Appendix H

PDCTC Energy Analysis for *Moving Dutchess*

The PDCTC used the following steps to complete the energy analysis work for *Moving Dutchess*, the long-range Metropolitan Transportation Plan for the Poughkeepsie-Dutchess County Transportation Council (PDCTC). This analysis builds on the analysis that was completed for *New Connections*, the previous long-range plan.

These steps are based on the guidance below, as provided by the New York State Department of Transportation-Environmental Science Bureau (NYSDOT-ESB). In addition to the documents below, Council staff consulted with the NYSDOT-Environmental Services Bureau (ESB).

1. Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12a: Energy Analysis Guidelines for TIPs and Plans (dated November 25, 2003)

2. Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12b: Greenhouse Gas (CO2) Emissions Estimate Guidelines for TIPs and Plans (dated November 25, 2003)

3. NYSDOT MOBILE 6.2 Emission Factors for Regional, Mesoscale, and CMAQ Project Emission Calculations, Part A, NYSDOT Environmental Science Bureau (April 2008)

Step #1 – Identify all non-exempt and regionally significant projects

The first step involved the identification of which projects would be analyzed. The Council reviewed projects based on guidance in 6NYCRR Part 240.6(h)(2) for their significance in affecting energy consumption. In general, projects such as safety improvements, resurfacing, bridge repair, and bus replacements, which maintain current levels of service or capacity, are considered **exempt** from the analysis. Similarly, projects that result in operations improvements but do not increase capacity, like an intersection widening, are also excluded from the analysis.

Regionally Significant projects are transportation projects (other than exempt projects) on a facility that serves regional transportation needs and would normally be included in the modeling of a metropolitan area's transportation network. This includes, 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 is 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.

The project list is the same as that developed for our conformity analysis, which we received concurrence on from the ICG. Figure H-1 identifies the recommendations included in the conformity analysis.

Figure H-1. Non-exempt or Regionally Significant Projects

Short-Range (2012-2015)

Metro-North Parking Improvements

- Beacon Train Station Parking Expansion (MTA/Metro-North Railroad)
- Wassaic Train Station Parking Expansion (MTA/Metro-North Railroad)

Demand Management Projects

- TDM Unit Activities (Enhanced Regional Commuter Choice, Ozone Action Days, and Regional Ridesharing Program)

Mid-Range (2016-2025)

Highway Projects

- Route 9/44/55 Interchange Reconstruction (NYSDOT)*

Demand Management Projects

- TDM Unit Activities (Enhanced Regional Commuter Choice, Ozone Action Days, and Regional Ridesharing Program)

Long-Range (2026-2040)

Highway Projects

- I-84 @ Rt. 9D Interchange Reconstruction (NYSDOT)*

Demand Management Projects

- TDM Unit Activities (Enhanced Regional Commuter Choice, Ozone Action Days, and Regional Ridesharing Program)

* Regionally significant.

Completing the energy analysis for *Moving Dutchess* meant analyzing some projects that are still in the conceptual stage. In accordance with the final transportation conformity rules by the U.S. Environmental Protection Agency (USEPA) and NYSDOT, if adequate information was available to produce reasonable assumptions, forecasts of the project impacts on vehicle miles of travel and average vehicle speeds were produced. In some cases, sufficient data was not available to properly model emissions. In these cases, the projects will be modeled as data becomes available and the results will be included when conformity is determined for updates to *Moving Dutchess* or future Transportation Improvement Programs (TIP). Future projects for which there was not enough data available to model include the Route 9-Route 44/55 interchange and the Taconic State Parkway/Rossway Rd/Tyrrel Rd interchange.

Step #2 - Transportation Modeling

To determine the impact of future projects in Dutchess County, the Council used a three-step gravity model incorporated within the TransCAD 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 data. The results generated by the model are then compared to traffic counts to calibrate the model. The Council calibrated the model to 2002 base year traffic conditions and 2010 Census data. Background documentation and technical information on the model is available at the Council's offices.

The analysis covers two scenarios: 1) 2040 No-build, and 2) 2040 Build (the horizon year of this long-range plan). The No-build scenario consists of the 2014 road network with forecasted 2040 land use conditions, while the Build scenario consists of the 2040 road network, augmented by the projects listed in Figure 1 and 2040 land use.

Projects that could not be modeled were analyzed separately and then added to the results from TransCAD to represent a more accurate Build scenario, as described in Step #3.

Step #3 – Off-model Projects

A quantitative analysis was undertaken for those recommendations in *Moving Dutchess* that could not be modeled in TransCAD. This included regionally-significant bicycle and pedestrian projects and transportation demand management (TDM) projects, as listed below. The air quality, energy, CO2 and VMT impacts of these projects were estimated based on the guidance provided by NYSDOT. The estimated impacts were added to the TransCAD model outputs in order to reflect a more accurate "Build" scenario.

Figure H-1. Off-model Projects

- Dutchess Rail Trail Stage 4 (trail and bridge)
- Harlem Valley Rail Trail- Millerton to Columbia County
- Transportation Demand Management (TDM) Programs (Enhanced Regional Commuter Choice, Ozone Action Days, and Regional Ridesharing Program)

Step #4 – Regional Emissions Modeling

To calculate the regional emissions that will result from the transportation system envisioned in *Moving Dutchess*, the model estimates the number of vehicle miles of travel (VMT). The VMT is then analyzed with the latest emissions model.

Emission estimates were determined using the MOBILE6.2 emissions model developed by the USEPA. This process involves using traffic volume and speed data provided by Council staff along with the most recent fleet characteristics and other traffic and meteorological parameters in MOBILE6.2 (established by NYSDOT in cooperation with NYSDEC). The emissions rate results from MOBILE6.2 were used in conjunction with the distribution of traffic by vehicle mix and facility type, and estimates of VMT. The results are shown in Table H-1.

Step #5 – Direct Energy Analysis

Direct energy is the energy consumed by vehicles using a transportation facility. For this analysis, the "facility" is the roadway segments in the Council's model. 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 2040 No-build and Build models and a calculated vehicle type. Vehicle classification data was based on aggregating data obtained from NYSDOT's Region 8 Vehicle Mix for Energy/GHG Analysis with NYSDOT Draft Guidelines (Based on June 2008 Emission

Factor Tables). Since NYSDOT-Region 8 includes Dutchess County, it was felt that these factors would accurately reflect vehicle distribution for the area. The classification data in the MOBILE 6.2 table is based on 28 EPA vehicle classifications, which are 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 classes 1-5, 14-15, 24 and 28 are equivalent to "light duty vehicles", classes 6-8 and 16-18 are equivalent to "medium trucks", and classes 9-13, 19-23 and 25-27 are "heavy trucks." Since the table lists percentages of type by functional class, an average of all functional classes was calculated and then summed to represent the percentage by the three vehicle types required for the energy analysis. Each of the three vehicle types have a fuel economy rate per year based on the fuel type used.

The 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 gallons of fuel used. The gallons used were then factored to British Thermal Units (BTUs) by multiplying each gallon by 125,000. Finally, the total direct energy consumption was totaled for all vehicles for each scenario. The results can be found in Table H-2.

Step #6 – Indirect Energy Analysis

Indirect energy is the energy consumed to operate a transportation system, which includes the energy required to construct and maintain a facility. For this analysis, per ESB guidelines, only the energy used in construction activities for Regionally Significant or Non-Exempt projects, including new construction, reconstruction, rehabilitation, and widening, was analyzed.

Indirect energy was calculated for all Regionally Significant and Non-exempt projects for which calculations could be made, including the off-model projects listed in Figure H-1 However, several projects, including the TDM programs, include no real construction and therefore energy could not be calculated for these. The intent of the indirect energy calculations was to measure the indirect energy used in the construction of the projects new to *Moving Dutchess* (i.e., the 2040 Build scenario).

Indirect vehicle energy was calculated using the Lane Mile Approach as described in Subtask 12a: Energy Analysis Guidelines for TIPs and Plans. Table 12 of Subtask 12a includes a table that associates a rate of Construction Energy Consumed per lane mile based on several types of improvements. We identified the type of improvement for each of the Regionally Significant and Non-exempt projects from the 2040 Build scenario. The number of lane miles for each project was multiplied by that rate, and a rate of Construction Energy Consumed in BTU's was calculated. For the off-model rail trail projects, the construction energy rates for new roads and bridges were reduced based on discussion with County Public Works staff.

Two projects, the Wassaic and Beacon Parking Expansions, had to be calculated differently since they are railroad station parking lot expansions. Their energy consumed was calculated

based on the cost of the project, their assumed energy factor, and their calculated Construction Energy Consumed.

The amount of indirect energy used to implement *Moving Dutchess* was calculated to be 248,599,820,039 BTUs. The indirect energy used in the 2040 No-build scenario is zero; therefore it is not possible to compute the percentage difference between the two scenarios.

Step #7 – Estimate CO2 Emissions from Direct Energy Consumption

Carbon Dioxide (CO2) 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 global warming. CO2 emissions were calculated as described in Subtask 12b: Greenhouse Gases (CO2) Emissions Estimates Guidelines for TIPs and Plans. The CO2 emissions from Direct Energy Consumption were based on the results calculated in Step 5.

The Direct Energy Consumed by vehicle type was taken from Step 5 above. 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 from Table H-1 and then by a factor representing the amount of carbon that is oxidized. This results in the total tons of carbon emitted, as shown in Table H-3.

Step #8 – Estimate CO2 Emissions from Indirect Energy Consumption

The CO2 emissions from Indirect Energy Consumption were based on the results calculated in Step 6. The Indirect Energy Consumed by vehicle type was taken from Step 6 above. Subtask 12b, Table 1 lists Carbon Emission coefficients based on vehicle type. The Indirect Energy consumed by vehicle type was multiplied by the Carbon Emission Coefficients from Table H-1 and then by a factor representing the amount of carbon that is oxidized. The results were the total tons of carbon emitted. The implementation of *Moving Dutchess* would result in 5,411 tons of carbon emitted, as shown in Table H-4.

Step #9 – Document and present the results of the analyses

A summary of the results of the quantitative analyses is presented in Table H-5. These results demonstrate that the projects new to *Moving Dutchess* will decrease, albeit by small amounts, VMT and the emissions of VOC, NOx, CO, and CO2, and the amount of direct energy used by vehicles in Dutchess County.

Table H-1. Emissions Analysis

Scenario	VMT	VOC* g/day	NOX* g/day	*CO** g/day
2040 No-Build	7,536,710	1,324,562	1,055,430	80,369,898
2040 Build	7,536,956	1,324,544	1,055,768	80,381,161
Off-model ped-bike projects[1]	0	-6,688	-5,245	-273,569
Off-model TDM projects[2]	-3486	-7,257	-4,536	-430,913
Adjusted 2040 Build	7,533,470	1,310,599	1,045,987	79,676,679
Difference (Adjusted 2040 - 2040 No Build	***-3,240***	***-13,963***	***-9,443***	***-693,219***

Notes:

*Adjusted based on seasonality factors (Rural facilities = 1.16, urban facilities 1.12), from NYSDOT Highway Data Services Bureau.

**CO was not adjusted based on guidance from Patrick Lentlie at NYSDOT-ESB.

[1] Includes Dutchess Rail Trail Stage 4 and Harlem Valley Rail Trail (Millerton to Columbia County)

[2] Includes Regional Commuter Choice, Ridesharing programs, Ozone Action Days, and Wassaic & Beacon Train Station Parking Expansions

Table H-2. Direct Vehicle Energy

Scenario	Total VMT	Light Duty Vehicles				
		% of Total[1]	VMT[2]	Fuel Economy[3]	Fuel Used (gallons)[4]	Direct Energy Consumption (btu)[5]
2040 No-build	7,536,710	92.38%	6,962,664	20.79	334,850	41,856,251,862
Adjusted 2040 Build	7,533,470	92.38%	6,959,671	20.79	334,706	41,838,258,035

Scenario	Total VMT	Medium Trucks				
		% of Total[1]	VMT[2]	Fuel Economy[3]	Fuel Used (gallons)[4]	Direct Energy Consumption (btu)[5]
2040 No-build	7,536,710	3.88%	292,173	8.54	34,218	4,277,301,913
Adjusted 2040 Build	7,533,470	3.88%	292,048	8.54	34,204	4,275,463,119

Scenario	Total VMT	Heavy Trucks				
		% of Total[1]	VMT[2]	Fuel Economy[3]	Fuel Used (gallons)[4]	Direct Energy Consumption (btu)[5]
2040 No-build	7,536,710	3.74%	281,873	6.51	43,306	5,413,188,119
Adjusted 2040 Build	7,533,470	3.74%	281,752	6.51	43,287	5,410,861,012

Scenario	Total VMT	All Vehicles				
		% of Total[1]	VMT[2]	Fuel Economy[3]	Fuel Used (gallons)[4]	Direct Energy Consumption (btu)[5]
2040 No-build	7,536,710	100.00%	7,536,710	n/a	412,374	**51,546,741,893**
Adjusted 2040 Build	7,533,470	100.00%	7,533,470	n/a	412,197	**51,524,582,165**

Notes:

[1] Vehicle split was estimated based on aggregating the 28 vehicle types from the Region 8 Vehicle Mix for Energy/GHG Analysis with NYSDOT Draft Guidelines (Based on June 2008 Emission Factor Tables) and then averaging their percentages.

[2] VMT calculated by multiplying the percentage of each type vehicle by the total VMT.

[3] Fuel economy from Table 2 - Fuel Correction Factors; NYSDOT Subtask 12a: Energy Analysis Guidelines for TIPs and Plans. Year 2035 data used, as it is the last year projected.

[4] Fuel Used calculated by dividing Vehicle VMT by the fuel economy.

[5] Direct Energy Consumption calculated by multiplying the rate of 125,000 BTU per gallon by the fuel used.

Table H-3. CO2 Emissions from Direct Energy Consumption

Scenario	Total Tons Carbon Emitted			
	Light Duty Vehicle	Medium Truck	Heavy Truck	All Vehicles
2040 No-build	883	93	118	1,094
Adjusted 2040 Build	883	93	118	1,094

Table H-4. CO2 Emissions from Indirect Energy Consumption

Scenario	Indirect Energy (BTUs)	Carbon Emission Coefficient*	Metric Tons Carbon Emitted	Total Metric Tons Carbon Emitted	Total Tons Carbon Emitted
2040 build	176,776,183,675	19.95	3,527	3,491	**3,848**
Off-Model Projects	71,823,636,364	19.95	1,433	1,419	**1,563**
Adjusted 2040 Build	248,599,820,039	39.90	4,960	4,910	**5,411**

* For this analysis, all construction equipment is assumed to use diesel fuel.

Table H-5. Energy Analysis Summary

		Air Pollution Emissions			Energy	Greenhouse Gas (CO_2) Emissions
Scenario	VMT	VOC g/day	NOx g/day	CO g/day	Direct (BTUs)	Direct (tons)
2040 No-build	7,536,710	1,324,562	1,055,430	80,369,898	51,546,741,893	1,094
Adjusted 2040 Build	7,533,470	1,310,599	1,045,987	79,676,679	51,524,582,165	1,094
Change (Adjusted Build-No build)	***-3,240***	***-13,963***	***-9,443***	***-693,219***	***-22,159,728***	***-0.47***
% Change (Adjusted Build-No build)	-0.04%	-1.05%	-0.89%	-0.86%	-0.04%	-0.04%