## Energy and Emissions Policy Analysis Tool Webinar Overview

<table>
<thead>
<tr>
<th>Presentation</th>
<th></th>
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<tbody>
<tr>
<td>Welcome and Background</td>
<td>John Davies, FHWA</td>
</tr>
<tr>
<td>Model Structure</td>
<td>Colin Smith, RSG</td>
</tr>
<tr>
<td>Q&amp;A</td>
<td></td>
</tr>
<tr>
<td>Using EERPAT and Pilot Studies</td>
<td>Bob Chamberlin, RSG</td>
</tr>
<tr>
<td>Q&amp;A</td>
<td></td>
</tr>
</tbody>
</table>
Administrative Items

• Attendees are on mute
• Type questions into chat pod at any time
• Webinar will last approximately 90 minutes
• Q&A session after Colin’s and Bob’s presentations
• Webinar will be recorded and posted
Motivation

- Identify tools to analyze transportation energy consumption and related emissions, especially at the State level
- Many States lack statewide travel forecasting and emissions analysis capabilities.
- Travel network detail at the statewide level does not match that of urban models
- Travel demand models may not be sensitive to the impact of demand-side strategies, which are often a key element of climate policy for transportation agencies
Transportation Models – From Forecasting to Backcasting

- Forecasting the future is complex and uncertain. Factors to consider include:
  - Population growth
  - Pricing, household income
  - Vehicle ownership
  - Vehicle type
  - Fuel type (carbon intensity of the fuel)
  - Systems management (supply, operations, pricing)
  - Transportation investments
  - Land use

- Need for tools to run lots of scenarios, which helps identify policy sensitivities and backcast a path to the desired future
What’s happened in the meantime…

- The transportation sector became the leading source of U.S. CO2 emissions in 2016, according to the Energy Information Administration.
- Transportation accounted for 31% of U.S. CO2 emissions in 2014 (most recent year of EPA data; value includes bunker fuels).
- On-road sources accounted for 84% of transportation GHG emissions in 2014.

Source: DOE, EIA, May 2016 Monthly Energy Review
What is the new Executive Order 13783, *Promoting Energy Independence AND Economic Growth*?

- Signed by President Trump on March 28, 2017
- Focuses primarily on energy production, DOI, DOE and EPA programs
- Calls for CEQ to rescind its August, 2016 guidance on climate change.
- Rescinds E.O. 13653 (Preparing the United States for the Impacts of Climate Change).
- May have some relevance to FHWA’s programs. USDOT is currently evaluating how our works aligns with and supports the EO.
GHG Models and the EERPAT Lineage
EERPAT is within a family of “strategic planning models”

- Address variables across multiple dimensions (income, technology, pricing, etc.)
- Run multiple scenarios
- Provide data outputs to support informed decisions
- Fills a niche between sketch planning tools and highly complex models.
- Fine granularity in household response to policy initiatives (v3 and v4)
- New detailed freight modeling capability (v4)
EERPAT Lineage

- Oregon DOT GreenSTEP Model (2009-2010)
  - Applied at State level
  - Implemented and applied through R
- Regional Strategic Planning Model (2012-2014)
  - Applied at metropolitan level
  - Implemented and applied through R
- RPAT – (SHRP2 C16, 2011-2016)
  - Applied at metropolitan level
  - Detailed land use modeling, including place types and employment
  - Implemented in R with Graphical User Interface
  - Applied at State level
  - Implemented in R with Graphical User Interface
  - 5 Pilot applications (CO, MD, VT, UT, WA) – use v3
- VisionEval – FHWA Pooled-Fund Study (2017- )
Other Approaches to GHG Analysis

- Travel Models + MOVES
- Travel Efficiency Assessment Method (EPA)
- Spreadsheet Methods
- Complex models
  - UrbanSim
  - PECAS
- EERPAT occupies middle ground between sketch planning tools and more complex approaches
  - Comprehensive policy space
  - Model set up and calibration
  - Run time
EERPAT’s Policy Space

- **Technology**
  - internal combustion engine,
  - hybrid, plug-in hybrid,
  - battery-electric

- **Alternative fuels**
  - electric
  - bio-diesel
  - CNG
EERPAT’s Policy Space

- Land use
  - Urban growth boundaries and density
  - Mixed use

- Pricing
  - Gas cost and tax
  - Electricity cost
  - Road user charge
  - Congestion charges
  - Carbon tax, air pollution tax
  - Costs of vehicle ownership (financing, registration, maintenance)
EERPAT’s Policy Space

– Travel demand management
  ➢ TDM programs
  ➢ Parking pricing
  ➢ Carsharing

– Alternative modes
  ➢ Conventional highway investment
  ➢ Investments in transit, bike/ped

– Operations
  ➢ Eco-driving
  ➢ Ramp metering, speed harmonization, operational efficiencies, incident response
<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Forecast Horizon</th>
<th>Geographic Focus</th>
<th>Modes</th>
<th>Estimation Process</th>
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<tbody>
<tr>
<td>FHWA, 2014</td>
<td>any</td>
<td>State-Level</td>
<td>Multi-Modal Household Travel Demand, Freight</td>
<td>Quantitative, internally-generated travel demand, mode choice, policy response</td>
</tr>
<tr>
<td>ULI, 2009</td>
<td>2050</td>
<td>National</td>
<td>All Surface Transportation</td>
<td>Research-based, application of elasticities</td>
</tr>
<tr>
<td>USDOT, 2010</td>
<td>2030</td>
<td>National</td>
<td>Total US Transportation</td>
<td>Research-based, application of elasticities</td>
</tr>
<tr>
<td>Mineta NTRC, 2014</td>
<td>2040</td>
<td>National</td>
<td>Multi-Modal Household Travel Demand, Freight</td>
<td>VMT Elasticities Derived from CA Statewide Travel Demand Model Applied to VISION Model (ANL); VMT applied by user; full life cycle emissions from GREET</td>
</tr>
<tr>
<td>EPA, 2014</td>
<td>2035</td>
<td>Metropolitan</td>
<td>Multi-Modal Household Travel Demand</td>
<td>Elasticities of VMT to policy interventions.</td>
</tr>
</tbody>
</table>
EERPAT Model Structure
Modeling Steps

1. Generate synthetic households
2. Apply urban area land use and transportation system characteristics
3. Model vehicle ownership types and ages
4. Model initial estimates of household vehicle travel
5. Model household vehicle types and allocate VMT to vehicles
6. Calculate household cost per vehicle mile
7. Recalculate household vehicle travel and adjust allocation to vehicles
8. Aggregate characteristics by county, income group and development type
9. Model heavy vehicle VMT
10. Adjust MPG due to congestion
11. Calculate fuel consumption by type
12. Calculate lifecycle CO₂e emissions by fuel type
Estimating Emissions from Household Travel

- Light-duty travel is 60% of transportation-GHG
- A key focus of EERPAT is on household response to policy initiatives implemented individually or in combination.

- HH synthesis
- HH income model
- HH density model
- HH travel model
- HH vehicle ownership model
- HH light vehicle model
- TDM model
EERPAT Household Budget Constraints on Travel

- **Pricing is an important policy tool affecting the cost of travel:**
  - Gasoline tax
  - Electricity cost
  - Road user charges
  - Congestion charges
  - Carbon tax
  - Parking cost

- **EERPAT incorporates a built-in household budget, approx 10% of HH income**

- **When household travel expenses:**
  - …are less than the travel budget, there is no effect on travel;
  - …exceed the travel budget, travel is cut back. DVMT is constrained to be within the HH travel budget.
EERPAT HH Vehicle Choice
EERPAT HH Vehicle Choice

- Estimate # of Vehicles per Household
- Determine Vehicle Types
  - Autos and Light Trucks
  - Powertrains
    - ICE
    - Hybrid
    - Plug-in Hybrid
    - EV
  - Plug-in Hybrids and EV Shares are Asserted by the User
    - Constrained by Range
Example Policy - Increase EV Market Share
EERPAT v4 Freight Model

Sources of Transportation GHG Emissions

- 60% - Light-Duty Veh
- 23% - Heavy-Duty Veh
- 8% - Medium- and Heavy-Duty Trucks
- 4% - Aircraft
- 2% - Other
- 2% - Watercraft
- 2% - Rail
Model Design

Firm Synthesis

• Individual business establishments produce and consume commodities

• Uses county business patterns, FAF commodity flow data, BEA Input Output data

Mode choice

• Varies by commodity
  - FAF data
  - VIUS data

• Depends on infrastructure, costs, distance

Forecasts

• Commodity flow forecasts available from FAF
Freight Model Policy Sensitivities

Fuels, engine technologies, and vehicle improvements
- Echoes passenger model when possible
- Alternative drivetrains (electric; hybrid-electric; diesel; CNG; biodiesel)
- Scaling factors for Phase 2 Heavy Duty Fuel Standards

Driving characteristics
- Including AV/CV and ecodriving
- Scaling factors, updated as research is available

Economic growth
- Explicit in model design
- Sensitivity to imports(exports)/through traffic

Mode shift
- Asserted
EERPAT Congestion Model
EERPAT Congestion Model

Transportation Supply –
• Freeway and Arterial Lane Miles
• Alternative Modes

Allocation of Household Vehicle, Commercial and Freight VMT to Freeway and Arterial Lane Miles

Apply Texas Transportation Institute Data on Urban Congestion

Estimate Fuel Efficiency Effects of Different Congestion Levels
EERPAT Congestion Model

Uncongested

Heavily Congested

Severely Congested

Extremely Congested
EERPAT Fuel Types and Emission Rates

Calculates Fuel Usage by Fuel Type
- Fuel types are specified by vehicle type

Fuel Types:
- Gasoline (including % ethanol)
- Diesel (including bio-diesel)
- CNG
- Electricity

Apply GHG Emission Rates to fuel usage and electricity consumption for charging
- Fuel specific emission rates are “wells to wheels” in V4, based on GREET2014
- Grid electricity emission rates have been updated in V4
EERPAT State DOT Pilot Tests
EERPAT Pilots and Applications


Maryland
Washington
Vermont
Colorado

Other Applications (2015-2016):

Utah
Massachusetts
Impact of GHG Reduction Policies Relative to Target Emissions

Maryland

Washington
Washington State’s Greenhouse Gas (GHG) Reduction Targets

As per Governor’s GHG emission goals RCW 70.235.020, statewide GHG Reduction **Targets** are:

- Reduce GHG to *1990 levels* by 2020
- Reduce GHG to *25% below 1990 levels* by 2035
- Reduce GHG to *50% below 1990 levels* by 2050
Washington State Growth

Percent Change in Population, Per Capita Income and Daily CO2 Eq. GHG Emissions for WA State
## Key Strategies in Groups

<table>
<thead>
<tr>
<th>TDM</th>
<th>Pricing</th>
<th>Technology</th>
<th>System Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>UGB</td>
<td>Gas Price</td>
<td>Increase to CAFE</td>
<td>Maximize System Operation</td>
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<tr>
<td>TDM</td>
<td>Carbon Tax</td>
<td>EV, HEV, PHEV penetration</td>
<td>TDM</td>
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<tr>
<td>Transit Service</td>
<td>Congestion Pricing</td>
<td>Renewable Energy Share</td>
<td>Transit Service</td>
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<tr>
<td>Mode Shift</td>
<td>Pay by Distance Insurance</td>
<td>Mode Shift</td>
<td>Mode Shift</td>
</tr>
<tr>
<td>Parking Costs</td>
<td>Parking Costs</td>
<td>Fuel Carbon Intensity</td>
<td>Car Sharing Rates</td>
</tr>
</tbody>
</table>
Statewide GHG Emissions Reduction – from each Group of Measures

- Strategies as listed in the previous slides

Daily CO2 Equivalent GHG Emissions for WA State

- **MODE**: CO2 Equivalent GHG Emissions (in Metric Tons)

- **Base Future_2010 Levels**
- **TDM Strategies**
- **Pricing Strategies**
- **Technology Strategies**
- **System Optimization Strategies**
- **TARGET Total**
## 2050 GHG Emission Reduction Compared to Base Case
(Washington State Target is -73% reduction by 2050)

<table>
<thead>
<tr>
<th>TDM 'a'</th>
<th>Run 1</th>
<th>Run 2</th>
<th>Run 3</th>
<th>Run 4</th>
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<tbody>
<tr>
<td>-19%</td>
<td>'a1'</td>
<td>'a2'</td>
<td>'a3'</td>
<td>-</td>
</tr>
<tr>
<td>Pricing 'b'</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-19%</td>
<td>'b1'</td>
<td>'b2'</td>
<td>'b3'</td>
<td>'b4'</td>
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<td>-26%</td>
<td>-</td>
<td>-29%</td>
<td>-26%</td>
<td>-</td>
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<tr>
<td>Technology 'c'</td>
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<tr>
<td>-36.9%</td>
<td>'c1'</td>
<td>'c2'</td>
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<tr>
<td>-47.0%</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>System Optimization 'd'</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-19%</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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Statewide GHG Emissions Reduction – from Combinations of Strategies

Daily CO₂ Eq. GHG EMISSIONS for Washington State

YEAR

1990 2010 2015 2020 2025 2030 2035 2040 2045 2050

CO₂ Equivalent GHG Emissions (in Metric Tons)

140,000

120,000

100,000

80,000

60,000

40,000

20,000

Target Total

Base Future_2010 Levels

Scn a3 - TDM

Scn b4 - Pricing

Scn c2 - Technology

Scn d1 - System Optimzn.

Scn a3+b4

Scn a3+b4+c2

Scn a3+b4+c2+d1
Statewide GHG Emissions Reduction – from Group of Strategies

Daily CO$_2$ Eq GHG Emissions for Washington State

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily CO$_2$ Eq GHG Emissions</th>
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</thead>
<tbody>
<tr>
<td>1990</td>
<td>140,000</td>
</tr>
<tr>
<td>2010</td>
<td>120,000</td>
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<tr>
<td>2020</td>
<td>100,000</td>
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<tr>
<td>2030</td>
<td>80,000</td>
</tr>
<tr>
<td>2040</td>
<td>60,000</td>
</tr>
<tr>
<td>2050</td>
<td>40,000</td>
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</table>

Key:
- Base Future_2010 Levels
- Scn a3 - TDM
- Scn b4 - Pricing
- Scn c2 - Technology
- Scn d1 - System Optimzn.
- Scn a3+b4
- Scn a3+b4+c2
- Scn a3+b4+c2+d1
- Scna3b4c2d1+truck mpg inc.
- TARGET Total
EERPAT Pilots: Key Take-Aways

• Range of capabilities across the 4 State DOTs requiring different levels of interaction.
• Continued model usage in 3 of 4 pilot states.
• Model has relatively steep learning curve, but has generated results considered plausible by DOT staff knowledgeable in the transportation-GHG area.
• Horizon year results strongly sensitive to assumptions, which must be thoughtfully developed; e.g.:
  - Fuel carbon content
  - Carbon intensity of electric charging
  - Fuel efficiency for all vehicles/drive trains
    *CAFÉ standards (sticker vs operating efficiency; forecast horizon)*
  - Relationship between economic activity and freight activity
• The Value of EERPAT – realistic and robust results, internally-generated VMT, broad policy space, data-driven, advances policy discussion
FHWA EERPAT Website

The Energy and Emissions Reduction Policy Analysis Tool (EERPAT) was developed to analyze policies designed to reduce transportation energy consumption and greenhouse gas emissions (GHG). Many states are seeking to perform this type of analysis, but lack the tools to do so. EERPAT was developed to meet this need. EERPAT allows agencies to quickly assess policy interactions in hundreds of scenarios.

EERPAT is based on GreenSTEP, developed by the Oregon State DOT. It is anticipated that EERPAT will have regular enhancements.

Resources
- User Guide (v.3)
- Model Documentation (v.3)

Scenarios

<table>
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<tr>
<th>Scenario</th>
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<tr>
<td>Base2010</td>
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<tr>
<td>BaseFuture</td>
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</table>
State Files (global across state scenarios)

- Global State Settings
- Vehicle Ownership Model Calibration Parameters
- Base year arterial lane miles by metropolitan area
- Base year rural population density by county
- Association of counties with regions and metropolitan areas
- Base year freeway lane miles by metropolitan area
- Factors to convert household daily VMT to light vehicle road daily VMT
- Household type membership probability by age
- Additional data to calculate metropolitan daily VMT
- Annual bus and rail revenue miles per capita by metropolitan area
- Cumulative vehicle age distribution for trucks and busses
- Proportions of truck and bus daily VMT by functional class

Documentation

Base year arterial lane miles by metropolitan area

Format

arterial_lane_miles.csv is a table of base year (2005) arterial lane miles by metropolitan area. The file has one row per metropolitan area and the values in units of miles.

How the file is used

The arterial lane miles data are used to describe the supply of arterial capacity in the models and calculations that adjust metropolitan area fuel economy to account for congestion.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td>1</td>
<td>Msa</td>
<td>ArtLmi</td>
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<tr>
<td>2</td>
<td>Baltimore</td>
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<tr>
<td>3</td>
<td>CaliforniaLexington</td>
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<td>Hagerstown</td>
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<td>PhiladelphiaCamden</td>
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<td>Salisbury</td>
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<td>8</td>
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<td>2937.86</td>
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<tr>
<td>9</td>
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Save
EERPAT File Structure

-what the GUI operates on
This page allows you to set up policies to apply to the base models you create. Once you have defined a policy, you can define differing degrees, or levels of intervention, of the policy. (Show Me An Example).

- EV Policy
- Moderate EV Policy Level
- Define Policy: Policy Title
- Define Policy: Policy Level
- Select the Files for Implementing the EV Policy-Moderate EV Policy Level Policy

The status of each file as it relates to the base scenario is specified below:

- File as been changed
- File has not yet been changed

Click on the links below to edit the files. Once you save the files, they will change status.

**Policy Level Files**
- Information on electric vehicles by model year
- Information on hybrid vehicles by model year
- Information on plug-in hybrid electric vehicles for each vehicle model year
Contacts

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