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

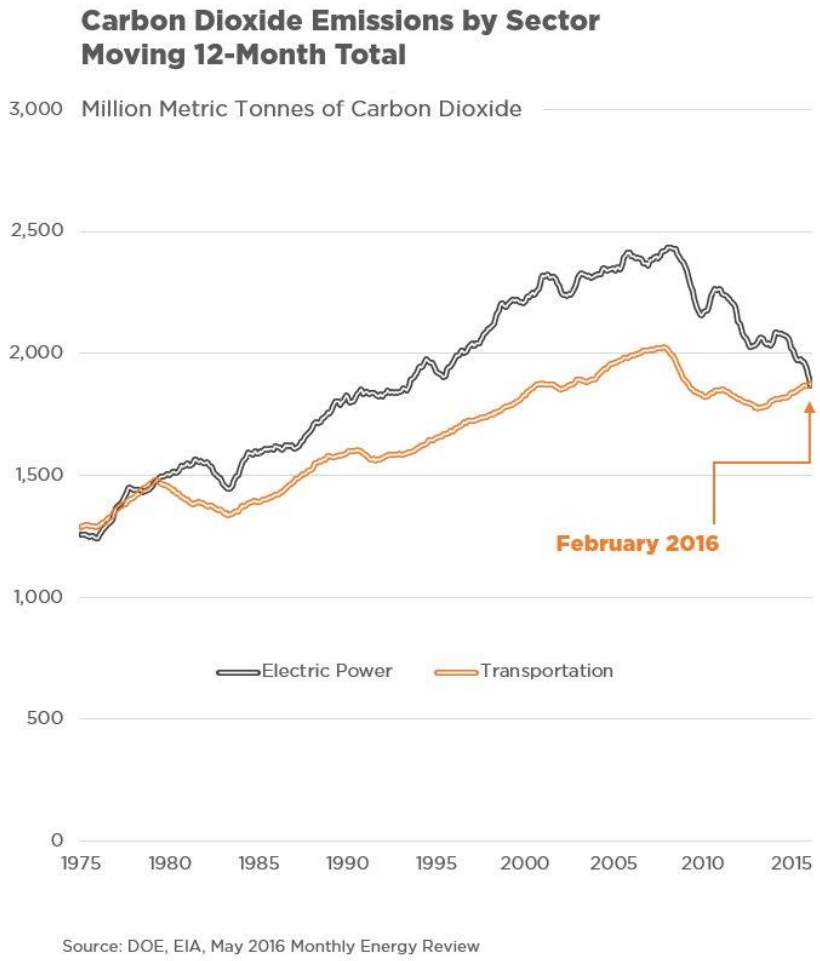
- Identify tools to analyze transportation energy consumption and related emissions, especially at the State level
- Many States lack statewide travel forecasting and emissions analysis capabilities.
- Travel network detail at the statewide level does not match that of urban models
- Travel demand models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



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.

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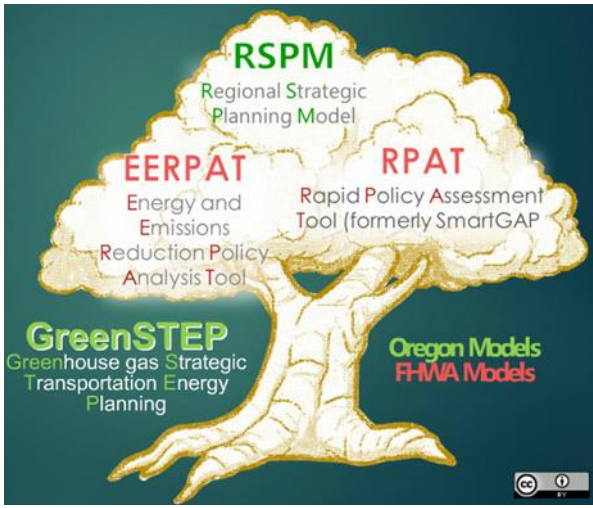
GHG Models and the EERPAT Lineage

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

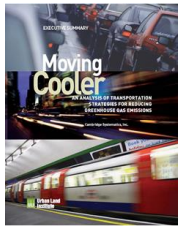
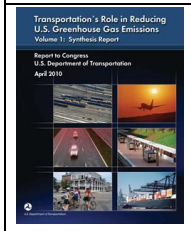
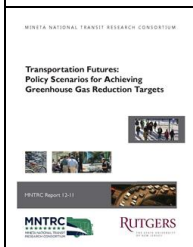
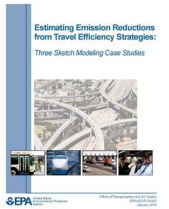
 – Alternative modes

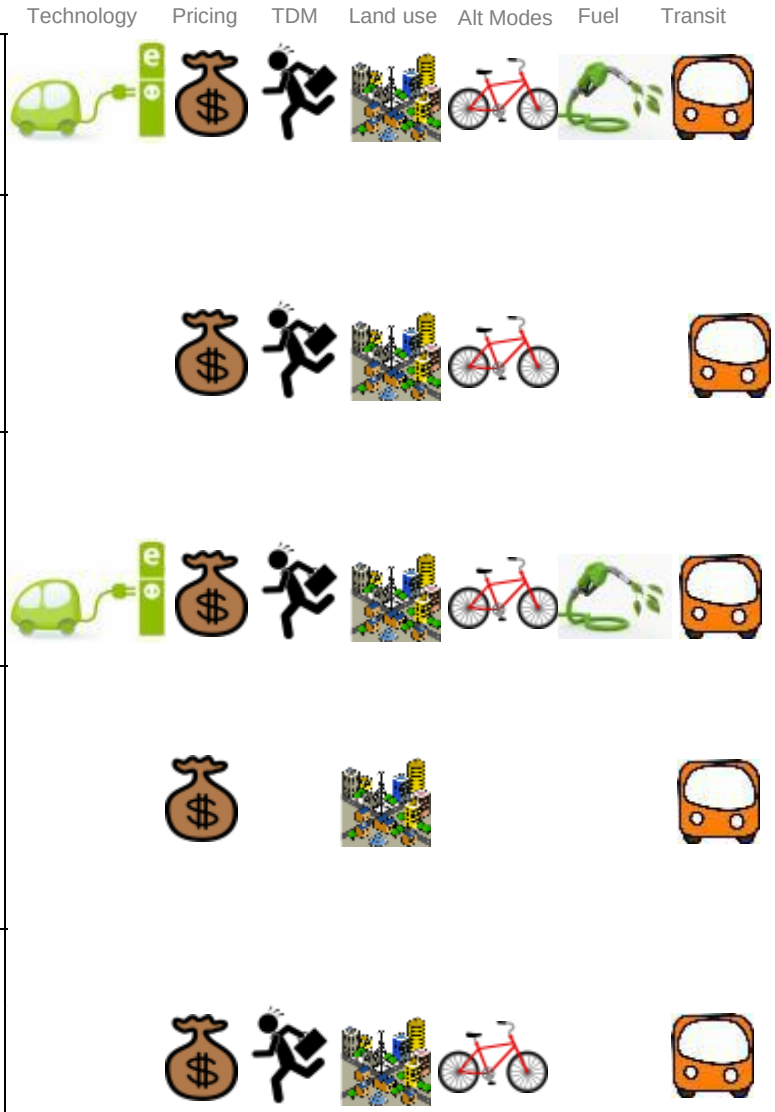
- Conventional highway investment
- Investments in transit, bike/ped

 – 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
	FHWA, 2014	any	State-Level	Multi-Modal Household Travel Demand, Freight	Quantitative, internally-generated travel demand, mode choice, policy response
	ULI, 2009	2050	National	All Surface Transportation	Research-based, application of elasticities
	USDOT, 2010	2030	National	Total US Transportation	Research-based, application of elasticities
	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
	EPA, 2014	2035	Metropolitan	Multi-Modal Household Travel Demand	Elasticities of VMT to policy interventions.



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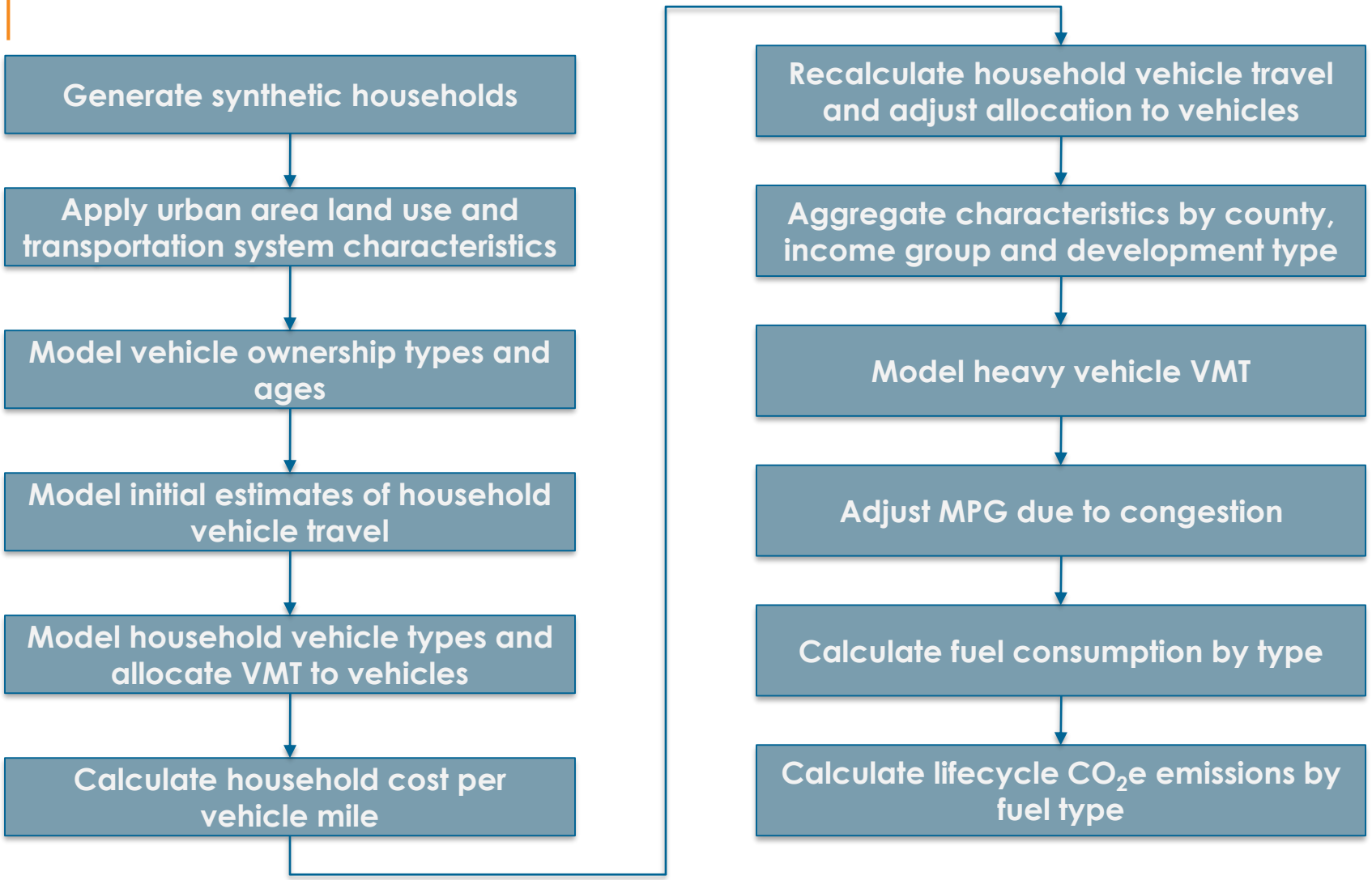
EERPAT Model Structure

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.

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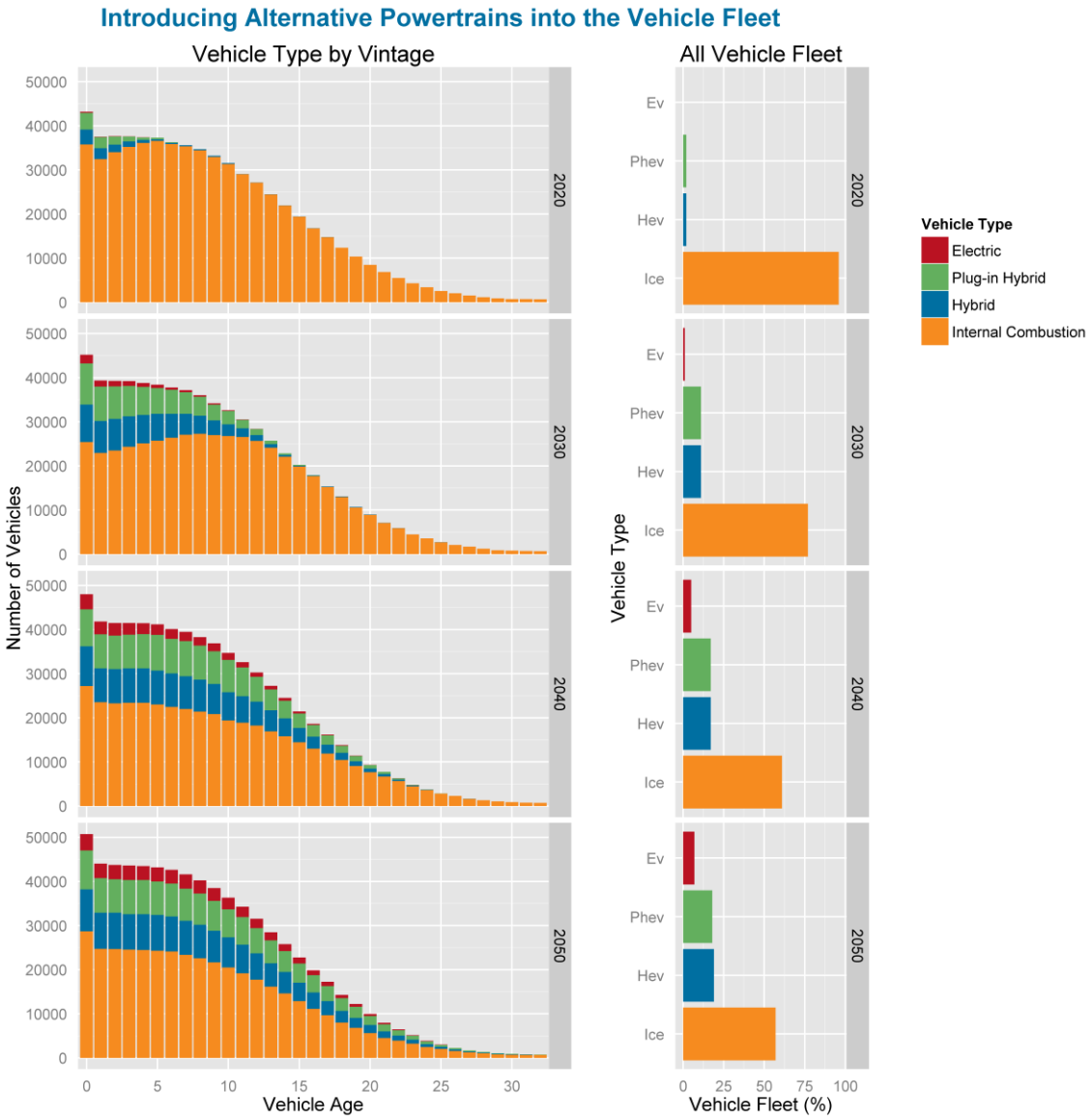
EERPAT HH Vehicle Choice

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



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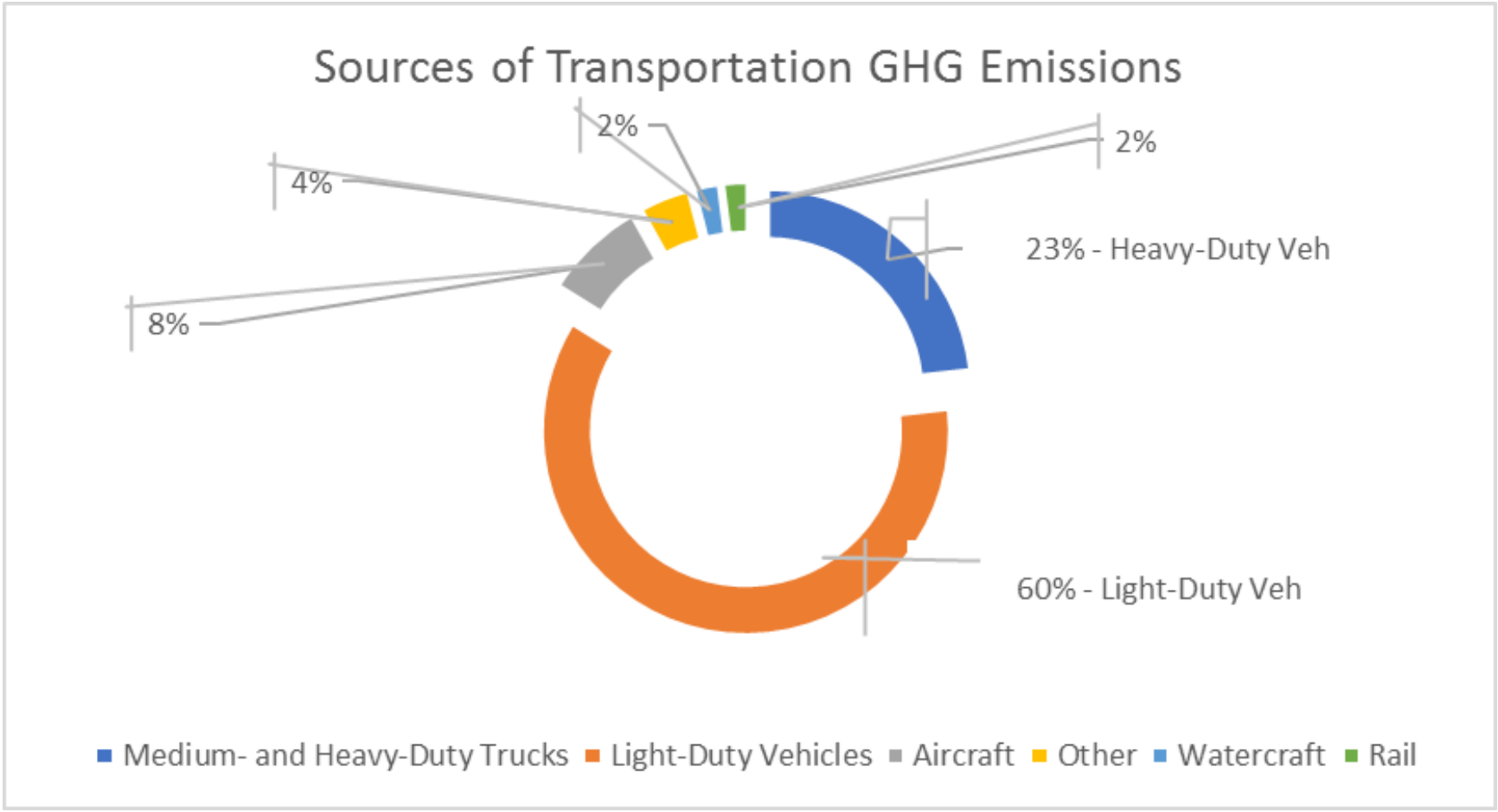
EERPAT v4 Freight Model

EERPAT v4 Freight Model



Model Design

Firm Synthesis

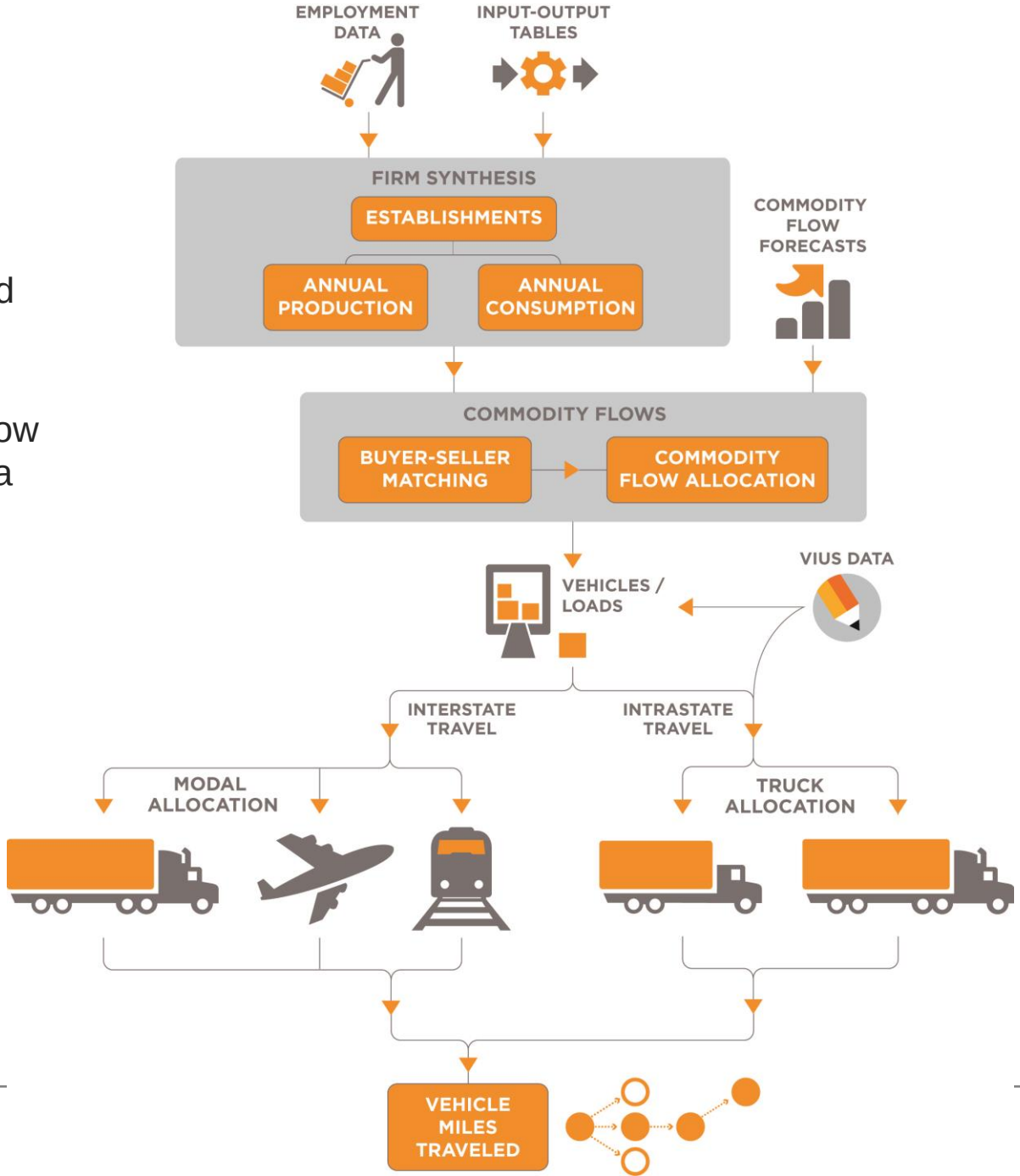
- Individual business establishments produce and consume commodities
- Uses county business patterns, FAF commodity flow data, BEA Input Output data

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

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EERPAT Congestion Model

EERPAT Congestion Model

Transportation Supply –

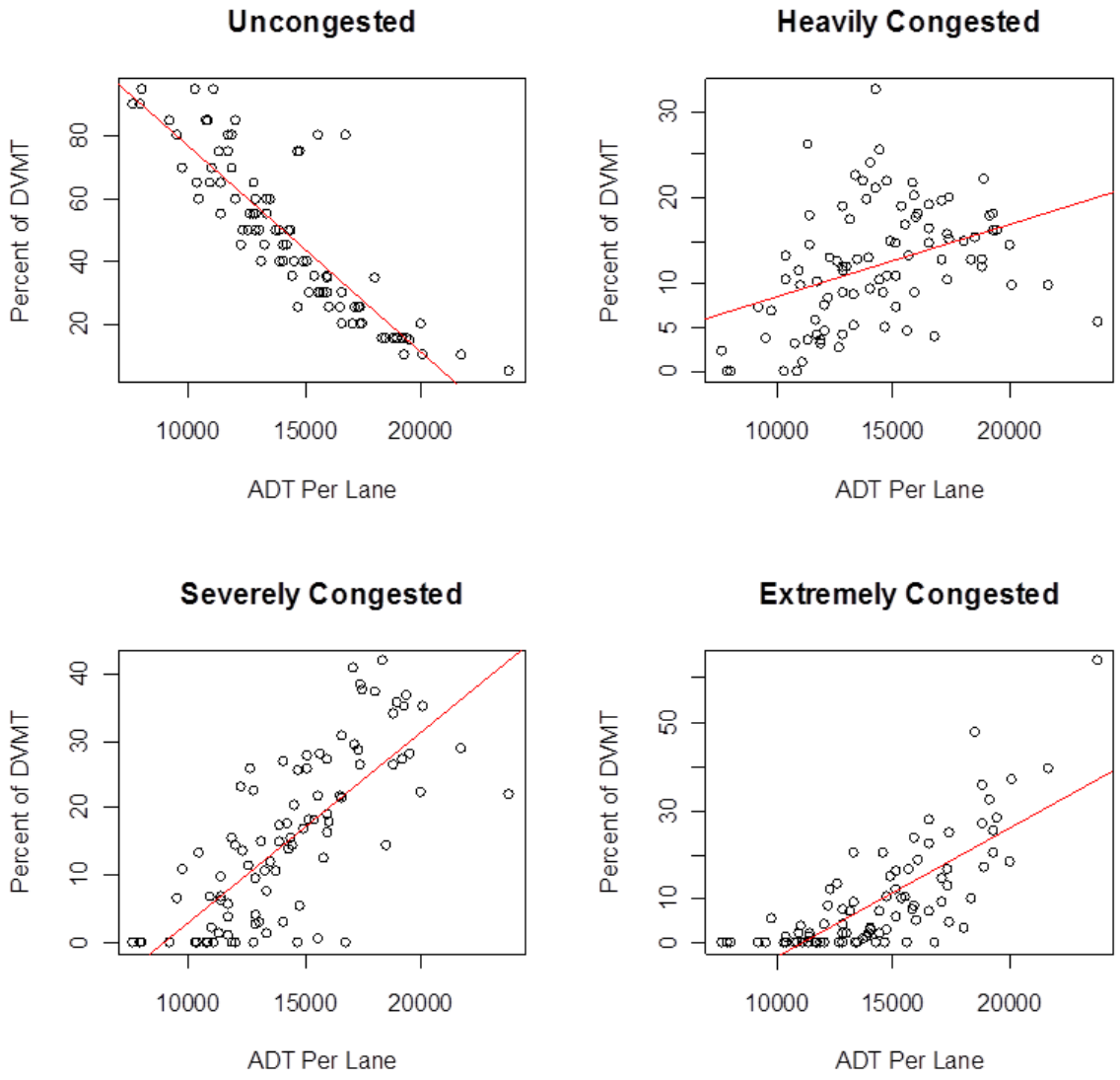
- Freeway and Arterial Lane Miles
- Alternative Modes

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



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

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EERPAT State DOT Pilot Tests

EERPAT Pilots and Applications

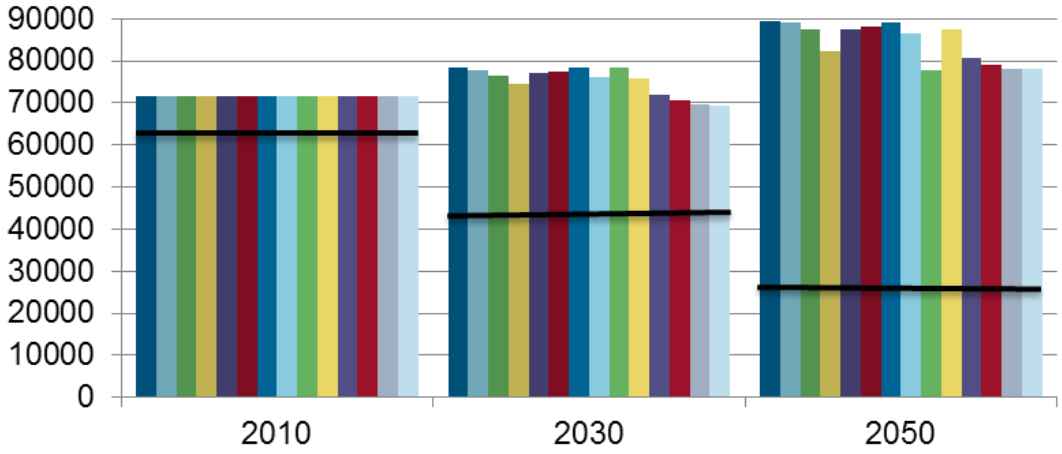
State Pilot Tests: 2012-2015

Maryland
Washington
Vermont
Colorado

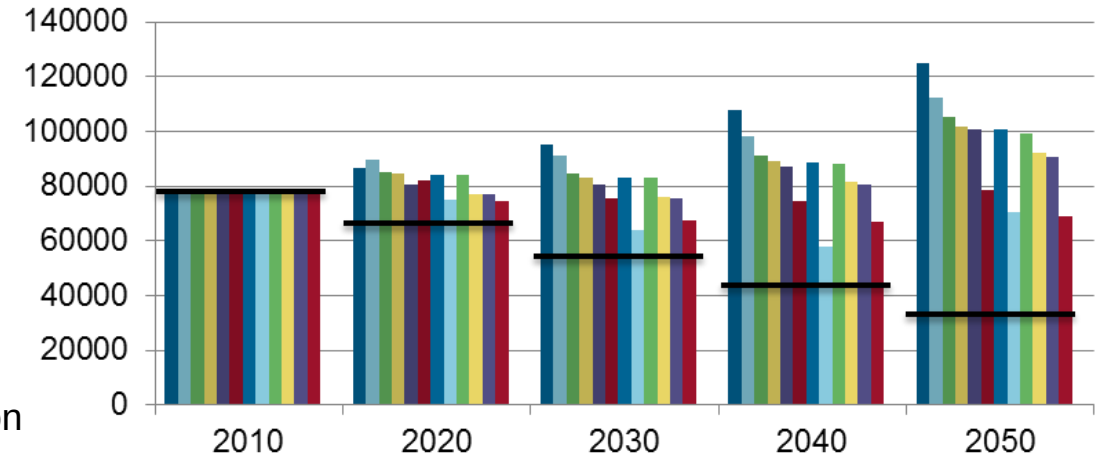
Other Applications (2015-2016):

Utah
Massachusetts

Impact of GHG Reduction Policies Relative to Target Emissions



Maryland



Washington

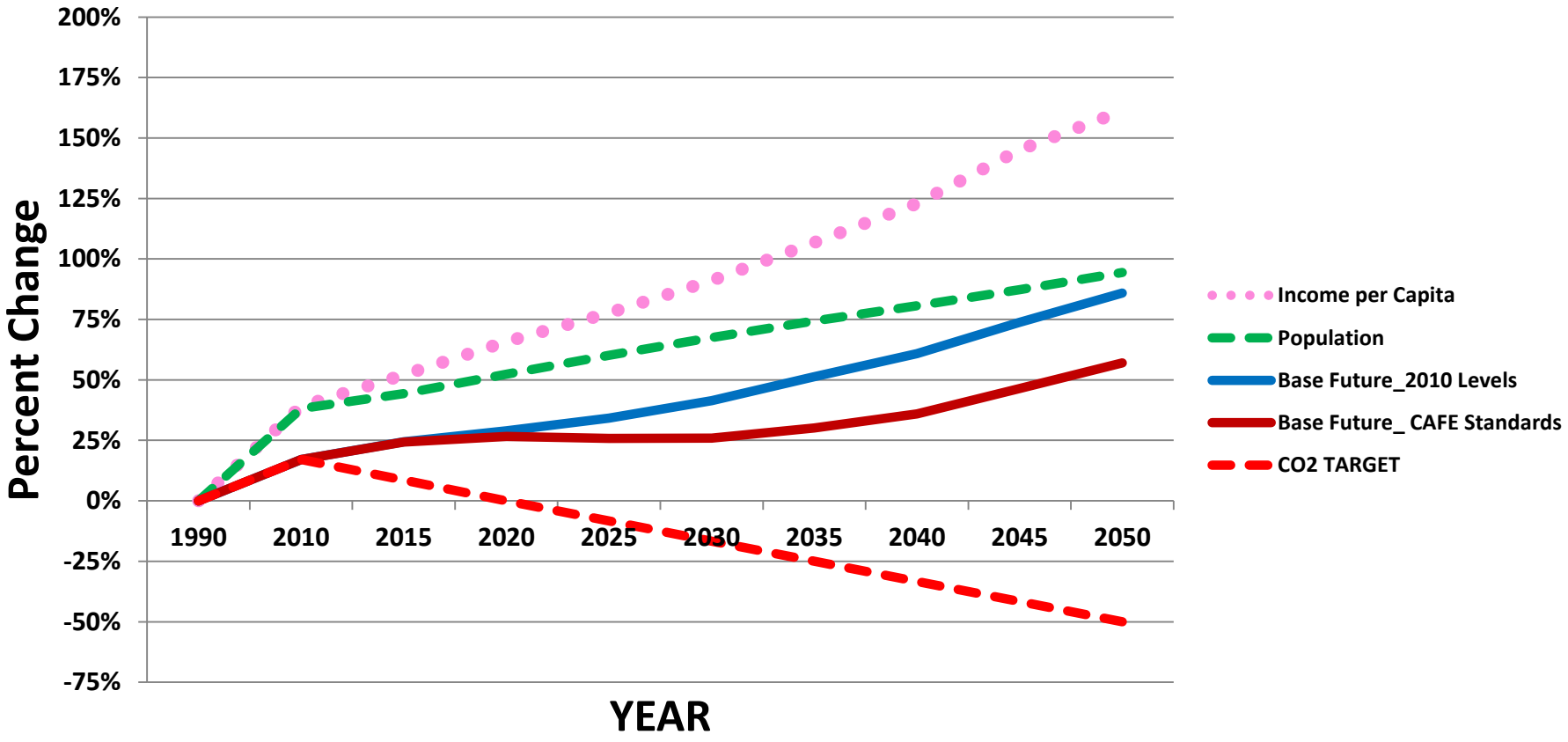
Washington State's Greenhouse Gas (GHG) Reduction Targets

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

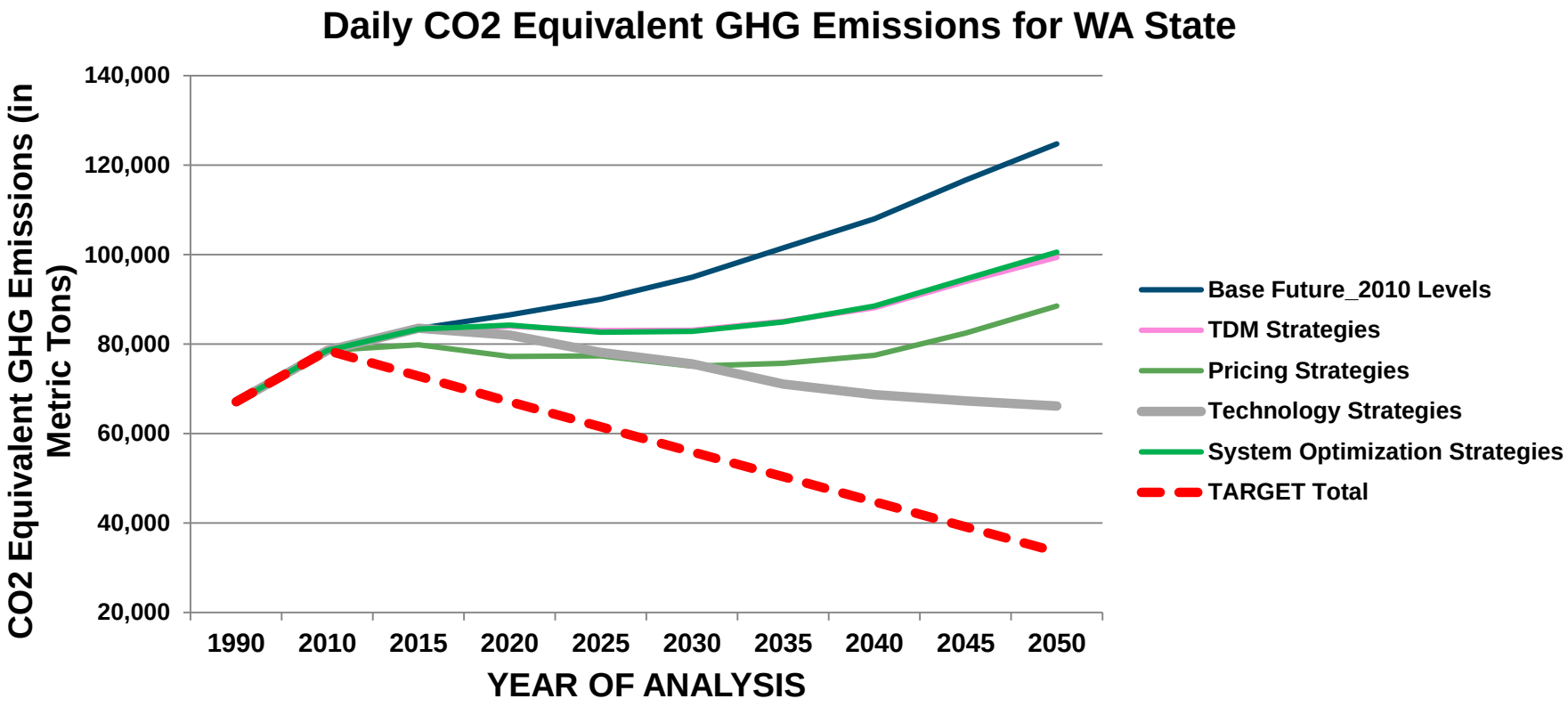


Key Strategies in Groups

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**

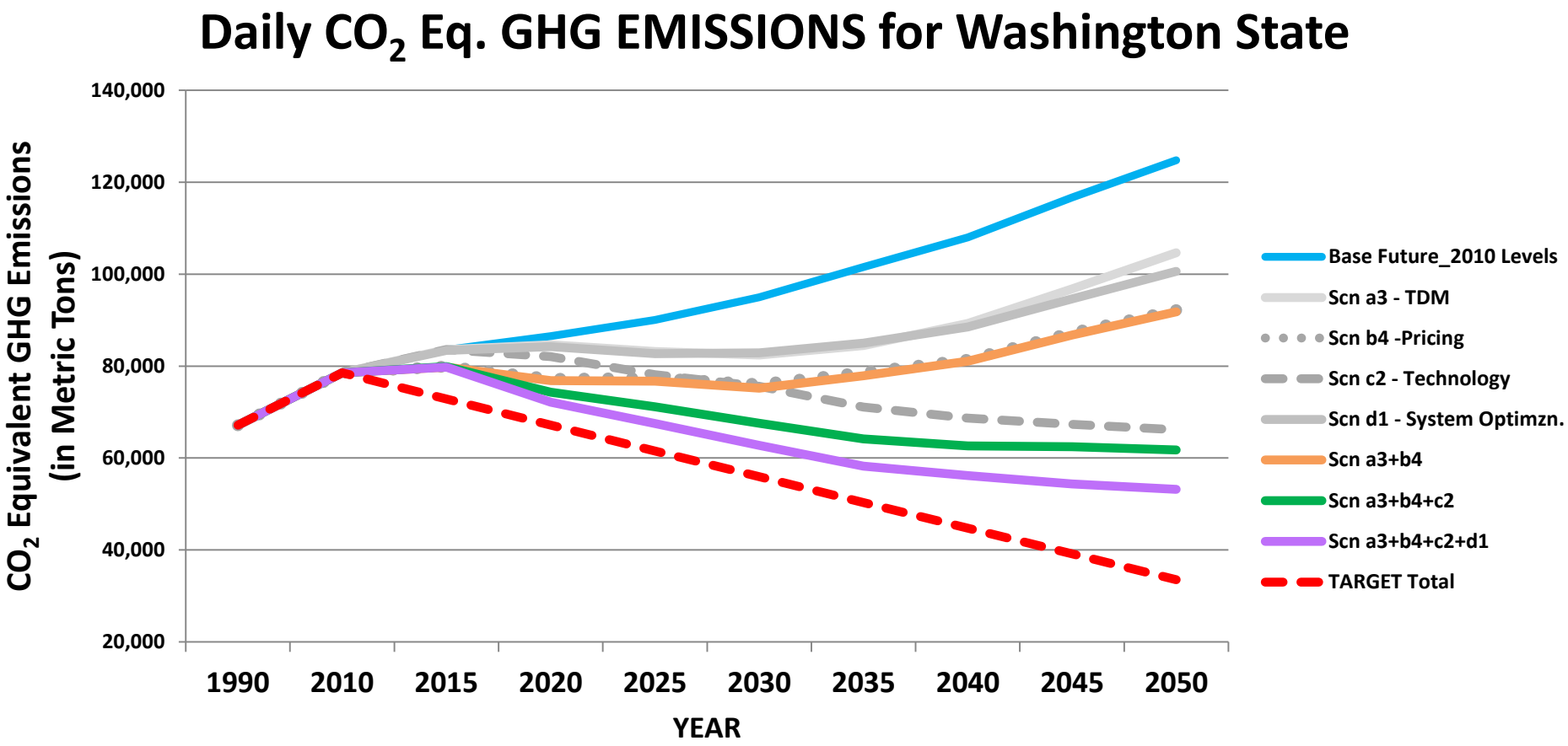


2050 GHG Emission Reduction Compared to Base Case

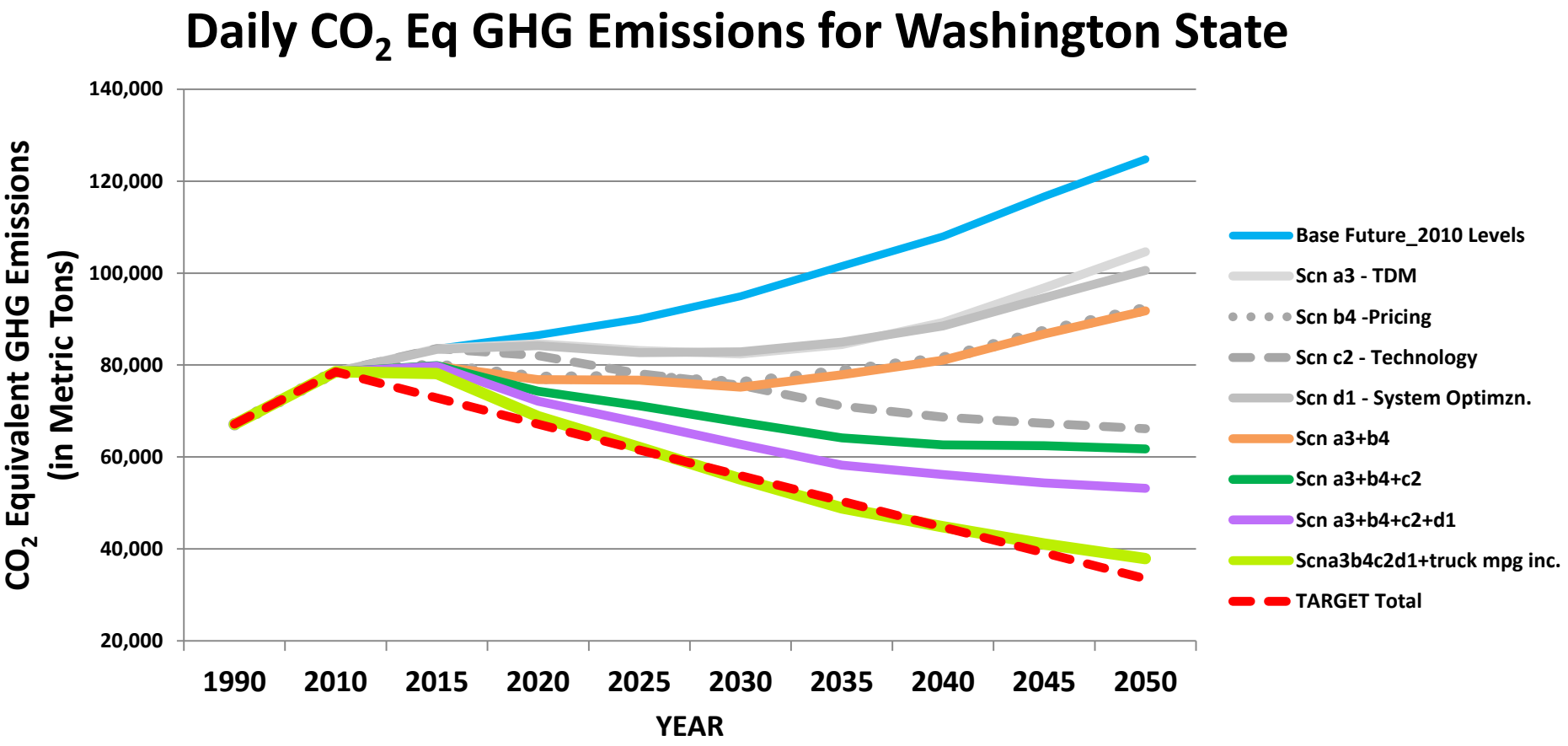
(Washington State Target is -73% reduction by 2050)

	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



Statewide GHG Emissions Reduction – from Group of Strategies



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

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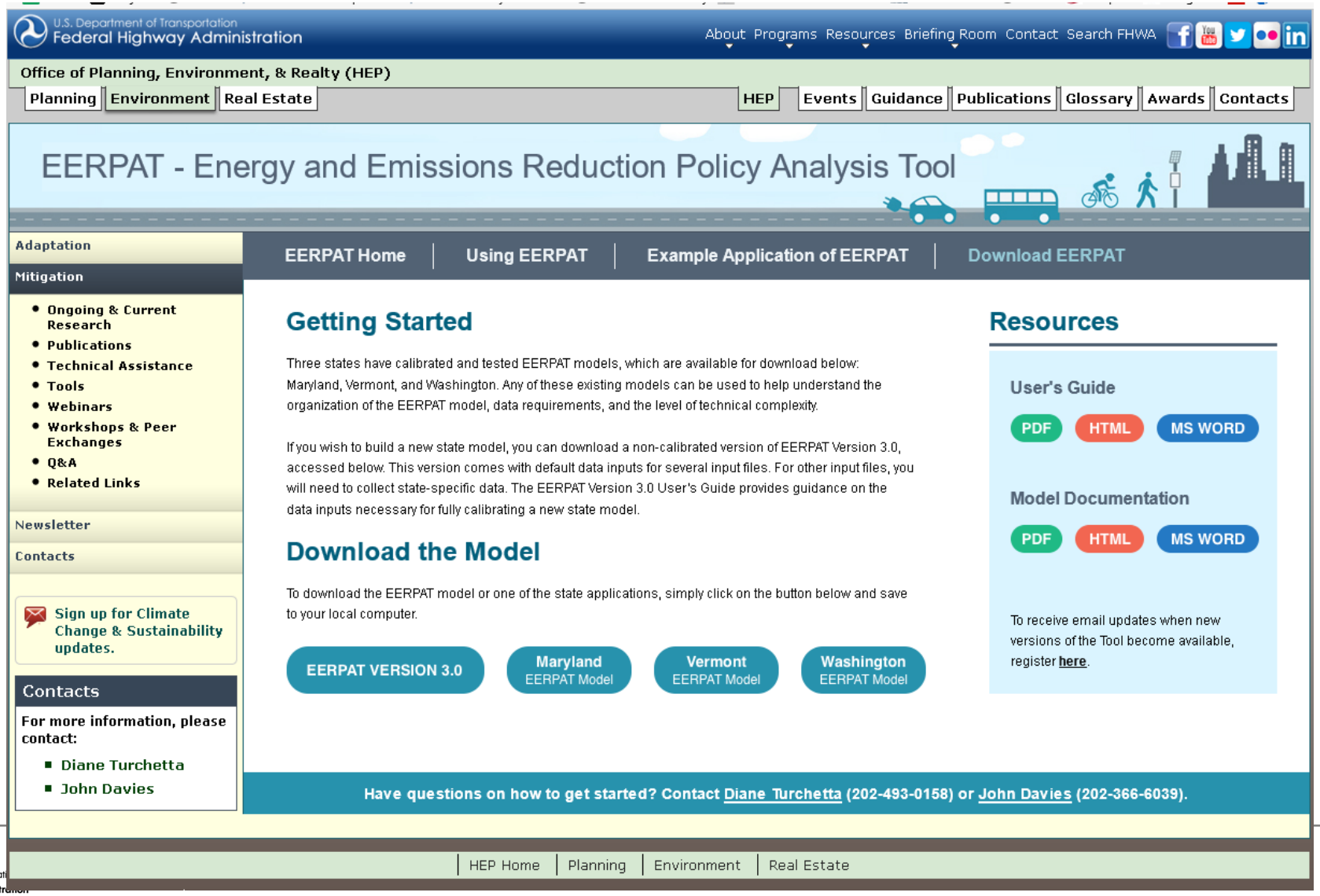
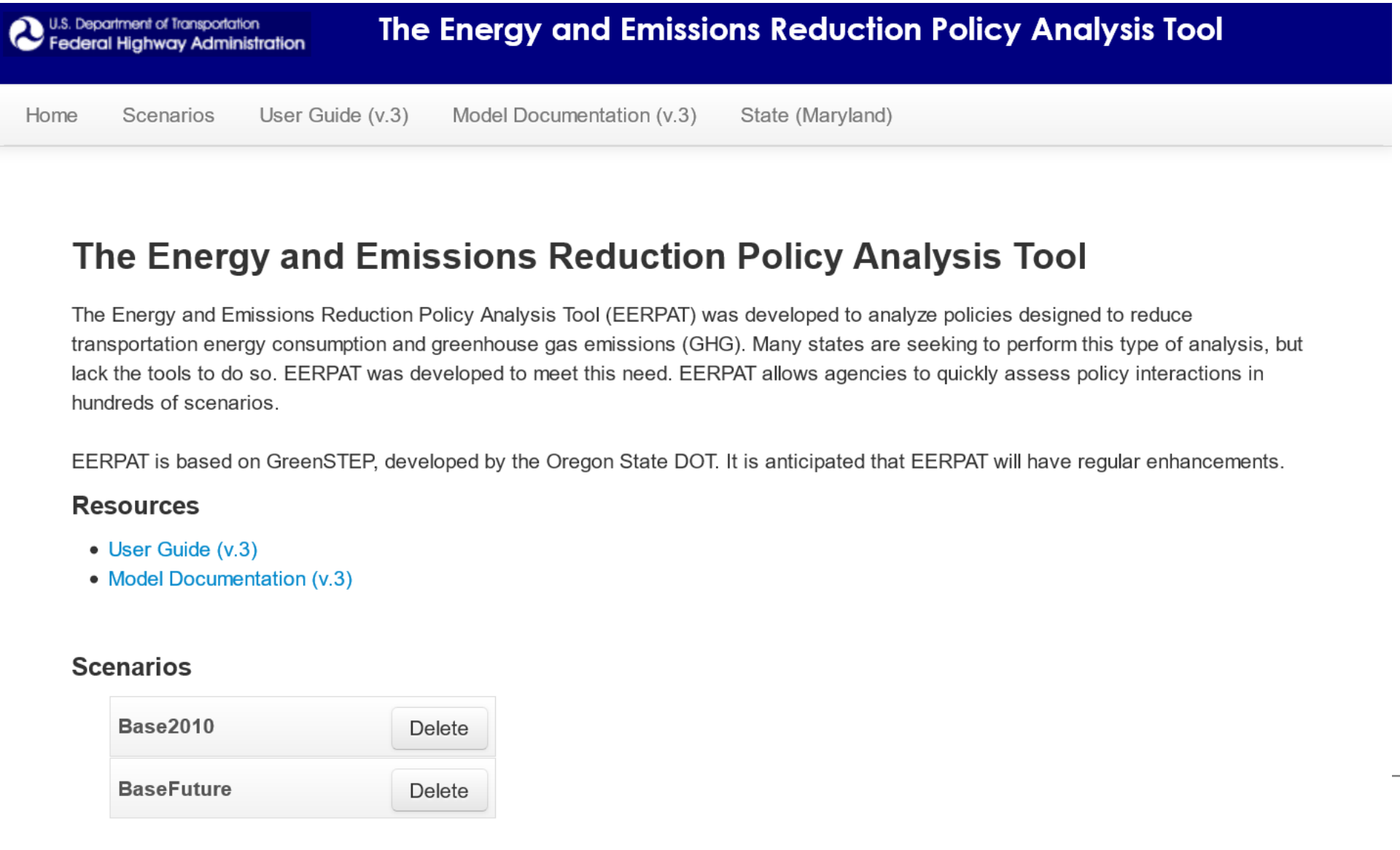
Downloading EERPAT

FHWA EERPAT Website

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



EERPAT v3 Graphical User Interface



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

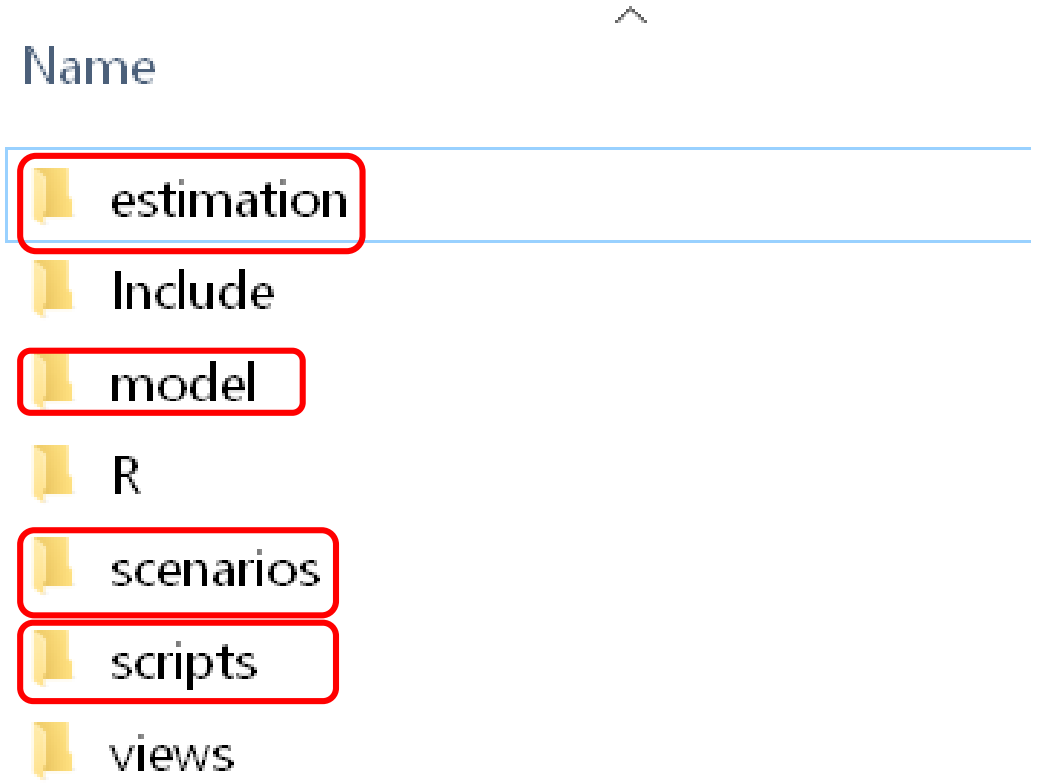
The arterial lane miles data are used to describe the supply of arterial capacity in the models and calculations that adjust metropolitan area fuel economy to account for congestion.

	A	B
1	Msa	ArtInmi
2	BaltimoreColumbi	3724.459
3	CaliforniaLexingto	99.805
4	Cumberland	172.873
5	Hagerstown	227.296
6	PhiladelphiaCamd	114.914
7	Salisbury	180.639
8	WashingtonArlingt	2937.66
9		

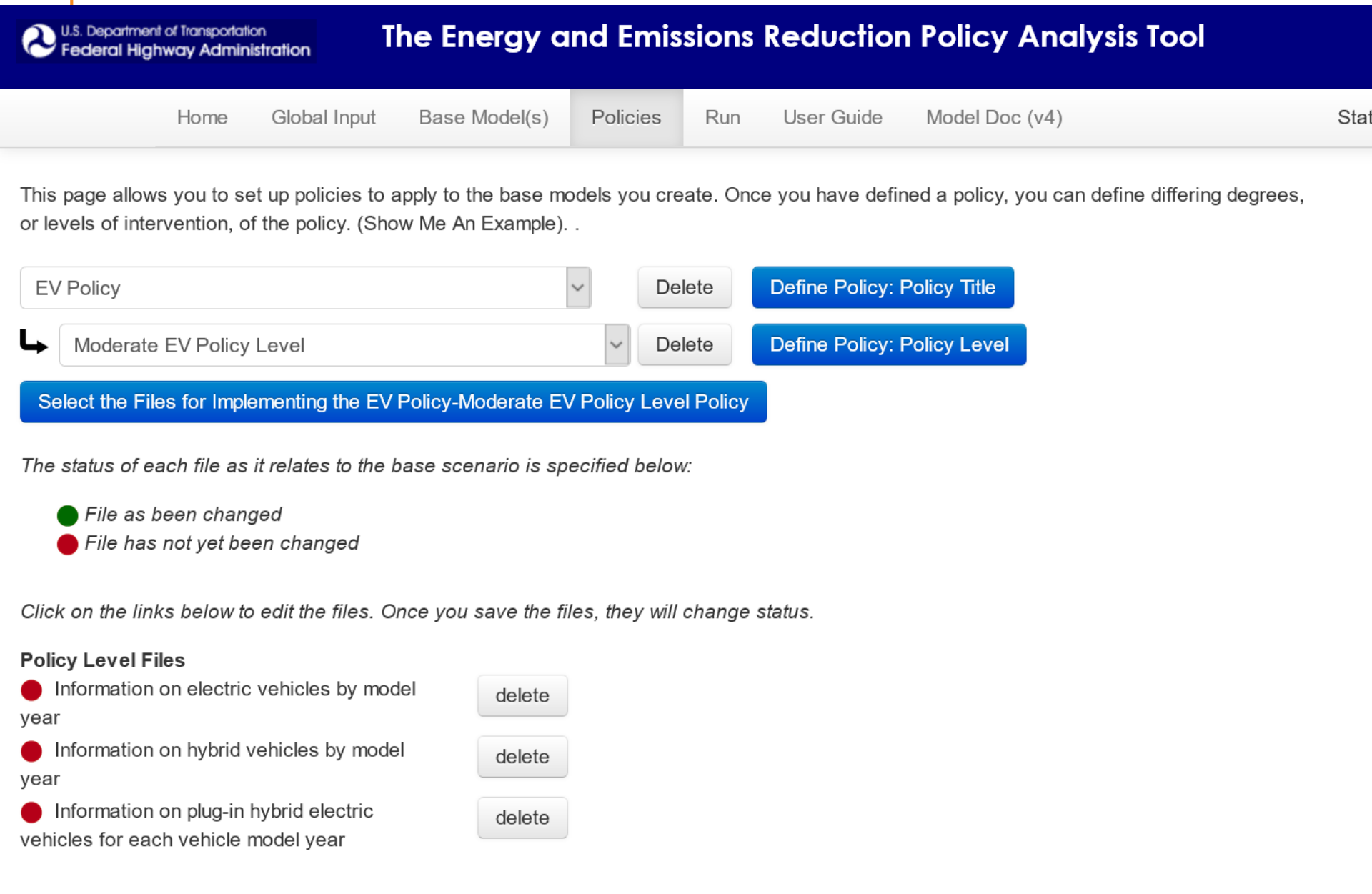
Save

EERPAT File Structure

-what the GUI operates on



EERPAT v4 Graphical User Interface



Contacts

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