



U.S. Department of Transportation
Federal Highway Administration

The Energy and Emissions Reduction Policy Analysis Tool

26 April 2017



Energy and Emissions Policy Analysis Tool Webinar Overview

Presentation	
Welcome and Background	John Davies, FHWA
Model Structure	Colin Smith, RSG
Q&A	
Using EERPAT and Pilot Studies	Bob Chamberlin, RSG
Q&A	

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

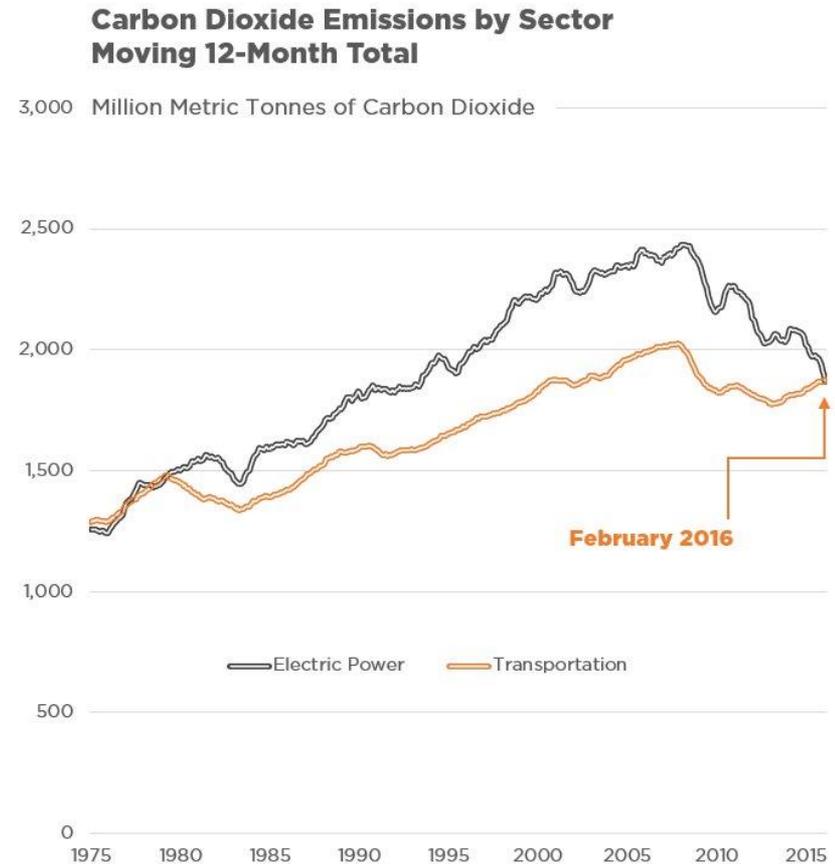
- Identify tools to analyze transportation energy consumption and related emissions, especially at the State level
- Many States lack statewide travel forecasting and emissions analysis capabilities.
- Travel network detail at the statewide level does not match that of urban models
- Travel demand models 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.



U.S. Department of Transportation
Federal Highway Administration



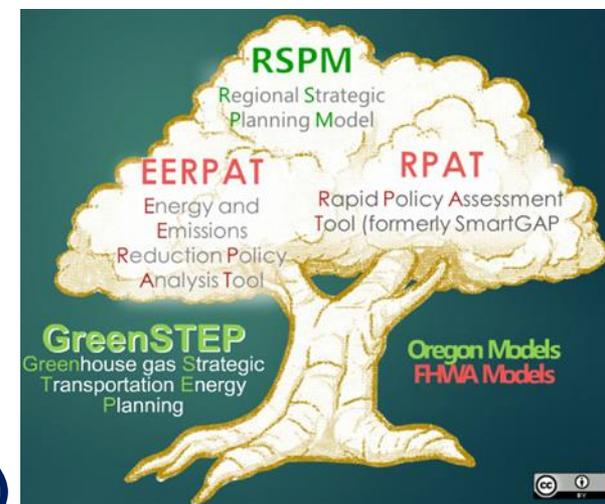
GHG Models and the EERPAT Lineage

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
- **Energy and Emissions Policy Analysis Tool (EERPAT, 2011-2016)**
 - 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

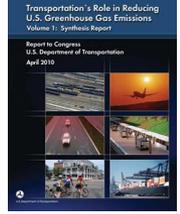
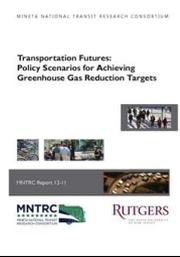
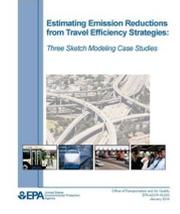
- Conventional highway investment
- Investments in transit, bike/ped



– Operations

- Eco-driving
- Ramp metering, speed harmonization, operational efficiencies, incident response

Comparison with Other Models/Research

Author, Year	Forecast Horizon	Geographic Focus	Modes	Estimation Process	Technology	Pricing	TDM	Land use	Alt Modes	Fuel	Transit
 EERPAT – The Energy and Emissions Reduction Policy Analysis Tool FHWA, 2014	any	State-Level	Multi-Modal Household Travel Demand, Freight	Quantitative, internally-generated travel demand, mode choice, policy response							
 Moving Cooler ULI, 2009	2050	National	All Surface Transportation	Research-based, application of elasticities							
 Transportation's Role in Reducing U.S. Greenhouse Gas Emissions USDOT, 2010	2030	National	Total US Transportation	Research-based, application of elasticities							
 Transportation Futures: Policy Scenarios for Achieving Greenhouse Gas Reduction Targets Mineta NTRC, 2014	2040	National	Multi-Modal Household Travel Demand, Freight	VMT Elasticities Derived from CA Statewide Travel Demand Model Applied to VISION Model (ANL); VMT applied by user; full life cycle emissions from GREET							
 Estimating Emission Reductions from Travel Efficiency Strategies: Three Sketch Modeling Case Studies EPA, 2014	2035	Metropolitan	Multi-Modal Household Travel Demand	Elasticities of VMT to policy interventions.							

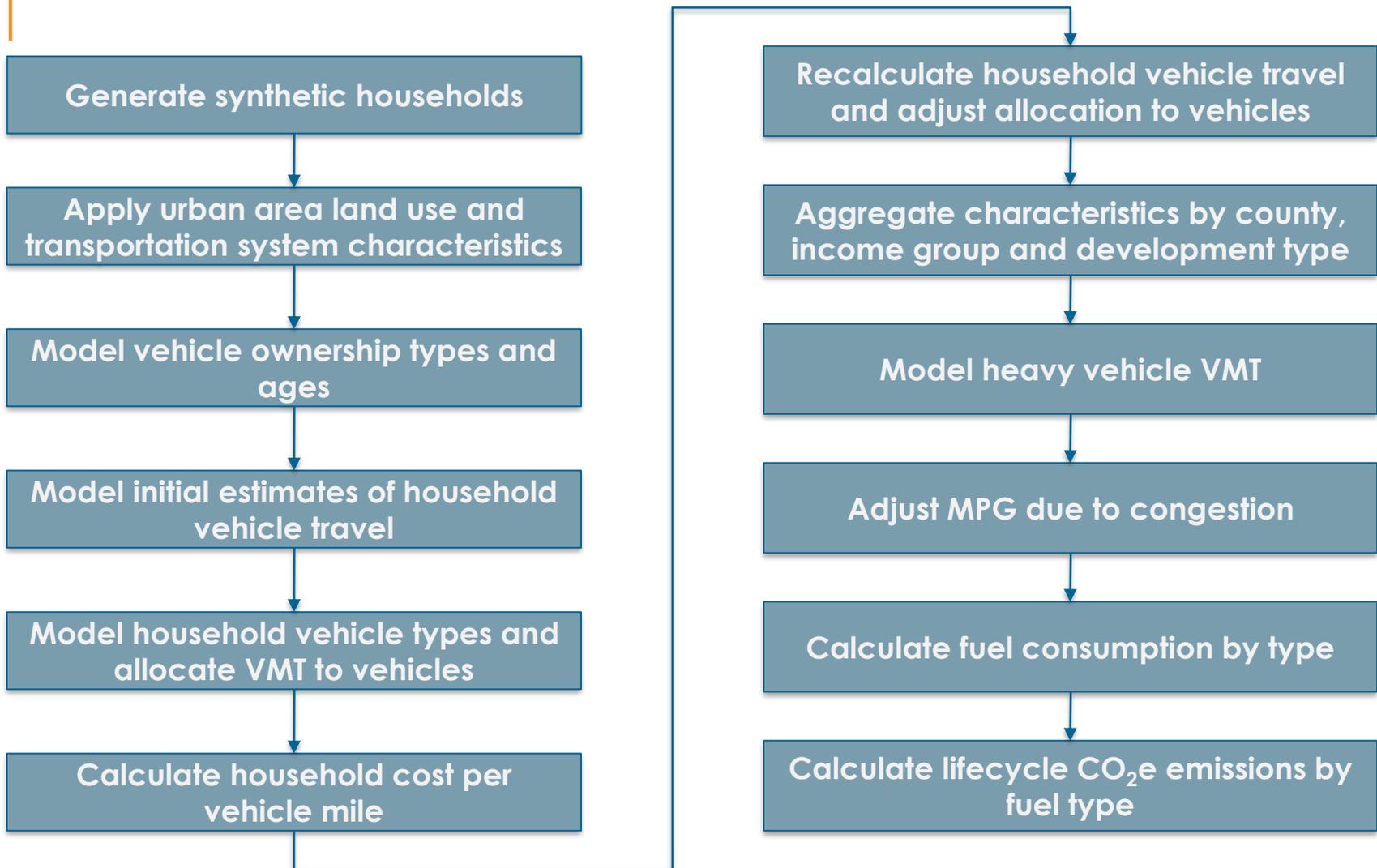


U.S. Department of Transportation
Federal Highway Administration



EERPAT Model Structure

Modeling Steps



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.



U.S. Department of Transportation
Federal Highway Administration



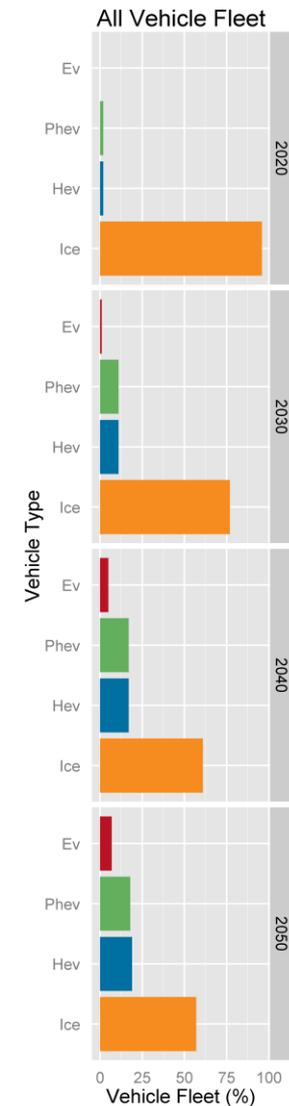
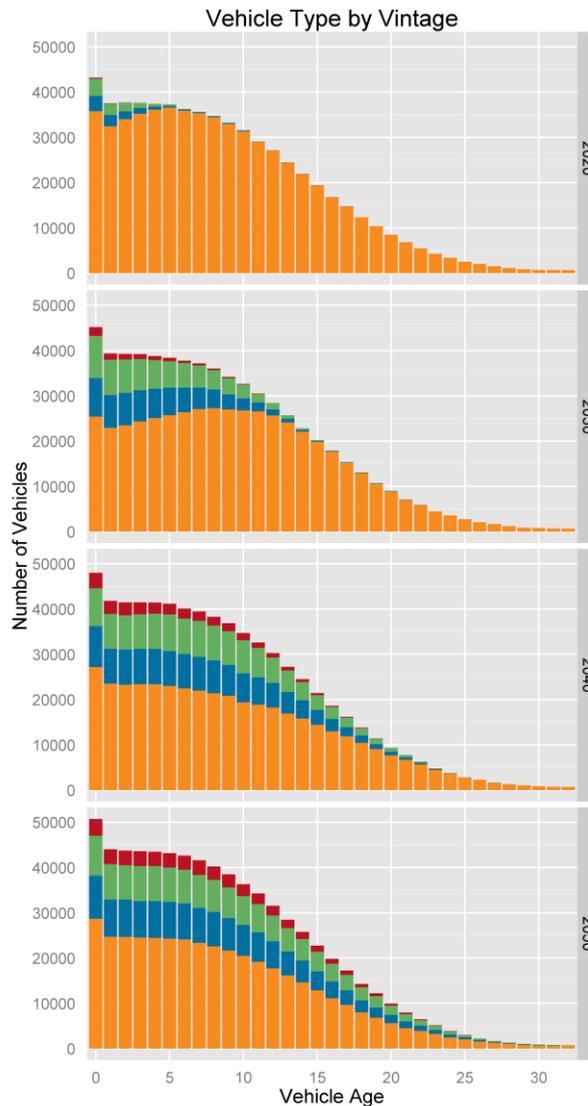
EERPAT HH Vehicle Choice

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



Vehicle Type
 Electric
 Plug-in Hybrid
 Hybrid
 Internal Combustion

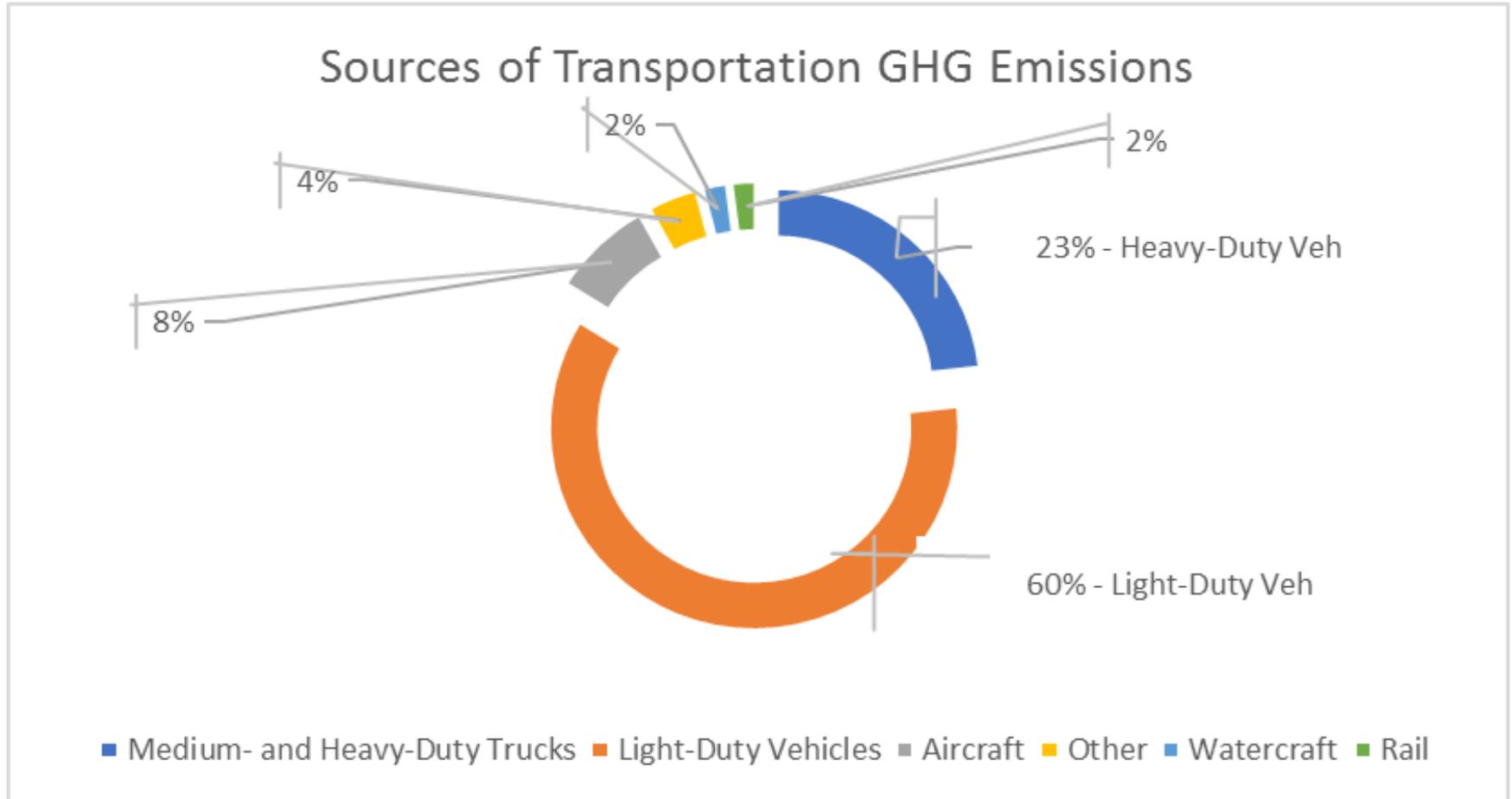


U.S. Department of Transportation
Federal Highway Administration



EERPAT v4 Freight Model

EERPAT v4 Freight Model



Model Design

Firm Synthesis

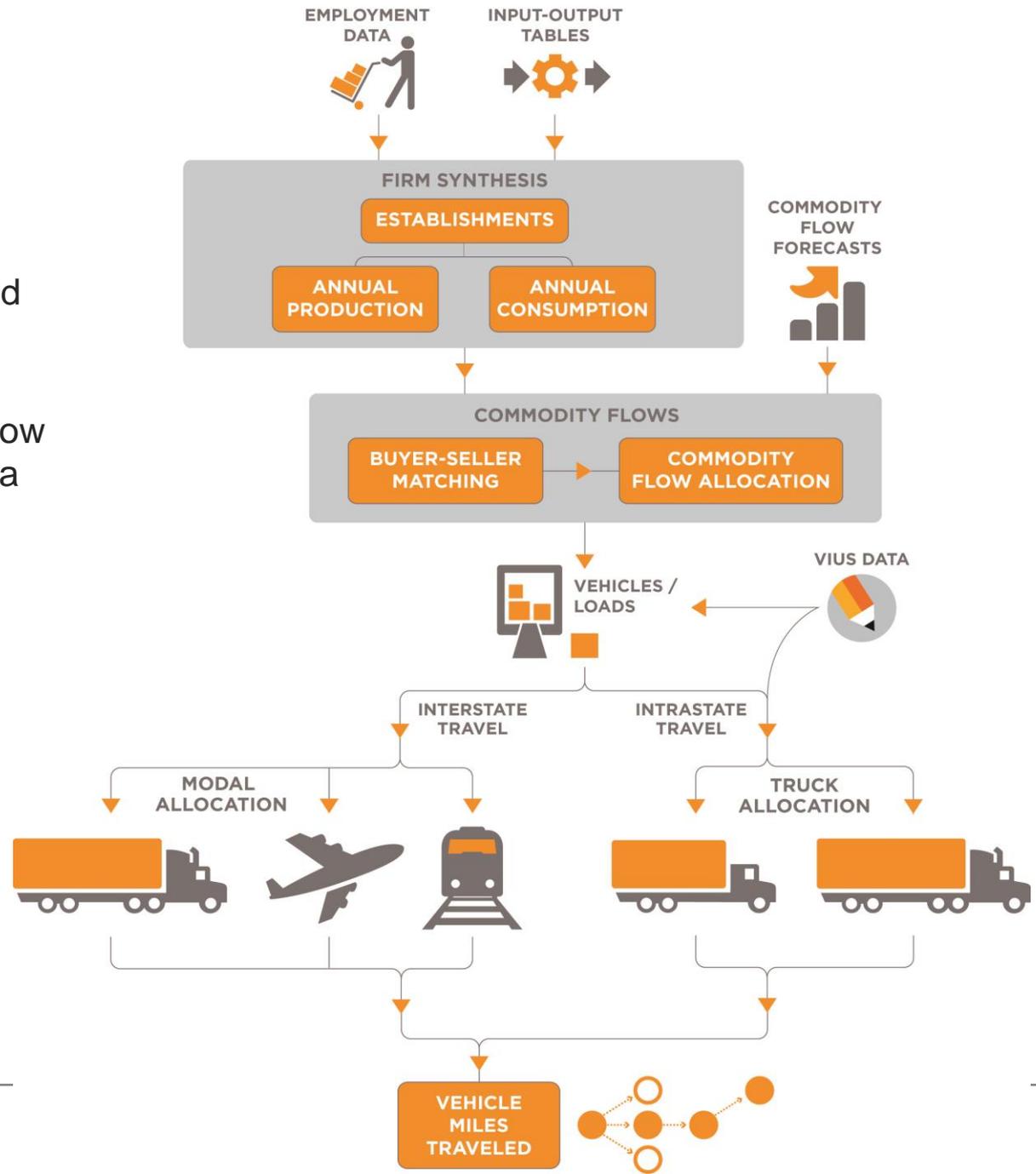
- Individual business establishments produce and consume commodities
- Uses county business patterns, FAF commodity flow data, BEA Input Output data

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





U.S. Department of Transportation
Federal Highway Administration



EERPAT Congestion Model

EERPAT Congestion Model

Transportation Supply –

- Freeway and Arterial Lane Miles
- Alternative Modes

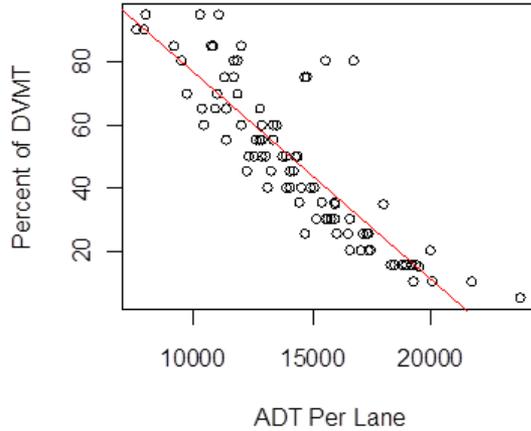
Allocation of Household Vehicle, Commercial and Freight VMT to Freeway and Arterial Lane Miles

Apply Texas Transportation Institute Data on Urban Congestion

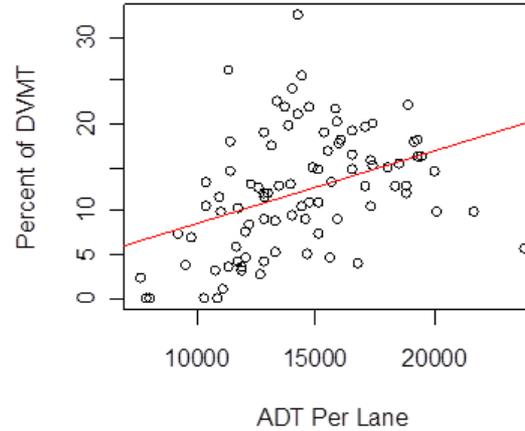
Estimate Fuel Efficiency Effects of Different Congestion Levels

EERPAT Congestion Model

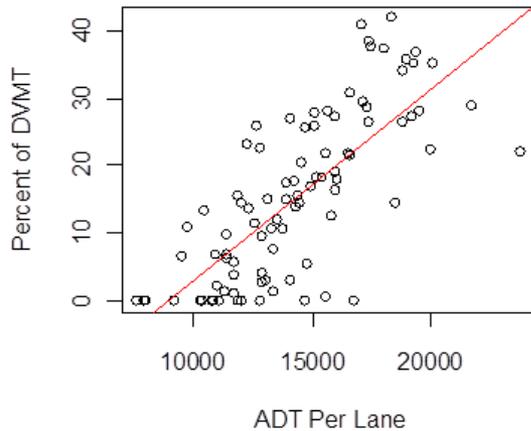
Uncongested



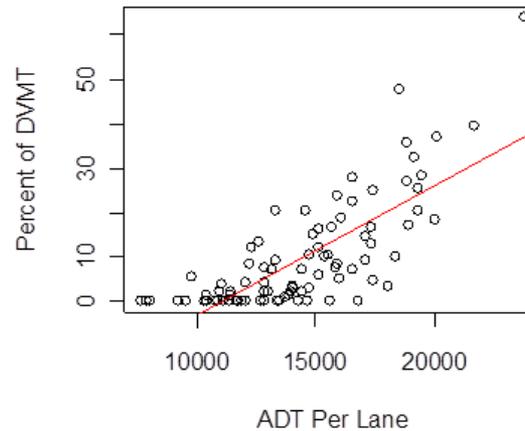
Heavily Congested



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



U.S. Department of Transportation
Federal Highway Administration



EERPAT State DOT Pilot Tests

EERPAT Pilots and Applications

State Pilot Tests: 2012-2015

Maryland

Washington

Vermont

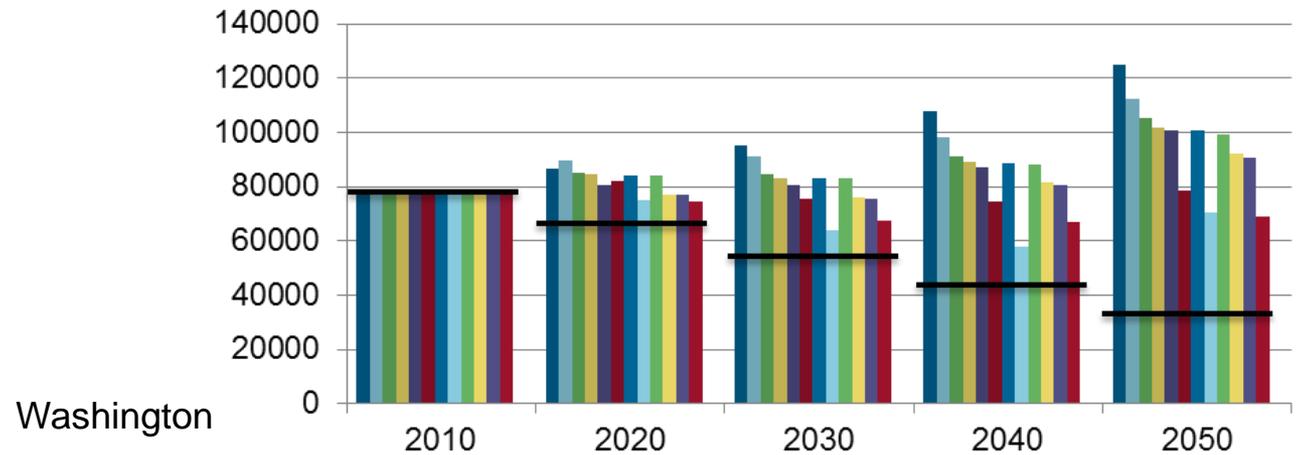
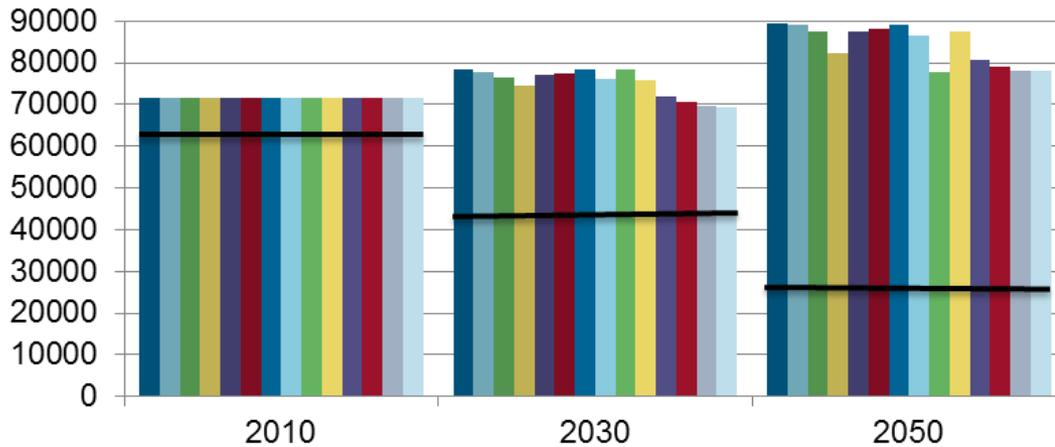
Colorado

Other Applications (2015-2016):

Utah

Massachusetts

Impact of GHG Reduction Policies Relative to Target Emissions



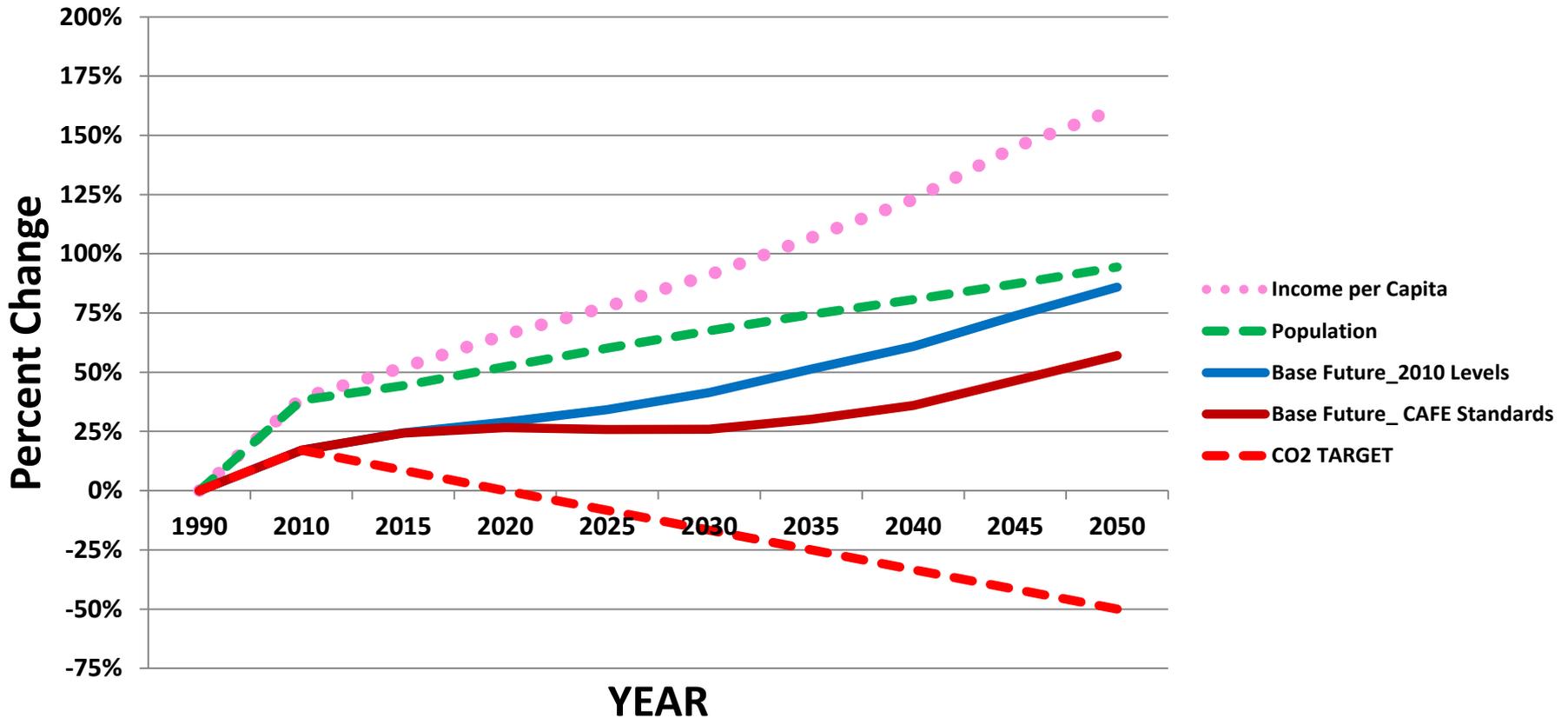
Washington State's Greenhouse Gas (GHG) Reduction Targets

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



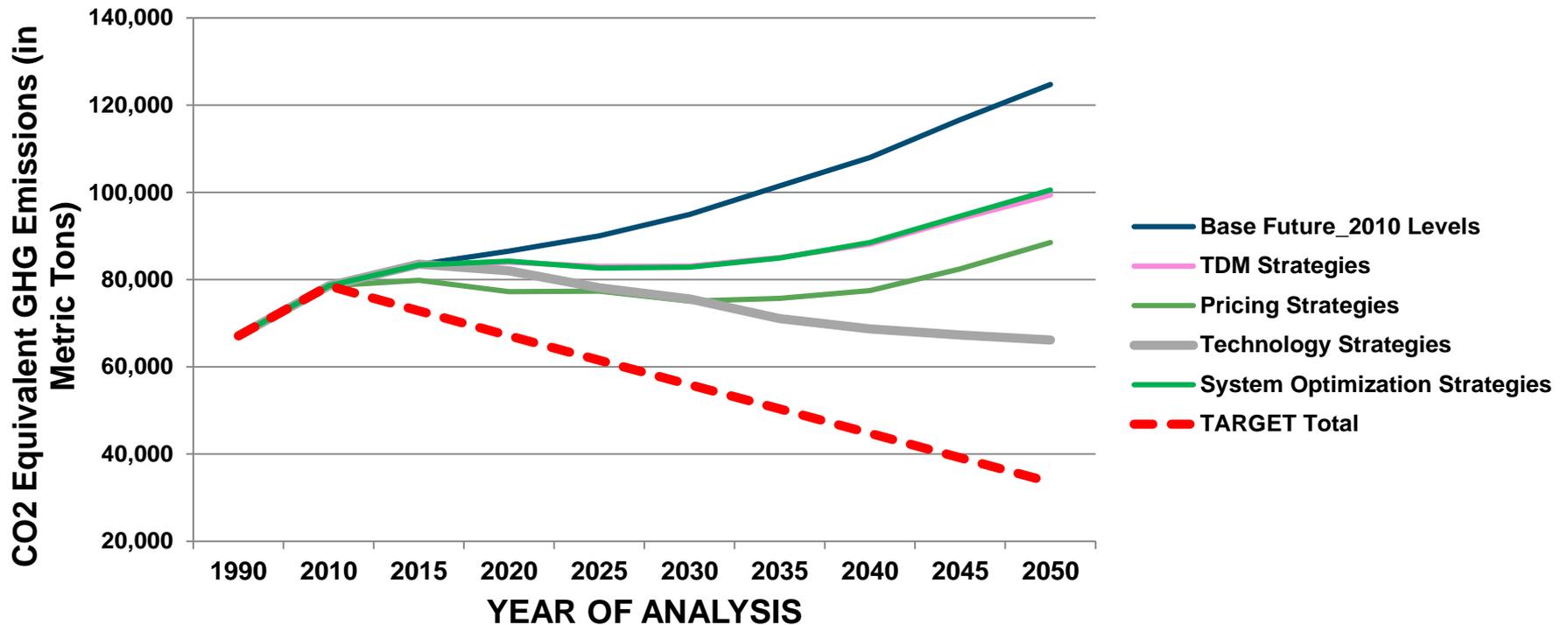
Key Strategies in Groups

TDM	Pricing	Technology	System Optimization
UGB	Gas Price	Increase to CAFE	Maximize System Operation
TDM	Carbon Tax	EV, HEV, PHEV penetration	TDM
Transit Service	Congestion Pricing	Renewable Energy Share	Transit Service
Mode Shift	Pay by Distance Insurance	Mode Shift	Mode Shift
Parking Costs	Parking Costs	Fuel Carbon Intensity	Car Sharing Rates

Statewide GHG Emissions Reduction – from each Group of Measures

- Strategies as listed in the previous slides

Daily CO2 Equivalent GHG Emissions for WA State



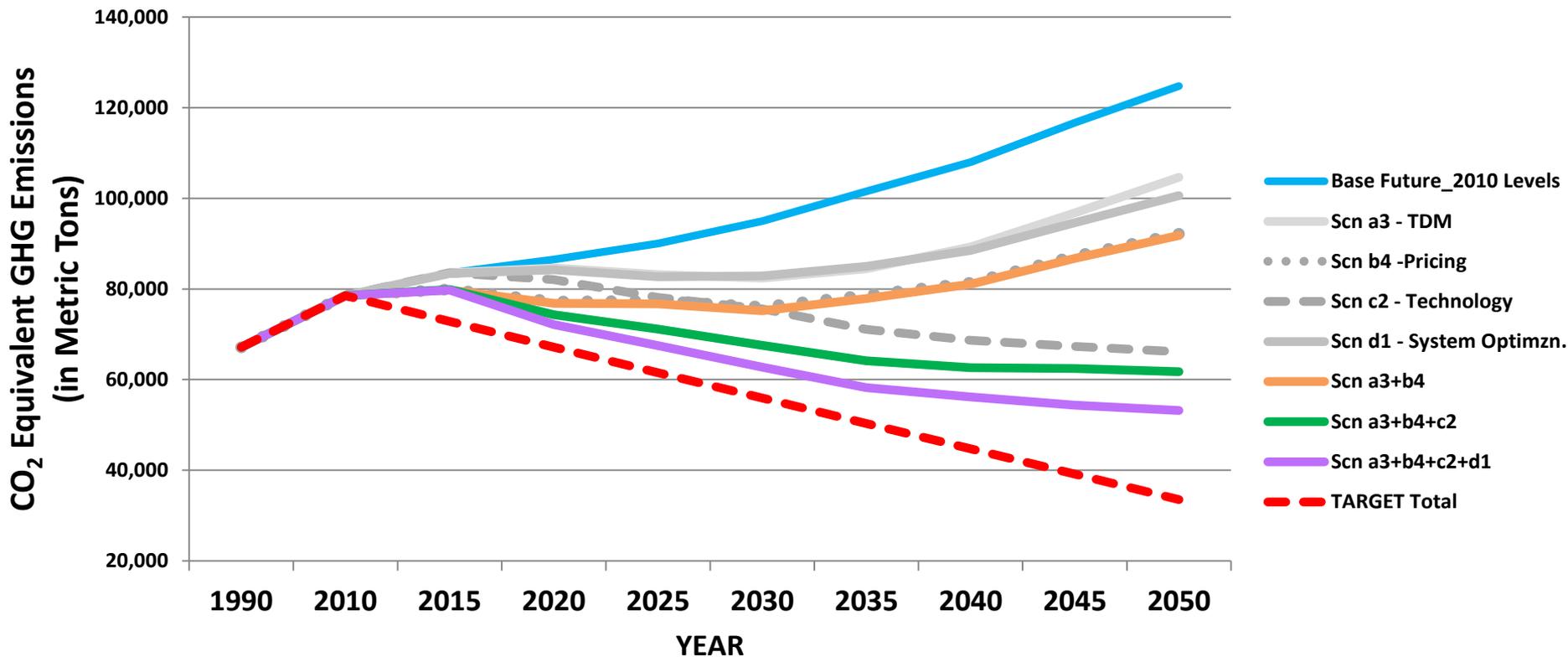
2050 GHG Emission Reduction Compared to Base Case

(Washington State Target is -73% reduction by 2050)

	Run 1	Run 2	Run 3	Run 4
TDM 'a'	'a1' -19%	'a2' -20%	'a3' -16%	—
Pricing 'b'	'b1' -19%	'b2' -26%	'b3' -29%	'b4' -26%
Technology 'c'	'c1' -36.9%	'c2' -47.0%	—	—
System Optimization 'd'	'd1' -19%	—	—	—

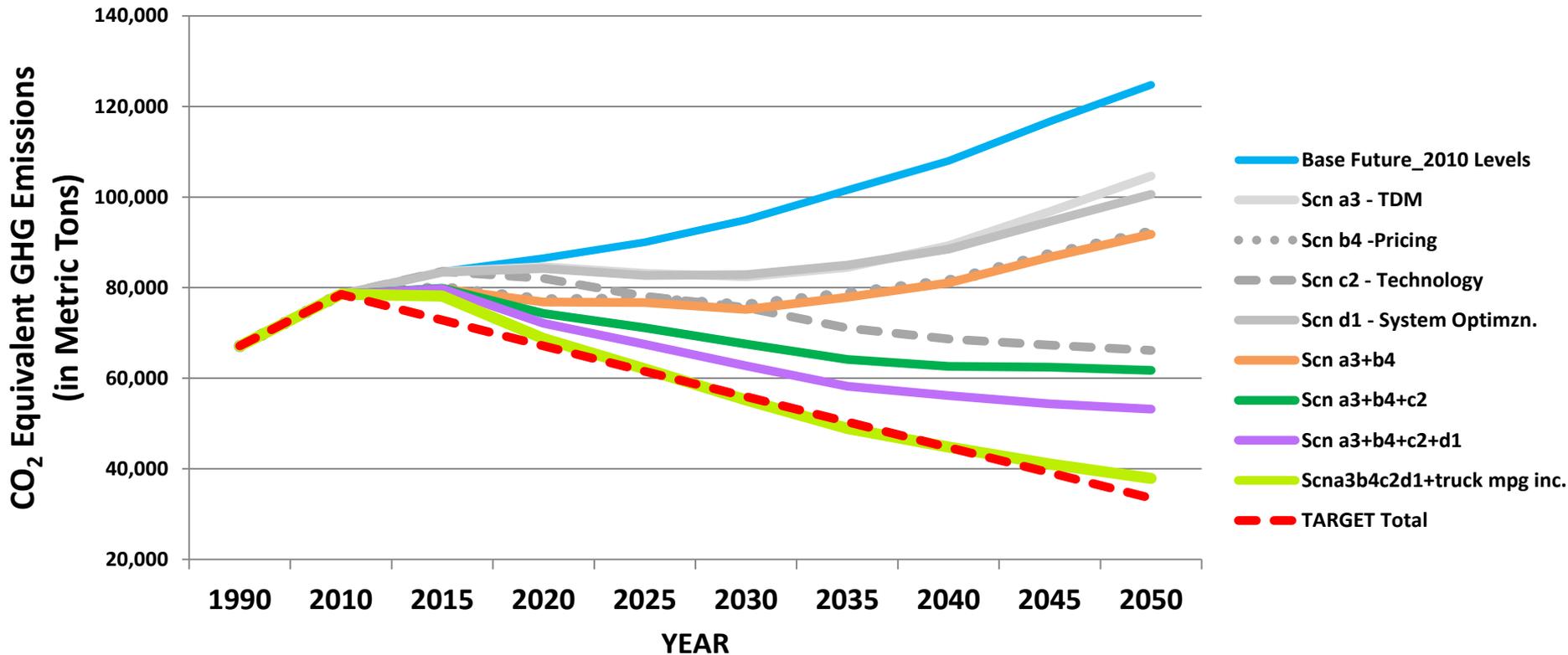
Statewide GHG Emissions Reduction – from Combinations of Strategies

Daily CO₂ Eq. GHG EMISSIONS for Washington State



Statewide GHG Emissions Reduction – from Group of Strategies

Daily CO₂ Eq GHG Emissions for Washington State



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



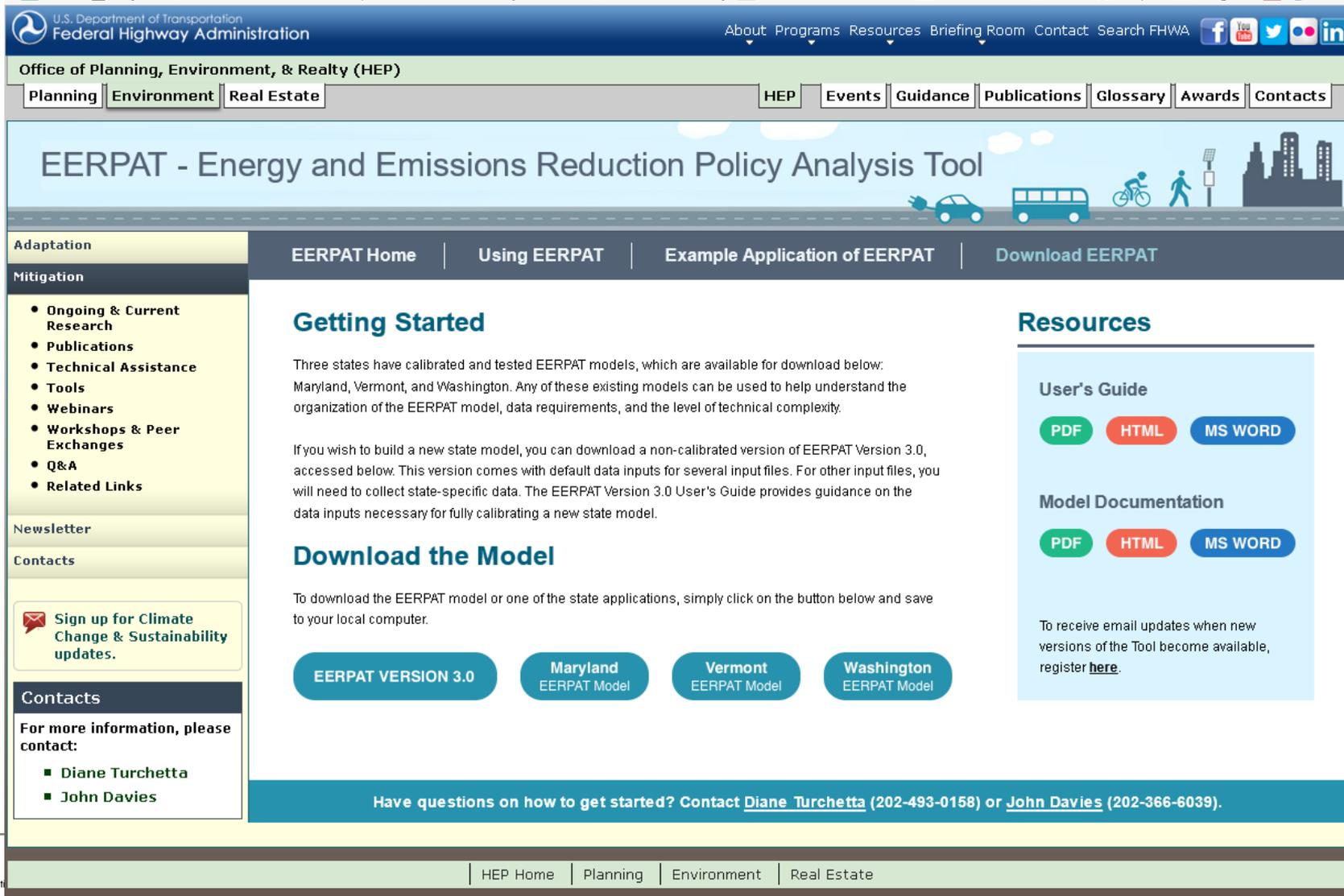
U.S. Department of Transportation
Federal Highway Administration



Downloading EERPAT

FHWA EERPAT Website

https://www.planning.dot.gov/FHWA_tool/Download.aspx



The screenshot shows the FHWA EERPAT website interface. At the top, there is a navigation bar with the FHWA logo and the text "U.S. Department of Transportation Federal Highway Administration". To the right of the logo are links for "About", "Programs", "Resources", "Briefing Room", "Contact", and "Search FHWA". Social media icons for Facebook, YouTube, Twitter, and LinkedIn are also present. Below this is a secondary navigation bar for the "Office of Planning, Environment, & Realty (HEP)" with tabs for "Planning", "Environment", "Real Estate", "HEP", "Events", "Guidance", "Publications", "Glossary", "Awards", and "Contacts".

The main content area features a large banner for "EERPAT - Energy and Emissions Reduction Policy Analysis Tool" with an illustration of a car, bus, bicycle, and city skyline. Below the banner is a navigation bar with four main sections: "EERPAT Home", "Using EERPAT", "Example Application of EERPAT", and "Download EERPAT".

On the left side, there is a sidebar menu with categories: "Adaptation", "Mitigation", "Newsletter", and "Contacts". Under "Mitigation", there is a list of links: "Ongoing & Current Research", "Publications", "Technical Assistance", "Tools", "Webinars", "Workshops & Peer Exchanges", "Q&A", and "Related Links".

The main content area is divided into three columns. The left column is titled "Getting Started" and contains text about calibrated models in Maryland, Vermont, and Washington, and information about downloading a non-calibrated version of EERPAT Version 3.0. The middle column is titled "Download the Model" and includes text about downloading the model and three buttons for "EERPAT VERSION 3.0", "Maryland EERPAT Model", "Vermont EERPAT Model", and "Washington EERPAT Model". The right column is titled "Resources" and includes a "User's Guide" section with buttons for "PDF", "HTML", and "MS WORD", and a "Model Documentation" section with similar buttons. Below these is a note about registering for email updates.

At the bottom of the main content area, there is a teal banner with the text: "Have questions on how to get started? Contact [Diane Turchetta](#) (202-493-0158) or [John Davies](#) (202-366-6039)."

The footer of the website includes the FHWA logo and the text "U.S. Department of Transportation Federal Highway Administration" on the left, and a navigation bar with links for "HEP Home", "Planning", "Environment", and "Real Estate" on the right.

EERPAT v3 Graphical User Interface

The Energy and Emissions Reduction Policy Analysis Tool

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

Base2010	Delete
BaseFuture	Delete

Active Scenario:

Base2010

Create New Scenario

Base Inputs

Scenario Inputs

Run

Reports

Outputs

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.

	A	B
1	Msa	ArInmi
2	BaltimoreColumbia	3724.459
3	CaliforniaLexington	99.805
4	Cumberland	172.873
5	Hagerstown	227.296
6	PhiladelphiaCamden	114.914
7	Salisbury	180.639
8	WashingtonArlington	2937.66
9		

Save

EERPAT File Structure

-what the GUI operates on

Name



Name
estimation
Include
model
R
scenarios
scripts
views

EERPAT v4 Graphical User Interface

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	▼	Delete	Define Policy: Policy Title
Moderate EV Policy Level	▼	Delete	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



U.S. Department of Transportation
Federal Highway Administration

John Davies, Environmental Protection Specialist
FHWA
Johng.Davies@dot.gov

Diane Turchetta, Environmental Protection Specialist
FHWA
Diane.Turchetta@dot.gov



www.rsginc.com

Robert Chamberlin
Senior Director
Robert.chamberlin@rsginc.com

Colin Smith
Senior Director
Colin.Smith@rsginc.com