Land Use and Driving

The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions

Evidence from Three Recent Studies

Urban Land Institute

ULI Foundation

If we could go to **2050** and look back, we would see that successfully implemented **compact development** strategies—even those with only modest increases in land use density and mix—resulted in a **win-win**: a boon both for the environment and for Americans looking for the **healthy** and convenient lifestyle benefits associated with this type of **high-quality land use**.

Climate change is one of the most important and complex long-term challenges ever faced by communities around the world. ULI's engagement in research and dialogue about climate change is part of a broader groundswell of inquiry that is revisiting the underlying assumptions around what we build, where we build, and how we build. The ULI community clearly has a central role to play in forging feasible and effective solutions to address global climate change that are at the nexus of land use, real estate, energy, and infrastructure.

So how does ULI's mission to provide leadership in the responsible use of land relate to the need to reduce automobile-related emissions? The Institute has long championed compact development as a way to build more livable, active, and sustainable communities. Intuitively, it makes sense that compact development reduces the amount of driving by bringing community life closer together and enabling more transportation options. Now, three studies—*Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment*—have analyzed and documented the effect of compact development on driving and greenhouse gas emissions. Their conclusion? **Compact development is a promising strategy for reducing greenhouse gas emissions in the transportation sector.**

This report summarizes the land use findings of these three in-depth studies and translates them into clear, accessible terms. We hope it will be a useful document for conversations from the national to the local scale about the role that changes in land use patterns can play in reducing long-term greenhouse gas emissions, and how best to overcome the many barriers—institutional, regulatory, and financial—to building in more compact ways.

ULI recognizes that effective strategies to combat global climate change will require cooperative effort by stakeholders in all segments of the economy and society around the globe. **Now, in addition to widely accepted approaches like improving building and vehicle energy efficiency, compact development can be added to the list of tools in our toolbox to mitigate climate change.**

ULI is grateful for the Rockefeller Foundation's support of this report and the Institute's infrastructure programs.

Patrick Phillips
Chief Executive Officer
Urban Land Institute

About ULI

The Urban Land Institute (www.uli.org) is a nonprofit education and research institute supported by its nearly 30,000 members. Its mission is to provide leadership in the responsible use of land and in creating and sustaining thriving communities worldwide. ULI's prestigious membership consists of the land use industry's foremost professionals around the globe. Established in 1936, the Institute facilitates the open exchange of ideas, information, and experience among local, national, and international industry leaders and policy makers dedicated to creating better places.

Support for This Publication

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About ULI's Infrastructure Initiative

Infrastructure is critical to economic vitality and the health of the real estate industry. Through forums, publications, and other activities, the Urban Land Institute seeks to inform and influence infrastructure decision making and promote sustainable infrastructure policies that support compact land use and reduce energy consumption.

About the ULI National Transportation Policy Dialogue

Transportation is critical to the vitality of the U.S. economy and the real estate industry. Through the ULI National Transportation Policy Dialogue, the Institute is engaging leaders from the real estate and transportation fields to discuss pressing transportation challenges and identify a common set of goals and principles for transportation policy reform. The Dialogue consists of a series of workshops and events, articles and publications, and other activities centered around the pressing transportation issues facing the country.

About ULI's Climate Change, Land Use, and Energy (CLUE) Initiative

ULI's CLUE initiative explores changes in professional practice at the nexus of land use, energy, and global climate change. Ranging from policy, planning, development, and investment practices, the initiative explores how climate change mitigation and adaptation frameworks are changing the professional practice of land use.

About ULI's The City in 2050 Initiative

Elevated concerns over capital markets, rising energy costs, climate change, exploding populations, and equitable development are changing how communities define "the responsible use of land." The City in 2050 creates a dialogue exploring paths of land use innovation as metropolitan areas around the world become more urbanized.

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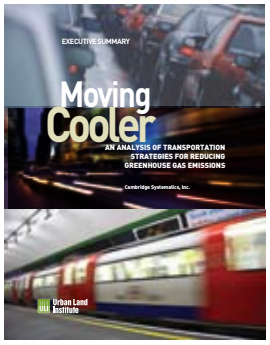
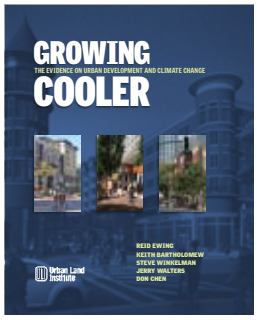
Contents

This report summarizes the land use findings of the following publications:



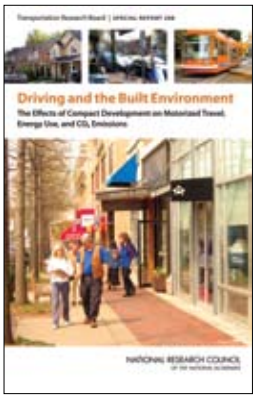
Cambridge Systematics, Inc. *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*. Washington, D.C.: Urban Land Institute, 2009.

The *Moving Cooler* Steering Committee included the American Public Transportation Association, the Environmental Defense Fund, the Intelligent Transportation Society of America, the Kresge Foundation, the Natural Resources Defense Council, the Rockefeller Brothers Fund, the Rockefeller Foundation, Shell Oil Company, the Surdna Foundation, the Funders Network for Smart Growth, and the Urban Land Institute, as well as a number of federal agencies, including the Environmental Protection Agency, the Federal Highway Administration, and the Federal Transit Administration.



Ewing, Reid, and Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen. *Growing Cooler: The Evidence on Urban Development and Climate Change.* Washington, D.C.: Urban Land Institute, 2008.

Author affiliations are as follows: Reid Ewing (University of Utah), Keith Bartholomew (University of Utah), Steve Winkelman (Center for Clean Air Policy), Jerry Walters (Fehr & Peers Associates), and Don Chen (Ford Foundation).



Source: ©National Academy of Sciences; used with permission of TRB.

Transportation Research Board. *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions.* Transportation Research Board Special Report 298. Washington, D.C.: National Research Council, 2009.

Prepared by the Committee for the Study on the Relationships among Development Patterns, Vehicle Miles Traveled, and Energy Consumption: José A. Gómez-Ibáñez, Chair (Harvard University); Marlon G. Boarnet (University of California at Irvine); Dianne R. Brake (PlanSmart); Robert B. Cervero (University of California at Berkeley); Andrew Cotugno (Metro, Portland, Oregon); Anthony Downs (the Brookings Institution); Susan Hanson (Clark University); Kara M. Kockelman (University of Texas at Austin); Patricia L. Mokhtarian (University of California at Davis); Rolf J. Pendall (Cornell University); Danilo J. Santini (Argonne National Laboratory); and Frank Southworth (Oak Ridge National Laboratory and Georgia Institute of Technology).

PART 1 Compact Development and Climate Change

(BETHESDA ROW) FEDERAL REALTY INVESTMENT TRUST

***Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment*, all independently researched, conclude: compact development strategies can decrease driving enough to produce meaningful reductions in national levels of greenhouse gas emissions by 2050.**

Introduction

There are many diverse reasons to pursue compact development outcomes. Convenient and conducive to healthy lifestyles, clustered development patterns help lower overall community infrastructure costs by pulling land uses closer together. Now, as interest in building more compact neighborhoods, cities, and metropolitan regions has grown, another, related question has arisen: Can compact development help mitigate climate change by reducing the amount of driving people do?

Three recent studies—*Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment*—have addressed this question. Examining the connection between land use and driving from different angles, analysis in all three of the reports suggests that compact development *can* reduce driving, and therefore energy consumption, when it makes up a significant portion of new development.

Moving Cooler and *Growing Cooler*, both published by the Washington, D.C.–based Urban Land Institute, and *Driving and the Built Environment*, produced by the National Academy of Sciences' Transportation Research Board, are three very different studies. However, each of them examines the connection between land use and driving, and tests the effect that building in a more compact way can have on energy and greenhouse gas emissions. For *Driving and the Built Environment*, quantifying these connections was central to the study. For *Moving Cooler* and *Growing Cooler*, it was a component of more wide-ranging research.

This report synthesizes the implications of these studies for land use professionals. Part 1 summarizes the land use and driving portions of the three studies, breaking down their data sources, analysis methods, quantitative results, and policy implications, concluding with a discussion of the steps needed to adopt compact development as a climate change mitigation strategy. Part 2 provides a more detailed summary of the analytical methods and conclusions of each of the three studies.

Compact Development Provides Many Benefits

The benefits of compact development over sprawl are clear and well documented. Compact development creates the underlying foundation for a variety of types of vibrant, healthy, and walkable communities—the types of communities that, many Americans have discovered, improve quality of life. Recent market trends and surveys indicate that Americans want to live in these communities.

Adding to this advantage, compact development is a recognized strategy to reduce public infrastructure costs, protect environmentally sensitive lands, and enable a variety of transportation choices. It also helps protect families from increasing household costs, especially those of transportation and utilities, which are directly tied to the price of fuel and energy.

Compact development offers a host of benefits, from enabling more walkable, livable communities to conserving land.

What Is Compact Development?

Successful compact development is a land use settlement pattern that features most or all of the following:

- concentrations of population and/or employment;
- medium to high densities appropriate to context;
- a mix of uses;
- interconnected streets;
- innovative and flexible approaches to parking;
- pedestrian-, bicycle-, and transit-friendly design; and
- access and proximity to transit.

Compact development can be built anywhere. It encompasses residential and commercial development and can be adapted to urban, suburban, and rural settings. Single-family houses, townhomes, and apartments all have a place in compact development. Employment centers are also important candidates for compact development.

The Advantages of Compact Development

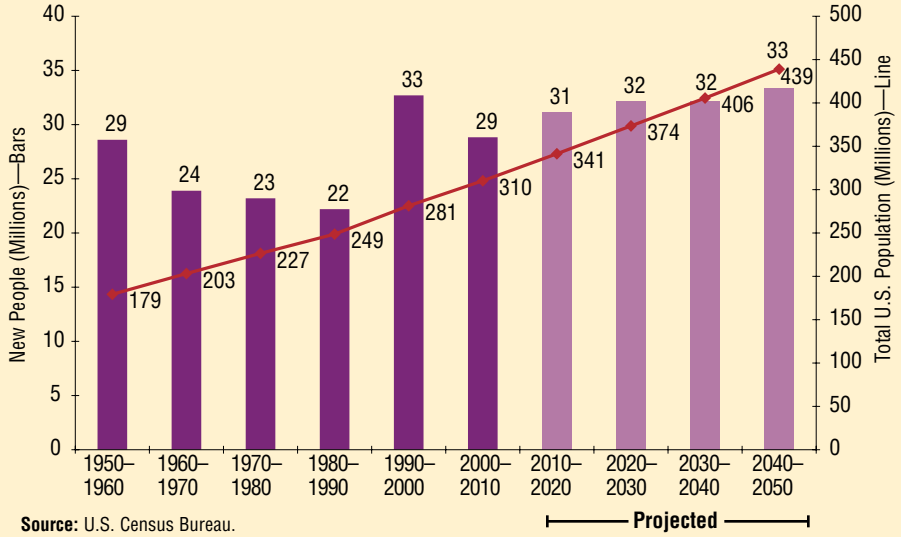
Compact development can:

- foster the emergence of vibrant, walkable communities;
- make active, healthier lifestyles easier to enjoy;
- conserve land by accommodating more people in less space;
- support transportation alternatives;
- reduce congestion;
- lower infrastructure costs for communities, families, and individuals;
- reduce household expenses related to transportation and energy; and
- make life more convenient by putting destinations closer together.

What Does Compact Residential Development Look Like?

Compact development can take many forms.

Every Decade between Now and 2050, the United States Will Add More Than 30 Million People



Source: U.S. Census Bureau.

Now, the three studies examined in this report add climate change to the mix. In addition to all of these benefits, compact development can lower greenhouse gas emissions by reducing driving.

Compact development becomes all the more compelling given that the United States will grow by more than 130 million people over the next 40 years, with the overwhelming majority choosing to live in metropolitan areas.

The Transportation Sector Is Key in Climate Change

Reducing emissions from the transportation sector will be critical to lowering overall greenhouse gas emissions.

Climate change, energy efficiency, and overdependence on foreign sources of energy have escalated to become a major center of federal and local policy reform. These reforms have set a goal for significant greenhouse gas (GHG) emissions reduction—often targeted at 80 percent below current levels. But in getting to that goal, the implementation challenge remains enormous.

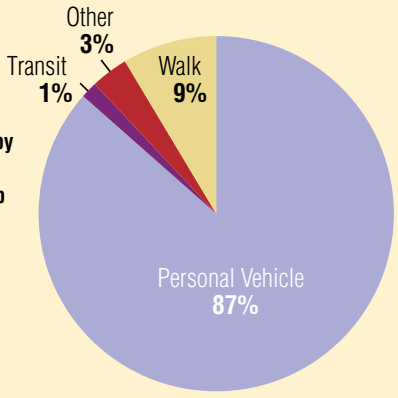
Two trends are pushing against each other. Over the next 40 years, as the total and metropolitan population of the United States climbs, the pressure is on to make overall emissions move in the other direction—down.

The transportation sector is a good place to start in the battle against greenhouse gas emissions. It represents about one-third of overall GHG emissions in the United States, and it is the fastest-growing sector in GHG emissions. The growth comes from a history of increasing amounts of driving—and underlying land use patterns can dictate the need to drive.

Why Land Use Patterns Matter

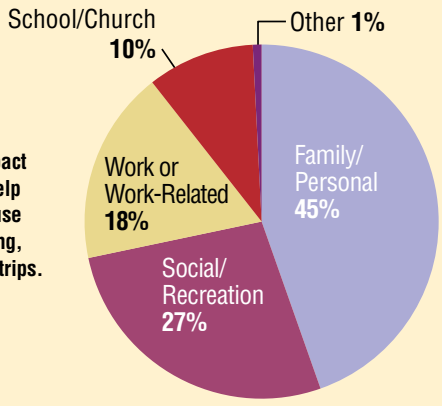
The key to successful compact development is a land use pattern that has a high-quality pedestrian network and a variety of land uses within walking distance of each other. Compact development also allows drivers to park once—for example, in a shopping district—and take care of many errands and activities without getting in their cars again. Since most trips of all modes are not work or work-related trips, compact development makes destinations like church, school, and shops more convenient to access with limited vehicular trips.

Proportion of Trips by Mode



Most trips are taken by automobile. Compact development can help decrease the number of trips taken by car and decrease the distance driven in each trip.

Proportion of Trips by Purpose

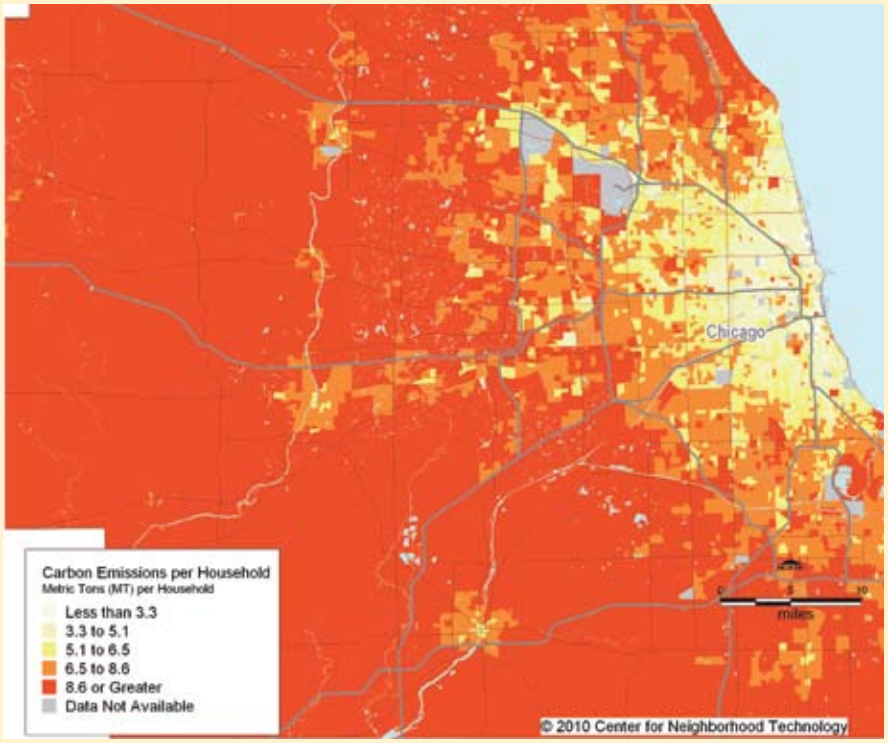


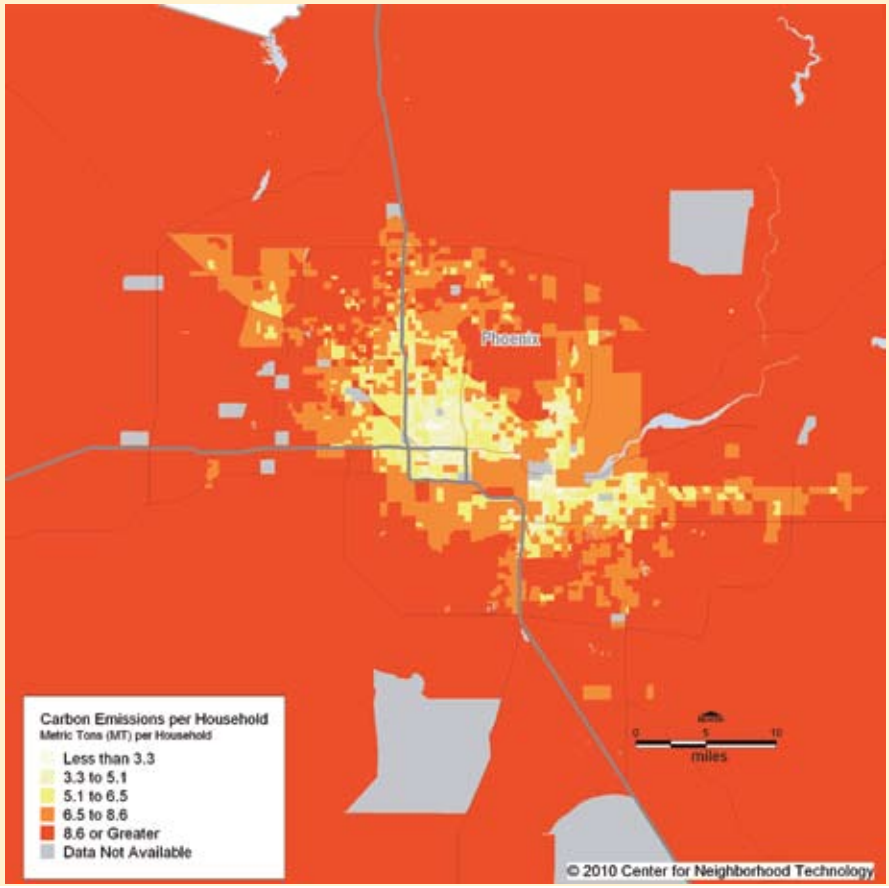
Most trips are not work-related. Compact development can help people reduce car use for errands, shopping, and other personal trips.

Source: National Household Travel Survey (2001), U.S. Department of Transportation.

Carbon Emissions per Household in Chicago, Illinois, and Phoenix, Arizona

Maps show CO_2 emissions from household automobile use in Chicago (top) and Phoenix (bottom). The areas with the highest emissions from driving tend to be in the more recently developed areas on the outskirts of the metropolitan region. (Center for Neighborhood Technology, 2010)





Compact Development Mitigates Climate Change by Reducing Driving

There is a certain logic to the observation that if the places where people work, play, and shop are closer to their homes and to each other, the amount of driving, in terms of distance, will shrink. Prior to the studies *Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment*, numerous benefits of compact development were understood, but there was a lack of solid information on the long-term climate value of compact development. More information was needed.

Specifically, do better land use choices pay off as a core strategy in the broader effort to reduce greenhouse gas emissions? How could the reduction in driving be measured? What was the extent of the reduction in driving—vehicle miles traveled (VMT)—and was it significant? And what does this reduction of VMT mean for the overall reduction in greenhouse gas emissions?

These studies provide some answers: Growth patterns *can* help reduce GHG emissions from business-as-usual projections. By reducing the need to drive, compact development can make a substantive difference. Implementing compact development strategies can help achieve U.S. emissions reduction goals over the next 40 years.

If we could go to 2050 and look back, we would see that successfully implemented compact development strategies—even those with only modest increases in land use density and mix—resulted in a win-win: a boon both for the environment and for Americans looking for the healthy and convenient lifestyle benefits associated with this type of quality land use.

The three studies find that compared to sprawling land use patterns, compact development reduces driving—and less driving means lower greenhouse gas emissions.

Trends in VMT from Compact Development: Shared Lessons from the Three Studies

Growing Cooler, *Moving Cooler*, and *Driving and the Built Environment* differ in their methods and the specifics of their conclusions, but they share several fundamental conclusions:

- Compact land use patterns result in fewer vehicle miles traveled (VMT), in terms of both the length and the number of vehicle trips, than do sprawling land use patterns.
- This reduction in VMT appears incrementally over a long period of time.
- As the amount and quality of compact development increases, the reduction in VMT accelerates.
- Importantly, this reduction in VMT and corresponding reduction in GHG emissions is permanent.

Quantifying VMT Reductions in the Three Studies

Each study settles on different estimates of the actual reductions in VMT for compact development versus typical suburban development. *Moving Cooler* finds that compact suburban development reduces VMT by 20 percent and urban development reduces VMT by up to 60 percent. *Growing Cooler* concludes that, in comparison to sprawling development patterns, compact development reduces VMT by 20 to 40 percent. And *Driving and the Built Environment*, after an extensive review of published research, concludes that doubling residential density reduces VMT by 5 to 12 percent, or by as much as 25 percent when combined with other changes.

Greenhouse Gas Emissions Reduction Targets

There is an emerging consensus across diverse policy-making bodies that greenhouse gas emissions must be reduced 60 to 80 percent by the year 2050. As of 2010, at least 20 U.S. states have adopted greenhouse gas reduction targets into law. All of these states vary in their specific goals and timelines, as do three multistate regional initiatives—the Western Climate Initiative, Regional Greenhouse Gas Initiative, and Midwestern Regional Greenhouse Gas Reduction Accord—that are creating mandatory, market-based regulations to reduce greenhouse gas emissions. These 20 states encompass a majority of the dynamic metropolitan real estate markets in the United States. In addition, over 1,000 cities across the United States have signed on to the GHG reduction goals as proposed by the U.S. Conference of Mayors.

Compact Development vs. Typical Suburban Development: Evidence from the Three Reports

Study	Method	Conclusions
Moving Cooler	Analyzes the VMT generated by Americans living at different densities.	In comparison to low-density suburban development, compact suburban development reduces VMT by 20 percent and urban development reduces VMT by up to 60 percent.
Growing Cooler	Analyzes past studies of the connection between VMT and the characteristics of compact development.	In comparison to outer-edge suburban development patterns, compact development reduces VMT by 20 to 40 percent.
Driving and the Built Environment	Extensive review of published research.	Doubling residential density reduces VMT by 5 to 12 percent. If doubling density is combined with other changes, such as an increase in mixed-use development and transit improvements, the study estimates an upper limit of 25 percent for VMT reductions from compact development.

At a Glance: VMT and GHG Reduction Estimates from Compact Development (vs. Typical Suburban Development)

Study	VMT Reductions	GHG Reductions
Moving Cooler	20–60 percent	20–60 percent
Growing Cooler	20–40 percent	18–36 percent
Driving and the Built Environment	5–12 to 25 percent	5–12 to 25 percent

Converting Vehicle Miles Traveled to Greenhouse Gas Emissions

To convert VMT reductions into greenhouse gas emission reductions, *Moving Cooler* and *Driving and the Built Environment* both assume a proportional relationship. Thus, if VMT decrease by 10 percent, greenhouse gas emissions also decrease by 10 percent. *Growing Cooler* assumes that the ratio of greenhouse gas emissions to VMT reduction is 9:10, reflecting lower average vehicle operating speeds.

Density and Compact Development

Moving Cooler, *Growing Cooler*, and *Driving and the Built Environment* agree that compact development is not simply another term for "density." For the purposes of modeling, however, the studies define the residential density component of compact development to *average* in the range of 11 to 15 dwelling units per net acre. There are many ways to build this average density. Compact residential development could consist of townhouses, apartment buildings, and single-family houses on small lots in a wide variety of combinations.

Conservative Estimates

Because all three studies are based on research and data from the American era of relatively inexpensive gasoline, it is likely that they provide conservative estimates of compact development's potential to reduce driving. In other words, people who live in low-density suburbia are stuck driving—oftentimes long distances—no matter what fuel costs. People who live and/or work in compact development have more choices about how to meet their daily needs through shorter trips and through walking, bicycling, and using transit.

The studies, moreover, isolate the effect of the built environment alone and do not examine how expensive energy could increase market preferences for compact development in the United States.

Finally, reducing drive time is not the only way compact development can have an effect on emissions. Compact development also has the potential to reduce energy consumption and greenhouse gas emissions through building efficiency. While all three studies acknowledge this additional benefit, the findings focus on the reductions gained through reduced VMT.

More to Learn

That the three studies reported reductions in VMT in such large ranges (5 to 60 percent) is an indication of how much more there is to be learned about the effect of compact development on driving. It is also a reminder that for individual development projects, on-the-ground results will vary depending on local context and specific project elements.

Narrow, landscaped streets and ground-level retail shops at the Kierland Commons development in Scottsdale, Arizona, provide access by car and by foot. (Dale Horchner)

The studies show reductions in VMT of between 8 and 18 percent percent, on a national basis, when compact development makes up 60 percent or more of all future development between now and 2050.

Looking to 2050: More Compact Development Means More Significant Reductions in Driving and Emissions on a National Basis

To assess the potential impact of compact development on climate change and energy consumption, *Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment* created models of land development extending to 2050. Each model included findings on key variables such as population growth, new residential development, replacement housing, and the relationship between compact development and VMT reductions.

The three studies then created scenarios that varied the amount of new development that meets the definition of compact development. Scenarios assigned compact development to shares ranging from 25 to 90 percent of future development. Each looks at the domestic U.S. market as a whole and does not model VMT scenarios on a local or metropolitan basis.

The models in the three studies started to show meaningful reductions in VMT when compact development made up more than 60 percent of future development and redevelopment. The studies projected VMT reductions in 2050 ranging from 8 to 18 percent. But if compact development makes up less than 60 percent of future development, compact development's ability to reduce VMT is less significant. At 25 percent of all future development, compact development reduces VMT in 2050 by just a few percentage points.

Summary of the Scenarios in the Three Studies: National Reductions of Annual VMT and GHG in 2050

Scenarios	Percent "Compact"*	Percent Reduction of Total VMT from Study Baseline	Percent Reduction of GHG from Study Baseline**
Moving Cooler			
Aggressive Deployment	64%	7.7%	7.7%
Maximum Deployment	90%	12.6%	12.6%
Growing Cooler			
Majority Compact	60%	12%	10%
Nearly All Compact	90%	18%	16%
Driving and the Built Environment			
Moderate	25%	1.3–1.7%	1.3–1.7%
Aggressive	75%	8–11%	8–11%

* Each of the three studies uses different definitions of "compact."

** Study baseline is 2050 household greenhouse gas emissions from VMT, not the often-cited 1990 total greenhouse gas emissions baseline.

Consumer Demand for Compact Development Will Help Determine How Much Is Built

Compact development is a relatively low-cost yet promising long-range strategy to mitigate climate change and reduce energy consumption. Its promise, though, is dependent on how well it can leverage the momentum of changing market demand.

To have a significant effect on GHG emissions nationally, compact development must make up a significant proportion of future development—at least 60 percent or even more. This would entail reversing decades-long trends of sprawling development patterns. All three studies are dependent on trends data that end in about 2000—and each study notes that little evidence through the 1990s indicates that Americans had changed course on sprawl. Whether recent trends have started the United States down the path of more compact development is still unclear.

While the studies caution that research on recent trends is inadequate, they also point out reasons to believe that demand for more compact development is on the rise. *Growing Cooler*'s survey of changing demand and preferences in housing concludes that compact development is already undersupplied. Demographic and cultural trends, moreover, indicate that by 2025 there will be an excess of large-lot, single-family houses; demand for new housing will be defined by smaller houses on small lots, townhomes, and apartments.

Consumer preferences—expressed through market demand—will be the most important factor contributing to the success of compact development as a climate change and energy strategy.

The Growing Demand for Compact Places

Market studies show that the demand for compact development is growing. For example, the U.S. Environmental Protection Agency has documented continuing trends toward center city investment, finding that many cities have doubled or even tripled their capture of regional residential construction since 2000. In addition, market preference research for "generation Y" (people in their 20s) showed that 77 percent plan to live in the urban core, and one-third will pay more to live near shops, work, and entertainment. The strong urban preference of generation Y suggests very high demand for urban housing types.

Sources: Environmental Protection Agency, *Residential Construction Trends in America's Metropolitan Regions*, 2010; RCLCO, *The Growing Demand for Smart Growth*, 2010.

Driving and the Built Environment concurs that there is currently unmet demand for compact development in the United States and asks whether current trends indicate an even higher demand for compact development in the future. The study finds that the aging population, the growth in immigrant populations, and preferences among young adults for urban living all support increasing demand for compact development.

Higher energy prices will also change travel patterns and perhaps even location decisions. Rising gas prices may make compact, walkable, and transit-oriented development patterns even more attractive to potential buyers. Rising incomes, on the other hand, usually track with increasing travel, driving, and sprawl. While *Driving and the Built Environment* expects growing demand for compact development, the study concludes that "it is unclear by how much," because so much is uncertain about trends in prices, income, and preferences.

Land use regulations and government policies must support the growing market for compact development in order for it to function effectively as a climate change strategy.

Policy and Regulatory Changes Are Essential for Compact Development Strategies to Work

While the studies show compact development is a viable climate change strategy and that the market is growing for it, effectiveness and demand alone are not enough to spur greater compact development efforts.

What are the obstacles to compact development? These are largely institutional, regulatory, and financial. On the institutional side, government fragmentation and sectoral silos can stymie attempts to build in more compact ways, because this type of development is more complicated than other types. Regulatory barriers include exclusionary zoning, large minimum lot sizes, engineering standards for street design and parking, and other impediments to change. Financial challenges include reluctance on the part of lenders to participate in more complicated mixed-use projects; compact development can also be more expensive to build than other kinds of development, and may require the integration of transit and other expensive infrastructure.

Challenges are local, regional, and national in scale. At the local level, land development regulations can get in the way of building in compact ways. At the regional level, jurisdictional competition can steer development away from close-in locations, and at the national level transportation and housing investments and priorities can work against the effort to build more compact places.

However, interest in and policy support for compact development are gaining momentum. The spread of "traditional" neighborhood developments, voter-approved expansions to light-rail systems, and the federal government's interest in promoting more livable, sustainable communities are three examples of this growing trend.

New Columbia, in Portland, Oregon, features interconnected local streets that provide pedestrians with quick connections in and through the development. (Pete Eckert)

Common Findings, Common Sense on the Road to 2050

The demographic trends between now and 2050 will lead to major metropolitan growth. This development pressure could result in sprawling, automobile-oriented suburbs—the type of development that increases both the need for driving and corresponding GHG emissions. Yet, because this development has not yet been built, it represents an opportunity to shape resulting land use patterns and achieve broader GHG emissions reduction targets.

There are many diverse reasons to pursue compact development strategies. From the ability to foster more vibrant places to supporting more active living, compact development appeals in many ways. The market is responding, providing increasing support for compact development. Now, the evidence in *Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment* makes the case for compact development even more compelling. By providing quantifiable results, these studies make it clear that compact development can help in the fight to mitigate climate change.

Although compact development has an important place in any broader package of climate change mitigation strategies, it is just one in a range of comprehensive measures needed to reduce GHG emissions. These include improvements in transitioning to cleaner energy sources, better vehicle efficiency, and an increase in the energy efficiency of buildings.

Compact development is one of many promising stategies for reducing GHG emissions, one that brings with it a host of other benefits as well.

PART 2 Technical Summaries of Land Use in the Three Reports

Moving Cooler, *Growing Cooler*, and *Driving and the Built Environment* quantify the potential for compact development to reduce driving and lower greenhouse gas emissions. This section reviews their methodologies, findings, and conclusions about driving and land use.

***Moving Cooler's* analysis shows that land use is one of the top-performing climate change strategies—one that becomes even stronger when combined with other transportation strategies supporting compact development.**

Moving Cooler: Land Use Is an Important Climate Change Strategy

Cambridge Systematics, a transportation consulting firm, prepared *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*, published by ULI in July 2009 under the guidance of a large, diverse group of sponsoring organizations. Of the three studies, *Moving Cooler* is the most wide-ranging, taking on nine different types of transportation strategies targeted at decisions about travel and improvements in operations. It also looks at the movement of both people and freight. *Moving Cooler* tests nearly 50 discrete transportation strategies and six different "strategy bundles," or combinations of strategies.

Moving Cooler found no silver bullet. No one strategy alone reduces greenhouse gas emissions enough to approach reduction targets. When strategies coalesce, however, greenhouse gas reductions become significant. The study projects possible national annual greenhouse gas emission reductions of up to 24 percent below baseline levels in 2050 when a mix of strategies, including land use, is employed at aggressive levels.

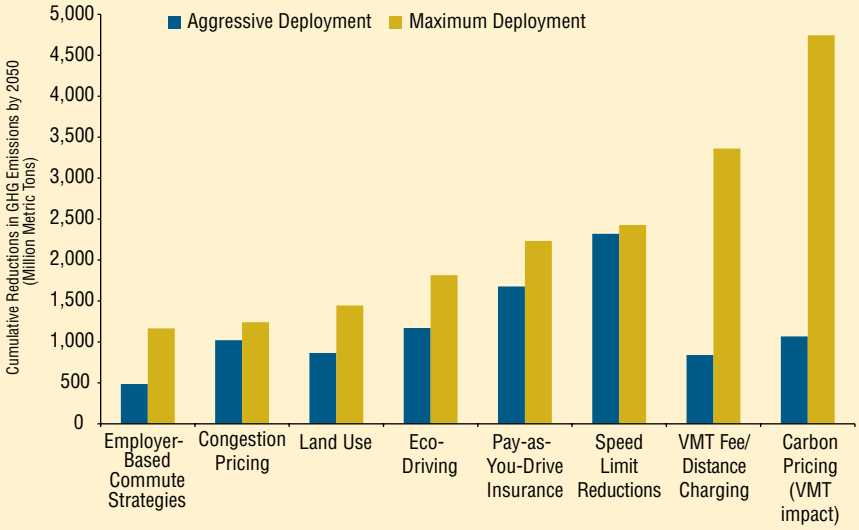
In addition to greenhouse gas reductions, *Moving Cooler* looks at implementation costs, vehicle cost savings, and equity issues. The report analyzes both individual strategies and bundles of several strategies at different levels of implementation. This summary focuses on implementation of the land use–related strategies at two deployment levels: aggressive and maximum.

Moving Cooler Tests an Ambitious Set of Strategies and Strategy Bundles

Types of Strategies	Strategy Bundles
Pricing and Taxes	Near-Term/Early Results
Land Use and Smart Growth	Long-Term/Maximum Results
Nonmotorized Transport	Land Use/Transit/Nonmotorized Transportation
Public Transportation Improvements	System and Driver Efficiency
Ride-sharing, Car-sharing, and Other Commuting Strategies	Facility Pricing
Regulatory Strategies	Low Cost
Operational and Intelligent Transportation System (ITS) Strategies	
Capacity Expansion and Bottleneck Relief	
Multimodal Freight Sector Strategies	

Moving Cooler shows that compact development is among the top-performing strategies, competitive with pricing strategies that raise the cost of driving or strategies that regulate driving. Land use ranks in the top tier of *Moving Cooler*'s 50 strategies. Combining land use with other strategies that support compact development results in even stronger performance.

Moving Cooler: Land Use Is among the Top Strategies to Reduce Greenhouse Gas Emissions



Source: *Moving Cooler.*
Note: Does not include carbon pricing (fuel economy impact).

A streetcar runs in front of the Terry Thomas building in South Lake Union, Seattle.
(Image courtesy of Weber Thompson; Gabe Hanson, photographer)

Scenarios Show Higher Residential Density Means Lower VMT

Moving Cooler calculates VMT reductions from land use by developing three scenarios that look at what happens if new development occurs at a range of progressively higher densities. *Moving Cooler* uses residential density as a proxy for a range of rural, suburban, and urban environments. At higher densities, vehicle trips are shorter and the built environment is more likely to support walking, bicycling, and transit use.

The land use model compares vehicle miles traveled per capita at a range of densities within the United States, using data from the 2001 National Household Travel Survey and the 2000 Census. Not surprisingly, the model finds that people living at densities exceeding 4,000 persons per square mile (approximately five dwelling units per acre) drive significantly less than people living at densities below 4,000 persons per square mile. (*Moving Cooler*'s measures of density approximate net residential density.)

To get to 2050, *Moving Cooler* looks at scenarios for distributing residential growth at different densities. The baseline scenario projects that the distribution of growth that occurred during the 1990s continues until 2050. During the 1990s, only 34 percent of growth took place in areas with densities of five dwelling units per acre and above. The aggressive deployment and the maximum deployment scenarios distribute more growth, including new development and redevelopment, into compact suburban and urban areas.

In terms of VMT, the model projects that in 2050 people living at urban densities (greater than 12.5 dwelling units per acre) will drive 60 percent less than people living on rural one- or two-acre lots, and people living at compact suburban densities (five to 12.5 dwelling units per acre) will drive 20 percent less than people living in low-density suburbia. (This explanation simplifies the model a bit in order to focus on the key variables.) Comparing the scenarios to the baseline produces annual VMT reductions in 2050 of between 7.7 percent and 12.6 percent.

Three *Moving Cooler* Land Use Scenarios: Reduction in Annual VMT in 2050

	Distribution of Residential Growth			
Scenarios	**Rural and Suburban**	**Compact Suburban**	**Urban**	**Percent Reduction in Total VMT from Baseline**
1990s Development Pattern	66%	21%	13%	Baseline
Aggressive Deployment	36%	31%	33%	7.7%
Maximum Deployment	10%	49%	41%	12.6%

Compact Suburban: 5 to 12.5 dwelling units per acre. Urban: Greater than 12.5 dwelling units per acre.

Moving Cooler also identifies a set of strategies that would promote the densities—and the compact development—analyzed in the land use scenarios. These land use and smart growth strategies range from incentives for compact development and regional planning to regulatory interventions such as zoning changes and urban growth boundaries. The projected VMT and greenhouse gas reductions, however, are based on analyzing the effects of the density variable alone. The land use analysis does not model the impact of techniques for achieving compact growth.

Moving Cooler's Compact Development Strategies: Cumulative Greenhouse Gas Reductions (in million metric tons) by 2050

Strategy	Aggressive Deployment	Maximum Deployment
Land Use	865	1,445
Nonmotorized Transport Strategies		
Pedestrian	171	227
Bicycle	117	176
Public Transportation Strategies		
Transit Fare Measures	34	78
Increased Frequency, LOS, Extent	72	168
Urban Transit Expansion	281	575
Parking Strategies		
CBDs and Regional Activity Centers:		
On-Street Parking Pricing	41	42
New Tax/Higher Tax on Free Private Parking	18	31
Urban Parking Restrictions	189	359
Residential Parking Permits	20	48
Sum of All Compact Development Strategies	**1,808**	**3,149**

Note: According to the U.S. Environmental Protection Agency, 1 million metric tons is approximately equal to annual greenhouse gas emissions from 190,000 U.S. passenger vehicles.

Synergy for a Stronger Effect: Looking at Other Compact Development Strategies

Moving Cooler also tests other compact development strategies, apart from changes in land use. These additional compact development strategies include building sidewalks, improving bicycle facilities, expanding transit service, and increasing the cost of parking. The cumulative reductions of all the compact development strategies are summarized in the table above.

Because *Moving Cooler* quantifies the effects of various strategies, the study creates specific definitions of each strategy and any accompanying assumptions. The cumulative greenhouse gas reductions cited above represent reductions only from specific strategies. The analysis results should not be interpreted as representing either the minimum or the maximum possible reduction from an exhaustive list of all nonmotorized transport, public transportation, and parking strategies.

In some cases, the definitions of these individual strategies in *Moving Cooler* are quite expansive. For instance, the pedestrian and bicycle strategies imagine urban and suburban areas served by continuous networks of sidewalks and bicycle lanes supported by other bicycle and pedestrian infrastructure.

The parking strategies, on the other hand, are more limited in their vision. Three of the four parking strategies target commuter traffic parking in central business districts (CBDs) and activity centers. Within the CBDs and activity centers, the pricing

analysis examines the effect of increasing the price of on-street parking by 25 percent and taxing free parking in large private parking lots at the equivalent of about $2.40 per round trip. *Moving Cooler* also looks at what happens if a "freeze" is put in place on the supply of commuter parking in CBDs and activity centers.

For residential parking, *Moving Cooler* looks only at on-street parking, analyzing the effects of requiring permits costing $100 per year (aggressive deployment) and $200 per year (maximum deployment).

In the public transportation area, *Moving Cooler* explores strategies that lower fares and expand service. The analysis looks at the effect of lowering fares by 33 percent and 50 percent and of increasing the frequency, speed, and extent of bus-based transit service.

Finally, the urban transit strategy analyzes expanded rail and bus rapid transit service, which leads to more trips on traditional buses, and finds that overall ridership would increase by 3.53 percent annually (aggressive deployment) and 4.67 percent annually (maximum deployment). To put these ridership increases in perspective, between 1999 and 2007 transit ridership in the United States has grown at an average annual rate of about 2 percent.

Moving Cooler **Conclusion**

On the question of whether land use strategies and associated transportation strategies can have a meaningful impact on climate change, *Moving Cooler* answers: Yes. Compact development is important to any climate change strategy bundle.

Wilshire Boulevard in west Los Angeles is an example of a compact corridor surrounded by lower-density buildings. (Shelly Albaum)

***Growing Cooler* shows that the five "*D*s" of compact development—density, diversity, design, destination, and distance to transit—can lead to 12 to 18 percent reductions in VMT by 2050.**

Growing Cooler: The Five "*D*s" of Compact Development Reduce Vehicle Miles Traveled

When *Growing Cooler: The Evidence on Urban Development and Climate Change* was published by ULI in 2008, it provided one of the first comprehensive overviews of the relationship between climate change, the built environment, and how people travel. *Growing Cooler*'s comprehensive approach to land use is broader than *Moving Cooler*'s focused analysis.

Growing Cooler studies the effects of the "five *D*s" of compact development: density, diversity, design, destination, and distance to transit. Compact development—as opposed to sprawl—is defined by medium to high densities, mixed uses, and concentrated centers, and is served by interconnected streets and pedestrian- and transit-friendly design.

Growing Cooler's land use model starts with a meta-analysis of studies that measure the relationship between VMT and the "five *D*s" of compact development. The report concludes that compact development has the potential to reduce VMT per capita from 20 percent to 40 percent, relative to sprawl. The report's authors choose a 30 percent reduction for their land use model.

Three Scenarios for 2050

To get to 2050, *Growing Cooler* analyzes scenarios that vary the share of compact development in new development and redevelopment. Based on an analysis by Chris Nelson, professor and demographic expert from the University of Utah, the scenarios forecast that in 2050, two-thirds of development on the ground will have been built after 2005. *Growing Cooler* then tests three what-if scenarios:

- What if all the post-2005 development is sprawl?
- What if 60 percent is compact development?
- What if 90 percent is compact development?

The reduction from the baseline is achieved by multiplying three variables:

- Proportion of land developed since 2005
- Proportion compact
- Percent reduction in VMT.

In comparison to the baseline, *Growing Cooler* finds VMT reductions in 2050 from 12 percent to 18 percent.

Three *Growing Cooler* Scenarios: Reduction in Annual VMT in 2050

Land Development Scenarios: 2005 to 2050	Proportion of Land Developed: 2005–2050	Proportion Compact	Percent Reduction in VMT from Compact Development	Percent Reduction in Total VMT from Baseline
All Sprawl—Base	Two-thirds	None	None	Baseline
Majority Compact	Same as base	60%	30%	**12%**
Nearly All Compact	Same as base	90%	30%	**18%**

Because *Growing Cooler* assumes the ratio of greenhouse gas emissions to VMT reduction is 9:10, the scenarios produce greenhouse gas reductions between 10 and 16 percent.

Growing Cooler's land use model does not define or prescribe "medium to high density." The authors emphasize that all of the "*D*s" are important; density is no more fundamental than is mixed use or are other characteristics of compact development. The 30 percent reduction in VMT is drawn from studies analyzing *all* the characteristics of compact development, not just density.

Growing Cooler **Conclusion**

Compact development's potential to reduce driving and greenhouse gas emissions is significant, although improvements in vehicle and fuel technology will also be needed to reach GHG reduction targets by 2050. Despite needed policy and regulatory reforms, increasing market demand for compact development means advancing it will be "worth the effort."

The 2200 Westlake project in the South Lake Union neighborhood of Seattle, Washington, features residences, retail shops, restaurants, and more. (Lara Swimmer Photography)

Despite its cautious approach to the analysis of compact development and driving, *Driving and the Built Environment* recommends that policies to support more compact development be encouraged.

Driving and the Built Environment: Compact Development Lowers Driving, Emissions, and Energy Use

The Transportation Research Board convened a committee of experts to prepare *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions*, released in August 2009, in response to a Congressional request for an examination of "the relationship between land development patterns and motor vehicle travel in the U.S." and an assessment of "whether petroleum use and CO_2 emissions could be reduced by changes in development design." Led by José Gómez-Ibáñez, a professor at Harvard, the committee included a number of the most prominent academics in the field.

Review of Past Studies

Driving and the Built Environment takes a guarded approach to past studies of the effect of the built environment on driving, critically analyzing their limits and assumptions. Most of the studies analyze the relationship between household density and vehicle miles traveled; fewer studies take a rigorous look at the other characteristics of compact development. *Driving and the Built Environment* defines "compact, mixed-use development" as "land use patterns that increase the density, mix of uses, contiguity, connectedness, and pedestrian orientation of development."

Based on review of past research into household density and VMT, *Driving and the Built Environment* concludes that doubling residential density lowers household VMT by 5 to 12 percent.

Recognizing that the other characteristics of compact development can enhance the effect of density, the committee noted a rigorous study that takes into account employment concentrations, improvements in public transit, increases in mixed-use development, and other changes. This study uses statistical techniques to envision what would happen to driving if auto-oriented Atlanta were rebuilt as a walkable city such as Boston: a theoretical Atlanta-to-Boston transformation would reduce driving by 25 percent.

Three Scenarios for 2050

To get to 2050, *Driving and the Built Environment*, like *Moving Cooler* and *Growing Cooler*, creates three land use scenarios. The Baseline scenario assumes that new and rebuilt housing matches the density of residential development built during the 1990s, which averaged between one and two dwelling units per acre. (This refers to gross density and includes all developed land and roads; averages vary depending on the data source.)

Three *Driving and the Built Environment* Scenarios: Reduction in Annual VMT in 2050

Land Development Scenarios to 2050	New and Replacement Housing	Density of New Residential Development	Percent Reduction of VMT for Households in New Compact Development	Percent Reduction of Total VMT from Baseline
Baseline	62–105 million units	Base assumes the density of residential development from the 1990s continues	Not applicable	Baseline
Moderate	Same as base	25% is twice as dense as base	12%	**1.3–1.7%**
Aggressive	Same as base	75% is twice as dense as base	25%	**8–11%**

The Moderate and Aggressive scenarios double the Baseline density for an increasing share of new and rebuilt housing. The Moderate scenario deploys compact development for 25 percent of new and rebuilt housing and assumes that compact development is coupled with a 12 percent reduction in VMT per household. In comparison to the Baseline scenario, the Moderate scenario produces reductions in annual VMT in 2050 of between 1.3 percent and 1.7 percent. (A 5 percent reduction in VMT per household produces VMT reductions in 2050 of less than 1 percent.)

The Aggressive scenario distributes 75 percent of new and rebuilt housing into compact development and uses a VMT reduction of 25 percent. In comparison to the Baseline scenario, the Aggressive scenario produces reductions in annual VMT in 2050 of between 8 percent and 11 percent.

Because *Driving and the Built Environment* assumes a proportional relationship between VMT and greenhouse gas reductions and energy consumption, the VMT reductions generated by the Moderate and Aggressive scenarios translate into reductions of between 1.3 percent and 11 percent for greenhouse gas emissions and energy use.

Questions about Feasibility

For future compact development, the Moderate and Aggressive scenarios posit a huge range: 25 percent to 75 percent of new and replacement development. Examining the highest end of this range, *Driving and the Built Environment* questions whether it is feasible for compact development to make up 75 percent of all development built between now and 2050. Does the Aggressive scenario represent "such a significant departure" from current trends and land use policies that "those measures are unrealistic"? Or, could the growing interest in compact development and trends toward higher energy prices "result in considerably higher densities by 2050"? Reflecting the difficulty of predicting the future in uncertain times, the committee did not come to agreement on an answer.

Sweeping changes to land use regulations and metropolitan development patterns, the study warns, will likely be slowed by political resistance from existing homeowners and local government. The report recommends another approach: targeted incentives and regulatory interventions such as overlay zoning. The greatest opportunities for compact development, the study concludes, are likely to be in areas already experiencing density increases, such as inner suburbs, developments near transit stops, and areas along major highway corridors or interchanges.

***Driving and the Built Environment* Conclusion**

Despite uncertainty about future trends and concerns about plausibility, the committee recommends to Congress that "policies that support more compact, mixed-use development and reinforce its ability to reduce VMT, energy use, and CO_2 emissions should be encouraged." Climate change is a problem "more easily dealt with sooner rather than later," and land use is a valuable strategy toward meeting ambitious goals for energy efficiency and greenhouse gas emission reductions. Yet promoting compact development on a large scale will require overcoming numerous obstacles, including local zoning regulations and land use governance. The durability of the built environment and the challenges of compact development, however, suggest that change should start now.

Acronyms

CBD	Central Business District
CO_2	Carbon Dioxide
GHG	Greenhouse Gas
TRB	Transportation Research Board
ULI	Urban Land Institute
VMT	Vehicle Miles Traveled

Two trends are pushing against each other. Over the next **40 years**, as the total and metropolitan **population** of the United States **climbs**, the pressure is on to make overall **emissions** move in the other direction—**down**.

Land Use and Driving

The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions

Evidence from Three Recent Studies

When people have the opportunity to work, play, and shop closer to their homes, the amount of driving they do lessens. This translates into reductions in greenhouse gas emissions. That is the conclusion of *Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment*, which document and attempt to quantify the effectiveness of compact development as a tool to reduce greenhouse gas emissions.

Compact development offers a host of benefits, from providing more walkable, livable, healthy communities to saving on regional infrastructure costs. Now, its benefits are being documented to include greenhouse gas emission reductions.

Based on exhaustive analyses of urban planning research and the formulation of new scenario-based models, *Moving Cooler*, *Growing Cooler*, and *Driving and the Built Environment* all find that, compared to historically sprawling land use patterns, compact development reduces driving and greenhouse gas emissions over time. On a national basis, the studies show that compact development can be an effective component of broader strategies to reduce greenhouse gas emissions.

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