GROWING WITH LESS GREENHOUSE GASES

State Growth Management Policies That Reduce GHG Emissions

National Governors Association
Center for Best Practices

Acknowledgements

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Executive Summary

Communities are grappling with the good and bad of growth. Growth is the engine of prosperity, but maintaining a good quality of life in a growing community can be challenging. Growth increasingly produces traffic congestion, greater demand on resources, loss of greenspace, and other undesirable consequences. By properly managing growth, communities can reduce the negative effects of expansion while still reaping its benefits.

Although not always identified as a benefit, common-sense growth policies can reduce greenhouse gas (GHG) emissions. In fact, a well-designed community can reduce emissions without having to implement expensive regulations or programs. This added benefit of growth management makes "smart growth" an even more attractive policy alternative. Three growth strategies are helping to curb GHG emissions: expanding transportation choices, conserving greenspaces, and designing communities that place less demand on energy production and infrastructure.

Expanding transportation choices.
Providing more transportation choices can play a significant role in reducing GHG emissions. Carbon dioxide (CO_2) emitted from transportation-related sources, such as cars and buses, accounts for 32 percent of U.S. greenhouse gas emissions. Transportation is also the second-fastest growing source of GHG emissions. Growth management programs can greatly reduce GHG emissions by providing citizens with more transportation options and reducing congestion.

Actions state officials can take to expand transportation choices include:

- creating incentives that increase public transit use;
- promoting bicycle- and pedestrian-friendly transportation options; and
- linking transportation funding to effective growth management strategies.

Conservation of greenspaces.
Conserving or creating rural, suburban, and urban greenspace (e.g., farms, parks, trails, roadside trees) improves quality of life by providing places where neighbors can congregate and people can recreate. Greenspaces also protect air and water quality and conserve fish and wildlife habitat. From a GHG standpoint, greenspaces provide "sinks" that help remove CO_2 from the atmosphere. Trees that help shade buildings, parking lots, streets, or other structures also reduce the "urban heat island effect." This phenomenon causes urban areas to experience higher temperatures than surrounding suburbs because of the prevalence of heat-retaining materials such as concrete and asphalt. Reductions in the heat island effect reduce heating and cooling needs and, subsequently, the GHG emissions attributable to energy production.

States can reap the growth management benefits of conserving greenspaces and also decrease GHGs by:

- recognizing the benefits of greenspace as carbon sinks;
- quantifying the carbon absorbed by greenspace and using this "savings" as an element of state GHG control programs; and
- structuring greenspace conservation programs in ways that also reduce the heat island effect.

Designing communities that place less demand on energy production and infrastructure. Well-designed communities that meet growth management goals can be energy efficient. In contrast, low-density sprawl communities spread out over many acres, requiring more land, roads, and infrastructure to move between destinations. Well-designed communities can reduce infrastructure demands and create shorter travel distances. Moreover, GHG reductions can be achieved if community designs include energy-efficient "green" building techniques for new and retrofitted buildings.

To benefit from community designs that reduce GHG emissions, states can:

- promote transit-oriented developments;
- encourage infill and mixed-use development; and
- develop policies that reduce energy use in commercial and residential buildings.

The strategies and best practices presented in this paper focus on actions that states can employ to reduce the cost of growth and improve their citizens' quality of life while simultaneously reducing GHG emissions. In light of the fiscal austerity required by smaller state budgets, states can greatly profit from the multiple benefits of growth management strategies.

- Wisconsin developed a comprehensive GHG emission reduction strategy and went on to conduct an economic assessment of mitigation options, such as programs to promote more efficient energy use and production and greater transit options. The state discovered that it could stabilize emissions at 1990 levels by 2010 for less than $15 per ton of CO_2, while saving up to $2.7 billion in energy and operating costs and creating more than 7,000 jobs.

- Vermont incorporated its Greenhouse Gas Action Plan into the state's energy plan. The plan identifies policy options that could reduce GHG emissions by 21 percent, increase employment by 1 percent, reduce energy costs by $6.2 billion, reduce acid rain precursors by 24 percent, reduce ground-level ozone precursors by 30 percent, and reduce energy use by 16 percent by 2020. The energy plan includes common growth management strategies, such as making new buildings more energy efficient and expanding transportation options.

- Rhode Island published its Greenhouse Gas Action Plan identifying 52 ways the state can reduce its GHG emissions. Sample actions include requiring that a percentage of electricity sold in Rhode Island come from renewable sources, and integrating land-use zoning and transit planning efforts to reduce vehicle miles traveled. In addition to in-state measures, the plan endorses regional and national efforts to reduce greenhouse gas

emissions. The document completes Phase I of the Rhode Island Greenhouse Gas Stakeholder Project, a collaborative effort between the Governor's office, Department of Environmental Management, and the Rhode Island State Energy Office.

Introduction

Communities new and old, big and small, East and West, North and South, are grappling with the good and bad of growth. Among the benefits, growth increases the available workforce, the consumer pool, and the overall prosperity of a community. Of course, growth often produces traffic congestion, greater demand on resources, loss of greenspace, and other undesirable consequences.

Improved growth management and community design can minimize the negative consequences of growth while creating healthier, more prosperous citizens and a cleaner environment. Although not always acclaimed as a benefit, common-sense growth policies can also reduce greenhouse gas (GHG) emissions.

Growth management is used in this paper as a general term to encompass a number of movements throughout the United States, all of which are attempting to define certain ideals for growth, make plans to achieve these visions, and remove obstacles that prevent success. These movements have been alternately termed "smart growth," "livability," "new urbanism," "new community design," "sustainability," "urban revitalization," and more. They sometimes include regulatory policies, sometimes incentive-based programs, and sometimes both. They can be grassroots movements or begin as government initiatives.

In fact, a well-designed community that allows for "smarter" growth can reduce GHG emissions without having to implement expensive regulations or programs. Growth plans developed for other reasons—to reduce traffic congestion or create more pleasing neighborhoods—can concurrently reduce GHG emissions.

Furthermore, growth management can act as a "no-regrets strategy" by providing tangible net benefits, such as significant infrastructure cost savings and improved quality of life, while simultaneously minimizing the impact of GHG emissions. Several states are turning to no-regrets strategies to lessen potential GHG effects on the earth's climate without assuming substantial costs beyond those they had already planned to spend to achieve other state goals.

Recognizing the connections between growth management and GHG mitigation will assist state leaders in developing policies and programs that can achieve their growth and GHG goals in tandem. Figure 1 shows the concomitant GHG benefits of growth management, thus illustrating how growth management can provide mitigation options. It is valuable for policymakers to be aware of the co-benefits of growth management. By recognizing and even quantifying the reductions obtained via smarter growth, states can earn credit toward compliance with federal air quality standards.

Furthermore, states and other entities that implement smart growth measures may be able to register greenhouse gas reductions as future credits in greenhouse gas markets or tradeable permit systems.

Figure 1
Connections between a Community's Growth Management Goals, Citizens, and Environment, with Concomitant GHG Benefits

Goals of Growth Management	Benefits to Citizens	Benefits to the Environment	GHG Benefits
TRANSPORTATION GOALS AND BENEFITS			
Provide options that allow individuals to choose between driving, taking mass transit, bicycling, or walking to their day-to-day destinations.	Increases citizens' quality of life by reducing traffic congestion. Reduces asthma (by improving air quality). Reduces obesity and diabetes (by promoting walking and bicycling). Provides companies with a more mobile workforce.	Reduces air pollution. This goal might also protect water quality by reducing the number and size of roads and parking lots needed, thus reducing the area of impermeable surfaces that increase runoff and non-point-source pollution.	Reduces GHG emissions resulting from reliance on passenger vehicles—one of the largest manmade sources of CO_2 emissions.
Maintain and create greenspaces by reducing sprawl and by designing urban greenspace in the form of parks, walking trails, and trees along streets and in yards.	Protects health by providing places for recreation and nonmotorized transit. Provides places for neighbors to congregate, contributing to good mental health and a safe community.	Protects air and water quality by "scrubbing" the air and filtering runoff, which benefits citizens as well as the environment. Reduces the impacts of drought. Provides critical habitat for fish and wildlife.	Maintains traditional carbon sinks. Creates new ones, such as urban parks and shade trees. Shade trees also reduce the heat island effect, thus lowering energy use and its resultant pollution.
COMMUNITY DESIGN GOALS AND BENEFITS			
Create attractive places to live, work, play, and congregate that are models of efficiency—efficient in their land use, efficient in their demand on infrastructure, and efficient in their energy use.	Provides aesthetically pleasing communities, even as the population and density of a community increases, thus maintaining a good quality of life and attracting desirable workers and businesses to the area.	Reduces air pollution by lowering energy consumption in several sectors: transportation, heating and cooling, and concrete production for construction projects. Reduces demand on land and natural resources.	Reduces GHG emissions resulting from electricity production, concrete paving and building materials, construction, and car use (assuming businesses and homes are located to reduce car use).

This paper is divided into the same three sections presented in this chart: transportation goals and benefits; greenspace goals and benefits; and community design goals and benefits. Each section will discuss the connections between GHG mitigation and growth management. Throughout the paper, best practices are cited to demonstrate what states are already doing to make these connections.

Expanding Transportation Choices

Transportation planning is a major component of growth management and community design. Growth planners strive to offer more transportation choices for citizens' day-to-day trips. Benefits of expanding transportation choices include:

- improving quality of life by reducing the time spent in traffic congestion;
- improving health by providing walking, bicycling, and mass transit alternatives that allow for increased physical activity, which combats obesity and its related diseases, such as diabetes and cardiovascular disease;
- increasing economic prosperity, because a better quality of life and a more mobile workforce help attract both businesses and high-tech workers to the community;
- improving air quality by reducing tailpipe emissions; and
- improving water quality by reducing the size and number of roads and parking lots needed, thus decreasing the impermeable surface area that increases runoff and non-point-source pollution.

State officials have traditionally focused on the primary demands of transportation planning—increased road capacity, reduced traffic congestion, and smog—rather than GHG emissions. Yet, providing efficient ways to get from here to there is probably the most direct and influential way that states can reduce GHG emissions.

The transportation sector is the second-largest contributor to GHG emissions.
Combustion of fossil fuel produces over 80 percent of total U.S. GHG emissions. Carbon dioxide from fossil fuel combustion is created during the generation of electricity and is emitted from transportation-related sources, such as cars and buses. Emissions from fossil fuel combustion have grown by 18 percent in the past 10 years and are responsible for nearly all of the increase in national emissions.[1]

Transportation-related sources account for 32 percent of fossil fuel combustion and are the second-fastest growing sources of GHG emissions.[2] (See Figure 2). From 1990 through 1999, carbon dioxide emissions from transportation-related sources grew 33 percent faster than overall U.S. GHG emission growth.[3] Two factors have contributed to this rise in transportation-related GHG emissions.

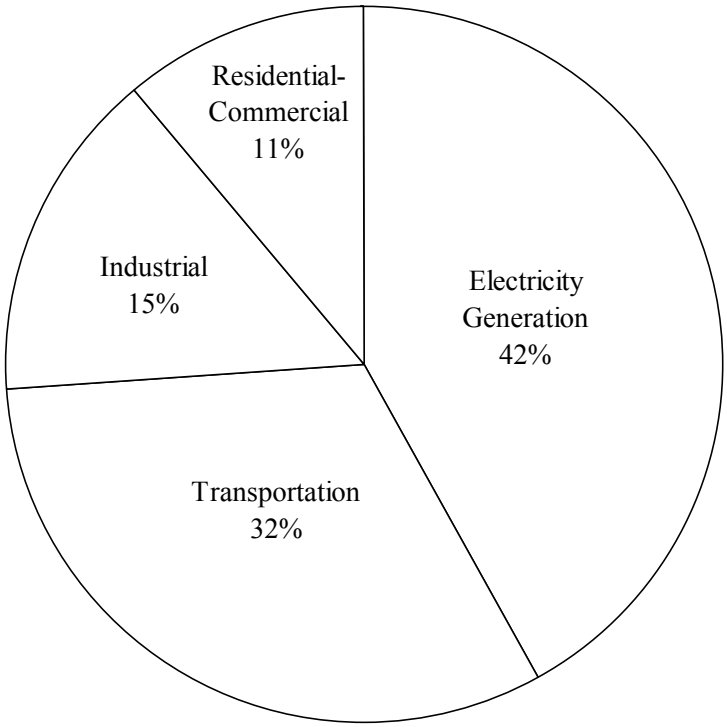
- Since peaking at 22.1 miles per gallon (mpg) in 1987 and 1988, average light-vehicle fuel economy has declined by 1.7 mpg (nearly 8 percent), to 20.4 mpg, and for 2001 is lower than it has been at any time since 1980. Light vehicles are defined as cars, sport utility vehicles, vans, and pickup trucks rated at less than 8,500 pounds gross vehicle weight. The primary reason for this decline is consumer demand for larger vehicles, which are heavier and often less fuel-efficient.[4]

- The U.S. has experienced a 21-percent increase in miles driven between 1990 and 1998, far greater than population growth.[5]

The primary cause of the increase in miles driven is that people are simply driving more frequently and longer distances. The most common measure of automobile use is "vehicle miles traveled" (VMT). A long-term study that ran from 1982 to 1997 found that population grew in metropolitan areas by 22 percent but the delay experienced by drivers grew by 235 percent, or roughly 10 times greater. This study ascertained that nearly all of the growth in driving came not from new drivers, but from more driving by the people already on the road.[6]

Three factors account for 69 percent of the increase in driving: longer average trips; a reduction in carpooling; and decisions to drive instead of walk, bike, or use public transit. These factors are related to development patterns that increase distances between destinations and reduce transportation options.[7] Growth management is an important tool for maintaining or even reducing vehicle miles traveled.

FIGURE 2: U.S. Sources of CO_2 Emissions



SOURCE: U.S. Environmental Protection Agency (EPA), Office of Atmospheric Programs, *Inventory of U.S. GHG Emissions and Sinks*, *1990-2000* (Washington, DC: April 2002, ES-13).

Growth management and expanding transportation choices can reduce GHG emissions. Sprawl has long dominated U.S. development patterns and is reflected in low-density development, vast shopping centers, large homes, oversized lots, high-speed roads, and dangerous conditions for bicyclists and pedestrians. During the 1980s, more than 80 percent of new homes were built in the suburbs. Approximately 60 percent of Americans now live in suburban communities, and in the 75 largest metropolitan areas, the percentage of people living in the suburbs is even higher (75 percent).[8]

These suburban neighborhoods are often far from vital places of employment and commerce, and, unfortunately, some community planners did not include transportation options for commuting when the homes were built. Thus, many people have only one option for travel to their everyday activities: driving. When each person's every trip must be made by car, the vehicle miles traveled add up quickly.

Development patterns that provide consumers with no choice but to live in sprawl and rely upon only a car for transportation are being re-evaluated. Growth management strategies can help both urban and suburban communities design greater options for housing, community layout, and transportation for people seeking a different kind of living style and greater flexibility. For instance, mixed-use and infill designs place residents nearer to work, retail, and established public transit routes, so residents can choose whether to drive, take the bus or rail, walk, or use some other mode.

The U.S. Environmental Protection Agency (EPA) sponsored a case-study comparison of a smart growth community (Metro Square) in Sacramento, California, and two conventional suburban developments. The research found that the pattern of development had a significant impact on transportation. The residents of Metro Square were four times as likely to accomplish daily tasks by walking and take only half as many driving trips, driving a total of 40 percent to 50 percent fewer miles.[9]

Another study compared an infill development in an urban, walkable, transit-friendly neighborhood of Atlanta—the Atlantic Steel site—to hypothetical developments of the same square footage in three suburban, sprawl locations in the Atlanta metropolitan area. The modeling estimated that the Atlantic Steel site would result in 22 percent to 62 percent lower CO_2 emissions per year than the sprawl sites.[10]

Of course, every community cannot be designed to allow for multimodal choice. For instance, rural areas are not populated enough to accommodate public transit. Even in the small town centers of rural regions, however, the main streets can be made welcoming to pedestrian traffic by designing storefronts at a human scale, sidewalks that are wide and aesthetically pleasing, and roads that are safe for cars and walkers alike.

The National Main Street Center, administered by the National Trust for Historic Preservation, offers tools for preserving traditional commercial centers in small towns and stresses the importance of good transportation planning.[11] In operation for 22 years now, the center has helped over 1,500 communities and has found that communities have generated an average of $39.96 for every dollar spent on their main street revitalizations.[12]

Common growth management, transportation-planning, and GHG mitigation goals exist. State growth management and transportation leaders should consider these goals as practical transportation strategies to reduce GHG emissions while growing smarter.

- Create incentives that increase public transit use.
- Promote bicycle- and pedestrian-friendly transportation options.
- Link transportation funding to effective growth management strategies.

Of course, there are many other methods for reducing GHG emissions. Improved gasoline mileage, improved vehicle technology and design, alternative fuels and propulsion systems, carpooling, and high-occupancy vehicle lanes are all important strategies for reducing GHG emissions. Because this paper focuses on the connections between growth management and GHG mitigation, however, it will not address these strategies. Readers are encouraged to consult the NGA Center for Best Practices publication "State Innovations to Reduce Vehicle Emissions" for more information.[13]

Increasing public transit use. Public transit—buses, trains, and subways—can help provide relief from pollution, congestion, and other "livability" problems. Public transit also produces lower GHG emissions than passenger vehicles for the same commute. Compared to passenger vehicles, public transit accounts for only half as much CO_2 output per million commuters.[14]

All too often, transit stations are located far from where people live, which effectively rules out transit as a viable transportation option. To counter this trend, a number of jurisdictions have begun to encourage transit-oriented development (TOD), i.e. new growth and redevelopment along transit routes that can reduce auto dependency. TOD's are usually mixed-use, pedestrian-friendly communities that enjoy higher densities than those allowed in the surrounding areas. States and local governments may support TOD by offering planning and zoning assistance, priority funding, expedited administrative review, and density bonuses which allow developers to exceed the number of units per acre allowed under traditional zoning. Transit-oriented development projects have been undertaken in California, Oregon, and the metropolitan DC area, among others.

In addition to working with local and regional governments to help fund public transit systems, states can provide incentives for the private sector to promote public transit. The following are two examples of partnerships between private firms and government that encourage public transit use.[15]

- Florida provides developers a financial incentive to build infill projects and other developments that locate homes near mass transit stations and thereby provide greater transit options to residents. The incentive reduces the transportation impact fee developers are assessed to fund new infrastructure, such as roads.

- Maryland helps employers provide their employees with commuter benefits by allowing participating companies to take a tax credit or exemption of 50 percent of the amount spent on various commuter options (e.g., transit passes, tokens, fare cards, and employer-supported van pools).

Promoting bicycle- and pedestrian-friendly transportation options. It is estimated bicycling and walking annually supplant between seven and 28 billion passenger vehicle miles, reduce the amount of gasoline consumed by up to 1,590 million gallons, and reduce CO_2 emissions by 15 million tons. [16] In addition, there is reason to believe that bicycling and walking could be a viable alternative for many commuters' routine trips, thus increasing the CO2 reductions attainable through bicycling and walking. Approximately 75 percent of trips of one mile or less are made by motor vehicle.[17] In fact, most urban trips are short enough to be accomplished by walking or bicycling. More than 25 percent of trips are less than a mile and 40 percent of urban trips are two miles or less.[18] In addition, 53 percent of Americans live within two miles of a public transit route.[19]

These short trips have a significant impact on GHG emissions. Frequent starting and stopping at intersections cause lower fuel economy, raising CO2 emissions. In addition, each time a person starts a vehicle, the emission-control equipment requires time to properly warm up and perform efficiently. So-called "cold starts" cause a disproportionate amount of the greenhouse gas nitrous oxide (N_2O) to be produced during the first few minutes of vehicle use.[20] Hence, strategies to promote walking and bicycling could easily help reduce emissions by reducing the number of short, inefficient trips. Moreover, community designs that locate homes closer to work and daily errands can help ensure these tasks can be reasonably accomplished by foot or bicycle.

Several states have taken steps to encourage walking and bicycling.

- Under Maryland's Smart Growth and Neighborhood Conservation program, the state has worked to make streets safer and more attractive for pedestrians and bicyclists. To support development in older towns and cities, the state has steered $150 million in transportation dollars to downtown "streetscaping" projects. The program has built more than 50 miles of sidewalks in older communities and helped nearly 300 private-sector employees buy homes closer to their work.[21]

- The State of Rhode Island facilitated the development of a "Greenway Project" at a former industrial site along a river near Providence. Rhode Island's Department of Environmental Management helped with cleanup of the site, including the retention of an easement along the river for a bike and pedestrian way. In addition, the state Department of Transportation used a matching federal grant program to help finance road improvements to make the site more attractive for development.[22] (Recent changes in Federal Highway Administration policy allow use of transportation funds to redevelop contaminated brownfields, which can help reduce VMT by creating more compact development patterns and bike and pedestrian corridors.) This project is part of Rhode Island's statewide commitment to developing an integrated greenway-bikeway system.

- Some states—such as California, New Jersey, and Texas—have found that development patterns discourage children from walking to school. Reasons include long distances from home to school and safety concerns such as the need to cross major thoroughfares.[23] Those concerns may be well-founded: injuries from motor vehicles are a leading cause of death for children between age 5 and age 14; and in 1999, an estimated 25,000 children ages 14 and under were injured in pedestrian incidents involving motor vehicles.[24] To

help deal with this issue, the New Jersey Department of Environmental Protection ensures that a portion of the $8.6 billion in state school assistance is used to encourage "smart growth" practices, such as construction of pedestrian walkways and street crossings.[25] California and Texas have created sophisticated "Safe Routes to School" initiatives. These programs encourage walking and bicycling by adding new crosswalks, bike lanes, and multiuse trails.[26] The California program also hosts "Kids Walk to School" days and other events and information resources to inspire more walking and bicycling.[27]

- Under an initiative called "Illinois Tomorrow: Balanced Growth for A Better Quality of Life," the Illinois Department of Transportation (IL DOT) spent more than $184 million from 1999 to 2001 to enhance its transportation system through non-motorized projects, such as the construction of bicycle and pedestrian trails. These projects were funded through an array of programs including the Illinois Transportation Enhancement Program, the Congestion Mitigation/Air Quality Program, the Highway Improvement Program, and the Public Transit Improvement Program. For instance, IL DOT reconstructed Lake Shore Drive in Chicago--replacing bridges, improving pedestrian access, and enhancing the adjacent Lakefront Trail-- to create a safer, more pedestrian-friendly corridor.[28]

- Pennsylvania encourages local communities to design for bicycling and walking as part of their development plans. In late 2000, the Pennsylvania Department of Transportation (Penn DOT) completed more than two years of planning assistance with each of the state's 21 metropolitan planning organizations and local development districts. Pursuant to federal guidelines, bicycle and pedestrian mobility were incorporated into development plans. The Penn DOT project involved working with each planning organization to ensure that the bicycle and pedestrian elements of the plans included, at a minimum, a statement of goals, a regional planning map, and a list of projects that could be considered high priorities in the state Transportation Improvement Plan.[29]

Linking Transportation Funding to Effective Growth Management Strategies. Existing norms, including zoning regulations, often make it easier for developers to build new homes on outlying, undeveloped greenfields rather than in urban neighborhoods already served by existing infrastructure. The cost of land becomes cheaper as one goes further out, neighborhood compatibility is not an issue, and banks are willing to finance traditional suburban development. In addition, municipalities, eager to expand their tax base, provide the needed roads, sewers, and schools, often subsidizing the costs. The end result is that most trips must be made by automobile.

To alter this pattern of development, states are implementing a variety of solutions, including comprehensive planning, financial incentives or penalties, streamlined permitting processes in designated areas, and technical assistance.

- Maryland's Smart Growth Act creates Priority Funding Areas. Funding for growth-related projects such as highways and sewers, as well as economic-development assistance, is targeted only to those areas that have been locally certified to meet the

state's requirements; i.e., they are already developed or are in areas designated for growth, with appropriate provisions for infrastructure. The state also provides funding through its Rural Legacy Program to protect valuable farmland and natural resources. Maryland hopes to preserve 200,000 acres by 2011.

- Washington has carefully crafted its Growth Management Act to slow the growth of sprawl in the rapidly growing western part of the state, while supporting the needs of the slower-growing eastern part. Only the faster-growing counties (those with growth rates that exceed 20 percent every 10 years or those with at least 50,000 people and a growth rate that exceeds 17 percent every 10 years) have to prepare and implement comprehensive plans. These plans must designate "urban growth areas" that will be able to accommodate a growing population, using creative tools such as cluster development, infill development, and mixed land uses. The state allocates funds to these counties for planning and offers substantial technical assistance, but the plans themselves are approved by regional hearing boards. A local government may lose state funding if its plan is found to be in noncompliance with the state's goals.

- In 2001 Delaware Governor Ruth Ann Minner signed an executive order laying out a comprehensive "Livable Delaware" strategy to address sprawl, congestion and other growth issues through legislation and policy changes that direct growth to areas where the state and local governments have planned for it to occur. Local governments are no longer able to annex additional land unless they have a comprehensive plan in place that designates future growth areas along with a detailed plan of service. State agencies are also required to realign their policies, budgets, and programs to be in accord with the objectives of Livable Delaware. For example, the Delaware Department of Transportation now lists among its responsibilities the need to prioritize funding to existing communities and designated growth areas through its Capital Improvement Program and Corridor Capacity Preservation process. The initiative also earmarks a portion of the Realty Transfer Tax revenues to provide funds for purchases of open space for another 18 years.

Impact fees are another tool that states are using to help control sprawl. Sprawl development often requires costly new infrastructure that has traditionally been paid for with taxpayer dollars. Requiring developers to pick up these costs can cause an otherwise profitable project to become financially unattractive or even unprofitable. If the project does not move forward, the pace of sprawl is thus slowed, leading to a reduction in GHG emissions.

These incentives appear to be successful at directing growth to designated areas and encouraging the preservation of open space and agricultural land. As a result, growth management goals are being achieved and GHG emissions are consequently reduced.

Conservation of Greenspace

One of the primary goals of growth management policies is to slow the march of sprawl that consumes large amounts of open space.[30] These policies seek to preserve the greenspaces that are rapidly disappearing—the farms, forests, parks, and wild landscapes of this country that help define the communities that reside in and near them and that are prized by all citizens. That is not to say that advocates for growth management choose to stop growth in its tracks. Instead, communities and government officials are pausing to think about what *kind* of growth works best for a community and its greenspaces and to craft policies and programs that achieve these goals.

Greenhouse gas emission reductions are sometimes cited as an explicit benefit of greenspace conservation policies. Whether explicit or not, GHG emitted into the atmosphere is indeed reduced when more greenspace exists to act as a "sink" for the most prevalent GHG, carbon dioxide. The GHG benefits of greenspace preservation include reduction of GHG emissions through maintenance, and even creation, of carbon sinks; and minimization of "urban heat islands" by providing shade to buildings, roads, and other structures and by breaking up the concrete expanses that absorb much more heat than greenspace.

Greenspace preservation confers several other recognized benefits.

- Improved mental and physical health—Greenspaces allow individuals more opportunities to be physically active and to feel as if they are part of a larger community.
- Improved quality of life—The natural attributes of a community are often seen as major contributors to its character and beauty. Retaining greenspaces, therefore, helps create a sense of identity and beauty for a place.
- Potential economic development—Greenspaces help fuel the tourist trade in many states. Moreover, beautiful communities attract workers and businesses to an area.
- Improved water quality—Greenspaces help filter water of impurities before it reaches streams, aquifers, and other tributaries. This is especially helpful in providing a buffer between non-point-source runoff from roads, parking lots, and other impermeable surfaces and from farms and ranches. The filtering protects both drinking water and water used for recreation.
- Improved air quality—Plants help process the pollution and harmful gases emitted by energy production, the refining of raw materials, transportation, and more.

These many benefits demonstrate that greenspace conservation can truly serve as a no-regrets strategy for reducing GHG.

Greenspace conservation can preserve, and even expand, carbon sinks.
The bulk of GHG mitigation achieved through greenspace preservation is realized in the preservation and perhaps expansion of rural and urban forests. The U.S. Forest Service estimates that an average tree absorbs and sequesters up to 26 pounds of carbon dioxide per year, which is the amount emitted by a car traveling 11,300 miles.[31] In fact, in 1999 U.S. forests sequestered enough CO_2 to offset approximately 15 percent of U.S. CO_2 emissions.[32]

Some states are already incorporating forest conservation as an important element of their GHG control programs. For example, the New Jersey Department of Environmental Protection (NJDEP) Greenhouse Action Plan includes a variety of management and technology strategies to increase carbon sequestration.[33] The management strategies include the following.

- Afforestation of marginal cropland and riparian strips (i.e., growing forests where there had been none)—NJDEP estimates that a relatively modest plan to add 550,000 acres of forest would result in absorption of 41,500 tons of CO_2 per year.
- Tree planting in urban and suburban areas—NJDEP estimates that 260,000 tons of CO_2 could be saved through relatively modest measures.
- Recycling of urban trees that have been removed—NJDEP estimates that 500,000 board feet recycled into sawlogs (logs that could be used for lawn borders, for example) would save 31,000 tons of CO_2.
- Reduction of forest loss to nonforest uses—NJDEP estimates that 5,500 tons of CO_2 would be absorbed if 1,000 acres of forests were saved.
- Improvements in forest management—through a variety of forest-management improvements, NJDEP estimates 10,000 additional tons of CO_2 could be saved.
- Reduction of waste in wood processing—NJDEP estimates that a 3-percent efficiency improvement in the processing of wood would result in a reduction (offset) of 5,000 tons per year of CO_2 emissions.

Greenspaces can help combat the urban heat island effect.
Dark materials absorb more heat from the sun—as anyone who has worn a black shirt on a sunny day knows.[34] Dark-colored rooftops and pavement can become up to 70°F (40°C) hotter than the most reflective white surfaces.[35] Irrigated farmland, for example, has surface temperatures of 70°F to 80°F, while surface temperatures on dark-colored rooftops can peak at 140°F to 180°F. The accumulated effect of this heat absorption is that air in a city can be 2°F to 8°F hotter than in the surrounding countryside.

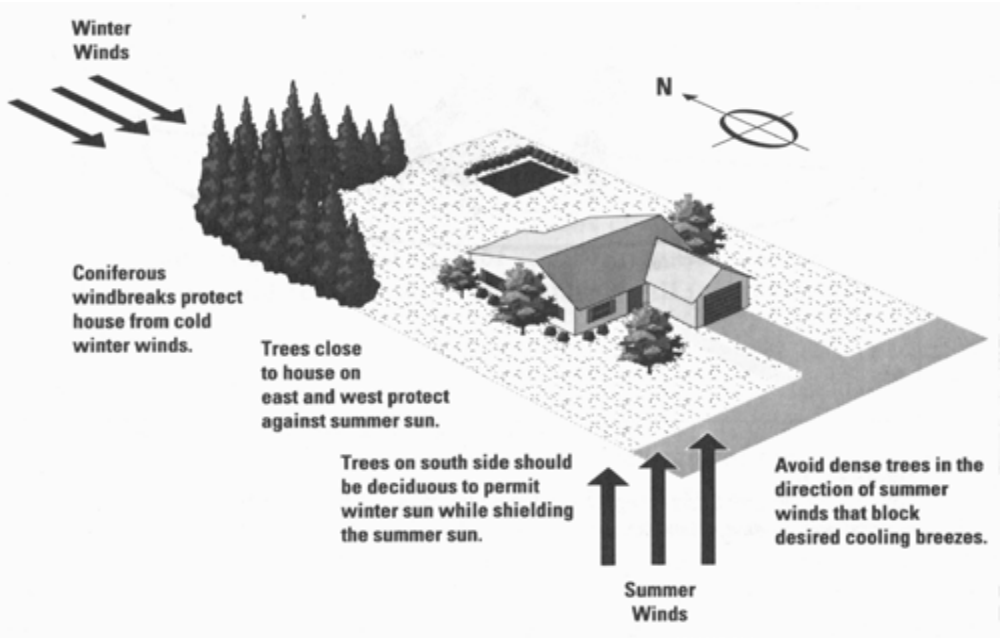
This phenomenon is known as the "urban heat island effect."[36] Researchers have estimated that urban heat island effects can be reduced by as much as 4°F with available mitigation technologies (e.g., installing whiter materials during new constructions and resurfacings).[37]

Preserving greenspace can also help reduce the urban heat island effect in three ways. First, plants and trees absorb less heat than darker-colored materials such as asphalt or dark shingles on a roof. Second, they provide shade. This reduces air conditioning needs and resulting GHG emissions. Third, trees, like most plants, soak up groundwater. The water then evapotranspires (evapotranspiration is the evaporation of water through leaves), cooling the leaves and indirectly cooling the surrounding air. A single properly watered tree can evapotranspirate 40 gallons of

water in a day, offsetting heat equivalent to that produced by a hundred 100-watt lamps burning eight hours per day.[38]

Computer simulations estimate that planting three trees around a typical house can save 18 percent to 44 percent of peak electrical power, and up to 53 percent of the total annual electricity used for cooling.[39] In short, preserving urban greenspace through growth management can help reduce heating and cooling needs by reflecting or shading summer sun and blocking winter winds, thereby cutting GHG emissions (see Figure 3).

FIGURE 3: Landscape design can help reduce building energy needs



Source: **Lawrence Berkeley National Laboratory.** See this diagram at the Lawrence Berkeley National Laboratory "Heat Islands" Web site at http://eetd.lbl.gov/HeatIsland/Vegetation/Planting.html.

When compared to the potential impact that decreased fossil fuel use can have in achieving GHG reductions, the potential contribution that reducing the urban heat island effect has on total GHG emission is relatively small but still provides a contribution to mitigation. Moreover, limiting the heat island effect can provide big benefits to building owners and occupants by reducing electricity demand from air conditioning, thus lowering their electric bills.

Urban heat island mitigation can reduce peak electrical demands that result from summer air conditioning loads. Reducing peak demand helps prevent "spikes" in electricity demand that can pose problems for electricity supply reliability programs and greatly increase electricity prices. Greenspace preservation, therefore, can lower individuals' electric bills while also providing ancillary GHG mitigation benefits.

Many state and local governments are adopting urban heat island abatement strategies as part of their GHG reduction activities. For example, in its Greenhouse Gas Action Plan, New Jersey estimates that if only 1 percent of its residents use tree planting to reduce heating and cooling

costs by 10 percent, it would prevent 260,000 tons of CO_2 from entering the atmosphere, not even considering the CO_2 that would be sequestered by the newly planted trees.[40]

In 1995 Salt Lake City initiated a program known as "Cool Communities"[41] in partnership with the Utah Office of Energy Services and Tree Utah.[42] The collaborative federal, state, and local program is designed to implement practical strategies that reduce peak-load electrical consumption, mitigate the development of urban heat islands, and directly improve air quality.[43]

Cool Communities strategies include the use of reflective ("cool") construction materials for streets and buildings; and the use of strategically planted, drought-tolerant trees, shrubs, and ground covers that evaporate cool water vapor into the air while directly shading and protecting buildings, streets, and parking lots.

In 1998, EPA, with other federal agencies, established the Heat Island Reduction Initiative to quantify the potential benefits of heat island reduction strategies and to promote mitigation. The Salt Lake City Cool Communities program was selected as one of EPA's first pilot projects, along with programs in Baton Rouge, Louisiana; Chicago, Illinois; Houston, Texas; and Sacramento, California.

Community Design

State approaches to and incentives for improved community design can produce greenhouse gas reductions even though GHG mitigation may not have been an intended benefit of the program. Reducing sprawl, co-locating a mix of buildings (e.g., residential, commercial, and workplace), and utilizing underused urban sites can all help reduce GHG emissions by:

- Reducing vehicle miles traveled, and thus the amount of GHG emitted from cars;
- Reducing the amount of concrete needed to build new buildings and subsequent roads (cement, a key ingredient in concrete, is a contributor to carbon dioxide emissions; see Appendix A);
- Reducing the energy needed to construct projects and their supporting infrastructure; and
- Potentially reducing the energy needed to live or work within the building, depending on the energy-saving devices used in constructing new buildings or retrofitting old ones.

Growth management and its relationship to transportation were addressed in the previous "Transportation Goals and Benefits" section. This section will focus on the links between GHG emissions and growth management practices such as infrastructure, building practices, and energy consumption.

Improved community design promotes efficient transit.
Communities that are more compact and support a mix of uses, or that are infill developments near mass transit stations, help increase transportation options. A recent study explored the differences in driving behavior between residents of traditional communities and suburban ones.[44] Traditional communities were defined as having narrow streets with a grid-like pattern, on-street parking, shallow setbacks, main-street shopping centers, a mix of land uses, and an emphasis on alternate modes of transportation. Suburban communities, on the other hand, were defined as featuring segregated land uses, a well-defined hierarchy of roads, extensive use of cul-de-sacs, and little transit service.

Recent research found that households in traditional communities generate 32 percent fewer automobile trips. Other research has found that people who live in homes built before 1974 indeed walk more. In fact, the research shows that people living in older homes are significantly more likely to walk one or more miles 20 or more times per month, controlling for gender, race and ethnicity, age, education, income, and any health-related activity limitations.[45] It is unclear, however, whether these results can be replicated in all "neo-traditional" communities—new suburban developments designed in the manner of traditional communities.

Traditional communities have evolved over six or more decades, and many feature high home density, access to extensive public transportation networks, proximity to large employment

concentrations that are well served by public transit systems, and a lack of off-street parking. The extent to which neo-traditional communities include these features will, in large part, determine their success.[46]

Smart growth developments promote efficient land use and building practices.
Several states are now recognizing the benefits of mixed-use and infill developments. These developments conserve greenspaces by reducing sprawl. They also conserve money, building materials, and energy by reducing the amount of construction needed to extend infrastructure (e.g., roads and sewer systems) to new buildings. Economies of scale for the construction of transportation, sewer, electricity, and communications services are increased along with density.

A tool developed by the California Energy Commission, the Oregon Department of Energy, and the Washington State Energy Office helps measure the impact that various types of growth have on a community. This computer planning method is called PLACE^{3}S, an acronym for **P**lanning for **C**ommunity **E**nergy, **E**conomic, and **E**nvironmental **S**ustainability.[47] The software recommends traditional neighborhood designs, with a mix of uses and transit and a compact development, to meet energy-efficiency goals.[48]

PLACE^{3}S examines the transportation, residential, commercial, industrial, infrastructure, and energy-production impacts of various growth and development options by quantifying energy use, energy cost, and energy-related air pollutants and CO_2 emissions. The software then compares the existing energy efficiency of the community to future design options.[49]

PLACE^{3}S focuses on energy use because energy efficiency is seen as a link to meeting other community goals, including providing transportation choices such as walking and mass transit, producing cleaner air, lowering the cost of public services, and conserving open space and agricultural lands. The San Diego Association of Governments used PLACE^{3}S to quantify the benefits of its Regional Energy Plan. Results show a cost savings of nearly $1.5 billion, the creation of over 5,000 new jobs in energy-efficiency services, and the elimination of half-a-million tons of air pollutants over 15 years if the plan were fully implemented.[50]

Perhaps the most direct action states and communities can take to reduce sprawl and promote improved community designs is to stop "subsidizing" sprawl with state tax dollars. The cost of providing infrastructure to new sprawl development often exceeds the revenue generated in taxes for that development. For example, the cost for connecting sewers to homes in Tallahassee, Florida, was found to be $4,447 for inner-city homes and $11,443 for homes at the northern edge of town. However, a constant fee of $6,000 per home was charged for all sewer connections, regardless of location or actual cost to the government.[51]

Growth management reduces sprawl and thereby reduces GHG emissions by requiring less energy to build infrastructure; but it also reduces GHG emissions by decreasing the use of one key construction material—concrete. If infrastructure does not have to reach as far into greenfields to service new communities, less concrete must be laid for roads, bridges, mass transit, sidewalks, drainage pipes, and other structures. And less concrete translates into reduced GHG emissions.

Conventional concrete combines sand, gravel, and water with Portland cement. To create Portland cement, alumina, silica, lime, iron oxide, and magnesium oxide are burned together in a kiln at high temperatures. The result is then pulverized into a fine powder. Because of the extreme heat needed to produce Portland cement, the manufacturing process is energy-intensive. It also releases large amounts of CO_2, both from the fuels burned and the chemical reactions that occur in the product as it is created.[52] Cement manufacture ranks ninth among the sources of U.S. GHG emissions (see Appendix A).[53]

Alternatives to traditional concrete, such as using fly ash in place of Portland cement, are combating the GHG problems associated with the material.[54] However, creating communities and planning for growth in ways that require less infrastructure because of compact designs also help reduce GHG emissions simply by requiring less concrete.

Several states have established policies and programs that help craft mixed-use and infill communities—communities that achieve GHG emission reductions while meeting the growth management goals of efficient land use, reduction of demands on infrastructure, and expansion of transit options:

- King Farm, a 430-acre mixed-use development in Rockville, Maryland, received approvals in 1995 for 3,200 housing units, 3.1 million square feet of office space, and 150,000 square feet of retail space. Although build-out was anticipated to take 15 years to 20 years, the project has been received so well that it will be completed within 10 years. King Farm has the advantage of being located close to the Washington metropolitan transit system (Metro), and the developer provides a free shuttle to transport residents and office workers to and from the Metro station. Ridership on the shuttle has been high since it began almost two years ago. In addition, the developer has set aside land for a transit-way to accommodate a future light-rail or bus system that will travel from the Metro station through the King Farm to residential and employment centers further north.

- Orenco Station—a 200-acre transit-oriented development near Portland, Oregon—is an example of a successful mixed-use community. Key to its development was its designation as a "town center," which resulted in a change from commercial zoning to mixed-use zoning. Also, state support of a light-rail station allowed Orenco Station to grow with less dependence on cars. Orenco Station is now part of a thriving high-technology center with 30,000 square feet of office space and 27,000 square feet of street-level retail. Orenco Station won an Oregon Livability award in 1998 from Governor John A. Kitzhaber. [55]

Well-designed buildings can reduce energy use.
Energy-efficient designs and technologies employed in new or renovated buildings—often known as "green building" practices—are consistent with the "smart growth" movement. Green building is a logical extension of the many land-use and conservation goals of growth management and community design.

Many technologies, such as improved building insulation and energy-efficient lighting, are almost immediately cost-effective. While a comprehensive examination of the myriad energy-

efficient building techniques is outside the scope of this paper, a brief discussion of some state strategies for reducing energy use is appropriate when drawing connections between GHG and growth management.

Incorporating green building techniques in growth management and community design is crucial, given the necessity to build new infrastructure that determines energy consumption for decades into the future. Simply put, it would be counterproductive to encourage smarter growth that helps reduce GHGs through greenspace conservation and reduced VMT and then build inefficient housing and offices that emit high levels of GHGs. There are opportunities for reducing energy use, costs, and GHG emissions within both the macro-level growth management decisions (e.g., community design and growth policies) and the smaller decisions (e.g., building insulation).

States can serve as role models for their citizens. In many states, the government itself is a large employer and a significant energy user. If citizens—particularly developers, builders, and businesses—see green building practices being applied in state building design, construction, and renovation, they could be more easily influenced to consider these technologies themselves when planning new development or community redevelopment. Moreover, a state has more credibility when encouraging developers to adopt energy-saving techniques if the state itself has a history of using these technologies.

Some states have already developed programs to evaluate the energy efficiency of any new plans to build state facilities. For example, California has an extensive energy program that includes technical assistance, monitoring of electric utilities, and programs to promote technologies that reduce GHG emissions.[56] In addition, PLACE^{3}S software can be used at a neighborhood level to evaluate the energy efficiency of just one block or even one building.[57]

Some states (e.g., Maryland) take green buildings and building efficiency one step further by procuring electricity generated from renewable resources for state facilities. The way states use electric power is a significant issue confronting state energy officials, because electric power plants produce a third of U.S. GHGs.[58] Electric power plant emissions in the United States grew by 15 percent between 1990 and 1998, faster than the national average rate for all emissions. Coal-fired generation contributes the majority of emissions from this sector, including 87 percent of the CO_2 emissions.[59]

Moreover, the types of building materials used in construction can either exacerbate or mitigate the urban heat island effect. In addition to preserving or planting trees, builders can use a variety of reflective building materials to reduce urban heat islands. For example, the difference between a surface painted black and a reflective white acrylic surface could be 77 degrees—142°F versus 65°F. A house with a reflectivity level of 90 percent consumes 60 percent less energy, has a 35-percent lower peak electrical power demand, and experiences 44 percent fewer cooling hours than a house that does not employ certain energy-saving green building techniques.[60]

Clearly, state and local governments can both save money and reduce GHG emissions by incorporating energy-efficient technologies into construction projects.[61] Because of limited budgets, many states have begun using energy service companies to realize opportunities to

conserve energy, which allows states to reap the financial and environmental benefits of energy efficiency without any up-front investment cost.

For example, Indiana is one of numerous states with laws that facilitate Guaranteed Energy Savings Contracts (GESC), or performance contracts. These GESC allow a public institution (e.g., a school district) to enter into a contract agreement with a company (i.e., a "provider") experienced in the design, implementation, and installation of energy conservation measures. The provider generally assists in locating financing, installs all energy conservation equipment, and provides post-project monitoring. Energy and operational cost savings, as measured against an agreed-to guaranteed baseline, are used to pay for the investment. If the guaranteed savings are not achieved, the provider must reimburse the public institution for the difference between the guaranteed and actual savings.[62]

In addition to reducing GHG emissions from their own operations, states can help businesses and citizens reduce energy use and GHG emissions.

- Maryland created the Energy Incentive Act of 2000, which provides sales tax exemptions and income tax credits to purchasers of certain appliances, electric or hybrid cars, and renewable resource energy systems. In addition, there is no sales tax on certain Energy Star appliances, including:
    - clothes washers (until July 2003);
    - room air conditioners (until July 2004); and
    - standard-size refrigerators (until July 2004).[63]

- In Michigan, several programs offered through the Energy Office of the Department of Consumer and Industry Services provide assistance to the residential, commercial, institutional, industrial, and transportation sectors in order to reduce energy use.[64] For example, the School and Local Government Energy Initiative (SLGEI) is designed to assist public schools, colleges, and local governments with improving the energy efficiency of their buildings. The program offers both technical assistance and financing. Eligible public institutions can install the recommended improvements with little or no up-front capital. In 2001 SLGEI provided technical assistance to help participants implement $2.2 million in energy improvements. These improvements will generate more than $352,000 in annual cost savings, which will repay the investment in about six years and then pay for core programs and activities. The improvements will immediately contribute to healthier and more productive building environments.[65]

- Wisconsin is promoting the conversion of electric water heaters to natural gas. The state has set a goal of converting 625 water heaters, which will save the average homeowner more than $150 per year and reduce greenhouse gas emissions from coal-fired utilities.[66]

Conclusion

NGA's Global Climate Change Policy recognizes a fundamental role for states in GHG mitigation policy because:

- states are responsible for implementing national clean air policies;
- states have authority over several policy areas potentially affecting climate change and the environment, including utilities, land use, transportation, and taxation; and
- states have already taken numerous actions, often justified on policy grounds unrelated to climate change, that nonetheless produce significant benefits in addressing GHG mitigation.[67]

States have regulatory authority over many direct and indirect sources of GHG emissions, or influence the emissions from these sources through work with local governments. For example, states define land-use and transportation policies; operate landfills; monitor air quality; pass and enforce building codes; define procurement policies; and sometimes influence zoning and regulate parking. States must also design, construct, and maintain state-owned facilities and procure electricity for them, which can offer significant opportunities for cost-effective GHG reduction efforts and concurrent reductions in overhead expenses, such as heating and cooling of state office buildings.

Improved growth planning and community design can foster economic growth, improved quality of life, a cleaner environment, and a stronger sense of community. With awareness of how GHG emissions are affected by growth management policies and programs, state leaders can also help curb GHG emissions without fear that mitigation will divert money from other state priorities. Growth management and community design offer many clear no-regrets strategies, and at a time when states must carefully monitor every dollar spent.

Appendix A: Sources of Greenhouse Gas Emissions in the United States

The U.S. Environmental Protection Agency (EPA) lists 40 individual sources of U.S. GHG emissions. In 2000 total U.S. greenhouse gases rose to 7001.2 teragrams of carbon dioxide equivalents (Tg CO_2 Eq.). This represents a 14.1-percent increase over 1990 emissions. The single-year increase in emissions from 1999 to 2000 was 2.5 percent, which is greater than the average annual rate of increase for 1990 through 2000 (1.3 percent). The higher-than-average increase in emissions in 2000 may be attributable to increased demand for electricity and fuels, cooler winter conditions, and decreased output from hydroelectric dams.[68]

Combustion of fossil fuel produces over 80 percent of total U.S. GHG emissions. Carbon dioxide from fossil fuel combustion is created during the generation of electricity and is emitted from transportation-related sources, such as cars and buses. Transportation-related sources are the second-fastest growing sources of GHG emissions, and the sources which state growth management policies can greatly affect.

Growth policies can affect fossil fuel combustion by influencing the scale of consumption (e.g., number of cars and size of houses), the efficiency with which energy is used in equipment (e.g., cars and building codes), and consumer behavior (e.g., walking, bicycling, or telecommuting to work instead of driving).

Top Ten Sources of U.S. GHG Emissions (2000)[69]

Rank	Source	Percent of total GHG emissions	Emissions measured in Tg CO_2 Eq.	Emissions measured In MMTCE*
1	Fossil Fuel Combustion	80.3%	5,623.3	1,533.6
2	Agricultural Soil Management	4.3%	297.6	81.2
3	Landfills	2.9%	203.5	55.5
4	Enteric Fermentation	1.7%	123.9	33.8
5	Natural Gas Systems	1.6%	116.4	31.7
6	Iron and Steel Production	1%	65.7	17.9
7	Coal Mining	0.87%	61	16.6
8	Mobile Combustion**	0.83%	58.3	15.9
9	Cement Manufacture	0.6%	41.1	11.2
10	Manure Management	0.5%	37.5	10.2
	Top Ten Sources Totaled	94.7%	6,628.3	1,807.6
	Total U.S. Emissions	100%	7,001.2	1,909.4
	Land-Use Change and Forestry ***	15%	(902.5)	(246.1)
	Net Emissions (Sources and Sinks)		6098.7	1663.3

* MMTCE stands for million metric tons of carbon equivalent.
** Mobile Combustion is for nitrous oxide only.
*** Parentheses indicate negative values (or sequestration).

What are Tg CO_2 Eq. and MMTCE?

GHG emissions are presented generally in "teragrams of carbon dioxide equivalent," or Tg CO_2 Eq. One teragram equals 1 million metric tons. This unit of measure allows for easier comparison of CO_2 emissions—the principal byproduct from fossil fuel combustion—with other GHG, such as nitrous oxides and methane. This new unit increasingly replaces MMTCE, or million metric tons of carbon equivalent, to make the U.S. inventory more consistent with international practices, which report emissions in Tg CO_2 Eq. Both units are offered in Appendix A because the United States has yet to fully convert from MMTCE.

Endnotes

[1] U.S. Environmental Protection Agency (EPA), Office of Atmospheric Programs, *Inventory of U.S. GHG Emissions and Sinks*, *1990-2000* (Washington, D.C., April 2002), ES-4.
[2] Ibid, ES-13. Virtually all of the energy consumed in this end-use sector came from petroleum products. Just over half of the emissions resulted from gasoline consumption by motor vehicles. The remaining emissions came from other transportation activities, including combustion of diesel fuel in heavy-duty vehicles and jet fuel in aircraft.
[3] Ibid, ES-2. Emissions of CO_2 from transportation sources increased at an average annual rate of 1.6 percent, while overall U.S. carbon emissions grew at an average rate of 1.2 percent per year (1.6/1.2 = 1.33). This is probably a conservative estimate, because it does not account for other GHGs, particularly nitrous oxides, which are the second-largest among mobile sources and grew by 18 percent from 1990 to 2000 (ES-4) and CFCs, which are increasingly related to mobile sources as they are phased out of other (i.e., nonmobile) air conditioning systems.
[4] U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Advanced Technology Division, "Executive Summary," *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2001*, EPA420-S-01-001, September 2001; available at http://www.epa.gov/otaq/cert/mpg/fetrends/s01001.pdf.
[5] David Shrank and T. Lomax , "2001 Urban Mobility Study," Texas A&M University, Texas Transportation Institute, May 2001; available at http://mobility.tamu.edu/.
[6] "Why are Roads So Congested: A Companion Analysis of the Texas Transportation Institute's Data on Metropolitan Congestion," (Washington, DC: Surface Transportation Policy Project (STPP), November 1999).
[7] Ibid.
[8] Joel S. Hirschhorn, *Growing Pains: Quality of Life in the New Economy* (Washington, D.C.: National Governors Association, 2000), 5.
[9] Kaid Benfield, "Environmental Characteristics of Smart Growth Neighborhoods: An Exploratory Case Study" (New York, NY: Natural Resources Defense Council, October 2000).
[10] U.S. Environmental Protection Agency, *Transportation and Environmental Analysis of the Atlantic Steel Development Project*, prepared by Hagler Bailly, Inc., November 1, 1999.
[11] For additional information, see http://www.nationaltrust.org/main_street/; and Leslie Tucker and Dan Costello, "Main Streets and Transportation Policies: Smart Growth Tools for Main Street" (Washington, DC: National Trust for Historic Preservation, 2002); available at http://www.nationaltrust.org/issues/smartgrowth/toolkit/toolkit_transportation.pdf.
[12] For additional information, see http://www.mainstreet.org/AboutMainStreet/numbers.htm.
[13] For additional information, see http://www.nga.org/center/divisions/1,1188,C_ISSUE_BRIEF^D_1543,00.html.
[14] The total GHG emissions attributable to passenger cars, light-duty trucks, and SUVs was 1,053.6 Tg CO_2 Eq. in 1999, while buses and commuter trains produced combined emissions of approximately 27 Tg CO_2 Eq. during the same year (U.S. Environmental Protection Agency, Office of Atmospheric Programs, *Inventory of U.S. GHG Emissions and Sinks*, *1990-1999*, EPA 236-R-01-001, April 2001, 2–12). This calculation assumes that approximately 40 percent of GHG emissions from locomotives is attributable to commuter trains, which is the result of a comparison of miles traveled of commuter rail and heavy rail

from Department of Transportation data in the DOT National Transportation Survey at http://www.bts.gov/btsprod/nts/.

[15] National Governors Association, *In the Fast Lane: Delivering Transportation Choices to Break Gridlock* (Washington, D.C.: National Governors Association, 2000).

[16] Sharon Boddy. "Car Free and Carefree: Living Without an Automobile is a New Lifestyle Choice," *E/The Environmental Magazine*, vol. XI, no. 2. (March/April 2000); available at http://www.emagazine.com/march-april_2000/0300curr_carless.html.

[17] Department of Transportation (DOT), Federal Highway Administration, *National Personal Transportation Survey* (Washington, D.C., 1995).

[18] Parkwood Research Associates Poll; in *Pathways for People* (Allentown, PA: Rodale Press, 1995).

[19] Department of Transportation, Federal Highway Administration, *National Bicycling and Walking Study* (Washington, D.C., 1994); and Kenneth R. Wylkie, "Pedaling Into the 21st Century," *Public Roads Magazine 62*, no. 8 (September/October 1999): 30-1.

[20] Terry Parker. "The Land Use–Air Quality Linkage: How Land Use and Transportation Affect Air Quality" (Sacramento, CA: California Air Resources Board, 1997).

[21] For additional information, see http://www.innovations.harvard.edu/release/2000winners/smart-growth.html; http://www.op.state.md.us/smartgrowth/; and Maryland Office of Planning, "Smart Growth and Neighborhood Conservation: A Legacy for our Children" (Baltimore, MD: Maryland Department of Planning, 1999).

[22] Barbara J. Braswell, "Brownfields and Bikeways: Making a Clean Start," *Public Roads 62*, no. 5 (March/April 1999).

[23] In some cases, children are required to walk to school if the distance is less than two miles, creating significant concerns among parents because of fast-moving traffic and the lack of sidewalks or walking/bicycle paths. See Tracey A. Reeves, "Worries Litter Walk to School," *Washington Post*, 7 October 2001.

[24] For additional information, see http://www.safekids.org/tier3_cd.cfm?content_item_id=3690&folder_id=183.

[25] Robert Shinn and Mike Winka, New Jersey Department of Environmental Protection, personal communication with author, 27 June 2001.

[26] For additional information, see http://www.ncsl.org/programs/health/ physical.htm.

[27] For additional information, see the California Department of Health Services "Safe Routes to School" Web site, at http://www.dhs.cahwnet.gov/routes2school/.

[28] George H. Ryan, *Illinois Tomorrow Balanced Growth for A Better Quality of Life: Accomplishments and Future Focus*, (Springfield, IL: Balanced Growth Cabinet, 2002)

[29] Dave Bachman, program manager, Pennsylvania Department of Transportation, personal communication with author, 3 July 2001.

[30] Joel S. Hirschhorn and Paul Souza, *New Community Design to the Rescue: Fulfilling Another American Dream* (Washington, D.C.: National Governors Association, 2001), available at http://www.nga.org/center/divisions/1,1188,C_ISSUE_BRIEF^D_2344,00.html; and Hirschhorn, *Growing Pains*, available at http://www.nga.org/center/divisions/1,1188,C_ISSUE_BRIEF^D_609,00.html.

[31] U.S. Forest Service, quoted by http://www.coolcommunities.org/urban_shade_trees.htm This report acknowledges that the amount of carbon already contained globally in tropical forests is significantly greater than the carbon sequestered in temperate forests (212 billion tons compared to 59 billion tons). U.S. forests—which are primarily temperate—have a lower rate of carbon fixation than tropical forests. While the U.S. forests' ability to sequester carbon may be small when assessed on a global scale, carbon sequestration can indeed serve as a no-regrets strategy and thus is highlighted in this report.

[32] Richard A. Birdsey, *Opportunities to Increase Carbon Sequestration through Forestry*, USDA Forest Service, Global Change Research Program, Senate Agriculture Committee Seminar, Washington, DC, 30 March 2001. 917 Tg CO_2 Eq. = 250 MMTCE.

[33] New Jersey Department of Environmental Protection (NJDEP), *NJDEP Greenhouse Action Plan* (Trenton, NJ, January 2000); and Robert C. Shinn, Jr., Commissioner, New Jersey Department of Environmental Protection, *Administrative Order 1998-09* (Trenton, NJ, 17 March 1998).
[34] The statement "dark materials absorb more sun" can be explained by albedo, which is a measure of the ability of a surface material to reflect sunlight (including the visible, infrared, and ultraviolet wavelengths) on a scale of 0 to 1. An albedo value of 0.0 indicates that a surface absorbs all the solar radiation, while a 1.0 albedo value represents total reflectivity. Roofs and pavements, particularly dark-colored ones, have a low albedo, meaning that these materials absorb more of the sun's heat, thereby causing surface and air temperatures to rise. Vegetation generally has a low albedo, as well; however, vegetation cools the environment by providing shade and conducting evapotranspiration.
[35] For additional information, see http://eetd.lbl.gov/HeatIsland/CoolRoofs/.
[36] Maurice G. Estes, V. Gorsevski, C. Russell, D. Quattrochi, and J. Luvall, "The Urban Heat Island Phenomenon and Potential Mitigation Strategies" (paper presented at the American Planning Association Conference, Seattle, WA, 1999). The Lawrence Berkeley National Laboratory performs extensive research in this field, sponsored largely by EPA. For additional information, see http://eetd.lbl.gov/HeatIsland/.
[37] Melvin Pomerantz, H. Akbari, P. Berdahl, and H. Taha, "Physics and Public Policy for Urban Heat Island Mitigation" (summary of a presentation to the American Physical Society, Atlanta, Georgia, March 1999). For additional information, see http://EETD.LBL.gov/HeatIsland.
[38] Arthur H. Rosenfeld, J. Romm, H. Akbari, and A. Lloyd, "Painting the Town White—and Green," *MIT Technology Review* vol 100*,* no 2. (February/March 1997).
[39] H. Akbari, S. Konopacki, and M. Pomerantz, "Cooling Energy Savings Potential of Reflective Roofs for Residential and Commercial Buildings in the United States," *Energy: The International Journal 24* (1999): 391–407.
[40] NJDEP, *Greenhouse Action Plan*; and Shinn, *Administrative Order 1998-09*.
[41] Salt Lake City was one of three cities, including Sacramento and Baton Rouge, to initiate this program.
[42] Estes et al., "Urban Heat Island Phenomenon."
[43] For additional information, see http://www.utah.org/energy/cool_communities.html; and http://eande.lbl.gov/HeatIsland/LEARN/CoolCommunity.
[44] Bruce Friedman, Stephen P. Gordon, and John Peers, *Effect of Neo-traditional Neighborhood Design on Travel Characteristics,* Transportation Research Record 1466 (Washington, DC: Transportation Research Board, 1994).
[45] David Berrigan and Richard P. Troiano, "The association between urban form and physical activity in U.S. adults," *American Journal of Preventative Medicine 23*, no. 2, supplement 1 (August 2002):. 74–79.
[46] Reid Ewing, Padma Haliyur, and G. William Page looked at trends in Palm Beach County, Florida, and reached findings in keeping with the studies discussed above (Reid Ewing, Padma Haliyur, and G. William Page, *Getting Around a Traditional Planned Unit Development, and Everything in Between*, Transportation Research Record 1466, (Washington, DC: Transportation Research Board, 1995). Looking at six communities in the county that were relatively homogenous in household size and income levels, Ewing et al. found that West Palm Beach, the most traditional community of the six, generated *two-thirds* fewer vehicle hours traveled than Jupiter Farms, the most sprawling community. Interestingly, Ewing et al. report that based on an accessibility index of their own creation, Jupiter Farms has only one-tenth the accessibility of West Palm Beach.
[47] For additional information, see the PLACE^{3}S website at http://www.energy.ca.gov/places/.
[48] *The Energy Yardstick: Using PLACE^{3}S to Create More Sustainable Communities: Executive Summary* (Washington, D.C.: U.S. Department of Energy, April 1997), 10; available at http://www.energy.ca.gov/places/EXECSUMM.PDF.
[49] Ibid, 5.
[50] Ibid.
[51] Phillip Longman, "Sprawl," *Florida Trend*, St. Petersburg, Florida, December 1994.

[52] For additional information, see http://www.consumerenergycenter.org/homeandwork/homes/construction/concrete.html.
[53] EPA, *Inventory, 1990-1999*, ES-4, 1-13 and 1-14.
[54] California Energy Commission, "Concrete."
[55] For additional information, see www.orencostation.com; and Hirschhorn and Souza, *New Community Design,* 31.
[56] For additional information, see http://www.energy.ca.gov/index.html; and http://38.144.192.166/renewables/index.html.
[57] *The Energy Yardstick*, 11.
[58] U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States: 1999*, DOE/EIA-0573(99) (Washington, D.C.: Department of Energy, 2000), 28, Table 10. This may be a slight underestimate because it is based on the EIA estimate of total CO_2 emissions from electricity generators (utility and nonutility), which was 614 MMTCE or 2,251 Tg CO_2 Eq., compared to the total U.S. GHG emissions of 1,839 MMTCE or 6,746 Tg CO_2 Eq.
[59] EPA, *Inventory*, *1990-1999*, 2–4.
[60] Mike Wooldridge and M.A. Wooldridge, "Cool ideas for roofs cut energy bills, smog," Lawrence Berkeley Labs Currents (November 18, 1994); available at http://www.lbl.gov/Publications/Currents/Archive/Nov-18-1994.html.
[61] Some examples include:

- purchasing ENERGY STAR® labeled computer equipment and other products;
- retrofitting traffic lights to use light-emitting diode (LED) technology;
- improving performance of energy-intensive operations (e.g., water and wastewater treatment plants);
- maintaining heating and cooling systems (also improves occupant comfort and productivity);
- specifying energy-efficient design and equipment for new buildings and replacements; and
- using a five-stage approach to upgrade building stock (lighting, system tune-ups, load reductions, fans, and heating and cooling system upgrades).

[62] For additional information, see http://www.in.gov/doc/businesses/EP_building.html.
[63] For additional information, see http://www.energy.state.md.us/incentive.htm.
[64] For additional information, see the Michigan Energy Office Web site at http://www.cis.state.mi.us/opla/eo/.
[65] *School and Local Government Energy Initiative: 2001 Annual Report* (Lansing, MI: Michigan Department of Consumer and Industry Services, Energy Office, 2002); available at http://www.cis.state.mi.us/opla/eo/pubs/slgei_ar01.pdf.
[66] For additional information, see http://www.epa.gov/oppeoee1/globalwarming/visitorcenter/decisionmakers/course.html.
[67] National Governors Association, "Global Climate Change Policy" (Time limited. Effective Annual Meeting 2002-Annual Meeting 2004), (adopted at Annual Meeting 1990; last revised and reaffirmed at Annual Meeting 2002); http://www.nga.org/nga/legislativeUpdate/1,1169,C_POLICY_POSITION^D_660,00.html.
[68] EPA, *Inventory, 1990-2000*, ES-2.
[69] EPA, *Inventory, 1990-1999*, ES-3.