Implementation of a Regional Greenhouse Gas Reduction Analysis Tool

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Implementation of a Regional Greenhouse Gas Reduction Analysis Tool

Final Report

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16. Abstract

The project assisted two metropolitan planning organizations (MPO), the Capital District Transportation Committee (CDTC) and the Ithaca-Tompkins County Transportation Council (ITCTC), in conducting greenhouse gas (GHG) inventories and policy testing through the application of a strategic planning tool called VisionEval Rapid Policy Assessment Tool (VERPAT). The consultant assisted MPO staff in creating all input files, installing the software, and calibrating it to their adopted travel demand models. The consultant also provided training on using the tool and testing five policy scenarios. The MPOs ran VERPAT for each policy scenario and analyzed the results. The project demonstrated that VERPAT is a useful tool for MPOs in analyzing the impact of various policy initiatives on regional greenhouse gas emissions.

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Abstract

The project Implementation of a Regional Greenhouse Gas Reduction Analysis Tool was cosponsored by the New York State Energy Research and Development Authority (NYSERDA) and the New York State Department of Transportation (NYSDOT). The purpose of the research was to assist two metropolitan planning organizations (MPO), the Capital District Transportation Committee (CDTC) and the Ithaca-Tompkins County Transportation Council (ITCTC), in conducting greenhouse gas (GHG) inventories and policy testing through the application of the strategic planning tool called VisionEval Rapid Policy Assessment Tool (VERPAT). The consultant assisted MPO staff in creating all input files, installing the software, and calibrating it to their adopted travel demand models. The consultant also provided training on using the tool and testing five policy scenarios. The MPOs ran VERPAT for each policy scenario and analyzed the results. The project demonstrated that VERPAT is a useful tool for MPOs in analyzing the impact of various policy initiatives on regional greenhouse gas emissions.

Keywords

Regional Greenhouse gas Implementation Tool, metropolitan Planning organizations, Greenhouse Gas inventories, VisionEval Rapid Policy Assessment Tool (VERPAT)

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Acronyms and Abbreviations

AASHTO	American Association of State Highway Transportation Officials
CAV	connected and automated vehicle
CBP	County Business Patterns
CDRPC	Capital District Regional Planning Commission
CDTA	Capital District Transportation Authority
CDTC	Capital District Transportation Committee
DOT	Department of Transportation
E-E	external-to-external
E-I	external-to-internal
EV	electric vehicle
FHWA	Federal Highway Administration
GHG	greenhouse gas
GreenSTEP	Greenhouse Gas Strategic Transportation Energy Planning
HPMS	Highway Performance Monitoring System
HEV	hybrid electric vehicle
ICE	internal combustion engine
I-E	internal-to-external
I-I	internal-to-internal
ITCTC	Ithaca-Tompkins County Transportation Council

ITS	intelligent transportation system
JSON	JavaScript Object Notation
LRTP	long-range transportation plan
MaaS	Mobility-as-a-Service
mpg	miles per gallon
MPO	metropolitan planning organization
MTP	Metropolitan Transportation Plan
NAICS	North American Industry Classification System
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
ODOT	Oregon Department of Transportation
PHEV	plug-in hybrid electric vehicle
RPAT	Rapid Policy Assessment Tool
RSPM	Regional Strategic Planning Model
SHRP2	Second Strategic Highway Research Program
SOV	single-occupancy vehicle
TAZ	traffic analysis zone
TCAT	Tompkins County Area Transit
VERPAT	VisionEval Rapid Policy Assessment Tool
VMT	vehicle miles traveled

Executive Summary

Under Governor Cuomo's leadership, New York State made a commitment to reduce greenhouse gas (GHG) emissions 40% from 1990 levels by year 2030 and 80% by year 2050. Reducing GHG emissions from transportation is critical to meeting these goals. As Metropolitan Planning Organizations (MPO) develop their 20-year, long-range transportation plans,[1] they assess actions and policies to support the State's GHG reduction goals. The purpose of this project was to introduce the strategic planning model VisionEval Rapid Policy Assessment Tool (VERPAT)[2] to two MPOs and determine whether the tool is practical and appropriate for evaluating regional policy scenarios intended to reduce GHG emissions.

Two New York State MPOs, the Capital District Transportation Committee (CDTC) and the Ithaca-Tompkins County Transportation Council (ITCTC) participated in the study. Resource Systems Group, Inc. (RSG) worked with each MPO to help develop the input files, perform a quality control check on the data, install VERPAT, and train the MPO staff on how to run the model. Each model was calibrated by testing baseline data outputs against the MPOs' travel demand model, making adjustments as necessary to achieve an acceptable calibration. RSG then assisted the MPOs in formulating five test scenarios, running them, and evaluating the results. CDTC and ITCTC evaluated variables and scenarios that their respective travel demand models are not able assess.

Based on this study, VERPAT emerged as a useful planning tool for MPOs, providing potential effects of policy choices that could assist in decision making for long-term planning.

VERPAT has the unique ability to quickly run numerous scenarios and allows MPOs to explore GHG impacts under several policy options, test a large number of input scenarios, and change individual variables or combine several scenarios. VERPAT provides information on the following regional impacts:

- Changes to the location of population and employment in various place types, from dense urban cores to rural/greenfield areas.
- Changes to travel demand that are influenced by demographics, economics, urban form, and vehicle fleet composition including electric vehicles (EV).
- Changes to transportation supply in terms of roadway capacity and transit service coverage.
- Influence of policy initiatives, including pricing, use of intelligent transportation systems (ITS) to improve roadway operations, and proactively managing travel demand.

Through such scenario evaluations, VERPAT can help support understanding the potential effect of policy choices on GHG emissions, energy consumption, vehicle miles traveled (VMT), and other variables.

MPO Policy Findings:

CDTC determined that achieving transportation emissions reductions consistent with New York State's GHG emission targets was possible with a high level of EVs in the light-duty fleet.

The scenarios used by both MPOs confirmed their assumptions that policies aimed at land-use changes have less of an impact on GHG emissions and VMT when these are targeted to the margins of an already built environment.

VERPAT is an open-source software allowing users to contribute code. VERPAT does not charge a licensing fee, making it very cost effective. However, staff capacity as well as technical support and training is required to use the model. MPOs with staff already engaged in travel demand modeling and data input sources will likely be more successful running VERPAT. At the time of the study, VERPAT's model output was not elegantly displayed, requiring modelers to repackage the output into a user-friendly format that could be easily understood by decision makers.

In conclusion, this project demonstrated that the MPO long-range planning process can benefit from the use of VERPAT. In conjunction with other models, VERPAT fills a niche and with some staff know-how can provide useful information for little to no cost.

1 Introduction

Two of New York State's metropolitan planning organizations (MPO) received assistance to build and apply the Rapid Policy Assessment Tool (RPAT) that aids strategic planning to forecast the greenhouse gas (GHG) emissions of different policy-based scenarios. The goal of this RPAT application was to help the MPOs perform their next Metropolitan Transportation Plan (MTP) update.[3] The MTP is a long-range transportation plan (LRTP) required by federal law, stipulating that the plan must have a horizon of at least 20 years into the future, build on vision, goals, and objectives, as well as forecast future population, employment, and land use. As future transportation needs are defined, alternative solutions may be created and analyzed. From the alternative solutions, a set of proposed projects, actions, and strategies is devised, tailored to be constrained by forecasts of available funds, and adopted by the MPO.

Forecasting 20 years into the future entails uncertainty. That uncertainty has been compounded by the rapid evolution of mobility including connected and automated vehicles (CAVs), fleet electrification through adoption of electric vehicles (EVs), and shared mobility services such as Uber and Lyft. One way that MPOs are addressing uncertainty is through scenario planning. This approach was initially used to evaluate different population and land-use scenarios. For example, scenario planning could help reveal how the transportation system would function if population growth over the 20-year plan horizon were characterized by sprawl, urban infill, suburban town centers, or transit-oriented development. The same approach is now being used to analyze *what if* questions about mobility, including the percentage of EVs in the fleet and the use of ride-hailing services.

The participants in this project are the Capital District Transportation Committee (CDTC), the MPO for the Albany urbanized area, and the Ithaca-Tompkins County Transportation Council (ITCTC). The primary objective of the project was for the MPOs with the assistance of RGS to install RPAT, learn how to use the program, and develop and analyze different planning scenarios to determine GHG and other outcomes.

This report explains the steps involved in using RPAT, including data inputs, calibration, scenario development, and scenario test results.

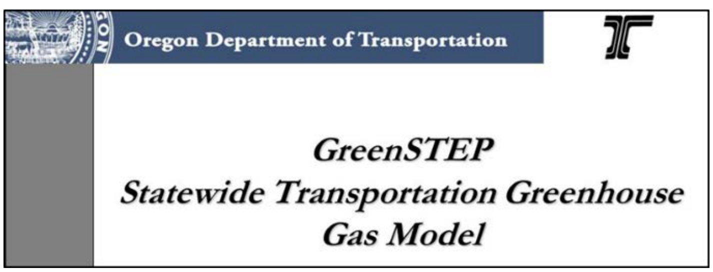
2 Strategic Planning Models

MPOs frequently use models for project development and to forecast travel demand, which in turn supports the development of their LRTPs. These models are often either traditional four-step models or activity-based models. Both are network-based models that simulate auto and sometimes transit trips using the existing and proposed roadway network.

Strategic planning models, also called sketch planning tools, serve a different purpose. These models assess trends and policy initiatives, typically at a regional or statewide scale. They also support scenario planning, an approach that the Federal Highway Administration (FHWA) encourages to help MPOs evaluate alternative futures (Bartholomew and Ewing 2010). Because strategic planning models use high-level geography rather than a network, they can rapidly evaluate multiple alternative scenarios. This capability helps planners and policy makers understand likely outcomes of different policy choices.

The first of these models was the GreenSTEP (Greenhouse gas Strategic Transportation Energy Planning) model. This model, developed by the Oregon Department of Transportation (ODOT), evaluates the effect of policy actions on greenhouse gas (GHG) emissions by light-duty vehicles at the state level. Its inputs include VMT, fleet mix, fuel type, price, and land-use factors. ODOT then developed the Regional Strategic Planning Model (RSPM) to perform similar functions at the metropolitan level. These models are written in the R programming language and are open source; they are reasonably easy to use for anyone with knowledge of R programming.

Figure 1. Screenshot of Oregon Department of Transportation GreenSTEP Statewide Transportation Greenhouse Gas Model Website



2.1 Rapid Policy Assessment Tool (RPAT)

- RPAT, developed under the Strategic Highway Research Program (SHRP2), project C16, is the focus of this project. RPAT was originally developed to model how smart-growth strategies might affect demand for highway capacity investment in a region.

RPAT is a tool for evaluating the impact of various regional growth policies. With a broad regional focus, RPAT evaluates policy scenarios and identifies those that an MPO may carry forward in their planning process. RPAT provides information on the following regional impacts:

- Changes to the location of population and employment in various place types, from dense urban cores to rural/greenfield areas.
- Changes to travel demand that are influenced by demographics, economics, urban form, and vehicle fleet composition.
- Changes to transportation supply in terms of roadway capacity and transit service coverage.
- Influence of policy initiatives, including pricing, use of intelligent transportation systems (ITS) to improve roadway operations, and proactively managing travel demand.

2.1.1 RPAT Enhancement

The original version of RPAT did not include EVs in its fleet mix. Instead, the model was focused on land-use choices, especially those that represent smart-growth strategies, such as infill development and transit-oriented development. However, given the importance of GHG emissions as a measurable outcome of alternative scenarios, all parties agreed that the project scope would be modified to enable RSG software developers to add this capability to RPAT. The enhancement was completed.

2.2 VisionEval

Both RPAT and RSPM require ongoing maintenance and enhancement of the models. The SHRP2 Solutions program addressed this challenge, and the American Association of State Highway and Transportation Officials (AASHTO) now houses the models in its TravelWorks website (TravelWorks: Advanced Travel Analysis Tools n.d.). VisionEval was created as an open-source programming platform to house RPAT and RSPM. It is maintained through the Collaborative Development of New Strategic Planning Models, a pooled fund hosted by FHWA. The pooled fund includes seven states and three MPOs and has the potential for others to join. This funding mechanism provides additional certainty that RPAT will be maintained into the future and that programmers may create new capabilities. This project was completed using VisionEval RPAT (VERPAT).

Figure 2. VisionEval and Travelworks Logos

3 Project Scope and Process

The project scope included five sequential tasks:

1. Develop VERPAT input files (Tech Memo 1: see Appendix A)
2. Install and calibrate the VERPAT model (Tech Memo 2: see Appendix B)
3. Develop and test five scenarios
4. Train MPO staff to independently operate VERPAT
5. Final report

RSG provided support to CDTC and ITCTC to complete Tasks 1 through 4.

3.1 VERPAT Input Files

Task 1 in the NYSERDA/NYSDOT project, Implementation of a Regional Greenhouse Gas Reduction Analysis Tool, was the assembly of the data input files necessary to run RPAT. In the course of the project, RPAT was moved to the VisionEval platform (VERPAT). VERPAT examines the effects of different policy options on transportation-related measures, including VMT, congestion, GHG emissions, and safety. This required minor changes to some of the input files that had already been prepared as the format had changed. The data remained unchanged.

RSG helped CDTC and ITCTC collect the input data for their regional VERPAT model. The model requires data on existing conditions and future forecasts. While the model is simpler to implement than a traditional travel demand model, many data sources are often needed to define all the input data. Technical Memo 1 (appendix A) explains the input data and details where CDTC and ITCTC found the data for their respective models.

VERPAT contains 17 user input files, nine input parameters that the user defines, and 18 model parameter files that are typically left unchanged. A description of each of these files, including information on input data and possible data sources, can be found on the GitHub wiki[4] (VisionEval n.d.).

Each input file contains one or more lines of data for the model. Most files contain variables that must be defined. Both MPOs used their regional travel demand model to define input data, where applicable, and both used data from additional sources. The next section provides a brief description of each input file. The following two sections describe the data sources each MPO used and discuss obstacles and issues that the MPOs encountered during the process.

3.1.1 Input Data

The scenario inputs contain four categories: built environment, demand, transport supply, and policy. These inputs are specified in two ways. CSV inputs are specified in a .csv file and JavaScript Object Notation (JSON) inputs are specified in the model_parameters.json file.

Some inputs, such as the csv file azone_gq_pop_by_age.csv or the czone locations, are not used in VERPAT, but they are required for the VisionEval framework. These files are described as "Not used—keep default," and the default files should not be changed in these cases.

Table 1. VERPAT Input Files

Category	Data Name	File Name	Description
Built Environment	Population and jobs by place type	bzone_pop_emp_prop.csv	Base distribution and future-year growth of population and jobs across the 13 place types
Demand	**CSV Files**		
	Auto and Transit Trips per Capita	region_trips_per_cap.csv	Average number of auto and transit trips per person per day in the region
	Employment (Existing)	azone_employment_by_naics.csv	Existing employment and number of firms in the region
	Relative Employment	azone_relative_employment.csv	Not used—keep default
	Population (Existing and Growth)	azone_hh_pop_by_age.csv	Base and future population in the region by age group
	Group Quarters	azone_gq_pop_by_age.csv	Not used—keep default
	Household Size	azone_hhsize_targets.csv	Not used—keep default
	Regional Income	azone_per_cap_inc.csv	Average per capita income for the base year and future year
	Truck and Bus VMT	region_truck_bus_vmt.csv	Truck and bus VMT in the region and split between functional classes
	model_parameters.json Variables		
	Base Daily VMT	BaseLtVehDvmt	Base-year VMT by autos in the region
	Freeway + Arterial VMT Proportion	BaseFwyArtProp	VMT proportion by functional class
	Employment Growth	EmploymentGrowth	Employment growth multiplier
Transport Supply	Road Lane Miles	marea_lane_miles.csv	Supply of freeways and arterials in lane miles
	Transit Revenue Miles	marea_rev_miles_pc.csv	Transit service in revenue miles by bus and rail

Table 1 continued

Category	Data Name	File Name	Description
Policy	**CSV Files**		
	Travel Demand Management Options	region_commute_options.csv	Participation levels and other parameters describing various workplace commuting programs
	% Road Miles with ITS Treatment	azone_its_prop.csv	Proportion of the freeway and arterial networks with ITS for incident reduction
	Bicycling/Light-Vehicle Targets	region_light_vehicles.csv	Bike ownership targets and parameters to describe effects of policies to encourage bicycling
	Increase in Parking Cost and Supply	marea_parking_growth.csv	Pricing and participation in various parking charging policies
	model_parameters.json Variables		
	Auto Ownership Cost Growth	AutoCostGrowth	Growth in car ownership costs, not including inflation
	Freeway Lane Miles Growth	FwyLaneMiGrowth	Change in freeway lane miles
	Arterial Lane Miles Growth	ArtLaneMiGrowth	Change in arterial lane miles
	Bus Revenue Miles Growth	BusRevMiPCGrowth	Change in bus revenue miles
	Rail Revenue Miles Growth	RailRevMiPCGrowth	Change in rain revenue miles
	Auto Operating Surcharge per VMT	VmtCharge	VMT charges levied on drivers

3.1.2 General Data Considerations

The bzone_pop_emp_prop.csv file contains base-year and future-year data on place types. The base-year rows are the proportion of the population and proportion of jobs in each place type. The future-year rows are the proportion of growth in each place type.

Several inputs, such as region_commute_options.csv, region_light_vehicles.csv, and BaseFwyArtProp, contain proportions of the population in decimal form. The decimal 0.05 means 5% of the population. This format was not always clear to the MPOs.

Some inputs, such as BaseFwyArtProp, could have used a nationally available data set (e.g., the Highway Performance Monitoring System [HPMS]) or the regional model. The MPOs both decided that the data in their own models would be more accurate than data provided by a national agency.

3.1.3 CDTC Data Inputs and Issues Encountered

CDTC relied on multiple data sources, including national data sets, its regional model, regional plans, local knowledge, and assumptions. CDTC adopted a base year of 2015 and a future year of 2050 to match the upcoming update of their LRTP, New Visions.

3.1.3.1 Bzone/Place Type

VisionEval defines four area types: azone, bzone, czone, and marea. Azone is the entire region, bzone includes the 13 place types, czone is not used in VERPAT, and marea is the metropolitan area, which is equivalent to azone for VERPAT. Because RPAT was originally developed to model outcomes of smart-growth policies, place type was important. Place types describe the density and land use of a location (e.g., suburban residential or urban mixed use). A precise definition or defining thresholds do not exist for place types, so defining them can appear subjective. CDTC used the descriptions of each place type, and the relative differences between locations in its region, to categorize each traffic analysis zone (TAZ) in its regional travel demand model as a place type.

3.1.3.2 Azone/Multiple Counties

The CDTC planning area comprises four counties. The azone designation is for counties within the region to be modeled or for the entire region itself. Where the azone name is required in input files, the user may aggregate all counties' data into one regional value (e.g., "CDTC Region"). The user must be consistent in their approach across all files. "CDTC Region" cannot be used in one place if the individual counties are used in a different place.

3.1.3.3 Employment Data

The employment data describe the total number of employees and the number of different-sized employers within the region. The main source of these data was the U.S. Census Bureau's County Business Patterns (CBP). CDTC also had employment data from the Capital District Regional Planning Commission (CDRPC); these data were based on data from the U.S. Bureau of Labor Statistics. The total number of employees in the CBP and CDRPC data was similar but did not match. CDTC used the CDRPC number of employees since other parts of their regional travel demand model already used the data. However, CBP data were used for the number of employers of each size. CBP data can undercount government establishments, so CDTC added the State as an employer. CBP data are aggregated by county and by North American Industry Classification System (NAICS) code. The input file can contain multiple counties as azones and multiple NAICS codes. Both the county and the NAICS data can also be summed so that each county has one row or the region has one row. CDTC summed their data across counties and NAICS codes so the employment file has one row.

3.1.3.4 Future-Year Income

CDTC was unsure of income growth out to the future year, which is used in the azone_per_cap_inc.csv file. To derive income growth, CDTC used historical trends and extrapolated future-year income levels. After finding higher future-year VMT than expected, they adjusted the 2050 income levels to calibrate the VMT growth between the base year and future year. CDTC decided to use zero% income growth based on their assertion that increased income will not lead to increased VMT in the future.

3.1.3.5 Vehicle MPG File

The model_veh_mpg_by_year.csv file contains vehicle fuel economy as miles per gallon (mpg) data through year 2050. VERPAT requires mpg data one year beyond the future year, so an additional line, year 2051, was added to the model_veh_mpg_by_year.csv file. This line was identical to the 2050 line.

3.1.3.6 Base-Year Simulation

VERPAT can simulate base-year output and future-year output. The same input variables are used, but rows of future-year data must be removed (e.g., azone_hh_pop_by_age.csv will only have a 2015 row and no 2050 row).

3.1.3.7 Lane Miles Growth

Base-year lane miles are defined in marea_lane_miles.csv. Although this file has a place for future-year lane miles, it is not used. It is a placeholder required in the VisionEval framework and should be equivalent to the base-year line. The JSON parameters FwyLaneMiGrowth and ArtLaneMiGrowth define future-year growth in lane miles. VERPAT assumes that freeway and arterial growth will follow population growth, and these numbers are the proportion of population growth that should be included for freeway and arterial growth. A value of one means that they will grow at the same rate as the population. A value of zero means that they will not grow and will stay the same as the base year.

3.1.3.8 Inflation/Constant Dollar Value

All dollar values in VERPAT must be attached to a year to account for inflation. The year is defined by the heading in the input value; for example, ParkingCost.2000 and parkingCost.2015 are the cost for parking in year 2000 dollars and parking in year 2015 dollars, respectively. The year of a dollar value is an important consideration when defining input data.

3.1.3.9 Data Sources

Table 2 shows CDTC's source(s) of data for each of the model inputs. Some input files, listed separately, contain multiple pieces of data. Where a data name or description is self-explanatory, it is not included.

Table 2. CDTC Data Sources

File/Param. Name	Data Name	Source	Description
bzone_pop_ emp_prop.csv	2015	Census/CDRPC	2015 population and jobs
bzone_pop_ emp_prop.csv	2050	CDRPC	2050 population and jobs growth
region_trips_ per_cap.csv	Veh. and Transit	National Household Travel Survey	Auto and transit trips per person per day
azone_employment_ by_naics.csv	Not applicable	CBP (US Census Bureau n.d.)	Existing employment and number of firms in the region
azone_hh_pop_ by_age.csv	2015	CDRPC	2015 population in the region by age group
azone_hh_pop_ by_age.csv	2050	CDRPC	2050 population in the region by age group
azone_per_cap_ inc.csv	2015	Bureau of Economic Analysis (US Bureau of Economic Analysis n.d.)	2015 income per capita in the region
azone_per_cap_ inc.csv	2050	Based on calibration	2050 income per capita in the region
region_truck_ bus_vmt.csv	BusVMT	Keep Default	Bus VMT by functional class
region_truck_ bus_vmt.csv	TruckVMT	Keep Default	Truck VMT by functional class
BaseLtVehDvmt	Not applicable	Regional Model	2015 auto VMT
BaseFwyArtProp	Not applicable	Regional Model	VMT by functional class
EmploymentGrowth	Not applicable	CDRPC	Employment growth multiplier

Table 2 continued

File/Param. Name	Data Name	Source	Description
marea_lane_ miles.csv	Year[5]	Regional Model	Freeway/arterial lane miles
marea_rev_ miles_pc.csv	BusRevMiPC[5]	Capital District Transportation Authority (CDTA)	Bus revenue miles per capita
marea_rev_ miles_pc.csv	RailRevMiPC	No rail in region	Rail revenue miles per capita
region_commute _options.csv	Ridesharing Participation	CDTC	Not applicable
region_commute _options.csv	Transit Subsidy Participation	CDTA	Not applicable
region_commute _options.csv	Transit Subsidy Level	CDTA	Not applicable
region_commute _options.csv	Schedule 980 Participation	None in Base Scenario	Percentage of workers who work 80 hours in 9 days
region_commute _options.csv	Schedule 440 Participation	None in Base Scenario	Percentage of workers who work 40 hours in 4 days
region_commute _options.csv	Telecommute 1.5 Days Participation	None in Base Scenario	Percentage of workers who telecommute 1.5 days/week
region_commute _options.csv	Vanpooling Low Level Participation	CDTC	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
region_commute _options.csv	Vanpooling Med Level Participation	None in Base Scenario	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
region_commute _options.csv	Vanpooling High Level Participation	None in Base Scenario	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
azone_its_prop.csv	Year	Regional plans	Proportion of freeway and arterial networks with ITS
region_light_ vehicles.csv	TargetProp	CDTC	Nonmotorized vehicle ownership rate
region_light_ vehicles.csv	Threshold	CDTC	Single-occupancy vehicle (SOV) trip length suitable for a light vehicle
region_light_ vehicles.csv	PropSuitable	CDTC	Proportion of SOV trips suitable for a light vehicle

Table 2 continued

File/Param. Name	Data Name	Source	Description
marea_parking_growth.csv	PropWorkParking	CDTC	Proportion of workers who park
marea_parking_growth.csv	PropWorkCharged	CDTC	Proportion of parkers who are charged at work lot
marea_parking_growth.csv	PropCashOut	CDTC	Proportion of workers in parking buyout programs
marea_parking_growth.csv	PropOtherCharged	CDTC	Proportion of parkers who are charged at nonwork space
marea_parking_growth.csv	ParkingCost	CDTC	Parking cost
AutoCostGrowth	Not applicable	Assumed unchanged	Growth in car ownership costs
FwyLaneMiGrowth	Not applicable	CDTC Regional Plan	Growth in freeway lane miles
ArtLaneMiGrowth	Not applicable	CDTC Regional Plan	Growth in arterial lane miles
BusRevMiPCGrowth	Not applicable	CDTC Regional Plan	Growth in bus revenue miles
RailRevMiPCGrowth	Not applicable	CDTC Regional Plan	Growth in rail revenue miles
VmtCharge	Not applicable	None in base scenario	Fee assessed for miles driven

3.1.4 ITCTC Data Inputs and Issues Encountered

ITCTC relied on several data sources, including national data sets, proprietary data they acquired for planning work, their regional travel demand model, regional plans, local knowledge, and assumptions. They have a base year of 2015 and a future year of 2040.

3.1.4.1 Bzone/Place Type

ITCTC also struggled at first with apportioning its land into place types. After the RSG research team reviewed each place type's definition in more detail, they were comfortable assigning a place type to each TAZ in their regional travel demand model.

3.1.4.2 Employment Data

ITCTC found that their employment data did not show employers in the largest categories even though they knew that such large employers existed in their region. They manually added these large employers.

3.1.4.3 Future-Year Income

ITCTC originally used Woods and Poole data (a proprietary socioeconomic data set) to project future-year income in the azone_per_cap_inc.csv file. This estimated a 38% increase in average income or 1.3% per year compounded annually. The average change per year over the last 17 years was 1.18% according to the U.S. Bureau of Economic Analysis, so the data from Woods and Poole seemed high. After calibration, ITCTC used an annual growth rate of 0.25%. This is lower than historical trends and represents the assumption that future income growth will not have as large of an effect on VMT as it does now.

3.1.4.4 Data Sources

Table 3 shows ITCTC's source(s) of data for each of the model inputs. Some input files, listed separately, contain types of data.

Table 3. ITCTC Data Sources

File/Param. Name	Data Name	Source	Description
bzone_pop_ emp_prop.csv	2015	Regional Model	2015 population and jobs
bzone_pop_ emp_prop.csv	2040	Regional Master Plan/Municipalities	2040 population and jobs growth
region_trips_ per_cap.csv	Veh. and Transit	National Household Travel Survey	Auto and transit trips per person per day
azone_employment_ by_naics.csv	Not applicable	US Dept. of Labor, Woods and Poole (Woods & Poole Economics n.d.) proprietary data set	Existing employment and number of firms in the region
azone_hh_pop_ by_age.csv	2015	Woods and Poole	2015 population in the region by age group
azone_hh_pop_ by_age.csv	2040	Woods and Poole	2040 population in the region by age group
azone_per_cap_ inc.csv	2015	Woods and Poole	2015 income per capita in the region
azone_per_cap_ inc.csv	2040	Based on calibration	2040 income per capita in the region
region_truck_ bus_vmt.csv	BusVMT	Transit Authority	Bus VMT by functional class
region_truck_ bus_vmt.csv	TruckVMT	State department of transportation (DOT) classification counts	Truck VMT by functional class
BaseLtVehDvmt	Not applicable	Regional Model	2015 auto VMT
BaseFwyArtProp	Not applicable	Regional Model	VMT by functional class
EmploymentGrowth	Not applicable	Woods and Poole	Employment growth multiplier

Table 3 continued

File/Param. Name	Data Name	Source	Description
marea_lane_ miles.csv	Year[5]	State DOT Pavement Data	Freeway/arterial lane miles
marea_rev_ miles_pc.csv	BusRevMiPC[5]	Tompkins Consolidated Area Transit	Bus revenue miles per capita
marea_rev_ miles_pc.csv	RailRevMiPC	No rail in region	Rail revenue miles per capita
region_commute _options.csv	Ridesharing Participation	Census American Community Survey	Not applicable
region_commute _options.csv	Transit Subsidy Participation	Tompkins Consolidated Area Transit	Not applicable
region_commute _options.csv	Transit Subsidy Level	Tompkins Consolidated Area Transit	Not applicable
region_commute _options.csv	Schedule 980 Participation	None in Base Scenario	Percentage of workers who work 80 hours in 9 days
region_commute _options.csv	Schedule 440 Participation	None in Base Scenario	Percentage of workers who work 40 hours in 4 days
region_commute _options.csv	Telecommute 1.5 Days Participation	None in Base Scenario	Percentage of workers who telecommute 1.5 days/week
region_commute _options.csv	Vanpooling Low Level Participation	Default	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
region_commute _options.csv	Vanpooling Med Level Participation	Default	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
region_commute _options.csv	Vanpooling High Level Participation	Default	Percentage of workers who participate in low-, medium-, or high-level vanpooling programs
azone_its_prop.csv	Year	Regional plans	Proportion of freeway and arterial networks with ITS
region_light_ vehicles.csv	TargetProp	Regional knowledge/defaults	Nonmotorized vehicle ownership rate
region_light_ vehicles.csv	Threshold	Regional knowledge/defaults	SOV trip length suitable for a light vehicle
region_light_ vehicles.csv	PropSuitable	Regional knowledge/defaults	Proportion of SOV trips suitable for light vehicle
marea_parking_ growth.csv	PropWorkParking	Spoke with major parking generators	Proportion of workers who park
marea_parking_ growth.csv	PropWorkCharged	Spoke with major parking generators	Proportion of parkers who are charged at work lot
marea_parking_ growth.csv	PropCashOut	Spoke with major parking generators	Proportion of workers in parking buyout programs
marea_parking_ growth.csv	PropOtherCharged	Spoke with major parking generators	Proportion of parkers who are charged at nonwork space

Table 3 continued

File/Param. Name	Data Name	Source	Description
marea_parking_growth.csv	ParkingCost	Spoke with major parking generators	Parking cost
AutoCostGrowth	Not applicable	Assumed value	Growth in car ownership costs
FwyLaneMiGrowth	Not applicable	State and local plans	Growth in freeway lane miles
ArtLaneMiGrowth	Not applicable	State and local plans	Growth in arterial lane miles
BusRevMiPCGrowth	Not applicable	Tompkins Consolidated Area Transit	Growth in bus revenue miles
RailRevMiPCGrowth	Not applicable	No rail	Growth in rail revenue miles
VmtCharge	Not applicable	None in base scenario	Fee assessed for miles driven

RSG performed a quality control review of all the input files submitted by both MPOs and resolved all questions and concerns through an iterative process.

3.2 VERPAT Installation and Calibration

VERPAT was installed remotely by RSG staff on host computers at each MPO's office. No issues arose in the installation. RSG then assisted CDTC and ITCTC with calibrating their regional VERPAT model.

3.2.1 Calibration Methodology

The VERPAT model is calibrated by comparing model outputs with target data from sources the MPO has formally accepted or deemed credible. Target data can include the following:

- Household VMT
- VMT growth
- Auto or transit trips
- Average vehicle ownership

Both CDTC and ITCTC used their regional travel demand model as the source of their target data. These models have been calibrated to ground counts and are accepted as accurate. Both MPOs then used household VMT and VMT growth as the calibration metrics for this project.

Calibrating the VERPAT model to target data required the MPOs to adjust input data such that the base-year model output converges with the target data to an accepted level of accuracy. Calibration of VERPAT relies on a credible set of base data.

3.2.1.1 Base Year

Calibration requires adjusting base-year variables to match base-year output with base-year targets. Both CDTC and ITCTC used household VMT as their target data point.

VERPAT contains a household microsimulation routine that models household trips and miles traveled. These data points are compared to the VMT output of the MPO's travel demand model. One major difference between VERPAT and travel demand models is that the VERPAT model only looks at households within the MPO-defined region, while travel demand models typically also include external trips. The VERPAT model includes some internal-to-external (I-E) and external-to-internal (E-I) trips, but the exact number cannot be known. Because some drivers may be leaving their houses for locations outside the region and some may be coming in from outside the region, the target VMT should fall between internal-to-internal (I-I) VMT and I-I+I-E+E-I VMT. No external-to-external through trips should be in the calibration target data.

CDTC found that, after removing E-E trips from their travel demand model, the daily light-vehicle VMT from their travel demand model was 17,435,113 miles. VERPAT, using the initial data provided, estimated daily light-vehicle VMT to be 17,476,681 miles, which is 0.2% higher than the target. CDTC accepted this level of accuracy as evidence that the model is calibrated.

ITCTC's travel demand model estimated 1,834,100 miles per day, and the VERPAT model estimated 1,813,392 miles per day, or 1.1% less than the travel demand model. This model can also be considered calibrated with default data.

In both cases, the discrepancies that may result from the unknown number of E-I/I-E trips in VERPAT are not accounted for. CDTC estimates approximately 12.5% of their VMT is E-I or I-E. ITCTC estimates that approximately 19% of their VMT is E-I or I-E and that a negligible number of trips are E-E (assumed to be zero). If some of these E-I/I-E trips are removed from the target data point, the results are still close enough to the VERPAT VMT to find the model calibrated. Both base-year models were considered calibrated using the input data as provided by the MPOs.

3.2.1.2 Future Year

VMT growth was used to calibrate the future-year model. Based on its travel demand model, CDTC expected 7.3% growth in VMT by 2050. CDTC also found that future-year income was the variable whose effect they least understood. They set their income growth rate to zero% with the belief that, in 2050, income should not be a driver of VMT. Their model produced 7.1% population growth, which is close to the 7.3% target, and the model was considered calibrated.

ITCTC expected 16.2% (2,130,800 VMT) growth in VMT by 2040. Originally, ITCTC used an income growth rate of 1.3% per year as projected by Woods and Poole. This rate produced a VMT growth that was too high. It was determined that an income growth rate of 1% per year, which was closer to the historical average of 1.1% from the Bureau of Economic Analysis, produced a VMT growth of 16.6%. All other inputs were left unchanged from what ITCTC had found.

After adjusting the income for the future year, both models were calibrated.

3.3 Scenario Development and Testing

Each MPO began by selecting a forecast base year. In each case, the year would match the horizon year of their next LRTP update. For ITCTC, the base year was set to 2040; for CDTC, the base year was set to 2050. Each scenario was for the horizon year, with the output measured against the base year.

3.3.1 CDTC Scenarios

CDTC selected the following scenarios. While developing the scenarios, only the forecasted population growth was assigned to new locations; there was no shift of existing population.

- **Base-Year 2050 Trend**. This scenario used the population, employment, and land-use forecasts that are incorporated in CDTC's travel demand model, which was used in the LRTP update.
- **Sprawl Development**. This scenario assumed that adoption of CAV technologies will encourage development further from urbanized areas. Some research suggests this will be the case, as some people traveling in CAVs will view travel time as potentially productive. The result would be increased sprawl development patterns beyond trend. This land-use pattern runs counter to the New Visions Plan goals.
- **Urban Development**. This scenario assumed that urban living will be made more attractive through new transportation options such as Mobility-as-a-Service (MaaS) and CAV technologies. In addition, this scenario assumed a high level of urban reinvestment and transit investments that encourage construction of transit-oriented development in the region's urbanized areas. This land-use pattern furthers the New Visions Plan development goals.

- **Optimistic EV**. This scenario assumed a high level of EVs in the light-vehicle fleet resulting from policies and incentives from CDTC, the State, and the federal government, as well as market-driven consumer choice. This level of fleet penetration exceeds that in the trend scenario and is consistent with New York State Energy Plan goals.
- **Pessimistic EV**. This scenario assumed the level of EV penetration in the fleet to be less than the trend scenario. This may be a result of market resistance or uncertain government policy support.
- **Urban Development with Pricing**. This scenario used the land-use assumptions from the Urban Development Scenario to explore the impacts of increasing household transportation costs. This could result from instituting several pricing options, including a carbon tax or fee structures to encourage ridesharing in MaaS.

3.3.2 Results of the VERPAT Model

CDTC used the VERPAT model to develop estimates of VMT and GHG emissions for 1990, 2015, 2030, and 2050. VMT estimates were calibrated against the CDTC travel demand model, called the STEP Model. VMT growth produced by the STEP Model between 1990 and 2015 is consistent with HPMS data. As indicated in Table 4, GHG emissions are estimated to decrease by 47% between 1990 and 2030, and by 72% between 1990 and 2050. This is a significant decrease that compares favorably with the New York State Energy Plan goals. The New York State Energy Plan goals are to decrease GHG emissions by 40% between 1990 and 2030, and by 80% between 1990 and 2050. These goals are for all emission sources, but transportation represents a significant portion of total emissions.

Table 4. CDTC—GHG Emissions

Scenario/Year	VERPAT VMT	GHG Emissions	GHG Emission Reduction from 1990	GHG Emissions Reduction from 2015	GHG Emissions Reduction from 2030 Trend	GHG Emissions Reduction from 2050 Trend
1990	14,673,091	15,509,305	None	None	None	None
2015	17,476,681	13,960,139	-10%	None	None	None
2030 Trend	18,442,823	8,269,093	-47%	-41%	None	None
2050 Trend	18,708,916	4,275,491	-72%	-69%	-48%	None
2050 Sprawl Development	18,876,875	4,306,853	-72%	-69%	-48%	0.7%
2050 Urban Development	18,075,207	4,051,321	-74%	-71%	-51%	-5.2%
2050 Optimistic EV	18,540,313	2,275,467	-85%	-84%	-72%	-46.8%
2050 Pessimistic EV	18,694,324	5,976,415	-61%	-57%	-28%	39.8%
2050 Urban Development with Pricing Support	16,896,418	3,848,737	-75%	-72%	-53%	-10.0%

The **Sprawl Development Scenario**, as tested, would result in an increase in greenhouse gas emissions of 0.7% compared with the trend scenario. The VERPAT model indicates that sprawl development would have a relatively small effect on future GHG emissions. This can be explained by the relatively small amount of growth expected in the Capital District. The CDTC New Visions Plan has emphasized the importance of land-use planning and smart growth for many reasons. Sprawl may have negative effects, but the VERPAT model suggests that the effect of sprawl development patterns on future GHG emissions would likely be relatively limited in the Capital Region. Testing of other sprawl scenarios could be considered in the future to explore whether the negative impacts are understated in this scenario. Table 5 shows the input assumptions used in this modeling scenario.

3.3.2.1 Input Assumptions Used in Modeling the Scenarios

Table 5. Sprawl Development Scenario Assumptions

File name: 2050 Alt 1-sprawl/Land Use (bzone_pop_emp_prop.csv).

Scenario	Sprawl: Population Growth	Sprawl: Employee. Growth
Rural	0.40%	16.30%
Suburban Residential	0.70%	1.60%
Suburban Employment	0.10%	0.90%
Suburban Mixed Use	52.90%	22.30%
Suburban Transit-Oriented Dev.	17.20%	17.20%
Close-in Community Residential	22.30%	52.90%
Close-in Community Employment	7.60%	7.60%
Close-in Community Mixed Use	0.00%	0.00%
Close-in Community Transit-Oriented Dev.	0.00%	0.00%
Urban Core Residential	0.00%	0.00%
Urban Core Employment	0.00%	0.00%
Urban Core Mixed Use	0.00%	0.00%
Urban Core Transit-Oriented Dev.	0.00%	0.00%

The **Urban Development Scenario**, as tested, would result in a 5.2% decrease in 2050 emissions compared with the 2050 trend. The Urban Development Scenario assumes that all new development would locate in transit-oriented or mixed-use areas, primarily in close-in communities or the urban core areas. It also assumes increasing investment in transit and increased popularity and acceptance of demand management, bike travel, and light-vehicle travel. It was assumed that CAVs and MaaS would make the urban areas more attractive. Despite these strong assumptions, GHG emissions reductions were positive under this scenario but not dramatic. Table 6 shows the input assumptions used in this modeling scenario.

Table 6. Urban Development Scenario Assumptions

File name: 2050 Urban, transit, tdm-2

Bikes or Light Vehicles (region_light_vehicles.csv)
2 - Double TargetProp and PropSuitable (0.4, 0.48)

Demand Management (region_commute_options.csv)
2 - Double all participation rates

Transportation Supply (model_parameters.json)
2 - Double transit supply (2.00)

Land Use (bzone_pop_emp_prop.csv)
2 - Urban reinvestment, infill, and close-in scenario:

Scenario	Urban Development: Population Growth	Urban Development: Employee Growth
Rural	0.00%	0.00%
Suburban Residential	0.00%	0.00%
Suburban Employment	0.00%	0.00%
Suburban Mixed Use	0.00%	0.00%
Suburban Transit-Oriented Dev.	10.00%	10.00%
Close-in Community Residential	3.90%	0.00%
Close-in Community Employment	0.00%	9.60%
Close-in Community Mixed Use	10.00%	10.00%
Close-in Community Transit-Oriented Dev.	12.50%	12.40%
Urban Core Residential	18.60%	0.00%
Urban Core Employment	0.00%	13.20%
Urban Core Mixed Use	22.10%	22.00%
Urban Core Transit-Oriented Dev.	22.90%	22.80%

The **Optimistic Electric Vehicle Achievement Scenario**, as tested, resulted in a dramatic reduction in GHG emissions. Under this scenario, GHG emissions would decrease by 46.8% compared with the 2050 Trend Scenario; and the reduction with respect to 1990 emissions would be 85%. This scenario would achieve the greatest reduction in GHG emissions by far. The scenario, while ambitious, is considered feasible with strong federal, State, and MPO policy support. The model result suggests that the most strategic, effective way to reduce GHG emissions would be to focus on vehicle powertrain technology. This conclusion has strong implications for the CDTC New Visions Plan update. Table 7 through Table 10 show the input assumptions used in this modeling scenario. Figure 1 shows the vehicle type market share by year for EV scenarios.

The **Pessimistic Electric Vehicle Achievement Scenario**, as tested, resulted in a dramatic future increase in GHG emissions compared to the 2050 Trend Scenario. Under this scenario, GHG emissions would increase by 39.8% compared with the 2050 Trend Scenario; the reduction with respect to 1990 emissions would be reduced to 61%. This significant negative result points to the importance of maintaining policy support for EVs and improved vehicle technology. Table 7 through Table 10 show the input assumptions used in this modeling scenario. Table 7 shows the vehicle type market share by year for EV scenarios.

Table 7. Summary of Inputs for EV Scenarios—model_ev_range_prop_mpkwh

Scenario	Year	Auto Range	Auto PropEv	Auto Mpkwh	LtTruck Range	LtTruck PropEv	LtTruck Mpkwh
Trend	2015	103	0.1	3.63	68.8	0.07	2.125
	2030	188	0.3	4	125	0.245	2.5
	2050	300	0.9	4.5	200	0.7	3
Optimistic	2030	300	0.8	4	125	0.66	2.5
	2050	300	1.0	4.5	200	1.0	3
Pessimistic	2030	188	0.2	4	125	0.123	2.5
	2050	300	0.7	4.5	200	0.45	3

Table 8. Summary of Inputs for EV Scenarios—model_phev_range_prop_mpg_mpkwh

Scenario	Year	Auto PhevRange	Auto PropPhev	Auto Mpkwh	Auto Mpg	LtTruck PhevRange	LtTruck PropPhev	LtTruck Mpkwh	LtTruck Mpg
Trend	2015	25	0	3.63	56	25	0	2.13	40
	2030	30	0.1	4	69	30	0.117	2.5	54
	2050	40	0.9	4.5	76.4	40	0.8	3	60
Optimistic	2030	30	0.8	4	69	30	0.75	2.5	54
	2050	40	1.0	4.5	76.4	40	1.0	3	60
Pessimistic	2030	30	0.1	4	69	30	0.117	2.5	54
	2050	40	0.7	4.5	76.4	40	0.6	3	60

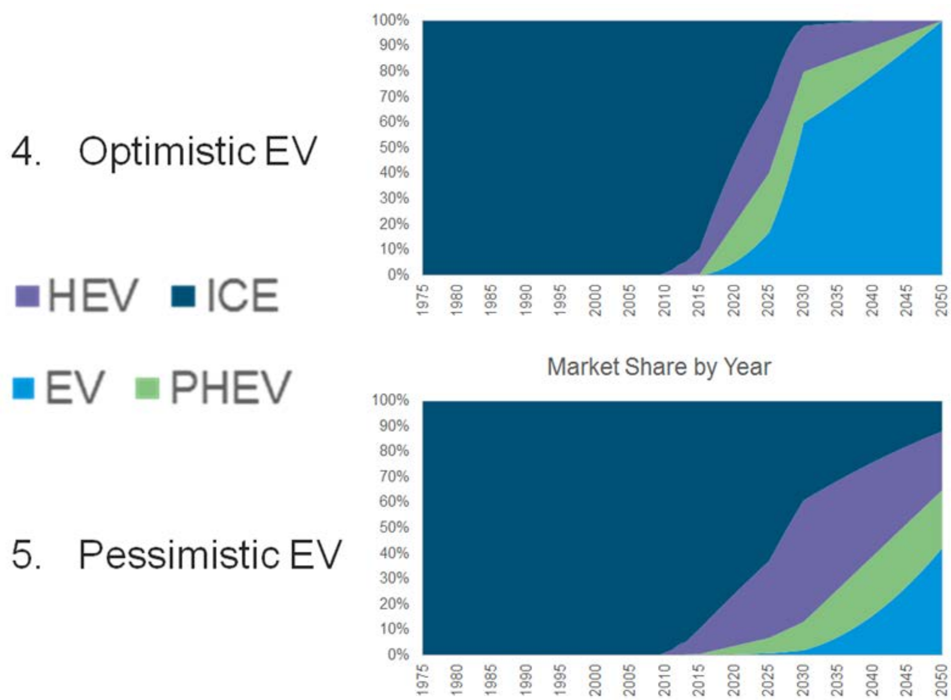
Table 9. Summary of Inputs for EV Scenarios—model_hev_prop_mpg

Scenario	Year	AutoPropHev	AutoHevMpg	LtTruckPropHev	LtTruckHevMpg
Trend	2015	0.1	56	0.08	36
	2030	0.83	69	0.63	51
	2050	1.0	76	0.75	56.3
Optimistic	2030	0.9	69	0.8	51
	2050	1.0	76	1.0	56.3
Pessimistic	2030	0.55	69	0.41	51
	2050	0.66	76	0.5	56.3

Table 10. Summary of Inputs for EV Scenarios—model_veh_mpg_by_year

Scenario	Year	AutoMpg	LtTruckMpg	TruckMpg	BusMpg	TrainMpg
Trend	2015	40.6	26	5.6	4.8	0.121
	2030	63.7	41	5.6	4.8	0.121
	2050	63.7	41	5.6	43.8	0.121
Optimistic	2030	63.7	41	30	30	0.121
	2050	63.7	41	49	49	0.121
Pessimistic	2030	49.1	33	5.6	4.8	0.121
	2050	49.1	33	5.6	4.8	0.121

Figure 3. Vehicle Type Market Share by Year for EV Scenarios



The **Urban Development Scenario with Pricing Support**, as tested, would result in an improvement from the Urban Development Scenario, producing a 10% reduction in GHG emissions compared with the 2050 Trend Scenario. The VERPAT model for this scenario used the same assumptions as the Urban Development Scenario and assumes that driving costs would increase by $0.08 per mile. Increasing driving costs could also reduce congestion and encouraging land-use planning, walkability, and smart growth. Future pricing strategies could encourage carpooling by charging a fee for SOV trips and offering a discount for shared trips. Table 11 shows the input assumptions used in this modeling scenario.

Table 11. Urban Development with Pricing Support Scenario

Bikes or Light Vehicles (region_light_vehicles.csv)
2 - Double TargetProp and PropSuitable (0.4, 0.48)

Demand Management (region_commute_options.csv)
2 - Double all participation rates

Transportation Supply (model_parameters.json)
Triple public transit service level—BusRevMiPCGrowth = 3.0 on model parameters.json

Increase Cost of Driving—Extra charge of .08/mile (equivalent to $2.00/gal @ 50 mpg)
VMTCharge = 0.09 in model parameters.json Land Use (bzone_pop_emp_prop.csv)
2 - Urban reinvestment, infill, and close-in scenario:

Scenarios	Urban Development: Population Growth	Urban Development: Employee Growth
Rural	0.00%	0.00%
Suburban Residential	0.00%	0.00%
Suburban Employment	0.00%	0.00%
Suburban Mixed Use	0.00%	0.00%
Suburban Transit-Oriented Dev.	10.00%	10.00%
Close-in Community Residential	3.90%	0.00%
Close-in Community Employment	0.00%	9.60%
Close-in Community Mixed Use	10.00%	10.00%
Close-in Community Transit-Oriented Dev.	12.50%	12.40%
Urban Core Residential	18.60%	0.00%
Urban Core Employment	0.00%	13.20%
Urban Core Mixed Use	22.10%	22.00%
Urban Core Transit-Oriented Dev.	22.90%	22.80%

3.3.3 ITCTC Scenarios

ITCTC developed scenarios to test the level of population and employment growth in 2040 and the intensity of transit service.

- **Base-Year 2040 Trend.** Similar to CDTC, this scenario used the population and employment forecasts that support the horizon year of the ITCTC travel demand model.
- **Plan—Capped**. Municipalities prepare comprehensive plans that include growth forecasts. In this scenario, population and employment growth followed city/town plans but were capped at the current projection. Close-in-communities and rural areas saw the most growth in this scenario. This scenario assumed a 24% increase in transit service. This is based on the plan for Tompkins Consolidated Area Transit (TCAT) to convert existing paratransit to fixed-route bus service.
- **Plan—No Cap**. Rather than using a control total to limit overall growth, this scenario used the forecasts in the city and town comprehensive plans, which tend to be optimistic. Comparable to the Plan—Capped Scenario, close-in-communities and rural areas saw the most growth and there was a 24% increase in transit service.
- **Transit Increase—Capped**. This scenario used the same population and employment forecasts as the Plan—Capped Scenario, but transit service was increased by 33% to evaluate the results of a larger investment in and use of TCAT service.
- **Transit Increase—No Cap**. This scenario used the same population and employment forecasts as the Plan—No Cap Scenario, but transit service was increased by 33% to evaluate the results of a larger investment in and use of TCAT service.

3.3.3.1 Input Assumptions Used in Modeling the Scenarios

Bus revenue mile growth in the model_parameters.json file is based on population growth. Population grew 12% and 29% in the 2040 Trend/Capped and No Cap scenarios, respectively. Transit revenue miles grew 24% in the 2040 Trend and Plan scenarios and grew an additional 7% in the Transit Scenario for a total of 33% growth (1.24 * 1.07 = 1.327). The values in Table 12 are used to provide the 24% and 33% growth in conjunction with a scenario's population.

Table 12. Transit Revenue Miles Growth Rates

Transit Type	Trend	Plan Capped	Plan No Cap	Transit Capped	Transit No Cap
Bus Revenue Miles Growth	1.110	1.110	0.965	1.188	1.033

The bzone_pop_emp_prop.csv file describes population and job location by place type. The Plan/Transit scenarios show more growth in the urban core and close-in community place types than the trend scenario (Table 13).

Table 13. Population and Employment Growth by Place Type

Place Type	Trend Growth Allocation		Plan/Transit Growth Allocation	
	Population	Employment	Population	Employment
Rur	31%	32%	21%	21%
Sub_R	13%	15%	2%	2%
Sub_E	1%	1%	2%	2%
Sub_M	22%	19%	11%	11%
Sub_T	0%	0%	0%	0%
CIC_R	16%	13%	0%	0%
CIC_E	0%	0%	25%	25%
CIC_M	7%	10%	8%	8%
CIC_T	0%	0%	0%	0%
UC_R	0%	0%	0%	0%
UC_E	0%	0%	0%	0%
UC_M	1%	1%	0%	0%
UC_T	10%	11%	32%	32%
Total	**100%**	**100%**	**100%**	**100%**

3.3.3.2 Results of the VERPAT Model

The ITCTC results indicate that VMT, delay, and GHG emissions will be slightly less in the Plan Capped Scenario compared to the trend scenario and slightly smaller still in the Transit Capped Scenario. The No Cap scenarios have a population increase of 15% and show similar increases in VMT (12%) and GHG emissions (14%).

Table 14. ITCTC Results

Indicator	1—Trend Scenario	2—Plan Capped Scenario	3—Plan No Cap Scenario	4—Transit Capped Scenario	5—Transit No Cap Scenario
Population	117,000	117,000	135,000	117,000	135,000
VMT (miles/day): Total	2,143,000	2,119,000	2,406,000	2,116,000	2,405,000
VMT (miles/day): ICE	1,872,000	1,851,000	2,101,000	1,852,000	2,104,000
VMT (miles/day): Electric	271,000	268,000	306,000	264,000	301,000
VMT (miles/day): Truck	127,000	127,000	144,000	127,000	144,000
VMT (miles/day): Bus	6,800	6,800	6,800	7,200	7,200
GHG (CO_2 eq, MT/day): Total	324	321	369	320	369
GHG (CO_2 eq, MT/day): ICE	319	315	362	315	363
GHG (CO_2 eq, MT/day): Electric	5.5	5.5	6.2	5.4	6.1
GHG (CO_2 eq, MT/day): Truck	170	170	190	170	190
GHG (CO_2 eq, MT/day): Bus	13.1	13.1	13.1	14.0	14.0
Delay (hrs./day): Total	6,297	6,174	6,291	6,166	6,288
Delay (hrs./day): Light Vehicle	5,697	5,580	5,605	5,572	5,603
Delay (hrs./day): Truck	600	594	686	594	685
Delay (hrs./day): Bus	0.31	0.30	0.31	0.32	0.33
Tot. Delay/VMT (sec/mi)	10.6	10.5	9.4	10.5	9.4

Table 15. ITCTC Results Compared with Trend Scenario

Indicator	2—Plan Capped Scenario	3—Plan No Cap Scenario	4—Transit Capped Scenario	5—Transit No Cap Scenario
Population	0%	15%	0%	15%
VMT: Total	-1%	12%	-1%	12%
VMT: ICE	-1%	12%	-1%	12%
VMT: Electric	-1%	13%	-3%	11%
VMT: Truck	0%	13%	0%	13%
VMT: Bus	0%	0%	6%	6%
GHG: Total	-1%	14%	-1%	14%
GHG: ICE	-1%	13%	-1%	14%
GHG: Electric	0%	13%	-2%	11%
GHG: Truck	0%	12%	0%	12%
GHG: Bus	0%	0%	7%	7%
Delay: Total	-2%	0%	-2%	0%
Delay: Light Vehicle	-2%	-2%	-2%	-2%
Delay: Truck	-1%	14%	-1%	14%
Delay: Bus	-3%	0%	3%	6%
Tot. Delay/VMT	-1%	-11%	-1%	-11%

The land-use changes associated with moving from the trend scenario to the Plan Scenario are not sufficient to offset the effect of the increased population in the No Cap scenarios. The additional transit in scenarios 4 and 5 has little effect on reducing VMT and GHG emissions. The 24% increase in transit in the trend scenario already includes most people who will use bus transit. According to the VERPAT model, increasing supply to this already-saturated market by 7% will put more buses on the road but not more people on the buses.

The transit scenarios calculated here show significantly more VMT than ITCTC calculated using their travel demand model. Their travel demand model does not have a transit component; to account for transit, households that use transit are removed from the model network. To model a 7% increase in transit, 7% of households were removed from the network. The VERPAT model investigates demand and supply and found that the additional transit does not meet a demand and consequently does not reduce VMT by an appreciable amount. This result has helped ITCTC focus on other approaches to VMT while acknowledging that increased transit service meets other needs, including access for rural and low-income residents.

The ease of running different scenarios in VERPAT allows planners to quickly test policies. In this case, VERPAT shows that increasing transit alone is not a viable policy. Other factors must be used to increase demand, including increasing the cost of driving, reducing the cost of transit, or placing more people in transit-friendly locations.

It is also possible that Tompkins County is a unique region and that it will respond to transit increases differently than the research used in the VERPAT model suggests. However, this divergence should be carefully considered. If a region wants to pursue a policy suite that VERPAT suggests will not be effective, it should clearly consider how the region differs from other locations. Careful consideration will help the region evaluate whether the historical precedence in the model does not in fact apply. Even in this situation, VERPAT can help a region understand pertinent historical trends as well as help the region to think about how to best leverage its unique character.

3.4 Training

RSG trained CDTC and ITCTC staff members in the full skill set needed to independently operate VERPAT. The initial training was done in concert with VERPAT installation at each agency. RSG had one person on site and another technical expert communicating remotely. Once the model installation was confirmed, the input data files that had been provided were used to run a base case. The steps are explained in the User Guide (RSG 2015); MPO staff members were walked through the user guide and the process to aid understanding at each step.

As noted, VERPAT is open-source code that uses R language. Familiarity with R is useful but not necessary. The CDTC staff members working on the project had background in R, while the modeler at ITCTC did not. As a result, the training was tailored for each location.

Subsequent to the installation, RSG technical staff members were available on a continuous basis to respond to email and telephone inquiries. RSG received several questions regarding input files and scenario development that resulted in further clarification as individuals at each MPO became more familiar with operating the model.

4 Findings and Conclusions

The original purpose of this project was to assist two MPOs, CDTC and ITCTC, to use RPAT in testing planning scenarios, with the output measuring GHG emissions and other variables. RSG assisted MPO staff members in installing the model, assembling and validating input data and parameters, calibrating the model to the MPO's travel demand model, defining the scenarios and how the input data would be changed for each, running the model for each scenario, and assembling the model outputs.

The project scope was modified in two steps. First, it was agreed that RSG would write a new module for RPAT to accommodate EVs in the light-duty vehicle fleet, a capability that was not in the original software. This was important because EVs are known to be a significant means to reduce GHG emissions. MPOs should be able to test policies that result in increased EV ownership, which may include, for example, a robust program to install publicly accessible electric vehicle supply equipment.

The second modification was governed by the development of the VisionEval strategic modeling platform that would include RPAT. VisionEval presented numerous benefits, including its support and maintenance by AASHTO through an FHWA pooled fund project; the original RPAT did not have a maintenance mechanism. Also, because it is an open-source software platform, users can suggest model enhancements and contribute code. Neither the original RPAT nor VERPAT have a licensing fee, so there is no acquisition cost to the MPOs. Although there were clear impacts to the project schedule and budget, it was agreed by all participants to use the VisionEval version of RPAT, referred to as VERPAT.

4.1 Installing and Using VERPAT

Software installation at both MPOs proceeded without issue and with some assistance from RSG. Both the AASHTO TravelWorks site (TravelWorks: Advanced Travel Analysis Tools n.d.) and GitHub (VisionEval n.d.) provide additional information and supporting materials. Both the software and RPAT User's Guide: Rapid Policy Assessment Tool Documentation can be downloaded from TravelWorks (TravelWorks: Advanced Travel Analysis Tools n.d.). GitHub (VisionEval n.d.) provides technical information, including a description of each of the inputs and parameter files. An MPO can download, install, and operate VERPAT for free.

While VERPAT is free, MPOs should consider staff capacity to operate the model. The MPO should employ a staff member who is familiar with modeling, particularly the operation of a travel demand model. Most MPOs maintain a travel demand model to produce forecasts, including support of the LRTP. As noted in section 3.2 in this report, outputs from the travel demand model provide the basis for calibrating VERPAT, unless the MPO has another method for forecasting future-year VMT. It is also helpful if the MPO staff member has experience with R or RStudio.

While GitHub explains the content and format of the input and parameter files, and while the default data provides examples of the correct format, understanding the nuances of some inputs, as explained in section 3.1, can be difficult on the first use. Consequently, populating the files may prove to be a challenge to an MPO with no assistance.

An MPO will create the input files using the default data as a reference. Although the model contains many input files, most files have only a few lines of data. The user proceeds through each file, changing the data to match their region or keeping the default value if they do not have regional data in that area. With each input file, the user will examine the data requirements on the GitHub wiki and the default data, investigate the data sources available to them (e.g., the regional model or Census data), and then make the appropriate changes to the input files. In some case, similar to quantifying the bzone csv file, GIS analysis or additional computation is needed. It is helpful to be able to consult with someone who has compiled this data before to better understand what each input data file represents and how best to assemble the data.

4.2 Value to the MPO Planning Process

Both CDTC and ITCTC found that using VERPAT as a high-level scenario analysis tool adds value to their planning process. As noted, both MPOs are in the process of updating their federally required LRTPs. Forecasting transportation demand and needs to a horizon year that is 20 years or more in the future is a difficult task. It has become more uncertain with the rapid changes in transportation technology and behavior across the spectrum of automated, connected, electrified, and shared mobility. Emerging agreement exists among transportation planners that the best way to address this uncertainty is through scenario planning, which is often coupled with a strategic approach.

Using a strategic modeling tool such as VERPAT fits well in that approach. MPO plans begin by defining a regional vision and the goals and objectives that support its achievement over time. VERPAT facilitates development and testing of policy-based scenarios related to land use, mode share, and fleet composition, among other topics that may reflect the MPO's goals.

The value of VERPAT is not limited to supporting the LRTP. MPOs engage in many other planning processes that can benefit from using this strategic modeling tool. For example, MPOs develop mode-focused plans, including transit analysis and bicycle and pedestrian plans. At the highest level, these plans are linked back to the LRTP in terms of shared goals and objectives. Though VERPAT is not a network-based analytic tool, it can generate outcomes, including reduction in GHG emissions that reflect different levels of transit investment or changes in mode share for nonmotorized travel in response to infrastructure investments or policy incentives.

4.3 Transferability to Other MPOs

This project has demonstrated that most MPOs can realize the benefits of VERPAT, using either their own staff capacity or with modest consultant support. Because of the support offered through TravelWorks and the GitHub wiki, MPO modeling staff may be able to easily find peer MPOs who can answer questions.

4.4 VERPAT Limitations

MPOs that choose to use VERPAT as a tool in their planning processes need to understand the limitations of the model. These limitations include the following:

- VERPAT is a regional strategic model. It is designed to work with a travel demand model, but not for the same purposes. For example, it will not provide information on network deficiencies. It will work best when the MPO maintains a travel demand model to provide benchmarks for calibration.
- VERPAT does not produce elegant outputs that can be directly conveyed to decision makers or the public. That is not its purpose. It is a tool that is best suited for use within an agency. MPO staff members will need to translate the model outputs into understandable information before sharing the results. This can be as simple as focusing on specific results of interest. For instance, "Here are the forecasted GHG emission levels in 2050 when EVs comprise 10%, 40%, or 75% of the fleet of cars and light-duty trucks."

5 References

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Appendix A. Technical Memorandum #1: VERPAT Data Sources

Technical Memorandum #1

TO:	Elisabeth Lennon, NYSDOT David McCabe, NYSERDA
FROM:	Steven Gayle PTP, David Grover PE
DATE:	November 29, 2018
SUBJECT:	VERPAT Data Sources

Task 1 in the NYSERDA/NYSDOT project Implementation of a Regional Greenhouse Gas Reduction Analysis Tool was the assembly of the data input files necessary to run the Rapid Policy Assessment Tool (RPAT). In the course of the project, RPAT was moved to the VisionEval platform (VERPAT). This caused minor changes to some of the input files that had already been prepared as the format had changed. The data stayed the same.

RSG assisted two Metropolitan Planning Organizations (MPO), the Capital District Transportation Committee (CDTC) and the Ithaca-Tompkins County Transportation Council (ITCTC), with collecting the input data for their regional VERPAT model. VERPAT examines the effects of different policy options on transportation related measures including vehicle miles traveled (VMT), congestion, greenhouse gas (GHG) emissions, and safety. The model requires data on existing conditions and future forecasts. While the model is simpler to implement than a traditional travel demand model, many data sources are often needed to define all the input data. This memo explains the input data and details where CDTC and ITCTC found the data for their respective models.

VERPAT contains 17 user input files and 15 input parameters that the user defines, as well as 18 model parameter files that are typically left largely unchanged. Visit GitHub wiki[6] for a description of each of these files, including information on input data and possible data sources.

Each input file contains one or more lines of data for the model. Most files contain specific variables that must be defined. Both MPOs used their regional travel demand model to define input data where applicable, as well as data from additional sources. The next section provides a brief description of each input file. The following two sections describe the data sources each MPO used and discusses obstacles and subtleties that the MPOs encountered through the process.

The memo is best read with a copy of the data files for reference. Visit GitHub[7] to download the files.

Input Data

The scenario inputs contain four categories: Built Environment, Demand, Transport Supply, and Policy. There are two ways to specify these inputs. CSV Inputs are specified in a .csv file and JSON Inputs are specified in the model_parameters.json file.

Some inputs, such as the csv file azone_gq_pop_by_age.csv or the czone locations, are not used in VERPAT, but they are required for the VisionEval framework. These files are described as "Not used–keep default," and the default files should not be changed in these cases.

CATEGORY	DATA NAME	FILE NAME	DESCRIPTION
Built Environment	Population and jobs by place type	bzone_pop_emp_prop.csv	Base distribution and future-year growth of population and jobs across the 13 place types
Demand		**CSV Files**	
	Auto and Transit Trips per Capita	region_trips_per_cap.csv	Average number of auto and transit trips per person per day in the region
	Employment (Existing)	azone_employment_by_naics.csv	Existing employment and number of firms in the region
	Relative Employment	azone_relative_employment.csv	Not used – keep default
	Population (Existing and Growth)	azone_hh_pop_by_age.csv	Base and future population in the region by age group
	Group Quarters	azone_gq_pop_by_age.csv	Not used – keep default
	Household Size	azone_hhsize_targets.csv	Not used – keep default
	Regional Income	azone_per_cap_inc.csv	Average per capita income for the base and future year
	Truck and Bus VMT	region_truck_bus_vmt.csv	Truck and bus VMT in the region and split between functional classes
		model_parameters.json Variables	
	Base Daily VMT	BaseLtVehDvmt	Base-year VMT by autos in the region
	Freeway + Arterial VMT Proportion	BaseFwyArtProp	VMT proportion by functional class
	Employment Growth	EmploymentGrowth	Employment growth multiplier
Transport Supply	Road Lane Miles	marea_lane_miles.csv	Supply of freeways and arterials in lane miles
	Transit Revenue Miles	marea_rev_miles_pc.csv	Transit service in revenue miles by bus and rail
Policy		**CSV Files**	
	Travel Demand Management Options	region_commute_ options.csv	Participation levels and other parameters describing various workplace commuting programs

% Road Miles with ITS Treatment	azone_its_prop.csv	Proportion of the freeway and arterial networks with ITS for incident reduction
Bicycling/Light-Vehicle Targets	region_light_vehicles.csv	Bike ownership targets and parameters to describe effects of policies to encourage bicycling
Increase in Parking Cost and Supply	marea_parking_growth.csv	Pricing and participation in various parking charging policies
model_parameters.json Variables		
Auto Ownership Cost Growth	AutoCostGrowth	Growth in car ownership costs, not including inflation
Freeway Lane Miles Growth	FwyLaneMiGrowth	Change in Freeway Lane Miles
Arterial Lane Miles Growth	ArtLaneMiGrowth	Change in Arterial Lane Miles
Bus Revenue Miles Growth	BusRevMiPCGrowth	Change in Bus Revenue Miles
Rail Revenue Miles Growth	RailRevMiPCGrowth	Change in Rain Revenue Miles
Auto Operating Surcharge per VMT	VmtCharge	Vehicle miles traveled charges levied on drivers

General Data Considerations

The bzone_pop_emp_prop.csv file contains base-year and future-year data on place types (see below). The base-year rows are the proportion of the population and proportion of jobs in each place type. The future-year rows are the proportion of growth in each place type.

Several inputs, such as region_commute_options.csv, region_light_vehicles.csv, and BaseFwyArtProp, contain proportions of the population in decimal form; for instance, 0.05 means 5% of the population. This format was not always clear to the MPOs.

Some inputs, such as BaseFwyArtProp could have used a nationally available data set (e.g., the Highway Performance Monitoring System, or the regional model). It was assumed that the regional model as a local product would be more accurate than data provided by a national agency.

CDTC

CDTC relied on a variety of data sources including national data sets, its regional model, regional plans, local knowledge, and assumptions. They adopted a base year of 2015 and a future year of 2050 to match the upcoming update of their long-range transportation plan, New Visions.

Issues Encountered

Bzone/Place Type

VisionEval defines four area types: azone, bzone, czone, and marea. Azone is the entire region, bzone are the 13 place types, czone is not used in VERPAT, and marea is the metropolitan area, which is equivalent to azone for VERPAT. Because RPAT was originally developed to model outcomes of Smart Growth policies, place type is important. Place types describe the density and land use of a location,[8] such as suburban residential or urban mixed-use. A precise definition or defining thresholds do not exist for place types, so defining them can feel subjective. CDTC used the descriptions of each place type as well as the relative differences between locations in its region to categorize each traffic analysis zone (TAZ) in its regional model as a particular place type.

Azone/Multiple Counties

The azone designation is for counties within the region to be modeled or for the entire region itself. Where the azone name is required in input files, the user may aggregate all counties' data into one regional value (e.g., "CDTC Region"). The user must be consistent in their approach across all files. "CDTC Region" cannot be used in one place if the individual counties are used in a different place.

Employment Data

The employment data describes the total number of employees and the number of different sized employers within the region. The main source of this data is the Census County Business Pattern (CBP).[9] CDTC also had employment data from the Capital District Regional Planning Commission (CDRPC), which is based on data from the U.S. Bureau of Labor Statistics. The total number of employees was similar but did not match. CDTC used the CDRPC number of employees since other parts of their regional model were based on this data. CBP data was used for the number of employers of each size.

The CBP data can undercount government establishments, so CDTC added the State of New York as an employer.

The CBP data is aggregated by county and by North American Industry Classification System (NAICS) codes. The input file can contain multiple counties as Azones and multiple NAICS codes. Both the county and the NAICS data can also be summed so that each county has one row, or the region has one row. CDTC summed their data across counties and NAICS codes so the employment file has one row.

Future-Year Income

CDTC was unsure of income growth to the future year, which is used in the azone_per_cap_ inc.csv file. First, they used historical trends and extrapolated future-year income levels. After finding higher future-year VMT than expected, they adjusted the 2050 income levels to calibrate the VMT growth between the base year and future year. They decided to use zero% income growth based on their assertion that increased income will not lead to increased VMT in the future.

Vehicle MPG File

The model_veh_mpg_by_year.csv file contains vehicle fuel economy as miles/gallon (mpg) data through year 2050. VERPAT requires mpg data one year beyond the future year, so an additional line, year 2051, was added to the model_veh_mpg_by_year.csv file. This line was identical to the 2050 line.

Base-Year Simulation

VERPAT can simulate base-year output as well as future-year output. The same input variables are used, but rows of future-year data must be removed, e.g. azone_hh_pop_ by_age.csv will only have a 2015 row and no 2050 row.

Lane Miles Growth

Base-year lane miles are defined in marea_lane_ miles.csv. Although this file has a place for future-year lane miles, it is not used. It is a place holder required in the VisionEval framework and should be equivalent to the base-year line. The JSON parameters FwyLaneMiGrowth and ArtLaneMiGrowth define future-year lane miles growth.

It is assumed that Freeway and Arterial growth will follow population growth, and these numbers are the proportion of population growth that should be included for freeway and arterial growth. A value of one means that they will grow at the same rate as the population. A value of zero means that they will not grow and will stay the same as the base year.

Inflation/Constant Dollar Value

All dollar values in VERPAT must be attached to a year to account for inflation. The year is defined by the heading in the input value (e.g., ParkingCost.2000 and parkingCost.2015 are the cost for parking in year 2000 and 2015 dollars respectively). It is important to pay attention to the year of a dollar value when defining input data.

Future-Year Income

ITCTC originally used Woods and Poole data (a proprietary data set) to project future-year income in the azone_per_cap_ inc.csv file. This estimated a 38% increase in average income or 1.3% per year compounded annually. The average change per year over the last 17 years was 1.18% according to Bureau of Economic Analysis, so Woods and Poole appeared high. After calibration, an annual growth rate of 0.25% was used. This is lower than historical trends and represents the assumption that income growth will not have as large an effect on VMT as it does now.

Data Sources

The table below states the source(s) of data for each of the model inputs. Some input files, listed separately, contain multiple pieces of data. Where a data name or description is self-explanatory, it is not included.

FILE/PARAM. NAME	DATA NAME	SOURCE	DESCRIPTION
bzone_pop_ emp_prop.csv	2015	Census/ Capital District Regional Planning Commission	2015 population and jobs
	2050	Capital District Regional Planning Commission	2050 population and jobs growth
region_trips_ per_cap.csv	Veh. and Transit	National Household Travel Survey	Auto and transit trips per person per day
azone_employment_ by_naics.csv	-	County Business Pattern[10]	Existing employment and number of firms in the region
azone_hh_pop_ by_age.csv	2015	Capital District Regional Planning Commission	2015 population in the region by age group
	2050		2050 population in the region by age group
azone_per_cap_ inc.csv	2015	Bureau of Economic Analysis[11]	2015 income per capita in the region
	2050	Based on calibration	2050 income per capita in the region
region_truck_ bus_vmt.csv	BusVMT	Keep Default	Bus VMT by functional class
	TruckVMT	Keep Default	Truck VMT by functional class
BaseLtVehDvmt	-	Regional Model	2015 auto VMT
BaseFwyArtProp	-	Regional Model	VMT by functional class
EmploymentGrowth	-	Capital District Regional Planning Commission	Employment growth multiplier
marea_lane_miles.csv	Year[12]	Regional Model	Freeway/arterial lane miles
marea_rev_ miles_pc.csv	BusRevMiPC[5]	Capital District Transportation Authority	Bus revenue miles per capita
	RailRevMiPC	No rail in region	Rail revenue miles per capita
region_commute _options.csv	Ridesharing Participation	CDTC	-

	Transit Subsidy Participation	Capital District Transportation Authority	-
	Transit Subsidy Level	Capital District Transportation Authority	-
	Schedule 980 Participation	None in Base Scenario	Percent workers that work 80 hours in 9 days
	Schedule 440 Participation		Percent workers that work 40 hours in 4 days
	Telecommute 1.5 Days Participation		Percent workers that telecommute 1.5 days/week
	Vanpooling Low Level Participation	CDTC	Percent workers that participate in low, medium, or high level vanpooling programs
	Vanpooling Med Level Participation	None in Base Scenario	
	Vanpooling High Level Participation	None in Base Scenario	
azone_its_prop.csv	Year	Regional plans	Proportion of freeway and arterial networks with ITS
region_light_ vehicles.csv	TargetProp	CDTC	Non-motorized vehicle ownership rate
	Threshold	CDTC	SOV trip length suitable for a light vehicle
	PropSuitable	CDTC	Proportion of SOV trips suitable for light vehicle
marea_parking_ growth.csv	PropWorkParking	CDTC	Proportion of workers that park
	PropWorkCharged	CDTC	Proportion of parkers that are charged at work lot
	PropCashOut	CDTC	Proportion of workers in parking buyout programs
	PropOtherCharged	CDTC	Proportion of parkers that are charged at non-work space
	ParkingCost	CDTC	Parking cost
AutoCostGrowth	-	Assumed unchanged	Growth in car ownership costs
FwyLaneMiGrowth	-	CDTC Regional Plan	Growth in freeway lane miles
ArtLaneMiGrowth	-	CDTC Regional Plan	Growth in arterial lane miles
BusRevMiPCGrowth	-	CDTC Regional Plan	Growth in bus revenue miles
RailRevMiPCGrowth	-	CDTC Regional Plan	Growth in rail revenue miles
VmtCharge	-	None in base scenario	Fee assessed for miles driven

ITCTC

ITCTC relied on a variety of data sources including national data sets, proprietary data they purchased, their regional travel demand model, regional plans, local knowledge, and assumptions. They have a base year of 2015 and a future year of 2040.

Issues

Bzone/Place Type

ITCTC also struggled at first with apportioning its land into place types. After RSG reviewed each place type's definition in more detail, they were comfortable assigning a place type to each TAZ in their regional model.

Employment Data

ITCTC found that their employment data did not show employers in the largest categories even though they knew that such large employers existed in their region. They manually add these large employers.

Data Sources

The table below states the source(s) of data for each of the model inputs. Some input files, listed separately, contain types of data.

FILE/PARAM. NAME	DATA NAME	SOURCE	DESCRIPTION
bzone_pop_ emp_prop.csv	2015	Regional Model	2015 population and jobs
	2050	Regional Master Plan/Municipalities	2050 population and jobs growth
region_trips_ per_cap.csv	Veh. and Transit	National Household Travel Survey	Auto and transit trips per person per day
azone_employment_ by_naics.csv	-	Dept. of Labor, Woods and Poole[13] data set	Existing employment and number of firms in the region
azone_hh_pop_ by_age.csv	2015	Woods and Poole	2015 population in the region by age group
	2050		2040 population in the region by age group
azone_per_cap_ inc.csv	2015	Woods and Poole	2015 income per capita in the region
	2050	Based on calibration	2040 income per capita in the region
region_truck_ bus_vmt.csv	BusVMT	Transit Authority	Bus VMT by functional class
	TruckVMT	State DOT classification counts	Truck VMT by functional class
BaseLtVehDvmt	-	Regional Model	2015 auto VMT
BaseFwyArtProp	-	Regional Model	VMT by functional class
EmploymentGrowth	-	Woods and Poole	Employment growth multiplier
marea_lane_miles.csv	Year5	State DOT Pavement Data	Freeway/arterial lane miles
marea_rev_ miles_pc.csv	BusRevMiPC5	Tompkins Consolidated Area Transit	Bus revenue miles per capita
	RailRevMiPC	No rail in region	Rail revenue miles per capita
region_commute _options.csv	Ridesharing Participation	Census ACS	

	Transit Subsidy Participation	Tompkins Consolidated Area Transit	
	Transit Subsidy Level	Tompkins Consolidated Area Transit	
	Schedule 980 Participation	None in Base Scenario	Percent workers that work 80 hours in 9 days
	Schedule 440 Participation		Percent workers that work 40 hours in 4 days
	Telecommute 1.5 Days Participation		Percent workers that telecommute 1.5 days/week
	Vanpooling Low Level Participation	Default	Percent workers that participate in low, medium, or high-level vanpooling programs
	Vanpooling Med Level Participation	Default	
	Vanpooling High Level Participation	Default	
azone_its_prop.csv	Year	Regional plans	Proportion of freeway and arterial networks with ITS
region_light_vehicles.csv	TargetProp	Regional knowledge/defaults	Non-motorized vehicle ownership rate
	Threshold		SOV trip length suitable for a light vehicle
	PropSuitable		Proportion of SOV trips suitable for light vehicle
marea_parking_growth.csv	PropWorkParking	Spoke with major parking generators	Proportion of workers that park
	PropWorkCharged		Proportion of parkers that are charged at work lot
	PropCashOut		Proportion of workers in parking buyout programs
	PropOtherCharged		Proportion of parkers that are charged at non-work space
	ParkingCost		Parking cost
AutoCostGrowth	-	Assumed value	Growth in car ownership costs
FwyLaneMiGrowth	-	State and local plans	Growth in freeway lane miles
ArtLaneMiGrowth	-		Growth in arterial lane miles
BusRevMiPCGrowth	-	Tompkins Consolidated Area Transit	Growth in bus revenue miles
RailRevMiPCGrowth	-	No rail	Growth in rail revenue miles
VmtCharge	-	None in base scenario	Fee assessed for miles driven

RSG performed a QC review of all of the input files submitted by both MPOs. Through an iterative process, all questions and concerns were resolved.

Technical Memorandum #2 describes the process of calibrating each model.

Appendix B. VERPAT Calibration

Technical Memorandum #2

TO:	Elisabeth Lennon, NYSDOT David McCabe, NYSERDA
FROM:	Steven Gayle PTP, David Grover PE
DATE:	December 14, 2018
SUBJECT:	VERPAT Calibration

Task 2 in the NYSERDA/NYSDOT project Implementation of a Regional Greenhouse Gas Reduction Analysis Tool was calibrating the two MPO specific VERPAT models. The project shifted to using the VisionEval (VE) version of the model before calibration began.

RSG assisted the Capital District Transportation Committee (CDTC) and the Ithaca-Tompkins County Transportation Council (ITCTC) with calibrating their regional VisionEval Rapid Policy Analysis Tool (VERPAT) model. VERPAT examines the effects of different policy options on transportation related measures including vehicle miles traveled (VMT), congestion, greenhouse gas (GHG) emissions, and safety. It thus facilitates the work of MPOs in evaluating scenarios for consideration in their planning process.

Calibration Methodology

The VERPAT model is calibrated by comparing model outputs with target data from trusted sources. Target data can include the following:

- Household vehicle miles traveled (VMT)
- VMT Growth
- Auto or transit trips
- Average vehicle ownership

Both CDTC and ITCTC used their travel demand model, which has been calibrated to ground counts, as the source of their target data. Both used household VMT and VMT growth.

To calibrate a VERPAT model to target data, the user will adjust input data such that the base-year model output converges with the target data. If there is uncertainty regarding any of the input data, or if the user relied on default inputs knowing that they could be inaccurate, the calibration process must begin by refining these input variables. Calibration of VERPAT relies on a credible set of base data.

Base Year

The first step of calibration is to adjust base-year variables to match base-year output with base-year targets. Both CDTC and ITCTC used household VMT as their target data point.

VERPAT contains a household microsimulation routine that models household trips and miles traveled. These data points are compared to the VMT output of the MPO's travel demand model. One major difference between VERPAT and travel demand models is that the VERPAT model only looks at households within the MPO-defined region while travel demand models typically also include external trips. The VERPAT model includes some internal-to-external (I-E) and external-to-internal (E-I) trips, but the exact number cannot be known. Because some drivers may be leaving their houses for locations outside the region and some may be coming in from outside the region, the target VMT should fall between internal-to-internal (I-I) VMT and I-I+I-E+E-I VMT. No external-to-external (E-E) through trips should be in the calibration target data.

CDTC found that, after removing E-E trips from their travel demand model, the daily light-vehicle VMT from their travel demand model was 17,435,113 miles. VERPAT, using the initial data provided, estimated daily light-vehicle VMT to be 17,476,681 miles, which is 0.2% higher than the target. This level of accuracy is accepted as evidence that the model is calibrated.

ITCTC's travel demand model estimated 1,834,100 miles per day, and the VERPAT model estimated 1,813,392 miles per day or 1.1% less than the travel demand model. This model can also be considered calibrated with default data.

In both cases, the discrepancies that may result from the unknown number of E-I/I-E trips in VERPAT are not accounted for. CDTC estimates approximately 12.5% of their VMT is E-I or I-E. ITCTC estimates that approximately 19% of VMT is E-I or I-E, and that a negligible number of trips are E-E (assumed to be zero). If some of these E-I/I-E trips are removed from the target data point, the results are still close enough to the VERPAT VMT to find the model calibrated.

Both base-year models were considered calibrated using the input data as provided by the MPOs.

Future Year

VMT growth was used to calibrate the future-year model. CDTC expected a 7.3% VMT growth by 2050. They also found that future-year income was the variable that they least understood. They set their income growth to zero% with the belief that, in 2050, income should not be a driver of VMT. Their model produced 7.1% population growth, which is close to the 7.3% target, and the model was considered calibrated.

ITCTC expected a VMT growth of 16.2% (2,130,800 VMT) by 2040. Originally, ITCTC used an income growth of 1.3% per year as projected by Woods and Poole. This rate produced a VMT growth that was too high. It we found that an income growth rate of 1% per year, which was closer to the historical average of 1.1% from the Bureau of Economic Analysis, produced a VMT growth of 16.6%. All other inputs were left unchanged from what ITCTC had found.

After adjusting the income for the future year, both models were calibrated.

Endnotes

[1] As detailed in 23 CFR 450.324, MPOs are required by federal law to develop a metropolitan transportation plan with a minimum 20-year horizon, and to update it at least every five years. Among other outcomes, the plan provides guidance to the decisions made by the MPO on the investment of FHWA and FTA program funds.

[2] The "Rapid Policy Assessment Tool" (RPAT) was the original focus of this study. VisionEval was created as an open-source programming platform to house RPAT. The model has been renamed to reflect this change: VisionEval Rapid Policy Assessment Tool (VERPAT). This research expanded VERPAT to include electric vehicles.

[3] Terminology from federal law (23 CFR 450); many MPOs use the terminology Long-Range Transportation Plan (LRTP).

[4] https://visioneval.org/

[5] Future-year value is not used; it is a place holder required for the VisionEval framework. The growth json parameters are used to define future-year values.

[6] https://github.com/VisionEval/VisionEval/wiki/VERPAT-Inputs-and-Parameters

[7] https://github.com/visioneval/visioneval, see /sources/models/VERPAT/inputs and sources/models/VERPAT/defs

[8] See https://github.com/VisionEval/VisionEval/wiki/VERPAT-Inputs-and-Parameters#geocsv and https://planningtools.transportation.org/files/124.pdf for a description of place types.

[9] https://www.census.gov/programs-surveys/cbp.html

[10] https://www.census.gov/programs-surveys/cbp.html

[11] https://www.bea.gov/data/economic-accounts/regional

[12] Future-year value is not used and should be the same as base year; it is a place holder required for the VisionEval framework. The growth json parameters are used to define future-year values.

[13] Propriety data set, https://www.woodsandpoole.com/

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