U.S. Department of Transportation

TRUCE-ST User's Guide

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This guide is designed to assist users of the FHWA's Tool for Rush Hour User Charge Evaluation, State Version, known as TRUCE-ST. A useful reference on TRUCE-ST is "Revenues from a Statewide Congestion Pricing Program: Estimation on a Shoestring Budget" by Patrick DeCorla-Souza (FHWA) and David Luskin (HDR Engineering Inc.), forthcoming in *Transportation Research Record*.

What is TRUCE-ST

TRUCE-ST builds on the foundation of the TRUCE 3.0 model developed at the U.S. Department of Transportation in collaboration with HDR|HLB Decision Economics. Readers interested in a technical description can consult our report to the U.S. Department of Transportation, *Congestion Pricing: Analyzing Financial and Greenhouse Gas and Fuel Impacts with TRUCE 3.0* and the addendum to that report, *Addendum to Technical Report on TRUCE Version 3.0***.** The report is available on FHWA's TRUCE website at: http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/tools/index.htm. As indicated by the model's full name (Tool for Rush-Hour User Charge Evaluation), users can apply TRUCE to quantify the impacts of congestion pricing on urban highways. In its current form, the model considers scenarios for congestion pricing on the network of limited-access highways, or "freeways". The sources for the key inputs of traffic data are the Urban Mobility Report (UMR) series produced by the Texas Transportation Institute and the FHWA *Highway Statistics* series. In the Urban Mobility Report, the peak traffic periods are defined as 6-10 am and 3-7 pm, a total of eight hours. For insights into the model's evolution, users of TRUCE-ST may review the present User's Guide in conjunction with that for TRUCE 3.0 and the report *Development of TRUCE-ST from TRUCE 3.0*. Both are available on FHWA's TRUCE website.

The Model Interface

The graphical user interface in TRUCE-ST allows the user to enter input data, change a number of default assumptions, and view the model's results. The "Inputs" worksheet provides separate sections for traffic and socioeconomic data and for assumptions about electronic tolling costs and current funding sources (e.g., fuel taxes, tolls, etc.). Data inputs should be values specific to the state being studied. For illustration, the inputs in the user interface are based on data for an eastern state in the U.S. The default assumptions in the user interface assign reasonable values to certain input variables that are either unlikely to differ much among states or for which state-specific values would be difficult to obtain. Users have the option to replace these defaults with values they consider more appropriate.

The graphical user interface presents tables of results for (1) traffic and revenues, arterial speeds, and toll collection costs under congestion pricing, (2) the average value of travel time savings per hour, (3) fuel consumption and greenhouse gas emissions in the base case and under congestion pricing, and (4) collection costs under the current highway funding system (e.g., costs of collecting motor fuel taxes). Key results are summarized in the "Results" worksheet.

From the information in the "Inputs" worksheet, TRUCE-ST creates the base case, which describes conditions in the absence of congestion pricing. These conditions, detailed in the worksheet "Base Case", are key inputs to the estimation of the impacts of congestion pricing on traffic and speeds ("Traffic Impacts" worksheet). The estimates of traffic and speed impacts, in turn, feed into the estimation of the average congestion charge and associated gross revenue in the separate worksheets for the aggressive and moderate congestion pricing scenarios ("Free Flow CP" and "Moderate CP"). The "Analysis" worksheet, columns E and F, contains: (1) a financial analysis that calculates revenue from congestion pricing net of the estimated cost of collecting the charges (from "Collection Cost" worksheet), (2) a summary of the estimated impacts on fuel consumption and emissions of greenhouse gases (CO2 and NO_x), taken from the "EmissionsFuel Consumption" worksheet, and (3) a rudimentary benefit-cost analysis of congestion pricing. Key results from the TRUCE-ST simulations are summarized in the "Results" worksheet.

Key Model Features

Description of the Base Case

TRUCE-ST uses data inputs from *Highway Statistics* to predict for each state the distribution of peak-period VMT by level of congestion. The peak-period spans the eight hours from 6-10 am and 3-7 pm, but in reality congestion occurs only during a portion of this period. (In the TTI Urban Mobility Report, the only area where the entire peak period entails congestion is Los Angeles). In the “Base Case” worksheet, TRUCE-ST predicts the percent of freeway peak-period VMT that travels during the congested portion of the peak (cell B17), and also the distribution of peak-period VMT by congestion level (cells B65-B70). In the distribution, the uncongested percentage includes traffic that travels either outside the congested portion of the peak or inside that portion, but on freeway sections that remain uncongested. The congestion levels are as defined in the TTI Urban Mobility Report.

Users who want more precise estimates of the distribution of peak-period VMT can apply the estimation procedures described in the TTI Urban Mobility Report (methodological appendix) to data from the Highway Performance Monitoring System (HPMS). The FHWA makes available the data from the HPMS sample for each state. Users following this approach would need to replace the values in cells B56-B60 of the "Base Case" worksheet. When applying TRUCE-ST to states with little congestion in the severe to extreme range, this more precise approach may be necessary to obtain results for the moderate congestion pricing scenario, which targets the elimination of severe-to-extreme congestion only, rather than of all congestion. This situation can arise because the model's approximation procedures are not sufficiently sensitive to detect a negligible share of VMT that travels under hyper-congested conditions. Users of the model will be alerted to this situation by negative entries in Table 4 in the "Base Case" worksheet.

At a given level of congestion, TRUCE-ST assumes average freeway speeds, excluding incident delay, to be everywhere the same as in the Los Angeles area (for which unpublished UMR data were supplied by David Schrank of TTI). These speeds are shown in the "Base Case" worksheet, cells B34-B38. The model recognizes, however, once incident delay is included, the average speed at a given level of congestion will vary among states. Ratios of incident to recurrent delay are entered in the "Inputs" worksheet. These can be calculated as suitably weighted averages of the ratios reported in the UMT for urban areas within the state being considered.

The Value of Time

The charges in a congestion pricing scheme depend partly on how much road users value travel time savings. The overall value of travel time is derived in TRUCE-ST as a traffic-weighted average of values calculated for cars and trucks ("Value of Time" worksheet). For trucks, the calculation allows for the differences in wages between drivers of light and heavy trucks, as well as the value of time for freight cargo. The truck share of VMT on the urban portion of a state's highway network can be obtained from FHWA *Highway Statistics,* Table PS-1.

Values of time can differ across states because of differences in income and wage levels. To estimate values for a particular state, users of TRUCE-ST can enter the median household income reported for urban residents of that state in the American Community Survey. Wage and employment data for truck drivers and general wage data for all occupations are also required. The wage and employment data — mean hourly wage and number of employees for both heavy and light truck drivers —can be obtained from Bureau of Labor Statistics (http://www.bls.gov/bls/blswage.htm).

The weighted average value of time is interpreted in TRUCE-ST as a median rather than a mean, and this affects the prediction of the average congestion charge in the "Free Flow CP" and "Moderate CP" worksheets. The implied mean value of time for autos is calculated in the "Analysis" worksheet in cell C177. In the application of the model to the case study state, the median and mean values of auto travel time are estimated respectively at $23.77 per hour (cell C53, "Values of Time" worksheet) and $32.53 per hour (cell C179, "Analysis" worksheet). Users of the model who regard these values as too high or too low can alter them by making adjustments in the "Values of Time" worksheet.

ETC Capital and Operational Costs

Capital and operational cost factors for Electronic Toll Collection (ETC) are the same as in TRUCE 3.0; for documentation of their derivation, see the technical report and User's Guide for that version. Users may want to alter the cost assumptions to reflect the most up to date cost estimates, or estimates specific to their project size and type. ETC costs may be changed by the user through the user interface. Modifications to assumptions about the toll system design (e.g., adding or removing capital items) must be made directly to the "ETC Cost" worksheet.

Fuel Consumption and Vehicle Emissions

The inputs to the fuel consumption and vehicle emissions calculations are generated internally within the model. The key inputs are the peak-period average speed and traffic volume (VMT) in each scenario, measured separately for freeways and arterials. Fuel economy is estimated using a modified version of the equation in the TTI 2007 Urban Mobility Report; this equation takes account of the differences in fuel consumption rates between automobiles and commercial trucks and expresses average miles per gallon as a function of average congested speed. The estimates of fuel economy thus obtained are then multiplied by vehicle miles of travel to generate estimates of total fuel consumption. EPA guidance on carbon dioxide emissions from gasoline and diesel fuel combustion is used to derive the CO2 emissions associated with the combination of speed and traffic volume. Vehicle emissions of nitrous oxides are derived from factors developed from the EPA MOBILE 6.2 emissions estimation model.

Collection Costs of Current Funding Sources

Collection costs associated with current sources of transportation revenue are estimated from state-level data provided by the Federal Highway Administration's Highway Statistics series. To estimate the portion of collection costs that is attributable to travel on the urban portion of the road network, TRUCE-ST prorates the state-level estimates by the urban share of state vehicle miles traveled. The required data on vehicle miles traveled can be obtained from FHWA's Highway Statistics.

Default collection cost rates – the percentage of revenue expended in collection activities – are included in the model. These have been developed from Highway Statistics, data from Federal, state and local governments. Collection costs for motor fuel and motor vehicle taxes can be obtained for most states from Highway Statistics. Default values for other sources of funding were developed after a review of revenue and budget data for selected agencies in a few states; users may wish to consider replacing these defaults with values tailored to the state they are studying.

Traffic Impacts

The freeway speeds under congestion pricing are largely fixed inputs into the model, as they represent policy targets that are assumed to be realized. In the aggressive pricing scenario, average freeways speeds on the freeways are 60 mph. In the moderate congestion pricing scenario, the elimination of severe and extreme congestion brings the average speeds on sections currently experiencing those congestion levels up to the average speed that prevails under "heavy" congestion (the level below "severe"). Excluding incident delay, that average speed is set in the model at 51.4 mph. For the highway sections currently at the heavy level of congestion or below, moderate congestion pricing has no impacts on speeds. The average speed under all freeway sections under moderate congestion pricing is calculated in the model ("Traffic Impacts" worksheet).

Once the spreadsheet determines the overall impact of congestion pricing on peak-period VMT (columns C rows 22 and 32), it determines the portion of this change that represents diversion of traffic toward the arterials (row 69). This portion is a function of the transit share of commuting trips in the area concerned. A high transit share indicates that many car-drivers priced off the freeways would turn to transit as an alternative rather than switching to the heavily clogged arterials. Representing this end of the spectrum is London, UK, where 38 percent of diverted commuters take transit, and only 25 percent of the traffic reduction due to congestion pricing diverted to arterials. At the other end of the spectrum is the Los Angeles area, where fewer than 7 percent of commuters take transit, and study findings suggest that abut 60 percent of the reduction in freeway traffic after congestion pricing would shift to the arterials. Linear interpolation between these extremes yields predictions of the extent of diversion to arterials in other cases. The actual extent of diversion onto arterials that would accompany a congestion pricing scheme would depend, of course, on policy actions such as the extent to which investments in transit accompany congestion pricing. Users are therefore encouraged to adjust the predicted values as appropriate.

Revenue Impacts

TRUCE-ST estimates the average congestion charge that would be needed to induce the predicted amount of diversion from freeways to arterials. The average charge depends on the estimated distributions of traveler willingness to pay for travel on uncongested freeways relative to slower arterials.

To annualize the estimates of congestion revenue per day, TRUCE-ST assumes conservatively that the revenues are collected on 250 days per year, fewer than the 330 assumed in the original version of TRUCE. Another difference between the two versions is that TRUCE-ST, like TRUCE 3.0, incorporates no specific travel subsidy or discounts for low-income travelers. The decision to subsidize low income travelers or other target user groups remains an option for any community. And the ability to implement that travel assistance, for example, by electronic transfer of travel funds into users' "smart card" or similar travel use accounts has become less complicated due to improvements in data and communications technology. (Users of the TRUCE-ST and other models could readily calibrate budgetary effects for subsidizing user groups, depending upon target traveler group size and assumed per-traveler amounts of assistance.)