Appendix E
Greenhouse Gas and Energy Plan Process

SMTC ENERGY and GREENHOUSE GAS ANALYSIS PROCESS

Detailed below are the steps that were taken in an effort to complete the energy and greenhouse gas analysis required for the Syracuse Metropolitan Transportation Council's (SMTC) Long-Range Transportation Plan (LRTP) 2004 Update. The detailed results of the analysis can be found in the following steps.

The steps that were followed are consistent with the guidance documents listed below, as amended through consultation with the New York State Department of Transportation's Environmental Analysis Bureau (NYSDOT-EAB).

- *Air Quality Analysis of Transportation Improvement Programs, Regional Transportation Plans, and Capital Project programs – Technical Guidance to Assist Metropolitan Planning Organizations and Department of Transportation Regional Offices Meet the Objectives of the 2002 New York State Energy Plan* (January 21, 2003);

- *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: Greenhouse Gases (CO_2) Emissions Estimates for TIPs and Plans* (June 21, 2002)

Step #1 – Identification of all Non-Exempt and Regionally Significant Projects

The first step in this process was determining which projects would be subject to analysis. Since the SMTC LRTP does not contain specific projects, the 2003-2006 Transportation Improvement Program (TIP) project listing was utilized as the project list for this update. All of the projects were reviewed for their significance in affecting energy consumption as per the guidance provided in 6 NYCRR Part 240.6 (h)(2). In general, projects that maintain current levels of service or capacity, such as safety improvements, resurfacing, bridge repair, or bus replacements were considered exempt from the analysis. Similarly, projects that result in operations improvements, but without an increase in capacity (such as intersection widening) were also considered exempt and excluded from the analysis.

A Regionally Significant project is, according to 6 NYCRR Part 240.2 (38)**,** "a transportation project (other than an exempt project) that is on a facility which serves regional transportation needs (such as access to and from an area outside the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including, at a minimum, all principal arterial highways and all fixed guideway transit facilities that offer an alternative to regional highway travel."

Non-exempt projects include highway and road projects that increase capacity by at least one travel lane, and transit projects that change capacity on a fixed route system. The non-exempt determination was made if the project type is not found in the list of exempt projects derived from “Table 2- Exempt Projects” in 40 CFR Part 93.126, 93.127 and NYCRR Part 240.27.

As mentioned above, the project list for the SMTC’s conformity analysis consisted of the projects included in the 2003-2006 TIP. Based on this project list, the two projects noted below were categorized as non-exempt projects and were analyzed utilizing the indirect energy lane-mile approach, consistent with *Subtask 12a:Energy Analysis Guidelines for Tips and Plans*.

- Kirkpatrick/Court/Solar Streets (City of Syracuse) – Reconstruction
- Route 31 Over Seneca River – Belgium Bridge (NYSDOT) – Bridge Replacement, Road Widening.

In addition, the two additional projects listed below were also categorized as non-exempt, yet these projects were unable to be analyzed utilizing the above-mentioned method because the project entails signal improvements only, with no additional lane miles of construction.

- Geddes/Genesee Streets Signal Interconnection – Update signals and inclusion in existing traffic interconnect system.
- Lodi/North Salina Streets Signal Improvements – Update signals and inclusion in existing traffic interconnect system.

Although exempt projects are not required to be included in the analysis, the EAB specifically requested the inclusion of one project in the indirect energy analysis. This project is noted below and is included in the analysis.

- Routes 5 & 92 – Safety improvement and ramp widening.

Step #2 – Travel Demand Modeling

To determine the impact of future projects in the Syracuse Metropolitan Planning Area (MPA), the SMTC uses the traditional four-step gravity Travel Demand Model process incorporated within TModel 2 travel simulation software. Like most other programs of this type, the model consists of a road network, land-use and employment data, trip generation, trip distribution, and trip assignment. The results generated by the program are then compared to known travel counts to calibrate the model. The SMTC travel demand model is calibrated based on 2003 base year traffic conditions and 2000 Census information. Background documentation and technical information related to the SMTC Model are available at the SMTC.

The analysis includes a year 2025 No-Build scenario and a year 2025 Build scenario (as 2025 is the horizon year of the SMTC LRTP). The No-Build scenario includes the 2003 roadway network with 2025 land-use characteristics, while the Build scenario consists of the 2025 network and 2025 land-use characteristics. Additionally, the Build scenario incorporates two significant private development projects (Syracuse lakefront area redevelopment/Carousel Center expansion and the proposed industrial development in the Town of Clay) that are excluded from the No-Build scenario. Development of these projects may or may not occur regardless of the adoption of the LRTP. Inclusion of these projects in the Build scenario has led to an increase in VMT for that scenario that is not a result of the programs and policies set forth by the LRTP.

Projects that were unable to be modeled due to TModel 2's limitations were analyzed separately and then factored into the results from TModel 2 to represent a more accurate Build scenario. A detailed explanation of this process is provided in Step 3.

Step #3 – Off-Line Model Analysis

A quantitative analysis was also undertaken to account for the visions of the 2025 LRTP that could not be modeled in TModel 2. Inclusion of transit and bicycle/pedestrian transportation modes is beyond the capabilities of the software. Using information developed by the SMTC and its member agencies, the SMTC calculated the reduction of vehicle miles traveled (VMT) as a result of transit and bicycle and pedestrian system improvements envisioned in the LRTP, as well as implementation of the New York State Thruway Authority's (NYSTA) Truck Stop Electrification program at Thruway Service Plazas serving the greater Syracuse area. The LRTP assumes that in the horizon year, NYSTA will equip each of the four plazas servicing the region (Port Byron, Warners, DeWitt, and Chittenango) with 44 TSE stations each. According to NYSTA estimates, each truck using the facility could save the equivalent of 56 vehicle miles in diesel fuel per usage. The total capacity of trucks using these facilities per day is 528. Additionally, the SMTC accounted for reductions of carbon monoxide and oxides of nitrogen as a result of conversion of the Centro fleet to diesel-electric hybrid busses. These calculations incorporated emission factors provided by BAE Systems, the manufacturer of the hybrid propulsion systems.

These VMT reductions were then factored into the TModel 2 outputs to better demonstrate the build scenario provided for in the LRTP. This process differed from that used in the Air Quality Conformity determination where only the results of VMT from TModel 2 were utilized.

As the SMTC's LRTP is not a project-specific document, the VMT calculations were based on staff and member agency assumptions related to the long-term vision of the LRTP. The results can be found in Table 1.

Step #4 - Regional Emissions Modeling

As stated earlier, TModel 2 estimates the number of vehicle miles traveled (VMT) for various scenarios provided for in the planning process. To calculate the regional emissions that will result from the transportation system envisioned in the LRTP Build scenario, this VMT information is utilized in the latest emissions model, also known as the MOBILE6 regional emissions model. MOBILE6 was developed by the US Environmental Protection Agency (EPA).

Emission estimates were determined using the VMT data and MOBILE6. This process involves the utilization of traffic volume and speed data provided by the SMTC, the most recent vehicle fleet characteristics, and other traffic and meteorological parameters established by NYSDOT in cooperation with the New York State Department of Environmental Conservation (NYSDEC). MOBILE6 incorporates these parameters to develop estimated emission outputs.

The emissions modeling for the SMTC has traditionally been performed by NYSDOT–EAB during the conformity analysis process. For this analysis, however, the SMTC averaged emissions factors by road type and speed, and developed emission factors for Volatile Organic Compounds (VOC) and Nitrogen Oxide (NOx) for both the Build and No-Build scenarios. Carbon Monoxide (CO) was also calculated using the same methodology. The SMTC then calculated the number of grams of CO produced for each scenario. These results can be found in Table 1.

Step #5 – Direct Energy Analysis

Direct energy represents the energy consumed by vehicles using a transportation facility (for this analysis, "facility" is defined as the roadway segments in SMTC's regional travel demand model). Indirect energy represents the energy required to construct and maintain the transportation system. For this analysis, per EAB guidelines, only the energy used in construction activities for Regionally Significant or Non-Exempt projects, including new construction, reconstruction, rehabilitation, and widening were analyzed.

Direct vehicle energy was calculated using the VMT Fuel Consumption Method as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. The calculations were based on VMT (not seasonally-adjusted) reported by the 2025 No-Build and Build scenarios and a calculated vehicle type. Vehicle classification data was based on aggregating data obtained from NYSDOT's *Mobile 6 Region 3 1999 Summer Time Emissions Factors*. NYSDOT Region 3 includes the majority of the Syracuse MPA. Therefore, it was determined those factors would accurately reflect vehicle distribution for the model. The classification data in the MOBILE6 table is based on 28 vehicle classifications, determined by EPA, which is not directly comparable to the three vehicle types used in the direct energy analysis guidance. For this analysis, it was assumed that, taken together, vehicle classifications 1-5, 14-16, and 28 are equivalent to "light duty vehicles", classifications 6-9 and 17-20 are equivalent to "medium trucks", and classifications 10-13 and 21-27 represent "heavy trucks". Since the table lists percentages of type of vehicle by functional class, an average of all functional classes was calculated and then summarized to represent the percentage by the three vehicle types required for energy analysis. Each of the three vehicle types have a fuel economy rate per year based on the fuel type used.

Each scenario total VMT was multiplied by the percentage of each vehicle type to determine vehicle type VMT. That vehicle type VMT was then divided by the fuel economy rate to calculate the number of gallons of fuel used. These fuel consumption values were then converted to British Thermal Units (BTUs) by multiplying each gallon by 125,000. Finally, these total direct energy consumption (in BTUs) were summarized for all vehicles in either scenario. These results can be found in Table 2.

Step #6 – Indirect Energy Analysis

Indirect energy values are calculated for any non-exempt project where this calculation is relevant. Certain non-exempt projects, such as ridesharing, include no energy-consuming construction or maintenance activities, and therefore, an indirect energy calculation is not applicable. The intent of the indirect energy calculations is to measure the energy used in the construction of the projects included in the 2025 Build scenario. The indirect energy value of the 2025 No-Build scenario is zero; therefore, it is not possible to compute the percentage difference between the two scenarios.

Indirect vehicle energy was calculated using the Lane Mile Approach as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. In Table 4 of *Subtask 12a,* there is a table that associates a rate of Construction Energy Consumed per lane mile based on several types of improvements. The SMTC staff identified the type of improvement for each of the non-exempt projects from the 2025 Build scenario. The number of lane miles for each project was then multiplied by said rate, and a rate of Construction Energy Consumed in BTU's was calculated. Results of this analysis are shown in Table 3.

Step #7 – CO_2 Emissions Estimates from Direct Energy Consumption

Carbon dioxide (CO_2) is a product of fossil fuel combustion, as well as other processes. It is considered a greenhouse gas, as it traps heat radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming. Carbon dioxide emissions were calculated as described in *Subtask 12b: Greenhouse Gases (CO_2) Emissions Estimates Guidelines for TIPs and Plans*. The carbon dioxide emissions from direct energy consumption were based on the results calculated previously in Step 5.

Subtask 12b, Table 1 lists Carbon Emission coefficients based on vehicle type. The Direct Energy consumed (by vehicle type) was multiplied by the Carbon Emission Coefficients for both gasoline and diesel engines and then by a factor representing the amount of carbon that is oxidized. This process created a value representing total tons of carbon dioxide emitted. The results can be found in Table 4.

Step #8 – CO_2 Emissions Estimates from Indirect Energy Consumption

The indirect energy consumed as a result of the Build scenario was determined in Step 6 above. *Subtask 12b, Table 1* lists Carbon Emission coefficients based on vehicle type. Similar to Step 7 above, the indirect energy consumed was multiplied by the Carbon Emission Coefficients for diesel vehicles and then by a factor representing the amount of carbon that is oxidized. The results were the total tons of Carbon emitted. The results can be found in Table 5.

Step #9 - Documentation

A summary of the results of the quantitative analyses is presented in Table 6. These results indicate that the Build scenario of the 2025 LRTP will result in an increase in VMT, VOC, NOX, CO, and CO_2, and the amount of direct energy used by vehicles in the Syracuse MPA over the No-Build scenario. However, this is due to the inclusion of the two previously mentioned private development projects in the Build scenario that were not modeled as part of the No-Build scenario. Adoption of the LRTP's programs and policies without consideration for these two private development projects would result in a reduction of VMT in the Build scenario.

Table 1
Emission Analysis

Scenario			VMT	VOC (grams)	NOX (grams)	CO (grams)
2025 no-build	Peak		4,519,672	949,131	949,131	48,104,377
	Off-Peak		10,008,969	2,402,153	2,201,973	109,031,038
	Total		**14,528,641**	**3,351,284**	**3,151,104**	**157,135,415**

Scenario			VMT	VOC (grams)	NOX (grams)	CO (grams)
2025 build	Peak		4,707,573	988,590	988,590	50,104,269
	Off-Peak		10,415,115	2,499,628	2,291,325	113,455,319
	Total		**15,122,688**	**3,488,218**	**3,279,916**	**163,559,588**
2025 build with off-model transit, bike/ped, and TSE assumptions	bike/ped reduction*		-30,245	-7,127	-1,563	-17,035
	transit reduction	increased ridership**	-410,650	-96,770	-21,217	-231,295
		conversion to hybrid vehicles***	N/A	N/A	-16,509	-29,488
	TSE reduction****		-29,568	-6,483	-1,421	-15,495
	Total		**14,652,225**	**3,377,838**	**3,239,206**	**163,266,274**

Avg. Emission Factors*****			
	35 mph	40 mph	Subtractive******
VOC	0.21	0.24	0.24
NOx	0.21	0.22	0.22
CO	10.64	10.89	10.90

*bike/ped reduction assumes decrease of 2% VMT in 2025 build scenario
**transit reduction assumes 32,852 daily riders with 12.5 mile average trip length in 2025 build scenario
***NOX and CO reductions from Centro conversion to diesel-electric hybrid vehicles based on emission factor of 1.19 for NOX and 0.008 for CO as per EAB guidance
****Truck Stop Electrification (TSE) at local Thruway Service Plazas accounts for 56 miles saved per truck using the facilities, according to NYSTA estimates
*****Emission factors were determined by an average of factors by road type for each speed
******Subtractive emission factors were developed as a function of peak versus off peak emission factors

Table 2
Direct Vehicle Energy

Scenario	Total VMT	Light Duty Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2025 no-build	14,528,641	91.94%	13,356,906	21.13	632,130	79,016,246,919	0.85
2025 build	14,652,225	91.94%	13,470,523	21.13	637,507	79,688,375,850	

Scenario	Total VMT	Medium Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2025 no-build	14,528,641	2.51%	364,185	8.58	42,446	5,305,719,822	0.85
2025 build	14,652,225	2.51%	367,282	8.58	42,807	5,350,851,399	

Scenario	Total VMT	Heavy Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2025 no-build	14,528,641	5.56%	807,550	5.96	135,495	16,936,877,354	0.85
2025 build	14,652,225	5.56%	814,420	5.96	136,648	17,080,946,020	

Scenario	Total VMT	All Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2025 no-build	14,528,641	100.00%	14,528,641	n/a	810,071	**101,258,844,095**	**0.85**
2025 build	14,652,225	100.00%	14,652,225	n/a	816,961	**102,120,173,269**	

Notes:

*From Table 2 - Fuel Correction Factors NYSDOT Subtask 12a: Energy Analysis Guidelines for TIPs and Plans

%of total: Vehicle split was estimated based on aggregating the 27 vehicle types from the 1999 Summer Time Vehicle Distributions Region 3, April, 2004 NYSDOT and then averaging their percentages.

Vehicle Type VMT: Calculated by multiplying the percentage of each type vehicle by the total VMT.

Fuel Used: Calculated by dividing Vehicle VMT by the fuel economy.

Direct Energy Consumption: Calculated by multiplying the rate of 125,000 BTU per gallon by the fuel used .

2025 Build scenario includes off model transit and bike/ped assumptions.

Table 3
Indirect Energy

Roadway Construction Energy Consumed

Project Description	Type of Improvement	Distance (miles)	Lanes	Lane Miles	Urban / Rural	Constr. Energy per Lane Mile (rate)	Constr. Energy Consumed (BTUs)
Kirkpatrick/Court/Solar Streets (City of Syracuse)	Reconstruction	1.0	2	2.0	Urban	6	12,000,000,000
Route 31 Over Seneca River - Belgium Bridge (NYSDOT)	Bridge Replacement, Widen from 2 lanes to 5	1.5	5	7.5	Urban	15.24	114,300,000,000
Route 5 & 92 (NYSDOT)	Safety Improvement, Widen Exit Ramp	0.2	1	0.2	Urban	15.24	3,048,000,000
							129,348,000,000

Projects with no construction

Project Description	Type of Improvement
Lakefront Area Transportation Planning	Planning for DestiNY Project
Creekwalk Study, Kirk Park to Armory	Planning Study
Regional Ridesharing Program (Connections)	TDM Activities
City of Syracuse Bridge Painting	Maintenance
NYSDOT Bridge Painting 02/03	Maintenance
NYSDOT Bridge Painting 03/04	Maintenance
NYSDOT Bridge Painting 04/05	Maintenance

	Constr. Energy Consumed (BTUs)
Total	**129,348,000,000**

Notes:

Indirect energy analysis based on non-exempt construction projects in the SMTC 2003-2006 TIP

Indirect vehicle energy was calculated using the Lane Mile Approach as described in Subtask 12a: Energy Analysis Guidelines for TIPs and Plans. Table 4 of Subtask 12a provides a table that associates a rate of Construction Energy Consumed per lane mile based on several types of improvements. The number of lane miles for each project then multiplied that rate, and a rate of Construction Energy Consumed in BTU's was calculated.

Table 4
CO_2 Emissions From Direct Energy Consumption

Scenario	Direct Energy (BTUs) Light Duty Vehicle	Direct Energy (BTUs) Medium Truck	Direct Energy (BTUs) Heavy Truck	Carbon Emission Coefficients * Light Duty Vehicle	Carbon Emission Coefficients * Medium Truck	Carbon Emission Coefficients * Heavy Truck	Metric Tons Carbon Emitted Light Duty Vehicle	Metric Tons Carbon Emitted Medium Truck	Metric Tons Carbon Emitted Heavy Truck	Total Metric Tons Carbon Emitted Light Duty Vehicle	Total Metric Tons Carbon Emitted Medium Truck	Total Metric Tons Carbon Emitted Heavy Truck	Total Tons Carbon Emitted Light Duty Vehicle	Total Tons Carbon Emitted Medium Truck	Total Tons Carbon Emitted Heavy Truck	Total Tons Carbon Emitted All Vehicles
2025 no-build	79,016,246,919	5,305,719,822	16,936,877,354	19.34	19.95	19.95	1,528	106	338	1,513	105	335	1,667	115	369	**2,151**
2025 build	79,688,375,850	5,350,851,399	17,080,946,020	19.34	19.95	19.95	1,541	107	341	1,526	106	337	1,681	116	372	**2,170**

Difference: 2025 no-build minus build **18**

* For this analysis, all Light Duty Vehicles are assumed to use gasoline and all trucks are assumed to use diesel

2025 Build scenario includes off model transit and bike/ped assumptions.

Table 5
CO_2 Emissions Estimates from Indirect Energy Consumption

Scenario	Indirect Energy (BTUs)	Carbon Emission Coefficient	Metric Tons Carbon Emitted	Total Metric Tons Carbon Emitted	Total Tons Carbon Emitted
2025 build	129,348,000,000.00	19.95	2,580.49	2,554.69	**2,815.27**

* For this analysis, all Light Duty Vehicles are assumed to use gasoline and all trucks are assumed to use diesel

Table 6
Summary

		Energy		Greenhouse Gas (CO_2) Emissions	
Scenario	VMT	Direct (BTUs)	Indirect* (BTUs)	Direct (tons)	Indirect (tons)
2025 no-build	14,528,641	101,258,844,095	0	2,151	0
2025 build	14,652,225	102,120,173,269	129,348,000,000	2,170	2,815
Change (build-no build)	123,584	861,329,174	--	18	--
% Change (build-no build)	0.85%	0.85%	--	0.85%	--

** The intent of the indirect energy and greenhouse gas calculations was to measure the impact of the construction of the projects in the SMTC Long-Range Plan. The indirect energy used in the 2025 No-Build scenario is zero (as is the greenhouse gas emissions arising from the indirect energy used); therefore it is not possible to compute the percentage difference between the two scenarios.*

2025 Build scenario includes off model transit and bike/ped assumptions.