January 4, 2014

CENTRAL LANE SCENARIO PLANNING

GreenSTEP Model Summary

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Introduction

Oregon Department of Transportation (ODOT) developed the Greenhouse gas Statewide Transportation Emissions Planning model (GreenSTEP) as a way to forecast greenhouse gas (GHG) emissions from transportation. GreenSTEP is one tool that planners can use to do high-level, strategic assessments of potential GHG reduction strategies, and will be used in the Central Lane Scenario Planning process. The model assesses the likely transportation sector GHG effects of a large variety of policies and other factors to meet the requirements of Section 2 of Senate Bill 1059 to support a statewide strategy to meet GHG emissions reduction goals.

This memorandum will describe the data used in the GreenSTEP model; analysis that can be completed with the model; details of the model, including the necessary inputs; and the training provided to LCOG staff to use the model in the scenario planning process.

GreenSTEP Data Used

The GreenSTEP model uses data from a variety of sources including the 2001 National Household Travel Survey, U.S. Census, Bureau of Economic Analysis, (BEA), National Transit Database (NTD), and *Moving Cooler*. The model uses Census data for Oregon from the public use micro-sample (PUMS) for to develop household characteristics including income, household size, and age of household occupants. Much of the travel behavior model components were estimated from the 2001 National Household Travel Survey (NHTS) data, specifically estimates of daily travel by household.

ODOT also uses data for specific metropolitan areas in GreenSTEP. Data for freeway and arterial supplies (lane-miles per capita) are from the 2001 Highway Statistics study, and transit revenue miles per capita are from the National Transit Database for 2001. Household age composition data are from county-level population forecasts by age. These data are synthesized from PUMS data to create a balanced set of households.

GreenSTEP Modeling Details/Inputs

The model uses a number of steps to determine GHG outcomes for different scenarios. Below is a short summary of each step in the process. ODOT's Greenhouse Gas Statewide Transportation Emissions Planning Model (GreenSTEP model) Documentation from November 2010 explains each of these steps in more detail.

The GreenSTEP model process includes the following steps:

1. Create synthetic households – based on the forecast year, and includes the likely household composition by county and by age. The model estimates a household income given the number of people in the household, their ages and the average per capita income of the region.
2. Calculate population densities and other land use characteristics – these estimates are based on values of density and land use characteristics at the Census tract level given policy assumptions about metropolitan and other urban area characteristics. Density assumptions are based on policy assumptions for urban growth boundary (UGB) expansions. Households are characterized based on whether or not they are within or outside of a metropolitan area, as these designations affect density.
3. Calculate freeway, arterial, and public transit supply – the model uses base year inventories for each metropolitan area, and assumes policy inputs on how rapidly lane-miles are added relative to the region's population. Transit revenue miles are calculated relative to the base year.
4. Determine Households Affected by Travel Demand Management and/or vehicle operations and maintenance programs – some households are selected to participate, others are not based on policy assumptions about the degree of deployment of those programs and household characteristics.
5. Calculate vehicle ownership and adjust for car-sharing – Based on the number of persons of driving age per household, elderly person households, population density, and household income, the model assigns a number of likely vehicles by household. In metropolitan areas, vehicle ownership also depends on freeway supply, transit supply, and if the household is located in an urban mixed-use area. The model estimates vehicle-sharing rates based on policy assumptions and household characteristics.
6. Calculate initial household Daily Vehicle Miles Traveled (DVMT). Based on household information from the previous steps. In metropolitan areas, the model calculates DVMT from a number of variables: household income, population density, number of household vehicles, lack of vehicles for a given household, levels of public transportation and freeway supply, the driving age of the household members, and presence of members over 65, and if the neighborhood is mixed use.

7. Calculate non-price TDM and light weight vehicle adjustment factors and adjust household DVMT – the model includes workplace- and household-oriented TDM marketing programs, and adjusts household DVMT accordingly based on assumed program participation. The model also reduces DVMT based on assumptions of light weight vehicle travel (bicycles, electric bicycles, and similar vehicles) for the household.
8. Calculate vehicle types, ages, and initial fuel economy and assign DVMT to vehicles – this assumes ownership of automobiles vs. light trucks by household based on the number of vehicles in the household, household income, population density, and presence of a mixed-use neighborhood by household. Once the model determines vehicle type, then it distributes vehicle age, and then vehicles fuel economy based on model year and vehicle type.
9. Assign plug-in hybrid electric vehicles (PHEVs) and optimize travel between vehicles – the model then determines PHEV by household based on market penetration, model year, and vehicle type. Once the model assigns the number of PHEVs per household, it then determines VMT per PHEV to incorporate assumptions into the emissions output based on range of battery operation, household income, population density, number of household vehicles, transit service level, number of drivers per household, number of elderly per household, and if the household is in a mixed-use neighborhood.
10. Calculate initial fuel consumption, electric power consumption, and GHG emissions – the model calculates fuel consumption based on vehicle type, fuel economy modeled in steps 8 and 9, and then converts fuel consumption into GHG emissions based on assumed fuel mix and carbon intensity of the fuel.
11. Calculate household mileage costs – the model considers costs of fuel, electric power, and depending on policy assumptions, carbon taxes, pay-as-you-drive insurance rates, and parking charges (both workplace and commercial parking fees).
12. Recalculate household DVMT and reallocate to vehicles – the model uses a household budget process to adjust DVMT to determine the effects of variable vehicle costs on the amount of household travel.
13. Assign electric vehicles (EVs) and calculate adjustments to fuel and electric power consumption – the model identifies household vehicles as candidates for electric vehicles based on usage patterns compared to the average travel range of EVs. The model only assigns EVs if a PHEV is identified for a given household in step 9 and the EV range accommodates most of the expected household vehicle usage.
14. Calculate auto and light truck travel on metropolitan area roadways – the model takes into account the differing fuel economy based on congested or free-flow conditions, and calculates the ratio of urbanized area road auto and light truck DVMT and estimates.

15. Calculate truck and bus DVMT and assign proportions to metropolitan areas – the model assumes that as state income growth increases, truck VMT increases proportionately. The model calculates bus DVMT based on revenue and non-revenue miles traveled.
16. Adjust metropolitan area fuel economy to account for congestion – once the model allocates DVMT by vehicle type (auto/light truck, truck, and bus DVMT) to freeways, arterials, and other roadways. The model then calculates speeds by congestion level, and determines the fuel efficiency to reduce fuel efficiency averages for each metropolitan area.
17. Adjust fuel economy to account for eco-driving and low-rolling resistance tires – these two adjustments allow the model to improve vehicle fuel economy.
18. Calculate final household light vehicle fuel consumption, electric power consumption, GHG emissions, and costs – the model recalculates these based on adjusted fuel economy and power consumption based on the previous steps
19. Calculate bus, truck, and passenger rail fuel consumption and GHG emissions adjusted for congestion – the model considers truck and bus age distributions from base year and includes assumptions about fleet turnover to compute average MPG of respective fleets, adjusted for congestion in metropolitan areas.

Model inputs

There are a number of inputs used in the GreenSTEP model to explore the likely GHG emissions impacts of a variety of policy, land use, and behavioral changes. These inputs and assumptions can be altered for a given scenario to determine the likely GHG emissions, and are described by topic below.

Community Design

- Urban growth boundary (UGB) (Rate of expansion relative to rate of population growth)
- Households in mixed-use areas by Census tract or county (percent)
- Rate of growth of public transportation service (revenue mile growth per capita compared to base year level)
- Bicycle or light vehicle adoption
- Work and non-work parking extent and cost

Pricing

- Pay-as-you drive insurance (percent households and cost)
- Gas tax (Includes state and federal gas tax, reference scenario assumes HB 2001 gas tax increases)
- Carbon emissions fee
- Vehicle travel fee

Marketing and Incentives
- Households participating in individualized marketing and eco-driving programs (percent)
- Participation rate in employer-based commute programs (percent)
- Extent and participation in car-sharing

Roads
- Rate of growth of freeway and arterial lane miles

Fleet
- Fleet turnover rate/ages
- Percentage of fleet that is light-duty truck/SUV/van

Technology
- Auto fuel economy – internal combustion engine
- Light truck fuel economy – internal combustion engine
- Auto fuel economy – plug-in hybrids
- Carbon intensity of fuels (Co2 grams/megajoule)
- Percent of autos that are plug-in hybrids or electric vehicles
- Percent of light trucks that are plug-in hybrids or electric vehicles

Training

GreenSTEP is a recently developed, relatively new modeling tool that ODOT is still refining. LCOG staff worked closely with Brian Gregor (an architect of the GreenSTEP model) from ODOT's Transportation Planning Analysis Unit (TPAU) between February and November 2013 to obtain and review GreenSTEP documentation, reports, and spreadsheet results from earlier implementations.

Additionally, LCOG staff worked with TPAU to upgrade the GreenSTEP model to develop more detailed synthetic households at the request of the TAC and PMT to refine the geographic extent of the districts (see step 1 of the GreenSTEP modeling details section above). This upgrade process involved LCOG staff throughout including the data development stage, coding, and calibration and validation. Being involved throughout the upgrade process allowed LCOG staff to become familiar with the new version of the model as well as its original functionality. There were approximately six three-hour in person meetings, and 20 two-hour weekly check-ins whereby LCOG and ODOT staff coordinated and collaborated on the model development, preparation, and implementation during the time period above.

LCOG also reached out to Portland Metro staff on GreenSTEP process and outputs to determine how to use the data and results, along with completing the scenario planning process, though there was no formal training or check in schedule.

There was no formal training on the Integrated Transport and Health Impact Modeling Tool (ITHIM), only documentation and a discussion with Metro on how that agency used the model to evaluate the public health co-benefits of selected transportation and land use GHG reduction strategies. LCOG staff spent around 12 hours reviewing ITHIM documentation and application in the UK, San Francisco, and Portland. LCOG has not yet used the ITHIM model, but staff anticipates using the model on the suite of feasible scenarios. Once the scenario planning process is ready to use the ITHIM model, LCOG staff will need approximately two days of training.