods.

As participation is voluntary, commuters wishing to use the system register online to receive a transponder and establish a user account for payment. The MnPASS transponder, mounted within the driver's vehicle, makes payments directly from the driver's account via antennae positioned along the highway. The antennae also monitor the speed of traffic on the highway, and vary the cost of express lane use accordingly. The price for one section of the road varies between $0.25 and $8.00. The average toll during the peak period is $1.00 to $4.00.[91] Sections of I-35W are also tolled (since September 2009), and further extensions are planned.[92] The revenues collected are used to pay for modifications in the corridor and the cost of implementing and administering the system. Excess revenues are split evenly towards capital improvement and bus transit services in the corridor. The lanes generate estimated revenues of $1.6 million annually.[93]

POSITIVE RESULTS

Data collected over the first year of operation revealed speed increases in both the MnPASS lanes as well as the unpriced lanes.[94] Speeds increased by an estimated average of 6 percent compared to pre-MnPASS levels, with some highway sections seeing an increase as high as 15 percent.[95] An increase in vehicle throughput was also observed (peak-hour volumes increased by 9 to 33 percent), as well as a decrease in reported crash incidents. Generally, those using MnPASS experience a 20 mile per hour increase in their speed.[96] Drivers on I-394 maintained speed limits on all but seven days of the year in 2009.[97]

POSITIVE RECEPTION

This and similar projects are also very popular with area residents. A 2011 survey of residents in Republican-leaning San Diego and Democratic-leaning Minneapolis areas indicated that dynamic toll lanes operating there are favored by those who use them, those who are familiar with them but do not use them, and those who learn about the concept. Of respondents who use the lanes at least once a week, 89 percent think that they are convenient, 82 percent that they reduce congestion, and 77 percent that they help save money on gasoline.[98] Similar surveys by the Minnesota Department of Transportation have found that more than 80 percent of users are satisfied with the speed of traffic flow and ease of transponder use.[99]

Priced lane and roadway projects with variable charges exist in a number of other states including California, Colorado, Florida, Georgia, Illinois, Maryland, New Jersey, North Carolina, Oregon, Pennsylvania, Texas, and Washington.[100]

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[89] Minnesota Department of Transportation (MnDOT), MnPASS, *What is it? How does it work?*

[90] MnDOT, MnPASS, *Express Lanes Background*

[91] DOT, Research and Innovative Technology Administration (RITA), *In Minneapolis, converting HOV to HOT lanes with dynamic pricing increased peak period throughput by 9 to 33 percent*, August 2008

[92] MnDOT, MnPASS, *Express Lanes Background, MnPASS Express Lanes*

[93] Dynamic toll lanes in the Miami-Fort Lauderdale and San Diego areas generate estimated annual revenues of $5 million and $2.2 million respectively.

[94] DOT, RITA, *In Minneapolis, converting HOV to HOT lanes with dynamic pricing increased peak period throughput by 9 to 33 percent*

[95] Id.; and Cambridge Systematics for MnDOT, I-394 *MnPASS Technical Evaluation*, at 7-2, November 2006

[96] MnDOT, FHWA, MnPASS, and University of Minnesota, *I-394 MnPASS: A New Choice for Commuters*, at 7, March 2006

[97] MnDOT, News Release, *Mn/DOT marks MnPASS Express Lanes five-year anniversary*, May 2010

[98] Public polling survey conducted by The Mellman Group Inc. and Ayres, McHenry and Associates, Inc. for Securing America's Future Energy, July 2011

[99] MnDOT, FHWA, MnPASS, and University of Minnesota, *I-394 MnPASS: A New Choice for Commuters*, at 7, March 2006

[100] FHWA, Tolling and Pricing Program

Accident/Incident Management

Effectively planning for, responding to, and addressing traffic incidents is crucial to minimizing system disruption and congestion.

SOURCES OF NON-RECURRING CONGESTION

A majority of traffic congestion is caused by accidents, work zones, special events, and other unexpected incidents (including bad weather). These events result in an often near-immediate delay in travel for system users. Unlike bottlenecks that result on a frequent basis during daily rush hours, their start and end times are near-impossible to predict. If occurring during rush hours, they can exacerbate already slow travel conditions.

Safety considerations are also a high priority for efforts focused on mitigating the sources of non-recurring congestion. The longer it takes to clear an incident, the greater the possibility that secondary incidents occur. In fact, the likelihood of a secondary crash is estimated to increase by 2.8 percent for each minute the primary incident continues to be a hazard.[101] The Department of Transportation estimates secondary crashes as the cause of 18 percent of all fatalities on freeways.[102]

TRAFFIC INCIDENT MANAGEMENT

Effective traffic incident management (TIM) can significantly reduce the impact of traffic incidents by responding to and clearing any fallout such that smooth traffic flow can be restored as quickly as possible. TIM programs generally refer to accidents, but many of the same techniques and organizations can be used to handle planned incidents (such as sporting events or work zones), and other emergencies.

Improving TIM is one of the keys to reducing congestion. Estimates suggest that the use of surveillance cameras and service patrols in more than 80 cities nationwide reduce travel delay by 135 million hours annually, and benefit-cost ratios for service patrols have been found to range from 2:1 to 36:1.[103] Even TIM activities that target minor accidents can have an impact on congestion and fuel use. For example, the Florida Road Ranger motorist assistance patrol program—a free service provided to motorists by the Florida Department of Transportation—was estimated to save 1.7 million gallons of fuel in 2004 (approximately 300,000 service assists are made annually).[104] The services provided to vehicles in need include small quantities of fuel, assisting with tire changes, and other minor emergency repairs.[105] Similar programs that reduce the duration of incidents and traffic delay exist in other states.

While states and localities have long had some TIM components integrated into their traffic management programs, today there is greater focus on more formal programs. Most TIM programs initially stemmed from traditional first responders (law or transportation enforcement, fire and rescue), sometimes operating under different jurisdictions (e.g. regional versus statewide). As a result, TIM program funding, organization, and procedures are highly variable. Some programs are jointly funded by the state's transportation agency and localized metropolitan planning organizations. In other instances, funding comes through one department (e.g. state patrol agency). TIM program revenue can also be supplemented by public-private partnerships.[106]

Examples of Highway Incidents[107]

Traffic Incidents
Vehicle Disablement, Vehicle Crash, Cargo Spill/Debris on Road, Hazardous Material Spill

Non-Traffic Incidents
Industrial Accident, Bridge Collapse, Road Work

Emergency
Severe Weather, Natural Disaster, Evacuations, Other Catastrophes

RESPONSE

TIM involves the multi-disciplinary coordination of various agencies, which the FHWA categorizes into five functional areas: detection and verification; traveler information; response; scene management and traffic control; and clearance and recovery.[107] Though many stakeholders may be involved on a case-by-case basis, the traditional

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[101] Karlaftis and Richards, *ITS Impacts on Safety and Traffic Management: An Investigation of Secondary Crash Causes*, ITS Journal, 1999, Volume 5, at 39-52

[102] National Traffic Incident Management Coalition, *Improving Traffic Incident Management Together*, at 1, December 2004

[103] TTI, *Urban Mobility Report 2011*, Exhibit 3-25; and David Fenno and Michael Ogden, Transportation Research Board, *Freeway Service Patrols: A State of the Practice*, January 1998

[104] Hagen, Zhou, and Singh, *Road Ranger Cost Benefit Analysis*, University of South Florida, at 18, November 2005

[105] Florida Department of Transportation, State Traffic Engineering and Operations Office, *Road Rangers*

[106] FHWA, *Freeway Safety Service/Motorist Assistance Patrol Sponsorship Programs Memorandum*, April 2008

[107] FHWA, *Best Practices in Traffic Incident Management*, at 3, September 2010

[108] FHWA, *Simplified Guide to the Incident Command System for Transportation Professionals*, Exhibit 1-1, at 2, February 2006

responders include law enforcement, fire and rescue, emergency medical services (EMS), transportation management, and towing and recovery. Each has different responsibilities at the incident scene.

Given the number of specific functional roles necessitated by traffic incidents and the number of responders that this might involve, communication is a primary challenge to effective incident management. The use of a more formal structure to address large and complex incidents is growing. Known as the Incident Command System (ICS), the basic premise is establishing a chain of command and operational structure among large groups of stakeholders that enables the most effective response to such incidents.

Historically, transportation stakeholders have not participated in the ICS structure, but this is now changing due to their increasingly important role in monitoring and controlling traffic flow. For example, though transportation management centers (TMCs) are generally considered secondary responders and are therefore not made part of the TIM communication chain until several minutes after an incident alert is made (e.g. 911 call), they can have vital traffic information regarding congestion or road conditions that can enable first responders to get to the scene of an incident more quickly and more safely.

The earlier that real-time traffic information can be incorporated into incident response, the greater value it will have with respect to effectively reestablishing free-flowing traffic conditions.

Intelligent Transportation System (ITS) technologies that provide real-time traffic data to multiple agencies through a central dispatch system can be of immense value to the entire TIM operation. It can also assist in public address communication, providing information to travelers impacted (or likely to be impacted) by the incident. This alone can reduce the impact of the incident on traffic flow by giving travelers an early signal and opportunity to use alternative routes, change departure times or make other arrangements.

Preventing Traffic Incidents

Bad weather cannot be prevented. Accidents, which account for approximately 25 percent of total traffic congestion, can be.[109] Preventative measures, like reactive measures, are part of the solution. These measures can take a variety of different forms. The use of advanced technology in particular that enables vehicles to be more in sync with the transportation system and each other is likely to become increasingly practical, necessary, and widespread.

Using existing technology such as GPS and onboard diagnostic data (such as travel speed or direction), vehicles will be able to broadcast what is known as a "Here I Am" message.[110] All vehicle-to-vehicle (V2V) equipped vehicles will be able to communicate with each other, giving each of them a much more complete picture of threats to safety. As a result, they will be able to warn drivers and/or take evasive action. Many major automakers, including Ford and General Motors who have created a joint research group on crash avoidance, are investing in this technology.[111] General Motors demonstrated their technology in October 2011.[112]

Preliminary analysis by the National Highway Safety Administration (NHTSA) attempted to estimate the annual frequency of crashes that could be addressed by V2V and vehicle-to-infrastructure (V2I) safety systems. Combined, the two systems could potentially address 81 percent of all vehicle-target crashes, 83 percent of all light-vehicle crashes, and 72 percent of all heavy-vehicle crashes.[113] Even V2V alone was estimated to address 79 percent, 81 percent, and 71 percent respectively.[114]

In August 2012, NHTSA will begin gathering data from 3,000 cars equipped with wireless communication technology to learn about data streams, determine which hardware is most cost effective, better understand how many vehicles must be equipped for the system to function effectively, assess the business case for deployment, and develop universal V2V standards.[115]

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[109] FHWA, *Focus on Congestion Relief: Describing the Congestion Problem*

[110] Wired, Autopia, *Feds to Begin Testing Connected Vehicles*, August 2011

[111] Ford, Press Release, *Ford accelerates intelligent vehicle research, creating 'talking' vehicles to make roads safer*, January 2011

[112] Wired, Autopia, *GM Shows Off Smart Collision Avoidance Technology*, October 2011

[113] National Highway Safety Administration (NHTSA), *Frequency of Target Crashes for IntelliDrive Safety Systems*, at vi, October 2010

[114] Id.

[115] Wired, Autopia, *Feds to Begin Testing Connected Vehicles*, August 2011

TRAFFIC INCIDENT MANAGEMENT / CHART

CASE STUDY B

After a tractor trailer collided with a car in Brandywine, Maryland, CHART coordinated the response between state agencies to provide emergency services while disseminating information to the public to help alleviate mounting traffic congestion on US-301.

The Coordinated Highway Action Response Team (CHART)—a Maryland ITS program—is coordinated by the Maryland DOT, Maryland Transportation Authority, Maryland State Police and other state and federal agencies. Starting in the 1980s as the "Reach the Beach" initiative aimed at improving travel to Maryland's eastern shore, CHART has since grown to serve not only the Baltimore-Washington Corridor, but the entire state of Maryland.

CHART was intended to be a traffic information and coordination focal point: able to identify traffic accidents, heavily congested areas, road closures and weather-related road conditions, and then convey that information to both drivers and multiple agencies responding to incidents. The program is comprised of four main parts: traffic monitoring, incident response, traveler information, and traffic management.[116]

OPERATION

Road sensors that capture traffic data transmit the change in traffic speeds to the Statewide Operation Center (SOC), CHART's central traffic control center. Both stationary and closed-circuit television surveillance cameras confirm the existence of an incident and change in traffic conditions. Traffic patrol officers are then dispatched to the incident scene.

One of CHART's aims was to foster interagency cooperation by creating a system that could integrate agencies deployment systems across the county and state. As such, the SOC allows different information and communication feeds to be more efficiently compiled and shared, painting a full picture of what is occurring.

At the same time, CHART transmits the real-time traffic information collected to its radio advisory system, dynamic message signs, video interface, and website. Drivers, seeing signs warning of slowed traffic ahead are prepared to stop. Individuals preparing for a trip, can easily inform themselves of the change in road conditions and make adjustments.

BENEFITS

Incident response times are consistently shorter with CHART than without. A 2002 CHART evaluation of program performance for 27,987 incident reports showed that the average incident duration was approximately 33 minutes with CHART and 77 minutes without it.[117] A 2006 CHART evaluation estimated that CHART directed incident management resulted in an average incident duration of 22 minutes compared to 29 minutes for other agencies.[118] Warnings of upcoming congestion also increase the safety of both first responders and drivers near the incident site. CHART resulted in 290 fewer secondary incidents in 2005.[119]

Using a traffic simulation program, analysts have estimated that CHART reduced travel delays by 32 million vehicle hours in 2009.[120] They calculated that this saved Maryland highway users 6.2 million gallons of fuel.[121]

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[116] Chang and Rochon, *CHART Input and Analysis: Performance Evaluation and Benefit Analysis for CHART in Year 2009*, at 1

[117] Chang and Point-Du-Jour, *Performance Evaluation of CHART Year 2002*, at IX

[118] Chang and Rochon, *Performance Evaluation and Benefit Analysis for CHART in Year 2005 Final Report*, at 29, May 2006

[119] Id., at 33

[120] Chang and Rochon, *CHART Input and Analysis: Performance Evaluation and Benefit Analysis for CHART in Year 2009*, at ix

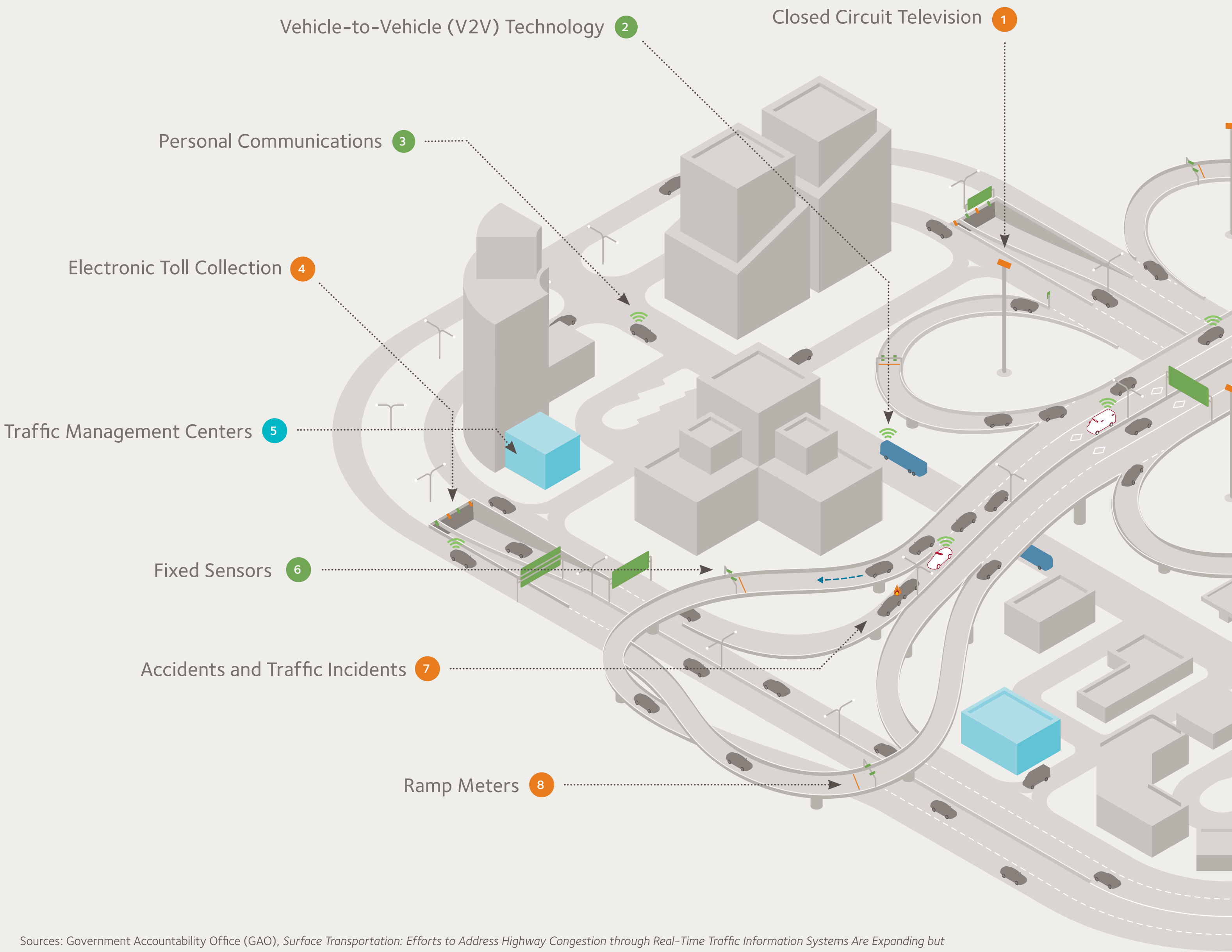
[121] Id.

FIGURE 3.2

Intelligent Transportation Systems

Real-time traffic information systems and other Intelligent Transportation Systems (ITS) involve the application of a broad range of information and communication technologies into the transportation system in order to improve operational performance as it relates to, among other factors, improving user safety, increasing travel reliability, and reducing energy consumption.

ITS is applicable to many, if not all, aspects of the transportation system, and reducing traffic congestion is a principal benefit, helping facilitate higher levels of productivity and economic growth. Other system-related benefits include reducing maintenance and construction costs by moving travelers more efficiently

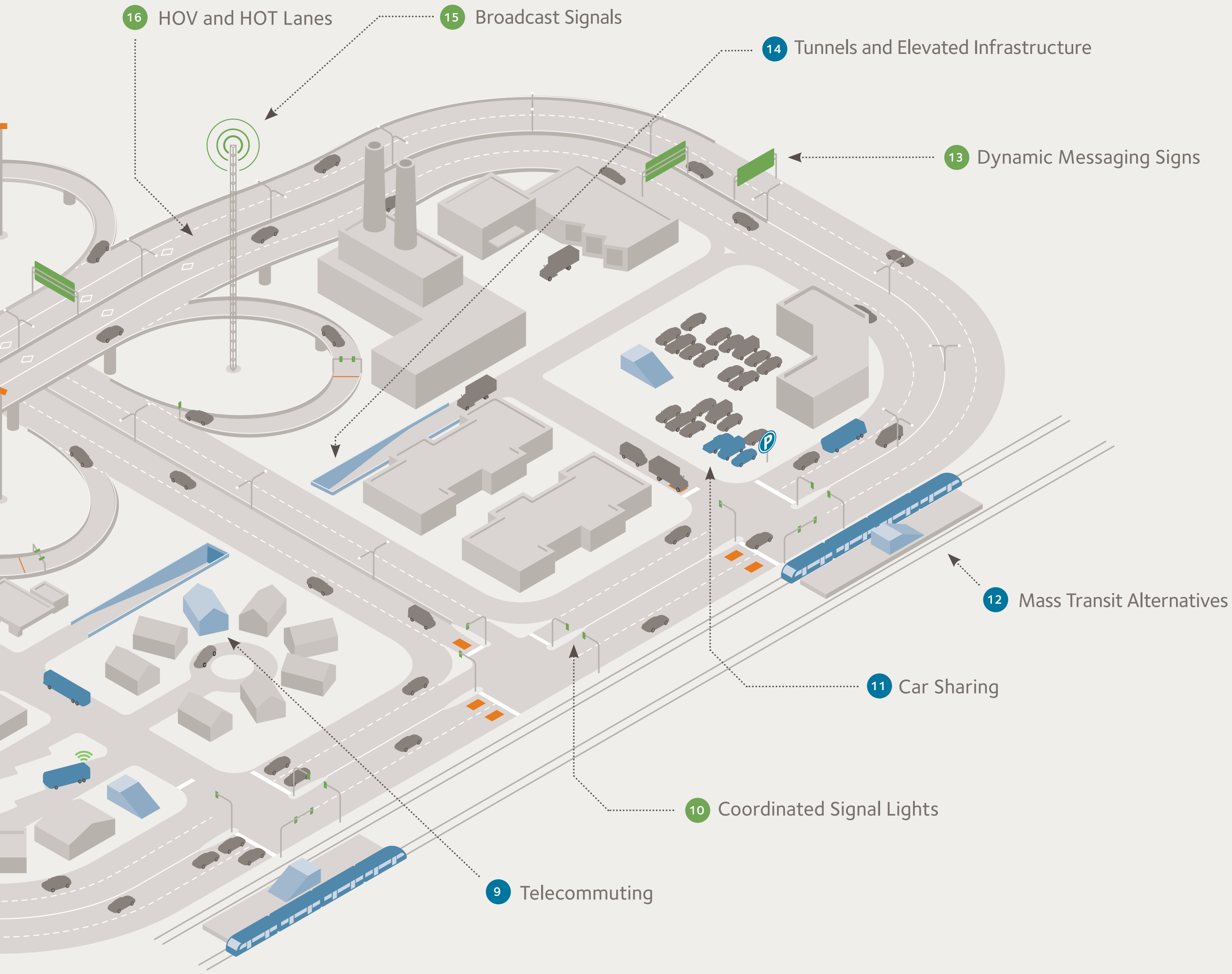


Sources: Government Accountability Office (GAO), *Surface Transportation: Efforts to Address Highway Congestion through Real-Time Traffic Information Systems Are Expanding but Face Implementation Challenges*, November 2009. Research and Innovative Technology Administration (RITA), Department of Transportation, *ITS Strategic Research Plan*, 2010-2014, December 2009. Stephen Ezell, The Information Technology & Innovation Foundation (ITIF), *Explaining International IT Application Leadership: Intelligent Transportation Systems*, January 2010.

across all available facilities rather than consistently through the same bottlenecks, and the use of performance-based data to inform cost-benefit analyses of potential transportation investment decisions.

INTELLIGENT TRANSPORTATION SYSTEMS OPERATE IN THREE PHASES

DATA COLLECTION	ANALYSIS & VERIFICATION	DISSEMINATION
Real-time data is monitored by a number of methods including on-road probe vehicles, roadside sensors, and video surveillance.	Both public and private entities can participate in analyzing and verifying gathered traffic information and data.	Information is communicated to system users through a variety of technologies including in-vehicle navigation devices, smartphones, radio, television, and internet.



Public Transportation and Other Alternatives

A selection of non-auto and non-road options for travelers can contribute to reducing congested traffic conditions.

NON-AUTO OPTIONS

Mass transit plays an important role in facilitating oil savings in U.S. metropolitan areas. However, due to the ubiquity of private vehicles and the flexibility they provide drivers, transit is more likely to have an impact on congestion and positive return on investment where demand already exists, such as in areas where people can live close to fixed bus and rail stops. In these locations, expanding transit capacity will make the most economic sense, and can help travelers improve quality of life while reducing per capita oil consumption dramatically. High-quality, time-competitive transit can also attract travelers who would otherwise drive, in addition to reducing the travel times of system users. Conversely, it will be less effective to fund transit expansion into locations with highly dispersed settlements, poor station access etc. Such transit services would likely face insufficient ridership demand to justify their operation.

Load Factor

A measure of capacity utilization in a transportation vehicle typically calculated as the ratio of filled seats to total available seat capacity. Sometimes also calculated commercially as the ratio of (revenue) passenger miles to available seat miles.

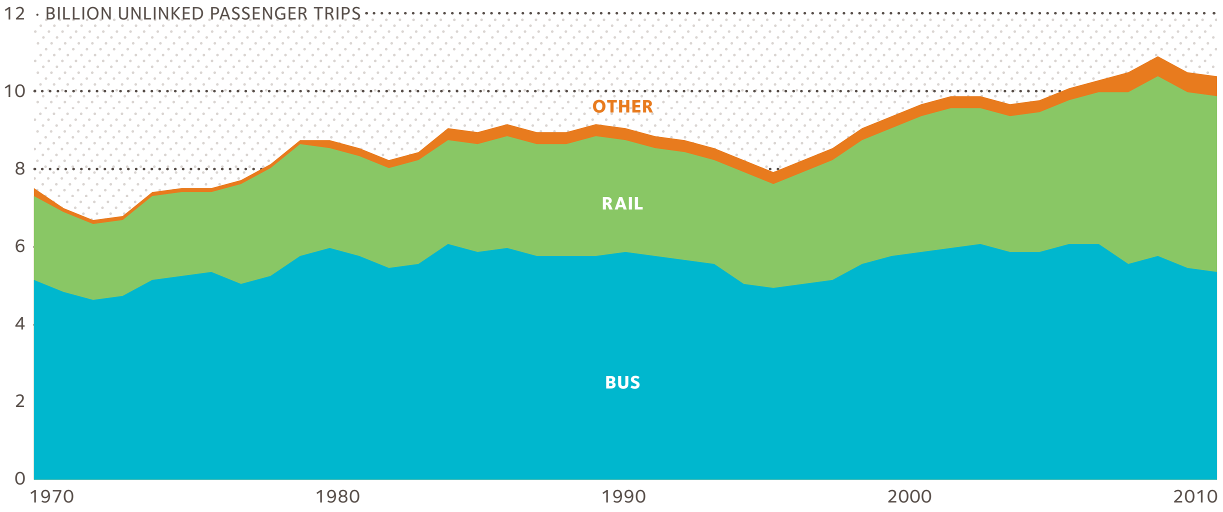
Studies have shown that cities with large, well-established rail systems have higher per-capita transit ridership, lower average per capita vehicle ownership and annual mileage, lower expenditures on transportation, and less traffic congestion.[122] Rail systems are also estimated to have substantial road and parking cost savings.[123]

Buses with flexible schedules, express routes, and sometimes exclusive or somewhat restricted access lanes, can provide even more extensive urban coverage and convenience for travelers, often at a lower ticketed price.

In major cities, where congestion is most costly and transit systems most heavily utilized, the effect is substantial. Public transportation has been estimated to save upwards of 300 million gallons of fuel annually, and potentially as much as 1.4 billion gallons.[124]

However, despite higher demand in recent years, in

FIGURE 3.3 Transit Trips, 1970–2010



Source: APTA

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[122] Todd Litman, Victoria Transport Policy Institute, *Rail Transit in America: A Comprehensive Evaluation of Benefits*, at 2, June 2011

[123] Id., at 27

[124] See for example, TTI, *Urban Mobility Report 2011*, at 3; Shapiro, Hassett, and Arnold, *Conserving Energy and Preserving the Environment: The Role of Public Transportation*, Table 2, July 2002; and Bailey, ICF International, *Public Transportation and Petroleum Savings in the U.S.: Reducing U.S. Oil Dependence*, Table 5, January 2007

certain locations, or at certain times of the day or week, buses and trains are plagued by low load factors. These transit services are both energy- and fiscally-inefficient and can result in higher energy consumption per passenger-mile traveled than traditional automobiles.[125] For travelers, overall service quality provided by transit is also important. Bad experiences with delays, construction work, and safety can have a negative effect on ridership.

Improving the current levels of operating efficiency is a crucial objective to ensure that load factors are maximized to the greatest extent. In some instances, this might require the recapitalization of the most heavily used transit systems that today face an urgent need to bring assets up to a state of good repair. However, given the large size of such investments, jurisdictions must be careful not to overcapitalize. An example would be building a rail system when adding targeted bus services would be sufficient to meet local needs. Rail provides most value serving concentrated corridors, whereas buses are a more readily scalable option for serving dispersed destinations with lower density demand.

TRAVELER BEHAVIOR, ENERGY COSTS, AND FUEL CONSUMPTION

Americans in the past have responded to higher gasoline prices with higher transit demand. During the third quarter of 2008, transit ridership increased 6.5 percent compared to 2007, while VMT dropped 4.6 percent.[126] Both 2007 and 2008 saw the highest levels of public transit ridership in more than 50 years. In fact, between 1995 and 2008 transit use increased by 36 percent.[127]

More than 10 billion unlinked individual passenger trips were taken on public transit in 2010.[128] In the 100 largest metropolitan areas, approximately 7 percent of commuters rely on public transportation.[129] In some of the nation's largest cities, this percentage is much higher. In New York, for example, it exceeds 50 percent. In Washington DC, San Francisco, and Boston, it is estimated at 38 percent, 34 percent, and 33 percent respectively, and in Chicago and Philadelphia, it exceeds 25 percent.[130] However, in several other major cities including Houston, San Diego, and Phoenix, transit is used by less than 5 percent of commuters.[131]

In Q1 2011, with oil prices once again spiking, transit ridership increased by 2.3 percent year-over-year.[132] Nearly 5.2 billion trips were taken on public transportation in the first half of 2011, an increase of 1.7 percent. Several light- and commuter-rail systems in major U.S. cities including New Orleans, Austin, Baltimore, Philadelphia, Dallas and Nashville all observed at least double digit increases in ridership.[133]

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[125] DOE, EERE, *TEDB*, Table 2.13

[126] American Public Transportation Association (APTA), *Public Transportation Ridership Surges as Gas Prices Decline – Highest Quarterly Transit Ridership Increase in 25 Years*, December 2008

[127] APTA, *2011 Public Transportation Fact Book*; and APTA, *Transit Ridership Report*, Q1 to Q4 2010

[128] APTA, Transit Ridership Report, Q1 to Q4 2010

[129] Brookings Institution, *Missed Opportunity: Transit and Jobs in Metropolitan America*, at 2, May 2011

[130] Id.

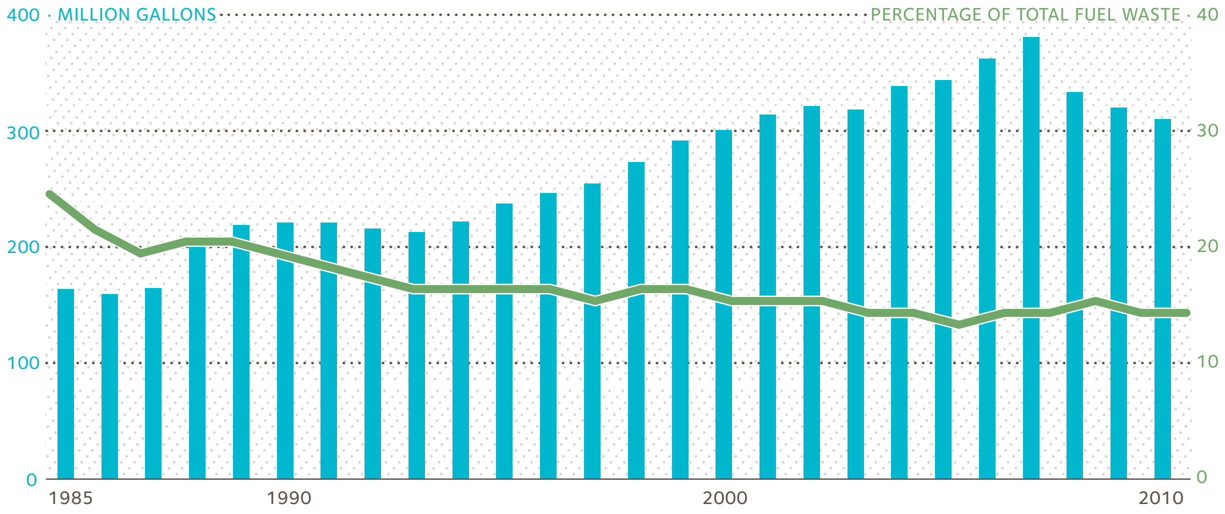
[131] Id.

[132] APTA, *Transit Ridership Report*, Q1 2010, June 2010; and APTA, *Transit Ridership Report*, Q1 2011, May 2011

[133] APTA, *Transit Ridership Report*, Q2 2011, August 2011

Congestion Fuel Waste Savings Attributable to Public Transit, 1985–2010

FIGURE 3.4



Source: Texas Transportation Institute

The ability of public transportation to facilitate mode shifting, take advantage of lower per traveler oil use, and perhaps more rapidly transition to alternative fuels, are all potentially important features. Heavy rail systems—like the Boston, New York, and Washington D.C. subways for example—run on electricity and are therefore completely delinked from oil. Bus transit, like private vehicles, also offer this opportunity, whether through a transition to electric, hybrid electric, biofuel, natural gas, or some other non-oil based fuel.

Travel Demand Management

In some locations, HOV/HOT facilities have prompted drivers and non-drivers to create ad-hoc carpooling initiatives to their mutual benefit.

Travel demand management (TDM) practices, which promote alternatives such as carpooling (ridesharing), and telecommuting have been in use since the 1970s. These programs aim to reduce traffic congestion by encouraging commuters to take advantage of alternatives to single-occupancy vehicle travel.

Carpooling is currently utilized by more than 13 million commuters in the United States—78 percent in a 2-person carpool, 13 percent in 3-person carpool, and 9 percent in a 4-or-more person carpool—and can be an effective way to reduce oil consumption and the cost burden of travel for drivers (particularly with respect to fuel use and vehicle maintenance).[134] Assuming an average daily commute of around 14 miles and a 50-week working year, every 300,000 additional personal vehicles taken off the road and into a carpool would save approximately 1 million barrels of oil per year. This does not take into account the additional oil savings attributable to any resulting reductions in system congestion.

Adding an hour to the workday and then allowing employees to take off a day every two weeks is also an effective way to reduce trips and save energy. A generally more flexible approach that allows employees to vary their working hours to some degree (commonly referred to as 'flexhours') can also deliver benefits—by, for example, enabling workers to avoid driving at the most congested times.

Telecommuting is also a powerful mechanism for reducing trips and improving both productivity and quality of life. With so much of modern work occurring on computers and over the phone, people who typically waste time commuting can instead use that time to work. Approximately 6 million people (or 4 percent of the total) work from home.[135]

There is some substantial overlap between TDM strategies and other policies used to address congestion, such as HOV/HOT lanes. An impact assessment on the SR91 Express Lanes in California, for example, found that even when a toll for vehicles with more than three occupants (HOV3+) was implemented two years after the lanes first opened (they initially paid no charge), the toll did not produce a decline in overall HOV3+ use.[136]

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[134] ACS 2010, Table B08301

[135] Id.

[136] Edward Sullivan, Cal Poly State University, prepared for the California Department of Transportation, *Continuation Study to Evaluate the Impacts of the SR 91 Value-Priced Express Lanes*, at 49, December 2000

CARSHARING PROGRAMS

Since most drivers do not need the vehicle for either extended periods of time or long distances, carsharing companies are increasingly providing more fuel-efficient options—including those vehicles that are grid-enabled—helping to further reduce oil consumption and waste attributable to congestion. (Felix Kramer, CalCars via Wikimedia Commons)

Many urban residents do not require daily access to a personal vehicle. Despite this, many continue to own cars for the convenience they provide to certain activities, such as weekly supermarket visits, irregularly-scheduled trips out of the city, or other infrequent or unpredictable needs.

Carsharing has emerged as a viable alternative to vehicle ownership for those with an occasional desire for private transportation. Having grown rapidly in popularity over the past decade, today more than half a million Americans are registered carsharing members, sharing more than 10,000 vehicles.[137]

A member-based system, carsharing gives drivers the flexibility to reserve, pick-up, and return vehicles at their convenience and rent for as short or long period as they desire. Operators of the systems provide maintenance, repair, and insurance, distributing the costs of vehicle ownership across a community of participants. Member surveys have estimated monthly savings ranging from $154 to $600 in comparison to vehicle ownership.[138]

Carsharing can facilitate effects and behaviors that reduce urban congestion. For example, carsharing has the potential to decrease the total number of vehicles in a city, which can lower the amount of land and infrastructure required for parking.[139] Studies and surveys suggest that 11 to 29 percent of carsharing participants sold a vehicle after joining and 12 to 68 percent delayed or forwent a vehicle purchase.[140] Shared vehicles have the added benefit of dedicated parking, which reduces driver tendency to 'circle' looking for the most convenient available spot.

Carsharing also forces a more direct consideration of trip cost in comparison to the monthly fuel, maintenance, insurance, and other expenses associated with vehicle ownership.[141] Such recognition can help promote more efficient personal travel decisions, particularly with respect to making discretionary trips at peak travel times, giving greater consideration to alternative modes, and giving generally more thought to the duration, necessity and distance of personal trips.

Additional fuel savings benefits are felt as a result of expanded use of newer, more fuel-efficient or alternatively-fueled vehicles, including those that are grid-enabled and rely more (or exclusively) on electricity rather than oil—vehicles that with lower emissions, and sometimes limited range are particularly well-suited for urban driving.

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[137] Innovativemobility.org, Research, Carsharing

[138] Susan Shaheen, Adam Cohen, and Elliot Martin, *Carsharing Parking Policy: Review of North American Practices and San Francisco, California, Bay Area Case Study*, 2010

[139] Michael Duncan, *The cost saving potential of car sharing in a US context*, at 365, September 2010

[140] Susan Shaheen and Adam Cohen, *Growth in Worldwide Carsharing: An International Comparison*, 2007

[141] Michael Duncan, *The cost saving potential of car sharing in a US context*, at 365, September 2010

Urban Planning and Development

Optimizing the physical infrastructure of the U.S. transportation system to minimize fuel waste and accounting for the likely impact on road conditions of new urban development are important initiatives with long-term benefits.

LONG TERM, HIGH IMPACT

While widely recognized as having a positive impact on urban activity and particularly road traffic congestion trends, urban design and city planning are often overlooked, given their limited relevance in the short term. However, from parking policy to transit-oriented development, and the general spatial location of activities, land use and development play an important role in either facilitating reductions in congestion and fuel waste, or vice versa.

LAND USE AND TRAVEL

The number of Americans living in urban areas increased from approximately 100 million in 1950 to almost 250 million in 2005.[142] Over the same time period, the urban population as a percentage of the total increased from less than 65 percent to more than 80 percent.[143] Yet urban inhabitants are no longer simply crowded into the high-density cities of old, but rather spread across vast land masses of lower-density city suburbs and satellite towns. Today, 82 percent of the population lives in urban areas (including suburbs), and urbanization continues at a steady rate just above 1 percent per annum.[144]

These areas must be supported by a large, and often complex, transportation system. Land use and transportation are thus part of a highly dynamic system in which each component is constantly evolving due to changes in policy, technology, economics, and even culture or values. The influencing factors are varied and numerous, large and small, altering the trade-offs between travel mode choice, time, and frequency.

The crucial issue for land use and transportation is urban density. Higher density urban development and the subsequently shorter distance between driving start and end points is generally considered to help reduce total travel time and reduce fuel waste. For example, the

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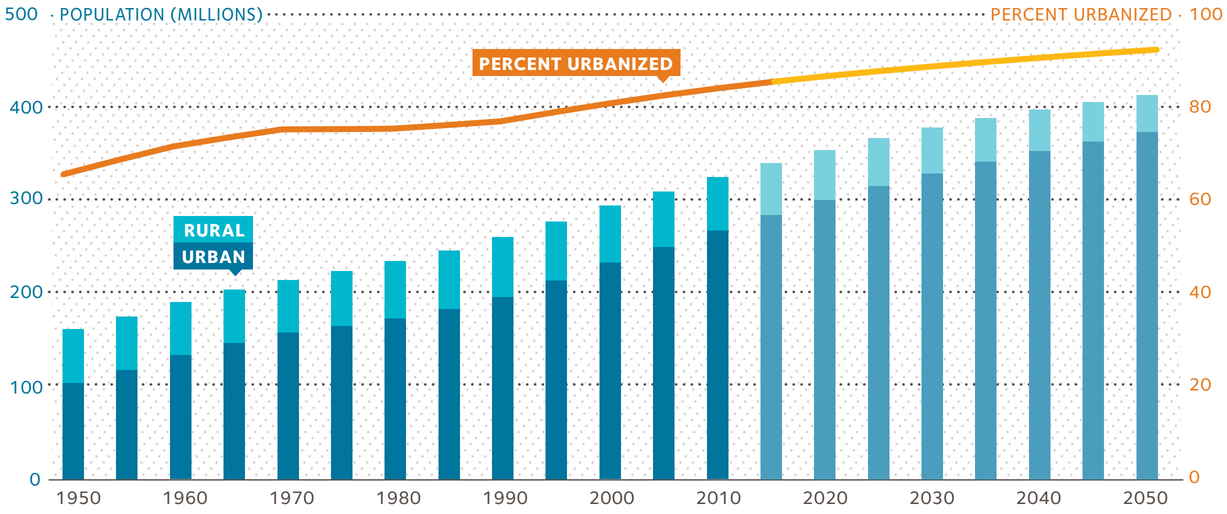
[142] United Nations, Department of Economic and Social Affairs: Population Division, Population Estimates and Projections Section, *World Urbanization Prospects: The 2009 Revision*, March 2010

[143] Id.

[144] CIA, *The World Factbook*, United States

FIGURE 3.5 Population and Urbanization, Historical and Forecast



Source: United Nations

difference in density between Chicago and Charlotte means average travel distances of 13.5 miles versus 19.0 miles. Therefore, despite having traffic that typically flows at a speed closer to the free-flowing baseline, drivers in Charlotte spend an average of approximately 48 minutes in traffic compared to 33 minutes in Chicago due to the greater distance.[145] Nationally, average commute distances for those traveling in private vehicles has increased from 8.9 miles in 1983 to 12.1 miles in 2009, and despite a marginal increase in average commute speed, average travel time increased by more than 5 minutes per trip.[146]

More dispersed, low-density development is also typically much more reliant on cars and trucks than higher-density areas. This phenomenon is strengthened by features such as multiple road lanes, limited sidewalks, large lots, little public transportation service, expansive parking areas, and a lack of mixed-use development. Some of these features are often legally required due to local zoning or construction laws, but they are also in part driven by a general preference for private vehicles amongst the populous. Each feature helps promote the more extensive use of private vehicles, often at the expense of other alternatives, when more careful urban development could have enabled shorter vehicle trips and reduced fuel consumption.

EXPANDING SYSTEM CAPACITY

To an extent, road traffic congestion—and recurring congestion in particular—can be reduced by increasing system capacity. Building road capacity effectively lowers the price of driving (reducing time delay) while enabling a higher volume of traffic. However, building new, unpriced highway lane miles can have a diminishing long-term benefit for congestion levels because it encourages travelers who had previously avoided congestion through alternative modes, routes or travel times to travel at peak times on the new capacity. This phenomenon is known as “induced demand”. Pricing any new capacity added to address congestion is therefore crucial.

Other factors undermining the effectiveness of adding new capacity include the growth expectations for VMT of all types over the next 25 years. Pricing and other measures (including ITS) to increase the efficiency of system function use are therefore complementary and very important to effective capacity expansion. It must be noted that some urban areas cannot increase system capacity due to practical space constraints. Again, it is thus important that these areas rely heavily on complementary, efficiency-focused initiatives and viable alternative transit services.

However, as part of a comprehensive demand- and supply-side strategy aimed at addressing congestion, the expansion of road capacity could be beneficial in some locales. Perhaps the greatest challenge is cost, especially when expansions require bridge widening or tunnel construction rather than simply the widening of existing surface roads. Partnerships with the private sector will be important to the successful completion of such capital-intensive projects.

A variety of capacity expansion solutions that can positively influence traffic flow exist. Underpasses and overpasses offer a reasonably simple, low-cost, and short distance option for avoiding congested intersections. For example, single-lane underpasses in Honolulu that enabled only light-duty vehicle access[147] were estimated to reduce travel time in peak morning and afternoon periods by 11 percent and fuel use by 24 percent.[148] Such benefits are, again, unlikely to endure over the long term without complementary measures.

Other additions and modifications—such as flyovers that enable drivers to cross roadways and/or change direction without stopping at traffic lights, navigating intersections, or accessing other roads—can also contribute to keeping traffic moving quickly and efficiently.

Elevation of roadways completes the three-dimensional concept of expanding system capacity in space-constrained urban areas. The use of multi-story and underground parking garages, office tower blocks, and apartment buildings are all based on essentially the same concept; when and where possible, building up and down adds capacity to the system in high-density locales. This has the added benefit of shorter travel distances (and times), and lower energy use per capita.

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[145] Joe Cortright, Impressa and CEOs for Cities, *Measuring Urban Transportation Performance*, at 14, September 2010

[146] FHWA, *2009 National Household Travel Survey: Summary of Travel Trends*, Table 27, June 2011

[147] Low clearance underpasses are more compact and economical than standard underpasses.

[148] Dehnert and Prevedouros, *Urban Intersection Congestion Reduction with Low Clearance Underpasses: Investigation and Case Study*, at 11, September 2003

CASE STUDY D

TUNNELS / A86 PARIS, FRANCE

The first toll tunnel has two low-clearance decks and is exclusively for light-duty vehicles. The second tunnel is of traditional style.

Despite some of the highest rates of transit use and pedestrian traffic observed in any major global city, Paris—like Los Angeles, Chicago, and other cities across the United States—suffers from severe road traffic congestion.[149] The A86 ringroad that surrounds the city was built to help relieve congestion and improve traffic connections between the suburbs of Paris. Until very recently, the final ringroad link remained incomplete.

A lack of space for highway construction through inner suburbs of historical and cultural value, combined with the importance of preserving the natural beauty of Versailles, prompted planners and policymakers to search for alternatives to new, conventional, surface roads. Twenty two proposals were in fact rejected before the construction of tunnels was deemed an acceptable solution.[150] This underground approach could emerge as a very practical solution to gridlock in many highly developed urban areas where increased surface road construction is infeasible.

Two tunnels completed in July 2009 and January 2011 today form this final link. These tunnels exhibit unique innovations and characteristics. Primarily, rather than being designated simply by direction, they are traffic-type selective. Freight trucks drive on a single-lane road in one tunnel, while light-duty vehicles drive in a separate two-deck, three-lane tunnel (the 'double-decking' resulting in the tunnel's common name of "Duplex"). The single-lane tunnel is also of lesser downward incline, reducing the risk of braking risks amongst heavier vehicles. This separation enabled the construction of lower-clearance decks, a substantial cost saving measure.[151] The use of vehicle-type selective tunnels is also considered safer for ordinary traffic, because the greatest risks of accidents and fires are posed by freight traffic.[152] The tunnels are equipped with cameras every 80m (262ft), emergency exits every 200m (656ft), fire sprinkler systems, and emergency crews with special low-height vehicles to respond to any breakdowns, accidents, or other emergencies.

Importantly, both of the tunnels are tolled.[153] Light-duty vehicle drivers pay between €1.50 ($2.00) and €9.00 ($12.50) depending upon distance traveled and the time-of-day the tunnel is entered.[154] This helps maintain steady free-flowing traffic. Furthermore, drivers can access real-time traffic data for the tunnel on their mobile devices.[155]

Traffic information on vehicle speeds and density is collected and relayed to a management center from which vehicle entry and exit to the tunnel is controlled. In-tunnel cameras complement this system.[156]

The tunnel is used by an average of 13,000 vehicles per day, with travel "peaks" of 15,000 vehicles per day.[157] The tunnel reduces the journey time between Malmaison and Versailles from 45 minutes to 10 minutes and is expected to greatly reduce pressure on the existing road infrastructure.[158] Due to the recent completion of the project, extensive data on time and fuel savings are not yet available, but one estimate suggests a 32 percent decrease in fuel consumption in comparison to the surface-based route.[159]

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[149] IBM Corporation, *Frustration Rising: IBM 2011 Commuter Pain Survey*, September 2011

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[151] tollroadsnews.com, *French low ceiling tunnelways of Duplex A86 comfortable to drive, "not claustrophobic"*, December 2008

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[157] Bloomberg, VINCI Inaugurates the A86 Duplex, the Final, Western, Link of the "Super-Ring Road", January 2011

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[159] 360Cities.net, *Inside Duplex A86 Tunnel*

Conclusion

Reliance on petroleum has created unsustainable risks to American national and economic security. The consistent supply of oil to the global marketplace is threatened by regional instability and rogue nations that share neither our interests nor values, helping render its price increasingly volatile. As a result, the U.S. economy is left at the mercy of events and actors beyond our control.

The U.S. transportation system and American energy use are irrevocably linked. And yet, despite this, transportation and energy policy have historically been debated in two entirely separate spheres in American politics, and a coherent, unified strategy for the federal surface transportation system has largely been absent since the construction of the interstate highway system.

Today, metropolitan areas across the country face growing road traffic congestion that threatens to undermine the potential oil savings associated with more efficient vehicles and the more widespread use of alternative fuels. Longer travel delays, greater quantities of fuel waste, and other negative outcomes are expected in the future.

Policies to promote more stable road speed conditions are crucial to lowering sectoral oil consumption. Urban congestion pricing programs, an expansion of tolling projects, and the increased use of alternatives to single-occupancy travel will help address recurring stop-and-go traffic. Integrated incident/accident management systems and technological advances that enable vehicle-to-vehicle communication will help reduce non-recurring congestion that results from unpredictable events and even reduce the occurrence of accidents. The application of advanced technologies that encourage higher operating efficiency and lower energy use will provide system-wide benefits with respect to both recurring and non-recurring congestion.

The current approach is untenable for the U.S. transportation system, national energy security, and the growth of the American economy. It is time for policymaking that emphasizes the crucial interaction between transportation policy and U.S. oil dependence, and aggressively combats growing congestion.

Credits and Acknowledgements

Securing America's
Future Energy

Securing America's Future Energy (SAFE) is a nonpartisan, not-for-profit organization committed to reducing America's dependence on oil and improving U.S. energy security in order to bolster national security and strengthen the economy. SAFE has an action-oriented strategy addressing politics and advocacy, business and technology, and media and public education. More information can be found at SecureEnergy.org.

Congestion in America builds upon the vision for a national transportation policy that recognizes U.S. oil dependence as a threat to both national and economic security, as first outlined in *Transportation Policies for America's Future*. To address the crucial interaction between national transportation policy and oil dependence, *Congestion in America* identifies a range of options available to policymakers to address worsening traffic congestion across the country, improve traveler mobility, and reduce wasted time and fuel.

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