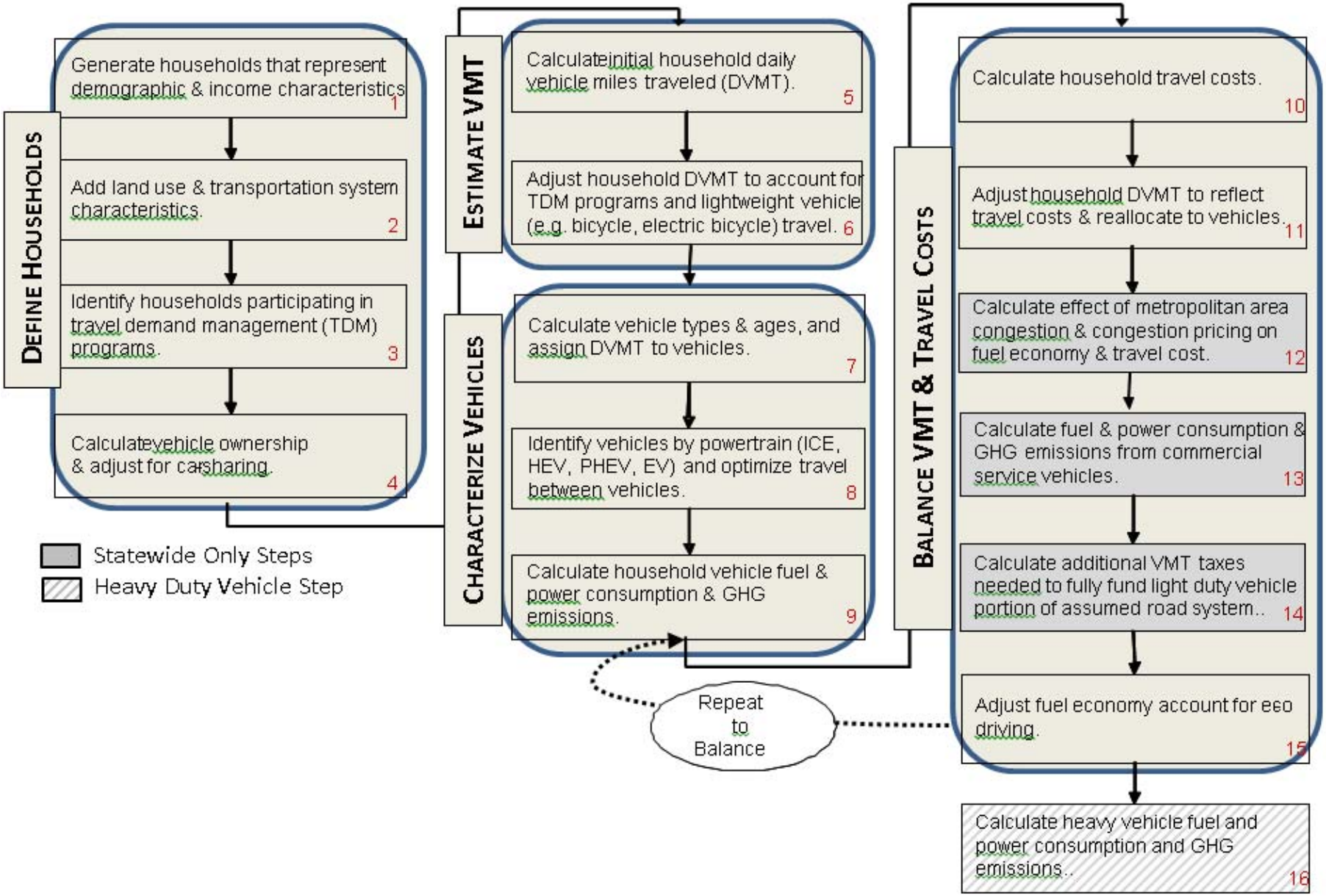
# Regional Strategic Planning Model (RSPM) Model



# RSPM SUMMARY

The Regional Strategic Planning Model (RSPM)[1], was developed by the Oregon Department of Transportation (ODOT) for the purpose of estimating and forecasting the effects of various policies and other influences on the amount of vehicle travel, the types of vehicles and fuels used, and the resulting greenhouse gas (GHG) emissions among other things.

The RSPM model estimates vehicle ownership, vehicle travel, fuel consumption, and GHG emissions at the individual household level. This structure accounts for the synergistic and antagonistic effects of multiple policies and factors (e.g. gas prices) on vehicle travel and emissions. For example, the battery range of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) is less of an issue for households residing in compact mixed-use neighborhoods because those households tend to drive fewer miles each day. Modeling at the household level makes it possible to evaluate the relationships between travel, emissions and the characteristics of households, land use, transportation systems, vehicles, and other factors. In addition, household level analysis makes it possible to evaluate the equitability of the costs and benefits of different strategies.

The RSPM model comprises 16 sequential steps with feedback. Each calculation step is composed of a number of calculations that operate on the results of the previous calculation step and on input data that reflect inputs. The nature of each calculation was determined through the statistical analysis of several data sources such as the National Household Travel Survey. A key method employed in many steps is to sample from observed or target distributions. For example, choosing which households are enrolled in a car sharing program is done by first isolating the correct conditions (e.g., applicable densities) and then randomly assigning enrollment to every $X^{th}$ household that meets the criteria. Each component calculation was estimated and checked using source data.

The RSPM steps are grouped as follows:

1. Define households;
2. Calculate VMT;
3. Characterize vehicles; and,
4. Balance VMT with travel costs.

The iterative process to balance the VMT with travel costs allows congestion and other costs introduced at this step influence the amount of travel. This step balances the amount of household travel with the cost of travel and recalculates household VMT, Fuel & GHG in the process.

The primary outputs of the RSPM are household travel, fuel and power consumption, and GHG emissions calculations, but other information is produced for households and commercial vehicles as well. The amount of commercial (light-duty) and freight (heavy duty) travel is calculated as well as associated fuel, power consumption and GHG emissions for those vehicles (steps 13 and 16 in figure 1, above). In addition, heavy vehicle travel, fuel and power consumption, and emissions are calculated (step 15).

The lack of an explicit representation of interactions between different districts within the study area limits some of the analytical capabilities of the RSPM.

Because RSPM is a new type of model, its development has and is being peer-reviewed by state, national and international travel and emissions modeling experts. The Components of RSPM were tested throughout the development process to check the reasonability of results and whether the model could replicate observed behavior and conditions. Sensitivity tests were also performed to check whether the sensitivity of the model is consistent with results reported by other studies.[2]

[1] RSPM was formerly known as GreenSTEP. The name was changed to reflect expanded capabilities for applying it at a metropolitan area level and to address a more general set of transportation and land use considerations in addition to greenhouse gas emissions.

[2] For example, the sensitivity of RSPM to changes in urban area population density and land use mix was compared to findings published in the TRB Special Report 298, *Driving and the Built Environment: Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions*. September 2009.

# RSPM SUB-MODELS

DEFINE HOUSEHOLDS

1. ***Generate households:*** A set of households is created for each forecast year that represents each resident in the model area with the likely household mix of household and person characteristics (e.g., household income given the ages of persons in the household and the regional average per capita income).
2. ***Add land use & transportation system characteristics:*** Households are assigned a housing type (e.g. single-family, multi-family, etc.) and a development type (metropolitan, town, rural) based on available input dwelling units. Households are assigned a location in the metropolitan area based on the projected supply of housing and neighborhood affordability. Neighborhood population density and mixed-use character are calculated. In metropolitan areas, transit and road service levels are assigned based on inputs regarding expansion of these services and facilities.
3. ***Identify households participating in TDM programs:*** Each household is assigned as a participant or not in a number of travel demand management programs and/or to vehicle operations and maintenance programs (e.g. eco-driving) based on inputs about the program deployment and household characteristics.
4. ***Calculate vehicle ownership and adjust for car-sharing:*** Each household is assigned a number of vehicles based on the characteristics of the household and the land use and transportation characteristics of its location. Households are identified as participating in a car-sharing program with adjustments to auto ownership, based on the characteristics of the household and inputs on the extent of car-sharing program.

ESTIMATE VMT

5. ***Calculate initial household DVMT:*** An initial estimate of average daily vehicle miles traveled (DVMT) is calculated for each household based on the household characteristics (e.g., demographics, income, transportation options, and land use).
6. ***Adjust household DVMT to reflect TDM and bicycle travel:*** Household DVMT is reduced for households identified as participating in TDM programs. DVMT is reduced by an estimated amount of single-occupant vehicle travel that might shift to bicycles or other light-weight vehicles based on input diversion targets.

CHARACTERIZE VEHICLES

7. ***Calculate vehicle characteristics and assign household DVMT to vehicles:*** Household vehicles are assigned to be either autos or light trucks (e.g. SUV, pickup truck, van) based on the household and land use characteristics and input light truck targets. The age of each vehicle is determined from age profiles by vehicle type and household income. Average household DVMT is assigned to vehicles (and adjusted in Step 8).
8. ***Identify vehicles by powertrain and optimize travel between vehicles:*** The powertrain of each household vehicle is identified as an internal combustion engine (ICE), hybrid-electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV), or electric vehicle (EV), based on inputs regarding future market shares by model year. Vehicle fuel economy and power efficiency (for PHEV and EV) is assigned to each vehicle based on the vehicle type, age and powertrain and corresponding inputs for each model year. Inputs specify how optimally households allocate mileage among their vehicles with different fuel efficiency.

BALANCE TRAVEL COSTS

*Steps #9-14 balance the amount of household travel with the cost of travel and recalculate household VMT, Fuel & GHG in the process. This is necessary because: 1) congestion calculations affect fuel economy and thus the amount and cost of fuel consumed; 2) congestion pricing affects the amount of travel and household travel costs; 3) fuel, vehicle travel, and other taxes and fees affect the amount and cost of travel; and 4) eco-driving improves fuel economy and reduces fuel cost. The effect of these adjustments to household travel costs need to be included in the total household travel costs and the adjustment to household DVMT. Steps #9-14 are repeated several times until DVMT changes very little between iterations.*

9. ***Calculate household fuel and power consumption and GHG emissions:*** Total household fuel consumption is calculated based on the DVMT assigned to each vehicle, the proportion of the DVMT that is powered by fuel, and the average fuel economy of the vehicle. Likewise electrical power consumption is calculated for electric miles driven. GHG emissions include future lifecycle carbon intensity of fuels and electricity production
10. ***Calculate household travel costs:*** Household travel costs are calculated from the amounts of miles driven, fuel consumed, electricity consumed, and GHG emitted. How much each household pays for parking is based on inputs on the proportions of employees and non-work trips that pay for parking, and the long-term daily parking rates, all inputs. Other inputs establish the rates for fuel costs, power costs, fuel taxes, VMT taxes, PAYD insurance, and several external costs (i.e. costs imposed on society by driving that drivers do not pay for such as pollution, some or all that can be paid for by drivers).
11. ***Adjust household DVMT to reflect travel costs:*** A household budget model is used to adjust household DVMT to reflect the effect of household travel costs on the amount of household travel. The adjusted household DVMT is allocated to vehicles in proportion to the previous allocation.
12. ***Calculate the effects of metropolitan area congestion and pricing:*** Total light duty vehicle (household and commercial service vehicle), truck and bus DVMT is calculated for the metropolitan area and assigned to portions of the road system (freeway, arterial, other). Congestion levels are and associated speed reductions are calculated considering the traffic loads and inputs regarding the deployment of traffic operations programs (e.g. ramp metering, traffic signal coordination) and congestion pricing. Speed-adjusted fuel economy is calculated considering variations by powertrain. Travel cost per mile due to congestion pricing is also calculated.
13. ***Calculate fuel & power consumption & GHG emissions from commercial service vehicles:*** Commercial service vehicle DVMT is split between different vehicle types, powertrains, and fuels based on inputs. The vehicle age distributions and fuel economy and power efficiency by vehicle type, powertrain and model year are the same at those used for household light duty vehicles.
14. ***Calculate additional VMT taxes needed to fully fund road system:*** In the future, as vehicle fuel economy improves and PHEVs and EVs become more prevalent, fuel taxes will be insufficient to pay the cost to maintain, operate and improve the road system. A VMT fee per mile can be specified directly, or the model can be iterated to identify fees necessary to pay for the planned road system improvements.
15. ***Adjust fuel economy to account for eco-driving:*** The average fuel economy of households identified as eco-drivers is adjusted to reflect improving fuel economy.

HEAVY VEHICLES

16. ***Calculate heavy vehicle fuel and power consumption and GHG emissions:*** Public transportation VMT is calculated from input assumptions about future service miles per capita, future population, and the ratio of vehicle miles to service miles. Transit VMT is split between vehicles powered by on-board fuels vs. electricity based on inputs. The fuel (gallons) and electricity (Kwh) consumed accounts for the age distribution of vehicles and associated differences in fuel economy. GHG emissions reflect inputs regarding the mix of fuels used (e.g. diesel, biodiesel, CNG) and the carbon intensity of electrical power generation.