

***TRANSPORTATION TOMORROW 2035 ~  
CREATING A SUSTAINABLE FUTURE***

APPENDIX 3

ENERGY AND GREENHOUSE GAS  
ANALYSIS

## Energy and Greenhouse Gas Analysis

### Methodology

In order to comply with the New York State Energy Plan, BMTS conducted an analysis of Energy and Greenhouse Gas Emissions as they relate to the Long Range Plan (Transportation Tomorrow 2035-Creating a Sustainable Future). The methodology for this analysis is outlined in two documents published by the New York State Department of Transportation:

*Development of Revised NYSDOT Energy Analysis Guidelines, Subtask 12a: Energy Analysis Guidelines for TIPS and Plans*; and *Development of Revised NYSDOT Energy Analysis Guidelines, Subtask 12b: Greenhouse Gas Emissions Estimates Guidelines for TIPS and Plans*.

The Energy and Greenhouse Gas Analysis was conducted for the future scenario using data derived from special population and land use forecasts as prepared by the economic forecasting firm Global Insight, for the New York State Department of Transportation. Both the base year and 2035 scenarios were evaluated for energy consumption and greenhouse gas emissions. The geographic extent of both analyses conforms to the area covered by the BMTS Travel Model i.e., the Binghamton Adjusted Urban Area (UZA).

The 2035 land use scenario was evaluated for a “build” condition, i.e., transportation improvements considered likely to be implemented within the time span of the Long Range Plan. In addition, the 2035 land use scenario was evaluated for “no-build” conditions, i.e., no change in the transportation network from base year (existing) conditions.

The Energy and Greenhouse Gas Analysis was conducted using an extension to the Motor Vehicle Emission Simulator (MOVES) software package developed by the United States Environmental Protection Agency, the MOVES Roadway and Rail Energy and Greenhouse Gas Analysis Extension (MOVES-RREGGAE). MOVES-RREGGAE is a travel demand model post-processor that uses output data, as derived from the BMTS travel model, to project Binghamton-area transportation energy consumption and greenhouse gas emissions, for both base year, and future year (2035) conditions.

The Energy Analysis consists of two basic sets of calculations. The first set of calculations is used to estimate the amount of energy consumed by vehicles using the road network, and is termed Direct Energy.

The Direct Energy analysis uses travel demand output data to estimate the amount of energy consumption. Vehicle-miles traveled and average speed data for each model network road segment are input into the MOVES-RREGGAE post-processor with the functional classification of each road segment as a basis for the emissions calculations. The vehicle type/fuel distributions used for these calculations were based on the default NYSDOT/NYSDEC determined vehicle distributions for the Binghamton region for the duration of the Long Range Plan.

The second set of Energy Analysis calculations addresses the amount of energy consumed in the course of constructing and maintaining a transportation system. This type of energy consumption is termed Indirect Energy.

In the analysis conducted for the Transportation Tomorrow 2035 Long Range Plan, the Indirect Energy consumption is calculated only for major transportation improvements likely to be implemented within the time span of the Long Range Plan, as it is assumed that maintenance and TSM type projects would occur under both build and no-build conditions.

The Indirect Energy figure is expressed in the amount of BTUs needed to complete each transportation construction project, and is determined by using the lane-mile construction calculations included in the MOVES-RREGGAE software package, in order to calculate the energy consumption projected to occur for a specific type of construction action. The figures for each construction project are then totaled to determine an area-wide figure for Indirect Energy consumption over the duration of the long range plan.

Greenhouse gas emissions (carbon dioxide) are also calculated for direct consumption and for indirect consumption, and are expressed in terms of carbon dioxide equivalent metric tons for carbon dioxide, nitrous oxide, and methane emissions, on a daily basis for Direct Greenhouse Gas emissions, and for the total of all projected construction for Indirect Greenhouse Gas emissions.

## **Results**

The results of the energy and greenhouse gas analysis are presented in the tables that follow. The results indicate that the amount of direct energy consumed, and the amount of greenhouse gases produced, will be slightly less for the Build scenario relative to the No-build scenario, for the land use conditions projected for the 2035 Scenario.

**MOVES Roadway and Rail Energy and Greenhouse Gas Analysis Extension (MOVES RREGGAE)**

Roadway Operation Detail Report: 8/3/2010 3:34:57 PM

Scenario: Long Range Plan 2010 Scenario

Analysis Year: 2010-Base Year

<b>Energy Consumption (in million BTU)</b>									
Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)			
Total Energy Consumption	2.3164E+004	2.7569E+003	8.4838E+001	6.2042E+003	3.2210E+004	2.6006E+004			
Petroleum Energy Consumption	2.2124E+004	2.6119E+003	8.4732E+001	2.7065E+003	2.7527E+004	2.4821E+004			
Fossil Fuel Energy Consumption	2.2622E+004	2.6778E+003	8.4779E+001	6.1037E+003	3.1488E+004	2.5384E+004			
<b>Emissions Summary (mass in metric tons)</b>									
Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)			
Methane (CH4)	4.8066E-002	4.5683E-002	0.0000E+000	2.7781E+000	2.8718E+000	9.3749E-002			
Nitrous Oxide (N2O)	4.6554E-002	8.8366E-002	0.0000E+000	4.3342E-002	1.7826E-001	1.3492E-001			
Atmospheric CO2	1.7463E+003	2.0719E+002	6.4954E+000	4.3117E+002	2.3912E+003	1.9600E+003			
CO2 Equivalent	1.7618E+003	2.3554E+002	6.4954E+000	5.0295E+002	2.5068E+003	2.0038E+003			

Note: The Summary Reports present only Fossil Fuel Energy Consumption, which is correlated with the CO2e increment. Total and Petroleum energy are presented here as additional information only.

**MOVES Roadway and Rail Energy and Greenhouse Gas Analysis Extension (MOVES RREGGAE)**

Roadway Operation Detail Report: 9/9/2010 10:09:37 AM

Scenario: Long Range Plan 2035 No Build Scenario

Analysis Year: 2035

**Energy Consumption (in million BTU)**

Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)
Total Energy Consumption	2.9914E+004	3.2091E+003	1.0354E+002	8.0273E+003	4.1254E+004	3.3227E+004
Petroleum Energy Consumption	2.8566E+004	3.0404E+003	1.0332E+002	3.5276E+003	3.5238E+004	3.1710E+004
Fossil Fuel Energy Consumption	2.9253E+004	3.1206E+003	1.0342E+002	7.9114E+003	4.0389E+004	3.2477E+004

**Emissions Summary (mass in metric tons)**

Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)
Methane (CH4)	4.4751E-002	5.2378E-002	0.0000E+000	3.5750E+000	3.6722E+000	9.7128E-002
Nitrous Oxide (N2O)	4.3176E-002	9.3156E-002	0.0000E+000	5.1981E-002	1.8831E-001	1.3633E-001
Atmospheric CO2	2.2560E+003	2.4126E+002	7.9249E+000	5.6046E+002	3.0657E+003	2.5052E+003
CO2 Equivalent	2.2704E+003	2.7124E+002	7.9249E+000	6.5165E+002	3.2012E+003	2.5495E+003

Note: The Summary Reports present only Fossil Fuel Energy Consumption, which is correlated with the CO2e increment. Total and Petroleum energy are presented here as additional information only.

**MOVES Roadway and Rail Energy and Greenhouse Gas Analysis Extension (MOVES RREGGAE)**

Roadway Operation Detail Report: 9/9/2010 10:12:10 AM

Scenario: **Long Range Plan 2035 Build Scenario**

Analysis Year: 2035

**Energy Consumption (in million BTU)**

Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)
Total Energy Consumption	3.0658E+004	3.2852E+003	1.0604E+002	8.2243E+003	4.2274E+004	3.4049E+004
Petroleum Energy Consumption	2.9278E+004	3.1125E+003	1.0580E+002	3.6143E+003	3.6110E+004	3.2496E+004
Fossil Fuel Energy Consumption	2.9982E+004	3.1947E+003	1.0591E+002	8.1056E+003	4.1389E+004	3.3283E+004

**Emissions Summary (mass in metric tons)**

Pollutant Name	Running Exhaust	Start Exhaust	Extended Idle	Well To Pump	TOTAL (with Well To Pump)	TOTAL (no Well to Pump)
Methane (CH4)	4.5529E-002	5.3671E-002	0.0000E+000	3.6637E+000	3.7629E+000	9.9201E-002
Nitrous Oxide (N2O)	4.3898E-002	9.5341E-002	0.0000E+000	5.3194E-002	1.9243E-001	1.3924E-001
Atmospheric CO2	2.3122E+003	2.4698E+002	8.1156E+000	5.7431E+002	3.1416E+003	2.5673E+003
CO2 Equivalent	2.3268E+003	2.7766E+002	8.1156E+000	6.6774E+002	3.2803E+003	2.6126E+003

Note: The Summary Reports present only Fossil Fuel Energy Consumption, which is correlated with the CO2e increment. Total and Petroleum energy are presented here as additional information only.

**Indirect Energy Consumption**

85,039 Million BTU

6,225 Metric Tons