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Reducing Greenhouse Gases from Personal Mobility: Opportunities and Possibilities

by Wendell Cox
Project Director: Adrian T. Moore

Reason Foundation

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Executive Summary

Federal, state and local governments are considering or have implemented policies that seek to reduce human emissions of greenhouse gases (GHGs). This study seeks to assess the relative merits of specific policies intended to reduce GHGs from automobiles. (It does not consider whether or not reductions in GHGs are actually desirable.)

Current policies and proposals for reducing GHGs from autos would require implementation of strong land use restrictions (compact development). Technological alternatives for reducing GHG emissions have received considerably less attention.

We estimated the costs of a range of such policies, beginning with government documents and reports prepared in cooperation with organizations advocating behavioral policies. Behavioral strategy costs and the costs of technological strategies were evaluated against the upper limit on acceptable costs for GHG emissions reductions as estimated by the Intergovernmental Panel on Climate Change. (This upper limit, $50/ton of carbon dioxide equivalent in 2020–2030, is used because of its source, not because we endorse that value).

GHG emission reduction goals cannot be realistically achieved by applying “fair share” quotas to economic sectors. Depending on the availability of strategies requiring expenditures less than $50 per ton, a sector might account for more or less of the eventual reduction in GHG emissions than its share of total emissions. A “fair share” approach would require some unnecessarily expensive strategies, while neglecting some less costly strategies. As an example, IPCC research indicates

that transportation represents 23% of global emissions, yet estimates the economic potential for GHG reduction in transport to be less than one-half that figure (10% or less).

Research by McKinsey & Company and The Conference Board found that substantial GHG emission reductions can be accomplished cost-effectively while “maintaining comparable levels of consumer utility” (an economic term denoting quality of life). This means “no change in thermostat settings or appliance use, no downsizing of vehicles, home or commercial space and traveling the same mileage” and “no shift to denser urban housing.”

Sustainability is often narrowly defined as pertaining to the environment, such as GHG reduction. However, environmental sustainability also depends upon achieving other dimensions of sustainability, including financial, economic and political.

Behavioral Strategies (Compact Development)

Proponents of this approach argue that GHG reduction will require radical changes in lifestyles. Their solution is *behavioral strategies* (compact development) to increase urban densities and change the way people travel.

The two most prominent reports on this approach (*Driving and the Built Environment* and *Moving Cooler*) predict that compact development could reduce GHGs from autos by between 1% and 9% between 2005 and 2050. *Driving and the Built Environment* acknowledges that there will still be significant increases in overall driving (vehicle miles traveled or VMT).

Compact development raises various issues:

- **Reasonable Expectations:** Projected results from the most aggressive scenarios appear to be implausible based upon reservations stated in *Driving and the Built Environment* and broader criticisms of *Moving Cooler*. It is suggested that a range of 1% to 5% is more realistic for the maximum GHG emissions reductions from autos between 2005 and 2050 under compact development policies.

- **Traffic Congestion and Compact Development:** Even this modest level of GHG reduction could be further diminished by the “GHG Traffic Congestion Penalty.” The higher densities required under compact development would cause greater local traffic congestion. As traffic slows and moves more erratically, the GHG reductions from less driving are diminished. Further traffic congestion retards the quality of life of households and imposes economic costs on metropolitan areas.

- **Housing Affordability and Compact Development:** Compact development is associated with higher housing prices. This is burdensome to lower income households, which are disproportionately minority. Assessing the impact of compact development on house prices, a Latino (Hispanic) think tank noted “an increase is always the result.” The increased household expenditures for mortgage interest and rents alone could amount to nearly $20,000 per GHG ton annually, nearly 400 times the IPCC $50 maximum expenditure by 2050 (2010$). This loss of housing affordability would represent a huge transfer of wealth from lower and middle income households.

- **Infrastructure Costs and Compact Development:** Despite theoretical claims that suburban infrastructure is more expensive than in more dense areas, data for metropolitan areas indicates no such premium.

- **Higher Densities:** Compact development would require unprecedented increases in density, well beyond those envisioned by current compact development policies. This densification could require aggressive use of eminent domain and could be prevented by neighborhood resistance and public reaction.

Compact development is incapable of reducing GHG emissions within the IPCC $50 maximum expenditure. Compact development’s higher than necessary expenditures could reduce economic growth, increase congestion costs, and result in public resistance and greater social imbalances. Because of its detrimental impact on financial, economic and political sustainability, compact development is unsustainable as a strategy for reducing GHG emissions from autos.

Facilitative Strategies

The alternate view is that technology solutions can achieve sufficient GHG reduction from autos. These *facilitative strategies* would alter the underlying GHG intensity of how people live and travel without requiring major changes in behavior or the standard of living.

There is substantial potential for reducing GHGs:

- The trend of present fuel efficiency improvements, if they can be continued beyond 2030, would produce auto-related GHG reductions of 18% by 2050 (from 2005). And if VMT increases at a lower rate, as some experts now project, a 33% reduction could be achieved.

- If the average auto were to achieve the best current hybrid fuel economy by 2040, GHGs would fall 55% between 2005 and 2050.

- Emerging fuel technologies also offer promise. Hydrogen fuel cells and zero-emission cars (principally plug-in electric vehicles), if paired with electricity from hydro-power, could help reduce GHGs from autos by 2050.

Various issues are examined with respect to facilitative strategies:

- **GHG Reduction and VMT Increases:** Department of Energy projections indicate that auto GHG emissions will decline, even though total driving will continue to increase.

- **Maximum Expenditures:** Facilitative strategies that would require more than the $50 IPCC maximum expenditure are rejected.

- **Quality of Life:** Current technologies can be implemented without retarding Americans' quality of life. However, some of the more advanced technology strategies may reduce quality of life by requiring smaller autos. Under either scenario, people could continue to live in houses of the same size at affordable prices, to travel the same mileage, and there would be no necessity for a shift to denser urban housing. Research associates greater economic growth with geographic mobility, which is preserved even under the more advanced technologies.

- **Relying on Technology:** Based upon the current availability of far more fuel-efficient technologies, such as hybrid vehicles, it is plausible to assume continued GHG reductions after 2030. The emerging strategies could accelerate the improvement. Of course, as noted above, any projection is uncertain.

New technologies have the potential to achieve substantial GHG emission reductions at costs within the $50 IPCC maximum expenditure per ton. This could be accomplished while preserving quality of life. As a result, public acceptance is more likely.

Conclusions and Recommendations

Generally, existing and likely future technologies have a far greater potential to reduce GHG emissions than compact development.

Based upon *Driving and the Built Environment* and *Moving Cooler*, compact development provides little possibility of achieving a reduction of more than 5% in auto GHGs by 2050.

On the other hand, wider application of existing technologies could produce GHG emission reductions of up to 54% by 2050 with current hybrid technology. GHG reductions from new technologies, such as electric cars, could be even greater. These technologies are potentially sustainable financially, economically and politically, and thus environmentally.

By contrast, imposing compact development would be enormously expensive, is likely to reduce economic growth substantially, and could stifle opportunity for lower income households, which are disproportionately African-American and Hispanic. These factors render compact development unsustainable financially, economically and politically, and thus environmentally.

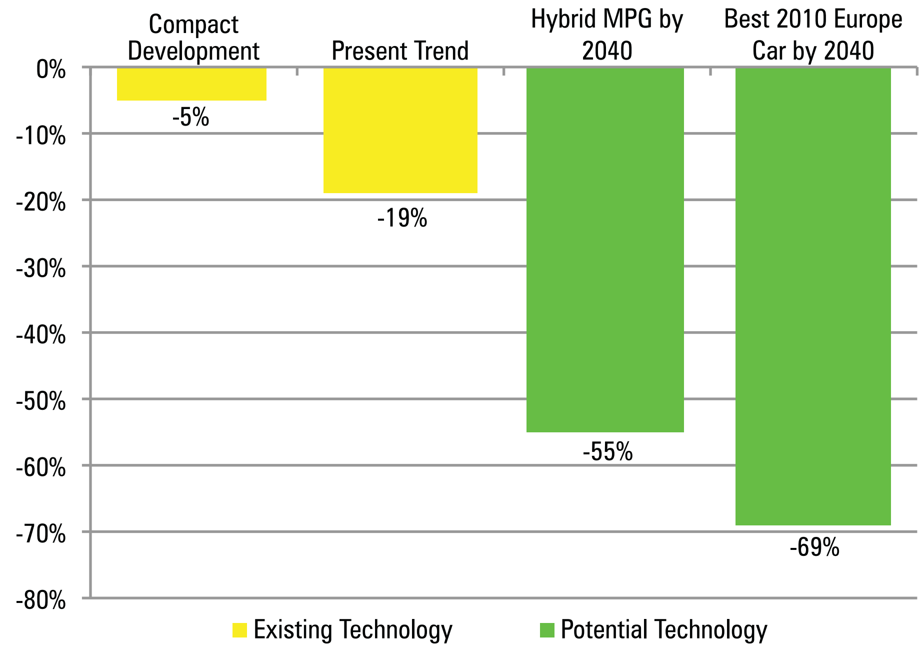
Figure ES1: Long Term GHG Emission Reductions (Various Strategies from 2005 to 2050)

As governments consider policies intended to reduce GHG emissions from autos:

- Compact development strategies should be neither mandated nor encouraged.
- Technology strategies should receive priority.

At the same time, any such policies other than removing government-imposed barriers to new technology development and adoption should be implemented with great caution.

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Part 1

Introduction

The population of the United States is expected to increase 42% (129 million) between 2010 and 2050.[1] Metropolitan areas will grow even more, at 55% (142 million), as non-metropolitan populations decline.[2] At the projected 42% growth by 2050, achieving an 83% reduction in total GHG emissions below current levels—as some have advocated—would require an 88% reduction in GHG emissions *per capita*, when compared with current levels.

The personal mobility sector (automobiles, sport utility vehicles and small trucks, hereinafter referred to as "autos") represents a particular challenge, because of its near total reliance on fossil fuels, which produce carbon dioxide (CO_2), the most common GHG.

Some national interest groups and members of Congress have expressed support for strong land use policies (compact development) to reduce GHG emissions from autos. At the same time, technological alternatives for reducing GHG emissions have received considerably less attention.

This report does not evaluate the merits of greenhouse gas reduction objectives, but limits its analysis to the impacts of strategies to reach such objectives, once established. The purpose of this analysis is to compare the potential and expenditures required materially to reduce auto GHG emissions through two different policy approaches: compact development and vehicle technology.

Assumptions: This analysis is based upon the following assumptions:

1. That the United States will adopt a GHG emission reduction program.
2. That there is a risk that GHG emissions reductions could be very costly to households and the economy and could lead to higher levels of poverty.
3. That, consistent with these economic concerns, any mandated GHG emissions reductions must be achieved at the least cost to households and the economy.

This analysis relies on readily available documentation likely to frame policies that government is expected to adopt, including reports from the United Nations Intergovernmental Panel on Climate Change (IPCC).[3]

The Uncertainty of Projections: Projections are inherently uncertain. The most highly regarded authorities and models cannot predict with certainty the behavioral changes that might result from proposed policies. Further, it is beyond the ability of anyone reliably to predict the technological advances that may occur in the future. Longer term projections tend to be less certain than shorter term projections. Generally, the time horizon of GHG emissions projections is long: up to 40 years (to 2050). The projections contained in this report and other GHG-related reports should be viewed in light of these uncertainties.

Maximum Expenditure per GHG Ton: The IPCC identified a range of $20 to $50 per ton of GHG removed as the maximum required to achieve sufficient GHG reductions.

> *…diverse strands of evidence therefore suggest a high level of confidence that carbon prices of 20–50 US$/tCO2-eq (75–185 US$/tC-eq) reached globally in 2020–2030 and sustained or increased thereafter would deliver deep emission reductions by midcentury consistent with stabilization.*[4]

For the purpose of this analysis, any expenditure above the $50 level is excessive. It is important to minimize expenditures to reduce negative impacts on households and the economy by keeping the costs of any policies to reduce GHG emissions as low as possible. Failure to do so will retard the quality of life for households and increase poverty. If all of the GHG emission reduction were achieved at $50 per ton in the United States, the annual expenditures would exceed $300 billion, which is more than 2% of gross domestic product in 2009.

The Inappropriateness of Fair Share GHG Reductions: GHG emission reduction goals cannot be cost-effectively achieved by a "fair share" approach to emitting sectors. For example, a sector (such as automobiles or buildings) might represent 10% of GHG emissions. However, that does not mean that 10% of the GHG emissions reductions must be obtained from that sector. There may be insufficient low cost opportunities, for example, such that imposing the 10% quota would require implementation of overly costly strategies in the sector, while less costly strategies in other sectors are not implemented. On the other hand, if there is an abundance of low cost possibilities, imposition of the 10% quota would result in missed opportunities, as other, more costly options are implemented in other sectors. Either eventuality would impose higher than necessary costs on households and the economy.

Whether there is a shortage or an excess of low cost opportunities, the "fair share" (or quota) approach would disadvantage both households and the economy, because it would require implementation of some unnecessarily expensive strategies, while neglecting some less costly strategies.

Thus, in the longer run, the potential to reduce GHG emissions cost-effectively in the auto sector may be greater or less than its current share in overall emissions. As an example, IPCC research indicates that transportation represents 23% of global emissions, yet estimates the economic potential for GHG reduction in transport to be less than one-half that figure (10% or less).[5] Any inability to achieve a reduction share equaling its emission share is not a concern in the auto sector or any other sector, because there are ample alternatives to achieve the overall GHG emission reduction objective at lower costs.

Quality of Life: A report by McKinsey & Company and The Conference Board and co-sponsored by organizations supporting the "behavioral strategies" critiqued below (the Environmental

Defence Fund and the National Resources Defence Council) concludes that strategies are available for substantially reducing GHG emissions in the United States, while "maintaining comparable levels of consumer utility" (an economic term denoting the quality of life). This means, "no change in thermostat settings or appliance use, no downsizing of vehicles, home or commercial space and traveling the same mileage" and no "shift to denser urban housing."[6] [7] These findings have been criticized as overly optimistic. But if the McKinsey findings were correct, it would mean that substantial GHG emissions reductions can be achieved without diminishing the quality of life.[8]

Behavioral Strategies (Compact Development): Advocates of compact development believe that people must materially change their behaviors and living conditions to reduce GHG: automobile use must be reduced and urban densities must be increased. This is based upon an assumption that any GHG emission reductions from vehicle technology will be more than offset by GHGs from a continuing increase in driving.

Behavioral strategies rely on compact development to increase metropolitan population densities, which, it is presumed, would materially reduce auto use and associated GHG emissions. Compact development prohibits urban development beyond the current urban boundaries and imposes infill quotas,[9] development moratoria, costly development fees and other measures that limit where development can occur and require higher densities. Compact development strategies can also require that development within urban growth boundaries be directed toward particular portions of the urban area (or urban footprint)[10] in which densities are already higher or where there is more intensive transit service (see "Behavioral Strategies," below). Compact development strategies are also referred to as "smart growth" or "growth management."

Facilitative Strategies: The alternate view is that facilitative strategies can achieve material GHG emissions reductions, while *facilitating* the continuation of current lifestyles and living standards. Facilitative strategies allow urban development to occur consistent with consumer preferences[11] and within fundamental environmental standards.

Dimensions of Sustainability

Sustainability is often narrowly restricted to environmental factors, such as reducing GHGs. This one-dimensional focus recurs in research that identifies a particular strategy as likely to reduce GHGs, followed by an implementation recommendation, without regard to other factors. However, the mere potential of a strategy to reduce GHGs is not sufficient. Strategies must be cost-effective and must not materially impede economic growth or unreasonably intrude on people's lifestyle choices, or they could be rejected by the public. Three additional dimensions of sustainability are prerequisites to achieving environmental sustainability.

(1) Financial sustainability pertains to affordable GHG reduction. This is important because spending too much on less cost-efficient strategies would reduce the resources available to achieve GHG reduction objectives. We assume that financial sustainability requires a maximum expenditure of less than $50 per metric ton of GHG removed, consistent with the IPCC report.

(2) Economic sustainability requires that GHG reduction strategies not materially reduce economic growth, job creation or poverty reduction. Rapid personal mobility is associated with better urban economic performance.[12] Researchers at the University of Paris found that labor productivity is greater in urban areas where more jobs can be accessed in a fixed time (such as 30 minutes). This was confirmed in U.S. research by David Hartgen and M. Gregory Fields.[13] Generally, travel by transit takes up to twice as long as travel by car, according to Bureau of the Census data.[14]

Other data indicate that traffic congestion is costly to both consumers and businesses[15] and that less congested freight traffic is important to metropolitan economic performance.[16] The Environmental Protection Agency has also noted travel produces "benefits to vehicle owners, which reflect the value to drivers and other vehicle occupants of the added (or more desirable) social and economic opportunities that become accessible with additional travel."

The mobility provided by the auto is especially important to lower income households. Research by the Progressive Policy Institute has shown that minority and low income employment is improved by having access to cars, noting that "In most cases, the shortest distance between a poor person and a job is along a line driven in a car."[17] A Brookings Institution report also concluded: "Given the strong connection between cars and employment outcomes, auto ownership programs may be one of the more promising options and one worthy of expansion."[18]

(3) Political sustainability requires that GHG reduction strategies be acceptable to the public. If strategies cost too much (financial unsustainability), materially hobble the economy (economic unsustainability) or otherwise retard the quality of life, they may not be acceptable to the public. Political sustainability is consistent with research by Harvard economist Benjamin Friedman, who found that economies that fail to grow can lapse into social instability.[19]

Part 2

Behavioral Strategies (Compact Development)

A. Proposed Strategies: Compact Development

Behavioral strategies seek to transfer travel from cars to transit and non-motorized modes (such as walking and biking) and to mandate higher densities. Land use regulations would force most development into existing urban footprints or even to the most densely populated sections of existing urban footprints. The higher densities are intended to reduce the amount of driving, as measured by vehicle miles of travel (VMT). GHG emissions are generally presumed to be reduced by a corresponding percentage. Intercity travel would be steered away from cars and airlines[20] to expanded intercity rail services, especially high speed rail.[21] Policies such as these were advocated by many planners and organizations long before there was serious concern about reducing GHGs.[22]

There is considerable support for compact development in Washington, DC. For example, Secretary of Transportation Ray Lahood has spoken of "coercing" people from their cars.[23] The Obama administration has established a "livability" partnership among three federal departments to advance compact development (see Box 1: The Livability Agenda, on page 8). Senators Jay Rockefeller (D, WV) and Frank Lautenberg (D, NJ) have introduced legislation that would require annual per capita driving reductions.[24]

B. Compact Development: Opportunities and Possibilities

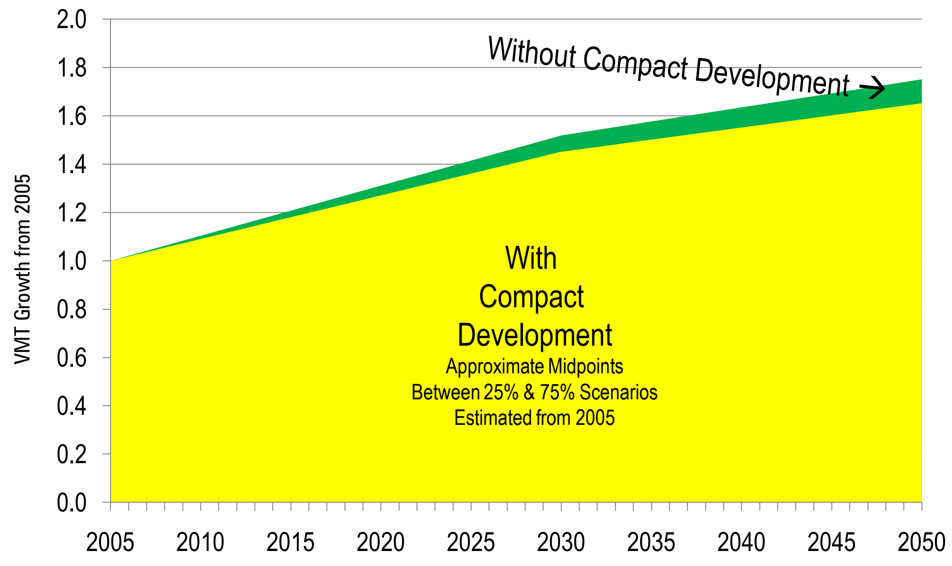
California's Senate Bill 375, enacted in 2008, has been cited as a model for national compact development proposals. SB375 accelerates approvals and provides exemptions for high density housing located on major transit routes and requires a minimum development density for new housing of 15,000 per square mile (six times the U.S. urban average).[25] This is nearly 25 persons per acre and 10 dwellings per acre at the average household size.

Driving and the Built Environment: *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use and CO_2 Emissions,*[26] produced by a special committee of the Transportation Research Board at the request of Congress, assesses the potential of compact development to reduce GHGs. The report reviews doubling the density of either 25% or 75% of all new development. *Driving and the Built Environment* projects compact development-related GHG (and VMT) reductions in the 25% scenario at approximately 1.0% in 2030 and 1.5%

in 2050 (midpoints of the projected ranges). Under the 75% scenario, compact development-related GHG (and VMT) reductions would be 6.8% in 2030 and 10.4% in 2050.[27] The report did not estimate the costs of the compact development strategies.

Despite the densification, VMTs would still rise substantially between now and 2050 due to continued economic and population growth, according to *Driving and the Built Environment* (Figure 1). In 2050, without densification, VMT would increase 74%. With 75% densification, VMT would increase 60%. In other words, although densification would require widespread coercion to force people to live at higher density than they would prefer, VMTs would continue to rise.

Figure 1: VMT With and Without Compact Development
(Based Upon *Driving and the Built Environment*)



Maximum Densification:

The maximum densification scenario of *Driving and the Built Environment* would require 75% of new development to be at substantially higher densities than would otherwise occur.[28] This density is already higher than all of the nation's urban areas with more than 1,000,000 population except for Los Angeles.[29] Yet, according to the projections in *Driving and the Built Environment*, VMT would continue to rise strongly with or without the strong land use policy interventions.

The challenge of building most new development at such high densities and the modest potential VMT reductions from a much higher 2050 base may have been at least partially behind this caveat in *Driving and the Built Environment*:

> *…the committee believes that reductions in VMT, energy use, and CO_2 emissions resulting from compact, mixed use development would be in the range of less than 1 percent to 11 percent by 2050, although the committee members disagreed about whether the changes in development patterns and public policies necessary to achieve the high end of these findings are plausible.*[30]

Driving and the Built Environment refers to dramatic changes in "housing trends," "land use policies" and "public preferences" in describing the feasibility difficulties with its higher densification scenario.[31]

Moving Cooler: *Moving Cooler,*[32] by Cambridge Systematics was sponsored by multiple organizations, some of which have long advocated compact development.[33] *Moving Cooler* indicates that its policies would require "considerable—and in some cases major—changes to current transportation systems and operations, travel behavior, land use patterns and public policy and regulations."[34]

Moving Cooler's policies would mandate densification, rather than creating incentives, as in California SB 375. The three densification scenarios would require 43%, 64% or 90% of future development to be in the most dense portions of urban areas.[35]

Expenditures: *Moving Cooler* predicts that its land use strategies would not impose substantial costs. Yet, *Moving Cooler* indicates that its transit strategies would require expenditures of nearly $600 per GHG ton removed, in 2050.[36] These expenditures are many times the IPCC $50 maximum expenditure. If the entire 83% proposed GHG reduction were achieved at an expenditure of $600 per ton,[37] it would require more than $3.5 trillion, an amount equal to 25% of the present gross domestic product. This amount is far beyond the most aggressive estimates of the expenditures of GHG emission reduction. Finally, *Moving Cooler* does not deal with the housing price increases that are inevitably associated with rationing developable land under compact development (see "Housing Affordability and Compact Development," below).

GHG Impacts: The GHG emission reductions from *Moving Cooler's* compact development scenarios[38] were similar to those of *Driving and the Built Environment* at from 1% in the 43% densification scenario, 3% in the 64% densification scenario and 5% in the 90% densification scenario in 2030. In 2050, the GHG emissions would be 2% in the 43% densification scenario, 5% in the 64% densification scenario and 9% in the 90% densification scenario.[39]

AASHTO Objections: For months the *Moving Cooler* coalition included the American Association of State Highway and Transportation Officials (AASHTO) as one of its principal sponsors.[40] AASHTO represents state transportation departments, which oversee highways and some transit systems and have proposed high speed rail systems. AASHTO withdrew from the *Moving Cooler* coalition over technical and objectivity concerns. AASHTO indicated that *Moving Cooler* attributes unrealistic GHG reductions to its strategies and underestimates the potential for more fuel-efficient cars, telecommuting, ridesharing and improved transportation operations. According to AASHTO, *Moving Cooler* "did not produce results upon which decision-makers can rely."

AASHTO researchers further said that *Moving Cooler* relied on "assumptions that are not plausible," analysis that was "flawed and incomplete," costs that were "incomplete and misleading," projected greenhouse gas emission results that were "not comparable or plausible" and contained "many assumptions" that were "extreme, unrealistic and in some cases, downright impossible." AASHTO dismissed *Moving Cooler* because its "heroic assumptions about land use and travel behavior and extraordinary pricing do not come close to providing the GHG reductions needed by 2050."[41]

THE LIVABILITY AGENDA

The Obama administration has established a "livability partnership" among the Environmental Protection Agency, the Department of Housing and Urban Development, and the Department of Transportation. The "livability partnership" would impact transportation significantly. Its principles call for "reliable and timely access" to employment and other urban destinations, "expanded business access to markets," increasing mobility, and lowering the combined costs of housing and transportation.

Compact development (smart growth) strategies would be relied upon heavily to achieve such objectives. This would include directing "growth to developed areas with existing infrastructure," reducing VMT and encouraging travel by transit and non-motorized modes, principally walking and bicycling.[42]

In proposing this program the Administration acknowledges the extent to which "automobile congestion impacts our communities and lives" and notes that "we … need to give that time and money back to our economy and our citizens."

In fact, the livability partnership has no potential to meet any of these objectives. The best evidence of this is that under the aggressive (and characterized as doubtful) 75% scenario in *Driving and the Built Environment*, VMT in 2050 would be from 43% to 78% higher than in 2000. It is estimated that the more aggressive of the compact development scenarios proposed in *Driving and the Built Environment* would increase VMT per square mile of urban land up to 50%.[43] Congestion would be thus be worsened. This would *increase* congestion costs. Moreover, because greater traffic congestion results in more intense air pollution, air quality would be worse than without compact development.

The greater traffic congestion would *retard* business access to markets. As traffic slows down (as is inevitable in traffic congestion), access to employment and other urban destinations would be *less* reliable and timely for people, reducing workers' access to jobs and employers' access to workers. Finally, as more people are "lured" or "coerced" out of their cars to ride transit, or to walk or bicycle, mobility would be further retarded and far fewer jobs would be accessible within the typical one-way commute time of less than 30 minutes. Based upon the connection between greater mobility and greater economic growth, these longer travel times could lead to lessened economic growth and greater poverty.

The higher housing prices induced by compact development would burden households and impose excessive costs on the economy. Thus, the livability partnership seems likely to make urban life *less* livable, by increasing travel times, reducing access, increasing costs and intensifying air pollution. Moreover, such policies would concentrate the population where there is greater air pollution.

Paradoxically, the livability agenda would diminish the quality of life by forcing people to live in smaller houses, drive smaller cars, travel less and live in denser urban housing.

Federal Legislative Proposals: Several transportation and climate change bills introduced in Congress in recent years have reflected the Administration's livability agenda. Typical provisions would require metropolitan planning organizations (MPOs) to meet specific GHG emissions reduction targets and to consider such strategies as encouraging walking, bicycling and transit and zoning that drives development to existing areas. This preoccupation with *means* rather than *ends* would likely result in only modest improvements in GHG emissions, because densification is likely to produce only small reductions in VMT, while the slower and more congested traffic conditions would diminish the GHG reductions from reduced travel (discussed above).

There is also a threat of federal interference in local land use decisions from the federal promotion of compact development. Legislative proposals typically grant the EPA wide authority to develop regulations with respect to the GHG reduction elements in planning processes. Legislative proposals typically grant the EPA wide authority to develop regulations with respect to the GHG reduction elements in planning processes. Federal agencies could intrude into state and local policy as the EPA did when it singled out Atlanta over air quality issues and worked to enact state planning legislation more to its liking.

In addition, legislative proposals have included substantial barriers to expanding highways, unless the expansion is limited to high-occupancy vehicle lanes, and defined "sustainable" as "transit, walking and bicycles." This definition means that a Toyota Prius hybrid, which would produce approximately 40% *less* in GHG emissions per passenger mile than U.S. transit rail and bus services[44] is not considered "sustainable," while more GHG-intensive transit services are considered sustainable.

A Metropolitan Area Example: Some have proposed requiring metropolitan areas (and states) to meet GHG emission targets. However, the most effective strategies— fuel economy and fuel technology improvements—are generally beyond the authority of state and local governments, and the potential of compact development, which is under the control of state and metropolitan authorities, is miniscule. The options available to state and local governments are heavily skewed toward behavioral strategies, which are exceedingly expensive and have only marginal potential for reducing GHG emissions (see: "The GHG Traffic Congestion Penalty," on page 12).

The limited potential of state or metropolitan targets is illustrated for a prototypical metropolitan area of 3,000,000 population (Figure 2).[45] The first alternative compares compact development to the present 35.5 MPG baseline and the other compares the impacts if fuel economy improved to the hybrid level by 2040. The gains from compact development are tiny compared to the fuel technologies.

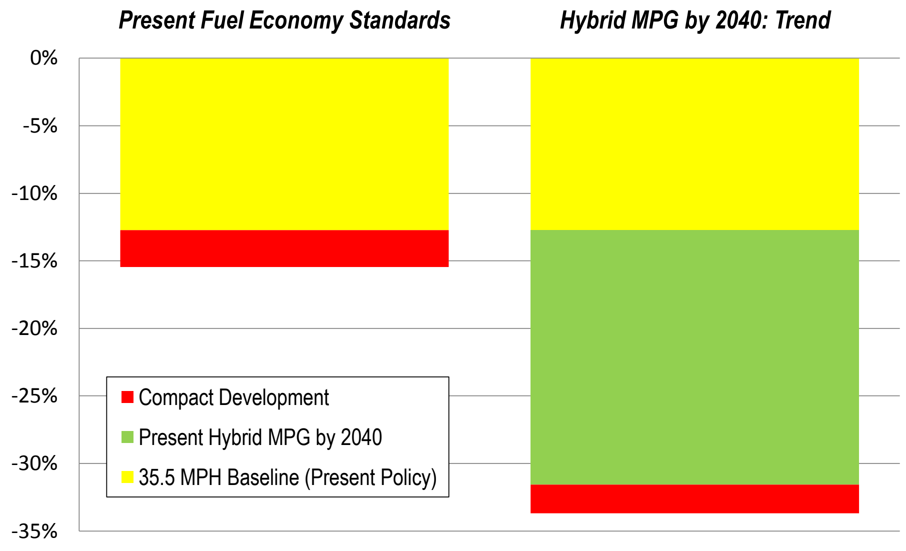


Figure 2: GHG Reduction: Contribution of Policies (Metropolitan Area: 2030 Compared to 2005)

C. Compact Development: Examination

A number of issues are raised by compact development.

Compact Development and the Quality of Life: The compact development strategies as proposed would diminish the quality of life. Houses would be smaller, people would travel less and there would need to be a shift to denser urban housing.

Traffic Congestion, Compact Development and GHG Emissions: The compact development reports assume a one-to-one (1:1) relationship between VMT and GHG reductions, i.e., that a 10% reduction in VMT will yield a 10% reduction in GHGs. But the inevitable increase in traffic congestion from higher densities renders this assumption invalid, as is discussed in this section.

Higher Densities and Traffic Volumes: National Housing and Transportation Survey data indicate that overall traffic volumes increase as population densities rise (Table 1). For example, the most densely populated urban census tracts (over 10,000 persons per square mile) generate 3.5 times as much VMT as the average density census tract (approximately 2,400 per square mile).[46]

As is discussed below, a U.S. Department of Transportation report (*Emissions Benefits of Land Use Strategies*) indicates that VMT reductions only become significant at much higher densities than average in the United States.

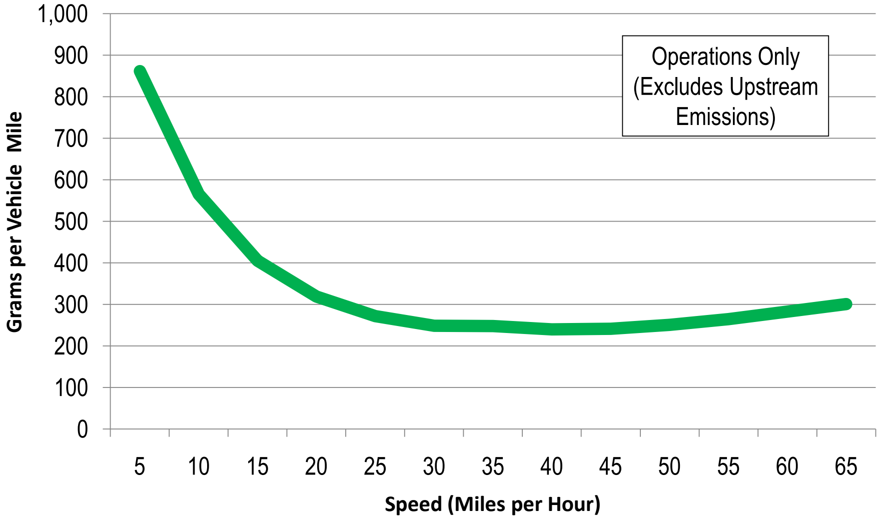
Table 1: Population and VMT By Density: Urban Census Tracts

	Average Population Density	Change from Lower Category	Average Daily VMT (Total)	Change from Lower Category	Exhibit: Share of Urban Population
Under 500	240		7,420		1%
500–1,999	1,160	383%	34,400	364%	25%
2,000–3,999	2,800	141%	71,660	108%	29%
4,000–9,999	5,780	106%	126,490	77%	31%
10,000 & Over	18,130	214%	220,390	74%	15%
Exhibit: Average	2,380		63,420		
Compared to Average	7.6		3.5		

NOTE: Estimated by this author, based upon University of South Florida, Center for Urban Transportation Research VMT forecasting model prepared for the National Surface Transportation Policy and Revenue Study Commission

Higher Densities and Traffic Congestion**:** Under compact development, road capacities would not be increased to accommodate the higher demand created by densification. As a result, the higher volume traffic would slow and traffic congestion would intensify, with more "stop and go" operations. Slower urban speeds and greater traffic congestion *reduce* fuel efficiency, which renders the one-to-one (1:1) VMT to GHG relationship assumption invalid. As vehicle speeds decline, GHG emissions increase, regardless of the distance driven (Figure 3).[47] Further, as traffic congestion becomes more severe, local air pollution ("criteria" pollutants, such as carbon monoxide, volatile organic compounds and NOx) become more intense, which increases the health hazards that justified auto environmental standards in the first place.

Figure 3: Effect of Speed on GHG Emissions (Data from California Air Resources Board)



The GHG Traffic Congestion Penalty: Research indicates a substantially diminishing rate of GHG reduction as traffic congestion increases. A one-half hour trip in congested conditions was found to reduce VMTs 62%, due to slower speeds and more stop and start operation. However, the reduction in GHGs is much less, at only 12%.[48] In this example, a 1% reduction in VMTs produces only a 0.19% reduction in GHGs[49] in more congested conditions (Table 2). This is an 81% loss in GHG emissions relative to the 1:1 relationship assumed in the compact development reports. In this regard, a UCLA public policy center told the California Air Resources Board: "VMT is an inadequate proxy for vehicle greenhouse gas emissions."[50]

Driving and the Built Environment does not discount GHG emissions from reduced VMTs to account for the slower speeds and greater traffic congestion that are likely to be produced by densification. As a result, the projections in *Driving and the Built Environment* are probably optimistic.

Table 2: Comparison of a 30-Minute Trip in Average and Congested Conditions

	Less Congested Conditions	Congested Conditions	Difference
Trip Time Assumed (Minutes)	30.0	30.0	0.0%
Average Speed (MPH)	41.9	15.8	-62.2%
Distance Traveled (VMT)	21.0	7.9	-62.2%
Fuel Consumed (Gallons)	0.56	0.49	-11.9%
Exhibit: Liters of Fuel per 100 KM	6.3	14.7	133.3%
Miles Per Gallon	37.3	16.0	-57.2%
GHG Grams (Trip)	6,225	5,496	-11.7%
Reduction in GHGs Relative to VMT			18.8%

Source: Martin Treiber, Arne Kesting and Christian Thiemann, How Much Does Traffic Congestion Increase Fuel Consumption and Emissions? Applying a Fuel Consumption Model to the NGSIM Trajectory Data, paper presented to the Annual Meeting of the Transportation Research Board, 2008.

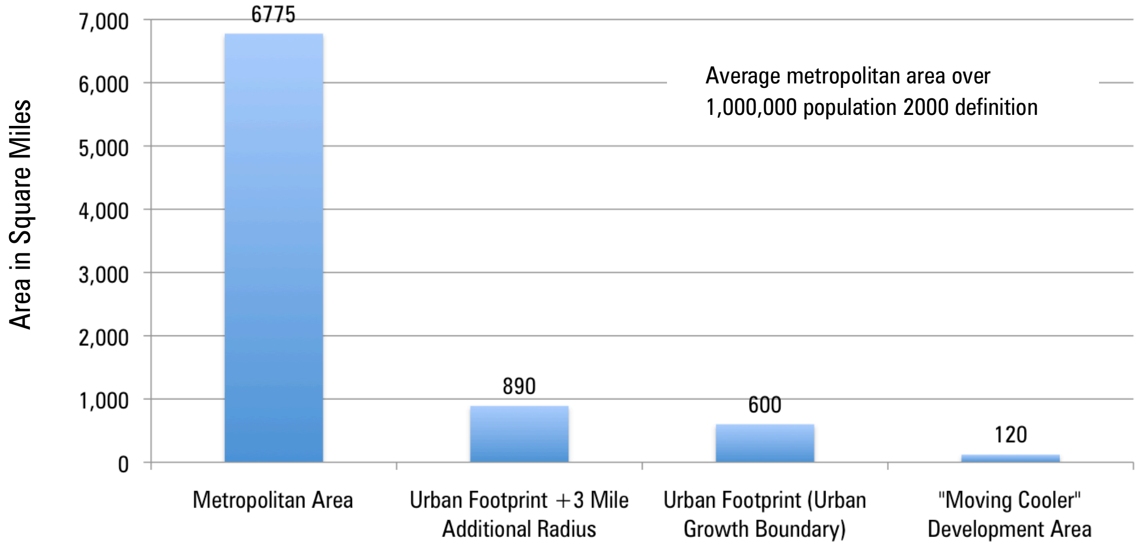
***Economic Impact of Traffic Congestion*:** As a result of traffic congestion, travel times would increase with compact development. This would include both auto travel and travel diverted to transit, because transit trips currently take significantly longer.[51] The mobility research indicates that this additional travel time would retard economic growth. The slower travel times would raise costs for trucks, delivery vans and on-site services (such as plumbers). All of this would retard economic productivity.

Densification: A Radical Departure: The high densification scenarios of *Driving and the Built Environment* and *Moving Cooler* would represent a radical departure from both present urban planning practice and the current urban form. Most new development would be restricted to a small portion of land within the urban footprint (see "Maximum Densification" under "*Driving and the Built Environment"* and *"Moving Cooler,"* above). These forced densification policies could require population densities to double or even triple (depending on population growth rates), in places like Berkeley, Boulder (Colorado), Brooklyn, Chicago, San Francisco and other dense sections of urban areas.

As Figure 4 indicates (on the next page), the availability of land for development would be radically reduced.[52] Even this depiction understates the aggressiveness of the proposed policies since there would be considerable land for development in the greater metropolitan area or in an area, say for example, three miles beyond the urban footprint. However, comparatively little vacant land would be available for development within the urban footprint[53] and even less in the *Moving Cooler* developable area or the smaller development area in *Driving and the Built Environment*.

This scarcity of developable land within the urban footprint has already increased prices in areas with compact development (see "Housing and Compact Development," below). The more restrictive environment in the high densification strategies of *Moving Cooler* and *Driving and the Built Environment* could raise land prices even more.

Figure 4: Metropolitan Area Development Potential
(Areas in which Most Development is Allowed)



Finally, the high densification scenarios under each of the two compact development reports would very likely bring drastic development reductions to most inner suburban areas and virtually all outer suburban areas. This is because little of land area in these suburbs reaches the density thresholds required for most development in *Moving Cooler* and *Driving and the Built Environment*. For example, future development could be severely retarded in larger suburbs such as Mesa (Phoenix area), Arlington (Dallas-Fort Worth area), Gresham (Portland, Oregon area), Bellevue (Seattle area), and Schaumburg (Chicago area), Aurora (Denver), Overland Park (Kansas City), Bloomington (Minneapolis-St. Paul), Moreno Valley (Riverside-San Bernardino), Waukesha (Milwaukee), O'Fallon, (St. Louis, Missouri area), Sandy Springs (Atlanta) and many others.

Housing Affordability and Compact Development: Compact development is associated with restrictions that lead to higher housing prices and a loss of housing affordability. Compact development policies prohibit development on large areas of otherwise buildable land by strategies such as urban growth boundaries, building moratoria and other growth controls. The result is to reduce the quantity of developable land, which results in higher land prices. The higher housing prices reflect a simple economic phenomenon: when the supply of any good (such as land for building) or service is limited, sellers are able to command a higher price. A result is that, for example, equal-sized building lots that are otherwise virtually identical except in the potential for development authority can have substantially different prices.[54]

Making Land Scarce: Since consumers prefer larger lots, compact development would be achieved by radically reducing the land available for development, especially residential development. The extent of this reduction is shown in Figure 4 (above), which indicates that new urban development is outlawed on most land within a metropolitan area with an urban growth boundary. The high densification scenarios in *Driving and the Built Environment* and *Moving Cooler* take the limitation much further, reducing the gross developable land by another 80%. The scarcity is exacerbated by the fact that most vacant land for development in a metropolitan area is outside the urban footprint (the area likely to be included in an urban growth boundary), and that much less land is vacant within the urban footprint. Further, even less vacant land is likely to be available in the small area designated for development under the high densification scenarios in *Driving and the Built Environment* and *Moving Cooler*.

Association between Compact Development and Higher House Prices: The association between compact-development-induced land scarcity and higher house prices has been noted by many economists:[55]

- Nobel Laureate economist Paul Krugman of Princeton University and *The New York Times* noted that the house price bubble was most pronounced in metropolitan areas with strong land use regulation.[56]

- Edward Glaeser, Joseph Gyourko and Raven Saks associated higher house prices in some metropolitan areas with more restrictive regulations.[57]

- William Fischel associated the inordinately high house price increases in California from 1970 to 1990 with land use regulation, including growth management strategies, voter initiatives and court decisions (See: "Estimating the Impact of Compact Development on Housing Affordability," below).[58]

- Former Reserve Bank of New Zealand Governor Donald Brash wrote that, "the affordability of housing is overwhelmingly a function of just one thing, the extent to which governments place artificial restrictions on the supply of residential land."[59]

- A United Kingdom government report by Kate Barker, a member of the Monetary Policy Committee of the Bank of England, blamed that nation's loss of housing affordability on its prescriptive land use policies under the Town and Country Planning Act of 1947 (The *Barker Report*).[60]

- A New Zealand government report by Arthur Grimes, Chairman of the Board of the Reserve Bank of New Zealand, blamed the loss of housing affordability in the nation's largest urban area, Auckland, on overly restrictive land use policies.[61]

- Theo Eicher, founding director of the University of Washington's Economic Research Center, associated more than 70% of the 1989 to 2006 house price increases in Washington (state) municipalities with land use regulation.[62]

An analysis by the Federal Reserve Bank of Dallas noted the association between metropolitan area house price increases in the 2000 to 2006 housing bubble and more restrictive land use regulation:

> *Demand for housing, driven by low interest rates and a growing economy, combined with supply restrictions—such as zoning laws, high permitting costs and "not in my backyard" regulations—to contribute to rapid price appreciation…. [L]ow levels of construction in the face of strong demand contributed to significant price appreciation…*[63]

The Federal Reserve Bank of Dallas further noted that in less restrictively regulated markets such as Atlanta, Dallas-Fort Worth and Houston, flexibility with respect to housing supply spared those metropolitan areas the price increases that occurred in the more restrictive markets:

> *…Atlanta, Dallas-Fort Worth and Houston weathered the increased demand largely with new construction rather than price appreciation because of the ease of building new homes.*

Impact on Metropolitan Economies: Research by Raven Saks of the Federal Reserve Board indicated that compact development policies were associated with lower employment growth:

> *…metropolitan areas with stringent development regulations generate less employment growth than expected given their industrial bases.*[64]

Impact on Minorities: The loss of housing affordability disproportionately disadvantages minority households, due to their generally lower incomes. California's Tomas Rivera Policy Institute, a Latino research organization, raised concerns about the impact of compact development on housing affordability:

> *Whether the Latino homeownership gap can be closed, or projected demand for homeownership in 2020 be met, will depend not only on the growth of incomes and availability of mortgage money, but also on how decisively California moves to dismantle regulatory barriers that hinder the production of affordable housing. Far from helping, they are making it particularly difficult for Latino and African American households to own a home.*[65]

The Tomas Rivera Policy Institute report also noted: "While there is little agreement on the magnitude of the effect of growth controls on home prices, an increase is always the result."

Compact development advocates largely ignore the upward impact on house prices. *Driving and the Built Environment* notes only that "restricting the amount of single-family housing through zoning or other measures that increase compact development could raise the costs of that housing, contributing to housing affordability problems."[66] *Moving Cooler* indicates that its land use policies would have a net positive impact on consumers between 2010 and 2050 of approximately $1 trillion in net benefits. However, *Moving Cooler* gives virtually no consideration to the house price increases that the laws of elementary economics, corroborated by significant economic research, associate with compact development.

Yet, a seminal report by compact development advocates, the *Costs of Sprawl—2000*, indicates the potential for seven of ten recommended land use tactics to raise housing prices (Table 3).[67]

Table 3: Prescriptive Planning Policies & Housing Affordability

	Strategy	Potential to Increase Housing Prices
1	Regional Urban Growth Boundaries	YES
2	Local Urban Growth Boundaries	YES
3	Regional Urban Service Districts	YES
4	Local Urban Service Districts	YES
5	Large-Lot Zoning in Rural Areas	YES
6	High Development Fees & Exactions	YES
7	Restrictions on Physically Developable Land	YES
8	State Aid Contingent on Local Growth Zones	
9	Transferable Development Rights	
10	Adequacy of Facilities Requirements	

Source: From Table 15.4, "Costs of Sprawl—2000"

Affordability Experience: The relationship between higher house prices and compact development policies is evident in the following examples:

- Median house values rose 30% in highly regulated California from 1970 to 2000 relative to the national rate (adjusted for household income).[68]
- In highly regulated Portland, Oregon, median house values rose nearly 60% relative to other major urban areas, as compact development policies were strengthened between 1990 and 2000. House prices continued to rise well above the national rate from 2000 to the 2006 peak of the housing bubble (adjusted for household income).[69]

During the housing bubble (2000 to 2006), median house prices in the major metropolitan markets with compact development rose substantially more than in metropolitan areas without compact development. This is illustrated by comparing the trend in a widely used indicator of housing affordability, the Median Multiple, which is the median house price divided by the median household income. Over at least the last four decades, the Median Multiple has tended to average 3.0 (3 years of household income) or less in U.S. metropolitan areas.[70] From 2000 to 2006, the increase in the Median Multiple was 2.5 (2.5 times household incomes) in the compact development metropolitan areas. From 2000 to 2006, the increase in the Median Multiple was 2.5 (2.5 times household incomes) for a total Median Multiple of 5.5 in the compact development areas. By contrast, the Median Multiple rose 0.7 (the equivalent of 0.7 times household incomes) in the metropolitan markets without compact development, little more than one-fourth the rate of metropolitan areas with compact development.[71] The overwhelming share of the U.S. house price escalation and subsequent losses that led to the international financial crisis (the "Great Recession") was concentrated in California and Florida, which rely heavily on compact development strategies.[72]

Impact on the Price of Rental Housing: Moreover, there is a general (though lagged) relationship between house prices and rents.[73] Thus, higher house prices are likely to lead to higher rental rates for the approximately one-third of households who do not own their own homes. These households tend to have lower incomes than home-owning households.

Estimating the Impact of Compact Development on Housing Affordability: The long-term land use restrictions proposed in *Driving and the Built Environment* and *Moving Cooler* would have significant impacts on housing affordability, the housing sector and the economy.

An estimate of the future additional housing expenditures under compact development is projected for the horizon year of 2050 (from 2010). The projection is developed using the 1970–2000 annual increase in California relative to that of the nation (house prices adjusted for household incomes).

The California experience is appropriate as a base for projection for two reasons:

1. California housing prices are well above the national average. However, this differential has developed since 1970. As late as 1971, California housing prices were similar to the national average.[74]

2. William Fischel has associated the increase in California housing prices relative to the nation with its stronger land use regulation. Fischel found that the rise in California housing prices from 1970 relative to the nation could not be explained by factors such as higher construction cost increases, population growth, quality of life, amenities, the state's property tax reform initiative (Proposition 13), land supply or water issues.[75]

It is estimated that additional consumer expenditures for housing would exceed $1.5 trillion (2010$) annually in 2050 (purchase price, financing and rent). The GHG emission reductions from *Moving Cooler* would be approximately 78,000,000 tons in 2050 (including upstream lifecycle emissions). This renders an expenditure per ton of GHG emissions of $19,700. This is nearly 400 times the IPCC maximum expenditure of $50 (Table 4). Even at the implausible maximum (high densification scenario) *Moving Cooler* projection, the expenditure per ton would be approximately 325 times the IPCC maximum.[76]

Expenditures of this magnitude are clearly unsustainable, but the estimates do suggest the intense pressure that would be placed on housing markets and household budgets. Housing affordability could be substantially weakened as households would likely pay a larger share of their income for housing than at present.

All of this would result in a massive rearrangement of the economy and composition of the Gross Domestic Product and possible economic disruption. The potential for housing market distortions to produce economic distress is illustrated by the recent experience of the Great Recession, which was closely related to unprecedented house price inflation and deflation, much of it in California. The additional housing expenditures in 2050 are projected at 3.7% of the 2050 Gross Domestic Product. This is an amount that rivals the *entire* national projected reduction in Gross Domestic

Product from GHG emission reduction efforts under the proposed cap-and-trade legislation (1.0% to 3.5%), according to the Congressional Budget Office.[77]

Aside from the clear economic shock, the increased cost of housing is likely to lead to a massive redistribution of income away from middle income and lower middle income households and from owners of land on the urban periphery to central city land holders, financial institutions and others. Economic crises hurt those at the bottom the most.

Because the compact development policies proposed in both *Driving and the Built Environment* and *Moving Cooler* are considerably more restrictive than the compact development policies in place in California in the base period used in this calculation, the estimates above could be conservative.

Table 4: Additional Consumer Expenditures for Housing Associated with Compact Development Policies: 2050

	Annual: 2050
Higher House Prices & Mortgage Payments	$1,450,000,000,000
Higher Rent Payments	$90,000,000,000
Total Additional Expenditures	$1,540,000,000,000
Annual GHG Tons Removed	78,000,000
Additional Consumer Expenditures per GHG Ton Removed	$19,700
IPCC Maximum Expenditure per GHG Ton Removed	$50
Times IPCC Maximum Expenditure	394
Projected Gross Domestic Product: 2050	$41,260,000,000,000
Additional Expenditures as a Share of GDP	3.7%

Methodology: House purchase prices, financing and rents in 2010$.

Estimate based upon house cost increases in California compared to the rest of the nation. Compact development house prices and financing increases at the California annual house value multiple (median house value divided by household income adjusted) compared to the nation from 1970 to 2000 U.S. Census. Reduced for the home mortgage income tax deduction at a 25% marginal rate.

Homeownership and renting is at the 2008 metropolitan rate of 66.4%. 72.4% of homeowners purchasing in 2010 or later have mortgages, which average 90% of the house price principal, with a 7% annual mortgage rate[78] (fixed 30-year term). Data from American Community Survey.

The owned housing stock turns over each 12 years (based upon National Association of Realtors and Census Bureau data).

The metropolitan area share of the national population would rise from 84% to 92%, based upon UN urban projections.

Real personal and gross domestic product estimated based upon Goldman Sachs estimate at (estimate was in 2006$, adjusted to 2010$ and based upon projected 2010 GDP), http://www.chicagogsb.edu/alumni/clubs/pakistan/docs/next11dream-march%20%2707-goldmansachs.pdf.

The baseline house value to household income ratio would continue to decline at the annual 1970–2000 rate.

From 2010 to 2040, the national rent to house price ratio would decline at the 2000 California 1970–2000 rate, based upon U.S. Census data...

Houses sold 2011 or later included in metropolitan areas over 1,000,000 population in 2008. Houses sold in 2021 or later included in metropolitan areas under 1,000,000 population in 2008.

GHG reduction from *Moving Cooler* for land use and transit, high (maximum) densification scenario, adjusted upward to account for life cycle.

Infrastructure Costs and Compact Development: Compact development proponents claim lower density development has higher infrastructure costs compared to infill development.[79] This, however, presumes that the costs of labor and materials are the same in compact urban cores as suburban areas, when in fact they are often higher. Moreover, higher densities can require retrofitting or replacing existing infrastructure, which tends to be older in more dense areas and may be unable to handle the higher volumes produced by the additional population. This can be particularly costly. Finally, Cox and Utt's analysis of the actual data indicates that costs are no higher in suburban areas.[80]

Community Resistance to Densification: Densification could lead to substantial NIMBY[81] reactions, such as forced a policy reversal in Portland in the early 2000s. In 2002, voters of the Portland Metro district approved a measure that outlawed forced densification in existing neighborhoods by a 66% to 34% margin.

It would be very difficult, if not impossible, to consolidate land parcels to transform such dense neighborhoods to meet higher density targets. Such a strategy could require local and regional governments to use far more aggressive eminent domain initiatives than those that sparked a national reaction and new state laws after the Supreme Court's "Kelo" decision.[82]

Inaccuracy of Behavioral Projections: The use of computer models to predict behavior, as in *Driving and the Built Environment* and *Moving Cooler,* is fraught with error.[83] An international study led by Oxford professor Bent Flyvbjerg found frequent and significant over-estimation of ridership in transportation projects during planning processes.[84] This is despite substantial experience obtained over many years that should have materially improved accuracy. Projecting changes in VMT over a 40-year period in urban areas is considerably more complex than shorter term projections of transportation behavior in specific corridors. As a result, these far more complex projections could be even less accurate and prone to an even larger upward bias than the less complex transportation projections.

The Problem of "Self-Selection:" Modeling results are made more uncertain by "self-selection." Self-selection is the tendency for people to choose residential locations that facilitate their preferred lifestyles, rather than changing their lifestyles based upon where they live. This issue was stated as follows in a paper by David Brownstone of the University of California, Irvine, which was commissioned in association with *Driving and the Built Environment:*

> *Households choose their residential (and work) locations based, among other things, on their preferences for different types and durations of travel. The observed correlations between higher density and lower VMT may just be due to the fact that people who choose to live in higher density neighborhoods are also those that prefer lower VMT and more transit or non-motorized travel. If this is the case, then forcing higher densities may not lead to anywhere near the reduction in VMT 'predicted' by observed correlations.*[85]

Driving and the Built Environment notes that self-selection could cause upward biases, which would overstate VMT reductions.[86]

Density and Driving: A Weak Relationship: Moreover, a U.S. Department of Transportation report, *Emissions Benefits of Land Use Strategies* concluded that: "The threshold value at which density seems to have a meaningful effect upon VMT, or trips, is somewhere probably between 6,000 and 7,000 persons per square mile."[87] Only two large U.S. urban areas have densities that high (Los Angeles and San Francisco).

Significant doubt was also raised about the potential for higher densities to reduce VMT in the Brownstone research:

> *There is evidence that there is a statistically significant link between aspects of the built environment correlated with density and VMT. Very few studies provide enough detail to judge whether this link is large enough to make manipulating the built environment a feasible tool for controlling VMT, but those that do suggest that the size of this link is too small to be useful.*[88]

Brownstone also indicates that: "the magnitude of the link between the built environment and VMT is so small that feasible changes in the built environment will only have negligible impacts on VMT."[89]

Residential GHG Emissions: Both *Driving and the Built Environment* and *Moving Cooler* imply that residences in auto-oriented suburban areas produce greater GHG emissions than higher-density areas.[90] This is counter to the Australian research cited below and raises further doubts about the potential for compact development strategies to reduce GHG emissions.

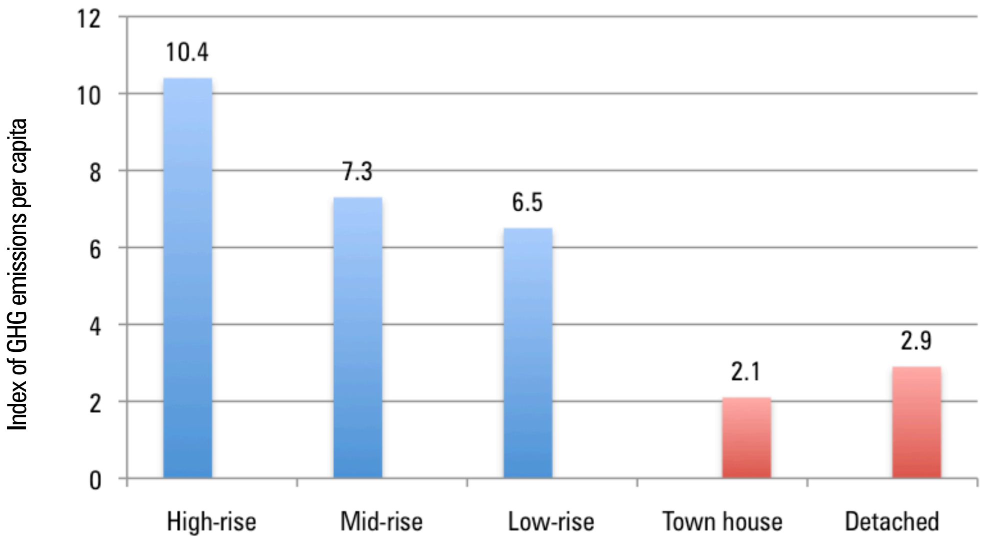
In perhaps the most comprehensive spatial research to date, the Australian Conservation Foundation allocated virtually all of the nation's GHG emissions to households based upon their residential location. The surprising result was that, all things considered, GHG emissions per capita were higher in more compact areas than in suburban areas, where there is more driving and where there is more detached housing.[91] Another report found that transportation and housing GHG emissions were greater in the core of Adelaide than in the suburbs, despite its higher density and lower rate of automobile usage. As the latter report indicates:

> *The densification of housing in central locations per se is not a sufficient condition for achieving a reduction in per capita greenhouse gas emissions in the built environment.*[92]

Expenditures: The expenditures under compact development's GHG reductions would be well above the IPCC maximum expenditure of $50 per ton as evidenced by the transit and housing reviews.

Exclusion of Common Energy: The authoritative source, the Residential Energy Consumption Survey (RCES)[93] includes only energy use reflected on residential utility bills, but excludes the common energy consumed in higher density housing.[94] Common energy is used for elevators, air conditioning, heating, water heating, building lighting, and commonly provided heating, cooling and water heating. Common energy can be substantial. An Australian study found that lower density housing produces less GHGs per capita than higher density when common energy is included (Figure 5).[95]

Figure 5: GHG Emissions by Housing Type (Annual Tons per Capita)



Source: Paul Myors, Rachel O'Leary and Rob Helstroom, *Multi Unit Residential Buildings Energy and Peak Demand Study*, Energy Australia, October 2005.

Building Materials and Construction Energy GHGs: Building materials used to construct detached houses produce less GHGs than those used in multiple unit housing. For example, wood, which is used to a greater extent in detached housing, tends to be less GHG-intensive than concrete and steel, which are used to a much greater extent in high rise construction. While the research is limited, data from one study indicated that GHGs from building materials used in multiple unit housing were from 3 to 14 times those of detached housing per square foot.[96] No estimates of GHG production from construction activities were identified.

Carbon Neutral Housing: Houses are becoming less GHG intensive. Britain requires that all new housing be carbon neutral by 2016. Carbon neutral housing has been developed, such as a 2,150 square foot detached house in Japan,[97] a 2,000 square foot detached house in the Shetland Islands,[98] and a 3,800 square foot detached house in the Washington, DC suburbs.[99] Thus, technology could conceivably eliminate housing type as a GHG concern.

D. Compact Development: Prospects

There are serious doubts about the feasibility of achieving the GHG emission reductions contained in the most aggressive densification scenarios in *Driving and the Built Environment* and *Moving Cooler*. The highest densification scenarios would require even greater efforts to coerce people into preferred lifestyle choices and would therefore seem to be even more out of reach. In the worst case, this could present a material threat to the well-being of households and economic growth.

The maximum density scenarios in *Driving and the Built Environment* and *Moving Cooler* would reduce GHG emissions from autos between 5% and 6% by 2030 from 2005 levels and approximately 9% by 2050. However, these projections seem implausible due to the extent of policy intervention required, as indicated in the reservations stated in *Driving and the Built Environment* and broader criticisms of *Moving Cooler*.[100] It is suggested that ranges of 1% to 3% in 2030 and 1% to 5% are more realistic for the maximum GHG emissions reductions from autos between 2005 and 2050 under compact development policies (See: "*Driving and the Built Environment:* Maximum Densification," above).[101]

Even these projections, however, are optimistic, because:

- The projections may not sufficiently account for the "GHG Traffic Congestion Penalty" (discussed above), by which GHG emissions reductions are diminished as traffic congestion increases (which is inevitable with higher densities). The "GHG Traffic Congestion Penalty" alone could diminish the projected GHG reductions by as much as two-thirds.

- Projections of behavioral changes are likely to be highly inaccurate, exhibiting an upward bias (see "Inaccuracy of Behavioral Projections," above).

Compact development policies could reduce economic productivity by forcing people to spend more time traveling to work and other activities due to increased congestion. Compact development would diminish the quality of life. The size of homes and yards would be reduced, while people would travel less and there would need to be a shift to denser housing.

Compact development could also lead to higher housing prices, higher rents and fewer opportunities for low income, especially minority, households to make economic gains. All of this could undermine public acceptance, an eventuality raised in *Driving and the Built Environment*, which questioned whether the substantial changes in "public preferences" were achievable.[102]

The expenditures under compact development's GHG reductions would be well above the IPCC maximum expenditure of $50 per ton as evidenced by the transit and housing reviews alone. As a result of its high expenditures, compact development policies are generally inappropriate for reducing GHG emissions from cars. This is because there are sufficient policies in other sectors to achieve the necessary GHG emission reductions within the maximum expenditure level.

Part 3

Facilitative Strategies (Technology)

A. Proposed Strategies: Technology

Facilitative strategies would reduce GHG emissions without interfering with the ability of people to live as they prefer.

B. Technology: Low GHG Opportunities and Possibilities

The most important facilitative strategies in transportation employ technology to improve the fuel economy of autos and reduce the GHG intensity of vehicle fuels. It's useful to compare the 35.5 MPG baseline, which reflects current federal CAFE fuel economy standards, with various technology opportunities. All GHG reduction projections include upstream life-cycle emissions.[103]

Present Technology and Policy: Existing technology and the latest fuel economy (CAFE) standards have considerable potential for reducing GHGs from autos.

Present Fuel Economy Standards: The new fuel economy standards would reduce GHGs 11% in 2030 from the 2005 base (Figure 6).[104] This assumes that overall driving (nationwide VMT) would increase 38% from 2010 to 2030, consistent with U.S. Department of Energy projections. In recent years, even before the much higher fuel prices, there were indications that the rate of VMT increase was slowing. This has also been documented in a Brookings Institution report, which noted that the decline was underway even before the large gasoline price increases.[105] This continues a trend of declining VMT increases going back at least to the 1950s, according to AASHTO's *Bottom Line* report. Steven Polzin of the University of South Florida has projected that future VMT growth will be more moderate than in the past, in a report for the United States Department of Transportation.[106]

In recognition of this development, AASHTO examined a lower-VMT-growth scenario in its *Bottom Line* report, in which VMT would increase 22% from 2010 to 2030, rather than the Department of Energy rate of 38%. At this lower VMT rate, the GHG emissions reduction from autos would be 19% (rather than 11%) by 2030 from 2005 (Figure 7).[107]

If that is true, then consumers would presumably prefer those more fuel efficient (but otherwise identical) cars and manufacturers would produce them with no prodding, so there is little need for government imposed fuel efficiency standards. Moreover, it indicates that there is substantial potential for additional progress.[108]

Figure 6: Potential to Reduce Auto GHGs with Baseline VMT Growth (EIA Projection and Trend)

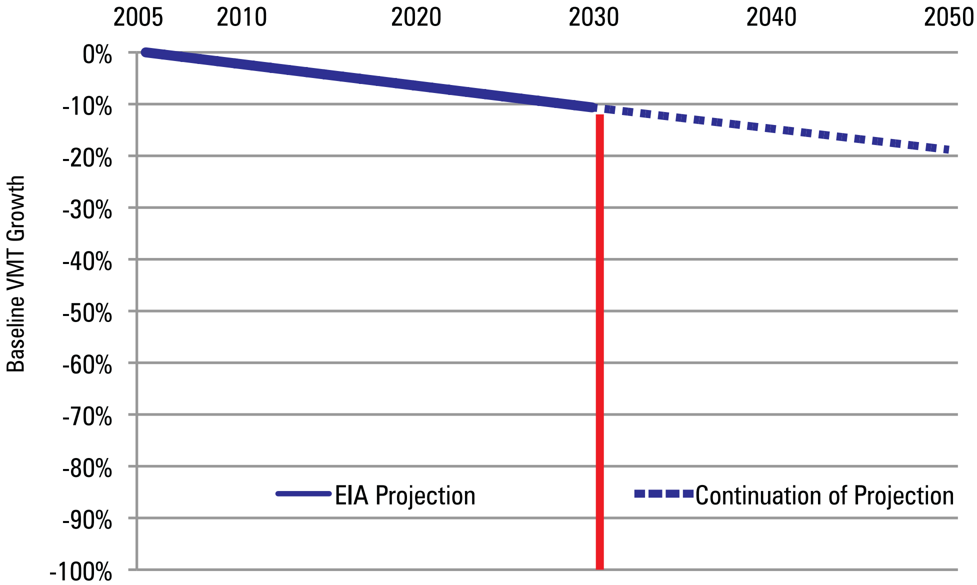
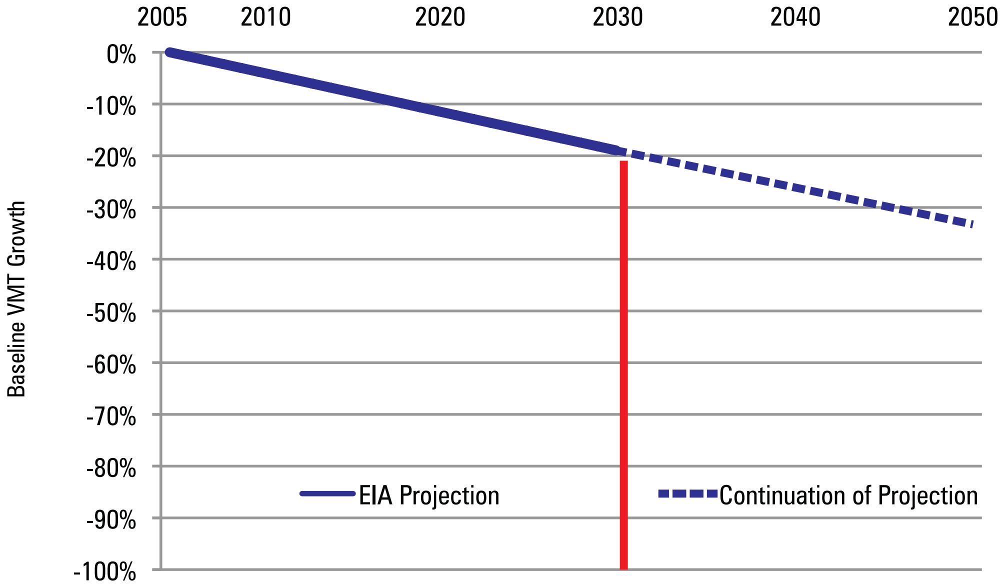


Figure 7: Potential to Reduce Auto GHGs with Lower VMT Growth (EIA Projection and Trend)



Continuation of the Trend: If the rate of fuel economy improvement from 2010 to 2025 could be sustained beyond that year, then GHGs from personal mobility would be reduced 18% by 2050, while VMT and the population continued to increase.[109] With the lower VMT growth-rate scenario, the decrease in auto GHGs would be 33% from 2005 to 2050 (Figures 6 and 7).

This longer term trend is plausible. Further, there are considerable opportunities for further advances in vehicle and fuel technology, which could improve GHG emissions reductions well beyond this fuel economy level. Potential opportunities are described below.

Additional Possibilities Using Present Technology: Other presently available strategies could further reduce auto-related GHGs.

Telecommuting (or working at home) eliminates the work trip thereby reducing emissions from commuting.[110] If the 2000–2008 trends continue, more people will work at home in 2020 on weekdays than commute by transit to work.[111] Already, working at home accounts for a larger market share of commuters than transit in 36 of the nation's 50 metropolitan areas with more than 1,000,000 population. The working at home commute share exceeds that of transit in more than 90% of metropolitan areas of all sizes.[112]

Improved traffic management and operations, especially from Intelligent Transportation Systems could reduce GHGs from congested traffic by up to 20%.[113]

There is also additional potential for reducing auto GHGs using existing technology or the mandates of present policy (Figures 8 and 9). Implementation could require financial incentives or more stringent fuel economy standards. These opportunities are not recommended as policy requirements, but rather are shown to indicate the potential for achieving greater GHG emission reductions through improved fuel economy.

***Hybrids*:** Hybrid vehicles can now achieve overall fuel efficiency of approximately 50 miles per gallon.[114] If the nation's personal mobility fleet were to achieve the *current* fuel efficiency of the best present hybrids by 2040, GHG emissions would fall 55% by 2050, despite continuing increases in VMT.[115] GHGs would decline 64% with the lower VMT increase rate. There are indications that the cost premium of hybrids over conventional vehicles could disappear, which suggests the possibility that such a conversion could be achieved within the $50 per ton maximum expenditure level.[116]

Europe: European fuel economy is substantially higher than that of the United States. The most fuel efficient new cars in Europe, such as a Volkswagen Polo model, now achieve 66 miles per (US) gallon.[117] If the U.S. light vehicle fleet were to achieve this fuel economy by 2040, GHGs would drop 69% by 2050. GHGs would decline 75% with the lower VMT increase rate. The expenditures required for these fuel economy improvements are not known, however the car model used in this projection retails for considerably less than the average car price.

However, fuel economy of this magnitude might not be accomplished without downsizing vehicles. This would diminish the quality of life. However, this would not impact other transportation and residential factors, such as the size of home or commercial space or the amount of vehicle travel, nor would a shift to denser urban housing be required. In view of the association between mobility, job creation and greater economic growth, this reduction in the quality of life might not have negative economic consequences.

Figure 8: Potential to Reduce Auto GHGs with Baseline VMT Growth: Additional Strategies

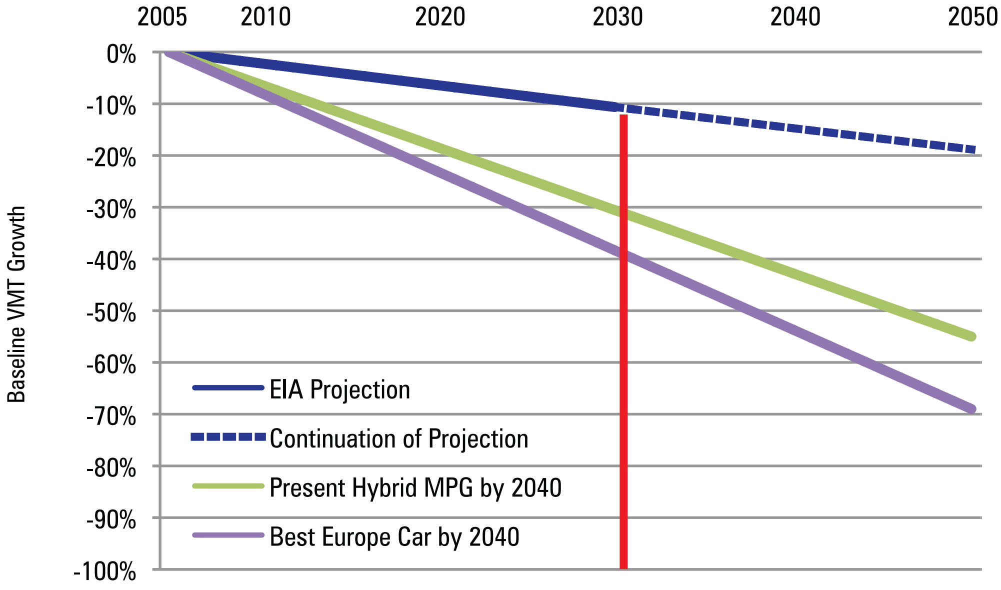
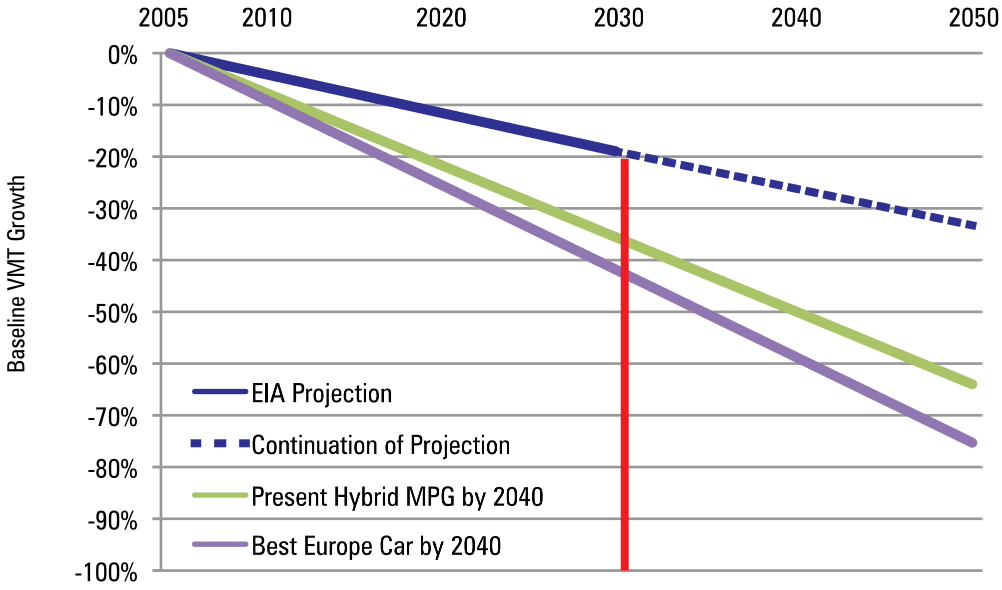


Figure 9: Potential to Reduce Auto GHGs with Lower VMT Growth



Future Technologies: There is the potential for further improvement in auto emissions from more advanced technologies. No evaluation is offered of any of the possibilities cited below, and, indeed, some are in the very early stages of development and may proceed no further. However, it is useful to note the volume of research that is underway, which may be a reminder of the potential of human research and entrepreneurship in developing advanced technological approaches.

Electric Vehicles: Electric vehicles could hold the greatest promise for GHG emission reduction. For example:

Plug-in hybrid vehicles will soon be available. A report by Massachusetts Institute of Technology researchers indicates the potential for plug-in hybrid vehicles to produce life-cycle GHG emissions of 139 grams per mile by 2030.[118] This is the equivalent of approximately 80 miles per gallon. If the vehicle fleet could achieve this efficiency by 2050, automobile GHGs would be reduced 61% from 2005 levels.

The same report identifies the potential for battery electric vehicle emissions to reach 186 grams per vehicle mile by 2030 or the equivalent of 60 miles per gallon. If the vehicle fleet could achieve this efficiency by 2050 automobile GHGs would be reduced 33% from 2005 levels. Under the lower VMT growth scenario, GHG automobile emissions would be reduced 47% by 2050.

Because battery electric vehicles are fully powered from the electricity grid and do not use fossil fuels directly, there is substantial potential for further reducing GHG emissions as electricity generation becomes less carbon intensive. If the carbon intensity of electricity generation could be reduced 50% by 2050 (a development considered “plausible” by the MIT report) and battery vehicle fuel efficiency were achieved by 2050, auto GHG emissions could be reduced 66%. At the lower VMT growth rate, the reduction in GHG emissions would be 74%.

Further, there is potential for electric cars that produce little or no GHG emissions. For example, German researchers have proposed using “redox flow” batteries that would be recharged at service stations by exchanging new battery fluid for spent fluid (which would then be recharged for use in another car). The fluid would be recharged through a chemical process.[119] Such cars would not rely on the electricity grid.

Fuel Cell Vehicles: The U.S. Congress mandated research on fuel cell technology in the Energy Policy Act of 2005. The resulting report by the National Research Council[120] found that a strategy principally relying on hydrogen fuel-cell vehicles (also biofuels and fuel economy) could reduce life-cycle GHGs 85% by 2050. GHGs would drop 88% at the VMT growth rate.[121] The report predicts that the technology could become commercially viable (and affordable) by the early 2020s.

Conventional Vehicle Advances: Volkswagen has developed a two-seat car that achieves 235 miles per gallon and reports indicate that it could be marketed within the next few years.[122] At this early stage of responding to GHG emission reduction mandates, this advance indicates that there may be substantial potential to improve conventional vehicle fuel economy even more in the future.[123]

C. Technology: Examination

Various issues are examined with respect to these technologies.

GHG Reduction and VMT Increases: Advocates of compact development have often suggested that auto GHG emission reduction advances will be cancelled out by emissions from VMT growth. However, contrary to this claim, auto GHG emissions are projected to decline 7% by 2025, despite the continuing (29%) projected increase in driving (VMT). As the analysis above shows, there is the potential for even more substantial reductions in auto GHG emissions, even while driving continues to increase.

Quality of Life: Some of the future technology-oriented policies could retard the quality of life because they would require reductions in vehicle size. However, people could continue to live in houses of the same size, to travel the same mileage, and no shift to denser urban housing would be required. As a result, new technology, implemented within the IPCC maximum expenditure level, would not otherwise diminish the quality of life and would represent no threat either to households or to the economy.

Housing Affordability: These new technologies would have virtually no negative effect on housing affordability, because they would allow continued development of inexpensive land on the urban fringe, consistent with household preferences. Thus, there would be no massive transfer of wealth, unlike under compact development.

Relying on Technology: There may be a concern that GHG emission reductions are so important that any and all potential actions should be implemented without delay and without consideration of expenditure levels. Or, it may be thought that it is too great a gamble to rely on the development of technological solutions.

Yet, there is considerable evidence that technology is advancing and that it does not require a leap of faith to believe that GHG emissions can be reduced sufficiently. The analysis above describes a number of existing and potential technologies that offer the possibility of deep reductions in auto-related GHGs. Based upon the current availability of far more fuel-efficient technologies, such as hybrid vehicles, it is plausible to assume continued GHG reductions after 2030. Of course, as noted above, any projection is uncertain.

Expenditures: Some of the more advanced technology strategies outlined above may not be achievable within the $50 IPCC maximum expenditure per ton. The maximum expenditure criteria would eliminate such strategies from implementation. At the same time, there are sufficient additional less costly strategies in other sectors to reduce GHG emissions at $50 per ton or less.

D. Technology: Prospects

Technological solutions have the potential to achieve material GHG emissions reductions from autos. The reductions can be achieved while allowing the economy to grow with minimal interference, thus maintaining or increasing job growth and minimizing poverty. It is thus possible to sustain the quality of life by not requiring smaller houses, less travel or denser urban housing. As a result such technologies are likely to be politically acceptable.

The use of autos will continue to increase rapidly in developing nations. American technology advances could be exported to assist such countries in reducing their GHGs as driving increases.

According to the criteria we established at the beginning of this paper, technology strategies (like other strategies) are appropriate to the extent that they can produce GHG reductions at less than the $50 expenditure level. Major reductions in U.S. auto GHG emissions can be achieved at expenditure levels below the IPCC maximum expenditure of $50 per ton, even while driving continues to increase. Indeed, if the EPA assessment of current fuel economy standards is to be believed, they can be achieved at essentially no additional cost.

Part 4

Conclusions and Recommendations

Direct and Indirect Approaches: New automobile technologies promise superior results by *directly* addressing GHG emissions without the need to regulate behavior. Compact development seeks to reduce GHGs *indirectly*, such as through restricting auto travel and regulating land use (Figure 10).

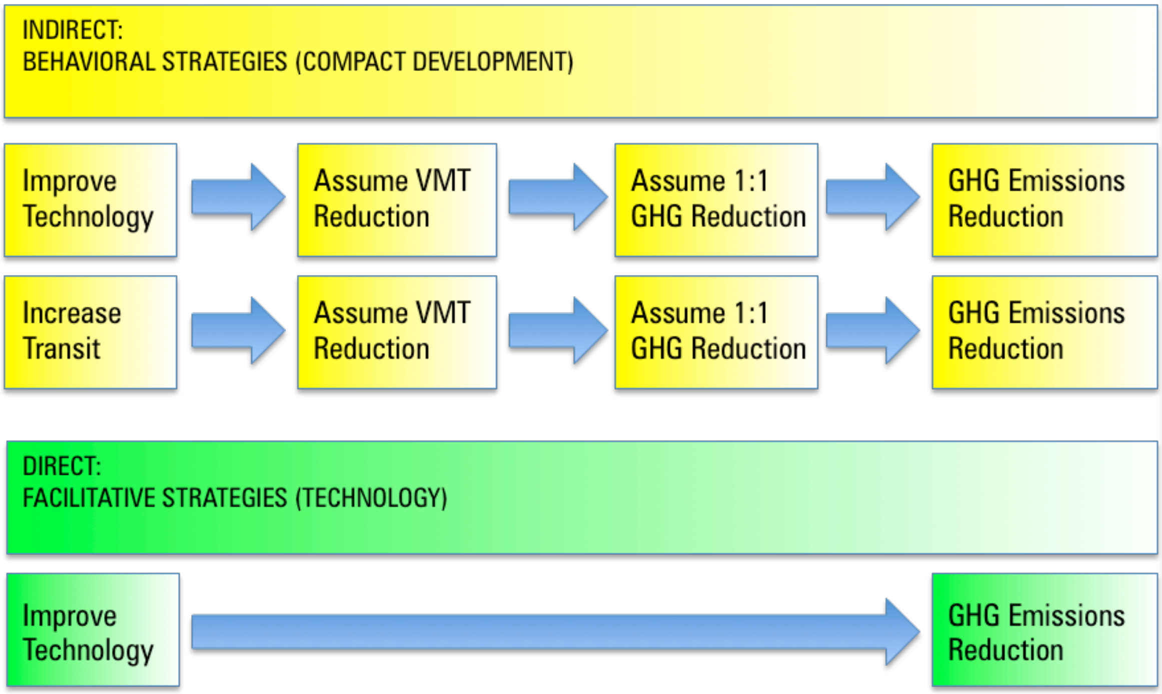
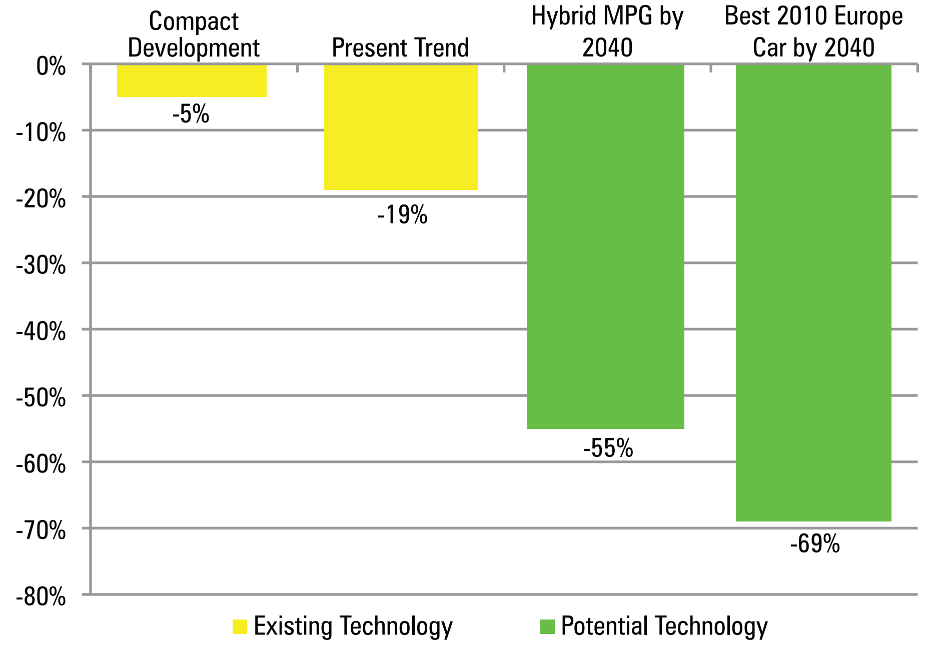


Figure 10: Indirect vs. Direct Strategies (Compact Development vs. Technology)

Generally, new technology has a far greater potential to reduce GHG emissions than compact development. *Driving and the Built Environment* notes that fuel economy strategies produce superior results (Figure 11 and Table 5).

> *In short, over the longer time frame (i.e., to 2050), the impacts of continuing improvements in fuel economy beyond 2020 on energy use and* CO_2 *emissions significantly outstrip those from more compact development.*[124]

Figure 11: Long -Term GHG Emission Reduction (Various Strategies: 2005–2050)



Comparing Compact Development and Technology: 2030: The greater effectiveness of technology strategies is illustrated by the fuel economy standards adopted in 2007 and 2008. These new standards reduced projected 2030 GHGs more than 30% from the previous standards from a 2005 base. This is despite a 97% projected increase in driving over the period.

In contrast, compact development would have produced a reduction of from 1% to an implausible 6% from the previous fuel economy standards between 2005 and 2030.[125] This is the equivalent of a less than 1 mile per gallon improvement in fuel efficiency.[126]

In the shorter term (2020), technology is projected to produce auto GHG emission reductions that are considerably better than that of compact development. Robert Poole of Reason Foundation characterized the lower range projected reductions for compact development as what would be called “a rounding error” in engineering.[127]

Comparing Compact Development and Technology: 2050: Based upon *Driving and the Built Environment* and *Moving Cooler*, compact development provides little possibility of achieving a reduction of more than 5% in auto GHGs by 2050. Reductions of up to 9% are theoretically possible, but improbable. The actual potential could be considerably less, given the impact of greater traffic congestion in the more dense urban areas that would be the result of compact development.

On the other hand, technology could produce GHG emission reductions of up to 55% by 2050 with present hybrid technology. GHG reductions from developing technologies, such as electric cars, could be even greater.[128]

Comparing the Dimensions of Sustainability: Compact development is overly expensive, could materially reduce economic growth, and could stifle opportunity for lower income households, which are disproportionately African-American and Hispanic. Further, compact development would substantially increase housing expenditures, which, again, would fall hardest on low income households. Compact development would result in a huge transfer of wealth from lower and middle income households to financial institutions and owners of developable land. These factors render compact development financially, economically and politically unsustainable. As a result, compact development is environmentally unsustainable. Yet, compact development has gained significant support in Washington through the Administration's "livability program," the draft surface transportation reauthorization bill, and the two cap-and-trade bills.

By contrast, new technology has the potential to materially reduce GHG emissions from autos. New technology can be economically and politically sustainable. As a result, new technology can be environmentally sustainable (Figure 12 on page 34).

Table 5: Greenhouse Gas Emissions Impacts: Compact Development vs. Technology

				Change from 2005	
	2005	**2030**	**2050**	**2030**	**2050**
BASELINE DRIVING RATE: EIA TREND					
Vehicle Miles (VMT): Billions	2,687	3,755	5,130	40%	91%
COMPACT DEVELOPMENT (BEHAVIORAL STRATEGIES): Millions of Annual GHG Tons					
Driving and the Built Environment: 25% Scenario Midpoint	2000 Base Scaled to 2005			-1%	-1%
Driving and the Built Environment: Midpoint between 2 Scenarios	2000 Base Scaled to 2005			-3%	-5%
Driving and the Built Environment: 75% Scenario Midpoint	2000 Base Scaled to 2005			-6%	-9%
Moving Cooler: Expanded Current Practice	1,500	1,486	1,475	-1%	-2%
Moving Cooler: Aggressive Deployment	1,500	1,459	1,422	-3%	-5%
Moving Cooler: Maximum Deployment	1,500	1,426	1,359	-5%	-9%
USDOT Report: *Emissions Benefits of Land Use Strategies*					
FACILITATIVE STRATEGIES: Millions of Annual GHG Tons					
Fuel Economy					
Pre-2007 CAFE Standards	1,500	1,886	2,577	26%	72%
Early 2009 EIA Projection	1,500	1,341		-11%	
2009 CAFE Standards (35.5 MPG Baseline): Trend Continuation	1,500		1,236		-18%
Hybrid Fuel Efficiency by 2040	1,500	969	670	-35%	-55%
European Standard Fuel Efficiency by 2040	1,500	801	458	-47%	-69%
Plug In Hybrid Fuel Efficiency by 2050: Present Electricity Generation Mix	1,500		712		-53%
Electric (Battery) Fuel Efficiency by 2050: Present Electricity Generation Mix	1,500		955		-36%
Electric (Battery) Fuel Efficiency by 2050: 50% Generation Improvement	1,500		477		-68%
Fuel GHG Intensity					
Hydrogen Fuel Cell Strategy Mix	1,500		229		-85%
LOWER VMT GROWTH RATE (AASHTO)				**Change from 2005**	
	2005	**2030**	**2050**	**2030**	**2050**
Vehicle Miles (VMT): Billions	2,687	3,405	4,155	27%	55%
COMPACT DEVELOPMENT (BEHAVIORAL STRATEGIES): Millions of Annual GHG Tons					
Driving and the Built Environment: 25% Scenario Midpoint	2000 Base Scaled to 2005			-1%	-1%

Table 5: Greenhouse Gas Emissions Impacts: Compact Development vs. Technology

				Change from 2005	
	2005	**2030**	**2050**	**2030**	**2050**
Driving and the Built Environment: Midpoint between 2 Scenarios	2000 Base Scaled to 2005			-3%	-4%
Driving and the Built Environment: 75% Scenario Midpoint	2000 Base Scaled to 2005			-5%	-8%
Moving Cooler: Expanded Current Practice	1,500	1,487	1,479	-1%	-1%
Moving Cooler: Aggressive Deployment	1,500	1,463	1,437	-2%	-4%
Moving Cooler: Maximum Deployment	1,500	1,433	1,386	-4%	-8%
Driving the Built Environment: 25% Scenario Midpoint	2000 Base Scaled to 2005				
Driving the Built Environment: 75% Scenario Midpoint	2000 Base Scaled to 2005				
USDOT Report: *Emissions Benefits of Land Use Strategies*	Little at Low Density				
FACILITATIVE STRATEGIES: Millions of Annual GHG Tons					
Fuel Economy					
Pre-2007 CAFE Standards	1,500	1,710	2,087	14%	39%
Early 2009 EIA Projection	1,500	1,216		-19%	
2009 CAFE Standards (35.5 MPG Baseline): Trend Continuation	1,500		1,001		-33%
Hybrid Fuel Efficiency by 2040	1,500	878	542	-41%	-64%
European Standard Fuel Efficiency by 2040	1,500	727	371	-52%	-75%
Plug In Hybrid Fuel Efficiency by 2050: Present Electricity Generation Mix	1,500		577		-62%
Electric (Battery) Fuel Efficiency by 2050: Present Electricity Generation Mix	1,500		773		-48%
Electric (Battery) Fuel Efficiency by 2050: 50% Generation Improvement	1,500		387		-74%
Fuel GHG Intensity					
Hydrogen Fuel Cell Strategy Mix	1,500		185	-100%	-88%

NOTES:

Base driving rate annual increase 1.6% (from Energy Information Administration)

Lower VMT Growth Rate annual increase 1.0% (from AASHTO)

Hydrogen Fuel Cell Strategy Mix based upon National Academy of Sciences report

Moving Cooler and Driving and the Built Environment Maximum scenarios considered improbable (see text)

Recommendations: As governments consider policies intended to reduce GHG emissions from autos:

1. Compact development strategies should be neither mandated *nor* encouraged.
2. Technology strategies should receive priority.

Technology strategies should thus be favored, consistent with the expected policy requirements to reduce GHG emissions. At the same time, government policies should be implemented with great caution. This imperative was stated by Massachusetts Institute of Technology Professor Richard K. Lester: “A steady stream of cost-reducing innovations in many different fields of energy technology—if sustained over decades—could bring the nation's climate and energy security goals within reach. But there are profound doubts about the government's ability to engineer this.”[129] In the end, better overall results are likely to be achieved with greater reliance on market-based strategies.

Figure 12: Dimensions of Sustainability (Potential to Reduce AUTO GHG Emissions)

Dimensions of Sustainability	Behavioral Strategies: (Compact Development Policies)	Facilitative Strategies (Technology)
Financial Sustainability Can the strategy reduce GHG emissions within the IPCC $50 expenditure range maximum per ton?	NO	YES
Economic Sustainability Can the strategy be implemented without impairing economic growth, job creation or poverty minimization?	NO	YES
Political Sustainability Will the strategy have public support and compliance?	NO	YES
Environmental Sustainability Does the strategy have the potential to materially reduce GHG emissions from autos?	NO	YES

About the Author

Wendell Cox is principal of Wendell Cox Consultancy (Demographia), an international public policy firm and specializes in urban policy, transport and demographics. He has provided consulting assistance to the United States Department of Transportation and was certified by the Urban Mass Transportation Administration as an "expert" for the duration of its Public-Private Transportation Network program (1986–1993). He has consulted for public authorities in the United States, Canada, Australia and New Zealand and for public policy organizations and lectured widely. He serves as visiting professor at the Conservatoire National des Arts et Metiers (a national university) in Paris, where he lectures on transport and demographics.

Related Reason Studies

David T. Hartgen, et al., *Impacts of Transportation Policies in Greenhouse Gas Emissions in U.S. Region*, October 2010, Policy Study No. 387.

Kenneth Green, *Q&A About Forests and Global Climate Change*, September 1, 2001.

Steven Schroeder and Kenneth Green, *Reducing Global Warming Through Forestry and Agriculture*, July 1, 2001, E-brief 105.

Kenneth Green, *Mopping up After a Leak: Setting the Record Straight on the "New" Findings of the Intergovernmental Panel on Climate Change (IPCC)*, October 1, 2000.

Kenneth Green, *A Plain English Guide to Climate Change*, August 1, 2000.

Kenneth Green, *Climate Change Policy Options and Impacts*, February 1, 1999.

Kenneth Green, *13 Questions Asked About the Science of Climate Change*, October 1, 1998.

Kenneth Green, *Evaluating the Kyoto Approach to Climate Change*, February 1, 1998

Kenneth Green, *Plain English Guide to Climate Change*, December 1, 1997.

Steven J. Moss and Richard McCann, *Nuts and Bolts: The Implications of Choosing Greenhouse-Gas Emission Reduction Strategies*, November 1, 1993.

Steven J. Moss and Richard McCann, *Global Warming: The Greenhouse, White House, and Poorhouse Effects*, September 1, 1993

Endnotes

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[1] The U.S. Bureau of the Census projects a population increase from 310 million in 2010 to 439 million in 2050. One of the principal reasons that metropolitan area populations decline is that non-metropolitan areas (counties and, in New England, towns) gain population and are reclassified into metropolitan areas.

[2] Based upon the United Nations estimate that the urban population will increase from 82.3% in 2010 to 90.4% in 2050. http://esa.un.org/unup/index.asp?panel=1.

[3] A critical analysis of the conclusions and assumptions of such reports is beyond the scope of this paper.

[4] Intergovernmental Panel on Climate Change, "Mitigation from a cross-sectoral perspective,"2007, www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter11.pdf p. 660 (20–50 US$/tCO2-eq is $20 to $50 per GHG ton).

[5] Transport share figure from http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter5.pdf. GHG emission reduction share calculated from Figures SPM.1 and SPM.6 in http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf.

[6] *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* McKinsey & Company and The Conference Board, Executive Report, December 2007, www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf, p. ix. This report was co-sponsored by the Environmental Defense Fund, the Natural Resources Defense Council (NRDC), Shell, National Grid, DTE Energy and Honeywell, pages xii and 80.

[7] See for example Howard W. Pifer III, W. David Montgomery, Dean C. Maschoff and Anne E. Smith "Managing the Risks of Greenhouse Gas Policies," Charles River Associates, January 2008, available at: http://www.crai.com/uploadedFiles/RELATING_MATERIALS/Publications/BC/Energy_and_Environment/files/Managing%20the%20Risks%20of%20Greenhouse%20Gas%20Policies.pdf

[8] Paradoxically, compact development advocates have coined "livability" to denote strategies that would require diminishing the quality of life. See Box: The Livability Agenda.

[9] "Infill" refers to development that occurs within currently developed areas (within the current urban footprint).

[10] An urban area (urban footprint or urban agglomeration) can be described as the lights visible from the air at night. An urban area is not defined by jurisdictional boundaries, such as city limits or county or state boundaries (see: http://demographia.com/db-define.pdf).

[11] Proponents of compact development sometimes contend that less restrictive land use strategies do not reflect genuine consumer preferences. However, the fact that compact development must impose strict land use regulations in an attempt to shape people's behavior in ways that would not otherwise occur demonstrates this contention to be invalid.

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[12] A comprehensive review of the social costs and benefits is provided in Joel Schwartz, "The Social Benefits and Costs of the Automobile," in Wendell Cox, Alan Pisarski and Ronald D. Utt, *21st Century Highways: Innovative Solutions to America's Transportation Needs* (Washington, D.C.: Heritage Foundation, 2005).

[13] http://usj.sagepub.com/cgi/content/abstract/36/11/1849 and http://reason.org/news/show/gridlock-and-growth-the-effect and http://www.newgeography.com/content/001044-traffic-congestion-time-money-productivity.

[14] Calculated from U.S. Bureau of the Census American Community Survey data, summarized at http://www.publicpurpose.com/ut-commute2007.pdf.

[15] For example, see the annual Texas Transportation Institute *Mobility Report* (http://mobility.tamu.edu/ums/).

[16] Delcan and Economic Development Research Group, "Economic Impact, Analysis of Investment in a Major Commercial Transportation System for the Greater Vancouver Region," Vancouver: Greater Vancouver Gateway Council, 2003, http://www.edrgroup.com/edr1/library/lib_trans_air/P099-Vancouver-economic-impact.shtml and Economic Development Research Group, "The Cost of Congestion to the Economy of the Portland Region," December 5, 2005: http://www.metro-region.org/library_docs/trans/coc_exec_summary_final_4pg.pdf.

[17] Margy Waller and Mark Alan Hughes, "Working Far from Home: Transportation and Welfare Reform in the Ten Big States," Progressive Policy Institute, August 1, 1999. See also Anne Kim, "Why People Need Affordable Cars," Blueprint: Ideas for a New Century www.ndol.org/ndol_ci.cfm?contentid=251220&kaid=114&subid=143.

[18] Evelyn Blumenberg and Margy Waller, "The Long Journey to Work: A Federal Transportation Policy for Working Families," Center for Urban and Metropolitan Policy, Brookings Institution, July 2003, p. 2.

[19] http://www.randomhouse.com/acmart/catalog/display.pperl?isbn=9780679448914

[20] Passenger rail systems, especially high speed rail, are often suggested as being less GHG intensive than airlines. Substantial progress, however, is likely, with the world airline industry having pledged to reduce GHGs 50% by 2050 (http://www.earth-stream.com/Earth/Community-and-Politics/Kyoto-protocol/Airlines-Pledging-to-Cut-Emissions-by-50-_18_193_729_205869.html). Michigan Technological University research indicates that biofuels could reduce the GHG intensity of jet fuel by more than 80% (http://www.greenaironline.com/news.php?viewStory=432).

[21] This could increase truck volumes because of the speed incompatibility between freight trains and passenger trains (see: Wendell Cox, Alan Pisarski, David Ellis [Texas Transportation Institute] and Tim Lomax [Texas Transportation Institute], *The Importance of Freight Mobility and Reliability to Economic Growth*, 2009).

[22] Despite decades' long opposition to suburban development by many in the planning community, suburban areas have accounted for nearly all of the metropolitan population increase in the United States, Western Europe and Japan for as many decades. See: http://demographia.com/db-highmetro.htm.

[23] http://www.boston.com/news/politics/politicalintelligence/2009/05/lahood_defends.html.

[24] A more radical bill would require a 16% reduction in driving over 20 years, introduced by Representatives Rush Holt (Indiana), Russ Carnahan (Missouri) Jay Inslee (Washington.).

[25] Assumes the national average household size.

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[26] *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use and CO_2 Emissions*, a National Research Council report requested by the United States Congress, http://www.nap.edu/catalog/12747.html.

[27] These figures are slightly different from those most reported in the media, which compared the 2050 business as usual baseline to the 2050 scenarios.

[28] Assumes 3.8 houses per acre and the national average household size.

[29] Despite popular impressions to the contrary, Los Angeles is the most dense major urban (urbanized) area in the country, with a population density of over 7,000 persons per square mile (2000 census). An urban or urbanized area is the "footprint" of urbanization, or the agglomeration, as defined by the U.S. Bureau of the Census. By comparison, the New York urbanized area has a density of 5,300 per square mile. Los Angeles (also San Francisco and San Jose) are more dense than New York because their suburbs are substantially more dense than the far-flung suburbs of New York in both New York State and New Jersey (See: http://demographia.com/db-ua2000pop.htm).

[30] *Driving and the Built Environment,* p. 116.

[31] Ibid.

[32] *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*, 2009, http://movingcooler.info/

[33] Such as the Urban Land Institute and the Environmental Defense Fund.

[34] *Moving Cooler,* p. 5.

[35] *Moving Cooler* recommended other policies as well, such as encouraging more environmentally-friendly driving behavior. *Moving Cooler* indicates that this would reduce GHGs *more* than compact development. *Moving Cooler* proposes that people pay for parking in front of their houses and indicates that smaller houses might be required. Overall, the *Moving Cooler* strategies, (compact development and other policy proposals) would reduce GHGs in 2050 between 18% and 24% from 2005.

[36] Calculated from the data in *Moving Cooler*. The experience suggests that transit costs would be even higher. *Moving Cooler* assumes that the expenditures per passenger mile will remain constant as transit expands. The reality is that transit expenditures per passenger mile have risen strongly relative to inflation. In the 25 years since of highway user fees were first dedicated to transit, expenditures per passenger mile have increased by 46% *after inflation* and *after accounting for increased ridership* (See: http://www.publicpurpose.com/ut-tr8297x.pdf).

[37] Compact development advocates generally tend to favor implementation of intercity high-speed rail systems. The data in *Moving Cooler* indicate that high speed rail would require expenditures of more than $7,000 per ton of GHG emissions removed in 2050, a figure well above the IPCC maximum expenditure level of $50. Further, the Reason Foundation report on the California High Speed Rail Project estimated that the cost per greenhouse gas ton removed would be as much as $10,000, far higher than the *Moving Cooler* intercity rail projection (http://reason.org/files/1b544eba6f1d5f9e8012a8c36676ea7e.pdf).

[38] Based upon GHG emissions reductions projections for transit and land use strategies.

[39] *Moving Cooler* includes commercial vehicle emissions (such as from trucks). This calculation is based upon 2005 auto GHGs only.

[40] A national association representing state departments of transportation.

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[41] AASHTO Statement on *Moving Cooler* Report, and C. Kenneth Orski, "A Tenditious Report has Transportation Community Up in Arms," *Innovation Briefs*, August 18, 2009.

[42] http://www.epa.gov/ocir/hearings/testimony/111_2009_2010/2009_0616_lpj.pdf.

[43] Estimated from data in *Driving and the Built Environment*.

[44] Estimated from National Transit Database data compiled by Randal O'Toole (http://ti.org/NTD08sum.xls).

[45] The percentage decline in GHGs from compact development is the same in the "Present Fuel Economy Standards" and "Hybrid MPG by 2040: Trend" scenarios. The actual reduction in tons is lower (as indicated in the figure), because it is calculated on a smaller total GHG emission base.

[46] The ICLEI-Local Governments for Sustainability Density-VMT Calculator" yields a 61% increase in traffic volumes for each doubling of density (http://www.icleiusa.org/library/documents/8-Density-VMT%20Calculator%20(2).xls). This is based upon research by the Sierra Club, long a proponent of compact development.

[47] http://www.arb.ca.gov/msei/onroad/downloads/pubs/co2final.pdf.

[48] Martin Treiber, Arne Kesting and Christian Thiemann, *How Much Does Traffic Congestion Increase Fuel Consumption and Emissions? Applying a Fuel Consumption Model to the NGSIM Trajectory Data*, paper presented to the Annual Meeting of the Transportation Research Board, 2008.

[49] Calculation (-0.12% divided by-. 62%).

[50] http://www.arb.ca.gov/cc/sb375/rtac/meetings/070709/commentaddendum.pdf.

[51] Transit work trips take 80% longer than work trips in single-occupant autos. Calculated from the American Community Survey, 2006 (United States Bureau of the Census).

[52] This figure is based upon the *Moving Cooler* high densification scenario. The developable area under the *Driving and the Built Environment* high densification scenario would be smaller.

[53] In theory, urban growth boundaries are often promoted as providing sufficient vacant land to accommodate new development for a period, such as 20 years. The reality is that planning authorities (such as in Portland) have tended to draw such boundaries with little vacant land beyond the urban footprint. Moreover, even a genuine 20-year supply (for example) can increase land prices because landowners within the urban growth boundary are able to command higher prices from sellers, while landowners outside experience a substantial reduction in their property values because it cannot be developed. The three-mile area beyond the urban footprint is shown as an example to illustrate the likely development area in an urban area without compact development policies.

[54] This is illustrated in the United Kingdom, where compact city policies have been in effect for more than 60 years. Dr. Timothy Leunig of the London School of Economics has reported that agricultural land on which housing is not permitted can escalate in value 500 times when rezoned to allow housing: "Turning NIMBYs into IMBYs," *The Guardian,* September 2, 2004. http://society.guardian.co.uk/housingdemand/0,14488,1192601,00.html.

[55] http://demographia.com/db-dhi-econ.pdf.

[56] http://www.nytimes.com/2005/08/08/opinion/08krugman.html and http://select.nytimes.com/2006/01/02/opinion/02krugman.html

[57] http://real.wharton.upenn.edu/~gyourko/Working%20Papers/working%20papers%202005/AER%20Proceedings-NBER%20version-122804.pdf

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[58] William Fischel, *Regulatory Takings, Law, Economics and Politics* (Cambridge, MA: Harvard University Press, 1995), pp. 218-252.

[59] Donald Brash, Introduction to the *4th Annual Demographia International Housing Affordability Survey*, http://www.demographia.com/dhi.pdf.

[60] Kate Barker, *Review of Housing Supply: Delivering Stability: Securing Our Future Housing Needs: Final Report—Recommendations* (Norwich, England: Her Majesty's Stationery Office, 2004 and 2006). www.hmtreasury.gov.uk/consultations_and_legislation/barker/consult_barker_index.cfm, and *Barker Review of Land Use Planning,* http://www.hm-treasury.gov.uk/media/4EB/AF/barker_finalreport051206.pdf.

[61] Arthur C. Grimes, *Housing Supply in the Auckland Region,* Center for Housing Research Oater New Zealand (2007). http://www.hnzc.co.nz/chr/pdfs/housing-supply-in-the-auckland-region-2000-2005.pdf.

[62] http://depts.washington.edu/teclass/landuse/housing_020408.pdf.

[63] http://www.dallasfed.org/research/houston/2008/hb0801.pdf.

[64] Raven E. Saks, *Job Creation and Housing Construction: Constraints on Metropolitan Area Employment Growth,* http://www.federalreserve.gov/pubs/feds/2005/200549/200549pap.pdf.

[65] Waldo Lopez-Aqueres, Joelle Skaga and Tadeusz Kugler, *Housing California's Latino Population in the 21st Century: The Challenge Ahead* (Los Angeles, CA: The Tomas Rivera Policy Institute, 2002) (http://www.trpi.org/PDFs/housing_ca_latinos.pdf). "Growth controls" are compact development policies.

[66] *Driving and the Built Environment,* p. 115.

[67] Robert W. Burchell, George Lowenstein, William R. Dolphin, Catherine C. Galley, Anthony Downs, Samuel Seskin and Terry Moore, *Costs of Sprawl—2000,* (Washington, DC: Transportation Research Board, 2002, Table 15-4).

[68] Calculated from U.S. Bureau of the Census data.

[69] Calculated from U.S. Bureau of the Census and Harvard University Joint Center on Housing data.

[70] http://demographia.com/dhi.pdf, Figure 4 and data from the United States Census.

[71] Calculated from Harvard University Joint Center on Housing median house price divided by median household income data. This is despite generally *higher* housing demand in the less restrictively regulated metropolitan areas, which attracted 900,000 new residents (domestic migrants) from elsewhere during 2000–2008, compared to a loss of 1,800,000 domestic migrants in the more restrictively regulated markets (See: http://demographia.com/db-2008mighaffcat.pdf).

[72] http://www.heritage.org/Research/Economy/wm1906.cfm.

[73] See, for example, http://morris.marginalq.com/DLM_fullpaper.pdf.

[74] Fischel, pp. 234–236.

[75] Ibid, pp. 218–252.

[76] *Moving Cooler* dismisses the potential for house price increases, saying "While there are potential concerns with the effects on property values, these may be offset by decreased transportation costs." In fact, transportation costs are often higher in compact development metropolitan areas. Moreover, the higher housing costs in compact development metropolitan

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areas are far larger than could conceivably be negated by higher transportation costs. For example, according to the ACCRA cost of living index from the first quarter of 2008, housing costs in the three largest metropolitan areas without compact development (Dallas-Fort Worth, Houston and Atlanta) were approximately three times those of Los Angeles, San Francisco and San Diego, all with compact development regulations. Average transportation costs were also higher in the California metropolitan areas. Estimated from ACCRA data (http://www.coli.org/).

[77] http://www.cbo.gov/ftpdocs/105xx/doc10573/09-17-Greenhouse-Gas.pdf.

[78] This compares to the 9.0% average annual rate in from 1971 to September of 2009 (http://www.freddiemac.com/pmms/pmms_archives.html).

[79] Burchell, et al., *Costs of Sprawl*—2000.

[80] Wendell Cox and Joshua Utt, *The Costs of Sprawl Reconsidered: What Does the Actual Data Show?* (Washington, DC: Heritage Foundation, 2004) (http://www.heritage.org/Research/SmartGrowth/bg1770.cfm.

[81] NIMBY is an abbreviation for “Not in My Back Yard.”

[82] *Kelo v. City of New Haven*. See, for example: http://www.nytimes.com/2006/02/21/national/21domain.html?_r=1&hp&ex=1140584400&en=0cc052e291d00295&ei=5094&partner=homepage.

[83] Research gaps could exacerbate compact development projection errors, such as (1) building material GHGs by housing types, (2) construction energy GHGs by housing type, (3) residential GHGs by housing type, including common energy, and (4) traffic congestion impacts on GHGs. It will be particularly important for the Environmental Protection Agency to develop genuine and credible models to predict the impact of traffic congestion on GHG reduction for use by state and metropolitan planners. Current legislative proposals would require planners to rely on EPA models.

[84] http://www.amazon.com/exec/obidos/ASIN/0521009464/qid%3D1028792510/sr%3D1-3/ref%3Dsr_1_3/102-6346546-5055320.

[85] http://onlinepubs.trb.org/Onlinepubs/sr/sr298brownstone.pdf, p. 2.

[86] *Driving and the Built Environment,* pp. 35-46.

[87] *Emissions Benefits of Land Use Strategies,* http://www.fhwa.dot.gov/environment/conformity/benefits/, Appendix D, page 5.

[88] Brownstone, p.7.

[89] Ibid, p.1.

[90] See: Box 2: Residential Greenhouse Gas Emissions.

[91] http://www.propertyoz.com.au/library/RDC_ACF_Greenhouse-Report.pdf

[92] http://www.informaworld.com/smpp/content~content=a916934688~db=all~jumptype=rss

[93] http://www.eia.doe.gov/emeu/recs/,

[94] Based on email communication to the author from Eileen O’Brien, RECS Survey Manager, Energy Information Administration, United States Department of Energy (September 19, 2007).

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[95] Paul Myors, Rachel O'Leary, and Rob Helstroom, Energy Australia. &. Rachel O'Leary and Rob Helstroom, *Multi Unit Residential Buildings Energy & Peak Demand Study*, https://www.basix.nsw.gov.au/information/common/pdf/alts_adds_req/energy_mu_study.pdf.

[96] Calculated from data in http://www.ecn.nl/docs/library/report/1997/c97065.pdf&ei=UHGuSvOuH5auNej2sLcM&sig2=OOaon-GtD8vSLFXyHa3How&ct=b

[97] http://www.japancorp.net/Article.Asp?Art_ID=18691

[98] http://www.zerocarbonhouse.com/Contactus.aspx

[99] http://www.greenspur.net/projects/projects_mcleanva.htm

[100] For example, see Alan Pisarski's evaluation at http://www.newgeography.com/content/00932-uli-moving-cooler-report-greenhouse-gases-exaggerations-and-misdirections and other criticisms, summarized at http://www.newgeography.com/content/00984-taking-fun-out-fighting-global-warming.

[101] This is the range of the lowest densification scenarios and the middle densification scenario in *Moving Cooler* and the midpoint between the lowest densification and highest densification scenarios in *Driving and the Built Environment*.

[102] *Driving and the Built Environment*, p 15.

[103] This includes GHGs produced in fuel extraction (such as drilling for oil), fuel production and transport. For petroleum, it is assumed that upstream GHGs add 28% to the emissions from conventional vehicle operations and 30% for hybrid vehicles, based upon the Argonne National Laboratories "GREET" model. See: http://www.transportation.anl.gov/modeling_simulation/GREET/ and http://www.transportation.anl.gov/modeling_simulation/GREET/pdfs/esd_39v2.pdf. For plug-in electric vehicles, life cycle GHGs would include electric power generation and transmission losses (which were not included in recent claims of more than 200 miles per gallon for future cars by some automobile manufacturers). See: http://www.newgeography.com/content/00977-vetting-volt-toward-meaningful-electric-car-fuel-consumption-ratings).

[104] All 2030 and 2050 GHG emission changes are in relation to a 2005 base, unless otherwise noted.

[105] http://www.brookings.edu/~/media/Files/rc/reports/2008/1216_transportation_tomer_puentes/vehicle_miles_traveled_report.pdf.

[106] http://www.cutr.usf.edu/pdf/The%20Case%20for%20Moderate%20Growth%20in%20VMT-%202006%20Final.pdf.

[107] The "lower rate" refers to a lower driving rate scenario in http://bottomline.transportation.org/FullBottomLineReport.pdf.

[108] http://www.epa.gov/otaq/climate/regulations/420d09003.pdf, Table 6-18.

[109] All projections in this section use a 35.5 mile per gallon baseline, which assumes that driving increases at the rate projected by the United States Department of Energy, Energy Information Administration (EIA) *Annual Energy Outlook: 2011*.

[110] See: http://reason.org/files/853263d6e320c39bfcedde642d1e16fe.pdf and http://www.itif.org/files/Telecommuting.pdf.

[111] Ibid.

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[112] Calculated from data in 2007 American Community Survey, shown in http://www.publicpurpose.com/ut-commute2007.pdf.

[113] http://www.cert.ucr.edu/research/pubs/TRB-08-2860-revised.pdf.

[114] 2010 Toyota Prius.

[115] Projections extended from 2040 to 2050.

[116] http://www.consumerreports.org/cro/cars/new-cars/news/2008/10/affordable hybrids/overview/affordable-hybrids-ov.htm and http://www.reuters.com/article/ousiv/idUSTKX00276320070510

[117] http://www.nextgreencar.com/view-car/26041/VW-Polo-Diesel-Manual-5-speed

[118] http://web.mit.edu/sloan-auto-lab/research/beforeh2/files/kromer%20msc%20thesis%202007.pdf.

[119] http://www.sciencedaily.com/releases/2009/10/091012135506.htm.

[120] http://www.nap.edu/catalog.php?record_id=12222. Report requested by the United States Congress in the Energy Policy Act of 2005.

[121] Reduction from 2005. Calculated from data in Tables 6.3 and 6.9. http://www.nap.edu/catalog.php?record_id=12222.

[122] http://www.volkswagen.de/vwcms_publish/vwcms/master_public/virtualmaster/de3/unternehmen/mobilitaet_und_nachhaltigkeit/technik___innovation/Forschung/1_Liter_Auto.html.

[123] President Obama also believes that substantial fuel economy improvements are possible, having proposed producing one million 150 mile per gallon cars by 2015. http://www.barackobama.com/pdf/factsheet_energy_speech_080308.pdf

[124] *Driving and the Built Environment,* p. 105.

[125] Not adjusted for the "GHG Traffic Congestion Penalty."

[126] Based upon the projected increase in fuel economy in 2030 compared to pre-2008/2009 fuel economy standards for 2030 (a 10 mile per gallon increase from 2010 to 2030).

[127] http://reason.org/news/show/surface-transportation-innovat-70.

[128] Research indicates that lower costs "induce" additional driving (in VMT, though not necessarily in overall travel times). The Environmental Protection Agency assumes that this effect (which EPA calls the "rebound" effect) would be 10% and that the effect is declining over time. If the EPA rebound effect is applied to the technology estimates, the reduction from present fuel economy technologies would be between 27% and 66% in 2050 (compared to 33% and 69%). http://www.epa.gov/otaq/climate/regulations/420d09903.pdf and http://www.epa.gov/otaq/climate/regulations/420d09901.pdf.

[129] http://online.wsj.com/article/SB20001424052748704007804574573771532217650.html?mod=djemITP

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National Congestion Tables

Table 1. What Congestion Means to You, 2010

Urban Area	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
	Hours	Rank	Value	Rank	Gallons	Rank	Dollars	Rank
Very Large Average (15 areas)	**52**		**1.27**		**25**		**1,083**	
Washington DC-VA-MD	74	1	1.33	2	37	1	1,495	2
Chicago IL-IN	71	2	1.24	13	36	2	1,568	1
Los Angeles-Long Beach-Santa Ana CA	64	3	1.38	1	34	3	1,334	3
Houston TX	57	4	1.27	6	28	4	1,171	4
New York-Newark NY-NJ-CT	54	5	1.28	3	22	7	1,126	5
San Francisco-Oakland CA	50	7	1.28	3	22	7	1,019	7
Boston MA-NH-RI	47	9	1.21	20	21	11	980	9
Dallas-Fort Worth-Arlington TX	45	10	1.23	16	22	7	924	11
Seattle WA	44	12	1.27	6	23	6	942	10
Atlanta GA	43	13	1.23	16	20	12	924	11
Philadelphia PA-NJ-DE-MD	42	14	1.21	20	17	18	864	14
Miami FL	38	15	1.23	16	18	16	785	19
San Diego CA	38	15	1.19	23	20	12	794	17
Phoenix AZ	35	23	1.21	20	20	12	821	16
Detroit MI	33	27	1.16	37	17	18	687	26

Very Large Urban Areas—over 3 million population.

Large Urban Areas—over 1 million and less than 3 million population.

Medium Urban Areas—over 500,000 and less than 1 million population.

Small Urban Areas—less than 500,000 population.

Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.

Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.

Excess Fuel Consumed—Increased fuel consumption due to travel in congested conditions rather than free-flow conditions.

Congestion Cost—Value of travel time delay (estimated at $8 per hour of person travel and $88 per hour of truck time) and excess fuel consumption (estimated using state average cost per gallon for gasoline and diesel).

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 1. What Congestion Means to You, 2010, Continued

Urban Area	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
	Hours	Rank	Value	Rank	Gallons	Rank	Dollars	Rank
Large Average (32 areas)	**31**		**1.17**		**11**		**642**	
Baltimore MD	52	6	1.19	23	22	7	1,102	6
Denver-Aurora CO	49	8	1.24	13	24	5	993	8
Minneapolis-St. Paul MN	45	10	1.23	16	20	12	916	13
Austin TX	38	15	1.28	3	10	27	743	23
Orlando FL	38	15	1.18	26	12	23	791	18
Portland OR-WA	37	19	1.25	9	10	27	744	22
San Jose CA	37	19	1.25	9	13	22	721	25
Nashville-Davidson TN	35	23	1.18	26	10	27	722	24
New Orleans LA	35	23	1.17	34	11	26	746	20
Virginia Beach VA	34	26	1.18	26	9	31	654	30
San Juan PR	33	27	1.25	9	12	23	665	29
Tampa-St. Petersburg FL	33	27	1.16	37	18	16	670	28
Pittsburgh PA	31	31	1.18	26	8	36	641	32
Riverside-San Bernardino CA	31	31	1.18	26	17	18	684	27
San Antonio TX	30	34	1.18	26	9	31	591	35
St. Louis MO-IL	30	34	1.10	56	14	21	642	31
Las Vegas NV	28	36	1.24	13	7	41	532	42
Milwaukee WI	27	38	1.18	26	7	41	541	38
Salt Lake City UT	27	38	1.11	51	7	41	512	45
Charlotte NC-SC	25	42	1.17	34	8	36	539	39
Jacksonville FL	25	42	1.09	68	7	41	496	50
Raleigh-Durham NC	25	42	1.14	43	9	31	537	40
Sacramento CA	25	42	1.19	23	8	36	507	46
Indianapolis IN	24	49	1.17	34	6	49	506	47
Kansas City MO-KS	23	52	1.11	51	7	41	464	55
Louisville KY-IN	23	52	1.10	56	6	49	477	52
Memphis TN-MS-AR	23	52	1.12	48	7	41	477	52
Cincinnati OH-KY-IN	21	60	1.13	45	6	49	427	60
Cleveland OH	20	64	1.10	56	5	58	383	65
Providence RI-MA	19	67	1.12	48	7	41	365	71
Columbus OH	18	72	1.11	51	5	58	344	79
Buffalo NY	17	77	1.10	56	5	58	358	73

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.
Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.
Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.
Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.
Excess Fuel Consumed—Increased fuel consumption due to travel in congested conditions rather than free-flow conditions.
Congestion Cost—Value of travel time delay (estimated at $16 per hour of person travel and $88 per hour of truck time) and excess fuel consumption (estimated using state average cost per gallon for gasoline and diesel).
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 1. What Congestion Means to You, 2010, Continued

Urban Area	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
	Hours	Rank	Value	Rank	Gallons	Rank	Dollars	Rank
Medium Average (33 areas)	**21**		**1.11**		**5**		**426**	
Baton Rouge LA	36	21	1.25	9	9	31	832	15
Bridgeport-Stamford CT-NY	36	21	1.27	6	12	23	745	21
Honolulu HI	33	27	1.18	26	6	49	620	33
Colorado Springs CO	31	31	1.13	45	9	31	602	34
New Haven CT	28	36	1.13	45	7	41	559	36
Birmingham AL	27	38	1.15	41	10	27	556	37
Hartford CT	26	41	1.15	41	6	49	501	49
Albuquerque NM	25	42	1.10	56	4	66	525	44
Charleston-North Charleston SC	25	42	1.16	37	8	36	529	43
Oklahoma City OK	24	49	1.10	56	4	66	476	54
Tucson AZ	23	52	1.11	51	5	58	506	47
Allentown-Bethlehem PA-NJ	22	57	1.07	79	4	66	432	59
El Paso TX-NM	21	60	1.16	37	4	66	427	60
Knoxville TN	21	60	1.06	85	5	58	423	62
Omaha NE-IA	21	60	1.09	68	4	66	389	64
Richmond VA	20	64	1.06	85	5	58	375	68
Wichita KS	20	64	1.07	79	4	66	379	67
Grand Rapids MI	19	67	1.05	94	4	66	372	69
Oxnard-Ventura CA	19	67	1.12	48	6	49	383	65
Springfield MA-CT	18	72	1.08	73	4	66	355	75
Tulsa OK	18	72	1.08	73	4	66	368	70
Albany-Schenectady NY	17	77	1.08	73	6	49	359	72
Lancaster-Palmdale CA	16	79	1.10	56	3	81	312	84
Sarasota-Bradenton FL	16	79	1.09	68	4	66	318	82
Akron OH	15	83	1.05	94	3	81	288	85
Dayton OH	14	87	1.06	85	3	81	277	88
Indio-Cathedral City-Palm Springs CA	14	87	1.11	51	2	89	279	87
Fresno CA	13	91	1.07	79	3	81	260	92
Rochester NY	13	91	1.05	94	2	89	241	94
Toledo OH-MI	12	93	1.05	94	3	81	237	95
Bakersfield CA	10	96	1.07	79	2	89	232	96
Poughkeepsie-Newburgh NY	10	96	1.04	99	2	89	205	97
McAllen TX	7	101	1.10	56	1	100	125	101

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Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 1. What Congestion Means to You, 2010, Continued

Urban Area	Yearly Delay per Auto Commuter		Travel Time Index		Excess Fuel per Auto Commuter		Congestion Cost per Auto Commuter	
	Hours	Rank	Value	Rank	Gallons	Rank	Dollars	Rank
Small Average (21 areas)	**18**		**1.08**		**4**		**363**	
Columbia SC	25	42	1.09	68	8	36	533	41
Little Rock AR	24	49	1.10	56	6	49	490	51
Cape Coral FL	23	52	1.10	56	4	66	464	55
Beaumont TX	22	57	1.08	73	4	66	445	58
Salem OR	22	57	1.09	68	5	58	451	57
Boise ID	19	67	1.10	56	3	81	345	78
Jackson MS	19	67	1.06	85	4	66	418	63
Pensacola FL-AL	18	72	1.08	73	3	81	350	77
Worcester MA	18	72	1.06	85	6	49	354	76
Greensboro NC	16	79	1.06	85	4	66	358	73
Spokane WA	16	79	1.10	56	4	66	329	80
Boulder CO	15	83	1.14	43	5	58	288	85
Brownsville TX	15	83	1.04	99	2	89	321	81
Winston-Salem NC	15	83	1.06	85	3	81	314	83
Anchorage AK	14	87	1.05	94	2	89	272	90
Provo UT	14	87	1.08	73	2	89	274	89
Laredo TX	12	93	1.07	79	2	89	264	91
Madison WI	12	93	1.06	85	2	89	246	93
Corpus Christi TX	10	96	1.07	79	2	89	194	98
Stockton CA	9	99	1.02	101	1	100	184	99
Eugene OR	8	100	1.06	85	2	89	171	100
101 Area Average	**40**		**1.21**		**17**		**829**	
Remaining Areas	**16**		**1.12**		**3**		**327**	
All 439 Urban Areas	**34**		**1.20**		**14**		**713**	

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Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 2. What Congestion Means to Your Town, 2010

Urban Area	Travel Delay (1000 Hours)	Rank	Excess Fuel Consumed (1000 Gallons)	Rank	Truck Congestion Cost ($ million)	Rank	Total Congestion Cost ($ million)	Rank
Very Large Average (15 areas)	**187,872**		**90,718**		**895**		**3,981**	
Los Angeles-Long Beach-Santa Ana CA	521,449	1	278,318	1	2,254	2	10,999	1
New York-Newark NY-NJ-CT	465,564	2	190,452	2	2,218	3	9,794	2
Chicago IL-IN	367,122	3	183,738	3	2,317	1	8,206	3
Washington DC-VA-MD	188,650	4	95,365	4	683	5	3,849	4
Dallas-Fort Worth-Arlington TX	163,585	5	80,587	5	666	6	3,365	5
Houston TX	153,391	6	76,531	6	688	4	3,203	6
Miami FL	139,764	7	66,104	7	604	9	2,906	7
Philadelphia PA-NJ-DE-MD	134,899	8	55,500	8	659	7	2,842	8
Atlanta GA	115,958	11	53,021	10	623	8	2,489	9
San Francisco-Oakland CA	120,149	9	53,801	9	484	11	2,479	10
Boston MA-NH-RI	117,234	10	51,806	11	459	13	2,393	11
Phoenix AZ	81,829	15	47,180	12	467	12	1,913	12
Seattle WA	87,919	12	46,373	13	603	10	1,905	13
Detroit MI	87,572	13	43,941	14	382	15	1,828	15
San Diego CA	72,995	18	38,052	16	321	16	1,541	18

Very Large Urban Areas—over 3 million population.
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Travel Delay—Value of extra travel time during the year (estimated at $16 per hour of person travel).
Excess Fuel Consumed—Value of increased fuel consumption due to travel in congested conditions rather than free-flow conditions (estimated using state average cost per gallon).
Truck Congestion Cost—Value of increased travel time and other operating costs of large trucks (estimated at $88 per hour of truck time) and the extra diesel consumed (estimated using state average cost per gallon).
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Table 2. What Congestion Means to Your Town, 2010, Continued

Urban Area	Travel Delay (1000 Hours)	Rank	Excess Fuel Consumed (1000 Gallons)	Rank	Truck Congestion Cost ($ million)	Rank	Total Congestion Cost ($ million)	Rank
Large Average (32 areas)	**33,407**		**11,968**		**148**		**688**	
Baltimore MD	87,199	14	36,303	17	449	14	1,853	14
Denver-Aurora CO	80,837	16	40,151	15	319	17	1,659	16
Minneapolis-St. Paul MN	78,483	17	34,689	18	300	18	1,595	17
Tampa-St. Petersburg FL	53,047	19	28,488	19	210	21	1,097	19
St. Louis MO-IL	47,042	21	23,190	20	283	19	1,034	20
San Juan PR	50,229	20	17,731	22	174	25	1,012	21
Riverside-San Bernardino CA	40,875	25	22,387	21	229	20	902	22
Pittsburgh PA	41,081	24	10,951	25	200	23	850	23
Portland OR-WA	41,743	23	10,931	26	185	24	850	23
San Jose CA	42,846	22	14,664	23	133	28	842	25
Orlando FL	38,260	26	11,883	24	207	22	811	26
Virginia Beach VA	36,538	27	9,301	28	98	40	693	27
Austin TX	31,038	28	8,425	30	119	32	617	28
Sacramento CA	29,602	30	9,374	27	123	30	603	29
San Antonio TX	30,207	29	8,883	29	105	37	593	30
Nashville-Davidson TN	26,475	33	6,971	34	142	26	556	31
Milwaukee WI	26,699	32	7,086	33	127	29	549	32
Las Vegas NV	27,386	31	7,428	31	83	45	530	33
Kansas City MO-KS	24,185	34	7,147	32	119	32	501	34
Cincinnati OH-KY-IN	23,297	35	5,889	38	120	31	486	35
New Orleans LA	20,565	39	6,218	37	135	27	453	36
Indianapolis IN	20,800	38	5,253	43	119	32	443	37
Raleigh-Durham NC	19,247	40	6,586	36	75	46	418	39
Cleveland OH	21,380	36	5,530	40	115	35	417	40
Charlotte NC-SC	17,730	43	5,228	44	101	39	378	41
Jacksonville FL	18,005	42	5,461	41	84	44	371	42
Memphis TN-MS-AR	17,197	44	5,038	45	87	42	358	43
Louisville KY-IN	17,033	45	4,574	47	61	50	357	44
Salt Lake City UT	18,366	41	4,713	46	85	43	353	45
Providence RI-MA	15,539	48	5,335	42	45	59	302	49
Columbus OH	14,651	51	3,904	48	53	51	289	51
Buffalo NY	11,450	56	3,257	52	51	54	234	56

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Table 2. What Congestion Means to Your Town, 2010, Continued

Urban Area	Travel Delay		Excess Fuel Consumed		Truck Congestion Cost		Total Congestion Cost	
	(1000 Hours)	Rank	(1000 Gallons)	Rank	($ million)	Rank	($ million)	Rank
Medium Average (33 areas)	**9,513**		**2,216**		**42**		**193**	
Bridgeport-Stamford CT-NY	21,233	37	6,857	35	102	38	441	38
Baton Rouge LA	14,577	52	3,295	51	66	49	331	46
Oklahoma City OK	16,848	46	2,847	57	110	36	329	47
Birmingham AL	15,832	47	5,639	39	71	47	326	48
Hartford CT	15,072	49	3,462	50	52	52	295	50
Honolulu HI	15,035	50	2,774	58	42	61	287	52
Tucson AZ	11,412	57	2,342	61	39	64	262	53
Richmond VA	13,800	53	3,105	53	92	41	262	53
New Haven CT	11,643	55	3,032	54	49	56	235	55
Albuquerque NM	10,477	58	1,724	69	37	66	231	57
Colorado Springs CO	11,897	54	3,552	49	69	48	228	58
El Paso TX-NM	10,452	59	1,971	64	52	52	214	59
Allentown-Bethlehem PA-NJ	9,777	60	1,777	66	43	60	197	60
Charleston-North Charleston SC	9,160	62	2,852	56	51	54	195	61
Oxnard-Ventura CA	9,009	64	2,869	55	39	64	184	62
Tulsa OK	9,086	63	1,861	65	42	61	183	63
Omaha NE-IA	9,299	61	1,737	68	23	78	173	65
Sarasota-Bradenton FL	8,015	67	2,240	62	32	69	161	66
Springfield MA-CT	8,305	66	1,975	63	27	76	161	66
Albany-Schenectady NY	7,467	71	2,384	60	32	69	156	69
Grand Rapids MI	7,861	68	1,595	72	35	67	155	70
Knoxville TN	7,518	70	1,622	70	32	69	151	71
Dayton OH	7,096	73	1,470	73	28	74	140	73
Lancaster-Palmdale CA	6,906	74	1,069	80	22	80	132	74
Wichita KS	6,858	75	1,460	74	21	81	131	75
Fresno CA	5,999	78	1,200	77	21	81	124	77
Rochester NY	6,377	76	1,229	76	29	73	123	78
Akron OH	6,198	77	1,042	81	21	81	120	79
Indio-Cathedral City-Palm Springs CA	5,633	80	983	82	28	74	116	80
Bakersfield CA	4,005	90	925	84	31	72	91	84
Poughkeepsie-Newburgh NY	4,271	85	809	88	20	85	87	87
Toledo OH-MI	4,223	86	951	83	18	88	85	88
McAllen TX	2,598	96	475	96	9	99	50	96

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Table 2. What Congestion Means to Your Town, 2010, Continued

Urban Area	Travel Delay		Excess Fuel Consumed		Truck Congestion Cost		Total Congestion Cost	
	(1000 Hours)	Rank	(1000 Gallons)	Rank	($ million)	Rank	($ million)	Rank
Small Average (21 areas)	**4,166**		**881**		**21**		**86**	
Columbia SC	8,515	65	2,723	59	47	57	181	64
Cape Coral FL	7,600	69	1,366	75	41	63	158	68
Little Rock AR	7,345	72	1,615	71	33	68	149	72
Jackson MS	5,488	81	1,124	78	47	57	128	76
Worcester MA	5,639	79	1,777	66	19	86	111	81
Provo UT	5,056	82	695	90	18	88	97	82
Pensacola FL-AL	4,699	83	888	86	19	86	93	83
Greensboro NC	4,104	87	1,110	79	26	77	90	85
Spokane WA	4,306	84	923	85	23	78	90	85
Winston-Salem NC	4,054	89	837	87	21	81	84	89
Salem OR	3,912	91	787	89	18	88	80	90
Beaumont TX	3,814	92	615	91	17	92	77	91
Boise ID	4,063	88	578	92	10	98	75	92
Madison WI	3,375	93	533	94	18	88	70	93
Anchorage AK	3,013	94	512	95	13	96	61	94
Stockton CA	2,648	95	394	98	15	93	55	95
Brownsville TX	2,323	98	326	100	15	93	50	96
Corpus Christi TX	2,432	97	469	97	13	96	50	96
Laredo TX	2,041	99	378	99	15	93	46	99
Boulder CO	1,612	100	541	93	3	101	30	100
Eugene OR	1,456	101	315	101	7	100	30	100
101 Area Total	**4,288,547**		**1,835,371**		**19,989**		**89,881**	
101 Area Average	**42,461**		**18,172**		**198**		**890**	
Remaining Area Total	**534,712**		**107,964**		**2,846**		**11,011**	
Remaining Area Average	**1,582**		**319**		**8**		**33**	
All 439 Areas Total	**4,823,259**		**1,943,335**		**22,835**		**100,892**	
All 439 Areas Average	**10,987**		**4,427**		**52**		**230**	

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Table 3. Solutions to Congestion Problems, 2010

Urban Area	Operational Treatment Savings				Public Transportation Savings		
	Treatments	Delay (1000 Hours)	Rank	Cost ($ Million)	Delay (1000 Hours)	Rank	Cost ($ Million)
Very Large Average (15 areas)		**15,636**		**$330.0**	**45,381**		**$960.0**
Los Angeles-Long Beach-Santa Ana CA	r,i,s,a,h	63,652	1	1,342.6	33,606	4	708.8
New York-Newark NY-NJ-CT	r,i,s,a,h	46,192	2	971.7	377,069	1	7,932.1
Houston TX	r,i,s,a,h	15,896	3	332.0	7,082	12	147.9
Chicago IL-IN	r,i,s,a	15,821	4	353.6	91,109	2	2,036.5
Washington DC-VA-MD	r,i,s,a,h	14,922	5	304.5	35,567	3	725.7
San Francisco-Oakland CA	r,i,s,a,h	14,679	6	302.9	28,431	6	586.6
Miami FL	i,s,a,h	12,065	7	250.9	9,276	10	192.9
Dallas-Fort Worth-Arlington TX	r,i,s,a,h	10,334	8	212.6	6,137	15	126.2
Philadelphia PA-NJ-DE-MD	r,i,s,a,h	8,851	9	186.5	26,082	7	549.5
Seattle WA	r,i,s,a,h	7,411	11	161.3	14,377	8	312.8
San Diego CA	r,i,s,a	6,340	12	133.8	6,460	13	136.3
Atlanta GA	r,i,s,a,h	5,603	13	120.3	8,589	11	184.4
Boston MA-NH-RI	i,s,a	4,988	14	101.8	32,477	5	662.9
Phoenix AZ	r,i,s,a,h	4,619	17	107.5	2,519	22	58.6
Detroit MI	r,i,s,a	3,170	22	66.2	1,937	25	40.4

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Operational Treatments—Freeway incident management (i), freeway ramp metering (r), arterial street signal coordination (s), arterial street access management (a) and high-occupancy vehicle lanes (h).

Public Transportation—Regular route service from all public transportation providers in an urban area.

Delay savings are affected by the amount of treatment or service in each area, as well as the amount of congestion and the urban area population.

Congestion Cost Savings—Value of delay, fuel and truck congestion cost.

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Table 3. Solutions to Congestion Problems, 2010, Continued

	Operational Treatment Savings				Public Transportation Savings		
Urban Area	Treatments	Delay (1000 Hours)	Rank	Cost ($ Million)	Delay (1000 Hours)	Rank	Cost ($ Million)
Large Average (32 areas)		**1,934**		**$40.0**	**2,304**		**$47.0**
Minneapolis-St. Paul MN	r,i,s,a,h	7,593	10	154.3	5,360	18	109.0
Denver-Aurora CO	r,i,s,a,h	4,720	15	96.8	6,376	14	130.8
Baltimore MD	i,s,a	4,644	16	98.7	13,924	9	295.8
Tampa-St. Petersburg FL	i,s,a	3,873	18	80.1	1,021	36	21.1
Portland OR-WA	r,i,s,a,h	3,701	19	75.4	5,581	17	113.7
Riverside-San Bernardino CA	r,i,s,a,h	3,636	20	80.2	1,140	35	25.2
San Jose CA	r,i,s,a	3,501	21	68.8	1,896	26	37.2
Virginia Beach VA	i,s,a,h	2,936	23	55.7	1,300	33	24.7
Sacramento CA	r,i,s,a,h	2,750	24	56.0	1,367	30	27.8
Orlando FL	i,s,a	2,254	25	47.8	1,399	29	29.7
Milwaukee WI	r,i,s,a	2,033	26	41.8	1,849	28	38.0
St. Louis MO-IL	i,s,a	1,975	27	43.4	2,805	21	61.7
Austin TX	i,s,a	1,541	28	30.6	1,941	24	38.5
Las Vegas NV	i,s,a	1,526	29	29.5	1,317	32	25.5
Pittsburgh PA	i,s,a	1,482	30	30.7	5,058	19	104.7
New Orleans LA	i,s,a	1,280	31	28.2	1,879	27	41.4
San Juan PR	s,a	1,217	32	24.5	5,798	16	116.8
Kansas City MO-KS	i,s,a	1,145	33	23.7	442	47	9.2
San Antonio TX	i,s,a	1,095	34	21.5	1,366	31	26.8
Jacksonville FL	i,s,a	1,055	35	21.8	398	51	8.2
Nashville-Davidson TN	i,s,a	1,040	36	21.9	509	45	10.7
Charlotte NC-SC	i,s,a	803	39	17.1	665	42	14.2
Raleigh-Durham NC	i,s,a	796	40	17.3	685	41	14.8
Salt Lake City UT	r,i,s,a	759	42	14.8	3,251	20	63.3
Cleveland OH	i,s,a	729	44	14.3	2,098	23	41.1
Cincinnati OH-KY-IN	r,i,s,a	715	45	14.9	1,255	34	26.2
Memphis TN-MS-AR	i,s,a	662	49	13.8	414	49	8.6
Columbus OH	r,i,s,a	472	54	9.3	310	56	6.1
Louisville KY-IN	i,s,a	449	55	9.3	426	48	8.8
Indianapolis IN	i,s,a	447	56	9.5	360	54	7.7
Providence RI-MA	i,s,a	324	62	6.3	747	40	14.5
Buffalo NY	i,s,a	287	65	5.9	804	38	16.4

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Urban Area	Operational Treatment Savings: Treatments	Operational Treatment Savings: Delay (1000 Hours)	Operational Treatment Savings: Rank	Operational Treatment Savings: Cost ($ Million)	Public Transportation Savings: Delay (1000 Hours)	Public Transportation Savings: Rank	Public Transportation Savings: Cost ($ Million)
Medium Average (33 areas)		**363**		**$7.0**	**263**		**$5.0**
Bridgeport-Stamford CT-NY	i,s,a	887	37	18.4	306	57	6.4
Baton Rouge LA	i,s,a	872	38	19.7	140	82	3.2
Honolulu HI	i,s,a	767	41	14.6	463	46	8.8
Birmingham AL	i,s,a	745	43	15.3	198	72	4.1
Albuquerque NM	i,s,a	705	46	15.3	212	67	4.6
Omaha NE-IA	i,s,a	687	47	12.8	152	79	2.8
Tucson AZ	i,s,a	673	48	15.5	362	53	8.3
El Paso TX-NM	i,s,a	659	50	13.5	764	39	15.7
Hartford CT	i,s,a	625	51	12.2	957	37	18.7
Richmond VA	i,s,a	544	52	10.3	571	43	10.8
Sarasota-Bradenton FL	i,s,a	509	53	10.2	116	85	2.3
Fresno CA	r,i,s,a	429	57	8.8	185	74	3.8
Colorado Springs CO	i,s,a	411	59	8.0	389	52	7.6
New Haven CT	i,s,a	384	60	7.8	269	58	5.4
Knoxville TN	i,s,a	318	63	6.4	51	93	1.0
Charleston-North Charleston SC	i,s,a	298	64	6.3	106	87	2.2
Oxnard-Ventura CA	i,s,a	239	66	4.9	156	78	3.2
Allentown-Bethlehem PA-NJ	r,i,s,a	235	67	4.7	254	59	5.1
Wichita KS	i,s,a	231	68	4.4	211	68	4.0
Albany-Schenectady NY	i,s,a	211	70	4.4	323	55	6.7
Indio-Cathedral City-Palm Springs CA	i,s,a	193	73	4.0	157	77	3.2
Oklahoma City OK	i,s,a	184	76	3.6	113	86	2.2
Rochester NY	i,s,a	167	78	3.2	221	64	4.3
Grand Rapids MI	s,a	163	79	3.2	250	61	5.0
Bakersfield CA	i,s,a	157	80	3.6	200	70	4.6
Dayton OH	s,a	157	80	3.1	198	72	3.9
Springfield MA-CT	i,s,a	154	83	3.0	240	62	4.7
Lancaster-Palmdale CA	s,a	147	84	2.8	571	43	10.9
Tulsa OK	i,s,a	58	93	1.2	44	96	0.9
Poughkeepsie-Newburgh NY	s,a	54	94	1.1	173	76	3.5
Toledo OH-MI	i,s,a	48	95	1.0	146	80	2.9
Akron OH	i,s,a	43	96	0.8	143	81	2.8
McAllen TX	s,a	16	101	0.3	25	100	0.5

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Urban Area	Operational Treatment Savings: Treatments	Operational Treatment Savings: Delay (1000 Hours)	Operational Treatment Savings: Rank	Operational Treatment Savings: Cost ($ Million)	Public Transportation Savings: Delay (1000 Hours)	Public Transportation Savings: Rank	Public Transportation Savings: Cost ($ Million)
Small Average (21 areas)		**142**		**$3.0**	**132**		**$3.0**
Little Rock AR	i,s,a	428	58	8.7	21	101	0.4
Cape Coral FL	i,s,a	382	61	8.0	132	83	2.7
Provo UT	i,s,a	225	69	4.3	49	94	0.9
Greensboro NC	i,s,a	205	71	4.5	118	84	2.6
Winston-Salem NC	i,s,a	203	72	4.2	39	97	0.8
Spokane WA	i,s,a	193	73	4.1	406	50	8.5
Jackson MS	s,a	189	75	4.4	53	92	1.2
Worcester MA	s,a	179	77	3.5	54	91	1.1
Columbia SC	i,s,a	155	82	3.3	254	59	5.4
Stockton CA	i,s,a	120	85	2.5	178	75	3.7
Salem OR	s,a	91	86	1.8	203	69	4.2
Beaumont TX	s,a	89	87	1.8	37	99	0.7
Anchorage AK	s,a	84	88	1.7	214	66	4.3
Eugene OR	i,s,a	78	89	1.6	217	65	4.5
Pensacola FL-AL	s,a	74	90	1.5	45	95	0.9
Boise ID	i,s,a	72	91	1.3	39	97	0.7
Madison WI	s,a	71	92	1.5	227	63	4.7
Brownsville TX	s,a	43	96	0.9	199	71	4.3
Laredo TX	i,s,a	40	98	0.9	102	88	2.3
Boulder CO	s,a	36	99	0.7	84	90	1.6
Corpus Christi TX	s,a	23	100	0.5	94	89	1.9
101 Area Total		**309,455**		**6,518.0**	**765,886**		**16,151.0**
101 Area Average		**3,095**		**65.0**	**7,583**		**160.0**
All Urban Areas Total		**327,157**		**6,875.0**	**795,668**		**16,811.0**
All Urban Areas Average		**745**		**15.0**	**1,812**		**39.0**

Very Large Urban Areas—over 3 million population.

Large Urban Areas—over 1 million and less than 3 million population.

Medium Urban Areas—over 500,000 and less than 1 million population.

Small Urban Areas—less than 500,000 population.

Operational Treatments—Freeway incident management (i), freeway ramp metering (r), arterial street signal coordination (s), arterial street access management (a) and high-occupancy vehicle lanes (h).

Public Transportation—Regular route service from all public transportation providers in an urban area.

Delay savings are affected by the amount of treatment or service in each area, as well as the amount of congestion and the urban area population.

Congestion Cost Savings—Value of delay, fuel and truck congestion cost.

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Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 4. Other Congestion Measures, 2010

Urban Area	Total Peak Period Travel Time		Delay per Non-Peak Traveler		Commuter Stress Index	
	Minutes	Rank	Hours	Rank	Value	Rank
Very Large Area (15 areas)	**107**		**13**		**1.38**	
Washington DC-VA-MD	120	4	17	2	1.48	2
Chicago IL-IN	102	26	19	1	1.34	11
Los Angeles-Long Beach-Santa Ana CA	107	18	16	3	1.57	1
Houston TX	106	20	14	6	1.40	4
New York-Newark NY-NJ-CT	116	6	11	13	1.39	5
San Francisco-Oakland CA	105	21	12	9	1.42	3
Boston MA-NH-RI	109	15	11	13	1.31	19
Dallas-Fort Worth-Arlington TX	96	37	14	6	1.34	11
Seattle WA	101	28	10	22	1.39	5
Atlanta GA	127	1	11	13	1.34	11
Philadelphia PA-NJ-DE-MD	105	22	12	9	1.29	22
Miami FL	106	19	12	9	1.32	18
San Diego CA	94	42	10	22	1.29	22
Phoenix AZ	99	32	10	22	1.30	21
Detroit MI	109	16	11	13	1.20	44

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Yearly Delay per Non-Peak Traveler—Extra travel time during midday, evening and weekends divided by the number of private vehicle travelers who do not typically travel in the peak periods.

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Table 4. Other Congestion Measures, 2010, Continued

Urban Area	Total Peak Period Travel Time		Delay per Non-Peak Traveler		Commuter Stress Index	
	Minutes	Rank	Hours	Rank	Value	Rank
Large Area Average (32 areas)	**93**		**9**		**1.25**	
Baltimore MD	83	67	16	3	1.28	26
Denver-Aurora CO	90	52	15	5	1.34	11
Minneapolis-St. Paul MN	100	30	10	22	1.33	17
Austin TX	82	69	8	45	1.38	8
Orlando FL	120	3	13	8	1.23	35
Portland OR-WA	85	62	8	45	1.38	8
San Jose CA	82	70	9	29	1.39	5
Nashville-Davidson TN	114	8	11	13	1.25	31
New Orleans LA	84	65	10	22	1.20	44
Virginia Beach VA	96	38	12	9	1.29	22
San Juan PR	61	91	9	29	1.34	11
Tampa-St. Petersburg FL	104	24	11	13	1.22	36
Pittsburgh PA	80	74	11	13	1.21	40
Riverside-San Bernardino CA	88	58	9	29	1.29	22
San Antonio TX	95	40	8	45	1.27	28
St. Louis MO-IL	109	13	9	29	1.15	62
Las Vegas NV	92	48	10	22	1.34	11
Milwaukee WI	88	59	8	45	1.27	28
Salt Lake City UT	76	79	9	29	1.20	44
Charlotte NC-SC	110	12	7	60	1.26	30
Jacksonville FL	108	17	8	45	1.14	63
Raleigh-Durham NC	115	7	8	45	1.20	44
Sacramento CA	82	68	7	60	1.28	26
Indianapolis IN	112	10	9	29	1.22	36
Kansas City MO-KS	101	29	7	60	1.17	53
Louisville KY-IN	88	56	8	45	1.17	53
Memphis TN-MS-AR	95	39	9	29	1.17	53
Cincinnati OH-KY-IN	93	45	6	74	1.20	44
Cleveland OH	91	49	5	85	1.16	58
Providence RI-MA	85	63	6	74	1.18	49
Columbus OH	86	61	5	85	1.18	49
Buffalo NY	92	46	6	74	1.14	63

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Table 4. Other Congestion Measures, 2010, Continued

Urban Area	Total Peak Period Travel Time		Delay per Non-Peak Traveler		Commuter Stress Index	
	Minutes	Rank	Hours	Rank	Value	Rank
Medium Area Average (33 areas)	**83**		**7**		**1.16**	
Baton Rouge LA	91	51	11	13	1.31	19
Bridgeport-Stamford CT-NY	92	47	8	45	1.35	10
Honolulu HI	73	83	9	29	1.24	32
Colorado Springs CO	81	73	11	13	1.17	53
New Haven CT	79	75	9	29	1.21	40
Birmingham AL	102	25	9	29	1.22	36
Hartford CT	94	41	7	60	1.21	40
Albuquerque NM	82	72	8	45	1.21	40
Charleston-North Charleston SC	88	57	9	29	1.24	32
Oklahoma City OK	117	5	10	22	1.16	58
Tucson AZ	113	9	9	29	1.18	49
Allentown-Bethlehem PA-NJ	79	76	9	29	1.09	83
El Paso TX-NM	69	88	7	60	1.24	32
Knoxville TN	112	11	8	45	1.09	83
Omaha NE-IA	94	43	8	45	1.13	67
Richmond VA	102	27	8	45	1.08	92
Wichita KS	84	64	6	74	1.12	71
Grand Rapids MI	94	44	6	74	1.10	79
Oxnard-Ventura CA	73	82	6	74	1.18	49
Springfield MA-CT	89	53	8	45	1.12	71
Tulsa OK	97	35	7	60	1.11	75
Albany-Schenectady NY	75	80	7	60	1.11	75
Lancaster-Palmdale CA	37	101	6	74	1.14	63
Sarasota-Bradenton FL	73	84	7	60	1.12	71
Akron OH	67	89	5	85	1.07	97
Dayton OH	89	55	5	85	1.09	83
Indio-Cathedral City-Palm Springs CA	54	97	5	85	1.22	36
Fresno CA	77	78	4	95	1.11	75
Rochester NY	82	71	4	95	1.08	92
Toledo OH-MI	87	60	4	95	1.08	92
Bakersfield CA	57	94	4	95	1.09	83
Poughkeepsie-Newburgh NY	72	86	5	85	1.05	100
McAllen TX	60	92	3	100	1.13	67

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Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 4. Other Congestion Measures, 2010, Continued

Urban Area	Total Peak Period Travel Time		Delay per Non-Peak Traveler		Commuter Stress Index	
	Minutes	Rank	Hours	Rank	Value	Rank
Small Area Average (21 areas)	**80**		**7**		**1.11**	
Columbia SC	104	23	9	29	1.12	71
Little Rock AR	109	14	7	60	1.16	58
Cape Coral FL	89	54	9	29	1.13	67
Beaumont TX	96	36	8	45	1.13	67
Salem OR	66	90	9	29	1.11	75
Boise ID	71	87	7	60	1.17	53
Jackson MS	126	2	7	60	1.09	83
Pensacola FL-AL	98	33	8	45	1.10	79
Worcester MA	100	31	7	60	1.10	79
Greensboro NC	98	34	7	60	1.09	83
Spokane WA	91	50	6	74	1.14	63
Boulder CO	52	98	6	74	1.16	58
Brownsville TX	56	96	6	74	1.08	92
Winston-Salem NC	83	66	5	85	1.07	97
Anchorage AK	50	100	6	74	1.07	97
Provo UT	73	81	7	60	1.09	83
Laredo TX	56	95	5	85	1.08	92
Madison WI	73	85	5	85	1.09	83
Corpus Christi TX	78	77	5	85	1.10	79
Stockton CA	52	99	4	95	1.03	101
Eugene OR	59	93	3	100	1.09	83
101 Area Average	**90**		**11**		**1.30**	
Remaining Area Average			**7**		**1.12**	
All 439 Area Average			**10**		**1.30**	

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Table 5. Truck Commodity Value and Truck Delay, 2010

Urban Area	Total Delay		Truck Delay			Truck Commodity Value	
	(1000 Hours)	Rank	(1000 Hours)	Rank	Congestion Cost ($ million)	($ million)	Rank
Very Large Average (15 areas)	**187,872**		**12,120**		**895**	**206,375**	
Chicago IL-IN	367,122	3	31,378	1	2,317	357,816	3
Los Angeles-Long Beach-Santa Ana CA	521,449	1	30,347	2	2,254	406,939	2
New York-Newark NY-NJ-CT	465,564	2	30,185	3	2,218	475,730	1
Houston TX	153,391	6	9,299	4	688	230,769	4
Washington DC-VA-MD	188,650	4	9,204	5	683	95,965	17
Dallas-Fort Worth-Arlington TX	163,585	5	9,037	6	666	227,514	5
Philadelphia PA-NJ-DE-MD	134,899	8	8,970	7	659	172,905	7
Atlanta GA	115,958	11	8,459	8	623	189,488	6
Miami FL	139,764	7	8,207	9	604	153,596	9
Phoenix AZ	81,829	15	8,139	10	603	129,894	12
San Francisco-Oakland CA	120,149	9	6,558	11	484	130,852	11
Seattle WA	87,919	12	6,296	12	467	150,998	10
Boston MA-NH-RI	117,234	10	6,227	13	459	128,143	13
Detroit MI	87,572	13	5,186	15	382	159,328	8
San Diego CA	72,995	18	4,316	17	321	85,686	20

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Travel Delay—Travel time above that needed to complete a trip at free-flow speeds for all vehicles.

Truck Delay—Travel time above that needed to complete a trip at free-flow speeds for large trucks.

Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas

Table 5. Truck Commodity Value and Truck Delay, 2010, Continued

Urban Area	Total Delay		Truck Delay			Truck Commodity Value	
	(1000 Hours)	Rank	(1000 Hours)	Rank	Congestion Cost ($million)	($ million)	Rank
Large Average (32 areas)	**33,407**		**2,024**		**148**	**62,310**	
Baltimore MD	87,199	14	6,103	14	449	94,943	19
Denver-Aurora CO	80,837	16	4,324	16	319	76,023	22
Minneapolis-St. Paul MN	78,483	17	4,073	18	300	95,819	18
St. Louis MO-IL	47,042	21	3,841	19	283	107,010	15
Riverside-San Bernardino CA	40,875	25	3,080	20	229	108,218	14
Orlando FL	38,260	26	2,856	21	207	63,106	32
Tampa-St. Petersburg FL	53,047	19	2,842	22	210	61,906	33
Pittsburgh PA	41,081	24	2,755	23	200	69,290	25
Portland OR-WA	41,743	23	2,546	24	185	64,964	30
San Juan PR	50,229	20	2,417	25	174	23,130	60
Nashville-Davidson TN	26,475	33	1,961	26	142	65,449	29
New Orleans LA	20,565	39	1,859	27	135	34,270	50
San Jose CA	42,846	22	1,815	28	133	52,079	36
Milwaukee WI	26,699	32	1,746	29	127	66,629	28
Sacramento CA	29,602	30	1,688	30	123	51,883	37
Cincinnati OH-KY-IN	23,297	35	1,660	31	120	64,323	31
Indianapolis IN	20,800	38	1,657	32	119	83,984	21
Kansas City MO-KS	24,185	34	1,641	33	119	72,545	23
Austin TX	31,038	28	1,636	34	119	32,824	52
Raleigh-Durham NC	19,247	40	1,569	35	115	49,468	40
San Antonio TX	30,207	29	1,428	37	105	50,600	39
Charlotte NC-SC	17,730	43	1,383	38	101	68,196	26
Virginia Beach VA	36,538	27	1,344	40	98	43,056	42
Memphis TN-MS-AR	17,197	44	1,195	42	87	98,356	16
Louisville KY-IN	17,033	45	1,170	43	85	55,226	35
Jacksonville FL	18,005	42	1,158	44	84	41,508	44
Las Vegas NV	27,386	31	1,141	45	83	35,458	49
Cleveland OH	21,380	36	1,016	46	75	67,808	27
Salt Lake City UT	18,366	41	823	50	61	56,160	34
Columbus OH	14,651	51	727	51	53	69,664	24
Buffalo NY	11,450	56	698	55	51	48,387	41
Providence RI-MA	15,539	48	610	59	45	21,633	61

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Table 5. Truck Commodity Value and Truck Delay, 2010, Continued

Urban Area	Total Delay		Truck Delay			Truck Commodity Value	
	(1000 Hours)	Rank	(1000 Hours)	Rank	Congestion Cost ($ million)	($ million)	Rank
Medium Average (33 areas)	**9,513**		**578**		**42**	**18,478**	
Baton Rouge LA	14,577	52	1,519	36	110	32,636	54
Bridgeport-Stamford CT-NY	21,233	37	1,380	39	102	11,205	73
Tucson AZ	11,412	57	1,287	41	92	28,654	58
Birmingham AL	15,832	47	971	47	71	38,401	45
Albuquerque NM	10,477	58	963	48	69	14,035	67
Oklahoma City OK	16,848	46	912	49	66	37,779	46
Hartford CT	15,072	49	716	52	52	42,403	43
El Paso TX-NM	10,452	59	714	53	52	31,703	55
Charleston-North Charleston SC	9,160	62	701	54	51	10,552	76
New Haven CT	11,643	55	676	56	49	8,276	86
Allentown-Bethlehem PA-NJ	9,777	60	597	60	43	15,827	65
Honolulu HI	15,035	50	595	61	42	10,125	78
Tulsa OK	9,086	63	562	63	42	28,827	57
Richmond VA	13,800	53	530	64	39	37,643	47
Oxnard-Ventura CA	9,009	64	529	65	39	9,187	83
Colorado Springs CO	11,897	54	509	66	37	6,546	91
Albany-Schenectady NY	7,467	71	484	67	35	32,655	53
Grand Rapids MI	7,861	68	446	69	32	37,551	48
Sarasota-Bradenton FL	8,015	67	446	69	32	7,591	89
Knoxville TN	7,518	70	439	71	32	11,989	72
Bakersfield CA	4,005	90	425	72	31	10,838	75
Fresno CA	5,999	78	396	73	29	9,474	81
Indio-Cathedral City-Palm Springs CA	5,633	80	389	74	28	5,455	94
Dayton OH	7,096	73	382	75	28	33,645	51
Springfield MA-CT	8,305	66	378	76	27	9,238	82
Omaha NE-IA	9,299	61	314	79	23	8,668	85
Lancaster-Palmdale CA	6,906	74	303	80	22	2,728	99
Rochester NY	6,377	76	295	81	21	26,077	59
Akron OH	6,198	77	290	82	21	9,828	80
Wichita KS	6,858	75	280	84	21	7,901	87
Poughkeepsie-Newburgh NY	4,271	85	272	85	20	13,714	68
Toledo OH-MI	4,223	86	247	90	18	10,950	74
McAllen TX	2,598	96	125	99	9	7,678	88

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Table 5. Truck Commodity Value and Truck Delay, 2010, Continued

Urban Area	Total Delay		Truck Delay			Truck Commodity Value	
	(1000 Hours)	Rank	(1000 Hours)	Rank	Congestion Cost ($ million)	($ million)	Rank
Small Average (21 areas)	**4,166**		**288**		**21**	**12,275**	
Columbia SC	8,515	65	651	57	47	12,404	70
Jackson MS	5,488	81	648	58	47	16,984	64
Cape Coral FL	7,600	69	567	62	41	5,962	93
Little Rock AR	7,345	72	457	68	33	15,221	66
Greensboro NC	4,104	87	362	77	26	50,964	38
Spokane WA	4,306	84	323	78	23	7,230	90
Winston-Salem NC	4,054	89	287	83	21	8,679	84
Pensacola FL-AL	4,699	83	261	86	19	6,339	92
Worcester MA	5,639	79	259	87	19	10,115	79
Salem OR	3,912	91	256	88	18	3,864	97
Madison WI	3,375	93	252	89	18	17,361	63
Provo UT	5,056	82	240	91	18	12,681	69
Beaumont TX	3,814	92	236	92	17	20,504	62
Laredo TX	2,041	99	212	93	15	30,799	56
Brownsville TX	2,323	98	206	94	15	2,380	100
Stockton CA	2,648	95	203	95	15	10,264	77
Anchorage AK	3,013	94	183	96	13	4,454	96
Corpus Christi TX	2,432	97	172	97	13	12,327	71
Boise ID	4,063	88	137	98	10	4,772	95
Eugene OR	1,456	101	98	100	7	3,658	98
Boulder CO	1,612	100	47	101	3	820	101
101 Area Average	**42,461**		**2,690**		**198**	**58,981**	
Remaining Area Average	**1,582**		**119**		**9**	**3,183**	
All 439 Area Average	**10,987**		**710**		**52**	**16,021**	

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.
Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.
Travel Delay—Travel time above that needed to complete a trip at free-flow speeds for all vehicles.
Truck Delay—Travel time above that needed to complete a trip at free-flow speeds for large trucks.
Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban area.
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 6. State Truck Commodity Value, 2010

State	Total Truck Commodity Value ($ million)	Rural Truck Commodity Value ($ million)	Urban Truck Commodity Value ($ million)
Alabama	225,316	140,281	85,035
Alaska	17,161	12,082	5,079
Arizona	266,930	102,058	164,872
Arkansas	160,049	130,440	29,609
California	1,235,308	295,145	940,164
Colorado	153,998	62,081	91,917
Connecticut	110,515	7,578	102,937
Delaware	35,030	12,397	22,633
Florida	552,621	138,470	414,151
Georgia	417,906	182,728	235,178
Hawaii	16,307	5,592	10,715
Idaho	57,974	47,004	10,970
Illinois	548,431	174,621	373,810
Indiana	368,446	199,151	169,296
Iowa	157,013	130,758	26,255
Kansas	142,534	100,076	42,458
Kentucky	222,880	146,951	75,929
Louisiana	217,425	101,396	116,029
Maine	44,693	36,143	8,550
Maryland	205,976	51,098	154,878
Massachusetts	164,871	10,433	154,438
Michigan	348,470	101,493	246,977
Minnesota	189,643	86,720	102,923
Mississippi	155,821	121,572	34,249
Missouri	297,147	150,722	146,425
Montana	41,673	39,489	2,184
Nebraska	96,020	84,448	11,572
Nevada	78,514	37,075	41,440
New Hampshire	38,649	23,312	15,338
New Jersey	295,927	12,901	283,026
New Mexico	111,128	91,403	19,725
New York	482,018	111,566	370,451
North Carolina	373,822	146,171	227,652
North Dakota	47,109	42,718	4,391

Total Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the state.
Rural Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the rural areas of the state.
Urban Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban areas of the state.

Table 6. State Truck Commodity Value, 2010, Continued

State	Total Truck Commodity Value ($ million)	Rural Truck Commodity Value ($ million)	Urban Truck Commodity Value ($ million)
Ohio	447,564	177,760	269,805
Oklahoma	205,346	137,892	67,453
Oregon	153,382	82,144	71,239
Pennsylvania	443,946	195,660	248,286
Rhode Island	21,139	3,786	17,353
South Carolina	192,648	97,765	94,883
South Dakota	44,693	39,879	4,813
Tennessee	349,114	156,776	192,337
Texas	1,150,012	441,184	708,828
Utah	143,138	60,146	82,992
Vermont	24,158	21,648	2,510
Virginia	253,058	110,587	142,471
Washington	273,611	91,855	181,756
West Virginia	85,762	62,040	23,722
Wisconsin	326,741	190,205	136,536
Wyoming	48,921	46,372	2,549
District of Columbia	9,059	-	9,059
Puerto Rico	38,653	3,494	35,159

Total Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the state.
Rural Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the rural areas of the state.
Urban Truck Commodity Value—Value of all commodities moved by truck estimated to be traveling in the urban areas of the state.

Table 7. Congestion Trends – Wasted Hours (Yearly Delay per Auto Commuter, 1982 to 2010)

Urban Area	Yearly Hours of Delay per Auto Commuter					Long-Term Change 1982 to 2010	
	2010	2009	2005	2000	1982	Hours	Rank
Very Large Average (15 areas)	**52**	**52**	**60**	**50**	**19**	**33**	
Washington DC-VA-MD	74	72	83	73	20	54	1
Chicago IL-IN	71	74	77	55	18	53	2
New York-Newark NY-NJ-CT	54	53	51	35	10	44	3
Dallas-Fort Worth-Arlington TX	45	46	51	40	7	38	6
Boston MA-NH-RI	47	48	57	44	13	34	8
Seattle WA	44	44	51	49	10	34	8
Houston TX	57	56	55	45	24	33	10
Atlanta GA	43	44	58	52	13	30	11
Philadelphia PA-NJ-DE-MD	42	43	42	32	12	30	11
San Diego CA	38	37	46	35	8	30	11
San Francisco-Oakland CA	50	50	74	60	20	30	11
Miami FL	38	39	45	38	10	28	16
Los Angeles-Long Beach-Santa Ana CA	64	63	82	76	39	25	23
Detroit MI	33	32	41	36	14	19	36
Phoenix AZ	35	36	44	34	24	11	79

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 7. Congestion Trends – Wasted Hours (Yearly Delay per Auto Commuter, 1982 to 2010), Continued

Urban Area	Yearly Hours of Delay per Auto Commuter					Long-Term Change 1982 to 2010	
	2010	2009	2005	2000	1982	Hours	Rank
Large Average (32 areas)	**31**	**31**	**37**	**33**	**9**	**22**	
Baltimore MD	52	50	57	41	11	41	4
Minneapolis-St. Paul MN	45	43	54	48	6	39	5
Denver-Aurora CO	49	47	53	47	12	37	7
Austin TX	38	39	52	36	9	29	15
Riverside-San Bernardino CA	31	30	37	24	3	28	16
San Juan PR	33	33	34	26	5	28	16
Orlando FL	38	41	44	47	11	27	19
Portland OR-WA	37	36	42	38	11	26	21
San Antonio TX	30	30	33	30	4	26	21
Las Vegas NV	28	32	32	24	5	23	26
Salt Lake City UT	27	28	25	27	6	21	27
Charlotte NC-SC	25	26	25	19	5	20	31
Raleigh-Durham NC	25	25	31	26	5	20	31
San Jose CA	37	35	54	53	17	20	31
Virginia Beach VA	34	32	41	37	14	20	31
Kansas City MO-KS	23	21	30	33	4	19	36
St. Louis MO-IL	30	31	38	44	11	19	36
Tampa-St. Petersburg FL	33	34	34	27	14	19	36
Memphis TN-MS-AR	23	24	28	24	5	18	43
Milwaukee WI	27	25	31	32	9	18	43
Nashville-Davidson TN	35	35	43	36	17	18	43
New Orleans LA	35	31	26	25	17	18	43
Cincinnati OH-KY-IN	21	19	28	29	4	17	50
Cleveland OH	20	19	17	20	3	17	50
Providence RI-MA	19	19	26	19	2	17	50
Columbus OH	18	17	19	15	2	16	56
Sacramento CA	25	24	35	27	9	16	56
Jacksonville FL	25	26	31	26	10	15	61
Indianapolis IN	24	25	30	31	10	14	68
Louisville KY-IN	23	22	25	25	9	14	68
Buffalo NY	17	17	21	16	4	13	74
Pittsburgh PA	31	33	37	35	18	13	74

Very Large Urban Areas—over 3 million population.

Large Urban Areas—over 1 million and less than 3 million population.

Medium Urban Areas—over 500,000 and less than 1 million population.

Small Urban Areas—less than 500,000 population.

Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 7. Congestion Trends – Wasted Hours (Yearly Delay per Auto Commuter, 1982 to 2010), Continued

Urban Area	Yearly Hours of Delay per Auto Commuter					Long-Term Change 1982 to 2010	
	2010	2009	2005	2000	1982	Hours	Rank
Medium Average (33 areas)	**21**	**21**	**24**	**22**	**7**	**14**	
Baton Rouge LA	36	37	37	31	9	27	19
Bridgeport-Stamford CT-NY	36	35	47	44	11	25	23
Colorado Springs CO	31	31	53	45	6	25	23
Hartford CT	26	24	27	26	5	21	27
New Haven CT	28	29	34	34	7	21	27
Birmingham AL	27	28	31	30	7	20	31
Honolulu HI	33	31	32	25	14	19	36
Oklahoma City OK	24	25	23	23	5	19	36
El Paso TX-NM	21	21	28	20	3	18	43
Omaha NE-IA	21	20	18	16	3	18	43
Oxnard-Ventura CA	19	19	23	16	2	17	50
Albuquerque NM	25	26	33	30	9	16	56
Richmond VA	20	19	17	13	4	16	56
Allentown-Bethlehem PA-NJ	22	22	24	24	7	15	61
Charleston-North Charleston SC	25	27	28	25	10	15	61
Grand Rapids MI	19	19	19	18	4	15	61
Knoxville TN	21	21	23	26	6	15	61
Albany-Schenectady NY	17	18	19	14	3	14	68
Tulsa OK	18	18	16	15	4	14	68
Wichita KS	20	20	19	19	6	14	68
Akron OH	15	16	19	22	3	12	77
Tucson AZ	23	23	28	19	11	12	77
Rochester NY	13	12	13	12	3	10	83
Toledo OH-MI	12	12	17	19	2	10	83
Bakersfield CA	10	11	7	4	1	9	86
Springfield MA-CT	18	19	19	18	9	9	86
Dayton OH	14	15	15	19	7	7	89
Sarasota-Bradenton FL	16	17	20	19	9	7	89
Fresno CA	13	14	16	18	7	6	93
McAllen TX	7	7	7	6	1	6	93
Poughkeepsie-Newburgh NY	10	11	10	8	5	5	96
Lancaster-Palmdale CA	16	18	17	12	19	-3	100
Indio-Cathedral City-Palm Springs CA	14	14	20	15	22	-8	101

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.
Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.
Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 7. Congestion Trends – Wasted Hours (Yearly Delay per Auto Commuter, 1982 to 2010), Continued

Urban Area	Yearly Hours of Delay per Auto Commuter					Long-Term Change 1982 to 2010	
	2010	2009	2005	2000	1982	Hours	Rank
Small Average (21 areas)	**18**	**18**	**20**	**17**	**5**	**13**	
Columbia SC	25	25	20	17	4	21	27
Little Rock AR	24	24	23	17	5	19	36
Salem OR	22	24	32	30	4	18	43
Beaumont TX	22	21	26	18	5	17	50
Boise ID	19	21	24	20	2	17	50
Jackson MS	19	19	20	12	3	16	56
Cape Coral FL	23	23	28	23	8	15	61
Pensacola FL-AL	18	19	21	16	3	15	61
Brownsville TX	15	14	10	8	1	14	68
Greensboro NC	16	15	19	24	3	13	74
Laredo TX	12	12	8	7	1	11	77
Winston-Salem NC	15	16	20	13	4	11	79
Worcester MA	18	20	22	22	7	11	79
Spokane WA	16	16	17	22	6	10	83
Provo UT	14	14	14	11	5	9	86
Madison WI	12	11	7	6	5	7	89
Stockton CA	9	9	10	7	2	7	89
Boulder CO	15	15	28	28	9	6	93
Corpus Christi TX	10	10	11	9	5	5	96
Eugene OR	8	9	14	15	5	3	98
Anchorage AK	14	14	21	20	16	-2	99
101 Area Average	**40**	**40**	**46**	**40**	**14**	**26**	
Remaining Area Average	**16**	**18**	**20**	**20**	**10**	**6**	
All 439 Area Average	**34**	**34**	**39**	**35**	**14**	**20**	

Very Large Urban Areas—over 3 million population.
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Yearly Delay per Auto Commuter—Extra travel time during the year divided by the number of people who commute in private vehicles in the urban area.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 8. Congestion Trends – Wasted Time (Travel Time Index, 1982 to 2010)

Urban Area	Travel Time Index					Point Change in Peak-Period Time Penalty 1982 to 2010	
	2010	2009	2005	2000	1982	Points	Rank
Very Large Average (15 areas)	**1.27**	**1.26**	**1.32**	**1.27**	**1.12**	**15**	
Washington DC-VA-MD	1.33	1.30	1.35	1.31	1.11	22	1
Seattle WA	1.27	1.24	1.33	1.31	1.08	19	4
Dallas-Fort Worth-Arlington TX	1.23	1.22	1.27	1.20	1.05	18	6
New York-Newark NY-NJ-CT	1.28	1.27	1.37	1.28	1.10	18	6
Los Angeles-Long Beach-Santa Ana CA	1.38	1.38	1.42	1.39	1.21	17	12
Chicago IL-IN	1.24	1.25	1.29	1.21	1.08	16	15
San Francisco-Oakland CA	1.28	1.27	1.40	1.34	1.13	15	16
Atlanta GA	1.23	1.22	1.28	1.25	1.08	15	17
San Diego CA	1.19	1.18	1.25	1.20	1.04	15	17
Miami FL	1.23	1.23	1.31	1.27	1.09	14	20
Boston MA-NH-RI	1.21	1.20	1.32	1.26	1.09	12	25
Philadelphia PA-NJ-DE-MD	1.21	1.19	1.22	1.18	1.09	12	25
Phoenix AZ	1.21	1.20	1.21	1.18	1.10	11	29
Houston TX	1.27	1.25	1.33	1.26	1.18	9	38

Very Large Urban Areas—over 3 million population.
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Small Urban Areas—less than 500,000 population.

Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 8. Congestion Trends – Wasted Time (Travel Time Index, 1982 to 2010), Continued

Urban Area	Travel Time Index					Point Change in Peak-Period Time Penalty 1982 to 2010	
	2010	2009	2005	2000	1982	Points	Rank
Large Average (31 areas)	**1.17**	**1.17**	**1.21**	**1.19**	**1.07**	**10**	
Austin TX	1.28	1.28	1.32	1.23	1.08	20	2
Portland OR-WA	1.25	1.23	1.27	1.26	1.06	19	4
Las Vegas NV	1.24	1.26	1.29	1.25	1.06	18	6
Minneapolis-St. Paul MN	1.23	1.21	1.33	1.31	1.05	18	6
San Juan PR	1.25	1.25	1.24	1.21	1.07	18	6
Denver-Aurora CO	1.24	1.22	1.28	1.26	1.07	17	12
Riverside-San Bernardino CA	1.18	1.16	1.19	1.13	1.01	17	12
San Antonio TX	1.18	1.16	1.21	1.18	1.03	15	17
Baltimore MD	1.19	1.17	1.19	1.14	1.05	14	20
Sacramento CA	1.19	1.18	1.26	1.20	1.05	14	20
San Jose CA	1.25	1.23	1.31	1.30	1.12	13	23
Milwaukee WI	1.18	1.16	1.17	1.18	1.06	12	25
Charlotte NC-SC	1.17	1.17	1.20	1.19	1.06	11	29
Indianapolis IN	1.17	1.18	1.15	1.15	1.06	11	29
Orlando FL	1.18	1.20	1.22	1.23	1.07	11	29
Cincinnati OH-KY-IN	1.13	1.12	1.14	1.15	1.03	10	34
Raleigh-Durham NC	1.14	1.13	1.17	1.13	1.04	10	34
Columbus OH	1.11	1.11	1.11	1.09	1.02	9	38
Providence RI-MA	1.12	1.14	1.18	1.15	1.03	9	38
Virginia Beach VA	1.18	1.19	1.24	1.21	1.09	9	42
Cleveland OH	1.10	1.10	1.12	1.15	1.03	7	49
Kansas City MO-KS	1.11	1.10	1.15	1.18	1.04	7	49
Memphis TN-MS-AR	1.12	1.13	1.18	1.18	1.05	7	49
Nashville-Davidson TN	1.18	1.15	1.20	1.18	1.11	7	54
Buffalo NY	1.10	1.10	1.13	1.11	1.04	6	57
Salt Lake City UT	1.11	1.12	1.16	1.18	1.05	6	57
Louisville KY-IN	1.10	1.10	1.12	1.11	1.06	4	72
Jacksonville FL	1.09	1.12	1.17	1.13	1.06	3	79
New Orleans LA	1.17	1.15	1.19	1.19	1.14	3	79
Pittsburgh PA	1.18	1.17	1.22	1.22	1.15	3	79
Tampa-St. Petersburg FL	1.16	1.16	1.18	1.15	1.13	3	79
St. Louis MO-IL	1.10	1.12	1.17	1.21	1.08	2	93

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Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.
Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.
Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 8. Congestion Trends – Wasted Time (Travel Time Index, 1982 to 2010), Continued

Urban Area	Travel Time Index					Point Change in Peak-Period Time Penalty 1982 to 2010	
	2010	2009	2005	2000	1982	Points	Rank
Medium Average (33 areas)	**1.11**	**1.11**	**1.12**	**1.11**	**1.04**	**7**	
Bridgeport-Stamford CT-NY	1.27	1.25	1.26	1.24	1.07	20	2
Baton Rouge LA	1.25	1.24	1.21	1.19	1.07	18	6
El Paso TX-NM	1.16	1.15	1.18	1.16	1.03	13	23
Oxnard-Ventura CA	1.12	1.12	1.12	1.08	1.01	11	28
Birmingham AL	1.15	1.14	1.15	1.12	1.04	11	29
Colorado Springs CO	1.13	1.12	1.18	1.18	1.03	10	34
Hartford CT	1.15	1.13	1.17	1.18	1.05	10	34
McAllen TX	1.10	1.09	1.08	1.07	1.01	9	38
Honolulu HI	1.18	1.18	1.18	1.15	1.09	9	42
New Haven CT	1.13	1.15	1.15	1.15	1.04	9	42
Oklahoma City OK	1.10	1.09	1.07	1.07	1.02	8	46
Omaha NE-IA	1.09	1.08	1.10	1.08	1.02	7	49
Charleston-North Charleston SC	1.16	1.15	1.17	1.16	1.09	7	54
Bakersfield CA	1.07	1.08	1.08	1.05	1.01	6	57
Tulsa OK	1.08	1.07	1.05	1.06	1.02	6	57
Albany-Schenectady NY	1.08	1.10	1.10	1.07	1.03	5	65
Albuquerque NM	1.10	1.13	1.16	1.17	1.05	5	65
Indio-Cathedral City-Palm Springs CA	1.11	1.13	1.12	1.08	1.06	5	65
Fresno CA	1.07	1.07	1.08	1.10	1.03	4	72
Toledo OH-MI	1.05	1.05	1.07	1.08	1.01	4	72
Tucson AZ	1.11	1.11	1.15	1.12	1.07	4	72
Wichita KS	1.07	1.08	1.06	1.06	1.03	4	72
Akron OH	1.05	1.05	1.08	1.09	1.02	3	79
Allentown-Bethlehem PA-NJ	1.07	1.08	1.08	1.09	1.04	3	79
Grand Rapids MI	1.05	1.06	1.05	1.06	1.02	3	79
Lancaster-Palmdale CA	1.10	1.11	1.10	1.07	1.07	3	79
Richmond VA	1.06	1.06	1.07	1.06	1.03	3	79
Sarasota-Bradenton FL	1.09	1.10	1.11	1.11	1.06	3	79
Springfield MA-CT	1.08	1.09	1.09	1.09	1.05	3	79
Knoxville TN	1.06	1.06	1.09	1.10	1.04	2	93
Rochester NY	1.05	1.07	1.07	1.06	1.03	2	93
Dayton OH	1.06	1.06	1.07	1.08	1.05	1	97
Poughkeepsie-Newburgh NY	1.04	1.04	1.05	1.04	1.03	1	97

Very Large Urban Areas—over 3 million population.

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Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.

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Table 8. Congestion Trends – Wasted Time (Travel Time Index, 1982 to 2010), Continued

Urban Area	Travel Time Index					Point Change in Peak-Period Time Penalty 1982 to 2010	
	2010	2009	2005	2000	1982	Points	Rank
Small Average (21 areas)	**1.08**	**1.08**	**1.08**	**1.08**	**1.03**	**5**	
Boulder CO	1.14	1.13	1.14	1.15	1.05	9	42
Boise ID	1.10	1.12	1.15	1.12	1.02	8	46
Little Rock AR	1.10	1.10	1.08	1.07	1.02	8	46
Columbia SC	1.09	1.09	1.07	1.06	1.02	7	49
Beaumont TX	1.08	1.08	1.06	1.05	1.02	6	57
Laredo TX	1.07	1.07	1.06	1.05	1.01	6	57
Provo UT	1.08	1.06	1.05	1.04	1.02	6	57
Salem OR	1.09	1.10	1.12	1.12	1.03	6	57
Greensboro NC	1.06	1.05	1.07	1.08	1.01	5	65
Pensacola FL-AL	1.08	1.07	1.10	1.09	1.03	5	65
Spokane WA	1.10	1.10	1.10	1.14	1.05	5	65
Winston-Salem NC	1.06	1.06	1.07	1.05	1.01	5	65
Corpus Christi TX	1.07	1.07	1.07	1.06	1.03	4	72
Jackson MS	1.06	1.07	1.09	1.06	1.02	4	72
Cape Coral FL	1.10	1.12	1.12	1.10	1.07	3	79
Madison WI	1.06	1.06	1.05	1.05	1.03	3	79
Worcester MA	1.06	1.07	1.09	1.09	1.03	3	79
Brownsville TX	1.04	1.04	1.07	1.07	1.02	2	93
Eugene OR	1.06	1.07	1.13	1.13	1.05	1	97
Stockton CA	1.02	1.02	1.05	1.03	1.01	1	97
Anchorage AK	1.05	1.05	1.06	1.05	1.05	0	101
101 Area Average	**1.21**	**1.20**	**1.25**	**1.22**	**1.09**	**12**	
Remaining Areas	**1.08**	**1.09**	**1.12**	**1.10**	**1.04**	**4**	
All 439 Urban Areas	**1.20**	**1.20**	**1.25**	**1.21**	**1.09**	**11**	

Very Large Urban Areas—over 3 million population.

Large Urban Areas—over 1 million and less than 3 million population.

Medium Urban Areas—over 500,000 and less than 1 million population.

Small Urban Areas—less than 500,000 population.

Travel Time Index—The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period.

Note: Please do not place too much emphasis on small differences in the rankings. There may be little difference in congestion between areas ranked (for example) 6th and 12th. The actual measure values should also be examined.

Also note: The best congestion comparisons use multi-year trends and are made between similar urban areas.

Table 9. Urban Area Demand and Roadway Growth Trends

Less Than 10% Faster (13)	10% to 30% Faster (46)	10% to 30% Faster (cont.)	More Than 30% Faster (40)	More Than 30% Faster (cont.)
Anchorage AK	Allentown-Bethlehem PA-NJ	Memphis TN-MS-AR	Akron OH	Minneapolis-St. Paul MN
Boulder CO	Baton Rouge LA	Milwaukee WI	Albany-Schenectady NY	New Haven CT
Dayton OH	Beaumont TX	Nashville-Davidson TN	Albuquerque NM	New York-Newark NY-NJ-CT
Greensboro NC	Boston MA-NH-RI	Oklahoma City OK	Atlanta GA	Omaha NE-IA
Indio-Cath City-P Springs CA	Brownsville TX	Pensacola FL-AL	Austin TX	Orlando FL
Lancaster-Palmdale CA	Buffalo NY	Philadelphia PA-NJ-DE-MD	Bakersfield CA	Oxnard-Ventura CA
Madison WI	Cape Coral FL	Phoenix AZ	Baltimore MD	Providence RI-MA
New Orleans LA	Charleston-N Charleston SC	Portland OR-WA	Birmingham AL	Raleigh-Durham NC
Pittsburgh PA	Charlotte NC-SC	Richmond VA	Boise ID	Riverside-S Bernardino CA
Poughkeepsie-Newburgh NY	Cleveland OH	Rochester NY	Bridgeport-Stamford CT-NY	Sacramento CA
Provo UT	Corpus Christi TX	Salem OR	Chicago IL-IN	San Antonio TX
St. Louis MO-IL	Detroit MI	Salt Lake City UT	Cincinnati OH-KY-IN	San Diego CA
Wichita KS	El Paso TX-NM	San Jose CA	Colorado Springs CO	San Francisco-Oakland CA
	Eugene OR	Seattle WA	Columbia SC	San Juan PR
	Fresno CA	Spokane WA	Columbus OH	Sarasota-Bradenton FL
	Grand Rapids MI	Springfield MA-CT	Dallas-Ft Worth-Arlington TX	Stockton CA
	Honolulu HI	Tampa-St. Petersburg FL	Denver-Aurora CO	Washington DC-VA-MD
	Houston TX	Toledo OH-MI	Hartford CT	
	Indianapolis IN	Tucson AZ	Jacksonville FL	
	Jackson MS	Tulsa OK	Laredo TX	
	Kansas City MO-KS	Virginia Beach VA	Las Vegas NV	
	Knoxville TN	Winston-Salem NC	Little Rock AR	
	Louisville KY-IN	Worcester MA	Los Angeles-L Bch-S Ana CA	
	McAllen TX		Miami FL	

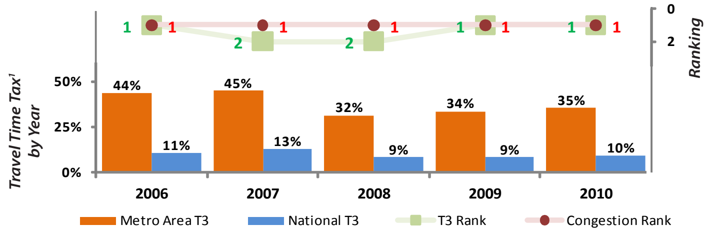
Note: See Exhibit 12 for comparison of growth in demand, road supply and congestion.

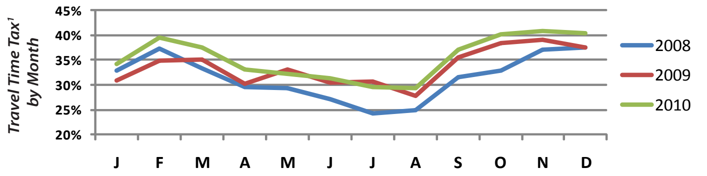
#1 Los Angeles Metropolitan Area

National Congestion Rank: #1

Population Rank: #2 (12,875,000)

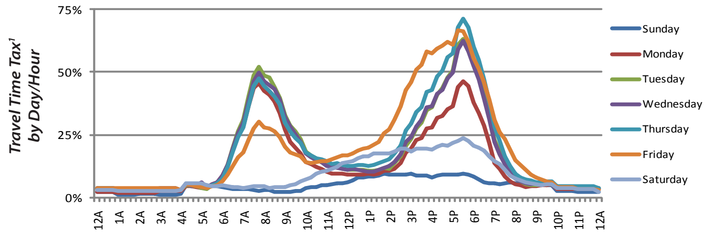
Trends
for Peak Period[2] Congestion in Metro Area





CBSA[4]: Los Angeles-Long Beach-Santa Ana CA

Patterns
for 2010 Congestion in Metro Area



What Was the Worst Time? Thursday, 5:30-5:45 PM *[71% Travel Time Tax[1]]*

Impact
of Employment Changes

	Total Employment				Travel Time Tax[1]			
	2006	2010	Change Total	Change %	2006	2010	Change Total	Change %
Metro Area	5695 K	5170 K	-525 K	-9.2%	43.7%	35.4%	-8.3%	-19.0%
Top 100 Metros	93.3 M	87.9 M	-5.4 M	-5.8%	11.1%	9.7%	-1.4%	-12.7%
National	136.9 M	130.7 M	-6.2 M	-4.5%	N/A			

Congested Corridors and Bottlenecks
across Metro Area in 2010

Congested Corridors[5] *(45 Total in Metro Area)*

Regional Rank	National Rank	Road/Direction	From	To	Length (miles)	Uncongested Travel Time (min)	Peak Period[2] (AM/PM)	Peak Period[2] Travel Time (min)	Peak Period[2] Tax[1](%)	Worst Hour (Day & Hour)	Worst Hour Travel Time (min)	Worst Hour Tax[1](%)
1	2	Riverside Fwy/CA-91 EB	CA-55/COSTA MESA FWY	MCKINLEY ST	20.7	20	PM	57	183%	F, 4-5pm	81	302%
2	3	San Diego Fwy/I-405 NB	I-105/IMPERIAL HWY	GETTY CENTER DR	13.1	13	PM	41	224%	F, 4-5pm	53	318%
3	5	Santa Monica Fwy/I-10 EB	CA-1/LINCOLN BLVD/EX 1B	ALAMEDA ST	14.9	14	PM	42	192%	Th, 6-7pm	49	244%
4	7	I-5 SB (Santa Ana/Golden St Fwys)	EAST CEASAR CHAVEZ AVE	VALLEY VIEW AVE	17.5	18	PM	47	167%	F, 5-6pm	63	255%
5	10	San Bernadino Fwy/I-10 EB	CITY TERRACE DR/HERBERT AVE	BALDWIN PARK BLVD	12.8	13	PM	37	188%	F, 5-6pm	45	253%
6	12	San Diego Fwy/I-405 SB	NORDHOFF ST	MULHOLLAND DR	8.1	8	AM	26	225%	T, 8-9am	35	331%
7	16	Pomona Fwy/CA-60 EB	WHITTIER BLVD	BREA CANYON RD	21.7	22	PM	50	128%	F, 5-6pm	61	178%
8	30	Santa Monica Fwy/I-10 WB	I-5/GOLDEN STATE FWY	NATIONAL BLVD	12.6	12	AM	30	146%	Th, 6-7pm	43	257%
9	31	US-101 NB (Santa Ana/Hollywood Fwys)	I-5/CA-60	HASKELL AVE	21.5	22	PM	46	108%	Th, 5-6pm	59	168%
10	32	Century Fwy/I-105 EB	NASH ST	I-605	17.6	17	PM	37	124%	Th, 5-6pm	46	175%

Bottlenecks *(385 Total in Metro Area)*

Regional Rank	National Rank 2010	National Rank 2009	Road/Direction	Segment/Interchange	County	State	Length (miles)	Hours of Congestion[3]	Average Speed when Congested[3] (mph)
1	10	11	Hollywood Fwy/US-101 SB	VERMONT AVE	Los Angeles	CA	0.62	117	16.7
2	11	85	San Diego Fwy/I-405 NB	I-10/SANTA MONICA FWY	Los Angeles	CA	1.23	91	14.1
3	18	12	Hollywood Fwy/US-101 NB	ALAMEDA ST	Los Angeles	CA	0.27	102	14.0
4	19	19	Hollywood Fwy/US-101 NB	SPRING ST	Los Angeles	CA	0.14	110	16.4
5	24	22	Hollywood Fwy/US-101 SB	MELROSE AVE	Los Angeles	CA	0.35	97	17.3
6	26	38	Santa Ana Fwy/I-5 NB	E 7TH ST	Los Angeles	CA	0.26	83	13.6
7	27	27	Harbor Fwy/I-110 NB	ADAMS BLVD	Los Angeles	CA	0.13	96	17.6
8	30	24	Hollywood Fwy/US-101 SB	CA-2/SANTA MONICA BLVD	Los Angeles	CA	0.40	87	17.0
9	33	29	Hollywood Fwy/US-101 SB	SILVER LAKE BLVD	Los Angeles	CA	0.42	110	21.1
10	34	31	Hollywood Fwy/US-101 SB	NORMANDIE AVE	Los Angeles	CA	0.40	93	18.7

Notes:

1 – **Travel Time Tax** is the percentage of extra travel time (vs. "free flow") a random trip takes in the specific region and time period analyzed. A 10% tax means 10% additional trip time due to congestion.
2 – **Peak hours** are Monday to Friday, 6 to 10 AM and 3 to 7 PM.
3 – **"Hours of Congestion"** is defined as times of the week when a road segment's average hourly speed is half or less than its uncongested speed.
4 – **CBSA** stands for "Core Based Statistical Area," the official term for a functional region based around an urban center of at least 10,000 people, based on standards published by the U.S. Government's Office of Management and Budget (OMB).
5 – **Corridors** are composed of multiple contiguous bottlenecks totaling at least 3 miles in length.

Additional information on the methodologies used in this report are available at http://scorecard.inrix.com.