Planning for Climate Change

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The debate about the reality of global warming, and the human role in precipitating climate change, has been largely put to rest. Four working groups from the United Nations–sponsored Intergovernmental Panel of Climate Change (2007) have come to a consensus that would be gratifying if it were not so frightening. Yes, the globe is warming they say. Yes, humans are the primary agent for this change. Yes, the consequences may be dire.

The Stern Review on the Economics of Climate Change (2007) was also released last year by the Treasury Department of the British Government, whose only task was to assess the financial implications of global warming. That report warned that the costs of correcting this problem were affordable in the short term, but if nothing was done soon, the coming global economic calamity would make the depression of the 1930s look like a period of great luxury.

The Transportation and Land Use Nexus

The burning of fossil fuels, mostly to heat and cool buildings and move our vehicles, is the predominant contributor to atmospheric climate change, helping to increase concentrations of carbon dioxide (CO_2) to a level 35 percent higher than they have ever been. The United States is the largest single producer of atmospheric CO_2, with per capita production second only to that of Canada. About a quarter of all CO_2 generated in the United States is directly attributable to the exhaust gases discharged from the tailpipes of cars and trucks on our roads, and this component as a percentage of the whole is rising. This amount does not include the CO_2 contributions associated with gasoline refining, car manufacturing, and road building for all these cars and trucks. For example, the concrete industry alone is responsible for 5 percent of the total CO_2 production globally, and much of this concrete is used for road infrastructure.

Clearly an across-the-board reduction in CO_2 production will require a more carbon-efficient relationship between transportation and land use, and in the industry and infrastructure that support them. Most of the recent proposals for mitigating this crisis have focused on new technologies for saving energy, notably on a dramatic increase in average miles per gallon (MPG) of cars and trucks, and a gradual switch to low-carbon fuels like ethanol. Unfortunately, in the absence of a strategy to reduce the average number of miles driven by Americans, all increases in fuel efficiency and low-carbon fuels will only slow, not reverse, the rise in per capita CO_2 emissions, and the seemingly inexorable increase in the average number of miles driven by Americans every year (known as vehicle miles traveled, or VMT per capita) (Ewing et al. 2007).

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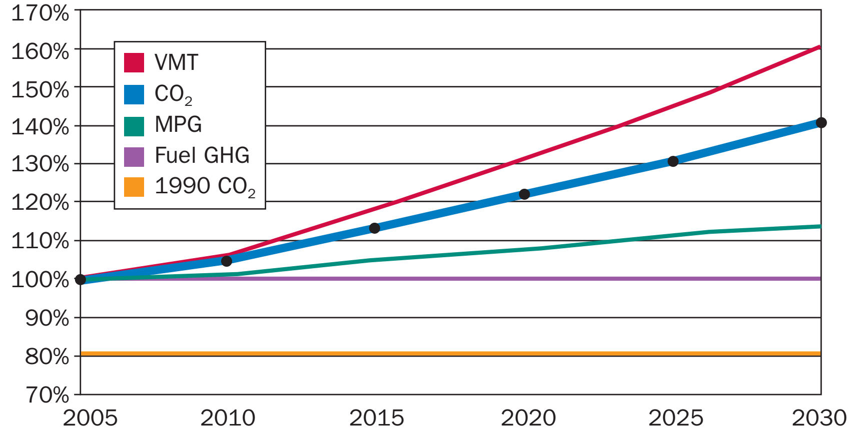
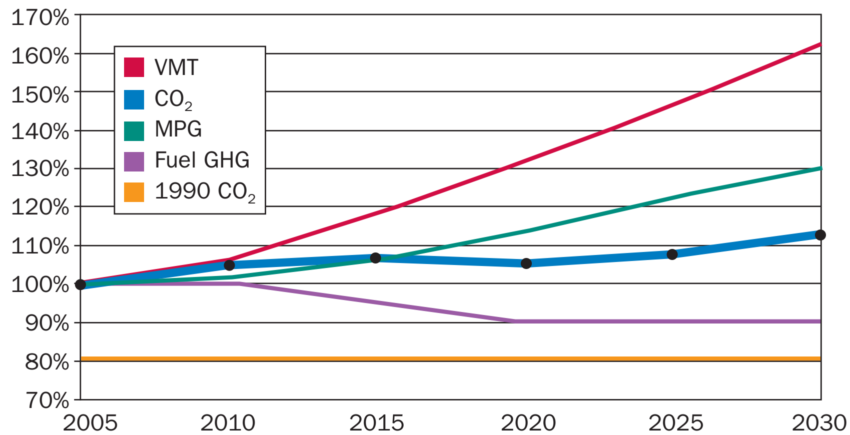
FIGURE 1
Projected Growth in CO_2 Emissions from Cars and Light Trucks



Source: Ewing et al. (2007)

FIGURE 2
Projected Growth in CO_2 Emissions from Cars and Light Trucks Assuming Stringent Nationwide Vehicle and Fuel Standards



Source: Ewing et al. (2007)

NOTE: Projected growth with Senate CAFE levels—new passenger vehicle fuel economy of 35 mpg in 2020 and California low-carbon fuel standard of –10% in 2020 applied nationally.

Urban planning officials who have examined this alarming and steady increase in average VMT per capita have implicated land use and transportation planning habits that were formed in a period when Americans gradually shifted from walking and transit to almost exclusive auto dependence. More than half of the U.S. urban landscape is now developed in a pattern that suits the car, but makes transit use or walking almost impossible. Not only do these landscapes increase the amount of energy required for transportation (Bernstein, Makarewicz, McCarty 2005), but they are also are linked to a 30 percent premium on the average cost of heating and air conditioning buildings when compared to buildings of similar uses in denser urban areas (Rong and Ewing 2007).

Given this trend, researchers and planning officials are asking: "What can we do to halt and reverse our damaging drift to ever-greater auto dependence? How can urban areas, the source of most greenhouse gas (GHG) production in the United States, reduce CO_2 by the amount necessary to at least lower GHG to 1990 levels by 2012, the target set in the Kyoto accord?" The possible contribution varies depending on the source, from about a 10 percent reduction in average per capita GHG to a 70 percent reduction—a level already achieved by the tightly packed and transit using residents of Manhattan (see figures 1 and 2).

The most recent and comprehensive study on this topic concludes that urban design can reduce VMT per capita by up to 40 percent. If 60 percent of new development were compact as opposed to conventional sprawl, the total aggregate reduction in national CO_2 production over trend would be in the order of 10 percent (Ewing et al. 2007). This change in the trend, in combination with stringent fuel economy standards, would be sufficient to lower aggregate GHG production attributable to cars and trucks to below 1990 levels. Perhaps of more importance, it would set in place an urban infrastructure far less dependent on the automobile and consequently more resilient to future disruptions in the energy supply.

Characteristics of a Good Model

The Lincoln Institute of Land Policy has been working with policy leaders and senior planners from across North America to identify solutions to this issue. As part of this effort, the Institute has identified the need for GHG modeling tools to chart the influence of urban form on climate change. While many people are working on modeling GHG, very little of this work focuses on how land use and transportation policies can be used to reduce GHG production. Additionally, researchers differ widely on the premises used to project the GHG consequences attributable to urban form.

Four alternative futures are dramatically displayed in this series of visualizations that show on-the-ground changes consequent to different policy actions. The visualizations are linked to science and provide a way for citizens and policy makers to more readily understand what is at stake in the GHG debate. Prepared by Stephen Sheppard, director, Collaborative for Advanced Landscape Planning, University of British Columbia.

According to planning directors from many of North America's major cities, there is a critical need for evidence-based models that can demonstrate the effects of different urban patterns on GHG production. Models are needed to support planning decisions that are increasingly impelled by laws and policies requiring reductions in CO_2. City and regional planners, notably those in California, are under new obligations to meet GHG reduction goals as part of their ordinary responsibilities, and to be able to quantify the GHG costs or benefits of any site or district scale land use or transportation decision.

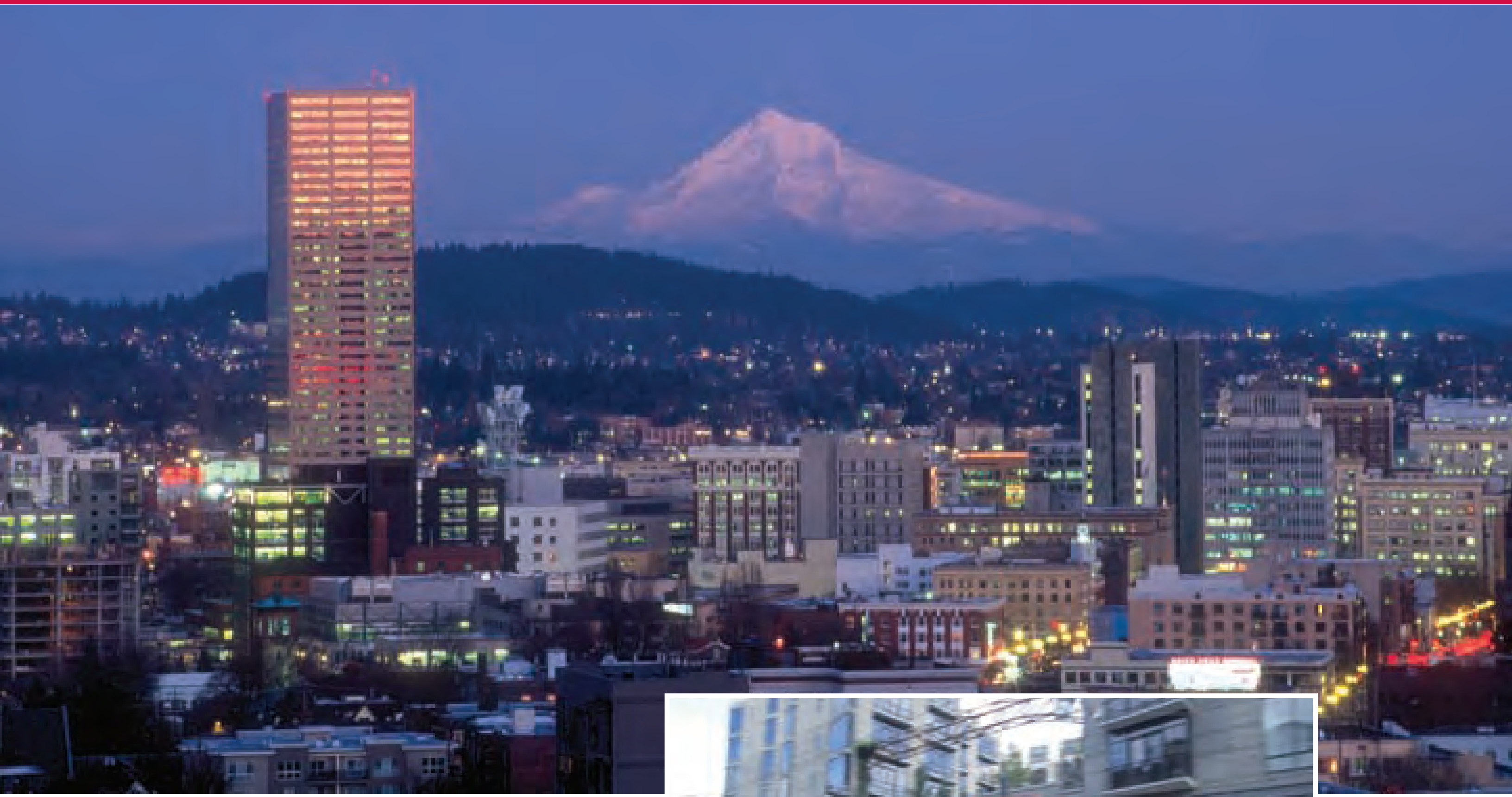
Absent robust evidence-based models that are easily applicable at the site and district scale, these officials are in a difficult if not untenable position. What is needed are tools that can explain these relationships in simple terms, generate credible quantitative results when alternative proposals are suggested, and are useful instruments for tracking overall progress towards medium- and long-range GHG reduction targets.

Experiences in the Cascadia Megaregion

As a first step, the Lincoln Institute is working with leaders from the three major Cascadia metropolitan areas: Portland, Oregon; Seattle, Washington; and Vancouver, British Columbia. Each city is farther along the path to GHG reduction than most other parts of the continent, making them ideal for this study purpose. Furthermore, all three urban regions share a similar policy approach that makes land use and transportation decisions within the context of strong growth management acts. Officials in the center cities of those regions have been particularly active in tackling issues associated with urban form and its negative GHG consequences.

Portland

The Institute for Local Self Reliance cited Portland as the only signatory of the U.S. Conference of Mayors Climate Protection Agreement of 2005 that was likely to meet its GHG reduction target (Bailey 2007). Of the 355 other cities in the program at that time (now there are more than 700), few if any seemed able to meet their goals, and in most cases GHG production had increased, sometimes dramatically. The authors attributed Portland's success to its urban growth boundary—a policy instrument set in place in 1974, not to reduce GHG, but to protect farmland and reduce sprawl. The benefits of this early initiative are now being felt in increased average density, reduced number and duration



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Portland and one of its streetcars.

of car trips, and increases in transit ridership.

The City of Portland will soon initiate a sustainable vision plan to accommodate a doubling of its population from one million to two million, while at the same time reducing its aggregate carbon footprint. Modeling tools that can quickly evaluate the costs and benefits of alternative urban design and planning scenarios will be tremendously important in this effort.

Seattle

Seattle's September 2006 Climate Change Action Plan commits it to reduce GHG production within city limits by 2012 by more than 600 million tons, an amount that would bring it back to levels not known since the 1980s. A recent *Climate Change Action Plan: Progress Report* (City of Seattle 2007) puts them on track to meet this goal. Most of the projected reductions come from the transportation sector, and anticipate a revolutionary shift away from the automobile to transit, bicycles, and walking. Key to the strategy is the continued development of green neighborhoods, where higher density and pedestrian access to services and transit make these dramatic mode shifts practical and feasible. Again, modeling tools are required to assure citizens and decision makers that the GHG targets will be met, while accurately describing the urban design consequences of these changes on existing neighborhoods.

Vancouver

The City of Vancouver is growing faster than any other large city in Canada. Growth rates consistently between 1 and 2 percent annually have boosted the population by 80,000 in less than ten years. Half of this new population has been accommodated in just one square mile on the downtown peninsula, almost all of it in high-rise construction. Planning policies have insured that increases in downtown population were accompanied by new open space and cultural amenities, all financed by proceeds from development. More than 75 percent of these new residents work within walking distance of home, eliminating the need for new bridge and freeway infrastructure that would have been required if these same workers had opted for living in the suburbs.

Encouraged by this success, Mayor Sam Sullivan has initiated the EcoDensity Initiative, a project that may double the population of the city while increasing amenities and cultural services (City of Vancouver 2007). The denser the city becomes, the more the

countryside can be preserved, and the lower will be the per capita carbon footprint of residents—or at least that is the argument made in favor of the EcoDensity project. Absent credible models, staff and elected officials are less than fully armed when citizens, rightfully, ask what are the costs and benefits they can expect from this initiative.

Common Purposes and Alternative Frameworks

Because of these related policy initiatives and the shared need for models, the Lincoln Institute convened a meeting, held in early October 2007 in Vancouver, for policy makers from municipal, state/provincial, and regional levels of the Cascadia megaregion. These officials were joined by the region's leading modelers, to see if a common purpose could be struck. This first meeting of its kind in the region produced five key conclusions.

1. There is a need for a clear and concise "frame" or theory for a GHG-focused set of policies. None exists. Absent a theoretical frame, our common progress toward a set of tools and policy instruments will be necessarily chaotic.
2. Any tool must operate at and between several scales. Site scale efforts must produce evidence of city and regional impacts. Conversely, the site and district scale impacts of regional transportation policies must also be computed.
3. Because of the myriad variables involved in any transportation and land use question, no model will be absolutely accurate. Users must understand that models produce a range of outcomes that are defensible, but not absolute.
4. The interplay between urban management and physical form must be modeled. No amount of transit investment in a vast area of low-density, single-use cul-de-sacs will be cost effective; conversely a mixed-use, high-density neighborhood with interconnected streets will still be car dependent if transit investment is lacking.
5. For models to be useful, visualization tools must be included. The physical form of the city cannot be modeled without three-dimensional representations of proposed changes. Policy makers and citizens will be ill-equipped to undertake the dramatic changes required to reduce GHG production without physical representations of the consequences of their choices.

These findings were presented and critiqued at the Big City Planning Directors Institute meeting, held later in October in Cambridge, Massachusetts, and jointly sponsored by Lincoln Institute, Harvard Graduate School of Design, and the American Planning Association. Attendees concluded that there are a number of possible modeling frameworks for this project, and that the very act of defining the problem and the potentials for solution will influence the nature of the tools produced, and the efficacy with which they may be applied. The following three frameworks explicate the range of possible modeling options.

Trend Modeling

Much of current modeling work might be called "trend based," where available data is analyzed and trend lines "bent" through one set of assumptions or another to produce an alternative future outcome. For example, researchers model the results of a 60 percent shift of the housing market to a more compact urban pattern, and calculate the GHG consequences of such a change (Ewing et al. 2007).

Inherent Capacity

A second might be called the "inherent capacity" framework, in which the actual fabric of the city is examined, often in the context of a design exercise. For example, a design visioning exercise could look at the physical reality of the existing city and propose a redesign to increase GHG efficiency. These changes might include transit access improvements, densification, and increased land use mixing. By way of illustration, Cleveland and other "shrinking cities" with many square miles of underused, low-carbon impact, streetcar neighborhoods have tremendous inherent capacity to reduce per capita greenhouse gas production if these underused districts were repopulated. This framework often reveals more dramatic improvements since it depends less on trend lines and more on the actual capacity of the region's existing land use and infrastructure for its conclusions.

The City as a Machine for Carbon Mitigation

This is a more robust, but necessarily more complex, framework wherein the city is seen as an organism capable of extensive adaptation for GHG reduction. For example, in addition to the density and transportation changes alluded to in the inherent capacity framework above, modelers would also examine the potentials of district scale infrastructure for heating, cooling, and energy load sharing. More aggressive changes in building performance also might be contemplated in the context of changes to urban infrastructure.

Street infrastructure might be completely reconceptualized to provide a host of unprecedented ecological and transportation services. Examples might include green streets for storm water management, ground source heating and cooling, and urban heat island mitigation. Streets might be reconceived for bicycles and pedestrians only, while rooftops could be converted for "green roof" community food production and local jobs. Obviously this framework requires the most dramatic reimagining of the city, but it may be the only one with sufficient capacity to project the 80 percent reduction in aggregate CO_2 production that most experts agree would be required by 2050.

Conclusion

Within the next ten years, North American cities will have to respond to what Al Gore has called a "planetary emergency." At the moment, few of the tools needed to understand and manage the relationship between urban form and GHG production exist. Without the tools necessary to understand, predict, and enact policies, cities and their officials will fail. Many actors must participate in a coordinated fashion to avoid this fate. Absent such coordination, efforts will be duplicated and wasted. Even worse, different regions and entities could produce work with so many different assumptions and methods that results might only add to our current confusion. The Lincoln Institute intends to play a strategic role in convening experts and helping to align otherwise separate initiatives.

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