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Estimating Transportation-Related Greenhouse Gas Emissions and Energy Use in New York State

Prepared by ICF Consulting

For the Department of Transportation's Center for Climate Change and Environmental Forecasting

March 18, 2005

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ACKNOWLEDGEMENTS

This report required extensive input from individuals at the U.S. Department of Transportation, New York State Department of Transportation, New York State Energy Research and Development Authority, Metropolitan Planning Organizations (MPOs) in New York, and numerous other state and local agencies. In particular, ICF would like to thank Diane Turchetta, John Zamurs, and Joe Rich for their guidance and feedback throughout all three phases of this project. ICF would also like to thank representatives of each of the New York State MPOs for their insightful and candid responses to our questions.

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1 I NTRODUCTION

Through a variety of government policies, New York State has been working to reduce energy consumption and anthropogenic greenhouse gas (GHG) emissions. In 2001, Governor George Pataki issued an Executive Order requiring State facilities to institute energy efficiency measures in their buildings and to purchase energy generated from renewable sources. That same year, Governor Pataki established the New York Greenhouse Gas Task Force to identify and recommend policy options for reducing GHG emissions. This task force is a collaboration of the business community, environmental organizations, State agencies, and universities, and its aim is to reduce GHG emissions while maintaining economic growth. The Task Force's final report – released in May 2003 – outlined 27 recommendations for reducing GHG emissions in New York State, such as setting a state reduction target and channeling State transportation funds to finance less GHG-intensive activities.

In addition, the New York State Energy Planning Board released the New York State Energy Plan (NY SEP) in 2002. The NY SEP seeks to provide New York State citizens with fairly priced, clean, and efficient energy resources; it also reflects elements of the Master Transportation Plan developed by the New York State Department of Transportation (NYSDOT) and the State Implementation Plan prepared by the State Department of Environmental Conservation. This plan has the distinction of being one of the first in the nation to integrate transportation planning, energy conservation, greenhouse gas (CO_2) mitigation, and air quality planning. The NY SEP identifies the following goals:

- Reducing primary energy use per unit of gross state product by 25 percent below 1990 levels by 2010.
- Increasing renewable energy from 10 percent of primary energy use currently to 15 percent by 2020.
- Reducing anthropogenic CO_2 emissions to 5 percent below 1990 levels by 2010 and 10 percent below 1990 levels by 2020.

As GHG inventories at all levels (e.g., national, state, local) have shown, transportation activities account for a significant share of total anthropogenic emissions. According to the New York State Energy Research and Development Authority (NYSERDA), transportation accounts for 38 percent of total energy consumption in the state.[1] The NY SEP acknowledges the importance of transportation in energy and GHG mitigation planning and includes several measures that are expressly designed to reduce these emissions.

This report discusses the findings of three relatively disparate tasks that were combined into a single project. All three tasks explored transportation-related GHG emissions and energy use in New York State, within the context of the NY SEP; however, the objectives and parameters of each task were slightly different. Each of the tasks is described below.

1. Task 1 was intended to quantify historical and projected state-wide energy use and anthropogenic CO_2 emissions and to compare the results to the goals of the NY SEP.[2] This task was designed to use "top-down" data to estimate CO_2 emissions and energy use by sector to determine whether the state and/or the state's transportation sector were on course to meet the NY SEP recommendations.
2. The purpose of Task 2 was twofold: (1) to gain feedback from metropolitan planning organizations (MPOs) on a new recommendation for MPOs to include estimates of energy use and GHG emissions in their transportation plans and (2) to estimate historical and projected CO_2 emissions and energy consumption by metropolitan region and by mode, where possible. Due to unique characteristics and data availability for each transportation mode and region, , the methodology used to develop the quantitative estimates under Task 2 reflect a "bottom-up" approach.

3. The purpose of Task 3 was to investigate the potential CO_2 and energy impacts of a variety of policies aimed at reducing transportation CO_2 emissions. Unlike the other tasks, this task had no region-specific outputs.

As mentioned above, Task 1 employed a top-down approach while Task 2 employed a bottom-up approach. This design decision was made at the outset of the project given the objectives of the respective tasks, data availability, and resource constraints. Thus, the results of Task 1 that relate to regional energy use and emissions may conflict with the results of Task 2. State-level data used in the development of Task 1 estimates are believed to be representative of the state's CO_2 emissions and energy use. In Task 1, state-level estimates were then apportioned to metropolitan regions based on a variety of assumptions; while these assumptions introduce a greater degree of uncertainty into the estimates, the metropolitan region estimates developed in Task 1 provide a fair approximation of emissions and energy use in those regions and allow for a comparison across metropolitan regions.

Because the purpose of Task 2 was to look at trends in emissions and energy use in each region by mode, the approach used in Task 1 was not sufficient. Therefore, alternate data sources were employed (such as the National Transit Database and FHWA's Freight Analysis Framework) to create a bottom-up analysis. While the estimates developed in Task 2 allow for a comparison of energy use and emissions by mode of travel, and between metropolitan regions, they are not meant for comparison to Task 1 estimates.

The remainder of this report includes a summary of findings and recommendations followed by more detailed explanations of methods, data, and results for the three tasks completed under this contract. Finally, we include a series of appendices that present more detailed information on data sources, methods, and results.

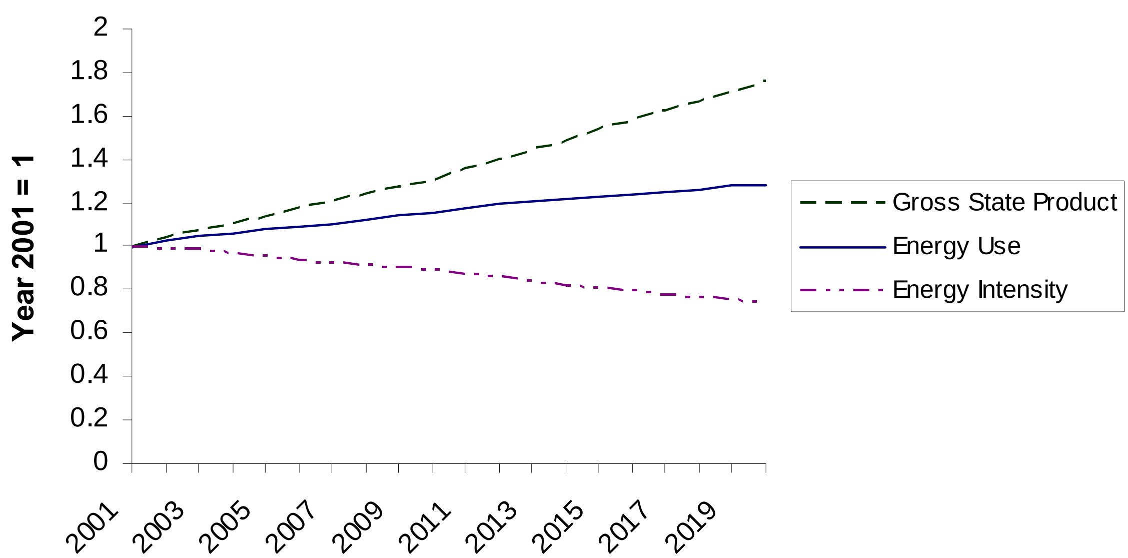
2 SUMMARY OF FINDINGS AND RECOMMENDATIONS

2.1 Lessons Learned

Our analyses under each of the three tasks resulted in the following conclusions:

Emission Baseline and Projections. While the absolute amount of energy use and anthropogenic CO_2 emissions is anticipated to increase for all regions analyzed (New York State, New York State transportation sector, and each of the 12 metropolitan regions), the CO_2 and energy intensities (i.e., CO_2 emissions or energy use per dollar of gross economic product) are expected to decrease for all regions. See Figure 2-1 for an illustration of trends of statewide transportation energy use and intensity.[3] These trends are due to the fact that gross product (at the state and the metropolitan region levels) are increasing at a faster rate than energy use and CO_2 emissions. The decrease in energy and GHG intensity is primarily due to a shift in the composition of the Gross State Product; several sectors that are less energy and CO_2 intensive (e.g., financial services) have grown rapidly, whereas the more intensive sectors (e.g., heavy manufacturing) have shown much slower growth or even decline in real terms. In addition, energy use is projected to increase at a slightly higher rate than CO_2 emissions, indicating a shift toward less carbon-intensive fuels.

Figure 2-1. Projected State Product, Transportation-Related Energy Use, and Energy Intensity (2001-2020)



MPO Analysis. Consistent with the findings in Task 1, transportation energy use and CO_2 emissions are projected to increase between 1990 and 2020, while most metropolitan regions are projected to reduce energy and CO_2 intensity (i.e., energy use and CO_2 emissions per unit of travel). For many of the travel modes investigated, small reductions in energy use and CO_2 intensities are predicted for the analysis period (also consistent with Task 1).[4] On a geographic basis, the New York City metropolitan area dominated energy use and CO_2 emissions in the state, accounting for about 56-57 percent of the state's transportation-related energy use and CO_2 emissions. Looking at the statewide distribution among different travel modes, energy use and CO_2 emissions came predominantly from cars and trucks, which accounted for 83 to 94 percent of the state's total transportation-related energy use and CO_2 emissions.

ICF also discovered that the data necessary to conduct a bottom-up analysis were often not available at the MPO level for many transportation modes. Therefore, improvements in the nature and availability of metropolitan region-level data are essential for MPOs attempting to quantify their GHG emissions and energy use by transportation mode.

During its interviews with the MPOs, ICF learned that completing the energy assessments required in the NY SEP typically requires two to four person-weeks. The MPOs largely agreed that these assessments have value, but expressed doubts that the results of such analyses would be able to significantly influence decisions. Additionally, some MPOs felt that some of the quantitative analyses could be more effectively developed at the state level.

Mitigation Analysis. Based on the preliminary analyses conducted under Task 3, four of the six mitigation strategies appear to offer of the most promise for reducing energy use and CO_2 emissions at a relatively low cost per ton of CO_2 reduced. These strategies are: feebates, freight modal shift, commuter benefits, and truck stop electrification. Under the project scenarios investigated for these four strategies, New York State's energy use in 2020 would be reduced by up to 51 trillion Btu, and its CO_2 emissions would be reduced by up to 3.6 million metric tons of CO_2 compared to the baseline; these values correspond to a 3 percent reduction in New York State's transportation-related energy use and transportation-related CO_2 emissions in 2020. In context to the New York State Energy Plan, this reduction would represent about 9 percent of the statewide reduction target for that year.

Two other strategies (CNG bus use and alternative fuels for airport equipment) were investigated; while implementation of these strategies would reduce energy use and CO_2 emissions as well, the results of this analysis indicate that savings in energy use and emissions would be much smaller relative to their cost of implementation. These strategies would each reduce energy use by less than 0.1 trillion Btu and emissions by less than 0.1 million metric tons of CO_2. It is important to note that the analyses conducted under Task 3 were resource constrained and did not allow for consideration of co-benefits (e.g., reductions in criteria air pollutants), costs to private industry, or other factors that could significantly affect policymakers' decisions to pursue and/or implement any given strategy.

2.2 Recommendations

This section discusses our recommendations for improving energy assessments in the metropolitan regions. Making these improvements will help reduce CO_2 emissions from the transportation sector in metropolitan areas while meeting their region's transportation needs. These improvements will also help streamline the energy assessment process, allowing MPOs to complete their analyses with fewer resources. Additionally, increasing MPO-State collaboration on these analyses will help ensure that both the MPOs and New York State are actively involved in, and aware of, efforts to reduce CO_2 emissions and meeting transportation needs.

This report does not set forth recommendations for implementation of specific policies. Instead, it provides preliminary estimates of the reductions and costs associated with implementation of the policies. Due to resource constraints, these results do not reflect comprehensive cost-benefit analyses, strategies for overcoming potential barriers to implementation, or assessments of ancillary benefits (e.g., reduced traffic congestion, reduced air pollution). These results *will* help identify potentially viable strategies; the State may or may not wish to conduct further analyses before pursuing implementation of specific policies or programs.

2.2.1 Improving Energy Assessments in Metropolitan Regions

In attempting to develop regional estimates of energy use and CO_2 emissions by mode, the project team learned first hand the data quality and availability constraints that exist. In our experience, the most significant hurdle in conducting this analysis was determining ways to allocate county-, state-, or national-level data to the metropolitan region level. Not only were these exercises time consuming, but they introduced a large degree of uncertainty to the results. Although the level of specificity required in the completion of Task 2 was beyond that recommended to the MPOs by NYSDOT, it would seem that the provision of improved data sources to enable local analyses of energy and GHG emissions would enhance the quality of the regional plans, improve consistency across plans, and reduce the amount of time required to do the energy and GHG analysis.

The sections below provide a series of recommendations that may be of interest to NYSDOT as the Department continues to refine and support implementation of the new recommendation. Recommendations for improving the energy assessments are grouped into two categories: general improvements and improvements in data availability.

General Improvements

Assessing the effectiveness of New York State's efforts to implement regional energy/CO_2 assessments at this early stage is somewhat premature. However, requesting feedback at this stage from local planners offers New York and other states an interim assessment of the process to date. As with many new policies, the energy/GHG recommendation in New York is meeting with some confusion as well as some resistance. The flexibility offered on the part of the state to facilitate the process for MPOs was sometimes viewed as a lack of guidance or clarity on the purpose and scope of the recommendation. MPO resistance stems from concerns about the overall utility of the assessment, the potential impact to the transportation decision-making process, and the additional resources needed to complete the assessment. The remainder of this section attempts to summarize some specific lessons that New York and other states could learn from early feedback received from New York State MPOs.

Further Clarify Goals of the Energy/GHG Assessment Policy

Several MPOs are unclear on New York State's motivation to require regions to conduct energy assessments. While interviewees generally agreed that energy use and GHG emissions need to be reduced, they did not understand why MPOs were being given such a prominent role in the assessment process. Most felt that MPO policies and investment choices could not significantly affect broader trends toward increasing energy use. Rather, interviewees suggested that policies at the State and Federal level would be required for any significant changes to take place.[5] Greater outreach may be required to assist MPOs in understanding their role in the energy/GHG assessment process and how it supports a broader strategy that can meaningfully affect energy use and GHG emissions statewide. Federal regulations such as vehicle technology improvements and more stringent fuel economy standards may result in larger emission reductions; however, actions by MPOs will also play a role in increasing or decreasing state transportation emissions over time.

In addition, MPOs do not understand which aspects of the assessment are mandatory. Currently, some MPOs view the assessment as a voluntary activity while others see it as a new requirement. This may be a reaction to NYSDOT's attempt to design a flexible methodology, allowing MPOs to develop a process that best informs their own planning and decision-making. Although this flexibility has advantages, some MPOs would prefer more detailed direction.

Finally, the metropolitan region energy/GHG assessments completed to date are not conducive to meeting the goals articulated in the NY SEP. Generally, MPOs sought to demonstrate reduced energy use and GHG emissions when comparing between build and no-build scenarios. This "build vs. no-build" approach may indeed promote projects that reduce transportation energy use; however, this type of comparison risks taking attention away from broader goals of reducing total energy consumption by focusing on strategies that simply slow the pace of energy use/GHG emissions increases.

Further Involve MPOs in Developing State Energy Assessment Methodologies

Some MPOs expressed interest in being more involved in developing the energy assessment methodology. This is a difficult request for several reasons including: what level of involvement are MPOs suggesting (e.g., what is too much, what is too little); what impact will MPO involvement have on the schedule and scope of the process; and what are the potential benefits of getting MPO buy-in from the beginning. From the state perspective, MPOs were involved in some of the early discussions about the process, but MPOs indicated that they would like to have been even more involved.[6] There are some clear advantages to maximizing MPO involvement early on in the process. These advantages include greater responsiveness, increased opportunity for the state to shape and manage expectations, increased collaboration, and increased consistency across the metropolitan region energy and GHG estimates.

Further Increase State Support for MPO Energy/GHG Assessments

As mentioned earlier, one reason for MPO reluctance in completing the analyses was a lack of resources. In order to maximize participation, increase efficiency, and promote consistency, the state might consider offering assistance in one or more of the following key areas: financial support, data support, and analytical support.

Financial Support: Several MPOs suggested that transportation energy/GHG assessments may take time from other critical MPO activities. To address this concern, states implementing regional transportation energy assessments may consider providing additional funds specifically targeted to support such analyses. As another form of financial support, states could establish certain incentives for selecting energy conserving transportation strategies.

Data Support: NYSDOT has a wealth of data that could be used to streamline development of both energy use and GHG emissions estimates. This includes detailed vehicle travel estimates, as well as freight and transit data. For example, the NYS DEC currently runs the MOBILE6.2[7] model to produce detailed CO_2 emissions data for every county in the New York; state-level resources such as these should be publicized and used to reduce the burden on MPOs and to maximize consistency across regions.

Analytical Support: Perhaps the state DOT could assist the MPOs in preparing baseline energy use and GHG emissions estimates, thus allowing MPOs to focus greater attention on evaluating projects and programs that could reduce energy consumption from these baseline values. New York State's involvement in the generation of energy use numbers would also ensure greater consistency, allowing for more accurate comparisons between metropolitan regions.[8] Currently, MPOs use a variety of methodologies to generate their estimates, making comparisons between metropolitan areas problematic. In addition, the state could attempt to simplify the indirect energy calculation, considering this was an area of concern among MPOs.

Link to Broader State Policies

More proactive State transportation policies are needed to significantly affect current trends toward increased energy use and GHG emissions (detailed in the MPO Data Tables in Appendix E). Transportation-related emission reductions achievable at the metropolitan region level are generally limited to funding roadway projects that relieve congestion, implementing rideshare programs, and providing incentives for alternative transportation. While these programs may slow the pace of increasing energy use, as currently planned, they will not be sufficient to meet the goals of the NY SEP. As several MPOs suggested, major regional land use strategies, more stringent Federal vehicle fuel efficiency mandates, or aggressive transportation pricing measures would probably be needed in order to reduce transportation energy use and GHG emissions.

As a result, New York State should continue to assess state policies that could reduce energy and GHG emissions, including both statewide policies (such as those addressed in Task 3), and policies that apply to New York State properties and employees (e.g., parking fees, carpool incentives, and transit oriented office locations). The State is in a position to take the lead and set an example; however, these actions will need to be undertaken by a broader segment of the population to achieve notable results. In addition, the state might coordinate with MPOs to consider the potential for regional land use controls or incentives where they can be demonstrated to influence long-term transportation energy use. However, land use controls are difficult to implement from a political standpoint and have had limited success in other states.

It is also recommended that the state more aggressively advertise actions that are being taken at the state, regional, and local level. This will demonstrate the state's commitment to achieving its energy use and GHG goals.

Improving Data Availability

Organize Data to Correlate with Metropolitan region Boundaries

NYSDOT is the best source of VMT estimates and forecasts for most, if not all, regions. Thus, it may be worth organizing NYSDOT data to correspond to metropolitan region boundaries. This organization may require that appropriate roadway segments be tagged with a metropolitan region code.

Transit data are not generally associated with specific metropolitan regions. Particularly for downstate regions (Orange County, Dutchess County, and NY City Region), a transit data organization scheme that facilitates allocation to a particular metropolitan region would be very useful. As the clearinghouse for state transit data, this may be a task for NYSDOT. At the same time, it may require more involvement from individual MPOs working with their region's transit agencies.

Improve Compatibility of Truck, Rail, and Water Freight Data

FHWA's Freight Analysis Framework (FAF) could be used to develop truck, rail, and water freight data that are more comparable and more useful for policy-making. For example, in the current analysis, energy use for truck freight only accounts for travel occurring on roads within New York State. In contrast, energy use for freight rail accounts for the entire shipment trip length.[9] If the FAF data were used to estimate truck freight instead of the current methodology, this would allow energy estimates that are more comparable with freight rail estimates, and thus make the findings more useful for policy analysis. For example, a decision of a company in New York State to ship or receive goods via rail versus truck has implications for the entire length of the shipment, not only for the component within New York State.

As another example, the current analysis treats water freight differently from truck and freight rail. Energy use for water freight is estimated for each region based only on shipment tonnage (i.e., distance shipped is not considered). Here again, the analysis would be most useful if water freight data could be readily compared with other freight modes. Toward this goal, ton-miles for domestic water freight could be estimated using FAF data by developing multipliers for straight-line distances based on different shipping routes (e.g., separate straight-line distance multipliers for coastal Atlantic trips, inland waterway trips, St. Lawrence Seaway trips, etc.).

Improve Freight Rail Estimates

Freight rail ton-miles could be estimated more accurately by using GIS to route all freight to and from NY onto the FAF rail network. In addition, freight rail energy intensities could be estimated more accurately by getting county-specific data on the typical number of rail cars per train. The number of rail cars can influence the energy use per ton-mile, particularly in cases where shipping and production schedules require trains that are much less than the optimal length.

Intra-county freight rail data would also improve energy estimates. FAF data used to calculate freight rail ton-miles could not be used to represent intra-county flows; therefore, these flows are omitted. While this is not a large source of freight-ton mileage, some MPOs indicated that intra-county short-line freight operations were allowing industries to reduce truck traffic and improve efficiency. Ultimately, the energy analysis should account for this kind of practice as a potential strategy to reduce emissions.

3 EMISSION BASELINE AND PROJECTIONS

3.1 Background

Our analysis began with the development of a baseline of energy consumption and anthropogenic CO_2 emissions for New York State and for each metropolitan region. This baseline, constructed assuming a business-as-usual scenario, provides context for comparing the increase in energy use, CO_2 emissions, and economic expansion; it also serves as a basis for assessing the benefits of mitigation strategies investigated under Task 3.

Baselines were developed for New York State, New York State's transportation sector, and for each metropolitan region, and covered the years 1990, 2001, 2010, and 2020. 2001 is considered the "current" year because it is the most recent year for which state energy data were widely available. The following types of baselines were developed:

- Gross Economic Product (in current dollars)
- Total CO_2 Emissions
- GHG Intensity (GHG emissions per dollar of gross economic product)
- Total Energy Use
- Energy Intensity (energy use per dollar of gross economic product)

3.2 Approach

The methodology used to estimate energy use and CO_2 emissions for New York State and each metropolitan region is detailed in Appendix A and is summarized below.

Energy and CO_2 estimates were developed for New York State using publicly available data; state-level estimates were then apportioned to metropolitan regions. Historical data (1990-2001) on total state and transportation-related fuel use were obtained from the *New York State Energy Profiles: 1987-2001*. Similar data for years 2001-2020 were taken from the New York State Energy Plan.

These data were used to estimate energy consumption and CO_2 emissions using methods developed by the US EPA (and consistent with international guidelines on GHG emissions developed by the Intergovernmental Panel on Climate Change). The basic equation for calculating emissions was as follows:

Fuel Consumption x Carbon Content x Combustion Efficiency[10] *x 44 gm CO_2/12 gm C = CO_2 Emissions.*

For fuel used for non-energy purposes, the fuel quantity was multiplied by a storage factor and then subtracted from the carbon emissions, to avoid double-counting.

Electricity emissions related to transportation were calculated by apportioning statewide electricity-related emissions to the transportation sector based on estimates of electricity sales to end-use sectors.

Historical data on gross state product (GSP) were obtained from the Bureau of Economic Analysis (BEA), and future values were estimated assuming a three percent annual growth rate (as used in the New York State Energy Plan). Gross state product was allocated to counties based on population. Then, each county was assigned to one specific metropolitan region. In cases where county boundaries fell entirely outside metropolitan region boundaries, counties were not assigned to an metropolitan region. Metropolitan region values were estimated by summing the values for the counties assigned to each metropolitan region.

Metropolitan region energy use and emissions were estimated by distributing state-level data to the different regions, rather than through reliance on more local data. The research team decided to use state-level data because local data were not consistently available across the MPOs. For example, for VMT estimates, some MPOs had no data, while other MPOs had data for regions that did not fully correspond with the boundaries of the metropolitan region, and others had data on overall VMT with little information about vehicle types. New York transportation-related energy use and CO_2 emissions were calculated by fuel type. These estimates were then allocated to New York counties based on a variety of factors – such as county population and fuel consumption – which varied based on fuel type (see Appendix A for further information). Then, county values were assigned to a metropolitan region using the same methodology used to estimate GSP at the metropolitan region-level.

3.3 Findings

Table 3-1 and Table 3-2 summarize of the results of the approach described above for New York. Table 3-1 shows the result for New York State as a whole, while Table 3-2 shows the results for just the transportation sector within New York State. Emissions decrease slightly between 1990 and 2001 due to a change in the overall fuel mix. Although total energy use increased slightly, the proportion of energy supplied by coal (which is the most carbon-intensive fuel) dropped by about 19 percent over the period. Appendix B provides the detailed results for each of the metropolitan regions.

Table 3-1. Analysis of Overall Anthropogenic CO_2 Emissions and Energy Use in New York State

	1990	2001	2010	2020
Gross State Product (Billion 2001 Dollars)	$502	$826	$1,078	$1,449
CO_2 Emissions (Million Metric Tons ($MMTCO_2$))	219	209	216	236
CO_2 Intensity ($MMTCO_2$ per Million 2001 Dollars)	436	253	200	163
Energy Use (Trillion Btu)	3,695	3,951	4,118	4,454
Energy Intensity (Thousand Btu per 2001 Dollar)	7.4	4.8	3.8	3.1
Reduction in CO_2 Intensity with Respect to 1990	NA	42%	54%	63%
Reduction in Energy Intensity with Respect to 1990	NA	35%	48%	58%

Table 3-2. Analysis of Transportation CO_2 Emissions and Energy Use in New York State

	1990	2001	2010	2020
Gross State Product (Billion 2001 Dollars)	$502	$826	$1,078	$1,449
CO_2 Emissions ($MMTCO_2$)	80	82	94	104
CO_2 Intensity ($MMTCO_2$ per Million 2001 Dollars)	159	99	87	72
Energy Use (Trillion Btu)	1,107	1,135	1,314	1,458
Energy Intensity (Thousand Btu per 2001 Dollar)	2.2	1.4	1.2	1.0
Reduction in CO_2 Intensity with Respect to 1990	NA	38%	45%	55%
Reduction in Energy Intensity with Respect to 1990	NA	38%	45%	54%

Across all sectors and over the 1990-2020 period, New York State's total energy use is projected to rise by about 21 percent, while CO_2 emissions increase by 8 percent and GSP increases by 189 percent. Despite the monotonic increase in energy use throughout the period, New York's total CO_2 emissions in 2001 and projected CO_2 emissions in 2010 are slightly below 1990 levels, reflecting a shift to less carbon-intensive fuels. The average emission rate declines from 16 kg CO_2 per million Btu in 1990 to 14 kg CO_2 per million Btu in 2001, and henceforth stays relatively constant through the end of the simulation period.

While the state's absolute energy use and emissions are projected to increase during the 1990-2020 period, the energy and CO_2-intensity (i.e., energy and CO_2 emissions per dollar of gross state product) are expected to decrease (by 58 percent and 63 percent, respectively). On a per capita basis, energy use is expected to increase by about 12% per person, while CO_2 emissions will increase less than 1 percent per person during the same time period.

Within the transportation sector, energy use and emissions increase over the entire 1990-2020 period. The GHG emission rate per unit of energy is relatively constant at about 20 kg CO_2 per million Btu. Note that the changes in energy and GHG intensities vary between the state analysis and the transportation sector analysis, due to differences in fuel mix and the carbon contents of the individual fuels.

The New York State Energy Plan's goal of reducing energy intensity in 2010 by 25 percent compared to 1990 levels was already reached by 2001 (35 percent decline statewide, 38 percent decline in the transportation sector) and is projected to decline even further by 2010 (48 percent statewide, 45 percent in transportation). The reductions in CO_2 intensity sector-wide are slightly higher than the corresponding reductions in energy intensity, due to a net move toward lower carbon fuels. The large reductions in both intensity measures appear to be driven primarily by the change in the state's economy in the 1990-2001 period; the rapid growth in the financial services sector (and other sectors of the economy that are not energy-intensive) has resulted in a significant increase in total GSP, without corresponding increases in energy or CO_2 emissions. The effects of this trend may be somewhat overstated in the transportation sector, due to the fact that reported fuel use (based on gasoline sales data) is approximately flat between 1990 and the present, while indicators like VMT and vehicle registration data would suggest that gasoline fuel use should have increased more over this time period.

As shown in Appendix B, the metropolitan regions are quite heterogeneous in their level of GSP, transportation energy use, and transportation emissions. The Elmira-Chemung Transportation Council has the lowest 2001 gross metropolitan region product ($2.8 billion), energy use (5.18 trillion Btu), and GHG emissions (0.40 $MMTCO_2$). The New York Metropolitan Transportation Council is at the other end of the scale, with 2001 gross metropolitan region product of $598 billion, energy use of 639 trillion Btu, and GHG emissions of 47.0 $MMTCO_2$.

From an intensity perspective, however, the metropolitan region ranking highest in terms of both transportation energy and transportation GHG intensity is the Adirondack-Glens Falls Transportation Council, with 2001 values of 180 $MTCO_2$ / $million and 2,600 Btu / $. Given its prodigious economic output in the financial services sector and relatively high use of mass transit, the New York Metropolitan Transportation Council ranks lowest in both intensity measures, with 2001 values of 79 $MTCO_2$ / $million and 1,100 Btu / $. For comparison, the statewide transportation values for 2001 were 82 $MTCO_2$ / $million and 1,400 Btu / $.

In terms of trends among the metropolitan regions, four metropolitan regions showed a slight decrease in energy use and emissions between 1990 and 2001: Greater Buffalo-Niagara RTC, Elmira-Chemung TC, Adirondack-Glens Falls TC, and Syracuse MTC. Otherwise, all metropolitan regions had monotonic increases in transportation energy and transportation emissions for all intervals.

4 MPO ANALYSIS

This chapter describes two MPO-level assessments of New York State transportation energy use and anthropogenic CO_2 emissions. The first analysis involved developing estimates of transportation energy use and CO_2 emissions for each region in New York State. Illustrated in Figure 4-1 and reported in detail in Appendix E, these estimates provide a baseline for more detailed future analyses and provide some context for why New York State is working with regional transportation agencies on strategies to reduce energy use and GHG emissions. The second analysis describes how regions throughout New York State have responded to the state's recommendation that MPOs conduct regional energy use and GHG emissions analyses. This analysis is based on interviews with MPOs and a review of initial energy/GHG analysis documents.

For each of these two analyses, this chapter discusses our approach, major findings, and lessons learned. Detailed methodologies, data findings, and contacts are included in appendices, as noted above.

Figure 4-1: Direct Transportation Energy Use for Each Metropolitan region by Year

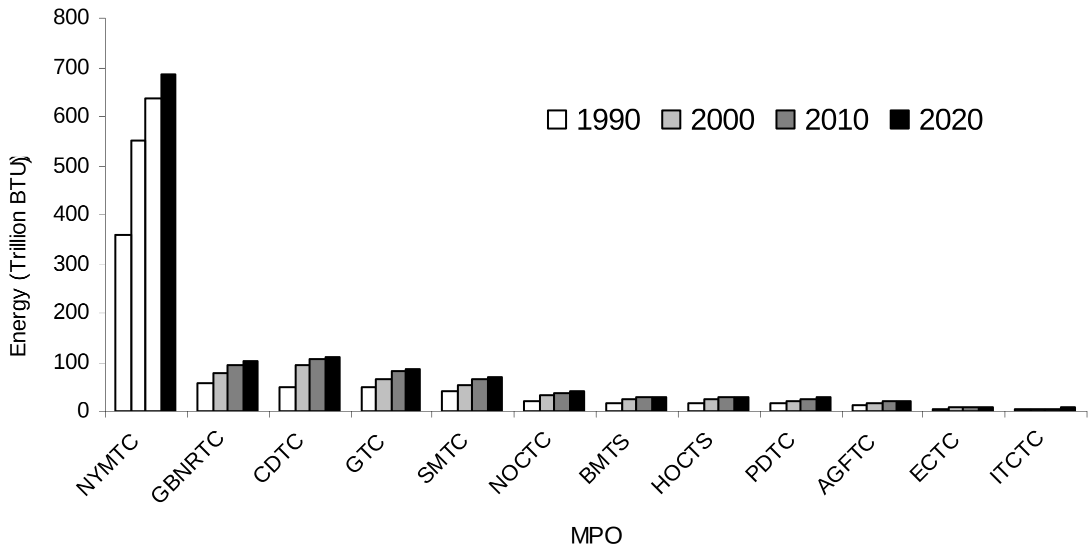


Table 4-1. State Travel Activity, Energy Use, and CO_2 Emissions, by Mode (2001)

Mode	Travel	Units ('000s)	Energy Use (1,000 Btu)	Energy Intensity (1,000 Btu per unit of Travel)	CO_2 Emissions ($MTCO_2$)	CO_2 Intensity ($MTCO_2$ per unit of Travel)
On-road Vehicles	110,605,341	Vehicle Miles Traveled (VMT)	819,924,369,540	7,413	57,373,508	0.52
Light-duty Vehicles	*60,608,819*	*VMT*	*350,459,900,651*	*5,782*	*24,418,807*	*0.40*
Light-duty Trucks	*43,920,975*	*VMT*	*358,518,288,327*	*8,163*	*25,003,784*	*0.57*
Heavy-duty Trucks	*6,075,547*	*VMT*	*110,946,180,563*	*18,261*	*7,950,918*	*1.31*
Buses	12,802,543	Passenger Miles Traveled (PMT)	20,293,937,730	1,585	1,460,316	0.11
Transit	*2,718,977*	*PMT*	*10,122,084,345*	*3,723*	*714,380*	*0.26*
School	*10,083,567*	*PMT*	*10,171,853,386*	*1,009*	*745,936*	*0.07*
Water Freight	33,975	Tons	116,330,198,008	NE*	8,753,672	NE*
Rail**	NA	NA	12,658,301,013	NA	1,494,596	NA
Freight	*5,191,081*	*Ton-miles*	*1,796,114,009*	*346*	*130,071*	*0.03*
Transit	*12,626,201*	*PMT*	*10,862,187,004*	*860*	*1,364,525*	*0.11*
State Total**	**NA**	**NA**	**969,206,806,291**	**NA**	**69,082,093**	**NA**

* NE = Not Estimated. Energy and CO_2 intensity were not estimated because the travel unit is provided in "tons" since ton-miles were not able to be calculated for water freight; because tons are actually a measurement of weight and not of travel, intensities were not calculated.

** NA = Not Applicable. Travel cannot be quantified across all modes since the units are mode specific (e.g., VMT, ton-miles) and therefore not comparable. Similarly, travel could not be quantified for the total rail travel since the travel units are different for transit and freight rail. Since travel units are not quantified, energy and CO_2 intensities across the difference modes cannot be calculated either.

4.1 Regional Transportation Sector Energy Use and CO_2 Emissions

4.1.1 Background

ICF was asked to prepare a quantitative assessment of each region's energy use and CO_2 emissions for the years 1990, 2001, 2010, and 2020, which required the development of a baseline in order to estimate current energy use and CO_2 emissions, and to project future estimates. Within each region, this assessment was conducted for each of the following modes of travel:

- Light-duty vehicles
- Light-duty trucks
- Heavy-duty trucks
- Transit buses
- School buses
- Freight rail
- Rail transit, and
- Water freight

For each of these travel modes, ICF estimated the following:

- Amount of travel,
- Energy consumption,
- Energy intensity (measured in thousand Btu per unit of travel), and
- Quantity of CO_2 emissions.

The key findings can be summarized as follows:

- Transportation energy use and CO_2 emissions are likely to increase for all metropolitan regions for the period from 1990 to 2020.
- For many modes, small (<10 percent) reductions in energy and CO_2 intensities are projected between 1990 and 2020.
- Data required for estimation of energy use and CO_2 emissions, such as fuel use and vehicle fuel economy, are not readily available at the metropolitan region level for most surface transportation modes.

4.1.2 Approach

Estimates of energy use and CO_2 emissions for each metropolitan region were developed primarily from state and national data sources.[11] Contacts from New York State and other organizations that provided these data are listed in Appendix C.

Following is a brief summary of the approach used to develop these energy/CO_2 estimates, with a more detailed methodology included in Appendix D.

On-Road Vehicle Data (not including transit buses): Historic VMT estimates were developed based on detailed New York State Department of Environmental Conservation (NYS DEC) data. NYS DEC data were derived from NYSDOT traffic counts and vehicle distribution data from state and national sources. VMT estimates were based on NYSDOT vehicle travel forecast models.

Transit Data: Bus and rail transit historic passenger-miles traveled (PMT) and fuel consumption data were drawn from the National Transit Database. Transit bus and rail PMT forecasts were based on a linear extrapolation of NYSDOT transit passenger data.

Freight Rail Data: Freight rail ton-miles were derived from FHWA's freight analysis framework. Ton-miles were translated directly to energy use and CO_2 emissions.

Water Freight Data: Domestic water freight tonnage was derived from FHWA’s Freight Analysis Framework. Water freight energy use estimates were based on the statewide use of residual and diesel fuel. State fuel use was apportioned based on each county’s water freight shipping tonnage.

4.1.3 Findings

This section summarizes key results of the regional energy/CO_2 assessment. Detailed data for each metropolitan region is included in Appendix E.

The results of the metropolitan region energy and emission analysis suggest that transportation energy use will increase for all metropolitan regions for the period from 1990 to 2020. Minor (<10 percent) reductions in energy intensity are projected for many modes during the same time period. Figure 4-1 illustrates this trend for total direct energy use for each metropolitan region. These trends occur in all transportation sectors in virtually all regions. For the majority of metropolitan regions, energy and CO_2 intensities decrease somewhat over the forecast period, but these reduced intensities do not mitigate increases in overall energy use to any significant degree. Figure 4-1 also illustrates the degree to which the New York City region dominates state energy use. This trend is consistent across all modes except freight rail.

We found that in many cases, the data necessary to estimate energy use and CO_2 emissions (such as fuel use and vehicle fuel economy) by mode were often not available at the metropolitan region level, necessitating the team to make a broad range of assumptions. Although much of this information was available at the state or national level, these data are often organized in a manner that makes data collection and analysis at the metropolitan region level difficult and time-consuming.

Energy and emissions from roadway construction were not estimated because insufficient data were available. However, five MPOs did develop estimates based on projects in their current Transportation Improvement Programs (TIPs).

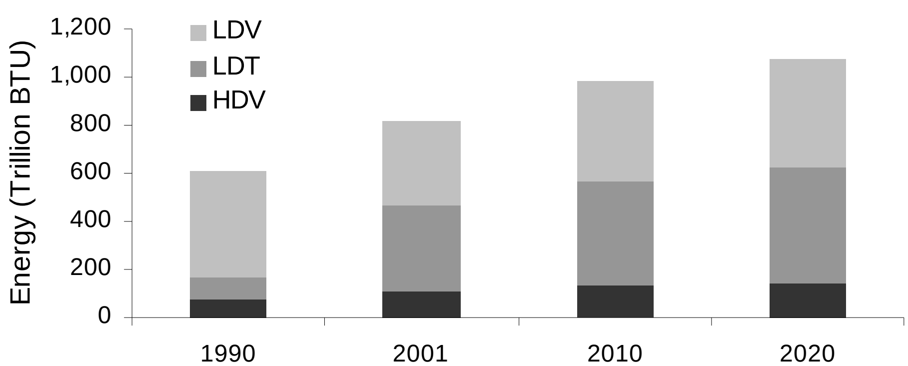
The complete quantitative analysis results are presented in Appendix E. The remainder of this section highlights noteworthy trends from this analysis, and discusses some key data concerns.

Cars and Trucks

Travel by cars and trucks makes up the largest source of transportation energy use in every one of the metropolitan regions. For these modes, all regions show continuously increasing travel, energy use, and CO_2 emissions throughout the study period. Part of the increase can be attributed to a shift from light-duty vehicles to light-duty trucks[12] (as shown in Figure 4 2), which require more energy to travel comparable distances, and therefore result in greater emissions of CO_2. Another reason for the increase in energy use and emissions is the large increase in vehicle miles traveled (VMT); over the 30-year study period, VMT is projected to increase by 57 percent.

Car and truck fuel economy was not directly calculated. Energy use and GHG emissions are estimated based on MOBILE6.2 model runs. MOBILE6.2 uses national fuel economy statistics based on vehicle type and vehicle year.[13] Fuel economy for each region depends on the current and forecasted VMT by vehicle type.

Figure 4-2: Growth in Energy Used by Cars and Trucks for All Metropolitan Regions

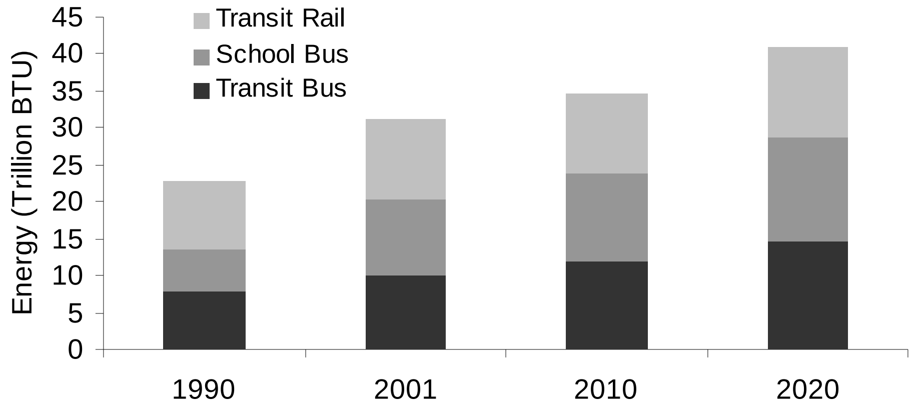


Travel by Rail and Bus

Mass transportation modes include school buses, transit buses, and transit rail.[14] These modes all consume similar amounts of energy, which is about one percent of the energy used by cars and trucks, although this percentage varies substantially by region. As shown in Figure 4-3 below, aggregate energy use among these modes increases steadily over the study period. The largest increase occurs from 1990 to 2001, due to a large increase in the school bus fleet size[15] and travel.

The New York City Metropolitan Region is responsible for the largest share of transportation by these rail transit and bus modes; thus, the large increases in passenger miles traveled by these modes in the New York City region are the main drivers behind the growth of energy use and emissions by these modes in New York State. In addition, while all metropolitan regions had passenger travel by transit and school bus, only the New York City Metropolitan Region and the Greater Buffalo-Niagara RTC had rail transit data.

Figure 4-3: Growth in Energy Used by Transit and School Buses for All Metropolitan Regions



Freight Travel by Ship and Rail

Energy use and CO_2 emissions in the water freight sector are expected to increase as well. Although water freight represents only a moderate portion of energy use among metropolitan regions in aggregate (generally about 10 percent), this energy consumption is concentrated in only three metropolitan regions. Therefore, in these metropolitan regions, water freight represents a much more significant proportion of emissions, ranging from 94 percent to 99 percent of transportation energy use in those particular areas. These three metropolitan regions are: CDTC (Albany), GBNRTC (Buffalo), and NYMTC (New York City).[16]

Unlike passenger rail travel, freight rail travel was present in every metropolitan region. In general, energy use for freight rail generally represents one of the smaller uses of energy in the metropolitan regions. As shown in Appendix E, each metropolitan region has the same energy intensity value for rail. This is due to the fact that energy use estimates were derived from a constant energy/ton-mile factor. This contrasts with the other travel modes in the table for which we had independent sources for units of travel and energy use.

Data Shortcomings

In many cases, data necessary to complete the quantitative assessment were difficult to obtain, or were not available in a form conducive to this type of analysis. As a result, broad assumptions needed to be made in the analysis, giving a large degree of uncertainty to the results.

Virtually no data were available by metropolitan region boundaries. Some data were available at the county level; however, since metropolitan region boundaries often cut across counties, county-level data could not be attributed to metropolitan regions with a large degree of precision. Similarly, state- and national-level data were abundant, but the process of allocating these data to metropolitan regions was equally imprecise. If data were to be collected at the metropolitan region level, MPOs would be better able to assess their transportation energy demands.

Some of the more significant concerns related to water freight data. The Corps of Engineers has the most detailed data on domestic water freight, but provide no forecasts of freight tonnages. FHWA's Freight Analysis Framework (FAF) provides historic water freight data as well as forecasts on a county-by-county basis but seems to be associated with a larger degree of uncertainty. For example, the FAF data allocate a large amount of freight to Albany, which is at odds with anecdotal information obtained during MPO interviews. The timeframe for this project required use of FAF data because it could be easily allocated to specific metropolitan regions and because forecast data aligned well with those requested for this research.

Additionally, data for freight mode were reported based on different measurement parameters. Water freight was measured simply by the tonnages entering NY ports; distance shipped was not considered. Truck and rail freight measurements reflect distance traveled, but truck data account only for travel within the state, while rail data account for the entire distance of shipment regardless of end point. In addition, the FAF data could not be used to calculate intra-state shipping; therefore, the freight estimates represent only shipping that either originated *or* ended in New York, but not freight that was shipped entirely within New York or freight that traveled through New York en route to its destination.

For this analysis, VMT data are based on State DOT projections. While these projections account for income and travel cost forecasts by region, they do not consider land use issues that may significantly affect regional VMT trends. Ideally, this analysis should be conducted with VMT projections from integrated transportation/land use models operated by each MPO.

The MPO Data Table also indicates a sharp increase in water freight energy use from 1990 to 2000. This jump is based on unusually low statewide consumption of residual fuel in 1990. If the residual fuel in 1990 were closer to the values for other years in the late 80s and early 90s, then the 1990 value would be only about 20 percent below the 2000 value.

4.2 MPO Response to NY SEP Recommendations

4.2.1 Background

The New York State Energy Plan recommends that MPOs, in conjunction with the State, assess the energy use and emissions expected to result from implementation of transportation plans and programs. NYSDOT has drafted detailed methodological guidance to help MPOs fulfill this recommendation. So far, only six MPOs have had to submit such energy/CO_2 assessments.[17] These assessments are currently being reviewed by NYSDOT. Other MPOs will be required to conduct similar analyses during the next few years. (See Appendix F for a listing of which MPOs have submitted assessments).

ICF reviewed a number of these energy/CO_2 assessments, interviewed MPOs about their views of this recommendation, and evaluated to what extent the recommendation appears to be influencing the transportation planning process.[18] Key findings are as follows:

- MPOs see value in the regional energy/CO_2 assessment process. They suggest potential outcomes such as educating planners and the public about trends in energy use and GHG emissions, and bringing attention to instances where transportation plans will increase energy use relative to status quo trends. At the same time, most MPOs see few circumstances in which these energy/ CO_2 assessments could influence decisions in a significant way.
- The reductions estimated in the regional assessments reflect changes in energy use as a result of regionally-significant transportation projects, but do not reflect all transportation-related energy use in the region.
- Most MPOs expressed some uncertainty about how the regional energy/CO_2 assessments will be used.
- On average, MPOs typically spent 2 to 4 person-weeks conducting the analysis.
- Some MPOs felt that NYSDOT was in a better position to do a substantial amount of the quantitative work.
- Some MPOs felt that the state government should take a larger role promoting actions that would reduce energy use, such as programs to promote fuel efficiency and to increase alternatives to single occupant vehicles for State employees.

- Each of the six MPOs that have conducted assessments showed that energy use and CO_2 emissions would increase over the period of the long-range plan. Five of these MPOs showed that implementation of the long-range plan would help reduce the rate of increase of vehicle energy use and CO_2 emissions.

4.2.2 Approach

For this task, ICF interviewed 12 MPOs throughout New York State; three MPOs (Capitol District TC, Elmira-Chemung TC, and Genesee TC) were interviewed in person, while nine were interviewed over the phone.[19] Exhibit C-2 presents a complete list of MPO staff members who participated in these interviews. The interviews served several purposes:

- To identify methodologies and available data used to estimate energy use and CO_2 emissions.
- To gather information on current and projected staff resources required to complete the energy analysis.
- To hear perspectives on how such energy assessments might eventually influence transportation decisions.
- To identify concerns, challenges, and suggested improvements related to on-going efforts to assess energy use and CO_2 emissions for each metropolitan area.

ICF developed the protocol used for MPO interviews based on these goals. The interview protocol is provided in Appendix G.

4.2.3 Findings

This section summarizes key results from MPO interviews and from a review of energy/CO_2 assessments (a more detailed discussion of the in-person interviews can be found in Appendix H). This section includes a summary of MPO analysis results, MPO reactions to the energy/CO_2 assessment process, a discussion of resource requirements, and MPO comments on how the analysis could influence transportation decision-making.

Direct Vehicle Energy

Direct vehicle energy is defined as the energy consumed by the vehicles using transportation facilities. MPOs generally based their direct vehicle energy assessments on the detailed methodology provided by NYSDOT.[20] These assessments focused primarily on cars and trucks.

All six of the MPOs that conducted an energy analysis evaluated a comparison of build vs. no-build conditions for the end-year of their long-range plan (usually 2025). The “build” scenario assumes that all potential projects and policies are implemented, while the “no-build” scenario assumes that none are implemented. Table 4-2 indicates that five of the six MPOs found that energy use would be reduced as a result of plan implementation.[21]

Table 4-2. Change in Energy Use Resulting from Plan Implementation

Metropolitan region	Change in Energy Use relative to the “no build” scenario
CDTC – Albany	-12.05 percent
GBNRTC – Buffalo	-19.26 percent
PDCTC - Dutchess County	-1.13 percent
NOCTC - Orange County	-0.31 percent
GTC – Rochester	-0.01 percent
SMTC – Syracuse	0.85 percent

Both Albany and Buffalo show that energy use would be reduced substantially if the regional transportation plan were fully implemented. In Albany's case, these energy use reductions (relative to the no build scenario) are derived from fuel efficiency gains along with substantial reductions in VMT. Albany's models assume that the region will not make substantial investments in transportation infrastructure that would accommodate 'urban sprawl.' Rather, their transportation models plan for higher population densities and a lower per capita VMT due to mixed-use development and improved alternative transportation options. With a decreasing per capita VMT, total VMT may decrease despite increases in population. In the case of Buffalo, the analysis did not include VMT data. Consequently, the rationale for energy savings projected in the plan is not readily available.

A summary of key results from the six MPOs that conducted the direct energy analysis are provided in Appendix I.

Indirect Energy Use

The NYSDOT methodology describes indirect energy use as the energy required to construct and maintain transportation facilities. Five MPOs attempted to address indirect energy use. These analyses generally included regionally significant construction projects listed in the Transportation Improvement Program, which spans a 5-year period. In some cases, agencies also included indirect energy use for projects more than five years in the future, though project information was generally sparse for these longer-range construction plans. The results of these analyses are summarized in Table 4-3.

Table 4-3. Estimates of Indirect Energy Use and Change in Direct Energy Use Associated with the Transportation Plan

Metropolitan region	Indirect Energy Use over the Analysis Period (1,000 Btu)[22]
Albany (CDTC)	931,000,000
PDCTC - Dutchess County	233,214,915
Newburgh-Orange (NOCTC)	406,587,600
GTC – Rochester	243,264,000
SMTC – Syracuse	129,348,000

In some cases, indirect energy use estimates were large relative to direct energy use. For example, if GTC's indirect energy estimate is converted to an annual estimate for the 5-year period during which these projects will be constructed, the result is about 48.7 Billion Btu per year. This compares with only about a 9.4 Billion Btu energy reduction per year resulting from the implementation of these projects. In other cases, the direct energy use reductions that would result from the projects and policies proposed in the transportation plan are much larger than energy increases associated with construction of the plan's projects. Albany is an example where this was the case.

In general, the different time frames used for the direct and indirect energy calculations made it difficult to compare these two sources of energy use. Direct energy use was generally calculated on an annual basis at the end point of the long-range plan. In contrast, indirect energy use addressed projects over a shorter and less-defined time period, since projects are typically only well-defined during the most recent years of the plan.

Only Orange County directly addressed the relationship between the direct and indirect energy use, stating:

> *Indirect energy expenditures and carbon emissions in the Build Scenario are considerable, however. This indirect energy and carbon may be recouped in direct energy and carbon saved by reductions in VMT realized in the Build Scenario after 30.2 and 32.5 years, respectively.*[23]

Other regions simply reported direct energy use and indirect energy use, without drawing any connection between these two sources of consumption.

A few MPOs expressed concerns about particular aspects of the indirect energy use/CO_2 assessment process:

- Two MPOs felt that the indirect energy assessment procedure was not as important as the direct energy assessment. These MPOs explained that roughly the same amount of money would be spent on transportation investments regardless of how these expenditures were distributed within each particular planning scenario. They argued that, for this reason, estimates of energy use for construction would be roughly the same. In other words, if an MPO did not spend money to build 2 miles of roadway, they would likely spend that same money to build 30 miles of bikeway or to resurface 30 miles of existing roadway. Each of these cases, they argued, would lead to roughly the same estimated energy consumption.
- One MPO felt that the transit method for indirect energy use included too much detail given the coarse estimates for other aspects of the process. They also felt that the energy embedded in manufacture of transit vehicles probably outweighed the energy required for many of the construction steps listed in the methodology.

Resource Requirements

All six regions conducted the analysis in-house, although Buffalo and Syracuse MPOs hired consultants to conduct supporting model runs. While each of the six regions faced some challenges, most thought that the process could become relatively simple with experience. Table 4-4 provides estimates of the effort required specifically for the energy analysis for each region.

Table 4-4. Resource Requirements for Conducting Analysis

MPO	Time Required (person weeks)
CDTC – Albany	2
GBNRTC – Buffalo	1
PDCTC - Dutchess County	4
NOCTC - Orange County	2.5
GTC – Rochester	6 to 8
SMTC – Syracuse	3 to 4

Effect on Transportation Decisions

At this early stage, MPO representatives were unsure of the utility of the energy assessment in reducing MPO energy and GHG emissions. MPOs that conducted the analysis thought that it could provide useful information to inform planning decisions. For example, several MPOs felt that decisionmakers and some members of the public would object if this analysis demonstrated that a proposed regional transportation plan would increase energy use and GHG emissions relative to the no-build scenario.[24] MPOs also suggested that planners may develop a better understanding of the energy implications of different projects and build these considerations into their thinking. One interviewee pointed out that this process has taken place with criteria pollutant emissions. Despite the capacity of the energy analysis process for raising awareness, most interviewees doubted that estimates of energy use and CO_2 emissions would, by themselves, influence transportation investments. Policies are more likely to be implemented in response to traditional air quality concerns (e.g., smog); in fact, some MPOs felt that members of the public may not equate CO_2 emissions with air quality issues.

Voicing support for the general concept of the energy/CO_2 reduction goals, the Albany region suggested that the energy/CO_2 recommendation gives them more weight in working out policy differences with NYSDOT. Albany interviewees felt that the new recommendation would serve to reinforce the MPOs' own long-term policies.

Most MPOs indicated that, to date, no agencies, stakeholder organizations, or members of the general public commented on the energy analysis except to ask how long it took.

5 MITIGATION ANALYSIS

5.1 Summary

Six transportation strategies were evaluated with regard to potential reductions in state energy use and CO_2[25] emissions, and their overall cost. These strategies address both public and private transit, a number of transportation modes, and different sectors of the state economy. While some strategies have a greater potential to reduce energy use and CO_2 emissions, each is unique in terms of cost, scope, ancillary benefits, political feasibility, and other barriers to implementation.[26]

Table 5-1 shows the potential CO_2 reductions for each strategy in 2010 and 2020, the percent reductions of CO_2 emissions from the New York State transportation sector in those years, and cost of CO_2 reduction over the entire period of the strategy 2007-2020. The reductions and costs were calculated by comparing the impact of implementing the strategies to the business-as-usual scenario in which the strategies were not implemented. Only direct costs to New York State were estimated.

Table 5-1. Potential CO_2 Reductions of Each Strategy

	Reduction in CO_2 Emissions (thousand $MTCO_2$)		Percent Reduction in CO_2 Emissions (%)		Cost per Metric Ton
	2010	2020	2010	2020	
Feebates	264.5 - 364.7	2,256.6 - 2,899.8	0.3 - 0.4	2.2 - 2.8	Low
Freight Modal Shift	59.3	351.3	0.1	0.3	NE
Freight Modal Shift (per percent shift) [a]	41.6	64.4	<0.1	0.1	NE
Commuter Benefits	148.2	257.8	0.2	0.2	NE
Truck Stop Electrification	14.1	103.0	<0.1	0.1	Low
CNG Buses	13.2	51.8	<0.1	<0.1	High
Airport GSE – Electricity	5.9	23.5	<0.1	<0.1	Low
Airport GSE – CNG	1.9	7.5	<0.1	<0.1	Low
Airport GSE – LPG	1.1	4.6	<0.1	<0.1	Low

Note: Percent reductions are with respect to the baseline emission projections for each year
[a] Change in energy use and intensity for each percentage point of freight shifted from truck to rail in the respective year.

Table 5-2 shows the potential reductions in energy use for each strategy in 2010 and 2020, the reduction in energy intensity (transportation energy use per GSP), and the percent reductions of energy use in the New York State transportation sector and energy intensity in those years.

Table 5-2. Potential Energy Reductions of Each Strategy

	Reduction in Energy Use (TBtu)		Reduction in Energy Intensity (Btu/$)		Percent Reduction in Energy Use and Energy Intensity (%)	
	2010	2020	2010	2020	2010	2020
Feebates	3.8 - 5.1	32.1 - 40.9	3.5 - 4.8	22.2 - 28.2	0.3 - 0.4	2.2 - 2.8
Freight Modal Shift	0.8	4.9	0.8	3.3	0.1	0.3
Freight Modal Shift (per percent shift)[a]	0.6	0.9	0.5	0.6	<0.1	0.1
Commuter Benefits	2.1	3.6	1.9	2.5	0.2	0.2
Truck Stop Electrification	0.2	1.4	0.2	1.0	<0.1	0.1
Airport GSE – Electricity	0.1	0.3	<0.1	<0.1	<0.1	<0.1
CNG Buses	b	b	b	b	b	b
Airport GSE – CNG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Airport GSE – LPG	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note: Percent reductions are with respect to the baseline emission projections for each year
[a] Change in energy use and intensity for each percentage point of freight shifted from truck to rail in the respective year.

[b] Switching from diesel to CNG buses actually increases energy use slightly (by about 0.01 percent in 2020) even though it reduces CO_2 emissions.

Based on the results of our analysis, we concluded that four of the six strategies offer significant potential to reduce energy and CO_2 emissions from NY State transportation–two of these with little to no direct cost to NY State. Given the constraints of this study, these strategies have been identified as “promising” options, and they should be examined further to expand on this preliminary analysis of impacts, costs, and feasibility of implementation. These options are summarized below.

Feebates – Of the six strategies evaluated, feebates offered by far the greatest potential to reduce CO_2 emissions and energy use in New York State. A feebate program would involve administering fees or rebates to consumers who purchase new cars and light trucks, based on their fuel economy. The high potential for this strategy is due to its scope, as it would affect all buyers of new passenger vehicles that register in New York State. These results are supported by numerous studies at the national level that show improving fuel economy as one of the most effective ways to reduce CO_2 emissions and fuel use. Establishing a feebate program can also be a low-cost strategy; if administered properly, no net cost to New York State would result. Because this report analyzed only costs to New York State, costs to industry were not assessed; however, the automotive industry would bear costs as consumer preference shifts.

Freight Modal Shift – Increasing rail use for freight transport also shows strong potential to reduce energy use and CO_2 emissions. Although the target for 2010 is just a one percent switch in the way freight is transported, this represented the second highest potential benefits of any strategy. Implementation, however, may present a number of challenges. These obstacles, which are discussed below, should be investigated further before adopting this strategy.

Commuter Benefits – An aggressive program to encourage employers to offer their employees commuter benefits has strong potential for reducing statewide transportation energy use and CO_2 emissions. Such a program would involve State incentives and substantial marketing to increase the percentage of employers offering employer-paid transit benefits and related programs, such as rideshare support and alternative work schedules. In addition to reducing energy use and CO_2 emissions, this strategy would also reduce traffic and local air pollution in urban areas.

Truck Stop Electrification (TSE) – Though the energy and CO_2 benefits of truck stop electrification are significantly less than both feebates and shifting freight modes, adoption of this strategy would provide notable reductions in energy use and CO_2 emissions in New York State. With TSE, truckers either use electricity or electric-powered heating and cooling, instead of idling their trucks to provide these needs. The public cost of implementation is relatively low, particularly with regard to advanced TSE, because companies like IdleAire pay for the cost of installation and recoup their costs by charging truckers for electricity and other services. Furthermore, decreases in local air pollution can be an important secondary benefit.

The remaining three strategies did not appear to hold as much promise for New York State from an energy/GHG perspective. While these strategies may be effective ways to address other environmental problems, such as local air pollution, they had a relatively high cost associated with reducing energy use and/or GHG emissions for reasons described below.

Compressed Natural Gas (CNG) Buses – This strategy involves switching from diesel transit buses to CNG-powered buses. Though some potential to reduce CO_2 emissions exists, energy reductions are low, and the cost of reducing each metric ton of CO_2 is high compared to other strategies. Switching to CNG buses can be an effective strategy to reduce the criteria air pollutants that contribute to the formation of smog, particulate matter, and other local air pollutants. However, this policy option is not considered to be a cost-effective strategy for reducing overall energy use and CO_2 emissions alone.

Airport Ground Support Equipment (GSE) – Airport GSE are vehicles and equipment that service aircraft between take-offs and landings. Switching from diesel- or gasoline-powered equipment to GSE powered by electricity or alternative fuels would reduce energy use and CO_2 emissions, but not by very much. Switching to electricity appears more promising than switching to CNG or LPG. Direct costs to New York State would be low, however, as GSE are usually owned or leased by the airlines.

It is important to note that, although GHG emission reduction potential from this strategy may be relatively low, fuel switching in airport GSE has the added benefit of reducing local air pollution such as smog and particulate matter. Currently the Federal Aviation Administration is administering several voluntary programs aimed at reducing air pollution by airport GSE. These programs promote switching to airport GSE that run on alternative fuels or that use low-emission technology. Programs such as this one reduce both criteria air pollutant emissions as well as CO_2 emissions.

In reviewing these findings, it is important to note that several factors drive our estimates of potential reductions and overall costs for these strategies. Some of these factors have the potential to make any given option more or less attractive as discussed below.

- The potential reductions outlined in this section are based on the specific targets recommended by FHWA and NYS DOT for each strategy at the outset of this study. Goals for some strategies may be more aggressive than others, and thus impact the relative benefits of the strategies. Given additional resources, these targets could be re-assessed to determine how sensitive the results are to changes in the 2010 and 2020 implementation targets.
- Each strategy has its own barriers to implementation – legal issues, lack of infrastructure, reliance on consumer preferences, practicality, etc. – that must be addressed for the strategy to be successful.
- Only direct costs to New York State were assessed in this study. Though a number of policies show a cost of CO_2 reduction of \$0/MTCO_2, costs to citizens and private companies were not estimated. As with all legislation and policies, costs to all affected parties should be examined before final decisions are made.
- A number of strategies offer ancillary benefits, especially with respect to criteria air pollutant emissions. These benefits can be significant, and should be considered.
- Due to data availability and other resource constraints, simplifying assumptions were made for many calculations. While the results of the analysis provide a rough estimate of potential costs and benefits, a more in-depth investigation into the strategies would be necessary to predict the full costs and benefits associated with each strategy.[27]

5.2 Potential Strategies for Transportation Emissions and Energy Reduction

The following section includes a description of each strategy analyzed in Task 3, the implementation targets, factors influencing the potential impacts, costs, and any other related issues. Full references for the resources consulted are provided in Appendix J.

5.2.1 Feebates

Feebate policies encourage consumers to purchase fuel-efficient vehicles. A fee is administered with the purchase of vehicles that emit CO_2 at a higher rate than the threshold determined by New York State. A rebate is given to the consumer if they purchase a vehicle that emits CO_2 at a rate below this threshold level. It is necessary to create a feebate "schedule" to determine this threshold level and the relative magnitude of the fees and rebates. A feebate schedule is structured as a sliding scale, so that more fuel-efficient vehicles earn higher rebates, and vice versa. Fees and rebates are scaled up over time to continue to encourage greater fuel efficiency of new vehicles purchased in New York State. Our analysis assumed that a feebate program in New York State would begin in 2007.

Data

The potential impact of feebates from two studies, CEC and CARB (2002) and CCAP (2003), are compared in this analysis. Estimates from both studies were generated under the assumption of a single schedule that comprises both passenger cars and light duty trucks.

CEC and CARB (2002) estimated the potential impact of feebates for a program in California. The CALCARS model was used for their analysis, which is a behaviorally based vehicle choice, usage, and demand model that predicts vehicle choice for California households. A response from manufacturers was assumed, though limited, since California represents 13 percent of the U.S. vehicle market. The threshold, or pivot point, was set to be roughly equivalent to 21 MPG (at about0.90 lb CO_2 per mile). The amount of the feebate was set at $30,000 per lb C emitted per mile (about $8,200 per lb CO_2 emitted per mile). Under this system, consumers that purchase a new vehicle with a fuel economy of 25 MPG would be given a rebate of about $1,200. Consumers that purchase a new vehicle with a fuel economy of 18 MPG would pay a fee of about $1,250. Under these assumptions, fuel efficiency of new passenger cars in California increased 4.4 percent from the baseline by 2010 (29.8 to 31.1 MPG), and 9.0 percent by 2020 (30.1 to 32.8 MPG). The fuel efficiency of new light trucks in California increased 5.4 percent from the baseline by 2010 (20.4 to 21.5 MPG), and 9.2 percent by 2020 (20.7 to 22.6 MPG). These percentage increases were applied to projections of MPG for new vehicles in New York.

CCAP (2003) estimated the potential impact of feebates from a program in New York State, based on the study by CEC and CARB (2002). As this analysis was specific to New York State, estimates of emission reductions from this study may be more appropriate. The threshold, or pivot point, was set at 0.80 lb CO_2 per mile, which is roughly equivalent to 24.6 MPG for gasoline vehicles. The amount of the feebate was set at $10,000 per lb CO_2 per mile. Under this system, consumers that purchase a new vehicle with a fuel economy of 28.1 MPG (which emits about 0.70 lb CO_2 per mile), would be given a rebate of $1,000. Consumers that purchase a new vehicle with a fuel economy of 21.8 MPG (which emits about 0.90 lb CO_2 per mile), would pay a fee of $1,000. Using these assumptions, emissions from new passenger cars were predicted to be reduced by 0.03 lb CO_2/mile from the baseline in 2010, and by 0.06 lb CO_2/mile in 2020. Emissions from new light trucks were predicted to be reduced by 0.05 lb CO_2/mile from the baseline in 2010, and by 0.08 lb CO_2/mile in 2020.

Miles traveled (VMT) by vehicles manufactured from 2007 to 2020 was estimated using VMT projections from NYSDOT (2004), the proportion of VMT in the U.S. from passenger cars and light trucks (FHWA 2003), and the proportion of VMT driven by each model year (EPA 2000). As total annual VMT by vehicles registered in New York State was not available, VMT by all vehicles traveling within New York State was assumed to be roughly equivalent. Projections of average fuel economy (MPG) for passenger cars and light trucks in the U.S. were obtained from BEA and BTS (2004).

It was assumed the feebate program would be structured to generate revenues equivalent to the cost of administrating the program. Under this assumption, there is no net cost to New York State.

Methods

The magnitude of the feebate in this analysis ranges from $8,000-10,000 per lb CO_2. At these rates, for example, a new car with a fuel economy three miles per gallon (MPG) higher than the New York State average will receive a rebate of $1,000. Two approximations of the potential impact of a program were used, one from the California Energy Commission and the California Air Resources Board (Method 1), and the other from the Center for Clean Air Policy (Method 2). For each method, VMT for both passenger cars and light trucks manufactured from 2007 to 2020 was used, derived from the sources mentioned above. The steps taken in each method are described briefly below.

Method 1 – Using Increases in MPG from CEC and CARB

This method uses the projected increases in MPG (in percent) for new vehicles in California to estimate to potential increases in MPG for new vehicles in NY State. As the MPG for new vehicles in NY State was not known, it was assumed to be equivalent to the national average.

Percentage increases in MPG for 2010 and 2020 were obtained from CEC and CARB (2002). As these increases were for a potential program in California beginning in 2003, they were assumed to be realized 4 years later in NY State, with a potential program beginning in 2007. Estimates of increases in MPG were interpolated to obtain values for intervening years. These reductions were applied to projected MPG for new vehicles in NY to determine the reductions in gallons of fuel consumed per mile for each model year. These reductions were then applied to VMT driven by each model year from 2007-2020, to obtain fuel savings in each year. These steps were performed separately for passenger cars and light trucks, as data specific to each category were used.

Energy reductions in each year were then converted to million Btu (mmBtu) using the standard heat rate for motor gasoline from EIA (2003). Carbon emission reductions were calculated by applying the carbon emission factor for motor gasoline from EPA (2004) by the annual fuel savings.

Method 2 – Using Decreases in CO_2 Emission Rates from CCAP

The feebate program described in CCAP (2003) was assumed to begin in 2005. Therefore, it was necessary to apply the projected reductions two years later, as explained above. Estimates of CO_2 reductions for new vehicles were interpolated to obtain values for intervening years. These reductions were then applied to VMT driven by each model year from 2007-2020. These steps were performed separately for passenger cars and light trucks, as data specific to each category was used.

Energy reductions in each year were then estimated by dividing CO_2 reductions by the carbon emission factor for motor gasoline from EPA (2004).

Results and Discussion

As shown in Table 5-1 and Table 5-2, implementing a feebate program could reduce New York's transportation-related CO_2 emissions and energy use by 2.8 percent in 2020. These results were derived using the methodology described above; however, the true effects of feebates are difficult to predict, as the success of the program depends heavily on individual choices of consumers and manufacturers. An array of factors will influence these decisions, including the price elasticity of demand for different classes of new vehicles, how aggressively the feebate system is structured, similar programs in other states (which are seen as critical in encouraging manufacturers to produce more fuel-efficient vehicles), technological changes, and other factors.

Ways in which the program is administered can also affect the impact of a feebate program, including how and when the feebates are assessed, and separate schemes for passenger cars and light-duty trucks. A successful program should administer the feebate at the point of registration rather than sale, to prevent consumers from crossing state lines to take advantage of the system. In addition, it is recommended that a single feebate schedule be structured for both passenger cars and light-duty trucks, as both are predominantly used for passenger travel.

The legality of feebates may be the greatest potential hurdle to implementation, as the U.S. courts have ruled that only the federal government has the authority to set fuel economy standards. While a feebate scheme based on CO_2/mile does not explicitly set fuel economy standards, gallons consumed and CO_2 emissions are inextricably linked. Therefore, there may be court challenges to a feebate proposal. Several years ago, one state's feebate legislation was challenged and ruled illegal. Therefore, the feebate system should be carefully designed to avoid potential legal barriers.

The societal costs of implementing a feebate scheme depend predominantly on how policymakers structure the program. One recommendation is that the program could be designed to be revenue neutral, so that the revenue generated by fees covers the costs of rebates and any administrative costs. Structuring it in this way will reduce resistance to the program, as it will not be seen as a revenue-generating tax.

5.2.2 Freight Modal Shift

Freight is typically transported by truck, rail, waterborne vessel, aircraft, or combinations of these modes. Some modes are more energy-intensive than others, so shifting modes of transportation can potentially reduce energy use and CO_2 emissions. Rail requires only about 15 to 25 percent of the energy used by trucks to ship freight equivalent distances; therefore, switching freight shipment from truck to rail will often reduce transportation-related CO_2 emissions. Shipping goods by waterborne transport instead of truck can similarly reduce shipping energy requirements.

This analysis investigates the advantages of increasing the percentage of ton-miles shipped by rail in New York from 15 percent to 16 percent in 2010, and to 20 percent in 2020. This analysis also presents CO_2 and energy savings per percentage point of freight shifted to rail. Additionally, this section provides a qualitative discussion on benefits of switching transport of goods from trucks to short sea shipping.

Data

Ton-miles data for 1997 (the latest year available) were obtained from Census (1999). Projected growth rates in shipping were derived from FHWA (2004), also used in Task 2. Projected ton-miles were estimated by applying these growth rates to ton-miles in 1997.

Values for 1990-2001 travel energy intensity (Btu/ton-mile) were obtained from Ang-Olson (2003) for rail and from BTS (2004) for trucks. Values for future years were projected based on average historical annual change. Energy use by each mode was estimated by multiplying ton-miles by travel energy intensity.

The travel energy intensity for truck on flat car (TOFC) type of rail was used instead of the national average for rail intensity. These intensity values were chosen because TOFC rail is most likely to carry the kind of goods that might be able to be switched to truck transport.

Methods

Diesel was assumed to be the fuel of choice for shipping freight, whether by rail or trucks. The emission factor used in Task 1 for the amount of CO_2 emitted per Btu was applied to the energy estimates to calculate CO_2 emissions.

To calculate energy and CO_2 emissions under the project scenario, the total ton-miles shipped was assumed to equal the baseline values. The proportion of shipping by rail was assumed to increase linearly from 15 percent in 2006 to 16 percent in 2010, and 20 percent in 2020, with the remainder shipped by trucks.

Results and Discussion

Table 5-1 and Table 5-2 present the results of the above analysis. As calculated by the methods described above, successful implementation of a freight modal shift policy could reduce New York's transportation-related CO_2 emissions and energy use by 0.3 percent by 2020.

A number of factors affect whether freight can be shifted from trucks to rail, including distance, availability of local infrastructure (e.g., port terminals, rail/truck intermodal facilities, commercial airports), the size of the shipments, time sensitivity, the durability of freight, and relative costs. Thus, one mode of shipping is not a perfect substitute for another, depending on situational characteristics. Nevertheless, some goods can be shipped by more than one type of mode, and some barriers to modal shift (such as relative cost and lack of infrastructure) can be overcome with governmental assistance.

In order to fully evaluate the potential impacts of shifting from truck to rail, the state should examine a couple of issues beyond the scope of this study. Differences in circuity between the routes taken by trucks versus those taken by trains should be considered. For example, depending on the layout of the rail and road infrastructures, one mode may take a more direct route between two destination points, leading to more or less efficient transport. In addition, the increased use of drayage trucks (i.e. trucks used to transport goods to and from rail terminals) due to a modal shift from truck to rail freight could reduce the benefits of rail freight. Finally, the state should give some consideration to how this strategy would be implemented, whether via mandate, financial incentives, etc. Policymakers should remember that businesses are drawn to the most cost-effective mode of transportation that fulfills their time-sensitivity needs, regardless of the GHG or air quality impact of those modes; for this reason, businesses may be reluctant to shift to a different mode of shipping without clear legal or financial incentives.

Costs of switching from trucks to rail are dependent on a wide variety of factors, including the available infrastructure, whether long- or short-haul freight is shifted, and regulations or incentives used to encourage modal shift. Cost was not quantified for this study.

Short Sea Shipping

Short sea shipping – the waterborne transport of goods between ports along a common coast – has recently begun to gain favor as a potential alternative for some land-based movement of goods. This transport mode is especially attractive in parts of the Northeast, including New York and particularly around the I-95 corridor, as a way to potentially reduce traffic congestion. Many marine ports and intermodal facilities in the Northeast are located in high-traffic areas. Traffic congestion negatively impacts the reliability and predictability of truck shipments, and can cause missed or delayed pick-up or delivery times. Additionally, congestion has a variety of negative societal impacts.

Traffic along many shipment routes is likely to increase, but there is limited opportunity for expansion of highways in many corridors. While rail may be a viable alternative to some movement of goods, many freight rail systems are already at or near capacity, and expansion of rail systems is associated with high costs. Moving goods via waterborne transport will help mitigate traffic congestion, providing helping to avoid congestion-related costs and provide many ancillary societal benefits.

More significant to this report, shifting freight movement to short sea shipping may also provide energy and GHG benefits. In general, watercraft require significantly less energy to ship a given amount of freight than trucks, resulting in energy savings and corresponding GHG reductions.

Sufficient resources were not available to quantify the energy and GHG savings associated with this type of modal shift. Potential benefits depend on a number of variables, including the types of commodities that would be shifted, the length of the shipment, and the length of truck drayage operations necessary to access port facilities. Freight that would be a good candidate for this type of modal shift includes shipments between cities along a common coast that are not time-sensitive. Freight that is moved a short distance, or to/from locations that are not on a common coast, cannot reasonably be transported by this mode. Bulk commodities with a low value-to-weight ratio are generally best suited for waterborne transport, although short sea shipping of containers has also proven successful.

In order to successfully shift from truck to short sea shipping, an adequate infrastructure must be in place. The current shipping infrastructure along the East Coast may not be sufficient to accommodate significant increases in short sea shipping, and may therefore require expansion. There is a high-cost associated with developing this infrastructure, which introduces a financial hurdle to this mitigation option. Additional hurdles include: potential increases in “door-to-door” delivery times since goods will need to be transported to and from ports via trucks; the increased complexity of maritime facilities compared with trucking depots, which can add to costs further; and state and federal taxes and fees on shipped goods, which could add to overall costs as well.

5.2.3 Truck Stop Electrification

Long-haul truckers often run their engines while they are parked (this practice is called “idling”) in order to heat or cool the cab, run electrical appliances, or keep the engine warm. It is estimated that heavy-duty trucks idle 6-8 hours each day on average, usually during the night. Idling is extremely inefficient, and results in increased energy consumption, CO_2 emissions, and criteria pollutant emissions.

Truck stop electrification (TSE) is a technology through which truckers can use electricity rather than their engines to produce the power they need while stopped. Two types of truck stop electrification exist. “Shore power” TSE allows a truck to connect to an external electrical power supply. Trucks need to be equipped with an on-board electric-powered HVAC system to take advantage of external power, and truck stops must be retrofitted to provide this power. This system is sometimes referred to as shore power, reflecting its common use in marine applications. A similar technology referred to as advanced truck stop electrification (ATE) provides truckers direct heating, cooling, electricity, and other amenities from an off-board source.

This analysis assumes that a statewide program to provide truck stops in New York State with TSE will begin in 2007. It is assumed that 30 percent of truck stop spaces in New York State will offer TSE or ATE by 2010, and 100 percent of truck stop spaces in New York State will offer TSE or ATE by 2020. The energy savings and environmental benefits of TSE and ATE are about the same, as both technologies use electricity to generate heating, cooling, and power.

Data

This analysis assumes that 0.85 gallons of diesel fuel are consumed per hour idling, which is a U.S. average based on survey data (Lutsey 2003). Average daily idling time per truck stop space was assumed to be 5.9 hours (Lutsey 2003). Average electricity required per hour was assumed to be 4.3 kW (Stodolsky 2000).

The amount of commercial truck parking spaces was obtained from FHWA (2002). In 2000, In New York State there were 1,257 truck stop spaces available at public facilities and 6,970 truck stop spaces available at private facilities. Utilization of these stops was also obtained from FHWA (2002).

A usage rate of 29.1 percent for truck stops with TSE was assumed for 2007, which is based on the average facility utilization in the DeWitt service area, an advanced TSE pilot program in New York State (Perrot et al, 2003). This rate was assumed to increase (linearly) to 100 percent by 2020.

The average cost of installing “shore power” at truck stops was assumed to be $2,100, the average of a range estimated by Baron et al (1998).

IdleAire installs their ATE system at truck stops free of charge, in exchange for the right to charge truckers $1.50 per hour for use of this service (or $1.25 for registered fleets).[28] Moreover, IdleAire shares a portion of this revenue with the truck stop owner. For the purposes of this study, the cost to New York State was assumed to be zero.

Methods

To estimate the potential energy and CO_2 emissions reductions for this strategy, estimated reductions due to decreased idling were calculated; additional electric energy used, and CO_2 emissions associated with electricity consumption were subtracted in order to estimate net savings.

Diesel fuel savings were calculated using the following formula, then converted to MMBtu using the standard heat rate for diesel fuel from EIA (2003):

*Diesel fuel reduced (gal) = Avg. number of spaces used per day * Usage rate (percentage of time the space is used) * Percentage of truck stops with shore power (percent) * Rate of fuel usage (gal/hr) * Yearly idling time per space (hrs)*

Electricity consumption (kWh) was calculated using the following formula, then converted to MMBtu using the average input heat rate for the Northeast Power Coordinating Council (NPCC), the region of the U.S. electricity grid in which New York State is located (EPA 2003):

*Electricity used (kWh) = Avg. number of spaces used per day * Usage rate (percent) * Percentage of truck stops with shore power (percent) * Electricity demand (kW) * Yearly usage time per space (hrs)*

Carbon emission reductions from decreased use of diesel fuel were calculated by applying the carbon emission factor for diesel fuel from EPA (2004) to the energy reduced in the previous step. Carbon emissions from increased electricity consumption were calculated by applying the average CO_2 emission rate from electricity generation in the NPCC (EPA 2003) to the energy consumed in the previous step.

The costs estimated are those associated with installing and maintaining shore power at public truck facilities only. An installation cost of $2,100 was assumed, as mentioned previously. An annual maintenance cost of 10 percent of the installation cost was assumed for each equipped truck stop. Revenue for providing shore power was calculated based on an assumed charge to truckers of $0.25/hr plus the cost of electricity.[29] Total cost to New York State was estimated for each year from 2007-2020, and then discounted to 2007 using a discount rate of 5 percent. As noted previously, only direct costs to the state are considered in this analysis. To the extent that these or any of the other strategies discussed in this section are funded in whole or in part through Congestion Mitigation Air Quality or other funds, one could argue that the value of that funding should be included as a cost since those funds could be used elsewhere to improve air quality. Accounting for these costs is not possible within the resources available for this report.

Results and Discussion

As shown in Table 5-1 and Table 5-2, implementation of a TSE policy could reduce New York's transportation-related CO_2 emissions and energy use by up to 0.1 percent by 2020.

The potential impact of this strategy depends primarily on two factors: 1) the rate at which truck stops in New York State are equipped, and 2) the rate at which truckers use these services. The first issue is the major challenge in having a successful program. Though there are pilot programs for both technologies underway in New York State,[30] most truck stops are not currently equipped to offer these services. Moreover, the majority of truck stop facilities in New York State are private, and thus incentives or legislation would be needed to encourage them to offer these services. The rate at which truckers use these services may be much slower for shore-power TSE than ATE. To be able to take advantage of shore power TSE, cabs must be equipped with an on-board electric-powered HVAC system, which can be a major up-front expense to the trucking company (costs can range from $1,200 for a small cab heater to over $7,000 for an auxiliary power unit with additional capabilities). For ATE, on the other hand, the only upfront cost is a $10 window adapter.

Based on a preliminary analysis of the IdleAire pilot program in New York State, ATE may be a more viable strategy than TSE in the long run. IdleAire installs the system at truck stops for free, in exchange for charging an hourly service fee to truckers. Truck stops may even be able to generate revenue, as IdleAire shares a portion of the fee with truck stops. Trucks can easily and cheaply be retrofitted to receive this service. Therefore, the rate at which this technology is adopted would most likely be faster than shore-power TSE. The cost of this service to truckers, $1.25 to $1.50 per hour, can be almost entirely offset by fuel savings from reduced idling.

The estimated cost of reducing CO_2 emissions, $1.29/MTCO$_2$, only takes into account the costs to New York State, which includes the costs of installing and maintaining the technology at truck stops. So while the energy and emission reductions are estimated for both public and private facilities, only public costs are provided. Costs and savings to truckers were not evaluated, and also should be taken into account when considering this strategy.

5.2.4 Commuter Benefits

Employers can offer their employees financial benefits for commuting by means other than driving, often referred to as “commuter benefits” or “Commuter Choice benefits.” For instance, under the Transitchek program, an employer can directly pay for the cost of transit passes for employees, allow employees to pay for transit or vanpool expenses themselves using pre-tax income, or pay a portion of the cost and allow employees to pay for the remainder with pre-tax income. By offering these benefits, employers provide an economic incentive for their employees to reduce commuting alone in their cars. When combined with other employer-based transportation strategies, such as preferential parking for carpools and vanpools, ride matching services, and provision of transit information, these programs have potential to significantly reduce single occupant vehicle commuting.

This study assesses the potential of a major marketing initiative and employer-focused financial incentives (such as a state tax credit for employer-provided transit passes) to increase employee participation in the Transitchek program and other alternatives to driving alone to work. This initiative is designed to significantly increase the share of employers that offer Transitcheck and other worksite commuting programs, such as rideshare support strategies, telecommuting, and compressed work hours programs.

Data

According to a 2003/2004 TransitChek survey of commuters working in the New York City metro area, approximately 28 percent of employees say that their employer offers a transit benefit. This strategy would aim to significantly increase the share of employees with access to employer-provided transit benefits and other commuting programs. Research indicates that offering employees a financial incentive to use transit results in a greater share of employees using transit.

Methods

The EPA COMMUTER Model was used to analyze the implications of the Commuter Choice marketing program. For the analysis, we used assumptions consistent with those used in the “Commuter Choice Emission Control Strategy Business Plan” (September 2002, Prepared for AKRF, Inc. for NYSDOT), but expanded the range of the program beyond the New York City MSA. The analysis assumes that the program will focus on six areas within New York State: New York City, Long Island, Mid-Hudson South, Buffalo, Rochester, and the Greater Albany region. For each thee six metro areas, the strategy assumes that the share of employees with access to a $2 per day (i.e., $40 per month) transit benefit will increase by 10 percent (e.g., from 28 to 38 percent in New York) by 2010 and by 20 percent by 2020.

The analysis also assumes that employers will increase offerings of other commuting programs and alternative work arrangements. It assumes that support for alternative modes (vanpool, carpool, bicycle, walk) will increase from 15 to 40 percent of the workforce, and offerings of alternative work schedules (flextime, compressed work weeks, staggered work hours, telecommuting) will increase from 25 to 50 percent of the workforce.

The COMMUTER Model was used to analyze the reduction in VMT in each region with this strategy. The COMMUTER Model uses data on starting regional mode shares in order to assess likely changes in overall commute mode shares. The VMT reduction was then used to calculate a reduction in carbon emissions. To simplify the analysis, it was assumed that vehicle trips reduced would have been made by gasoline passenger cars. The average U.S. fuel economy (MPG) for these vehicles was used to estimate gallons saved, and the standard heat rate for motor gasoline from EIA (2003) was used to estimate energy reductions. Carbon emission reductions were calculated by applying the carbon emission factor for motor gasoline from EPA (2004) by the energy reductions. We also assumed that the existing transit infrastructure could absorb the new passengers; therefore, there would not be increased fuel consumption and costs related to running additional bus or transit rail routes or increased frequency of service.

Results and Discussion

As shown in Table 5-1 and Table 5-2, implementing a commuter benefits program could reduce New York's transportation-related CO_2 emissions and energy use by 0.2 percent by 2020.

The effectiveness of the Commuter Choice strategy depends on two key factors: (1) employer participation – how many new employers will offer a commuter benefit program in response to the marketing and incentive program; and (2) employee response – what will be the reaction of employees to these programs in terms of changes in travel behavior.

Limited experience with these programs has shown that employers are not always interested in implementing these programs due to a variety of concerns, from the cost of the program, to administrative hassles, payroll issues, and equity concerns. Employers most likely to adopt commuter benefits programs are those who are most likely to see the program as a valuable benefit for their employees. These employers generally are located in areas with good transit services, employ a substantial number of existing transit riders, and/or have parking problems. An employer tax credit for implementing Commuter Choice options in Maryland has shown very limited impacts, with few employers taking advantage of these financial incentives. However, staff from the Maryland Transit Administration indicate that the program's success has been limited due to lack of marketing for the program, and that with sufficient marketing, such a program could be very effective in generating more employer interest.

Once an employer offers a transit benefit (or other commuter support programs), there is substantial evidence that these programs do affect employee travel behavior. Although a large portion of employees who accept transit benefits are those who already commuted by transit, recent surveys in several cities nationwide indicate that that many employees receiving transit benefits increased their transit use. These surveys also indicate that most new transit riders previously commuted in single occupant vehicle.

Under this type of program, the costs are borne by New York State (in terms of reduced corporate income taxes associated with an employer tax credit) and individual employers (in terms of costs to purchase transit vouchers). Costs depend on the number of participating employees, their transit/vanpool costs, and administrative costs. One factor that should be considered is that companies already offering commuter benefits can take advantage of a tax credit, though this will not contribute to any increase in transit/vanpool use. To encourage employers to offer commuter benefits without the need for continual state funding, start-up incentives could be offered.

5.2.5 Compressed Natural Gas (CNG) Buses

There are a number of alternative fuel options for transit buses, which have traditionally run on diesel or gasoline. Transit agencies are increasingly opting to purchase alternative fuel buses for their fleets in an attempt to reduce smog, soot, and air pollution. Buses running on alternative fuels often produce fewer CO_2 emissions as well. Alternative fuel options for transit buses currently include methanol, compressed natural gas (CNG), liquefied petroleum gas (LPG), and electricity. However, the majority of alternative fuel transit buses run on CNG. In general, transit agencies are more likely to purchase new buses that are designed to run on alternative fuels than to retrofit existing vehicles.

This analysis assumed that by 2010, 25 percent of vehicle miles traveled (VMT) by transit buses in New York will be from CNG-powered buses, and by 2020, 50 percent of transit bus VMT will be from CNG-powered buses.

Data

Historical VMT by transit buses for New York State was obtained from the National Transit Database (FTA 2004). Historical and projected passenger miles traveled by transit bus were obtained from NYSDOT (2004). The projected rate of increase for passenger miles traveled was used to estimate future VMT for transit buses.

Projected fuel economy of diesel and CNG buses was obtained from Browning (2003). Energy consumption was calculated by dividing the VMT by fuel economy. The resulting fuel consumption quantities[31] were then converted to Btu based on the heat content of each fuel (EIA (2003) and Browning (2003)). CO_2 emissions were then calculated based on the carbon content of each fuel.

Data used to estimate costs was obtained from FTA (2004), NYSERDA (2002), Browning (2004), DOE (2004a) and DOE (2004b). FTA (2004) provided information on the number of vehicles in New York's bus fleets. Browning (2004) provided an estimate on the average life span of transit buses, and DOE (2004a) provided estimates on current costs of buses. Projected prices for diesel and natural gas were obtained from NYSERDA (2002), while current prices for diesel and compressed natural gas were taken from DOE (2004b).

Methods

Baseline values were calculated assuming 85 percent of all transit bus mileage was traveled by diesel-powered buses, and 15 percent was traveled by CNG-powered buses. The project scenario values were calculated under the assumption that 25 percent of transit mileage was traveled by CNG-powered buses in 2010 and 50 percent in 2020, with the remainder traveled by diesel-powered buses. Emissions and energy values for intermediate years were calculated assuming a constant increase in VMT by CNG buses.

For each type of bus (diesel or CNG), energy use (in Btu) was calculated by dividing the VMT by the projected fuel economy to obtain fuel consumption in diesel gallon equivalent, and then multiplying by the energy content of each fuel. Energy reductions were then calculated by subtracting energy use under the project scenario from energy use under the baseline scenario.

Emissions for each type of bus were calculated by multiplying the consumption of each type of fuel by the carbon content and oxidation factor for each respective fuel. Emission reductions were then calculated by subtracting the emissions generated under the project scenario from the emissions generated under the baseline scenario.

Cost estimates for this strategy take into account the difference in price for CNG buses (versus diesel buses) and differences in fuel cost over the lifetime of the project.

The future size of the bus fleet was estimated by multiplying projected VMT by the average VMT per bus for both diesel and CNG buses. Average annual VMT per bus was calculated by dividing the 2002 total VMT by the number of buses in the fleet. The number of CNG buses purchased under the project scenario to replace diesel buses was estimated taking into account the project targets and bus lifespan (assumed to be 12 years). This value was then multiplied by $50,000, the approximate difference in price between diesel and CNG buses.

Total fuel cost was estimated by multiplying the price of fuel by the projected quantity of fuel consumption for each type of fuel.

Results and Discussion

As shown in Table 5-1 and Table 5-2, a shift to CNG buses could reduce New York's transportation-related CO_2 emissions by less than 0.1 percent by 2020. Energy consumption would actually increase slightly (about than 0.1 percent).

The savings in CO_2 emissions are compared to a baseline assuming diesel-powered buses account for 85 percent of VMT, and CNG-powered buses account for the remainder. This baseline is derived from 2002 statistics on transit bus fuel consumption, as reported by NYSDOT (2004). New York City is currently is greening its bus fleet under its Clean Fuel Bus Program; however, this program is expected to have minimal effect on the baseline. The Clean Fuel Bus Program focuses mainly on switching to “clean” diesel for all of its diesel-powered buses; while additional CNG and hybrid buses are to be added to the fleet as well, the relative number of such buses is small compared to the overall fleet size.

The potential impacts of this strategy were calculated assuming all transit buses in New York would run on either CNG or diesel, and that the current fuel mix would remain constant under a baseline scenario. In fact, about 1 percent of New York’s bus fleet currently run on other fuels, including methanol, electricity, and gasoline. However, the simplifying assumption adopted for this study is unlikely to significantly change the results. This analysis did not consider factors such as additional financial incentives or legislation (such as changes in fuel prices, subsidies, taxes) that might make certain fuels more or less attractive in the future.

Although fuel savings were significant over the lifetime of the project, they were outweighed by the capital cost of CNG buses. Under the project scenario targets, about 3,200 CNG buses must be purchased in lieu of diesel buses, at an additional cost of approximately $50,000 each. However, as technology advances, it is likely that the relative prices of these two types of buses may change, thus impacting the costs. It was assumed that the existing CNG refueling stations will be sufficient for the additional buses through 2020.

Diesel-electric hybrid buses are expected to play an increasingly significant role in transit bus fleets; however, in the short term, CNG buses are the most prevalent alternative to traditional diesel buses. In contrast to CNG buses, diesel-electric hybrids do not need additional infrastructure development. Additionally, the CO_2 reduction is greater for diesel-hybrid buses than for CNG buses.

5.2.6 Airport Ground Support Equipment (GSE)

Airport ground support equipment (GSE) consist of a variety vehicles and equipment that service aircraft between take-offs and landings. Common examples of airport GSE are baggage tractors and belt loaders, which account for over one-third of all airport GSE in the United States. As demand for air travel continues to grow, it is increasingly important to examine emissions and energy use from GSE. Though most types of GSE can run on multiple fuel types – including gasoline, diesel, CNG, LPG, and electric – the large majority (over 80 percent) are still powered by diesel or gasoline. GSE can either be manufactured to be powered by alternative fuels such as CNG, LPG, or electricity, or can be retrofitted to run on these fuels.

Potential CO_2 and energy reductions were assessed for various programs in which gasoline and diesel powered GSE are replaced with CNG, LPG, or electric GSE in New York State, beginning in 2007. It was assumed that 30 percent of the diesel and gasoline-powered equipment at New York State airports will be replaced or converted by 2010, and 100 percent by 2020. Three scenarios were analyzed: 1) replacing diesel and gasoline GSE with CNG-powered equipment, 2) replacing diesel and gasoline GSE with LPG-powered equipment, and 3) replacing diesel and gasoline GSE with electric-powered equipment.

Data

Energy and CO_2 reductions were estimated for a wide range of GSE for which population data, usage rates, and CO_2 emission rates were available. These equipment include air start units, aircraft pushback tractors, baggage tugs, belt loaders, bobtails, cargo loaders, carts, conditioned air units, deicers, forklifts, fuel trucks, ground power units, lavatory carts, lavatory trucks, lifts, maintenance trucks, service trucks, and water trucks.

Population of airport GSE in New York State was estimated using a methodology developed by EPA (1999). This study found that the amount of GSE is often proportional to the number of landings and takeoffs at each airport. Using data from DOT (1999), it was determined that NY accounts for approximately 4.4 percent of the departures in the U.S. This value was applied to the U.S. population data for each equipment and fuel type from EPA (1999) to estimate the amount of GSE in New York State. These results yielded about 2,000 GSE, of which approximately 84 percent were gasoline or diesel.

Average annual operating hours for each type of GSE were obtained from EPA (1999). CO_2 rates (in grams CO_2 per operating hour) for all diesel-, gasoline-, CNG-, and LPG-powered equipment were also obtained from EPA (1999). These CO_2 rates were calculated using load factors, rated horsepower, brake-specific fuel consumption, and CO_2/gal rates. Though emission rates for each type of electric-powered vehicle were not provided, they were estimated from the average potential CO_2 reduction attained by replacing diesel equipment with electric-powered equipment. CO_2 rates for a few types of GSE were not provided, and were not included in this analysis.

Methods

The population of each type of diesel and gasoline equipment was reduced to 70 percent of 2007 levels by 2010 and then phased out by 2020. For each scenario, alternative fuel-powered GSE replaced this equipment at a 1:1 ratio.

Population, operating hours, and CO_2 per hour were used to estimate emissions of each category and fuel type of GSE. Energy reductions were determined by applying carbon per unit of energy from EPA (2003) and EPA (2004) to CO_2 reduction estimates.

Results and Discussion

As shown in Table 5-1 and Table 5-2, a shift to alternative fuel GSE equipment could reduce New York's transportation-related CO_2 emissions and energy use by less than 0.1 percent by 2020.

Though a number of assumptions affect the potential reductions for a fuel-switching program for airport GSE, the two most significant are the total number of each type of GSE in New York State, and options for replacing or converting each type. GSE population was not known, and was estimated using the number of landings and take-offs at NY airports. While this is an accepted methodology for estimating the number of GSE at airports, surveys could be used to determine the population and fuel types of GSE currently in use. Furthermore, although each scenario assumes that all diesel and gas equipment were replaced with equipment powered by one alternative fuel type, in reality, a combination of alternative fuels should be used. Different types of GSE operate better or have lower emissions with different fuels, depending on their function, operating schedule, expected lifetime, and other factors.

The ancillary benefits to this strategy can be significant, and should be considered. Using alternative fuels results in lower emissions of local air pollutants such as HC, CO, NO_x, and PM than vehicles that run on gasoline or diesel. Fuel-switching in airport GSE is one of the strategies employed in FAA's Voluntary Airport Low Emissions (VALE) Program.

No direct cost to New York State was estimated, as the GSE are typically owned by airlines or leased by airlines from private companies. However, cost is an important consideration for purchasing or converting to alternative-fuel GSE. Capital costs for electric-powered equipment can often be much higher than that for other fuels, though this can often be offset by lower fuel costs over the lifetime of the equipment. Diesel-fueled GSE are often the least expensive of fossil fuel powered GSE. Gasoline and LPG-powered equipment often have comparable costs, while CNG is often more expensive.

6 APPENDICES

There are several appendices included at the end of this report. Each of the attached appendices is briefly described below:

Appendix A. Baseline Estimation Methodology. Provides a detailed description of the methods employed to estimate state- and MPO-level estimate for gross economic product, energy use, CO_2 emissions, energy intensity, and CO_2 intensity.

Appendix B. Transportation Energy Use and CO2 Emissions, by Metropolitan Region. Details the energy consumption, energy intensity, CO_2 emissions, and CO_2 intensity for each metropolitan region. Provides these estimates for 1990, 2001, 2010, and 2020.

Appendix C. State and Regional Contacts. Lists names of contacts who provided data used in the MPO analysis.

Appendix D. Methodology for Developing MPO Data Table. Describes the methodology employed to develop estimates for each of the parameters listed in Appendix E.

Appendix E. MPO Data Table. Details the energy consumption, energy intensity, CO_2 emissions, and CO_2 intensity for each metropolitan region, by mode of travel. Provides these estimates for 1990, 2001, 2010, and 2020.

Appendix F. Status of Energy Analyses by New York MPOs. Indicates the status of energy analyses by each MPO.

Appendix G. Interview Protocol. Describes the interview protocol used during the MPO interviews. Includes the specific questions asked of each MPO to ensure that sufficient information was provided by all MPOs.

Appendix H. Memo Summarizing In-Person Interviews. Memo originally submitted June 10, 2004, to FHWA. Summarizes the findings of the in-person interviews.

Appendix I. Summary of MPO Self-Reported Energy Data. Summarizes the projected travel activity and energy use under build and no-build scenarios, as reported by the MPOs themselves. All six MPOs that completed an energy assessment are represented.

Appendix J. Mitigation Analysis References. Provides references for the sources used to assess the various mitigation options.

Appendix A. BASELINE ESTIMATION METHODOLOGY

Statewide Energy and Emissions Estimates – All Sectors and Transportation Sector

Although GHG inventories often cover six different gases and dozens of individual source categories, for this project we limited our scope to emissions of CO_2 from fossil fuel consumption. These emissions were calculated by sector and by fuel. For the “all-sector” estimate the sectors include residential, commercial, industrial, transportation, and electricity generation. The “transportation sector” estimate includes transportation, plus the subset of electricity generation where the end-use is transportation (electric rail). Fossil fuels include coal, natural gas, distillate fuel, residual fuel, kerosene, LPG, jet fuel, and motor gasoline.

To calculate emissions of CO_2 from fossil fuel consumption for 1990-2000, we used the State Inventory Tool (SIT), and for 2001-2020, we used the State Inventory Projection Tool (SIPT). Both the SIT and SIPT were developed for the U.S. EPA by ICF Consulting. These tools automate the methodology presented in the Environmental Protection Agency’s *Emissions Inventory Improvement Program’s (EIIP) State Guidance for Estimating Greenhouse Gas Emissions*. These methods, in turn, are based on the methodologies approved by the U.S. EPA and the International Panel on Climate Change (IPCC).

The key component of the calculations was energy consumption data. For 1990-2000 calculations, we used data from the New York State Energy Profiles: 1987-2001. For 2001-2020, we used data from the New York State Energy Plan (NYSERDA, 2002). In addition, New York State data for industrial energy consumption were adjusted based on the national percentage of industrial energy consumed for non-energy use, as reported by the Energy Information Administration (EIA).

To convert energy use to CO_2 emission calculations, we used a series of factors including combustion efficiency, carbon coefficients, and storage factors for non-energy use of fuels. These factors were provided by the EIA.

The basic equation for calculating emissions was as follows:

$$\textit{Fuel Consumption x Carbon Content x Combustion Efficiency x 44 gm } CO_2\textit{/12 gm C} = CO_2 \textit{ Emissions.}$$

Combustion efficiency refers to the percentage of the fuel that is actually consumed when the fuel is combusted; many fuels often do not combust entirely, and the leftover fuel is emitted as soot or particulate matter. For the fuels analyzed in this report, the combustion efficiencies ranged from 99.0 percent to 99.5 percent.

When some of the fuel is used for non-energy uses, the non-energy portion is multiplied by a storage factor and then subtracted from carbon emissions. Each fuel and sector was calculated individually.

Because simply reporting emissions for the electricity generation sector would not distinguish between the various end uses of the electricity, we also calculated transportation electricity emissions separately in order to develop energy and emission estimates for the transportation sector. Using electricity consumption data from the aforementioned NY energy data sources and the emissions from the electricity generation sector calculated as discussed above, we apportioned state electricity-related emissions based on sales to the end-use sectors to calculate transportation emissions from electricity.

NY is a net importer of electricity. For purposes of estimating the CO_2 emissions associated with that electricity, it was assumed that the fuel mix and emissions per unit of electricity generated was the same for imported electricity as for electricity generated in-state.

Statewide Economic Output Estimates

The US Bureau of Economic Analysis (BEA) provides historical data on New York's Gross State Product (GSP). We assumed that GSP would grow at a rate of 3 percent per year, which is the estimated growth rate of US GDP provided in EIA's *Annual Energy Outlook* (outlook case). This assumption is consistent with the projection methodology used in the New York State Energy Plan.

In addition to the statewide calculations, we needed to develop estimates of economic output for use in calculating transportation sector intensity measures, both at the state level and at the metropolitan region level. GSP attributed to transportation-related final demand includes dollars attributed to such items as personal consumption of transportation (such as purchases of vehicles, parts, fuel, maintenance, and auto insurance), public and private domestic investment in transportation structures and equipment, public and private purchase of transportation services, other transportation expenditures, and net exports of transportation-related goods and services. Comparing transportation-related GSP with transportation-related CO_2 emissions is therefore problematic because it does not relate emission sources to their economic output. Based on discussions with FHWA, NYSERDA, NYDOT, and ICF, we decided to use *total* GSP rather than *transportation-related* GSP because (1) transportation-related GSP isn't a significantly better measure of transportation-related activity than total GSP and (2) it would be extremely hard to gather info at the MSA level on the elements of transportation-related GSP.

Allocation to Metropolitan Areas

In addition to estimating statewide energy use, emissions, and economic output (across all sectors and for the transportation sector), we estimated values for each of the regions serviced by New York's 12 Metropolitan Planning Organizations (MPOs). Since these data are not reported directly by MPO, we developed methods to apportion the statewide estimates to the metropolitan areas.

In all cases, the starting point for the calculations was to map counties to the MPOs, and to use county-level data as the basis for allocating statewide statistics. Each county was assigned to a corresponding metropolitan region based either on information provided by the MPOs or through estimation based on MSA boundaries. MSA boundaries fall along county boundaries, whereas metropolitan region boundaries often include partial counties. Economic and fuel consumption data for partial counties were not available, so we designated each county as either wholly within or wholly outside of the metropolitan region boundaries. We mapped the metropolitan region boundaries to correspond with the MSA boundaries, except where counties could be entirely excluded from the metropolitan region. Since we could not disaggregate partial counties from the metropolitan regions, some estimates may be slightly overestimated.

Note that for all three measures – energy use, emissions, and economic output – the sums of the metropolitan region values is less than the statewide values. This is because some of New York's counties are not included in metropolitan regions.

Energy and Emissions

The methods to allocate statewide transportation energy and emissions to metropolitan regions differed from fuel to fuel, as described below. For all fuels and regions, we assumed that the percentage of statewide energy used in 2010 and 2020 remained constant at the 2001 percentage.

<u>Motor gasoline</u> – We apportioned gasoline use (and emissions) based on estimated annual gasoline consumption by county.[32]

<u>Jet fuels</u> – Use of this fuel was apportioned based on air enplanements.[33] We matched the individual airports with metropolitan regions.

<u>Distillate</u> - This includes use for diesel on-road vehicles (trucks and buses), rail, and vessels. This fuel is a relatively small contributor to total energy use and emissions (<20 percent of each), and it would be relatively complicated to allocate in a precise way. Because our calculations for the US national

GHG inventory indicate that about 85 percent of transportation distillate fuel nationally is from on-road vehicles, as a simplifying assumption, we apportioned distillate using the same factors as used for motor gasoline. This introduces error to the extent that rail, vessel, and bus fuel consumption do not correspond with motor vehicle gasoline, but given the time and resource constraints, it appears to be a reasonable assumption.

Residual – Residual fuel is used for shipping. Based on publications from the US Army Corps of Engineers Navigation Data Center,[34] virtually all of the NY freight from shipping is handled in the Port of New York, with a much smaller amount (1.8 percent of tonnage in 1990, 0.8 percent in 2001) handled in the Port of Buffalo. We used these proportions to allocate statewide residual use to the New York Metropolitan TC and Greater Buffalo-Niagara RTC regions. All other metropolitan areas were assumed to have negligible residual fuel use.[35]

Electricity – Electricity end-use in the transportation sector is primarily from transit rail (light rail, heavy rail, commuter rail). According to statistics in the National Transit Database,[36] in 2001 the vast majority of electricity consumption by transit authority is in the New York City area, with a small fraction (0.3 percent) in the Greater Buffalo-Niagara RTC. We assumed that the 2001 percentages applied to 1990 as well (and held this constant for 2010 and 2020).

Compressed Natural Gas (CNG) – CNG is used in as a clean fuel for buses. CNG statistics are also available by transit authority in the National Transit Database.[37] Three regions have some CNG use: New York Metropolitan TC, Syracuse MTC, and Greater Buffalo-Niagara RTC. The proportions, based on 2001 data, are 91.7 percent, 8.0 percent, and 0.3 percent, respectively. As with electricity, we assumed that the 2001 percentages applied to 1990 as well (and held this constant for 2010 and 2020).

Propane – A very small amount of propane is also used in transportation. Given that propane comprises less than 0.1 percent of energy use and emissions, and is likely to be used in the same geographic locations as CNG, we simply distributed statewide propane use across metropolitan regions according to the same proportions as CNG.

Economic Output (GSP)

The US Bureau of Economic Analysis (BEA) provides historical data on New York's Gross State Product (GSP). We were unable to find a more local breakdown of the GSP (e.g., by county or metropolitan region). However, BEA reports personal income at the state and county (but not metropolitan region) levels.

We distributed the New York GSP among counties based on each county's percentage of total New York personal income. We first calculated the percent contribution of each county to the total state income, and then multiplied the GSP by these percentages to estimate each county's contribution to GSP. The metropolitan region totals were then estimated by summing the values for the corresponding counties.[38]

Using personal income as the basis for allocating statewide GSP does have some shortcomings: personal income represents the income of residents living within each county without distinguishing the source of that income (e.g., investment income, wages from jobs in other counties or states), while GSP represents the total value of goods and services in the state economy irrespective of the residency of income earners. However, for purposes of providing general indicators of energy intensity and CO_2 intensity, we believe personal income serves as a reasonable proxy for apportioning GSP among the counties.

We assumed that GSP would grow at a rate of 3 percent per year, which is the estimated growth rate of US GDP provided in EIA's *Annual Energy Outlook* (outlook case). This assumption is consistent with the projection methodology used in the New York State Energy Plan. We assumed that each metropolitan region would have this same annual growth rate through 2020, and calculated values for 2010 and 2020 based on extrapolating from the 2001 values for metropolitan region gross product.

Appendix B. TRANSPORTATION ENERGY USE AND CO_2 EMISSIONS, BY METROPOLITAN REGION

Exhibit B-1. MPO Product, CO_2 Emissions, Energy Use, and CO_2 and Energy Intensity, by Metropolitan region (1990, 2001, 2010, 2020)

	1990	2001	2010	2020
CDTC – Albany				
Gross Metropolitan region Product (Million 2001 Dollars)	$19,375	$31,330	$40,878	$54,937
CO_2 Emissions ($MMTCO_2$)	4.2	4.7	5.5	6.0
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	215.0	150.0	133.4	109.7
Energy Use (Trillion Btu)	58.9	66.6	77.3	85.4
Energy Intensity (Thousand Btu per 2001 Dollar)	3.0	2.1	1.9	1.6
Binghamton Metropolitan Transportation Study				
Gross Metropolitan region Product (Million 2001 Dollars)	$5,739	$7,801	$10,179	$13,679
CO_2 Emissions ($MMTCO_2$)	1.4	1.4	1.6	1.7
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	235.6	178.4	157.6	127.6
Energy Use (Trillion Btu)	19.1	19.7	22.7	24.7
Energy Intensity (Thousand Btu per 2001 Dollar)	3.3	2.5	2.2	1.8
Greater Buffalo-Niagara RTC				
Gross Metropolitan region Product (Million 2001 Dollars)	$26,791	$39,175	$51,114	$68,693
CO_2 Emissions ($MMTCO_2$)	7.2	5.8	6.7	7.4
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	267.8	147.4	131.2	108.3
Energy Use (Trillion Btu)	101.4	81.8	95.0	105.4
Energy Intensity (Thousand Btu per 2001 Dollar)	3.8	2.1	1.9	1.5
Poughkeepsie-Dutchess County TC				
Gross Metropolitan region Product (Million 2001 Dollars)	$7,003	$11,100	$14,483	$19,464
CO_2 Emissions ($MMTCO_2$)	1.0	1.3	1.4	1.6
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	137.6	112.9	99.4	80.1
Energy Use (Trillion Btu)	13.6	17.7	20.4	22.1
Energy Intensity (Thousand Btu per 2001 Dollar)	1.9	1.6	1.4	1.1

	1990	2001	2010	2020
Elmira-Chemung Transportation Council				
Gross Metropolitan region Product (Million 2001 Dollars)	$1,862	$2,807	$3,662	$4,922
CO_2 Emissions ($MMTCO_2$)	0.5	0.4	0.4	0.5
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	243.4	130.1	115.6	94.9
Energy Use (Trillion Btu)	6.4	5.2	6.0	6.6
Energy Intensity (Thousand Btu per 2001 Dollar)	3.4	1.8	1.6	1.3
Adirondack-Glens Falls TC				
Gross Metropolitan region Product (Million 2001 Dollars)	$2,319	$3,604	$4,702	$6,319
CO_2 Emissions ($MMTCO_2$)	0.7	0.6	0.7	0.8
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	285.9	180.1	158.7	127.8
Energy Use (Trillion Btu)	9.4	9.2	10.6	11.4
Energy Intensity (Thousand Btu per 2001 Dollar)	4.0	2.6	2.2	1.8
New York Metropolitan TC				
Gross Metropolitan region Product (Million 2001 Dollars)	$350,993	$597,638	$779,782	$1,047,962
CO_2 Emissions ($MMTCO_2$)	44.0	47.0	53.8	59.6
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	125.3	78.7	68.9	56.9
Energy Use (Trillion Btu)	609.4	639.0	740.2	830.1
Energy Intensity (Thousand Btu per 2001 Dollar)	1.7	1.1	0.9	0.8
Newburgh-Orange County TC				
Gross Metropolitan region Product (Million 2001 Dollars)	$7,221	$11,846	$15,456	$20,772
CO_2 Emissions ($MMTCO_2$)	1.3	1.6	1.8	2.0
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	180.4	133.8	118.3	96.1
Energy Use (Trillion Btu)	18.4	22.5	25.9	28.3
Energy Intensity (Thousand Btu per 2001 Dollar)	2.5	1.9	1.7	1.4
Genesee Transportation Council				
Gross Metropolitan region Product (Million 2001 Dollars)	$24,226	$36,793	$48,007	$64,517
CO_2 Emissions ($MMTCO_2$)	5.1	5.1	5.9	6.5
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	211.9	139.6	123.8	101.2
Energy Use (Trillion Btu)	72.6	72.8	84.2	92.5
Energy Intensity (Thousand Btu per 2001 Dollar)	3.0	2.0	1.8	1.4

	1990	2001	2010	2020
Syracuse MTC				
Gross Metropolitan region Product (Million 2001 Dollars)	$14,892	$21,648	$28,246	$37,960
CO_2 Emissions ($MMTCO_2$)	3.7	3.4	3.9	4.3
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	249.1	156.4	139.1	114.2
Energy Use (Trillion Btu)	52.5	48.0	55.7	61.5
Energy Intensity (Thousand Btu per 2001 Dollar)	3.5	2.2	2.0	1.6
Herkimer-Oneida Counties Transportation Study				
Gross Metropolitan region Product (Million 2001 Dollars)	$6,238	$8,819	$11,507	$15,465
CO_2 Emissions ($MMTCO_2$)	1.4	1.4	1.6	1.8
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	223.3	160.4	141.3	113.8
Energy Use (Trillion Btu)	19.7	20.0	23.0	24.9
Energy Intensity (Thousand Btu per 2001 Dollar)	3.2	2.3	2.0	1.6
Ithaca-Tompkins County TC				
Gross Metropolitan region Product (Million 2001 Dollars)	$1,934	$3,045	$3,973	$5,339
CO_2 Emissions ($MMTCO_2$)	0.4	0.4	0.5	0.5
CO_2 Intensity ($MTCO_2$ per million 2001 Dollars)	213.4	139.6	123.7	101.0
Energy Use (Trillion Btu)	5.8	6.0	7.0	7.6
Energy Intensity (Thousand Btu per 2001 Dollar)	3.0	2.0	1.8	1.4

Appendix C. STATE AND REGIONAL CONTACTS

Exhibit C-1: Data Contacts at State and Regional Agencies

Contact	Agency
On Road VMT Data	
Mike Keenan	NYS DEC
Jeff Marshall	NYS DEC
Nathan Erlbaum	NYSDOT
School Bus Data	
Patrick Bolton	NYSERDA
James Brunet	NYSDOT
Marion Edick	NYS Education Department
Mike Moltzen	US EPA, Region 1
Bill Fehey	New York School Bus Contractors Association
Joe LeCivaliar	NYSDOT
Peter Mannella	NY-Association of Pupil Transportation
Karen Roseberger	NYMTC
Transit Forecasts	
Jim Davis	NYSDOT
David Armstrong	Metropolitan Transit Authority
Steven Lewis	NYSDOT
Freight rail	
Howard Mann	NYMTC
Nathan Erlbaum	NYSDOT
Water Freight	
Laura Shabe	Port Authority of NY and NJ
Nathan Erlbaum	NYSDOT

Exhibit C-2. MPO Contacts and Interview Dates

Agency	Date	Interviewees	Interview Format
Adirondack–Glens Falls Transportation Council	June 24, 2004	Aaron Frankenfeld, Transportation Analyst	Telephone
Binghamton Metropolitan Transportation Study	July 1, 2004	John Sterbentz, Senior Transportation Planner Steve Gayle, Director	Telephone
Capitol District Transportation Committee	June 1, 2004	John Poorman, Director Chris O'Neil, Senior Planner	In person
Elmira-Chemung Transportation Council	June 23, 2004	Jay Schissell, Staff Director	Telephone
Genesee Transportation Council	June 2, 2004	Rich Perrin, Director Brian Lakeman, Transportation Planner James Stack, Assistant Director	In-person
Greater Buffalo–Niagara Regional Transportation Council	June 3, 2004	Hal Morse, Director Doug Struckle, Principal Analyst	In-person
Herkimer–Oneida County Transportation Study	July 1, 2004	Harry Miller, Principal Planner	Telephone
Ithaca Tompkins County Transportation Council	June 17, 2004	Fernando de Aragón, Director	Telephone
New York Metropolitan Transportation Council	June 25, 2004	Larry McAuliffe, Sangeeta Bhowmack	Telephone
Newburgh–Orange County Transportation Council	June 21, 2004	Fred Budde, Planner Chris Champany, Deputy Director	Telephone
Poughkeepsie–Dutchess County Transportation Council	June 22, 2004	Eion Wrafter, Senior Planner	Telephone
Syracuse Metropolitan Transportation Council	June 22, 2004	Charles Poltenson, Planner Sean Murphy, Planner	Telephone

Appendix D. METHODOLOGY FOR DEVELOPING MPO DATA TABLE

Methodology for LDV, LDT, HDT

NYSDOT VMT data were used for all vehicle calculations for the following reasons:

- Most counties had either no VMT data or only 2025 data.
- Nathan Erlbaum at NYSDOT expressed confidence that NYSDOT VMT data for current years and projections are more accurate than MPO numbers.
- NYDEC had already used MOBILE 6.2 to estimate CO_2 emissions by detailed vehicle type and roadway type.[39]
- Data were available in a consistent format for all counties.

Use of these data required the following steps:

- Conversion of Summer DVMT to Annual Average DVMT (based on NYS DEC Motor Vehicle Emissions Budget Attachment 19: NYSDOT Seasonal Adjustment Memo.)
- Used the appropriate conversion factor based on Urban Rural Classification of roadway and Size of Urban area.
- Annual Average DVMT = Summer DVMT / Summer Adjustment Factor.
- This analysis used a Summer Adjustment Factor of 1.12 for urban roadways and 1.16 for rural roadways in the following counties (relatively urban counties): Albany, Bronx, Erie, Kings, Monroe, Nassau, New York, Niagara, Putnam, Queens, Richmond, Rockland, Suffolk, and Westchester.
- This analysis used a Summer Adjustment Factor of 1.16 for urban roadways and 1.21 for rural roadways in all remaining counties.
- For each vehicle type and county, used appropriate conversion factors for Diesel and Gasoline vehicles to convert EPA MOBILE6.2 model CO_2 estimates to energy use. Assumptions on vehicle type breakdown (i.e., the percentage of passenger cars vs. light trucks in the fleet) are inherent in the MOBILE6.2 model.
- VMT, Energy Use, and CO_2 emissions were then summed by county and by vehicle class into designated categories as follows (using standard EPA notation for the 28 vehicle types):

Light-duty Vehicles	LDGV, LDDV, MC
Light-duty Trucks	LDGT1, LDGT2, LDGT3, LDGT4, LDDT12, LDDT34
Heavy-duty Trucks	HDGV2b, HDGV3, HDGV4, HDGV5, HDGV6, HDGV7, HDGV8a, HDGV8b, HDDV2b, HDDV3, HDDV4, HDDV5, HDDV6, HDDV7, HDDV8a, HDDV8b

(Note that heavy-duty trucks exclude school bus and transit bus categories. These are included in separate categories.)

- Energy and CO_2 intensities were calculated based on annual VMT data.
- Data were summed by county in order to approximate metropolitan regions according to Exhibit D-1.

Methodology for School Buses

- School bus data followed the same methodology described for other on-road vehicles, in order to generate VMT, Energy Use, and CO_2 emissions by county for Heavy Duty Diesel School Buses (a category reported by NYSDEC).
- Data gathered during biennial inspections (conducted by the NYS Motor Carrier Safety Bureau) indicates that the school bus fleet is approximately 90 percent diesel buses in all NYSDOT districts. Thus, diesel bus data (VMT, energy use, and emissions) were increased to reflect non-diesel buses.
- Data were summed by county in order to approximate metropolitan regions according to Exhibit D-1.

Methodology for Transit Bus and Passenger Rail

- Obtained 1990, 2001, and 2002 data from the National Transit Database for each New York transit agency, regarding passenger-miles traveled and fuel use (by fuel type) for transit bus and passenger rail.
- Assigned transit agencies to metropolitan regions according to Exhibit D 1.
- Used NYSDOT annual passenger and VMT trend data to conduct linear regression for forecast years 2010 and 2020. This regression was conducted for the following years based on advice from NYSDOT's transit office (Jim Davis).
- Agencies serving the NYC Region were forecast based on a 5-year trend.
- All other agencies were forecasts based on a 10-year trend.
- Based on these forecasts, calculated percent increase between 2002 and 2010, and between 2010 and 2020.
- Applied these percentages to 2002 NTD data to estimate future fuel consumption and passenger-miles traveled
- Fuel use data were forecasted based on trends in miles traveled. For transit bus, fuel use was adjusted based on projected changes in fuel efficiency, derived from MOBILE 6.2 CO_2 emissions factors. We used the bus fuel efficiency gains assumed within EPA's MOBILE model which did not explicitly account for existing and planned hybrid bus fleets. Region-specific hybrid bus statistics could be an important consideration for a more detailed analysis. A number of regions indicated current and future plans for hybrid bus purchases. Potential rail fuel economy improvements were not estimated, and therefore are not reflected in the fuel consumption analyses.
- The same ratio was applied to all fuel types. This assumption implies that New York will continue to purchase transit buses and rail cars in the current ratio of fuel breakdown. There is uncertainty in this assumption, as transit agencies may shift favoring some fuels over others, irrespective of future policies enacted.
- Some forecasts suggested declining transit use. For these cases, we assumed stable ridership and stable transit service provision. This was consistent with qualitative statements from MPOs.
- Converted gallons of fuel to Btu, and then Btu to $MTCO_2$ (based on heat and carbon contents published by the EIA (or provided by Lou Browning of ICF Consulting for CNG).[40]

Methodology for Freight Rail

- Used Freight Analysis Framework data for nationwide county-to-county freight flows. FAF data include these flows (in tons) for 1998, 2010, and 2020.
- Freight ton-miles were estimated based on county-to-county distances.
- Straight line distance were approximated based on county centroid latitude/longitude data, according to the following equation:
  - Distance = d*ACOS[(sin a)(sin b)+(cos(a) cos(b) cos|c|], where
  - a = latitude of origin
  - b = latitude of destination
  - c = difference between origin and destination longitudes
  - d = radius of the earth (approx 3963 miles)
- A uniform 20 percent "circuity factor" was applied to convert straight-line distances into typical rail distances.
- Ton-miles were calculated based on tons shipped and received.
- Ton-miles were attributed to each New York county based on 50 percent of all outbound freight + 50 percent of all inbound freight.
- Counties then assigned to metropolitan regions based on Exhibit D 1.
- 1990 and 2001 values estimated using a linear regression.
- Assumed all freight rail uses diesel as a fuel.
- Obtained average Class I freight rail intensity values for 1970-2001 from DOE's *Transportation Energy Data Book, Edition 23,* Table 9.9.
- For years beyond 2001, assumed an annual growth rate equal to the average annual growth rate for 1990-2001.
- Multiplied intensity values (in Btu per ton-miles) by the ton-mile estimates to calculate total Btu usage for each year.
- Multiplied total Btu usage for each metropolitan region by carbon conversion factors to estimate total CO_2 produced.

Note that Energy and CO_2 intensities will all be the same for freight rail because energy and CO_2 values were calculated based on an assumed constant relationship with ton-miles.

Methodology for Domestic Water Freight

- Water Freight used the Freight Analysis Framework data for US-wide county-to-county freight flows. FAF data include county-to-county freight tons for 1998, 2010, and 2020.
- Tons were calculated based on tons shipped and received.
- Tons were attributed to each New York county based on 50 percent of all outbound freight + 50 percent of all inbound freight.
- Counties then assigned to metropolitan regions based on to Exhibit D 1.
- 1990 and 2001 values estimated using a linear regression.
- Calculated the average breakdown of freight shipped by diesel and residual fuel using national estimates.

- Used breakdown of fuel use by ships to estimate how much of New York's consumption of diesel is used for ships.
- Calculated energy use and CO_2 emissions based on heat and carbon contents provided by EIA.
- Distributed state energy use and emissions to metropolitan regions based on their percent contribution to state freight tons.

Note that Energy and CO_2 intensities will be all be the same because energy and CO_2 was calculated based on tons. Also note that although county-to-county flows are provided in the FAF, ton-miles could not be calculated because distances associated with each county-to-county route could not be easily estimated.

Indirect Construction Impacts

- Indirect impacts could not be estimated without a detailed and very time-consuming analysis of specific project schedules in each region.
- Indirect impacts were reported wherever MPOs provided these data.

Exhibit D-1: List of Metropolitan Regions and Associated Counties

Metropolitan Region	Counties Included
Capital District Transportation Committee (CDTC) – Albany	Albany, Saratoga, Schenectady, Rensselaer
Binghamton Metropolitan Transportation Study (BMTS) - Binghamton	Broome, Tioga
Greater Buffalo-Niagara Regional Transportation Council (GBNRTC) - Buffalo	Erie, Niagara
Poughkeepsie-Dutchess County Transportation Council (PDCTC) – Poughkeepsie	Dutchess
Elmira-Chemung Transportation Council (ECTC) – Elmira	Chemung
Adirondack-Glens Falls Transportation Council (AGFTC) - Fort Edward	Warren, Washington
New York Metropolitan Transportation Council (NYMTC) - New York	Bronx, Kings, Nassau, New York, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester
Newburgh-Orange County Transportation Council (NOCTC) - Goshen	Orange
Genesee Transportation Council (GTC) – Rochester	Livingston, Monroe, Ontario, Wayne
Syracuse Metropolitan Transportation Council (SMTC) - Syracuse	Madison, Onondaga, Oswego
Herkimer-Oneida Counties Transportation Study (HOCTS) - Utica	Herkimer, Oneida
Ithaca-Tompkins County Transportation Council (ITCTC) - Ithaca	Tompkins

Exhibit D-2: List of Metropolitan Regions and Associated Transit Agencies

Metropolitan Region	Associated Transit Agencies
CDTC - Albany (NY)	Capital District TA
Binghamton Metropolitan Transportation Study - Binghamton (NY)	Broome County Department of Public Works
Greater Buffalo-Niagara RTC - Buffalo (NY)	Niagara Frontier TA
Poughkeepsie-Dutchess County TC - Poughkeepsie (NY)	Dutchess County Mass Transit
Elmira-Chemung Transportation Council - Elmira (NY)	No Transit Agencies Listed
Adirondack-Glens Falls TC - Fort Edward (NY)	Glens Falls Transit
New York Metropolitan TC - New York (NY)	American Transit Atlantic Paratrans City of Long Beach Clarkstown Mini-Trans Green Line Huntington Area Transit Liberty Lines Express Liberty Lines Transit Long Island Bus Long Island Rail Road Metro North RR Monsey New Square Trails New York Bus Tours, Inc. New York City DOT New York City Transit New York-GTJC Private Transportation Queens Surface Corp Rockland-Ride Share Spring Valley Bus Staten Island
Newburgh-Orange County TC - Goshen (NY)	No Transit Agencies
Genesee Transportation Council - Rochester (NY)	RGRTA & Lift Line
Syracuse MTC - Syracuse (NY)	CNY Centro, Inc. Centro of Oswego, Inc

Herkimer-Oneida Counties Transp. Study - Utica (NY)	Utica Transit Authority
Ithaca-Tompkins County TC - Ithaca (NY)	Tompkins Area Transit

Appendix E. MPO DATA TABLE

Provided in separate Excel file titled “Appendix E.”

Appendix F. STATUS OF ENERGY ANALYSES BY NEW YORK MPOS

MPO	Status
Capital District Transportation Committee (CDTC) – Albany	Submitted
Binghamton Metropolitan Transportation Study (BMTS) - Binghamton	Not started
Greater Buffalo-Niagara Regional Transportation Council (GBNRTC) - Buffalo	Submitted
Poughkeepsie-Dutchess County Transportation Council (PDCTC) - Poughkeepsie	Submitted
Elmira-Chemung Transportation Council (ECTC) – Elmira	Not started
Adirondack-Glens Falls Transportation Council (AGFTC) - Fort Edward	Not started
New York Metropolitan Transportation Council (NYMTC) - New York	In-Progress
Newburgh-Orange County Transportation Council (NOCTC) - Goshen	Submitted
Genesee Transportation Council (GTC) – Rochester	Submitted
Syracuse Metropolitan Transportation Council (SMTC) - Syracuse	Submitted
Herkimer-Oneida Counties Transportation Study (HOCTS) - Utica	Not Started
Ithaca-Tompkins County Transportation Council (ITCTC) - Ithaca	Not Started

Appendix G. INTERVIEW PROTOCOL

On-road energy use and CO_2 emissions

- What model or methodology was used?
- What data sources were used?
- Were VMT and speeds taken from the travel demand model?
- Was additional data collection needed?
- How were gasoline, diesel, and alternative fuel vehicle use estimated?

Non-road energy use and CO_2 emissions

- Which non-road sources were analyzed?
- Water freight considered?
- Passenger and freight rail?
- Construction equipment?
- Other sources?
- What methodologies were used to estimate current emissions and to forecast future emissions?
- What data sources were used?

Resource requirements

- Was the work conducted by consultants, in-house staff, or both?
- Roughly how much staff time is devoted specifically to the energy analysis?
- Can you estimate a cost specifically for performing the energy analysis?
- Can you estimate what future analyses might cost?

Effect on Transportation Program

- Has the analysis influenced projects and strategies that were included in the TIP? Can you give examples?
- Do you anticipate that the analysis will affect updates of the long-range plan?
- How is the analysis reflected in the Unified Planning Work Program?
- Were any of the following strategies taken into consideration or given additional emphasis:
- Land use strategies?
- Transportation pricing strategies?
- Alternative fuel vehicle strategies?
- TDM strategies?

Appendix H. MEMO SUMMARIZING IN-PERSON INTERVIEWS

Memorandum

To: Diane Turchetta, FHWA

From: Jonathon Kass and Michael Grant

Date: June 10, 2004

Subject: Initial Summary of Findings from Interviews with Albany, Buffalo, and Rochester MPOs

This memo summarizes findings from in-person interviews conducted under Task 2.1 of ICF's Assessment of the New York State Energy Plan. These interviews were conducted for several purposes:

- To identify the methodology that was used
- To gather available data used to estimate energy use and GHG emissions
- To gather information on current and projected future staff resources required for the analysis
- To hear perspectives how such energy assessments might eventually influence transportation decisions
- To identify concerns, challenges, and suggested improvements related to on-going efforts to assess energy and GHG emissions for each metropolitan region.

The following interviews were conducted:

Agency Loca	tion	Date	Interviewees
Capitol District Transportation Committee	Albany	June 1, 2004	John Poorman, Director Chris O'Neil, Senior Planner
Genesee Transportation Council	Rochester	June 2, 2004	Rich Perrin, Director Brian Lakeman, Transportation Planner James Stack, Assistant Director
Greater Buffalo–Niagara Regional Transportation Council	Buffalo	June 3, 2004	Hal Morse, Director Doug Struckle, Principal Analyst

Summary notes are as follows:

METHODOLOGIES

Direct Energy Calculation:

For on-road vehicles, all three MPOs based their approach on NYSDOT's methodology to the extent that their model data permitted. For on-road vehicles, all three used VMT and speeds from their travel demand model. The models did not include vehicle type data so they generally used an overall estimate for percent trucks (i.e., not distinguished by speed or roadway link). They either assumed all trucks use diesel, or they used gasoline values for all travel. All three regions used fuel economy data provided by NYSDOT. Buses were generally assumed to be included in the heavy vehicle data.

For non-road vehicles, none of the three regions did any meaningful evaluation. They generally suggested national data sources, and pointed out some issues that might make linear forecasts unreliable.

Indirect Energy Calculation:

For the indirect energy calculation (i.e., the energy required for construction of transportation facilities) Rochester and Albany used NYSDOT's methodology. They both only included energy for road construction, but only addressed projects listed in the TIP, not additional projects proposed in the LRP. Neither of these regions included energy required for construction or maintenance of facilities when calculating the overall energy impact of the long-range plan or TIP Versus the no-build scenario.

Buffalo did not conduct the analysis of emissions from construction activity based on the assumption that it would not significantly impact energy use.

Resource Requirements:

All three regions conducted the analysis work entirely in-house. All three felt that the process could become relatively simple and routine if the methodology stayed the same and they had an opportunity to develop a routine for doing the analysis. Following are the rough estimates of the effort required. (This effort is above and beyond what was required in the conformity analyses.)

- Albany – two person-weeks
- Rochester – 1.5 to 2 person-months
- Buffalo – one person-week (triple this effort if the analysis had been done according to the guidelines (i.e., including indirect analysis, with assessment of passenger rail and more careful assessment by vehicle type.))

The longer time for Rochester was mainly because they do not have a model post-processor and had to do a lot of manual work to evaluate VMT by speed.

General Attitude about the Methodology:

All three regions felt that the overall process was relatively straightforward and could become streamlined if the methodology did not change significantly from year to year. However, there were concerns about some particular aspects of the process:

- Getting data for interim designated years was difficult. Regions generally relied on the time frame that related to their TIP and long-range plan.
- There were two significant critiques about the indirect energy estimation process:
    - Albany thought that the transit method was vastly more complicated than the roadway method. They felt that the transit indirect energy method involved too much detail given the level of other assumptions in the process. They also felt that the energy embedded in manufacture of transit vehicles probably outweighed the energy required for many of the construction steps listed in the methodology.
    - Buffalo did not do the indirect energy assessment because they thought it was not worthwhile, citing the fact that roughly the same amount of money would be spent on transportation regardless of the plan scenario, and that the indirect energy impacts would be roughly the same. (I.e., the Plan's "no build" scenario would still have indirect construction impacts associated with more maintenance or more facilities for alternative modes.)
- Rochester appears to have done the indirect energy analysis improperly. Their indirect energy values dwarf those associated with direct energy use. We are trying to figure-out why this is the case.

GENERAL ATTITUDES ABOUT THE VALUE OF THE POLICY AND PROCESS

Overall, all three regions thought that the effort to evaluate energy and GHG emissions was worthwhile toward the goal of providing an additional tool for making transportation decisions. However, there was some suspicion that this was simply another numerical evaluation with no link to policy, in part because no one has heard anything back about their submissions.

One region suggested that it would have been more appropriate if the state had involved the MPOs in the development of this methodology from the beginning, though they appreciated being asked about how it was working at this stage.

All three regions viewed this first effort as a trial and expect the process to be improved in the future. They thought it was appropriate that the state seemed to be treating the effort that way.

Effect on Transportation Decisions:

- As expected, all three MPOs described little or no impact on transportation decisions in this first round. They also expected only limited impact on decisions in the long run. Albany, and to some degree Buffalo thought that the limited impact was partly due to the fact that they already strived for energy efficient transportation systems in their current policies. Rochester explained that if there were a choice between economic development and energy efficiency, economic development would win.
- All three regions placed heavy emphasis on the fact that the build scenario reduced energy over the no-build scenario. This was mostly due to reduced congestion, and resulting energy efficiency fuel savings from greater fuel economy. . They noted that if they reached a situation where a build scenario increased direct energy use then decisionmakers might take note.
- The Albany region suggested that the energy policy gives them more weight in working out policy differences with NYSDOT because some of the MPO's long-term policies are now supported by state goals, not just the region's plan.
- Albany described a chicken and egg situation when considering to what degree energy policies are the basis for the region's energy saving transportation programs. There is a strong relationship between urban reinvestment policies, for example, and the governor's policies promoting energy conservation. Without the urban reinvestment goals and successes, the energy policies may not be as strong. When it comes to the actual public debate, energy issues are not top of the list – livability is top of the list. People do not want to lose their current quality of life. Air quality issues can also be a critical issue. Energy and GHGs are down the list.

Potential Improvements:

The state's role:

Two regions felt that the state should consider requesting raw numbers from the MPO's and simply conduct the energy and GHG assessment itself. They thought that this would create both efficiency and consistency. They suggested that at the very least, state should go through the analysis for one region in order to work out the kinks.

- Albany thought that the legitimacy of the process depended on the state taking more leadership in instituting energy efficiency programs itself, citing, for example, that under priced parking and poor commuter benefit offerings for state employees completely contradicted Albany's efforts to reduce energy in the region's transportation sector.
- Buffalo and Rochester suggested that all MPOs should not necessarily reduce energy use by the same amount. Some may be in a better position to reduce energy use than others. It is possible that the state should set goals or requirements for each region

Other Suggested Changes:

- All three suggested that the different components of the energy analysis methodology do not demonstrate a consistent level of detail. Some parts require great effort (e.g., indirect transit costs) while adding little accuracy, given the small level of these emissions in relation to motor vehicle travel. Some felt that elements of the analysis that are not significant should be cut.

- Some felt that as nothing more than a goal, the process was not very meaningful. They thought that unless it had teeth behind it as a requirement, it would be ignored.

DATA REQUIRED FOR SPREADSHEET ATTACHMENT B

- No one had data for the years listed (1990, 2001, 2010, 2020)
- Only on-road direct energy use for a year close to 2020 is directly available from the MPOs. National data sources will have to be used for most other topics.
- Generally, all three regions felt that linear interpolation would be sufficiently accurate to fill in these years, with some potential exceptions, for example:
    - Rochester's primary transit agency recently completed a study that calls for a larger fleet of much smaller vehicles. They are planning to implement these changes, but the agency recently purchased new full-sized buses, so it will be some time before this shift begins.
    - Buffalo has seen substantially higher through truck traffic as a result of border trade. There is substantial uncertainty in where these trends will go, but these could be continued dramatic increases.
    - Rochester is developing a major intermodal facility that has potential to increase truck traffic.

* * * *

Appendix I. SUMMARY OF MPO SELF-REPORTED ENERGY DATA

MPO	Scenario	Vehicle	Annual VMT (000's)	Annual Direct Energy (1000 BTUs)	Energy Intensity (BTU/VMT)
CDTC - Albany	2021 no-build	All	10,130,940	43,499,000,000	4,293.7
	2021 build	All	9,103,830	38,256,000,000	4,202.2
	2021 build + New Visions	All	8,685,540	36,350,000,000	4,185.1
GBNRTC - Buffalo	2025 no-build	All	n/a	69,389,781,754	
	2025 build	All	n/a	56,025,017,904	
PDCTC - Dutchess Cnty	2025 no-build	All	4,670,429	32,337,331,585	6,923.8
	2025 build	All	4,723,900	31,971,299,000	6,768.0
NOCTC - Orange Cnty	2025 no-build	LDV	1,300,243	7,691,925,194	5,915.8
		LDT	36,348	529,540,605	14,568.8
		HDT	57,829	1,212,857,159	20,973.2
		All	1,394,420	9,434,322,958	6,765.8
	2025 build	LDV	1,294,963	7,660,687,174	5,915.8
		LDT	36,718	534,937,543	14,568.8
		HDT	58,420	1,225,245,212	20,973.2
		All	1,390,100	9,420,869,928	6,777.1
GTC - Rochester	2025 no-build	LDV	9,372,777	47,965,874,025	5,117.6
		LDT	280,983	3,144,263,401	11,190.2
		HDT	381,334	8,227,452,069	21,575.5
		All	10,035,093	59,337,589,496	5,913.0
	2025 build	LDV	9,371,631	47,958,278,098	5,117.4
		LDT	280,948	3,143,730,638	11,189.7
		HDT	381,287	8,226,129,725	21,574.6
		All	10,033,866	59,328,138,461	5,912.8
SMTC - Syracuse	2025 no-build	LDV	4,875,536	28,840,930,125	5,915.4
		LDT	133,104	1,936,587,735	14,549.4
		HDT	294,844	6,181,960,234	20,966.9
		All	5,303,484	36,959,478,095	6,968.9
	2025 build	LDV	4,917,008	29,086,257,185	5,915.4
		LDT	134,236	1,953,060,761	14,549.4
		HDT	297,352	6,234,545,297	20,966.9
		All	5,348,597	37,273,863,243	6,968.9

Appendix J. MITIGATION ANALYSIS REFERENCES

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Endnotes

[1] NYSERDA. “Patterns and Trends – New York State Energy Profiles: 1987-2001.” December 2002.

[2] At the national level, CO_2 emissions account for roughly 95 percent of transportation-related emissions. As a result, the project team agreed to limit the analysis of GHG emissions to CO_2 as these estimates serve as a reasonable proxy for overall GHG activity.

[3] CO_2 emissions and intensity closely match these trends and were omitted from the graph since the lines would be difficult to discern from the energy lines.

[4] In this context, energy intensity is defined as energy use per unit of travel. Similarly GHG intensity is defined as GHG emissions per unit of travel. These measures are helpful for tracking efficiency changes in a particular mode from year to year. However, because the unit of travel is different for different modes (e.g., VMT for cars and trucks, passenger miles for transit), these intensity measures are generally not comparable between modes.

[5] These perceptions may be accurate given the magnitude of increased energy use and GHG emissions forecasted in the quantitative component of this MPO analysis (Appendix E).

[6] This research did not assess what opportunities were available for MPOs to help develop the energy/GHG analysis requirements. It is possible that MPOs had significant opportunities to be involved, or that they have on-going opportunities to suggest changes to these regulations. This report simply summarizes MPOs’ responses to the current requirements.

[7] The MOBILE6.2 model can generate CO2 emissions estimates based on CO2 emissions factors. These emissions factors are derived from national fuel efficiency data and account for local distribution of vehicle age and vehicle type.

[8] The importance of consistent approaches for developing GHG inventories was specifically highlighted in the following publication, “Developing a New York State Greenhouse Gas Tracking System,” Center for Clean Air Policy, May 2004.

[9] As an example a region that ships many goods to California would use more transportation energy than a region that ships many goods to Pennsylvania. However, under the current estimation procedure, this difference in energy use would appear only for freight rail, not for freight trucks.

[10] Combustion efficiency refers to the percentage of the fuel that is actually consumed when the fuel is combusted; many fuels often do not combust entirely, and the leftover fuel is emitted as soot or particulate matter. For the fuels analyzed in this report, the combustion efficiencies ranged from 99.0 to 99.5 percent.

[11] Initially, it was thought that portions of this information could be developed from energy use and GHG emissions data collected directly from MPOs. However, because many MPOs had very little information to support consistent regional estimates, ICF Consulting chose to rely on state and national data sources. A discussion of data reported directly by MPOs can be found in Section 4.2 below.

[12] Nationwide, light-duty truck travel grew between 1990 and 2001; however, the magnitude of the jump in New York State seems especially large. The higher-than-average increase in New York State may be due to New York’s consumer preferences shifting to light-duty trucks over passenger cars at greater rate than nationally. However, further investigation would be required to determine the underlying demographic and economic causes.

[13] For details on Fuel Economy statistics in MOBILE, see Updating Fuel Economy Estimates in MOBILE6.3 (DRAFT), Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, EPA420-P-02-005, August 2002. http://www.epa.gov/otaq/models/mobile6/m6tech.htm

[14] This analysis does not include intercity passenger rail (e.g., Amtrak) for two reasons. First, this task was specifically focused on the MPO planning process and the MPOs do not maintain data on intercity passenger rail. Second, even if state-level data were available from Amtrak or FRA, information would not be sufficient to allocate state-wide travel to each of the MPO regions.

[15] Data on school bus inspections, including number of active buses, provided by Joe Civalier, New York State DOT – Motor Carrier Safety.

[16] As discussed under data shortcomings (above), these figures are based on county-level water freight allocations in the freight analysis framework. These allocations may not conform with the way regions themselves allocate water freight responsibilities.

[17] The requirement to conduct the GHG/energy assessment is triggered when a region does a major update to its Transportation Improvement Program and Regional Transportation Plan. These current analyses are ongoing, and additional MPOs have begun similar analyses as well.

[18] Note that this analysis took place in the midst of the first round of submissions, and some MPOs have not yet been required to conduct the analysis. The MPOs that have conducted assessments awaiting NYSDOT's feedback. While much can be learned from this analysis, the findings must be viewed in light of the fact that the requirement is still in the early stages of implementation.

[19] Ulster County is not included in the interviews or data tables because it was only recently designated as an MPO. The team was advised by neighboring MPOs that Ulster County has not yet conducted an energy analysis.

[20] Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12a: Energy Analysis Guidelines for TIPs and Plans (June 21, 2002); and Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12b: Emissions Estimates for TIPS and Plans (June 21, 2002).

[21] The Syracuse MPO (SMTC) is the one MPO for which energy use increased as a result of plan implementation. However, SMTC disagreed with some of the assumptions that led to this finding. SMTC felt that certain land use assumptions should have been the same for both the build and no-build scenarios, but they were instructed by NYSDOT to use different land use scenarios. A major development associated with the plan implementation scenario was an important factor in the higher energy use estimate.

[22] The Analysis Period for Indirect Energy Use is usually 5 years, but varies somewhat since several regions included projects that go beyond the TIP period.

[23] NOCTC Energy Analysis for Vision 2025.

[24] This situation occurred in Syracuse without any significant public concerns (i.e., the plan scenario showed higher energy use than the no build scenario, yet decisionmakers and the public did not raise concerns.) However, if the energy assessment process became a routine part of transportation analysis, decisionmakers and stakeholders might pay closer attention to these issues.

[25] As in Task 1, CO2 was the only GHG analyzed in Task 3. Because the overwhelming majority of New York State's transportation-related emissions are CO2, it provides a reasonable estimation of greenhouse gas emissions in general.

[26] Due to resource limitations, comprehensive cost-benefit analyses could not be conducted for these strategies. Readers are encouraged to use these results to get an overall sense of the potential strategies for reducing emissions. Additional analyses would be required to more precisely assess the costs and benefits of each strategy.

[27] For example, relative fuel prices could impact the vehicles people drive, the modes they choose for travel and shipping, and the fuels these modes use. Technological developments could also lower the costs or increase the benefits of some strategies. In addition, other state programs that impact the cost of transportation – such as changes in gasoline prices or tolls, or traffic congestion mitigation strategies – may influence costs, baseline emissions, etc. even if the purpose of such strategies is not related to reducing CO2.

[28] The only additional cost to truck drivers is a one-time, $10 charge for a window adapter.

[29] For 2007 the total hourly cost to truckers is projected to be about $0.59/hr (based on a projected electricity cost of $0.34/hr). The average fuel cost of idling is projected to be about $1.22/hr (based on a projected cost of diesel fuel of $1.43/gal and fuel consumption rate of 0.85 gal/hr).

[30] Several ATE pilot programs are underway in NY State, operating at the Chittenango Travel Plaza, DeWitt Travel Plaza, and Hunts Point Cooperative Market. A pilot program for shore power is also underway at a travel plaza on the Adirondack Northway (I-87) in Wilton, Saratoga County.

[31] Quantities of CNG are expressed in diesel-equivalent gallons. Since CNG is a gas and not a liquid, it cannot be quantified in gallons of CNG. However, for comparison purposes, it was necessary to express these fuels in a common unit. A diesel-equivalent gallon of CNG is the quantity of CNG that contains the same amount of energy as one gallon of diesel fuel.

[32] NYSERDA 2003. Patterns and Trends - New York State Energy Profiles: 1988-2002. Appendix D: Estimated Annual Gasoline Consumption by County, 1997-2002.

[33] Data on enplanements by airport for 1990 are available from NYSDOT 2003a. "NYS Enplanement Data 1990-1993." http://www.dot.state.ny.us/pubtrans/enpl2.html, and for 2001 from NYSDOT 2003b. "NYS Enplanement Data 1994-2001." http://www.dot.state.ny.us/pubtrans/enpl1.html.

[34] NDC 1999. Waterborne Commerce of the United States: Calendar Year 2001, Parts I and III. U.S. Army Corps of Engineers, Navigation Data Center; NDC 2002. Waterborne Commerce of the United States: Calendar Year 2002, Parts I and III. U.S. Army Corps of Engineers, Navigation Data Center. Both available at http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm.

[35] Note that, as reported by the Army Corps of Engineers, the Port of New York is comprised of several smaller ports, some of which are located in New Jersey. Similarly, the Port of Buffalo included some ports in Ohio. Since we were using these data only for apportionment purposes, and since residual fuel contributes a small proportion of overall GHG emissions, we decided to not break out the data for non-NY ports.

[36] NTD 2001. 2001. Table 17: Energy Consumption by Transit Agency, Directly Operated Service. http://www.ntdprogram.com/NTD/NTDData.nsf/DataTableInformation?OpenForm&2001

[37] Ibid.

[38] This methodology differs slightly from the methodology outlined in ICF's 4/27 memo. Previously, we had derived MPO estimates by starting with the MSA totals and then subtracting those counties that could be entirely excluded from the MPO. The results are identical; however, the methodology was revised for simplicity and to be consistent with fuel allocation methodology, for which no MSA data was available.

[39] The MOBILE6.2 model uses default assumptions about future vehicle mix (including the ration of light duty vehicles to light duty trucks). A detailed description of the procedures used to develop this vehicle mix forecast can be found in, Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6, U.S. EPA, EPA420-R-01-047, September, 2001. <www.epa.gov/otaq/models/mobile6/r01047.pdf> As an example, this forecast for the year 2010, the number of light duty trucks will be 125% of the number of light duty vehicles.

[40] Compressed natural gas (CNG) was reported by NTD in units of gallons. Since CNG is a gas and not a liquid, it cannot technically be expressed in terms of gallons. However, it can be expressed in terms of diesel or gasoline gallons (more commonly, diesel gallons). One diesel-equivalent gallon of CNG is the quantity of CNG containing the same amount of energy as one gallon of diesel. For this analysis, we assumed that "gallons" of CNG actually referred to "diesel-equivalent gallons" of CNG.