Taking the Temperature: Transportation Impacts on Greenhouse Gas Emissions in the Atlanta Region

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Introduction

Climate change refers to any significant change in measures of climate lasting for an extended period.[1] Weather is the condition of the atmosphere over a short period of time, while climate is how the atmosphere behaves over relatively long periods of time.[2] Although climate change is commonly associated with extreme temperatures, it also includes measures such as precipitation and wind.

The change in temperature is caused by carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other gases trapped in the atmosphere. The temperature change, in turn, leads to long-term changes in normal weather patterns.

While the debate on climate change continues, the benefits of reducing harmful emissions extend beyond adapting to a changing climate. Taking appropriate actions now will alleviate congestion and improve public health. The potential impacts to Georgia include more frequent and more intense heat waves, storms, droughts, and forest fires. Longer and hotter summers will likely degrade regional air quality, increase the risk of the spread of infectious diseases, and challenge water supplies and agriculture. This ultimately affects our economy and our quality of life.[3]

The transportation sector is responsible for roughly one-third of domestic CO_2 emissions,[4] the predominant greenhouse gas (GHG) contributing to global climate change. While improvements in fuel efficiency and development of more sustainable energy sources for cars and trucks can result in significant CO_2 reductions, strategic transportation and land use planning are also crucial in reducing GHG emissions. To this end, cooperation on regional, statewide and multi-state levels is more effective than the efforts of individual cities or counties.

Local Context

The Atlanta region is among the largest urbanized areas in the country. In 2007, metro Atlanta ranked eighth in population and third in land size.[5] According to a 2008 study by the Brookings Institute, the average carbon footprint of metro Atlantans ranks among the highest one-third of footprints in 100 major metropolitan regions across the country, mostly due to fast growth, low density, and limited mass-transit systems.[6] (Brookings measured transportation and residential energy consumption, not including transit energy consumption and not including industrial and commercial energy consumption, so the result is a partial measure of metropolitan footprints.)

As the federally designated Metropolitan Planning Organization (MPO) for all or portions of 18 counties within the 19-county Atlanta Urbanized Area, the Atlanta Regional Commission (ARC) is committed to improving transportation and air quality in the metro region. This occurs through the leadership of programs such as the Livable Centers Initiative (LCI), Community Choices, and Green Communities, planning and visioning efforts such as Fifty Forward, and goals outlined in Envision 6, ARC's long-range Regional Transportation Plan (RTP) and Regional Development Plan (RDP). The primary goals of the Envision6 RTP are listed below.

Envision6 RTP Goals:
- *Improve accessibility and mobility for all people and freight*
- *Encourage and promote the safety, security and efficient development, management, and operation of the surface transportation system*

• *Protect and improve the environment and the quality of life*
• *Support economic growth and development*

The majority of the specific objectives intended to support these goals are related to the issue of climate change (see Appendix A). ARC's efforts in cooperation with state, regional and local planning partners with regard to regional land use and transportation planning have the opportunity to significantly reduce mobile emissions in the Atlanta region over the next 30 or more years. Beyond the emissions benefits, the economy, the health of the general public, and the overall quality of life are also anticipated to improve.

Regional Impacts

Although carbon dioxide levels are increasing around the globe, climate change manifests itself locally. While climate models cannot predict temperature variability at the local level, national studies[7] and research conducted by Georgia scientists have assessed the impacts of global warming in the Southeast.[8,9,10] In terms of natural variability, heat waves, storms, droughts, and forest fires will occur more often and more intensely. They also predict that air quality will worsen, infectious diseases will threaten the population, and agriculture methods will be challenged.[11]

Extreme weather impacts
The Atlanta region has experienced its share of weather catastrophes in recent years. FEMA has declared 19 major disaster areas in Georgia since 1990, consisting of hurricanes, tornados, and floods.[12] In 2004, Atlanta suffered $41 million in damages from Hurricane Frances, primarily from flooding due to inadequate storm sewer systems.[13] In 2007, Georgia, along with much of the Southeast, experienced its worst drought in history.[14] Tornados that swept through the state, including downtown Atlanta, in March 2008 caused $250 million in damages statewide.[15] Eight days of continuous rain in September 2009 led to flooding and $500 million in damages in 17 Georgia counties.[16]Enormous amounts of money are required to recover from the damages of these weather events. No single weather event can be directly attributed to climate change but the severity and frequency of these disasters will likely increase, as will the subsequent costs to recover.[17]

Public health
Hotter weather leads to harmful air quality. There were 29 days that exceeded the federal ozone standard in 2008,[18] primarily due to a hot, dry summer. With a more stringent ozone standard now in place, the number of unhealthy air days exceeding the new standard will likely increase. Combined with the potential for hotter and longer summers, it is likely that in the near future, occurrences of unhealthy air days will be a significant public health challenge for the region. Poor air quality endangers public health, especially sensitive populations.[19] Heat-related illnesses and deaths are exacerbated by high temperatures. Hot weather also encourages the spread of diseases, such as malaria and West Nile Virus.

Transportation impacts
Transportation has been a catalyst for Atlanta's growth. The movement of people and goods is vital to the economy, as Atlanta is home to the world's busiest airport, an extensive railway network, and major interstate highways. Roadways, railways and airport runways are all vulnerable to high temperatures and natural disasters.[20] Extreme weather events will challenge this infrastructure and may lead to deformities in rail-track, pavement, and concrete.

Economic impacts
All types and levels of impacts have economic implications. Cost of health care will increase with the rise in adverse health conditions. The increase in days with extreme temperatures will consequently increase energy consumption to achieve more comfortable indoor temperatures. A significant percentage of Georgia's economy thrives on agricultural outputs, which are dependent on specific climate conditions. Although longer growing seasons could mean greater crop yields, these may subside in the long term as temperatures continue to rise and drought conditions worsen.[21] Breakdowns in the transportation system due to extreme weather events, such as floods and tornados, are also costly. These cause delays for employees commuting to work and in the transfer of goods, which are factors of economic conditions. Shortages in water supplies may result in businesses locating elsewhere or in business failures as a result of high water costs or restrictions on use. Collectively, these negative impacts may make Atlanta less appealing for future economic development.

On-Road Transportation CO_2 Emissions

Carbon dioxide is the most prevalent anthropogenic GHG, contributing 85 percent of the greenhouse effect.[22] It is released into the atmosphere by the combustion of fossil fuels. Because CO_2 is the most prevalent GHG, GHG emissions are commonly reported in CO_2-equivalents (CO_2e). For transportation alone, CO_2 is responsible for 96 percent of GHGs emitted,[23] so this report will focus on CO_2.

Figure 1 illustrates the sectors that contribute to CO_2 emissions. In Georgia, power and transportation are the leading sources of CO_2 emissions. Like many other states in the southeast, Georgia is heavily dependent on coal as a source of energy, with 63 percent of energy generation from coal.[24] In fact, coal remains the primary source of energy generation across the country.

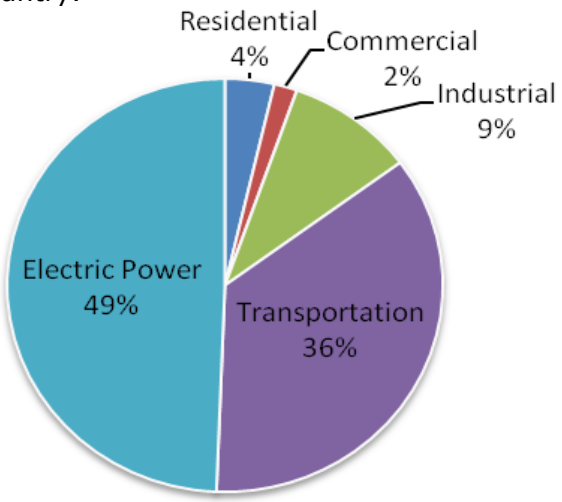

Figure 1. Georgia CO_2 emissions, 2007
Source: Energy Information Administration, "Georgia Carbon Dioxide Emissions from Fossil Fuel Consumption (1980 to 2007)." 4 Feb 2010.

Between 1990 and 2005, transportation sector CO_2 emissions in Georgia outpaced the national trend. Georgia CO_2 emissions increased 42 percent compared to 26 percent across the U.S. as a whole (Figure 2). This increase in CO_2 emissions is directly tied to expansive economic growth in the state and increased energy demands, especially in the Atlanta

region. From 1998 to 2008 the Total Gross Domestic Product for Georgia increased 56 percent, slightly lower than the national increase of 63 percent. Georgia ranked 10th nationally in total GDP in 2007.[25]

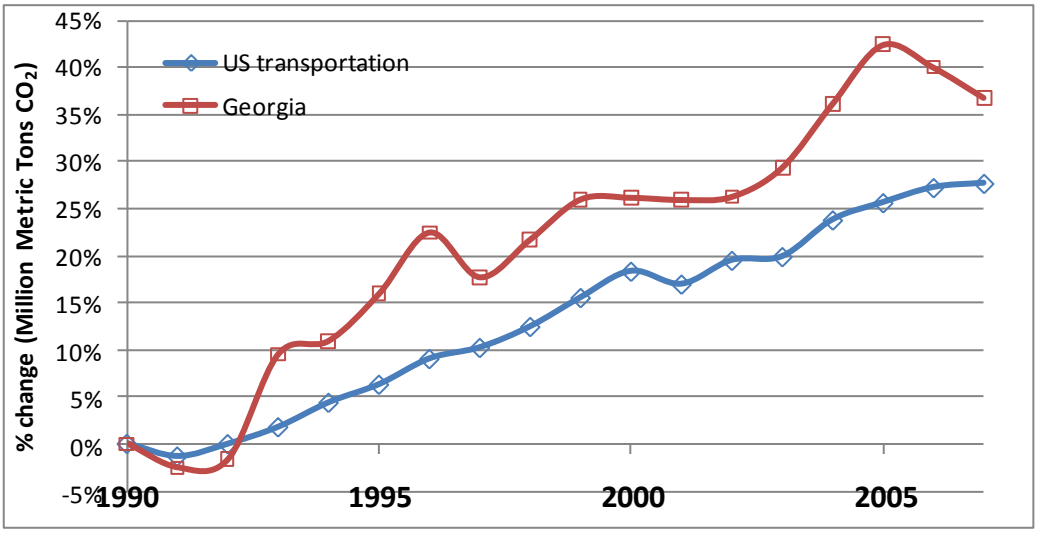

Figure 2. Transportation CO_2 Emissions
Source: Energy Information Administration, "Georgia Carbon Dioxide Emissions from Fossil Fuel Consumption (1980 to 2007)." Oct 2009.

The majority of transportation sector CO_2 is emitted from on-road light- and heavy-duty vehicle tailpipes; a minority comes from off-road sources.[26] The increase in CO_2 in the Atlanta region can be attributed to four primary factors: increase in Vehicle Miles Travelled (VMT), fleet inefficiency, increase in freight volume (especially container shipments), and system/vehicle operating characteristics (e.g., congestion, speed, idling, acceleration, etc.).

Factor 1: Increase in VMT

VMT is a critical driving factor in on-road transportation CO_2 emissions. Simply stated, CO_2 emissions are directly related to the amount of fuel consumed. Therefore, if VMT increases significantly without similar increases in vehicle fuel economy, CO_2 emissions will increase at the same rate.

The Atlanta region has experienced significant growth in VMT from 1990 to the present. In 1990, the 20-county regional VMT was 94 million, with a total population of 3.06 million. By 2000, the regional VMT was 137 million with a total population of 4.23 million. In 2010, the regional VMT is estimated at 167 million with a total population estimated at 5.1 million.

Between 1990 and 2000, the region added 1.2 million persons. On average, each one of these new residents contributed 36 vehicle miles of travel per day. (This includes drivers as well as non-drivers; therefore the number of miles *per driver* is actually much higher.) From 2000 to 2010 the region forecasts adding about 850,000 persons. On average, each one of these new residents will contribute 31 vehicle miles of travel per day, a significant decrease from the average VMT per new resident in the prior decade. This is a positive change for the Atlanta region and is a result of more growth in the urban core of the region combined with increased travel costs and different location decisions, resulting in shorter trips and increased use of alternative travel modes. The following charts present additional data regarding regional VMT and population growth.

Figure 3 shows regional population and VMT trends in metro Atlanta. The increasing VMT can be attributed to many factors. Atlanta's development pattern has historically been low density, characterized by single-use development on the urban fringe. Between 1990 and 2005, Atlanta's urbanized land area increased 88 percent.[27] Urban expansion was a result of the availability of inexpensive raw land for development. Population exploded and communities developed further and further from the city center, causing VMT per capita to increase from 22 miles per day per person in 1990 to 28 miles per day per person in 2000. From 1990 to 2005, the rate of population growth has essentially been mirrored by the rate of growth in regional VMT.

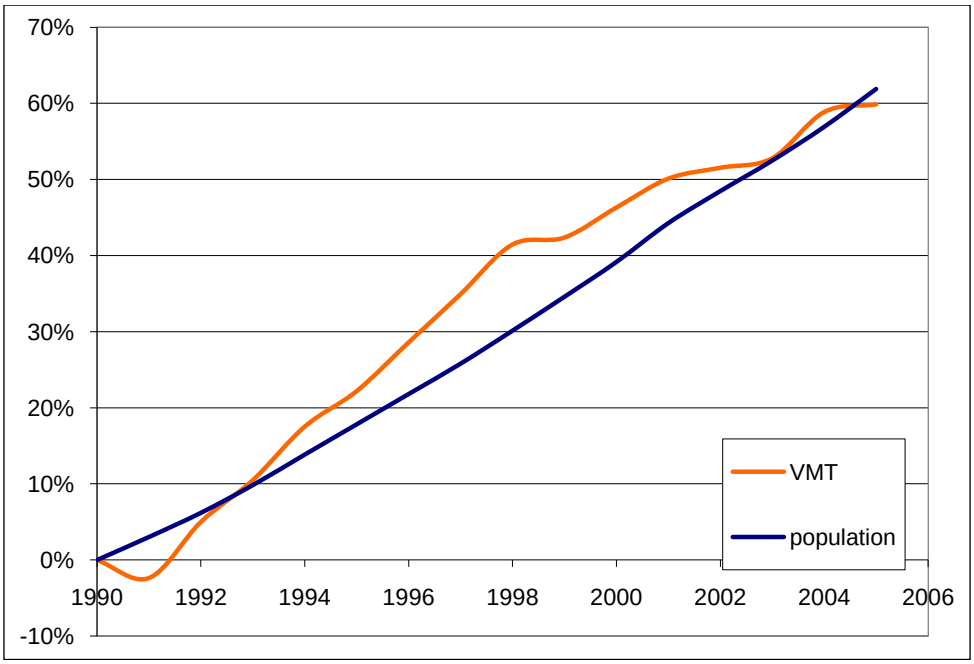

Figure 3. VMT & population change in metro Atlanta
Source: Georgia Dept. of Transportation, Atlanta Regional Commission

Figure 4 compares VMT per capita in Atlanta to peer regions. These Sunbelt regions have similar regional growth patterns to Atlanta. Atlanta has seen declines due to large increases in the size of the urbanized area. Many new trips in the expanded region are in exurban or rural areas that do not commute to the Atlanta core, and thus have shorter average distances. Additionally, some positive impacts of increased development in activity centers and transit corridors have led to reductions in VMT. In 2007, Atlanta had an average VMT per capita of less than 21 miles travelled. The size of these regions' urbanized areas has remained fairly constant since 2000.

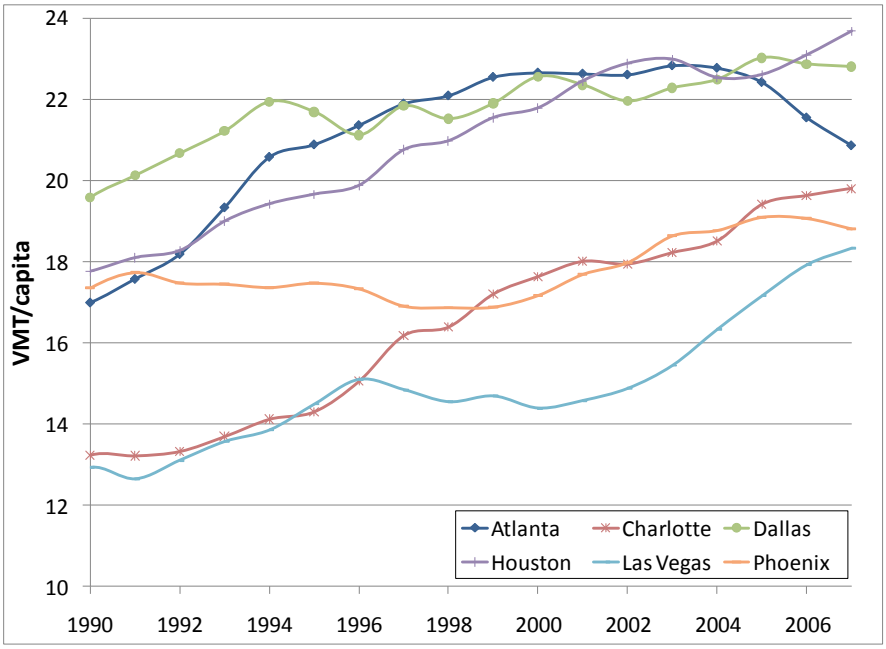

Figure 4. VMT per capita
Source: Texas Transportation Institute, "2009 Urban Mobility Report." July 2009.

Figures 5 and 6 show that population and VMT growth among peer metropolitan regions are similar to the Atlanta region. All regional forecasts indicate that VMT will continue to rise at a similar or faster rate than population over the next 25 years. However, these forecasts were made before the increase in gasoline prices and the national economic downturn, which have caused a significant reduction in VMT. In addition, there is evidence of a demographic shift and saturation in auto ownership, both of which may also contribute to a long-term reduction in VMT growth rates.

Using a baseline year of 2005, Atlanta is forecasting the smallest percent increase in population and VMT compared to these regions. Compared to recent Regional Transportation Plans in the Dallas-Fort Worth and Houston-Galveston regions, the Envision6 RTP for the Atlanta region shows a 54 percent increase in VMT by 2030, compared to 67 percent and 89 percent increases respectively in Dallas and Houston.

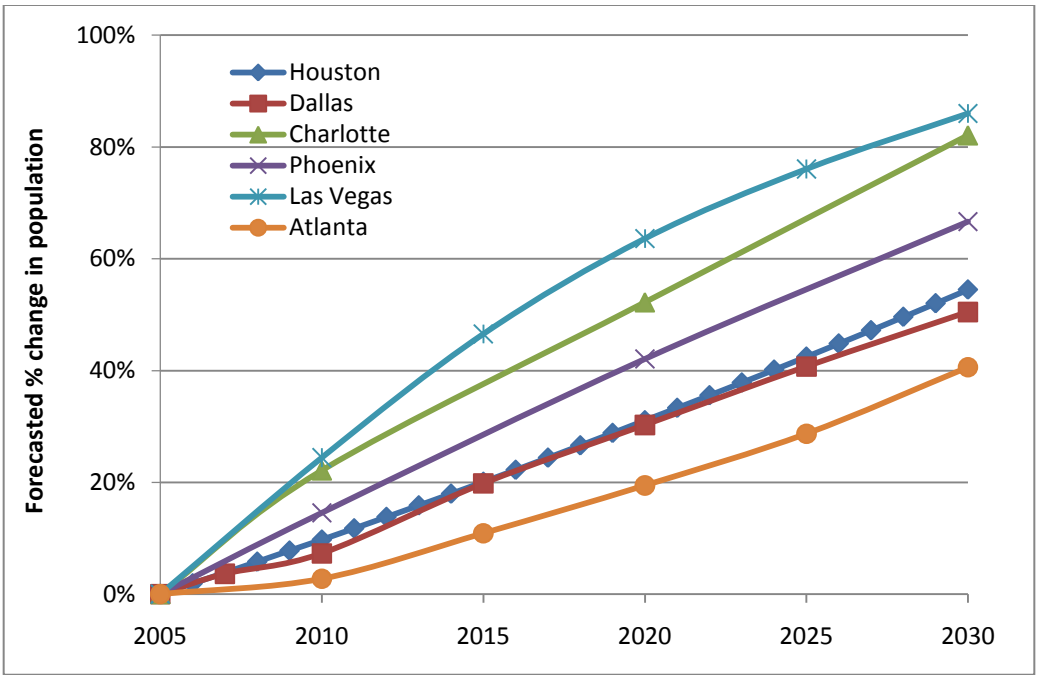

Figure 5. Comparison of population forecasts

Sources: Houston-Galveston Area Council, North Central Texas Council of Governments, Mecklenburg-Union MPO, Maricopa Association of Governments, Regional Transportation Commission of Southern Nevada, Atlanta Regional Commission

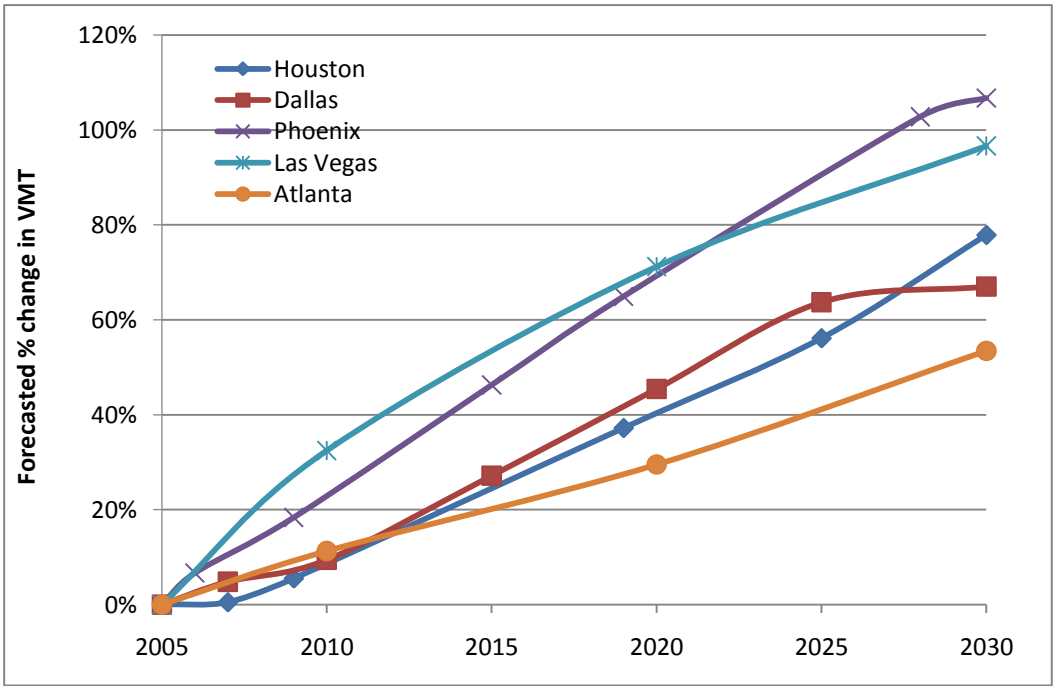

Figure 6. Comparison of VMT forecasts*

Sources: Houston-Galveston Area Council, North Central Texas Council of Governments, Mecklenburg-Union MPO, Maricopa Association of Governments, Regional Transportation Commission of Southern Nevada, Atlanta Regional Commission

*data not available for Charlotte

In contrast, VMT per capita of Atlanta is compared to that of high-density regions (Figure 7). These regions have dense population and employment centers with expansive, high

capacity transit systems. VMT per capita remained constant in the Washington D.C. and San Francisco regions from 1990 to 2005, while New York experienced a slight increase. In comparison to Atlanta, VMT per capita in these more compactly developed regions is, on average, five to 10 miles fewer per day per person. These regions have launched climate change initiatives that are discussed in Appendix B.

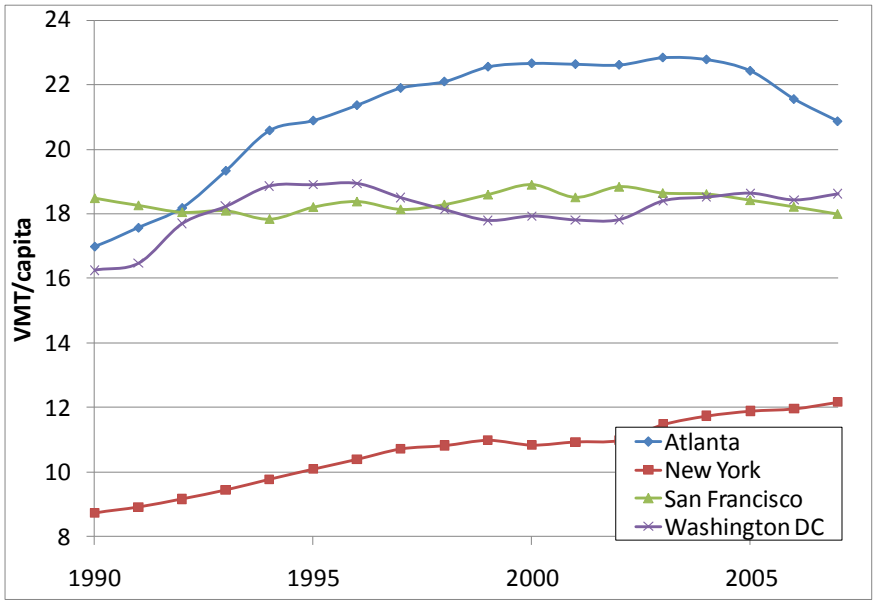

Figure 7. VMT per capita in high-density cities
Source: Texas Transportation Institute, "2009 Urban Mobility Report." July 2009.

Factor 2: Fleet Efficiency

Fleet efficiency is considered by most experts to be the most critical factor in impacting CO_2 emissions. Fleet efficiency refers to the average fuel economy of a fleet. In fact, because of the long-term changes required to alter patterns of VMT growth, such as land use changes and investment in alternative transportation modes, improving fuel economy is the first step in addressing CO_2 emission challenges. In the last two decades, fuel economy in Georgia has remained nearly constant or has decreased. In light of the VMT growth presented previously, this has resulted in significant growth in CO_2 emissions. Although fuel economy for light-duty vehicles has a slightly improving trend (Figure 8), this is completely offset by the increasing number of fuel-inefficient vehicles (light-duty and medium-duty trucks) in the fleet.

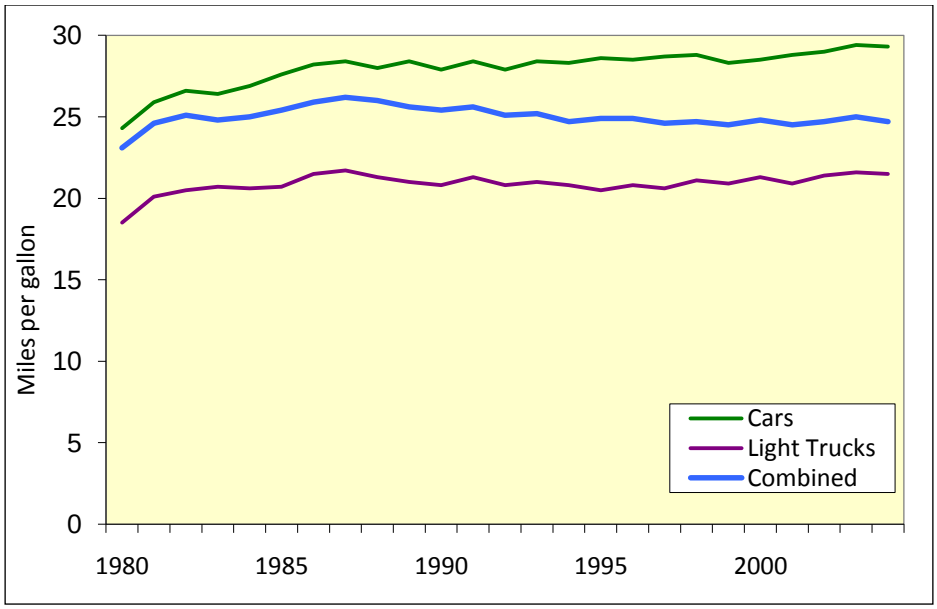

Figure 8. Average fuel economy for new light-duty vehicles, 1980-2004
Source: Energy Information Administration. Fuel Economy of the Light Duty Vehicle Fleet. 2005

The number of sport utility vehicles and pick-up trucks, the least fuel-efficient vehicles in the passenger vehicle fleet, registered in Georgia has increased dramatically over the last two decades (Figure 9). In 2002, there were 2.7 million private and commercial trucks registered in Georgia, up 21 percent from 2.3 million trucks in 1997. Georgia had approximately one pickup for every 6 people and about one SUV for every 10 people in 2002. It also has approximately one pickup for every four licensed drivers and about one SUV for every seven licensed drivers.[28] (The Vehicle Inventory and Use Survey has since been discontinued; 2002 represents the latest data.)

However, the recent dramatic increases in fuel costs have led to an equally dramatic decrease in sales of fuel-inefficient vehicles.[29]

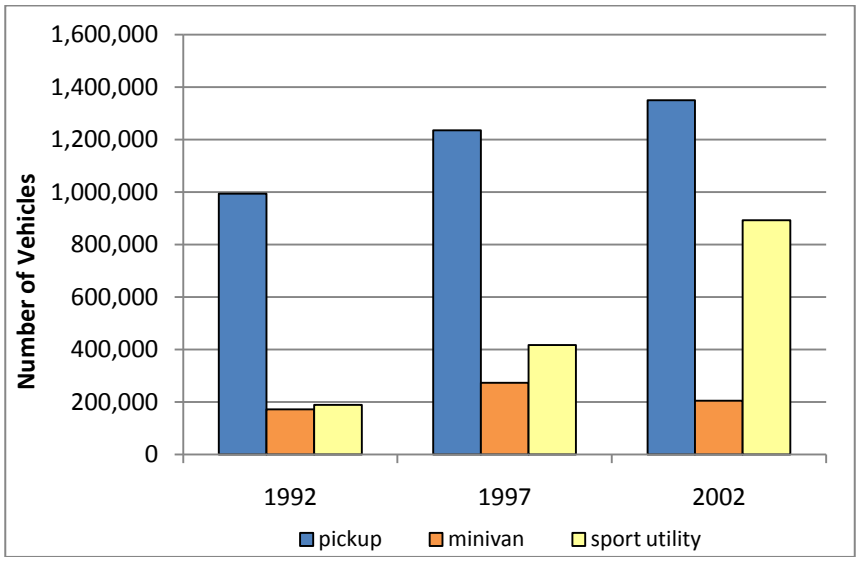

Figure 9. Registrations of Sport Utility Vehicles, Minivans, and Pickups in Georgia
Source: U.S. Census Bureau, "2002 Economic Census, Vehicle Inventory and Use Survey, Georgia 2002." Dec 2004.

The average fuel economy of the light-duty gasoline vehicle and truck fleet in the 20-county Atlanta nonattainment area for ozone and fine particulate matter has remained constant since 2002 at about 17 miles per gallon. In December 2007, Congress enacted the Energy Independence and Security Act of 2007 (EISA), dedicated to improving fuel economy and helping to reduce U.S. dependence on oil.[30] The bill calls for increasing the Corporate Average Fuel Economy (CAFE) standard to 35 mpg for light-duty vehicles with model years between 2011 and 2020, a 40 percent improvement from the current standard. In May 2009, President Obama created a new national policy aimed at increasing fuel efficiency and decreasing GHG emissions. The new CAFE standard of 35.5 mpg by 2016 is projected to save 1.8 billion barrels of oil and reduce 900 million metric tons of GHG emissions.[31]

Factor 3: Freight Truck Traffic Growth

The Atlanta region is one of the strongest and fastest-growing logistics clusters and freight transportation centers in the nation. Metro Atlanta ranks fifth in the nation in transportation and logistics employment and the State of Georgia was recently ranked as the best state for logistics because of its air, ground, rail and sea facilities, as well as corporate logistics centers and intellectual capital.[32] The Atlanta region is a major hub for distribution of goods across the country because of its extensive interstate, roadway, and rail network and access to a major international airport. Trucks are the primary mode of freight transportation in the region, accounting for approximately 84 percent of all freight movement.[33] Truck VMT in the Atlanta region is expected to increase 55 percent between 2005 and 2030.[34] Figure 10 indicates that this increase outpaces average VMT growth for all vehicles in the Atlanta region.

Heavy-duty diesel engine emissions are a primary contributor to GHG emissions.[35] They have, on average, a much lower fuel economy than light-duty vehicles and, due to operating procedures, waste significant amounts of fuel and emit large amounts of CO_2 by idling at distribution centers and truck stops. It is likely that the Federal government will regulate fuel economy or GHG standards for medium and heavy-duty diesel engines. EISA requires the National Academy of Sciences to evaluate and report on the potential for improving truck fuel economy and also requires US DOT to initiate rulemaking after it receives the NAS report. EPA has estimated that heavy duty truck engine efficiency can be improved 40 percent by 2015,[36] and identifies a wide range of other opportunities to reduce heavy duty GHG emissions. Although the emergence of clean diesel fuel has provided significant reductions in criteria pollutant emissions, it has not led to reductions in CO_2 emissions.[37]

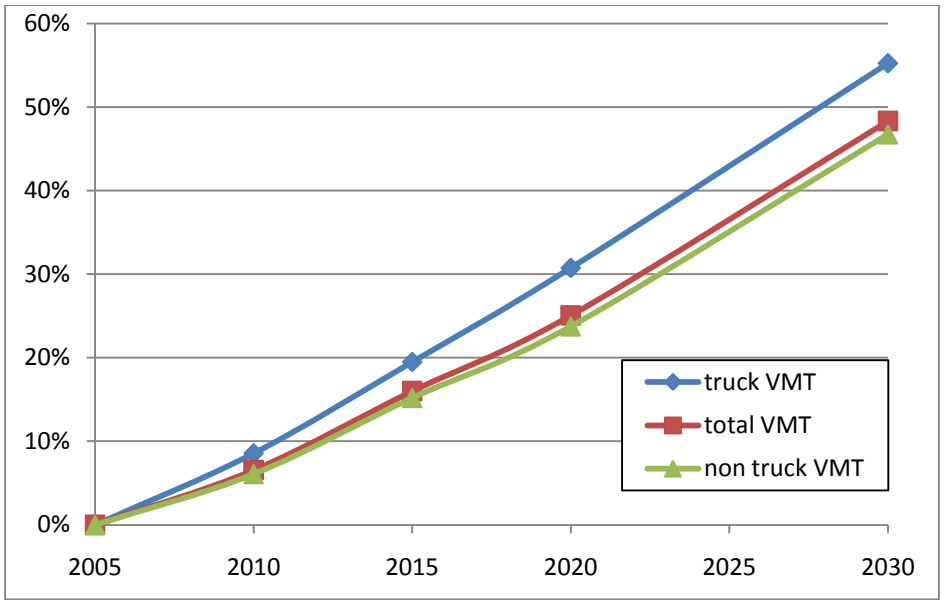

Figure 10. Freight Truck Projections
Source: ARC Travel Demand Model

Factor 4: Congestion

Congestion and its associated impacts, such as wasted time and fuel, decreased regional economic competitiveness, and worsened air quality, are among the most significant problems facing the Atlanta region. Congestion is caused by bottlenecks, traffic incidents, work zones, bad weather, poor signal timing, lack of competitive alternatives to single occupant vehicle (SOV) travel, and overall travel demand exceeding system capacity. In 2008, it resulted in $9 billion of annual delay costs, representing more than $1,200 per traveler in wasted time and fuel.[38] Low travel speeds, inefficient accelerations, and idling also lead to decreased vehicle efficiency and result in increased ozone precursor and CO_2 emissions. A common measurement of congestion is the Travel Time Index (TTI), which is a ratio of total travel time to free flow travel time.[39] According to a study by the Texas Transportation Institute, Atlanta's TTI in 2007 was 1.35 – it took 35 percent longer on average to get to a destination. As depicted in Figure 11, TTI increased 19 percent between 1988 and 2007. It is estimated that the regional TTI for *Envision6* RTP 2030 network is 1.64. This trend of continued increases in regional congestion results in a total annual delay cost in 2030 of more than $20.4 billion. In 2008, delay caused by congestion resulted in an additional 1.67 million daily gallons of fuel consumed by private vehicles.

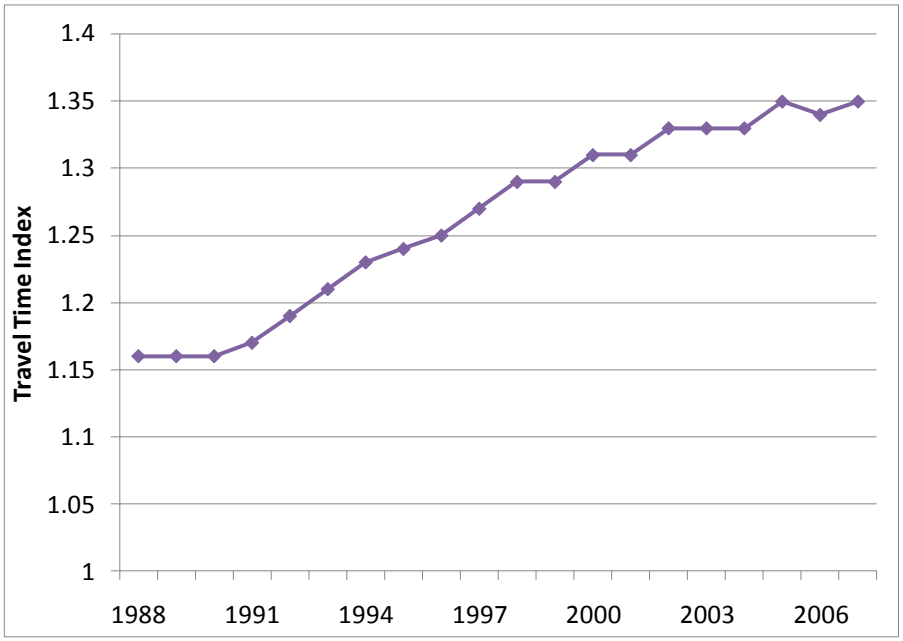

Figure 11. Travel Time Index (TTI)
Source: Texas Transportation Institute, "2009 Urban Mobility Report." July 2009.

CO_2 Mitigation Strategies

As population and economic activity increase, so will total travel demand. Consequently, traffic and congestion will worsen. Carbon dioxide emissions are a direct product of fossil fuel combustion, and no practical way of capturing them from vehicles currently exists. However, there are multiple ways to decrease CO_2 emissions from vehicles – improve vehicle efficiency, convert to low-carbon or zero-carbon fuel sources, improve operational/driver efficiency in on-road operations and reduce VMT.

Regional Growth Scenarios

Slowing the rate of VMT growth in the Atlanta region is largely dependent on the relationship between the provisions of transportation infrastructure and local land use decisions. Employing a "business as usual" future local land use scenario, ARC projects a 58 percent increase in VMT[40] between 2005 and 2030. This scenario was developed through a compilation of local comprehensive plans and results in greater employment and more expansion of low density housing in existing exurban or rural areas compared to the Envision6 scenario. Assuming no change in carbon content of fuel and no change in fuel economy, this equates to a 65 percent increase in CO_2.[41] Assuming the same transportation system under the Envision6 land use scenario, which focuses more growth in centers and corridors, VMT increases 48 percent and CO_2 increases 55 percent (Figure 12).

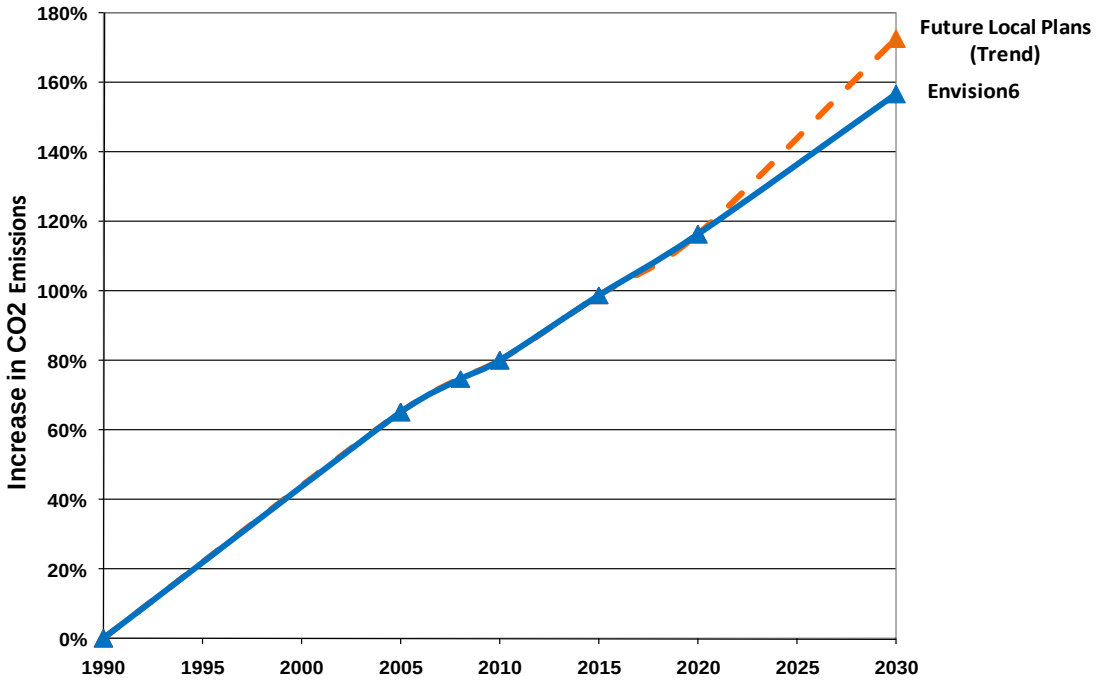

Figure 12. Projected Growth in CO_2 Emissions 1990-2030
Source: Atlanta Regional Commission

Table 1: Change in VMT and CO_2 Emissions (1990 - 2030)

	1990	2005	2010	2015	2020	2030 Envision6	2030 FLU
VMT TOTAL	93,787,634	154,852,259	165,012,089	179,645,146	193,682,307	229,713,754	243,945,473
CO2 TOTAL	57,263	94,546	103,138	113,885	123,924	147,002	156,109
CO2 Change							
% change from 1990	0.0%	65.1%	80.1%	98.9%	116.4%	156.7%	172.6%
% change from 2005	-39%	0%	9%	20%	31%	55%	65%
VMT Change							
% change from 1990	0.0%	65.1%	75.9%	91.5%	106.5%	144.9%	160.1%
% change from 2005	-39.4%	0.0%	6.6%	16.0%	25.1%	48.3%	57.5%

Source: Atlanta Regional Commission

As discussed previously, under EISA 2007, Congress raised CAFE standards to 35 mpg for light-duty vehicles with model years between 2011 and 2020.[42] Incorporating these new standards into Envision6 growth forecasts (Figure 12), CO_2 emissions are projected to increase only eight percent between 2005 and 2030, a difference of 48 percent between the business-as-usual and increased fuel efficiency cases (Figure 13).

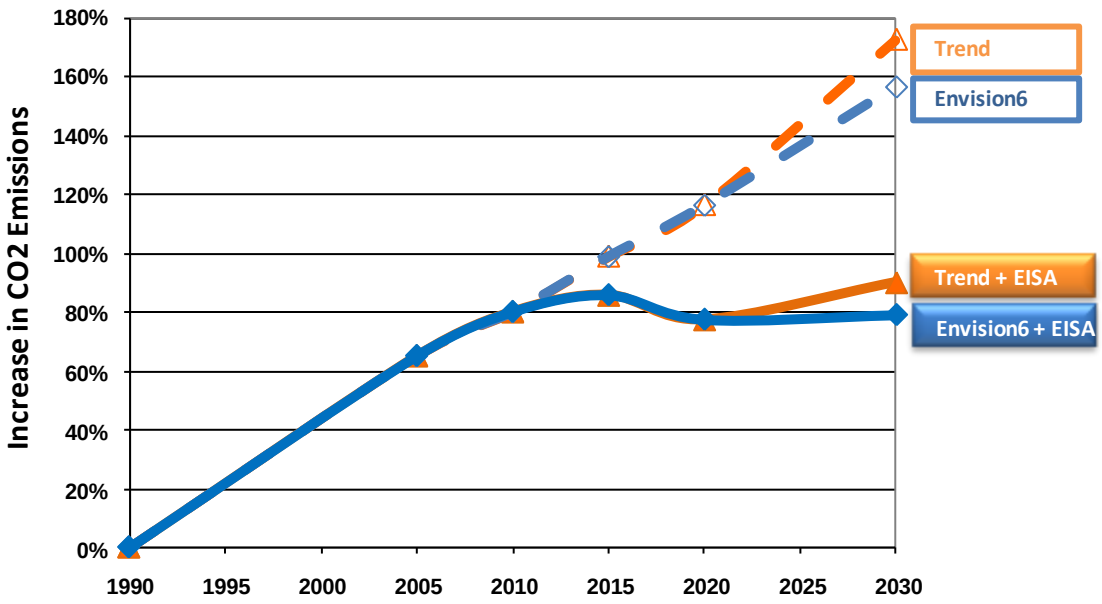

Figure 13. Projected CO_2 Emissions 2005-2030 with higher CAFE standard
Source: Atlanta Regional Commission

The CO_2 emissions were estimated using MOBILE6.2. This capability is limited to fuel economy estimates and cannot be adjusted for speed, temperatures, fuel content, or the effects of vehicle inspection maintenance programs.[43]

A final land use scenario to consider, assuming the existing transportation system in the year 2030, is a scenario which grows population and employment in the densest areas. The method increases densities in zones with the greatest population and employment in 2005 by twice the average growth rate. All other zone growth rates are increased in proportion to their density. This represents a significant redistribution of 2030 population and employment to densely developed activity centers. The results are decreased commute trip length, increased transit ridership and thus, lower regional VMT. Analysis indicates that CO_2 emissions in 2030 would be only 2 percent higher than emissions in 2005 with implementation of this land use scenario. Compared to Envision6 land use, this represents a 6 percent reduction by 2030 (Figure 14).

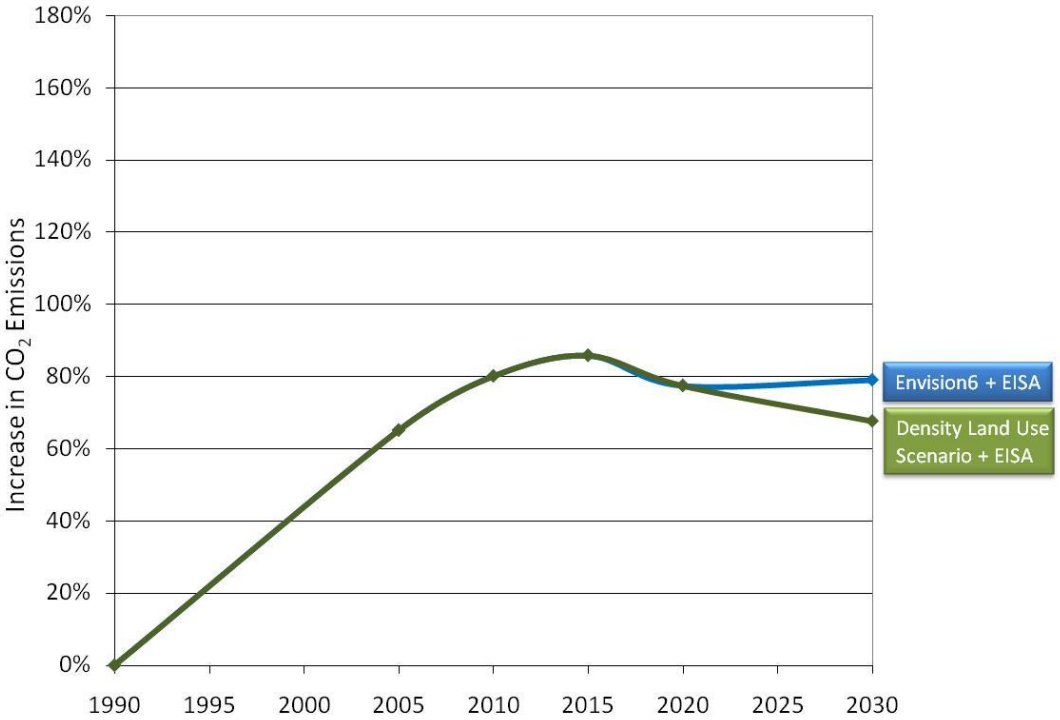

Figure 14. Projected CO_2 Emissions 2005-2030 with Increased Density in Centers
Source: Atlanta Regional Commission

Regional Transportation Scenarios

The region's anticipated increases in population and employment will result in an additional 6.6 million person trips, or 5.6 million more vehicle trips, per day on the regional roadway system in 2030. Envision6 RTP modeling of this scenario indicates that average daily congested speeds in the 20-county Atlanta nonattainment area decrease from 26.4 mph in 2008 to 22.5 mph in 2030. Similarly the percent of PM peak period (4-7pm) vehicle hours of travel in congested conditions is expected to increase on freeways from 32 percent to 60 percent and on arterials from 41 percent to 59 percent.

In 2008, the Transit Planning Board (TPB) developed a comprehensive regional 2030 transit plan, referred to as "Concept 3." This plan expands significantly on the amount of regional transit programmed in the Envision6 RTP. Figure 16 shows the results of this significant planned regional transit investment. Notably, adding significant transit capacity alone to the regional transit system does little to impact regional VMT and thus CO_2 emissions. This is primarily a result of incompatible land uses in many proposed high capacity transit corridors. When the regional distribution of population and employment is refocused on activity centers and major transit corridors, significant reductions in regional VMT and CO_2 emissions are achieved. In fact, Concept 3, in combination with a regional transit-focused land use scenario, results in regional CO_2 emissions dropping seven percent below 2005 levels by 2030.

Compared to 1990 CO_2 emission levels, all 2030 scenario tests still result in an increase of at least 50 percent in CO_2 emissions. The annual rate of growth in CO_2 emissions from 1990 to 2005 was five percent. While the rate of growth is slowing, by 2030, even with a very aggressive land use and transit-focused scenario plus significant advancements in vehicle technology, a growing region like Atlanta can only expect to hold on-road transportation CO_2 emissions to roughly a 2005 level.

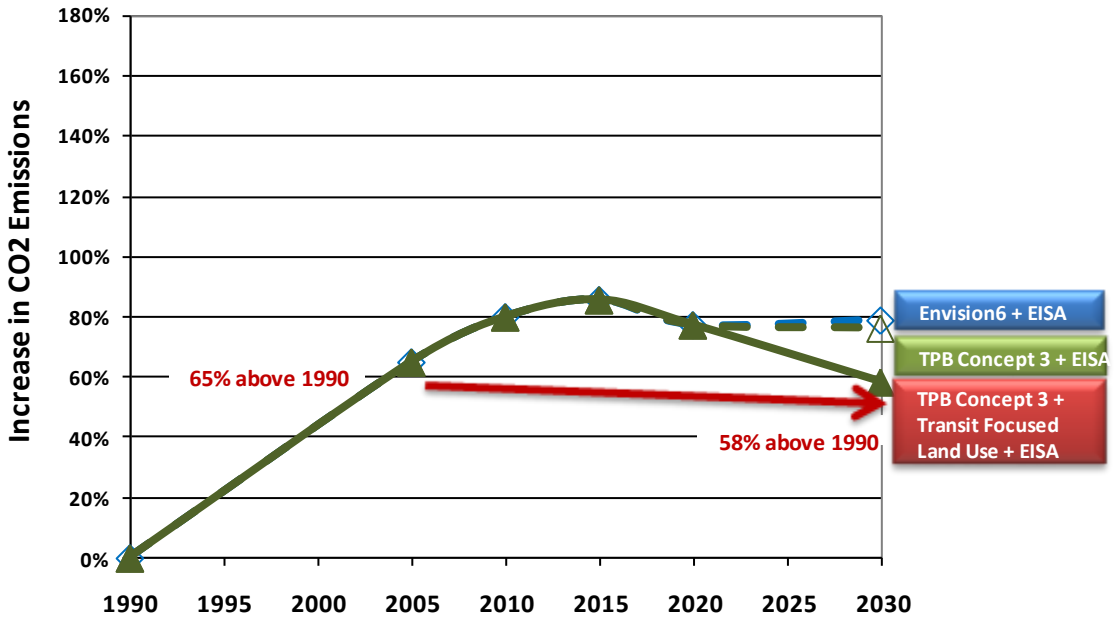

Figure 15. Emissions 2005-2030 with Concept 3 & Transit Focused Land Use Centers*

*These trends all incorporate the higher CAFE (EISA) standard.
Source: Atlanta Regional Commission, Transit Planning Board

Figure 16 below compares all the scenarios. The 2009 CAFE standard results in a further decrease of two percent.

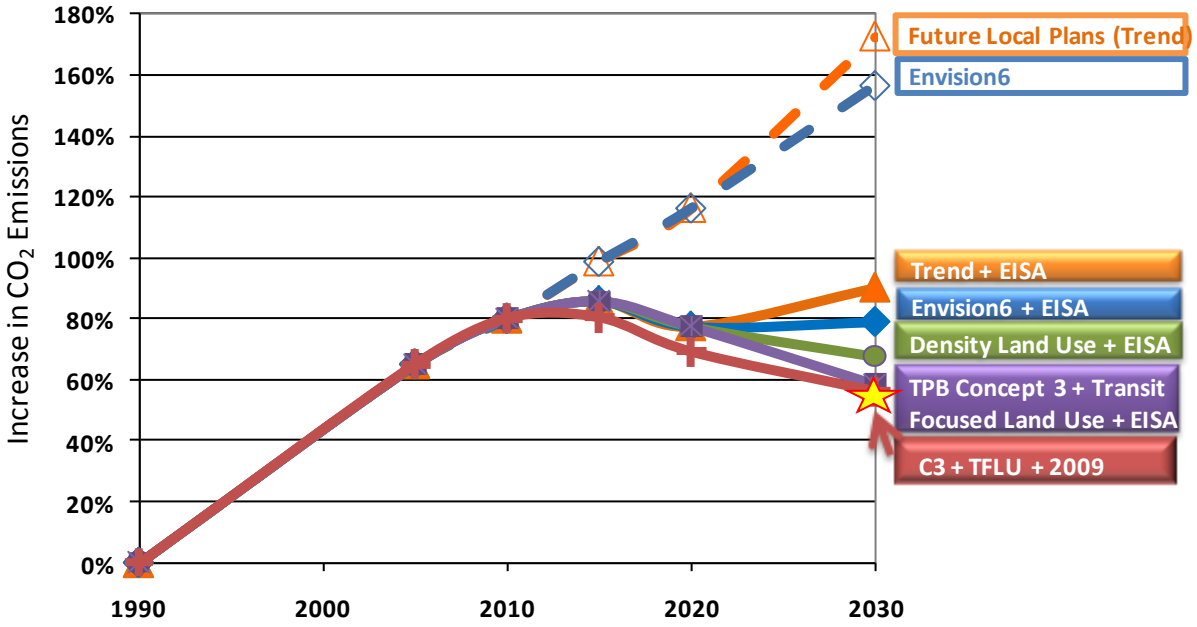

Figure 16. CO_2 Summary of Scenarios

In summary, CO_2 reductions from the on-road transportation sector could come from:

1. Regional land use policies focusing on dense, mixed-use development with access to transit,

2. Expanded opportunities for carpooling, vanpooling, bike/ped, transit, and telecommuting,
3. Improved vehicle fuel economy and low-carbon fuels,
4. Pricing strategies (including continued high gasoline prices) that cause people to eliminate or combine low-value trips and make other choices to reduce the cost of travel and reduce GHG, and
5. Arterial corridor access management, improved signalization and ITS.

Regional land use policies focusing on significant expansion to the regional transit system result in the greatest benefit. However, they would come at the highest cost and likely take the longest to implement.

While EISA is a good start for improving the efficiency of the light-duty fleet, it will be several years before action is taken on the EISA provisions relating to rulemaking for the heavy-duty fleet. In 2030, roughly 20 percent of regional VMT will be contributed by medium- and heavy-duty trucks. Potential strategies for improving the fuel economy of this segment of the fleet, or regional transportation policy addressing through truck traffic and idling could result in significant benefits to CO_2 emissions.

GHG Reduction Strategies from Transportation

The key to reducing GHG emissions is widely thought to be fourfold: [44, 45]

- Improve light- and heavy-duty vehicle fuel efficiency
- Improve on-the-road operating efficiency by lowering congestion, reducing very high and very low speeds, and educating passenger drivers and truck drivers in fuel-economical driving habits
- Decrease VMT
- Reduce amount of carbon in fuel (including shifting to plug-in hybrid electric vehicles and development of hydrogen fuel cell cars)

Vehicle System/Operations

As population and economic activity increase so will total travel demand. Consequently, traffic and congestion will worsen. Carbon dioxide emissions are a direct product of fossil fuel combustion, and there is currently no practical way of capturing them from vehicles. However, there are multiple ways to decrease CO_2 emissions from vehicles -- improve vehicle efficiency, convert to low-carbon or zero-carbon fuel sources, improve operational/driver efficiency in on-road operations and reduce VMT.

The average speed of travel in the region is of concern because several studies have analyzed the relationship between speed and CO_2 emissions.[46, 47] It was determined that the speed at which an engine runs most efficiently and releases the least amount of CO_2 is approximately 45 mph. Speeds above or below this "sweet spot" will emit more CO_2 per mile traveled.

Figure 17 shows a general relationship between CO_2 and speed (fuel economy and speed multiplied by the emission of CO_2 per gallon of gas). This approximation would apply to Atlanta but perhaps with different magnitudes. The above congestion performance measures clearly indicate that congestion mitigation strategies are the primary technique needed to address region-wide low speeds. Congestion mitigation strategies include

investment in new roadway or transit capacity or improved management of the transportation system through ITS or ATMS technologies. Travel demand strategies can also mitigate congestion through encouraging fewer total vehicle trips.

Traffic flow smoothing techniques such as access management, signal timing systems and intelligent transportation systems (ITS) all can reduce speed variability, idling and delay as a result of incidents.

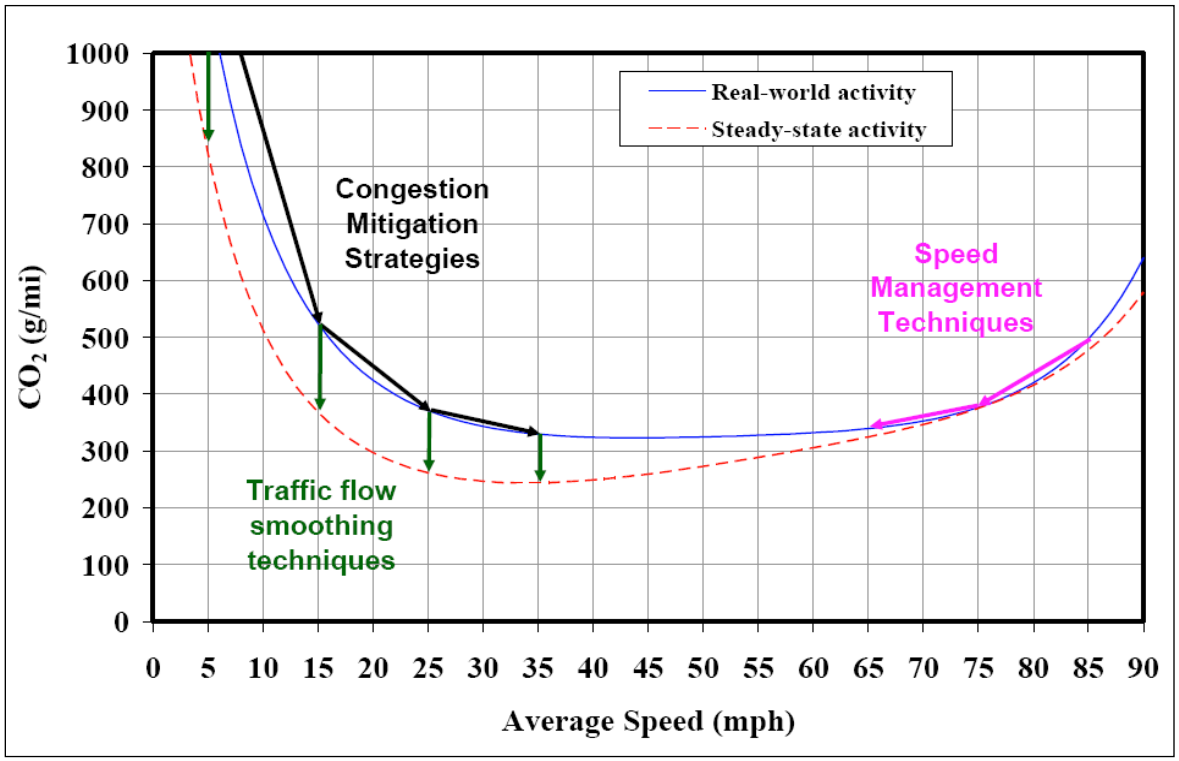

Figure 17. Possible use of traffic operation strategies in reducing on-road CO_2 emissions
Source: Barth, M; Boriboonsomsin, K. "Real-World Impacts CO_2 Impacts of Traffic Congestion." TRB 2008 Annual Meeting

While congestion mitigation strategies and traffic flow smoothing techniques can improve flow and reduce CO_2 emissions on a corridor level, more significant regional transportation scenarios can result in benefits at the regional level.

Travel Demand Management Strategies

While fuel efficiency and carbon content are largely dependent on technological advances, the reduction of VMT is not. Transportation Demand Management (TDM) strategies are becoming more valuable as increasing pressure is placed on the region's roadways and highways. Changing travel behavior is a critical transportation challenge. Through better management of the demand, the efficiency of existing infrastructure can be improved. TDM is a key strategy in Envision6.

The current average single occupant vehicle (SOV) emission rate is approximately 1.0 pound of CO_2 per mile.[48] Assuming the average VMT of 33.1 miles per person in Atlanta, each person emits 33.1 pounds of CO_2 every day. Moving SOVs off the road during peak periods, consolidating passengers into higher-occupancy vehicles or eliminating work trips

altogether, can help relieve the congestion, improve air quality, and increase convenience for the region's commuters. Additionally, land use decisions focusing on mixed use development or transit-oriented development can result in shifting discretionary vehicle trips to non-motorized modes such as biking and walking. According to a recent IBM study, seeking alternatives to driving is occurring fastest in Atlanta.[49]

Transit

Transit not only helps alleviate traffic congestion, but also stimulates development around stations, reduces energy consumption, achieves clean air standards, generates jobs and helps maintain vitality in business districts of major cities. The average SOV driver in Atlanta would save approximately 8,000 pounds of CO_2 a year if he/she took public transportation to and from work every day.[50]

Figure 18 shows the increase in transit ridership between 2004 and 2008. Atlanta's five major transit providers reported a total of over a half million daily boardings in 2008.[51] To support this increasing trend, approximately $4 billion of transit expansions are planned for Envision6.[52]

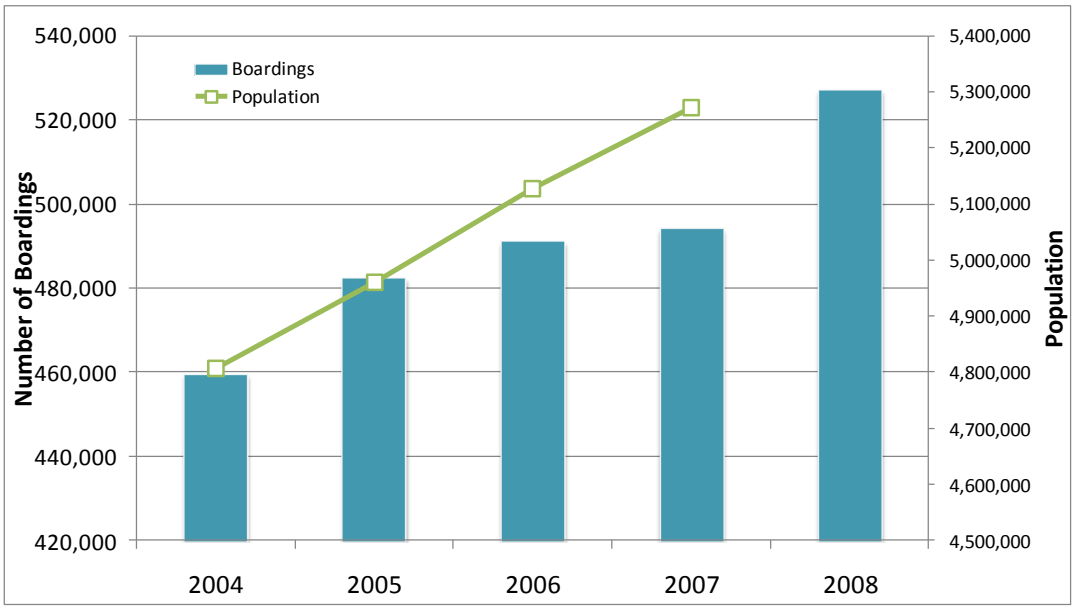

Figure 18. Major transit ridership trends
Source: ARC 2009 Transportation Fact Book

Bicycle and Pedestrian System

Bicycling and walking are rapidly becoming realistic modes of transportation as traffic congestion becomes more severe and the market builds more mixed use and transit-oriented developments. Bicycle and pedestrian facilities help to offset the demand on motor vehicles, thus reducing the emission of potential air pollutants from vehicles.

While cyclists and pedestrians can use almost any regional transportation corridor, many facilities are not equipped or safe enough to support this mode of transportation. The ARC has been promoting safe, functional and regional bicycle and pedestrian planning since 1973 and continues to update its process to address new needs and trends, as described in its comprehensive Bicycle Transportation and Pedestrian Walkways Plan[53.]

Discretionary trips such as trips for shopping and other errands are forecast to make up 32 percent of all vehicle based person trips in 2030. Land use policies further encouraging mixed use and transit-oriented development combined with investment in bicycle and pedestrian infrastructure can convert these trips out of vehicles to either transit or non-motorized modes. The Livable Centers Initiative has been a critical driver in creating communities where the choice to not use the automobile for these trips is easy to make.

Employer strategies

Because home-to-work commutes are daily routines, more options besides SOV travel exist. Besides riding transit, biking, and walking, employer-incentivized strategies include compressed work weeks, teleworking, vanpooling, and carpooling.

Carpooling and vanpooling are especially attractive strategies to reduce GHG, because

- there is huge existing capacity in existing cars and vans which can be tapped;
- since there is existing capacity, they require essentially no additional energy to construct or increase operations;
- they can have immediate payoff;
- they cost little for the public sector to promote compared to transit and other strategies;
- they save users money; and
- they can reduce the need for parking spaces, which saves money for employers and local governments.

ARC's RideSmart program helps commuters find others to form carpools, vanpools, or match up with a Bike Buddy through an on-line ridematching feature. The SchoolPool program, in conjunction with ARC's Governmental Services Division, also assists schools to match up parents of children to carpool to school. A Guaranteed Ride Home program is offered to help those commuters who experience an unscheduled event on the days they use an alternative mode, up to five times per year. The RideSmart program also offers a comprehensive website at www.MyRideSmart.com for commuters to locate information on these and other programs. In 2009, RideSmart helped more than 75,000 commuters look for rideshare partners.

Parking management

Parking must be efficiently managed to ensure a successful transportation system. Parking prices have a profound effect on travel choices. Parking subsidies substantially increase vehicle travel. For commuters, incorporating parking cost into the decision on how to get to work encourages carpooling and other modes of transportation. Charging parking fees has been found to reduce employee vehicle trips, and consequentially parking demand, by between seven percent and 30 percent. This range depends on several factors, such as price and availability of alternatives.[54]

The city of Atlanta has developed a strategic parking management plan for the downtown district. Key goals include reducing parking demand and improving the efficiency of the existing supply, integrating parking management that supports greater use of transit, vanpools, carpools, flexible work schedules, accessing improvements for bicyclists and pedestrians, and supporting a balanced, linked and sustainable multimodal transportation system characterized by transit use and vibrant neighborhood businesses and residential areas.[55]

Congestion Pricing
Congestion pricing (also known as road user charge) refers to charging for use of roadways during peak hours in efforts to relieve congestion and promote alternative modes of transportation. Tolls vary throughout the day depending on the expected level of congestion. The conversion of HOV (High Occupancy Vehicle) to HOT (High Occupancy Toll) lanes is a common way to relieve congestion in the U.S. Users of HOT lanes are charged a toll, but HOVs may use the lanes at reduced or no charge. Cordon tolls charge a price for entering and driving in an urban area, and are more common internationally. This form of congestion pricing, modeled after a successful implementation in London, was recently proposed in New York City. It was opposed by a key leader in the New York legislature and approval vote was never taken. [56]

In Orange County, California, four variably-priced express lanes in the median of a highly traveled freeway opened in December 1995.[57] Traffic during rush hours in these lanes moves at more than 60 mph, while the traffic in adjacent lanes crawls at average speeds of 15 mph or less. Commuters on the priced express lanes thus save as much as half an hour each way on the 10-mile trip.[58] During the peak hour on Friday between 5pm and 6pm, the two express lanes move almost double the volume because of the congestion in the free lanes. Commuters are willing to pay tolls to enjoy the benefits of reduced travel time, as demonstrated by the increasing number of toll users in Orange County.

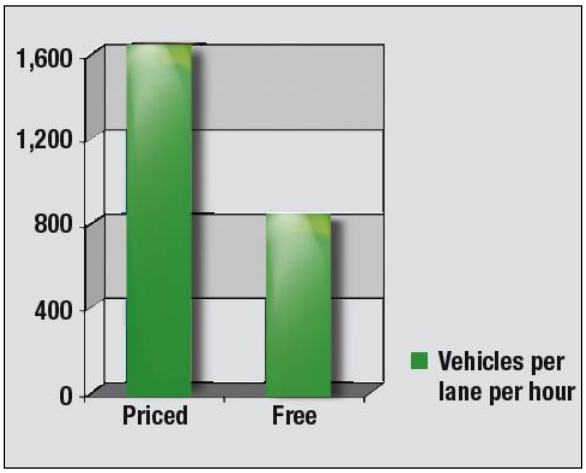

Figure 19. Priced vs. free lanes during peak period on CA SR 91
Source: Federal Highway Administration. "Congestion Pricing." Dec 2006

SRTA and GDOT are currently in the construction stages of a HOV to HOT conversion on I-85 in Gwinnett County. Planning efforts are underway for similar projects on other major interstates.[59]

Greater reductions are produced when two or more of these TDM strategies are combined. In central London, congestion pricing paired with improvements in public transportation led to a 15 percent reduction in traffic.[60] Implementing parking pricing schemes led to further reductions.[61]

Vehicle and Fuel Technology

Energy security and independence from oil imports were the stimuli for seeking alternative-transportation fuels in the 1970s. Today the emergence of vehicle technology and fuels also focuses on reducing GHG emissions. To obtain low GHG emissions, it is not only necessary

to use alternative fuels but also to produce them in unconventional methods.[62] Alternative methods should also not increase primary pollutant emissions.

Current alternative fuels being explored include biodiesel, cellulosic and corn ethanol, electricity, natural gas, and hydrogen.[63] Electricity is also a future power source for vehicles, one that is likely to grow rapidly in the near future. Infrastructure and vehicle compatibility are other factors that affect the development of a full-scale alternative fuels market.

In the long term, a virtually carbon-free transportation system will be necessary to meet worldwide GHG reduction targets of 50-80 percent. This is especially necessary in the rest of the world, where auto usage is growing dramatically and will far outstrip usage in the United States in the next 20 years. There are a number of technologies being researched now which could achieve near-zero carbon emissions, such as hydrogen fuel cell vehicles and electric vehicles. However, there are many technological and economic hurdles to be overcome.

Current Policies

ARC policies will help reduce GHGs through goals outlined in Envision6. Realizing that land use and transportation are mutually dependent, Envision6 integrates these elements. The majority of these goals result in positive impacts to GHG emissions. For example, they focus on reducing reliance on SOV travel, reducing VMT and encouraging transit & non-motorized trips through the strategic provision of infrastructure. They also focus on adopting regional policies that support mixed-use, transit-oriented development, neighborhood access to jobs and services and greenspace preservation.

Livable Centers Initiative

ARC's Livable Centers Initiative (LCI) is a nationally recognized program that encourages local governments to develop and implement strategies that link transportation improvements with land use development strategies to create dense mixed use communities consistent with regional development policies. These centers connect residences, retail conveniences, and businesses. Pedestrian needs are met by enhancing streetscapes and sidewalks. Access to transit and transportation alternatives are emphasized. Since 1999, ARC has helped complete 86 LCI studies throughout the metro area.

In 2004, Georgia Regional Transportation Authority (GRTA) and Georgia Institute of Technology completed a study assessing the land use, travel and air quality characteristics of different scenarios for three specific LCI sites: the West End, Marietta, and Perimeter Center.[64] Each site compared conditions across three cases: a case study base representing conditions in the year 2000; the LCI case forecasted out to the year 2030, representing a more aggressive planning strategy; and the status quo case, forecasted out to the year 2030 under existing standards and trends. All three sites witnessed significant reductions in VMT and corresponding emissions under LCI scenarios. The most dramatic results occurred in Perimeter Center.

Table 2: Comparison of LCI sites

Case		base to LCI	base to status quo
Perimeter	VMT	-25%	-1%
	GHG	-25%	-1%
Marietta	VMT	-6%	4%
	GHG	-6%	4%
West End	VMT	-3%	1%
	GHG	-3%	1%

Source: "SMARTRAQ Before and After Study, Livable Centers Initiative (LCI)," Mar 2004.

Perimeter Center is currently dominated by large-scale development, in terms of both land use patterns and transportation system characteristics. Large office and retail spaces are surrounded by major highways. Under the strategic LCI plan, Perimeter Center would be transformed into an activity center and transit-oriented development hub for north metropolitan Atlanta. By adding commercial and residential uses to the area and by creating a transit-oriented community, residents are less likely to use their automobiles for trips that may be more convenient on foot or on public transportation. Both VMT and GHG emissions decrease by 25 percent from the base to the LCI case. In the status quo case, VMT and GHG emissions decrease by 1 percent.

The 2008 ARC LCI Index Report analyzed ten LCI project sites and found that well-designed bicycle and pedestrian connections produced the most reductions in vehicle GHG emissions. Figure 16 illustrates reductions in vehicle GHG emissions across the study sites.[65] (Population increased at a faster rate than employment at the Brookhaven site, resulting in higher VMT and CO_2.)

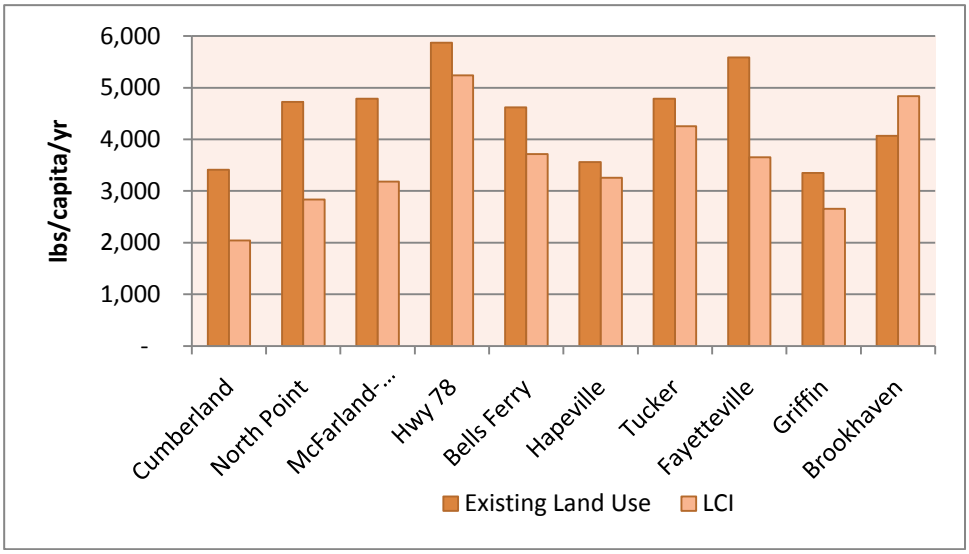

Figure 20. Vehicle GHG emissions across LCI study sites
Source: 2008 ARC LCI Index Report

Atlantic Station

Infill development refers to construction on vacant parcels of land that were once industrial sites or other underutilized land. Atlantic Station is a mixed-use redevelopment that sits on the site of a former steel mill. In addition to cleaning up one of Georgia's largest brownfields, Atlantic Station delivers transportation and air quality benefits while meeting

housing and employment needs. The 138-acre site is home to numerous housing units, retail shops, restaurant and entertainment venues, and acres of parks.[66] Similar to the typical LCI plan, it incorporates pedestrian and bicyclist necessities and provides multiple transportation alternatives.

In 2008, average daily VMT per resident of the site was 13.9 miles.[67] This was 57 percent lower than the average daily commute of 32.4 miles for the rest of the region.[68] In addition, five percent of the trips made by Atlantic Station residents or employees working at the site were made using non-SOV modes of travel.[69] This is compared to the 39 percent mode share for non-SOV trips made by individuals residing in ARC's 20-county modeling domain.[70]

Green Communities

Green Communities is an ARC program to assist local governments to reduce their overall environmental impact. This effort will allow ARC and local governments to set an example of being "green" to the rest of the communities while educating and encouraging them to also adopt sustainable practices. The program is designed to encourage local governments to take environmental responsibility and set an example for the community by conserving energy, investing in renewable energy, conserving water, conserving fuel, reducing waste and protecting and restoring the community's natural resources. To date, there are nine certified Green Communities.[71]

Congestion Mitigation Task Force

As discussed previously, congestion is one of the most significant challenges facing the region. In March 2005, the governor formed the Congestion Mitigation Task Force (CMTF) comprised of members of ARC, GDOT, Georgia State Road and Tollway Authority (SRTA), and GRTA. Together they are charged with cost-effectively reducing congestion in the metro Atlanta nonattainment area, developing a benefit/cost methodology to be applied to project selection, and recommending solutions for incorporation into the regional and statewide planning processes. Three recommendations were adopted[72] and used in the development of Envision6:

- Increase weighting of the congestion factor to 70 percent for project selection. Previously, congestion was one of nine equally weighted criteria.
- Develop and implement a consistent methodology for benefit/cost analysis.
- Use of TTI to measure improvement in congestion. Goal of 1.35 TTI by 2030.

Prioritizing congestion-relieving projects for investment in future regional transportation plans provides a mixed set of benefits and disbenefits with regard to CO_2 emissions. Removing congested conditions leads to decreased idling, improved flow, increased congested speeds and overall improvements in vehicle fuel efficiency along project corridors. However, increased system capacity has been shown to induce additional vehicle travel, therefore leading to increased VMT. Ultimately solving one problem does not necessarily solve the other. Strategic transportation planning to address the congestion problem with a variety of techniques should help to minimize the negative GHG emissions impact of added capacity.

State Policies

ARC continuously works with the Georgia Environmental Protection Division (EPD) on regional air quality issues. Individual states demonstrate strategies and measures to reduce air pollution from stationary, area, and mobile sources in their State Implementation Plans (SIPs).[73] Although EPD is responsible for preparing SIPs, ARC, along with GDOT, GRTA, and EPA are involved in the development of SIPs and motor vehicle emissions budgets. This cooperative planning process is conducted through the Interagency Consultation Group as

required in Section 93.105 of the Transportation Conformity Rule. The interagency group goal is to discuss issues related to the development of regional transportation plans and programs and associated conformity determinations. The interagency group meets on a regular basis to address all transportation and air quality issues.

Georgia's Clean Air Force (GCAF) is the state's vehicle emission inspection and maintenance (I/M) Program. GCAF is designed to identify and repair vehicles that pollute the air while helping the region work toward attaining federal clean air standards. GCAF tests approximately 2.3 million vehicles a year with more than 750 testing stations and 900 testing lanes.[74]

Georgia environmental officials are focusing on voluntary measures to eliminate unnecessary idling of vehicles.[75] The primary voluntary focus points in 2009 are implementing truck stop electrification projects and adopting an idling reduction policy in school systems throughout the state. Currently, only the city of Atlanta regulates idling by setting a 15-minute limit for non-emergency vehicles. Reductions in idling times reduce fuel consumption and tailpipe emissions.

Georgia is a member of The Climate Registry (TCR), a non-profit that supports reporting programs. TCR sets consistent and transparent standards for the measurement, verification, and public reporting of GHG emissions throughout North America in a single unified registry.

Numerous sustainability initiatives exist on various levels. The International Council on Local Environmental Initiatives (ICLEI) is a membership association of more than 1,100 local governments worldwide, committed to advancing climate protection and sustainable development.[76] Atlanta, Decatur, Fulton County, and Savannah are participating communities in Georgia. More than 1,000 cities across the country have committed to reduce their GHG emissions to 7 percent below 1990 levels by 2012 as defined in the U.S. Conference of Mayors Climate Protection Agreement.[77] To date, Alpharetta, Athens, Atlanta, Augusta, Decatur, East Point, Macon, Roswell, Savannah, and Tybee Island are included signatories from Georgia.

Future Actions

National Targets

In addition to President Obama's policy for increasing fuel economy and lowering GHG emissions, two climate change bills were introduced in Congress in 2009. The American Clean Energy and Security Act (also known as the Waxman-Markey bill) passed the House in June 2009. The Clean Energy, Jobs, and American Power Act was introduced in the Senate in September 2009. Both of these bills have established emission reduction goals for the transportation sector.

Statewide Climate Change Initiatives

To date, 36 states have completed or commenced comprehensive Climate Action Plans; Georgia is one of 14 states that have yet to take action.[78] Each plan details steps that the state can take to reduce its contribution to climate change. The individual characteristics of each state's economy, resource base, and political structure provide different opportunities for managing effects of climate change. The process can identify cost-effective opportunities to reduce GHG emissions that are relevant to the state. As depicted below, most of the Southeast is currently inactive.

States and several Canadian provinces have banded together to form several regional climate change coalitions around the country and are consistent with individual state goals. Members of the Western Climate Initiative (WCI) have set a regional emissions target of 15 percent below 2005 levels by 2020. They have developed recommendations for a market-based system to aid in meeting their goal.[79] The Regional Greenhouse Gas Initiative (RGGI) is a joint effort by Northeastern and Mid-Atlantic states to reduce carbon dioxide emissions. The program will cap emissions at current levels in 2009 and then reduce emissions 10 percent by 2019. At present, RGGI's efforts are solely concentrated on combating emissions from power plants, but the program will eventually expand its efforts to include pollution from other sectors.[80] Signatories of the Midwestern Regional GHG Reduction Accord agreed to establish regional GHG reduction targets, including a long-term target of 60 to 80 percent below current emissions levels, and to develop a multi-sector cap-and-trade system to help meet the targets.[81] A GHG emissions reductions tracking system will be established as well as other policies, such as low-carbon fuel standards.

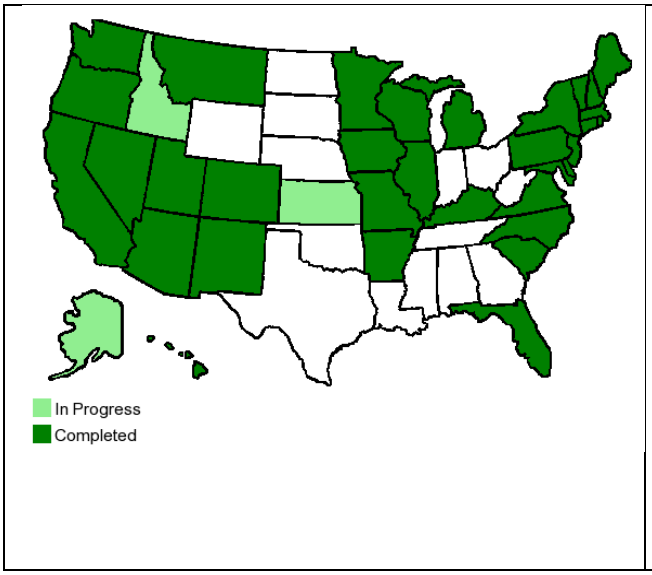

Figure 21. State Action Plans
Source: Pew Center on Global Climate Change.
10 November 2009

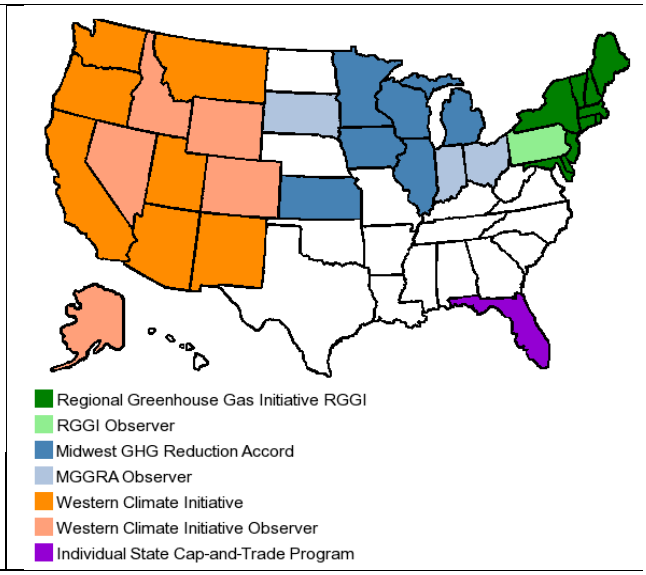

Figure 22. Regional Initiatives
Source: Pew Center on Global Climate Change.
9 October 2009

As depicted in Figures 21 and 22, Georgia and much of the southeastern US are currently not participating in any regional climate action strategies. This is where ARC could possibly partner with other organizations to potentially lead this broader region on GHG-reduction initiatives.

Georgia has identified the need for climate change mitigation as expressed in the State Energy Strategy.[82] The strategy calls for the preparation for potential federal climate change policy by developing a GHG inventory and providing an update every three years. EPD developed the State's first GHG inventory in 1999 and released an update in November 2008.[83] The next step (as identified in the Strategy) is to develop a GHG registry amongst states in the Southeast. These two strategies will provide a stepping stone to calculating emissions on a more detailed level, such as county or city level, where the effects of climate change will be the most profound.

Fifty Forward
In late 2007, ARC launched an ambitious initiative, called "Fifty Forward: Metro Atlanta Futures Forum," to explore possible future scenarios for metro Atlanta and forge an action plan to ensure future livability, prosperity and sustainability. Community leaders and interested residents have been engaged with critical topics that the region will confront as it moves forward and crafts a vision for the preferred future.[84] Citizens have voiced their concerns and brainstormed solutions. The product of these forums will be a statement of principles of where citizens would like the region to be in 50 years. From there, these principles can be turned into actions.

The first forum, "Going Green: Creating Sustainable Cities," was held in April 2008 and featured Seattle Mayor Greg Nickels. Topics have included energy, transportation, mega-regions and globalization, and demography and diversity. The two-year visioning and planning effort will close with a public health forum in Spring 2010.

Other MPO Efforts
On a regional level, metro Atlanta is lagging behind other major metropolitan area efforts to act on climate change issues. Puget Sound Regional Council (PSRC), King County, and 32 cities within the state of Washington have pioneered action on climate change and sustainability issues. PSRC is incorporating reductions of GHG emissions not only into their RTP but into their entire regional growth strategy. They created a regional climate change action plan in cooperation with member organizations and the state.[85] The Metropolitan Washington Council of Governments (MWCOG) introduced one of the nation's first initiatives to address local GHG emissions on a regional level. In one year, the Climate Change Steering Committee established comprehensive reduction goals and an implementation schedule across various sectors. The committee evaluated "what would it take" transportation scenarios to achieve desired GHG reductions as part of the regional strategy.[86]

Summary

The current environment in which the climate change issue is being addressed occurs at all levels of government through a variety of legislation, policies, programs and planning activities. At the national stage, ARC plans to continue to monitor and participate in the discussion with our federal partners and organizations such as AMPO and NARC.

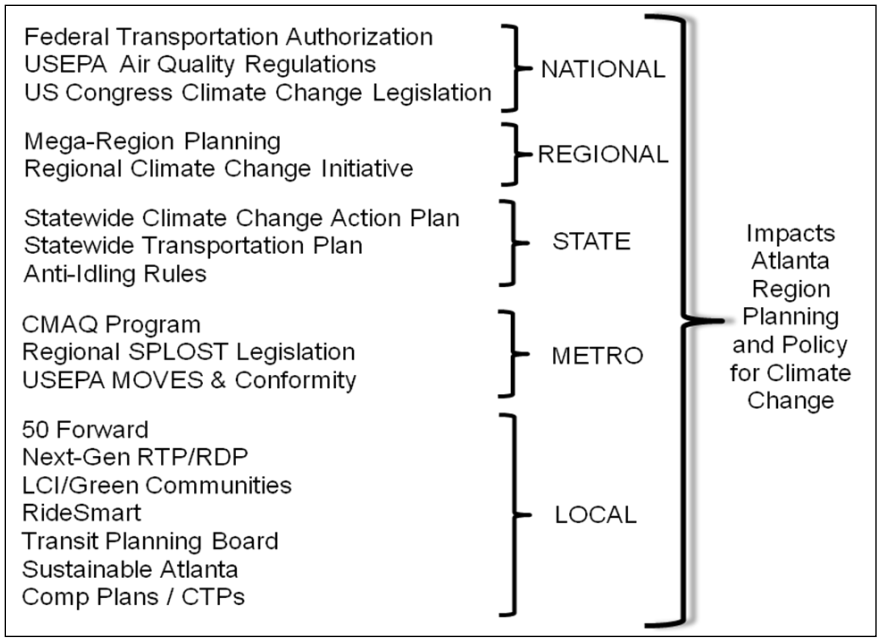

Figure 23. Levels of Climate Change Related Activities
Source: Atlanta Regional Commission

Policy Recommendations for ARC

The following goals and actions are recommended for consideration:

Goal 1: Promote sustainable development through integrated land use and transportation strategies

Actions:

- Shift from sprawl to compact development
- Continue LCI program
- Increase involvement in ARC's Green Communities Program
- Support development around transit stations
- Promote infill development
- Tie state and federal transportation funds to support sustainable development

Goal 2: Reduce VMT by supporting alternative modes and implementing transportation pricing measures

Actions:

- Increase programs and incentives to maximize carpooling and vanpooling
- Adopt transportation pricing policies that discourage SOV travel (congestion pricing, parking pricing, mileage-based user fees, etc.)
- Increase safe, reliable public transportation, including higher occupancy of existing transit buses and rail vehicles.
- Target bike/pedestrian projects in areas that will reduce number of vehicle trips. Include improvements in sidewalks, crosswalks, bicycle lanes, and lighting.
- Continue to encourage employers to adopt TDM strategies
- Explore other TDM options

Goal 3: Support the use of cleaner & more fuel-efficient vehicles and alternative fuels

Actions:

- Support Federal and state investments in R&D to decarbonize transportation vehicles and fuels by 2050, not only in the U.S. but worldwide.
- Encourage conversion of public fleets into clean efficient vehicles.
- Continue to fund retrofits for cleaner diesel engines on buses, heavy-duty trucks, and locomotives.
- Outlaw and enforce unnecessary idling.

Goal 4: Work with stakeholders to set meaningful and realistic emission reduction targets.

Actions:

- Identify potential partners, such as the state of Georgia and other Southeast states. Align goals with local governments. Engage the general public. Increase public awareness.
- Incorporate nonroad emissions. Include rail & airports.
- Model CO_2 emissions with travel demand model.
- Add CO_2 emissions as a criterion in transportation decisions
- Measure and report progress regularly.
- Develop useful tool for local governments to identify best practices.
- Investigate carbon offsets.

Goal 5: Consider adaptation responses

Actions:

- Develop emergency management plans
- Create inventory of vulnerable infrastructure

ARC has made significant progress with Goals 1, 2, and 3 to address primary pollutants. ARC should continue to support these efforts to address GHGs. The fourth set represents new initiatives that should be tailored to specifically set a framework for setting goals associated with GHG emission reductions.

Thinking Further:

- What role can ARC play to lead the state/southeast region on climate change?
- What should the first step be? Multi-state, state, metro region? Formation of Climate Action Team?
- What actors are not engaged that could bring resources to the table?
- Appropriate role in TIP, RTP, and RDP?
- How to consider and propose adaptation strategies?

Conclusion

Uncertainty should no longer justify inaction. Climate change is only one reason to move towards sustainability. An effective transportation system is vital to the future of our region. Improvements in transportation are important for congestion relief, public health, climate change mitigation, and overall quality of life.

Recognizing that transportation and land use are only part of the equation, other realms must also be involved – energy efficiency, buildings, electricity, industrial sectors. Partnerships with other agencies and organizations are crucial. Breaking old habits may be one of the most difficult obstacles to overcome but responsiveness to these issues is increasing as fuel prices rise dramatically and congestion worsens.

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Appendix A

Envision6 RTP Goals and Objectives

ADOPTED GOALS	OBJECTIVE	BENEFITS OF CO_2 REDUCTION
Improve accessibility and mobility for all people and freight	Relieve congestion on the surface transportation system for all modes	Higher congested speeds & less idling result in less CO2 emissions. However benefit may be offset by added VMT due to new capacity.
	Improve connectivity between low income and minority populations to employment and activity centers	Added connectivity should be predominantly multimodal to encourage greater share of non-SOV commute trips, thereby reducing VMT and CO2 emissions.
	Improve access to employment opportunities via alternative travel modes	Managed lane or transit system expansion will lead to increased shares of carpooling and transit and will reduce CO2 emissions per commuter.
	Increase the use of alternative modes of travel	Commute options programs encouraging alternative commute modes will help reduce CO2 emissions per commuter by switching trips to carpools, transit or non-motorized.
	Improve intermodal freight and passenger connectivity	Freight specific infrastructure investments reduce idling for freight vehicles and thus reduce a major source of regional CO2 emissions.
	Provide transportation alternatives that satisfy a full range of needs for all travel market segments	Transportation investments should serve the region's diverse population, especially seniors and special needs groups. Also transportation investments and land use decisions should focus on providing alternatives to SOV travel for all travel decisions.
	Provide transportation alternatives that are suited to, and supported by existing and future land uses in the region	Appropriate connections between land use patterns and transportation investment will minimize the impact of new development on regional VMT and thus CO2 emissions.

Encourage and promote the safety, security and efficient development, management, and operation of the surface transportation system	Improve the management and operations (M&O) of the transportation system for all modes	Operational improvements to the arterial system reduce delay and idling at intersections, thereby decreasing speed variability, increasing fuel economy and reducing CO2 emissions.
	Provide for the proper maintenance of the existing transportation system	Continued system maintenance prevents unnecessary delays and added VMT due to road closures.
	Provide mobility options that help alleviate congestion	Additional commute options that encourage alternative work hours, teleworking and transit or carpooling will better manage roadway system demand and thus reduce VMT and CO2 emissions.
	Enhance the responsiveness of the transportation system to user needs through upgraded customer service	Added customer service for the regional transit system will enhance the transit users experience and lead to a more positive image and potentially greater ridership for transit.
	Encourage the use of Intelligent Transportation Systems (ITS) in improving system performance, safety, and security	ITS can assist in mitigating delays caused by traffic incidents, thus reducing idling and CO2 emissions.
	Improve the movement of freight on the surface transportation network	The on- and off-road mobile freight sector is a major contributor to CO2 emissions. Any strategies that will reduce delays and idling for freight movement will be strongly positive for CO2 emissions.
	Increase the safety of the transportation system for motorized and nonmotorized users	Delay attributed to non-recurring congestion represents as much as 50% of regional delay. Decreasing the number of and severity of incidents reduces fuel consumption, reduces idling due to delay and thus reduces CO2 emissions.
Protect and improve the environment and the quality of life	Develop a transportation system that supports the region in providing healthy air quality	This objective should explicitly state that there is also a goal to mitigate the increase in regional greenhouse gas emissions from transportation.
	Promote efficient land use by developing transportation programs and projects, including incentives, which support local governments and private entities in developing livable communities	Livable, mixed use, and transit oriented communities all have the potential to reduce VMT from the current growth trend and thus reduce CO2 emissions. The definition of livable communities can also include "green" measures to provide commute option programs or green fleet/alternative fuel programs. DRI reviews can be expanded to consider the development's strategies to mitigate VMT increases and CO2 emissions.
	Further energy conservation in the future transportation system	Regional energy conservation policies in the transportation sector should include promoting the use of more fuel efficient vehicles and restricting unnecessary idling.

Support economic growth and development	Further the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity and efficiency	The region can become an international leader in sustainable development and transportation planning practices. The leadership role can help to market the region and maintain economic expansion in a sustainable manner.
	Develop and support efficient freight movement as a means to support economic growth	Unnecessary delays as a result of inefficiencies in the freight system have economic and environmental impacts. Focused improvements on removing these bottlenecks will result in less idling and thus lower GHG emissions.

Envision6 RDP Goals and Objectives

ADOPTED GOALS	OBJECTIVE	BENEFITS OF CO_2 REDUCTION
Developed Area Policies	Promote sustainable economic growth in all areas of the region.	Encouraging complete communities (live, work and play) that are built around sustainable practices can lessen the need for long commutes and reduce trip lengths associated with daily travel.
	Encourage development within principal transportation corridors, the Central Business District, activity centers, and town centers.	Livable, mixed use, and transit oriented communities all have the potential to reduce VMT from the current growth trend and thus reduce CO_2 emissions.
	Increase opportunities for mixed-use development, transit-oriented development, infill and redevelopment.	Livable, mixed use, and transit oriented communities all have the potential to reduce VMT from the current growth trend and thus reduce CO_2 emissions.
	At strategic regional locations, plan and retain industrial and freight land uses.	Delineation of specific freight areas or districts will allow programs that focus on freight related emissions (e.g. reduced idling programs) to be more targeted and effective.
	Design transportation infrastructure to protect the context of adjoining development and provide a sense of place appropriate for our communities.	
	Promote the reclamation of Brownfield development sites.	
Housing & Neighborhood Policies	Protect the character and integrity of existing neighborhoods, while also meeting the needs of communities.	
	Encourage a variety of home styles, densities and price ranges in locations that are accessible to jobs and services to ensure housing for individuals and families of all incomes and age groups.	Scenario and sensitivity testing in 2006 demonstrated the strong relationship between the location of housing for future workers and transportation performance, including potential VMT reductions.
	Promote new communities that feature greenspace and neighborhood parks, pedestrian scale, support transportation options and provide an appropriate mix of uses and housing types.	Many communities in the Atlanta region have been designed and built in such a way as to only support trips via automobile. Providing land use patterns and urban design amenities that support non-automotive trips can be a major factor in reducing travel emissions.
	Promote sustainable and energy-	Communities that provides for a mix of uses and are multi-modal, while

	efficient development.	also focusing on energy efficient buildings are likely to reduce energy demands in two critical sectors (transportation and buildings), and thus reduce emissions.
Open Space & Preservation Policies	Protect environmentally-sensitive areas including wetlands, floodplains, small water supply watersheds, rivers and stream corridors.	
	Increase the amount, quality, connectivity and accessibility of greenspace.	Greenspace in the Atlanta region is increasing being recognized as a necessity rather than an amenity. Greenspace and natural areas may play a pivotal role in any effort to address GHG emissions by storing carbon and/or becoming a key component in the market of carbon offsets.
	Provide strategies to preserve and enhance historic resources.	Preservation of historic resources is a key strategy in promoting sustainable development. The construction, operation and demolition of buildings accounts for a significant portion on national GHG emissions. Maintaining and reusing existing buildings can reduce these emissions dramatically.
	Through regional infrastructure planning, discourage growth in undeveloped areas of the region.	Continued residential development on the urban fringe of the region is likely in time to result in significant numbers of long home-to-work trips. Reducing trips and trip lengths are critical elements to any strategy to address GHG.
Coordination Policies	Assist local governments to adopt growth management strategies that make more efficient use of existing infrastructure.	
	Inform and involve the public in planning at regional, local and neighborhood levels.	
	Coordinate local policies and regulations to support regional policies.	
	Encourage the development of state and regional growth management policy.	

Appendix B

Atlanta Regional Initiatives

U.S. Conference of Mayor's Climate Protection Agreement
http://www.usmayors.org/climateprotection/

- Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns;
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol -- 7% reduction from 1990 levels by 2012;
- Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system
- To date, Atlanta, Alpharetta, Athens, Augusta, Decatur, East Point, Macon, and Tybee Island are included signatories from Georgia.

Sustainable Atlanta http://sustainableatlanta.org
In 2006, Mayor Franklin identified environmental sustainability as a critical factor in making Atlanta a "best in class" city. In early 2007, she charged her administration to create and foster a community dedicated to sustainability through best in class leadership and to implement solutions and practices as they are identified. To answer that charge, a team of city officials and expert consultants has assessed Atlanta's current sustainable practices and made recommendations for a course of action in 2008 for new high impact programs and policies.

Brook Byers Institute for Sustainable Systems, Georgia Institute of Technology
http://sustainability.gatech.edu
Georgia Tech's Institute for Sustainable Systems is a global and comprehensive sustainability program that addresses both the challenges and opportunities associated with sustainability in the 21st century. Georgia Tech's tradition in sustainability is an interdisciplinary systems approach that addresses a hierarchy of integrated technological, scientific, and management systems that interact in complex ways. The Institute for Sustainable Systems is organized around the following intersecting programs: Sustainable Energy Systems, Climate and Environmental Stewardship, Sustainable Enterprise, and Sustainable Urban Systems.

Georgia Climate Change Summit, 6 May 2008. http://climatesummit.gatech.edu
The objective of this Summit was to open a statewide dialogue on the challenges of climate change, its impacts on Georgia, and opportunities for success now and in the future. The Conference highlighted how state and local governments, businesses and industries, and other leaders from the public and private sector are already reacting to the challenges and opportunities associated with climate change. Hosted by Brook Byers Institute for Sustainable Systems.

Southern Alliance for Clean Energy http://www.cleanenergy.org

Southern Alliance for Clean Energy (SACE) is a nonprofit, nonpartisan organization that promotes responsible energy choices that solve global warming problems and ensure clean, safe and healthy communities throughout the Southeast.

Regional initiatives across the U.S.

Puget Sound Regional Council (PSRC), King County, and 32 cities all within the state of Washington, have pioneered action on climate change and sustainability issues. PSRC is incorporating reductions of greenhouse gas emissions not only into their RTP but into their entire regional growth strategy. They are also creating a regional climate change action plan in cooperation with member organizations and the state.

- Modeled CO_2 projections and identified potential targets in RDP and RTP.

Joint Policy Committee (JPC) – Regional Agencies Climate Protection Program, 20 July 2007 Association of Bay Area Governments (ABAG); Bay Area Air Quality Management District (BAAQMD); Bay Conservation and Development Commission (BCDC); Metropolitan Transportation Commission (MTC)

- Completed a six-month study program and provided a set of recommendations for a continuing joint action program.
- MTC's T-2035 Transportation Plan (RTP) includes CO_2 target of Bay Area transportation CO_2 reduced to 40% below 1990 levels by 2035.
- MTC's climate change program features information gathering on 40+ transportation CO_2 strategies in 4 categories—vehicle efficiency, infrastructure (transit, roads, bike/walk, smart growth, freight), behavior change and "Other." For each strategy, the resource document provides information on possible lead/support agencies, background data, existing real-world examples, impacts and costs (where available) and possible RTP action.

New York City – PlaNYC http://www.nyc.gov/html/planyc2030/html/home/home.shtml
NYC adopted a plan in April 2007 that can focuses on the five key dimensions of the city's environment - land, air, water, energy, and transportation.

- Climate Change Initiatives http://www.nyc.gov/html/planyc2030/html/plan/climate.shtml
    1. Create an interagency task force to protect the city's vital infrastructure
    2. Work with vulnerable neighborhoods to develop site-specific protection strategies
    3. Launch a citywide strategic planning process for climate change adaptation
    4. Target: 30% reduction in global warming emissions by 2030.
- Progress Report 2008 on Climate Change http://www.nyc.gov/html/planyc2030/downloads/pdf/progress_2008_climate_change.pdf

Climate Change Progress

	INITIATIVE	LAUNCHED*	PROGRESS SINCE APRIL 22, 2007	IMPLEMENTATION MILESTONE FOR DECEMBER 2009
1	CREATE AN INTERGOVERNMENTAL TASK FORCE TO PROTECT OUR CITY'S VITAL INFRASTRUCTURE			
	Expand our adaptation strategies beyond the protection of our water supply, sewer, and wastewater treatment systems to include all essential city infrastructure	✓	Members have been identified and a kick-off meeting is being scheduled. In coming months, the City will guide the task force as it completes an inventory of critical at-risk infrastructure and begins to develop adaptation plans	Complete an inventory of all at-risk infrastructure with a priority list of high-risk components
2	WORK WITH VULNERABLE NEIGHBORHOODS TO DEVELOP SITE-SPECIFIC PROTECTION STRATEGIES			
	Create a community planning process and "toolkit" to engage all stakeholders in community-specific climate adaptation strategies	✓	The City has worked with UPROSE and the Sunset Park community to develop a model educational process and "toolkit." Two pilot workshops have been held so far in Sunset Park and Broad Channel, Queens. In summer 2008, we will hold additional pilot workshops before launching a citywide campaign	Complete community planning toolkit and create a climate change adaptation plan with UPROSE
3	LAUNCH A CITYWIDE STRATEGIC PLANNING PROCESS FOR CLIMATE CHANGE ADAPTATION			
	Create a strategic planning process to adapt to climate change impacts	✓	The City will begin a scoping study as a first step toward creating a strategic planning process	Release scoping study for a comprehensive climate adaptation planning process
	Ensure that New York's Federal Emergency Management Administration (FEMA) 100-year floodplain maps are updated	✓	The City continues to identify strategies for working with FEMA to update its FIRMs. Over the next few months, the City will meet with appropriate FEMA staff to develop the scope of work for map revision	Complete remapping of NYC 100-year floodplain
	Document the City's floodplain management strategies to secure discounted flood insurance for New Yorkers		Held discussions with FEMA and NYSDEC on National Flood Insurance Program's (NFIP) Community Rating System (CRS) application. An analysis of the costs/benefits demonstrated the potential for minimal reductions in premiums; therefore, application efforts are on hold	Complete application to FEMA
	Amend the building code to address the impacts of climate change		The City will incorporate climate change adaptation issues into upcoming code updates	Create a Task Force to evaluate necessary changes to the Building Code

* Initiative begun by the City, including planning or advocacy stages

Extended version of Progress updates and full list of acronyms available online at www.nyc.gov/PlaNYC2030

Metropolitan Washington Council of Governments

- Created a Steering Committee to develop a regional strategy.
- Established comprehensive reduction goals and implementation schedule after its one year tenure
- Draft report (released July 2008) addresses various sectors. With respect to transportation, the committee is evaluating "what would it take" scenarios to achieve desired GHG reductions.

Boston MPO

- Released a discussion paper "Carbon Dioxide, Climate Change, and the Boston Region MPO," Aug 2007
- Includes calculating CO_2 emissions in all work, mainly travel model work for the MPO and member agencies, including CMAQ work.
- Includes CO_2 emissions in addition to VOC, CO, and NOx, as part of TIP criteria in project selection and is rated accordingly
- Provides CO_2 emissions for MEPA process (the state's NEPA process). MEPA now requires all projects that are large enough to estimate their CO_2 emissions and mitigate accordingly. Boston MPO provides a majority of the modeling work for the transportation projects that go through MEPA.