# CLIMATE CHANGE AND URBANISM: AN OVERVIEW OF THE CHOICES BEFORE US

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**Abstract**

The authors present an overview of current research into the detailed contributions of urban form to climate change, and the policy choices and tools available to respond, together with the implications for needed methodology. The authors summarize the science, the current understanding of the urban factors that affect greenhouse gas emissions; the economics of pricing signals and incentives; the politics of public process and participation; and the law as it affects implementation and regulation. The authors conclude with a call for a "new operating system for growth" that includes a customized mix of codes, certifications, incentives, penalties and other instruments to manage complex outcomes. For the sake of political feasibility as well as effectiveness, these must be customized for each set of local conditions, using a public design process such as a charrette.

One or more authors were involved in the Council for European Urbanism's September 2008 conference, "Climate Change and Urban Design", and the follow-up initiative, "The Oslo-Denver Initiative." There are other links to work in California implementing the new global warming and anti-sprawl bills, as well as other ongoing collaborations with researchers around the world.

*Note: Parts of this paper were used in a policy white paper by the authors as background for the proposed collaboration between the Congress for the New Urbanism, the California governor's Office of Policy Research, the Local Government Commission, and the Sacramento Area Council of Governments. This proposed collaboration has been agreed to and at this writing is awaiting funding for a major "kickoff" charrette.*

## INTRODUCTION

As of early 2009 we can make two confident assertions about climate change. The first is that there is overwhelming scientific consensus that the phenomenon is occurring, and that urgent action is needed to avoid -or in some cases to adapt to – large-scale disruptions. The second is that climate change is unfortunately not the only challenge we must deal with if we are to ensure a prosperous and livable human environment.

In that light it would seem unwise to regard climate change as an isolated crisis of the moment. It is more accurately described as one egregious example of a wider set of interrelated environmental and social challenges.1 Thus the more alarming aspects of climate change may serve as a timely wake-up call to mitigate less immediate but equally critical long-term issues that we have neglected in the past, because we have been unable, until now, to marshal the political will or technical skills to do so.

The wider challenge before us is, undoubtedly, to greatly reduce our negative impact upon the natural systems upon which we ultimately depend; but more accurately, it is to improve the ratio of human benefit to environmental cost. That is surely the essence of sustainability: not merely to limit our impact, but to create healthy, livable communities that do not over-consume the resources on which their residents depend. This ratio of benefit to cost can be called settlement efficiency.

A low settlement efficiency is the production of relatively little human benefit over time, in comparison to the cost in resources. By contrast, a high settlement efficiency produces such benefits at a higher rate, over a longer period of time. It is what we may describe in the popular parlance of the day as "sustainable prosperity."

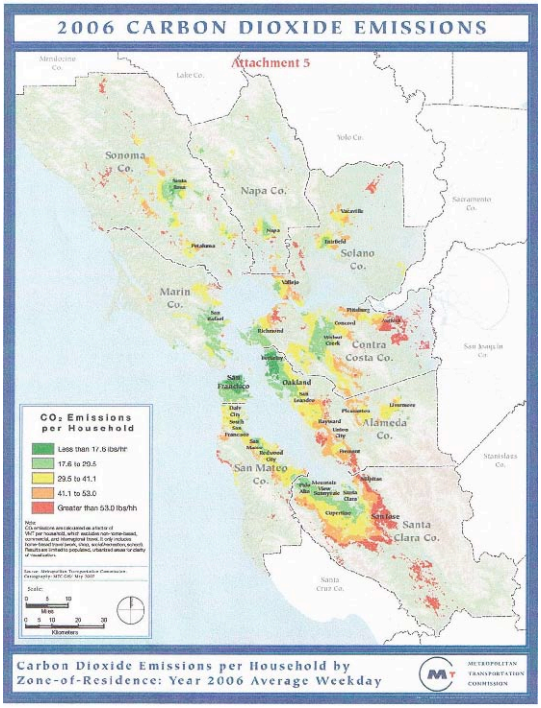
An extremely high settlement efficiency is routinely observed in natural ecosystems, where species are often able to thrive for millions of years. The opposite condition is also occasionally seen in nature: a quick over-consumption of resources for immediate benefit, followed by a period of distress and deprivation, or worse. Numerous examples of this kind of condition can be seen in our own human history, in a number of past civilizations that offer us cautionary lessons today.

What the science is showing us today, and what this paper will summarize, is that settlement efficiency is measurable, analyzable, and closely related to particular kinds of settlement patterns -

and to the choices that produce them. In particular, it has a direct and significant effect upon carbon emissions, and the buildup of greenhouse gases (GHGs). The opportunity to increase settlement efficiency also presents an opportunity to reduce GHGs. While individual building efficiency is a major part of the equation -indeed, representing almost one-third of all energy use -so is the larger arrangement of buildings, transportation and daily activities, accounting for almost another one-third. (The remainder includes industrial and other activities.) A disordered, diffused pattern that is heavily dependent on high-energy transport systems like automobiles – what is commonly called "sprawl" – is a highly inefficient pattern in comparison to others available, and its sustainability is therefore in considerable doubt. Its relative increase in contribution to greenhouse gases can be measured. We will summarize these findings here.

Furthermore, the science is beginning to show us much more clearly that certain kinds of decisions – economic, political and legal – over time produce certain kinds of settlement patterns that have direct implications for carbon emissions and other negative impacts. The policy implications are becoming equally clear: if we want to address carbon emissions, we will have to address these other issues of urban form and urban process as well. We can do so, it appears, through certain kinds of rules and codes, including a promising new set of alternative codes and mechanisms. We will discuss these new alternatives briefly from the following perspectives:

- The Science
- The Economics
- The Politics
- The Law




## THE SCIENCE: WHAT WE KNOW ABOUT URBAN FORM AND CARBON EMISSIONS

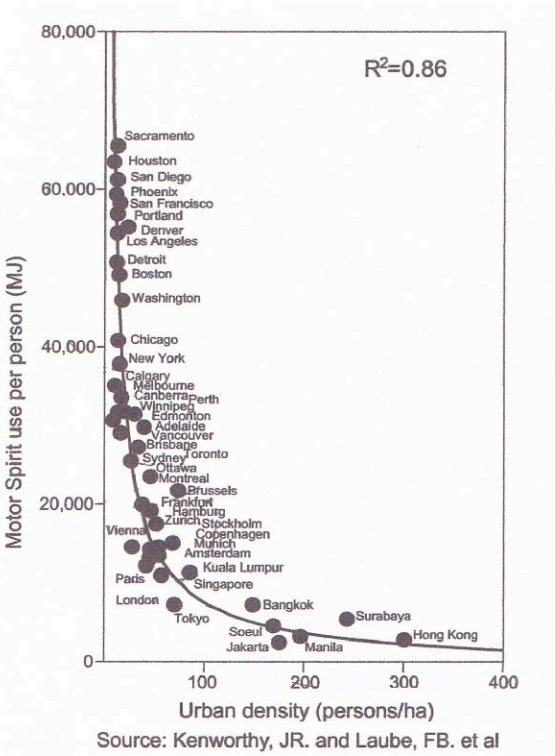
A growing body of recent peer-reviewed studies shows compelling correlations between urban form and greenhouse gas emissions from a range of sources, with vehicle travel as perhaps the most conspicuous (but by no means the only) source. For example, a recent study by the Bay area Metropolitan Transportation Commission (2006) shows a dramatic disparity in $CO_2$ vehicular emissions per household between compact urban communities such as San Francisco, and surrounding low-density suburban areas – amounting to as much as a tripling of emissions per suburban household on average. (See chart at left.) Other studies show similar dramatic ranges.

In the quest to identify opportunities to significantly reduce greenhouse gas emissions this finding is certainly attention-getting. But

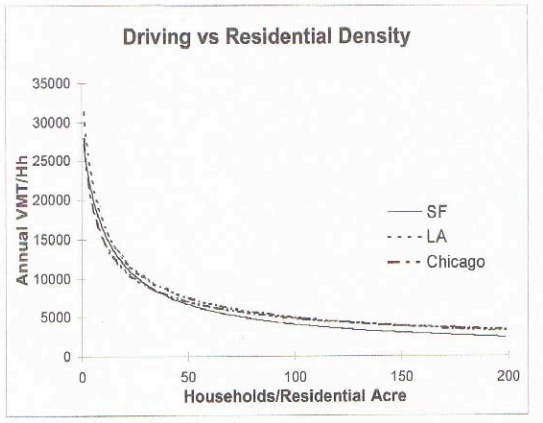
It is not so simple to identify the actual factors that account for the disparity. Among them density is one major factor, but also to be accounted for are income disparities, variations in household size, availability of public transit, diversity and proximity of uses, neighborhood walkability, and other factors.

Nonetheless, evidence does point to the individual significance of a number of these factors, particularly factors that can be varied by design. We can summarize the correlations as follows. (Detailed citations are given in the appendix.)

***Density.*** There is a well-established close correlation between residential density and average daily automobile driving distance per person or "Vehicle Miles Traveled" (abbreviated "VMT"). This in turn has a strong correlation with carbon emissions. There is a comparatively modest variation from other factors such as the fuel efficiency of vehicles. This makes sense intuitively, as more things packed more closely together would seem to require shorter trips between them. (See the diagram on right; note that "motor spirit" refers to gasoline or diesel.)



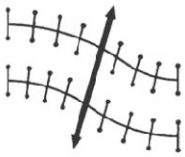

Greater density also correlates with other reductions. Shorter distances per residence for roads and other infrastructure mean reduced emissions from embodied energy, construction and maintenance. Power distribution losses are reduced, and there are greater opportunities for co-generation of power. Other emissions sources also tend to be markedly reduced[2].



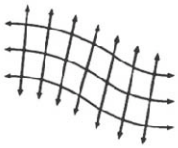

At the same time, it is important to understand that density is only one variable among many. Badly-designed neighborhoods with high density are likely to

***Location Efficiency.*** There is a less well understood, but still compelling, correlation between the *distribution* of daily needs, and average automobile driving per person. Roughly, a more evenly mixed pattern of employment, shopping and other needs correlates to lower VMT, and to lower emissions. This too makes intuitive sense: if the distribution of your job,

shopping and other daily needs is well-mixed, you will not need to drive as far on average to access them, and in some cases you may be able to walk, bike or use more efficient public transportation. A number of new measures of location efficiency have been developed, and in some cases have been used as the basis for reduced-qualification mortgages, or so-called "Location-Efficient Mortgages" (since the buyers will save on their commuting cost on average, hereby qualifying for a larger monthly mortgage).



Dendritic Pattern



Network Pattern

***Street Network.*** A "dendritic" street, based upon a hierarchy of arterials, collectors and local streets, has been shown to require longer trips on average than a more interconnected street grid. This is because a trip between two random points generally only has one path within a hierarchy --up and down the hierarchy -whereas it will have a number of possible paths in the network. One of these network paths is likely to be shorter, and may also be suited to walking, biking or other transit modes.

**SOURCE: The Lexicon of the New Urbanism**

***Walkability.*** It would seem intuitively obvious that an environment that is hostile to pedestrians, even where location efficiency is high, will see on average less walking, more driving, and an increase in carbon emissions. Yet many jurisdictions do not have a comprehensive policy to promote a walkable network, and any breaks or degradations in the network can result in a non-functioning system. The elements that promote a more walkable network are not well-documented in research, nor is the overall potential contribution to reduction of greenhouse gases, and more research here would be beneficial. But it is clear enough that such pedestrian networks benefit from neighborhood compactness, efficient layout of daily needs, pedestrian amenities, perception of safety, and a visually appealing streetscape. Healthy pedestrian networks are damaged by high-speed streets and hierarchical street systems (which are both longer on average and require navigating high-speed arterials). Those same streets are also more expensive to build and maintain, further increasing emissions.

***Bikability.*** Similar issues apply to bicycle networks. Dendritic systems that force bikers onto busy, high-speed arterials are not as beneficial as networks, where quieter and more efficient paths can be customized for each trip. Safe paths and appealing streetscapes promote biking, as do relatively high locational efficiencies. Once again, more research in this area would be beneficial, as its potential contribution to reduced emissions has likely been underestimated (particularly in milder climates, but even in colder climates, as suggested by European examples).

***Quality over Time.*** Much of the emission generated in the life of a building – perhaps as much as half - is generated during construction. Therefore the longer the buildings and struc

tures last, the lower their emission contributions, all other things being equal. The more the structures are durable, repairable, adaptable, and well cared for by residents, the more likely they are to last a longer time, and to reduce their greenhouse gas contribution. The same is true for the neighborhood as a whole: the quality of place matters.

Such a qualitative criterion is not always easy to measure. The best assessment is done in collaboration with the residents themselves, in post-occupancy surveys, visual preference surveys, and other diagnostic tools. Professionals can also incorporate evidence-based design and other best-practice standards, combining research from wider sources. No less importantly, the planning process needs to include potential residents as stakeholders within a meaningful representative process.

**THE ECONOMICS: LIMITS AND CORRECTIONS TO THE RATIONALITY OF MARKETS**

Active policy lobbyists within the U.S. frequently advocate a radical *laissez-faire* approach to development policy, and to related issues such as climate change. Markets, they argue, are far more efficient mechanisms than government regulations for allocating costs through pricing, and creating disincentives from the costs of environmental damage.

Markets are indeed sophisticated self-organizing and allocating systems. But recent Nobel Prize-winning work in economics has also clearly demonstrated a sobering "bounded rationality" in market processes. In particular, future costs are often under-represented or not represented at all in current prices. This can result in disastrous consequences, of the sort that public and scientific institutions were designed precisely to avert.

When scientific institutions identify likely future costs – as is happening, imperfectly but convincingly, in the science of climate change – the responsibility must fall on regulatory institutions to take those costs into account and to work with market mechanisms to allocate them most efficiently. This may represent an optimal combination of the efficiency of markets and the collective intelligence of scientific and other human institutions.

For example, a "cap-and-trade" scheme creates a shared regulatory standard for overall emissions limits, and it exploits a market process to allocate those limits efficiently, preserving incentives and economic opportunities. Similar mechanisms are already used in the development process, as, for example, with Tradable Development Rights (TDRs). A promising area of exploration is whether a similar "cap-and-trade" system could be established for developments, allowing the trading of VMT values, or other capped credits. Another market incentive mechanism is the use of certification systems which can become the basis of buyer incentives, such as the environmental standard LEED (Leadership in Energy and Environmental Design). The new LEED-ND standard ("ND" refers to "Neighborhood Design") has been created to rate the "green" design quality of neighborhoods, with a close correlation to settlement efficiency. Other similar certification systems are also in development.

Lastly, we cannot afford to overlook more direct pricing mechanisms on high-emissions activities, and credits for low-emission activities. For example, parking at dense urban employment sites often carries a cost, creating an incentive to use public transit. Yet current Internal Revenue Service rules work against this incentive and tend to encourage employees to drive to work, by allowing a deduction for jobsite parking costs. Models and empirical studies have convincingly shown that the elimination of such a deduction, coupled with additional pricing mechanisms on automobile commuting (for example, through congestion pricing or tolls) can significantly reduce VMTs.

Indeed, transportation modeling tends to show that dramatic reductions in greenhouse gas emissions are possible, up to 30%, through a strategic combination of land use changes and pricing strategies. For example, Robert A. Johnston at University of California, Davis, has surveyed European modeling research literature, and combined these findings with his own modeling, to draw the following conclusions (Johnson, 2006):

1. Expanding road capacity increases auto travel and emissions, compared to doing nothing. New HOV lanes on radial freeways increase travel and emissions. They also increase sprawl. Congestion generally becomes worse, in spite of adding highway capacity.

2. Expanding transit (only) decreases emissions about 1%, compared to doing nothing. It decreases travel costs for lower-income households. It can increase sprawl somewhat due to the outlying rail stations.

3. Expanding transit (only) and supporting it with land use intensification around Light Rail stations decreases emissions about 5%. It decreases travel costs for lower income households.

4. Expanding transit (only) and supporting it with land use intensification around Light Rail stations and with urban growth boundaries decreases emissions about 10%. It decreases travel costs and travel delays for all households.

5. Expanding transit (only) and supporting it with higher fuel taxes and with workplace parking charges (refunded in higher wages as cash-in-lieu-of-parking incentives) and shopping parking charges (refunded through lower costs for goods and services) lowers emissions about 10%. It greatly increases economic benefits to all travelers, due to better transit and faster freeways. This scenario reduces congestion significantly.

6. Expanding transit (only) and supporting it with land use intensification and urban growth boundaries and with fuel taxes and parking charges, as above, lowers emissions about 15-30%. This scenario maximizes economic welfare for the region and reduces congestion the most.

**THE POLITICS: BROADER ISSUES OF LIVABILITY, COMMUNITY AND PARTICIPATION**

Beyond the market mechanisms, we face a civic question of how we will jointly manage our "commons" – not only our shared environmental resources, but also our shared public realm: that is, our streets, walkways and public spaces. It is becoming much clearer that this public realm has important implications for public health, environmental impact, economic prosperity, and long-term sustainability. It is in the public realm that "settlement efficiency" best expresses itself, in a well-organized, well-connected urban system of streets, public spaces and buildings.

The aim of greater settlement efficiency requires a well-functioning political process – one that cannot be derailed by scattered NIMBY opposition, or mired in bureaucratic stalemate. Yet that is the regrettable state of too much of the public process in modern planning.

On the one hand, local and individual decision-makers are best able to judge local issues, and best able to determine their own local needs free of external obstructions. But on the other hand, an aggregation of local actions does not necessarily add up to a greater whole.

Neither is it sufficient to impose a restrictive top-down scheme or a one-size-fits-all solution. But all too often the public process is mired between these two poles: onerous top-down restrictions and chaotic bottom-up congestion.

What is needed is a new approach to the public process, integrating local information and knowledge of needs into a wider regional collaboration between professionals and stakeholders. Such a process can engage more meaningful public participation in creating a more efficient and more rational plan – of exactly the sort that is urgently needed to respond effectively to current challenges.

A number of promising and efficient collaborative approaches exist, including the community charrette and related processes. Such processes have been used successfully across the U.S., perhaps most notably in the recovery of the Gulf Coast after Hurricane Katrina.

In Mississippi, for example, hundreds of New Urbanist professionals from throughout the country were invited by the Governor's Commission on Recovery, Rebuilding and Renewal to prepare emergency rebuilding plans and codes for eleven damaged coastal communities; astonishingly, they completed the entire draft plan over an intense eight-day design charrette. This provides us with an effective model for other urgent regional and global planning matters before us.

## THE LAW: REFORMING THE "RULES OF THE GAME" – AND THE RULES FOR MAKING RULES

Even the most laissez-faire economy operates within a strong legal framework that profoundly shapes its behavior. In the case of the U.S., and in California in particular, that legal and regulatory framework is a notably complex one. Many of these mechanisms are the means by which political decisions are implemented, including, we might add, the decisions made at successful community charrettes. Even the most intricate laws and regulations have evolved in response to very real conditions and needs, and for that reason their importance should not be dismissed.

Yet, over time, such regulatory mechanisms can become overly complex and confusing. Various added provisions conflict with one another in unforeseen ways and, over time, emergent outcomes can produce unintended consequences. The IRS deduction for employee parking is a case in point. Meant to encourage worker productivity and economic development, it has the unintended consequence of increasing driving and, it follows, greenhouse gas emissions.

A particular challenge comes from the legal structures that govern planning, and in particular the zoning ordinances that regulate new and infill development. In many cases these ordinances originally reflected the belief that conflicts between uses could best be resolved through segregation
– much as a parent might deal with fighting siblings by separating them. If cities experienced overcrowding, then new zoning would move residents to low-density, segregated subdivisions, connected by the new automobile. Of course the eventual system-wide consequences of this scheme, with its increasing sprawl and congestion, were not foreseen.

Today we recognize that settlement efficiency requires not segregation, but a higher degree of integration, through careful design. Buildings can include a mix of uses, for example, so long as their partitions are designed to deal with issues of fire safety, noise, privacy and other issues. A new generation of mixed-use codes and regulations is coming on line, supplanting the older accretion of segregationist rules and ordinances.

Similarly, new legal mechanisms are being developed to allow condominium and other more flexible forms of co-development. Legal structures are also allowing new kinds of tradable financial instruments and incentives, which we believe will prove very important in the effort to reduce greenhouse gases.

Lastly, we believe that the reduction of greenhouse gases warrants legislation to effect large-scale pricing schemes, to transmit the future cost of settlement inefficiency to the present, and thereby to reward high-efficiency behavior, and to avoid passing these costs on to future generations. We stress that this is a market-based pricing mechanism, designed to have a net neutral effect on economic activity. (Indeed, in some cases there is evidence that these efforts actually create new economic opportunities.) It only requires a legal enabling ordinance, established through a collaborative public process. We believe that as such – and assuming it

is designed to be flexible and adaptive -this is an entirely proper public response to a threat to the commonwealth.

## CONCLUSION: A NEW "OPERATING SYSTEM" FOR GROWTH

In computer science, an "operating system" is a set of processes, codes and rules that allow specific programs to function efficiently. The design of the operating system governs what can happen within the system, and broadly defines its characteristics. The comparison has proven useful in a number of fields where similar rules operate to produce complex and often unintended consequences.

The analogy is a particularly useful one in the world of urban growth. The laws, economic processes, political processes and other protocols, all function together in what amounts to an "operating system for growth." The features of that operating system, more than the intentions of clever designers or policy makers, often define and limit the characteristics of the development that results.

Our old operating system – the one that specifies single-use zoning, wide streets, large setbacks, economic monocultures and economies of scale – has shown itself incapable of producing the necessary settlement efficiency required in today's environment. In an age of climate change and related challenges, we cannot bear this cost indefinitely. We need a new operating system. In that light, following are the policy elements we recommend.

## POLICY RECOMMENDATIONS

*Policy Recommendation One: Reform the old zoning and traffic codes*. Replace them with a new generation of form-based codes such as the SmartCode, and new standards of street design reflecting networked, pedestrian-and bike-friendly layouts.

*Policy Recommendation Two: Reform the participatory processes that involve the community in planning decisions.* Require greater accountability on the part of citizen participants, to be involved throughout the process. Require public agencies and jurisdictions to provide the community with the education, tools and processes needed for meaningful participation. Encourage true representative participation, and not mere self-selection of a vocal minority. Consider a number of useful processes such as the Community Design Charrette.

*Policy Recommendation Three: Overhaul the contradictory patchwork of State and Federal requirements, which often operate at cross purposes, to include transparency, accountability and coordination.* (For example, we mentioned the IRS deduction for employee parking costs.) Create a new, coherent criterion of GHG reduction, and require policy to adapt to that criterion.

*Policy Recommendation Four: Create new incentives to encourage brownfield, infill and preservation work, in areas of existing high settlement efficiency.* Develop additional tax credits and public financing mechanisms. Develop public-private models where private-sector entities can assess market dynamics and develop successful responses. Coordinate with the participatory processes to ensure successful neighborhood participation. Emphasize the "reduce, re-use, recycle" model.

*Policy Recommendation Five: Consider new economic mechanisms and pricing signals, integrated with the development and construction process.* Consider an emissions credit trading scheme. Consider automobile travel pricing schemes tied to credits for offsetting activities. Develop strategies to maintain revenue neutrality and avoid regressive penalties.

*Policy Recommendation Six: Consider a local implementation strategy that begins with a major "kickoff" workshop or charrette.* Bring together national, state and local technical experts; political leaders; stakeholder representatives; and planners and facilitators. Develop a recommended greenhouse gas reduction strategy; a climate change adaptation approach; and a plan for updating our disaster preparedness. Elaborate model plans and codes for a complete range of levels, from the statewide scale down to the size of an individual project. Include comprehensive treatment of technical issues in the full breadth of applicable fields, including land use law, civil engineering, environmental planning, mobility, energy, economic development and other areas. Generate strategies and tools that can be easily dispersed to, and implemented by, all levels of government.

NOTES

1 Among these we might include such well-recognized modern phenomena as pollution, resource depletion, habitat destruction, environmental illnesses (including "lifestyle" diseases related to obesity), social isolation, and psychological stress. There is a growing body of literature on the real and growing costs of these phenomena, and their unsustainable consequences; see the references attached.

2 It is important to look beyond vehicle miles traveled (VMT) to the other factors that also shape the pattern of emissions in relation to density, and, more broadly, to settlement efficiency. As noted, we should also consider the following factors, among others:

- Embodied energy and resources in additional infrastructure
- Energy of ongoing infrastructure maintenance and repair
- Albedo (reflectivity) effects of impervious cover per person (from pavement and from low-density buildings)
- Transmission losses from a more dispersed network
- Additional energy required to pump water
- Loss of opportunities for co-generation, district heating and local renewable generation
- Inefficient building typologies associated with lower density: more single family detached and standalone structures, fewer shared-wall and shared-floor structures.
- Evidence for the greater resilience and inherent capacity of more compact neighborhoods,

which appear to translate into more low-carbon activities. This is an active area of research that requires much more careful investigation to tease out all the factors and their interactions. Nonetheless we believe the evidence is clear enough that policymakers must take these factors into account now. Among other factors, infrastructure is one of the most long-lasting features of the built environment, affecting patterns of movement and emissions for many years to come.

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