Improving Mobile Source Planning Tools

California Environmental Protection Agency
AIR RESOURCES BOARD

June 2013

The Air Quality Challenge

- 2023 ozone standard: 80 ppb
  - Requires 80% reduction in ozone forming emissions from current levels
- 2032 ozone standard: 75 ppb
  - An estimated 90% reduction in ozone forming emissions from current levels
- 2050 Greenhouse Gas Emissions Goal
  - 80% reduction from 1990 levels

Mobile Source Analysis Tools

- Originally designed to characterize mobile source emissions at county level
- Used to forecast emissions with the benefit of new vehicle standards
- Used to support project level assessment
- Used to support air quality planning / modeling
- Synthesized from many different data sources

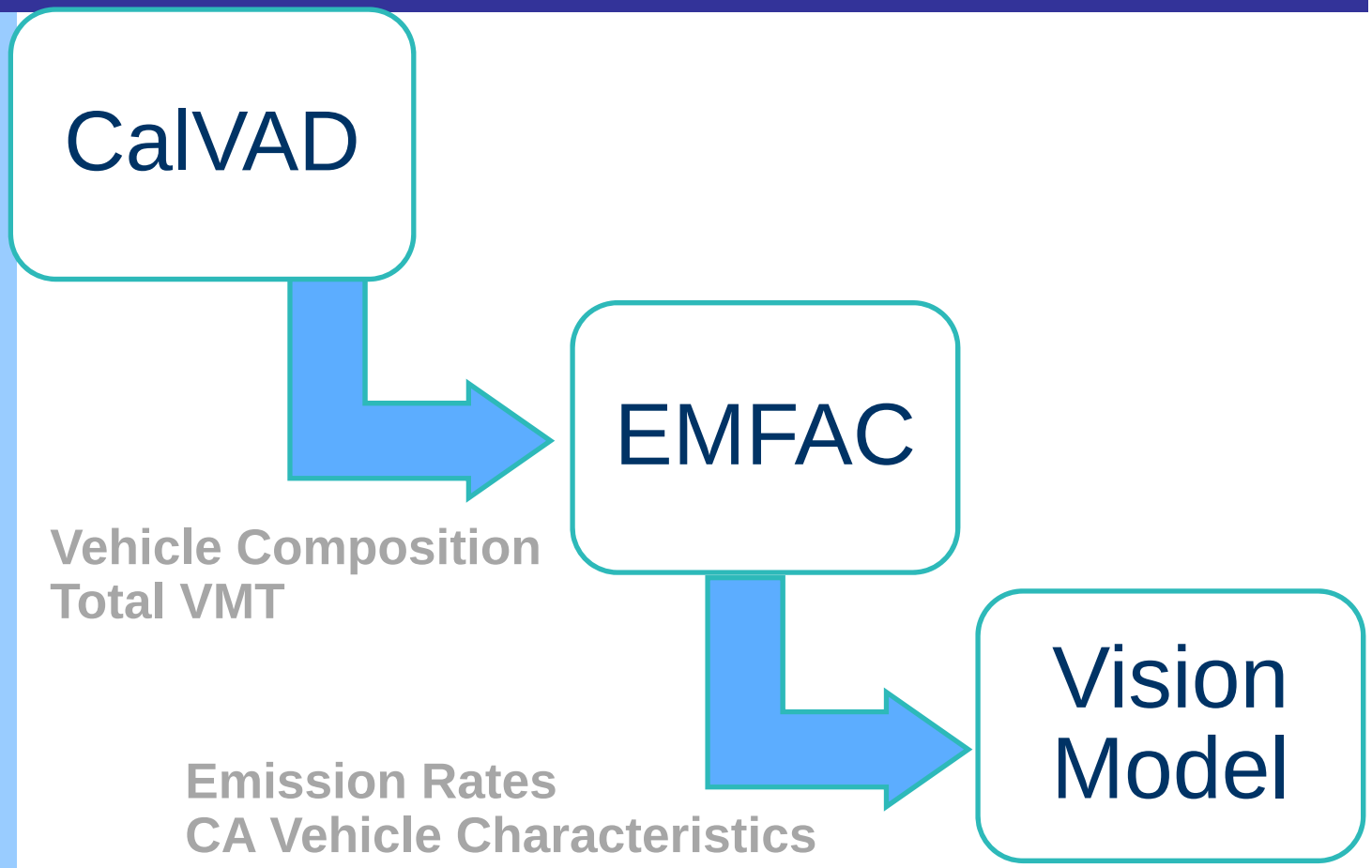
Tools Are Expanding

- Transportation and air quality modeling efforts are responding in light of climate change and more stringent ozone standards
- No single tool can meet all needs
- All tools need to be based on sound, fundamental data
- Need flexible tools for improvement over time

Assessing Planning Needs

- Multiple future scenarios
  - Dynamic activity estimates
  - Vehicle and fuel technologies
  - Transportation efficiency
- Multiple scales
  - Statewide (climate), regional (NAAQS), local (projects)
- Improved spatial and temporal resolution for air quality modeling

The Tool Framework



ARB Tool Improvements

- The EMFAC model
- California Vehicle Activity Database (CalVAD)
- Vision Scenario Tools

The EMFAC Model

The EMFAC Model

- Designed to assess emissions standards
- Evolved for federal air quality requirements
- Also supports
  - Transportation planning for technology, land-use
    - Multiple scenarios, multiple planning targets
  - Greenhouse gases and criteria pollutants
  - Detailed project level assessments
- An update is underway

EMFAC Update Plan

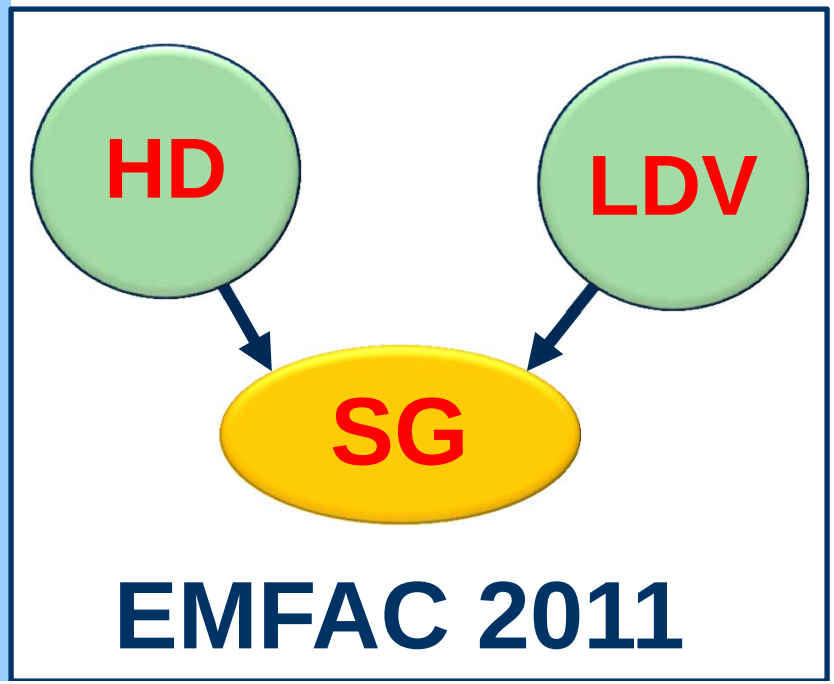
- **EMFAC2011**
  - First step to more flexible structure
- **EMFAC2013**
  - Includes Advanced Clean Cars and LCFS
  - Ensures consistency with historical fuel use
  - Provides a bridge between the regional and climate planning
  - Improves ability to evaluate technology penetration at regional levels

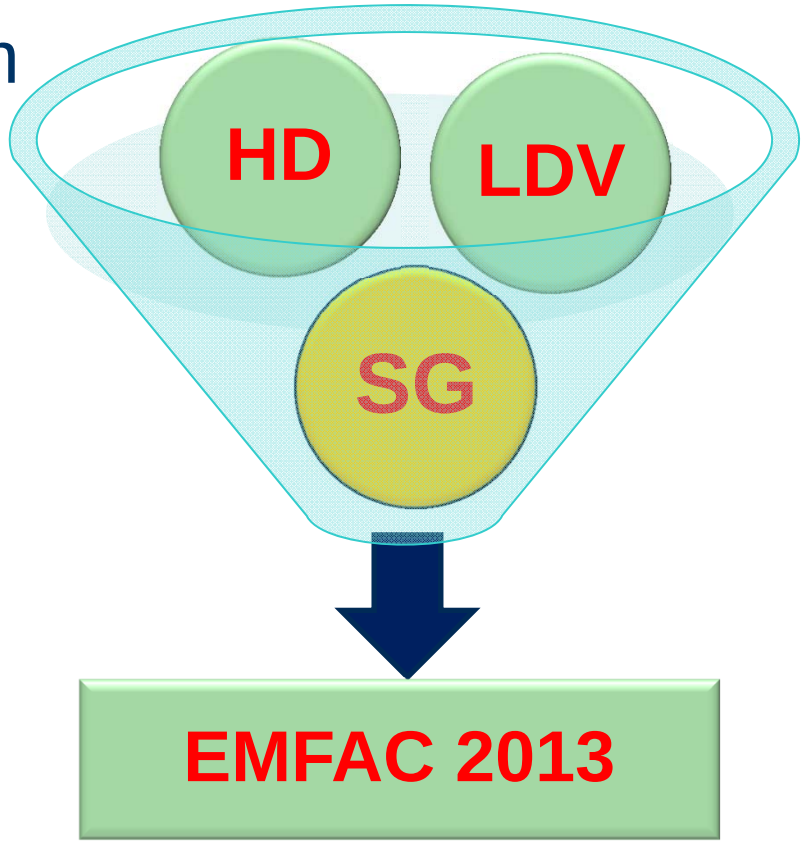
EMFAC 2013 Model Overview

- One module with new programming architecture
- Match historical fuel sales
- New forecasting methods
  - Vehicle age distribution
  - Statewide and regional VMT
- Integrates Advanced Clean Cars and LCFS
- Updates truck emission factors
- Updates regional planning tools

EMFAC 2013 Architecture

- Designed for future programming flexibility
- Python/MySQL platform





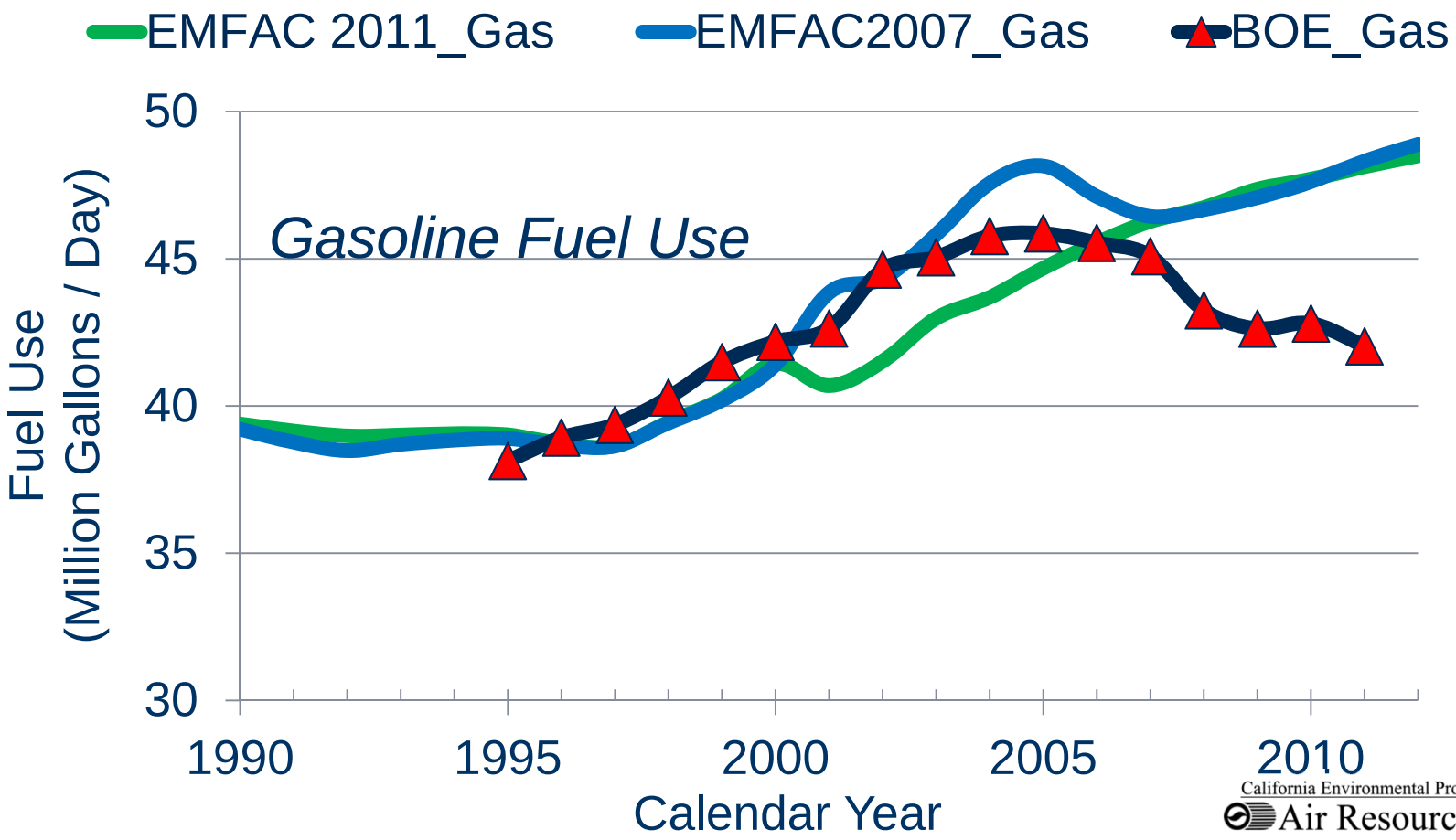
Matching Fuel is Important

- It is an important indicator of vehicle activity and helps to inform criteria emissions
- We know how much fuel is sold and used in California
- Matching fuel use is important for climate change planning

Matching Fuel Use and MPO Regional VMT data

- MPO data used for regional planning
  - SG is the scenario planning tool for these assessments
  - Planning inventories will be based on MPO VMT
- Climate change planning requires consistency with statewide fuel use
  - EMFAC2013 base model estimates will match statewide historical fuel sales data
- There is a need to reconcile the regional VMT with statewide fuel use

Gasoline Fuel Use Estimates



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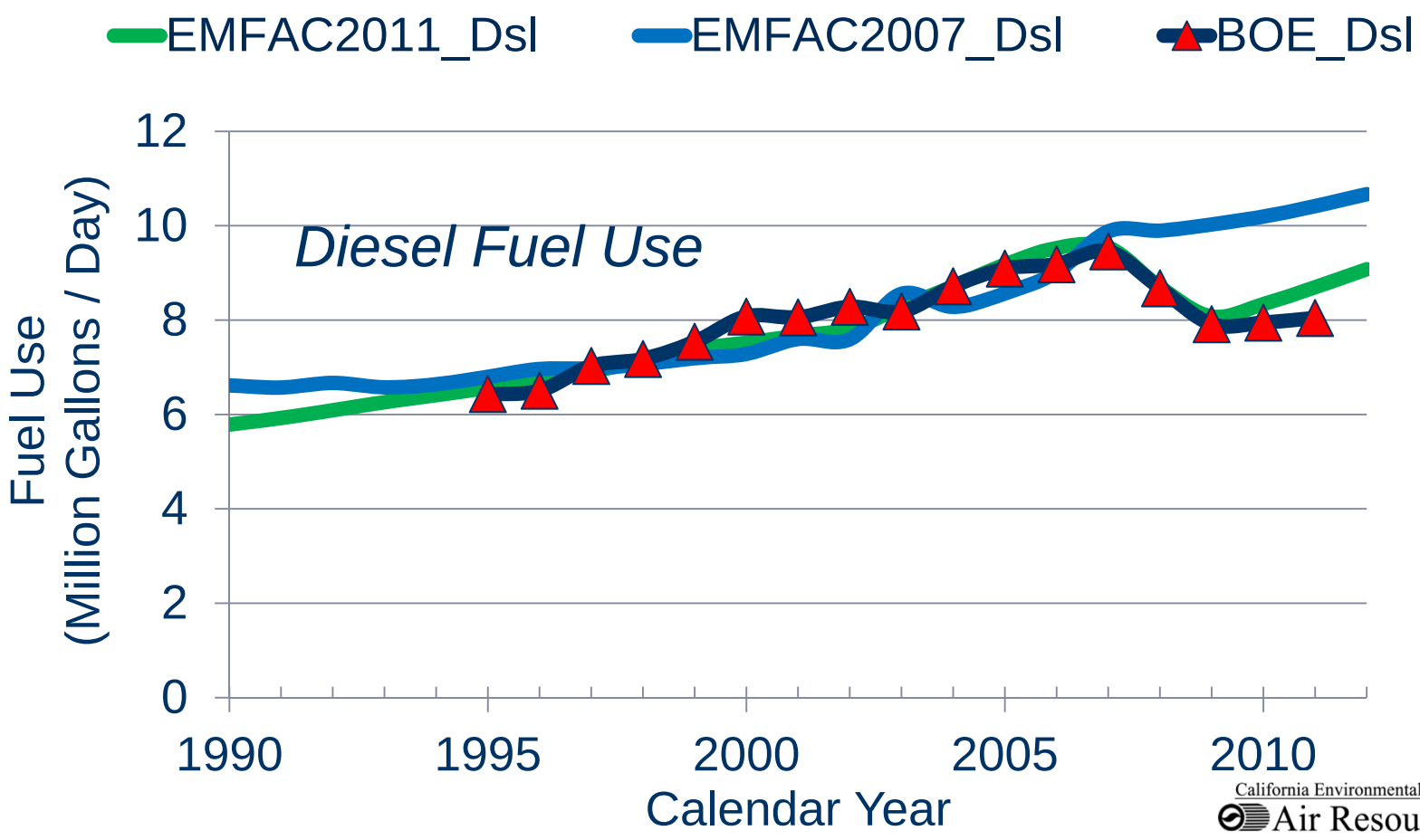
EMFAC2011 Matched Diesel Fuel Use



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Resolving Fuel Use on a Regional Level

- There are no direct measurements of regional fuel use
- There are indirect estimates
  - Vehicle population model estimates: EMFAC
  - Travel model VMT estimates: MPO models
  - VMT measurement estimates

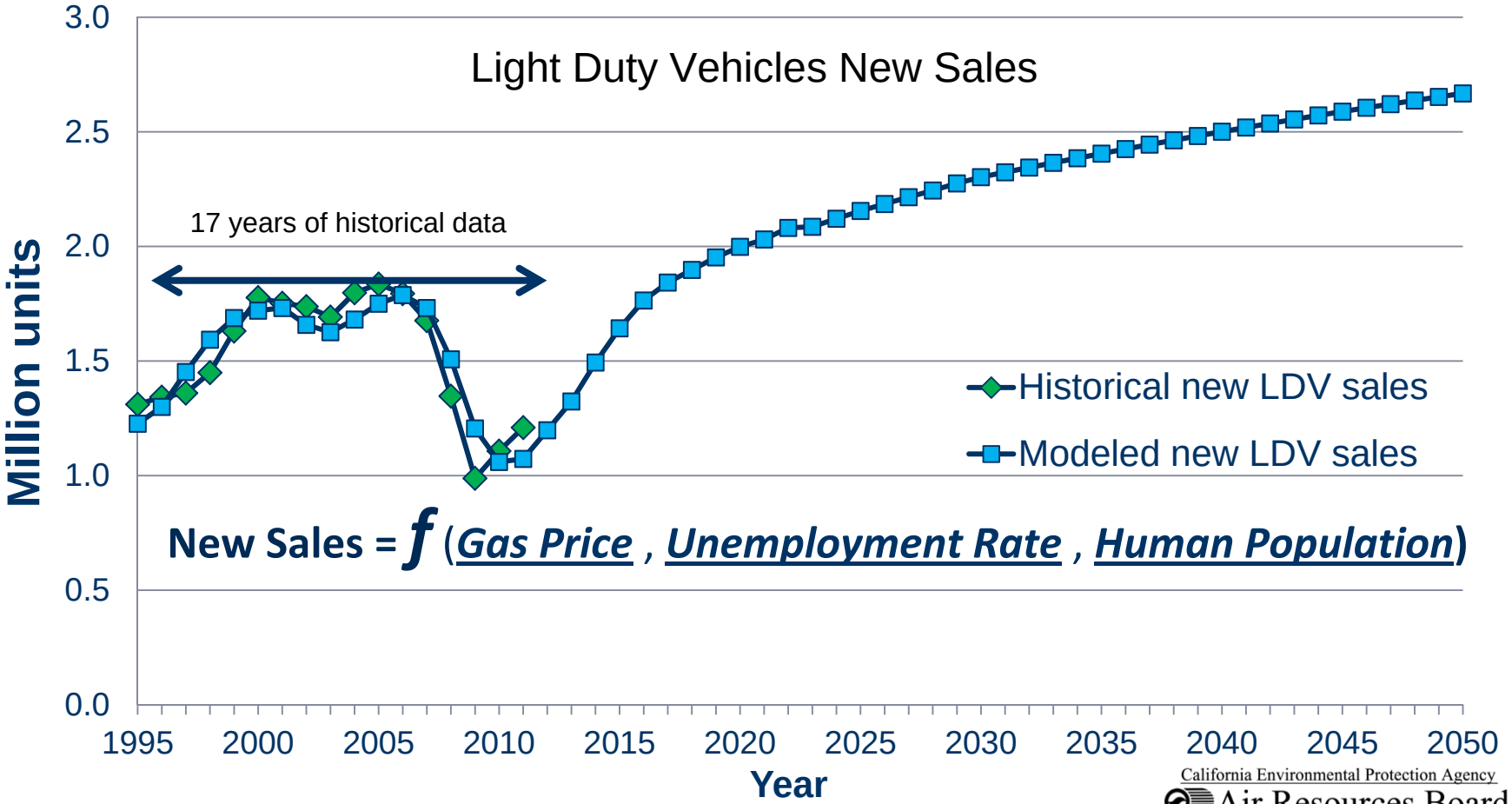
EMFAC2013 Approach

- Statewide inventory will match historical fuel
- Statewide fuel, VMT, fleet forecasts based on econometric, demographic, regulatory data
- Default regional fleet, VMT, emissions disaggregated from statewide data and calibrated with external information
- Planning inventories will rely on MPO VMT

Statewide Forecasting Methods

- New vehicle sales
- Baseline statewide VMT and fuel use
  - Assuming forecasted economic trends and no implementation of new technology
  - Based on multiple regression to statewide economic forecasts
- Overlay ARB rules
  - Scenario planning will overlay on top of ARB regulatory technology penetration

Approach Under Development: New Vehicle Sales



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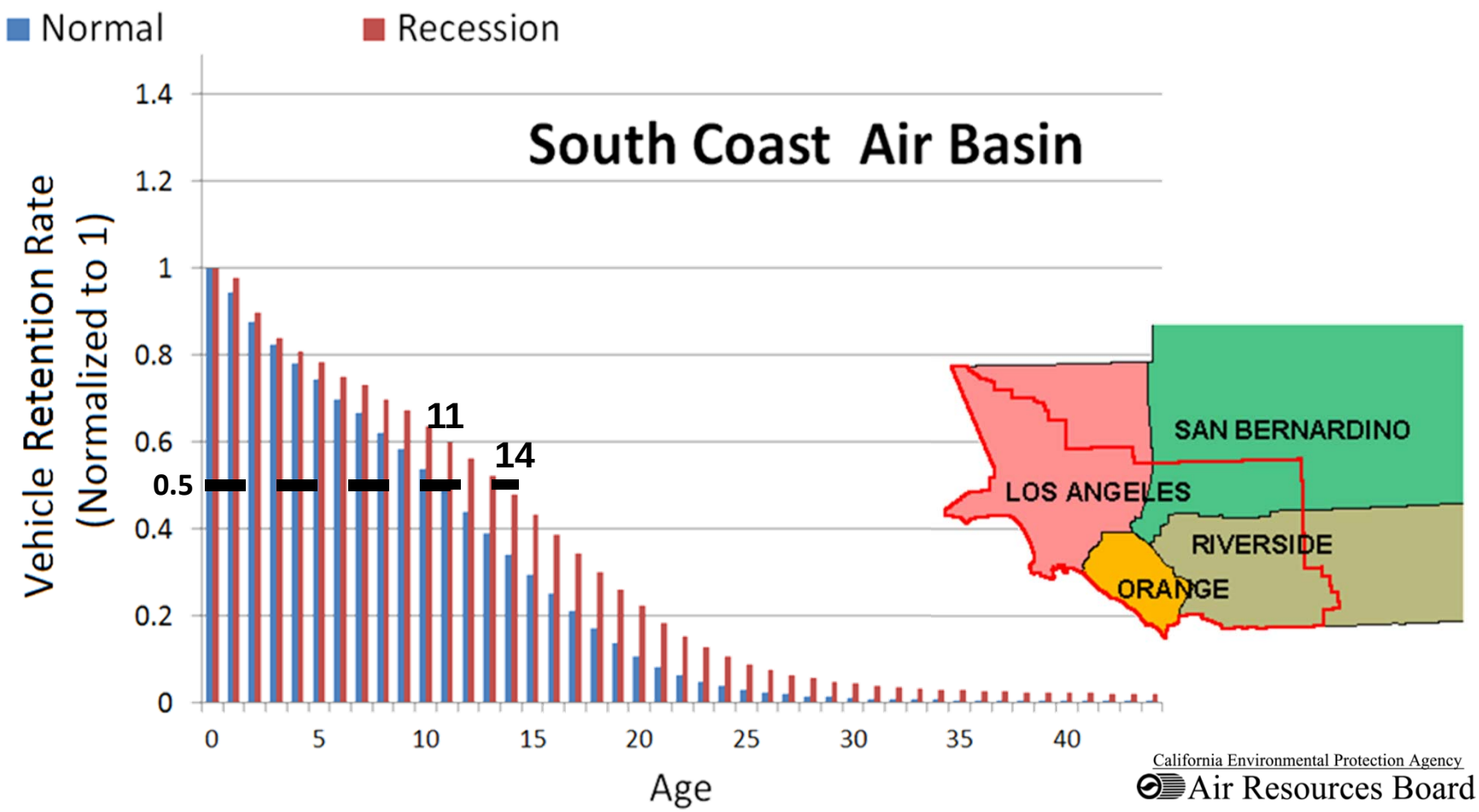
Approach Under Development: Regional Vehicle Retention

- Forecasting population requires an estimate of retired vehicles
- EMFAC2011 used statewide attrition rates
- EMFAC2013 uses regional retention rates:
  - Includes both attrition and migration
  - Recession vs. Business As Usual (BAU) period

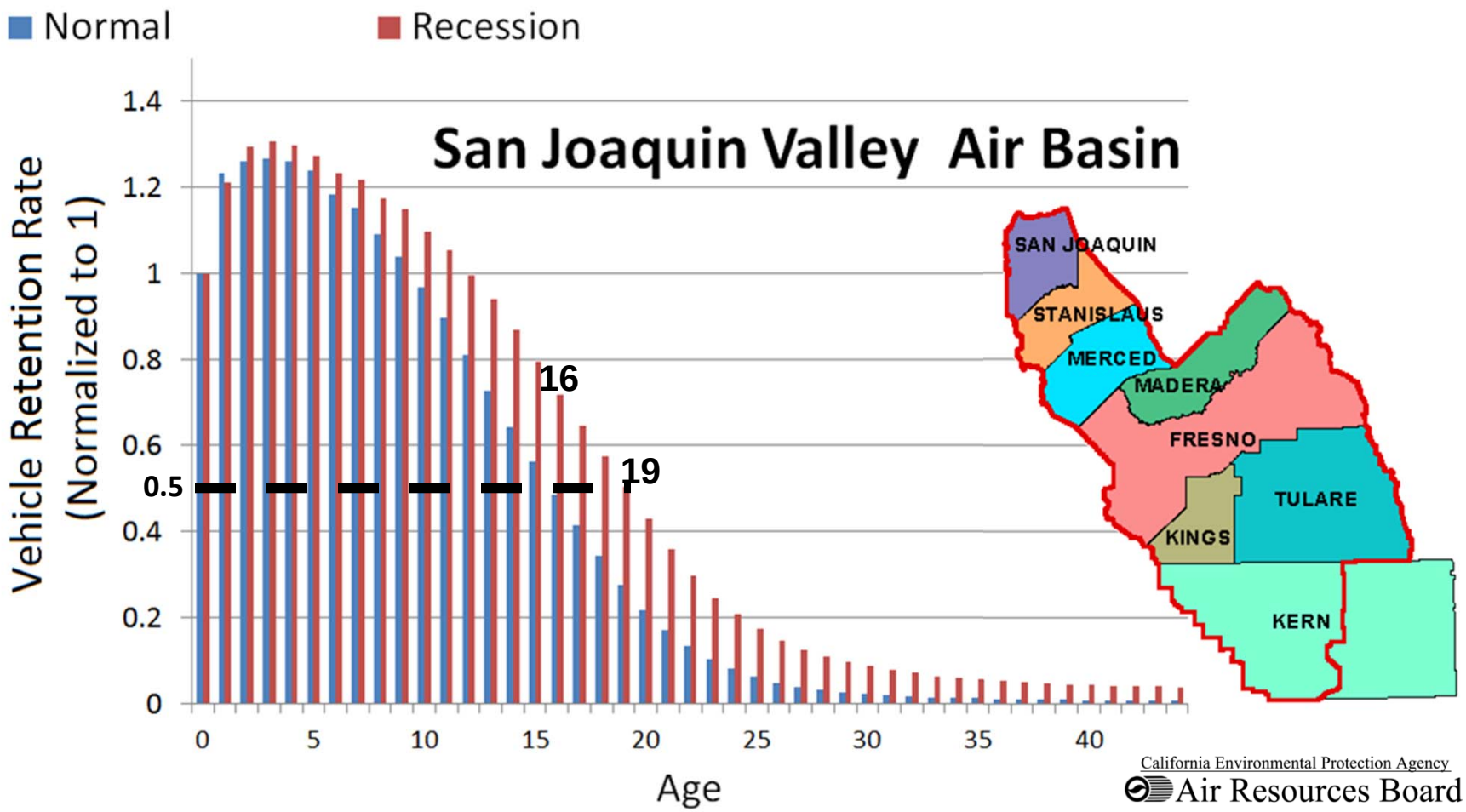
Approach Under Development: Regional Vehicle Retention

- South Coast vs. San Joaquin Valley retention:
  - There is a net influx of used vehicles into San Joaquin Valley from other regions.
  - People in the San Joaquin Valley keep their vehicles 5 years longer on average than those in South Coast.
- The recession caused people to keep their vehicles 3 years longer on average.

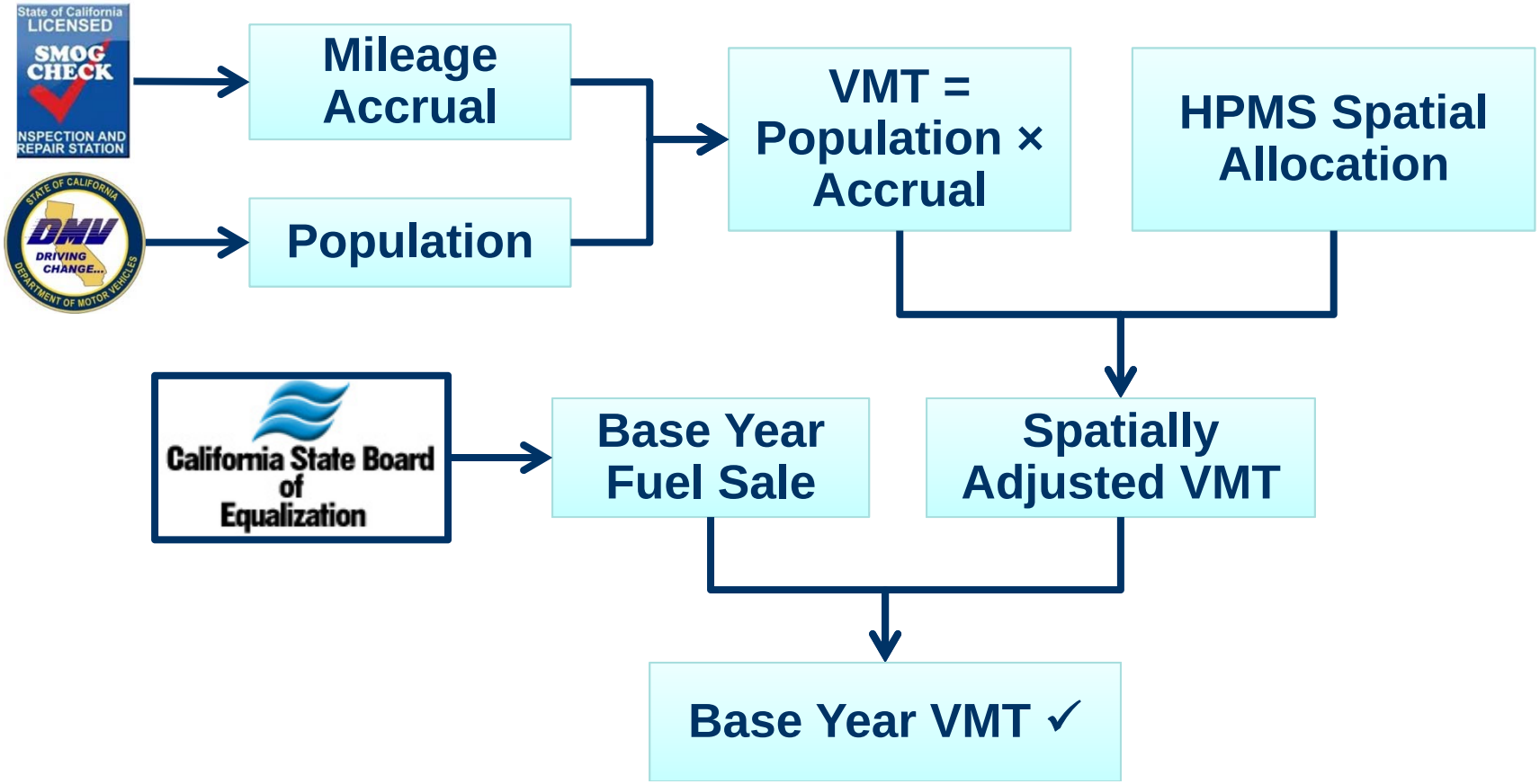
Approach Under Development: Regional Vehicle Retention



Approach Under Development: Regional Vehicle Retention



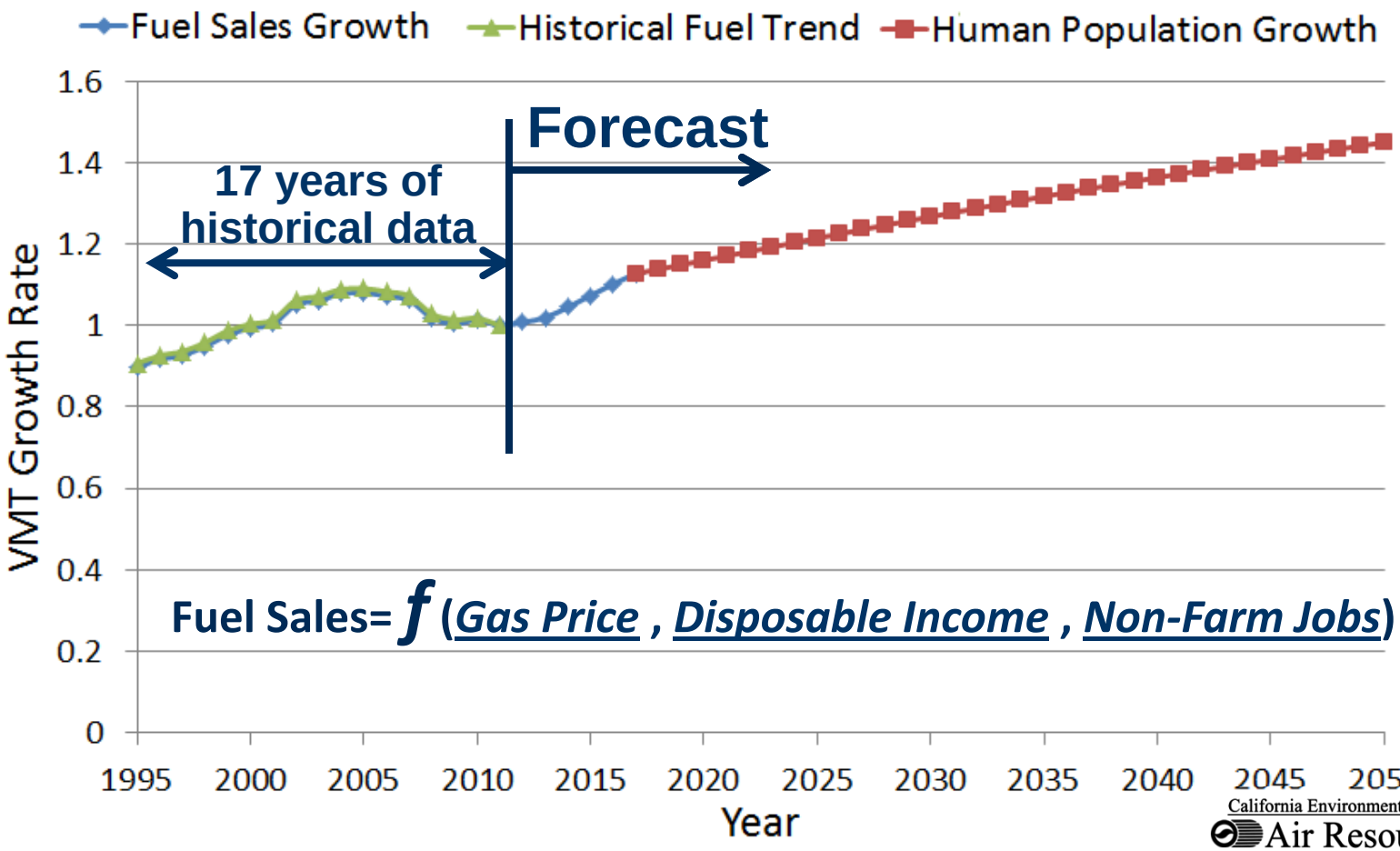
Approach Under Development: Base Year VMT



Approach Under Development: Forecasting VMT

- Regression model to estimate fuel use growth without considering technology penetration
- Statewide VMT growth is matched to
  - Forecasted fuel growth for 2011-2017
  - Human-population growth for 2018-2050

Approach Under Development: Forecasting VMT



Regional Disaggregation

- Statewide forecasts must be dis-aggregated to regional levels
- Potential approach uses region-specific data
  - Vehicle populations
  - Mileage accrual rates from Smog Check
  - Demographic projections

California Vehicle Activity Database (CalVAD)

CalVAD Goal

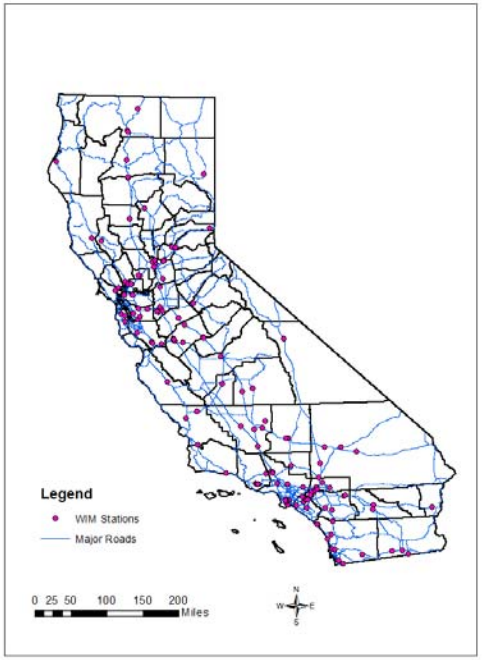
- Develop high quality VMT estimates for each sub-region in California
  - Cars and trucks (with improved vehicle class information)
  - Based on measurements from multiple data sources
  - Summarized at multiple spatial and temporal scales
  - Ability to evaluate individual roadways and grid cells
  - Will be available to the public when completed

Input Data Sources

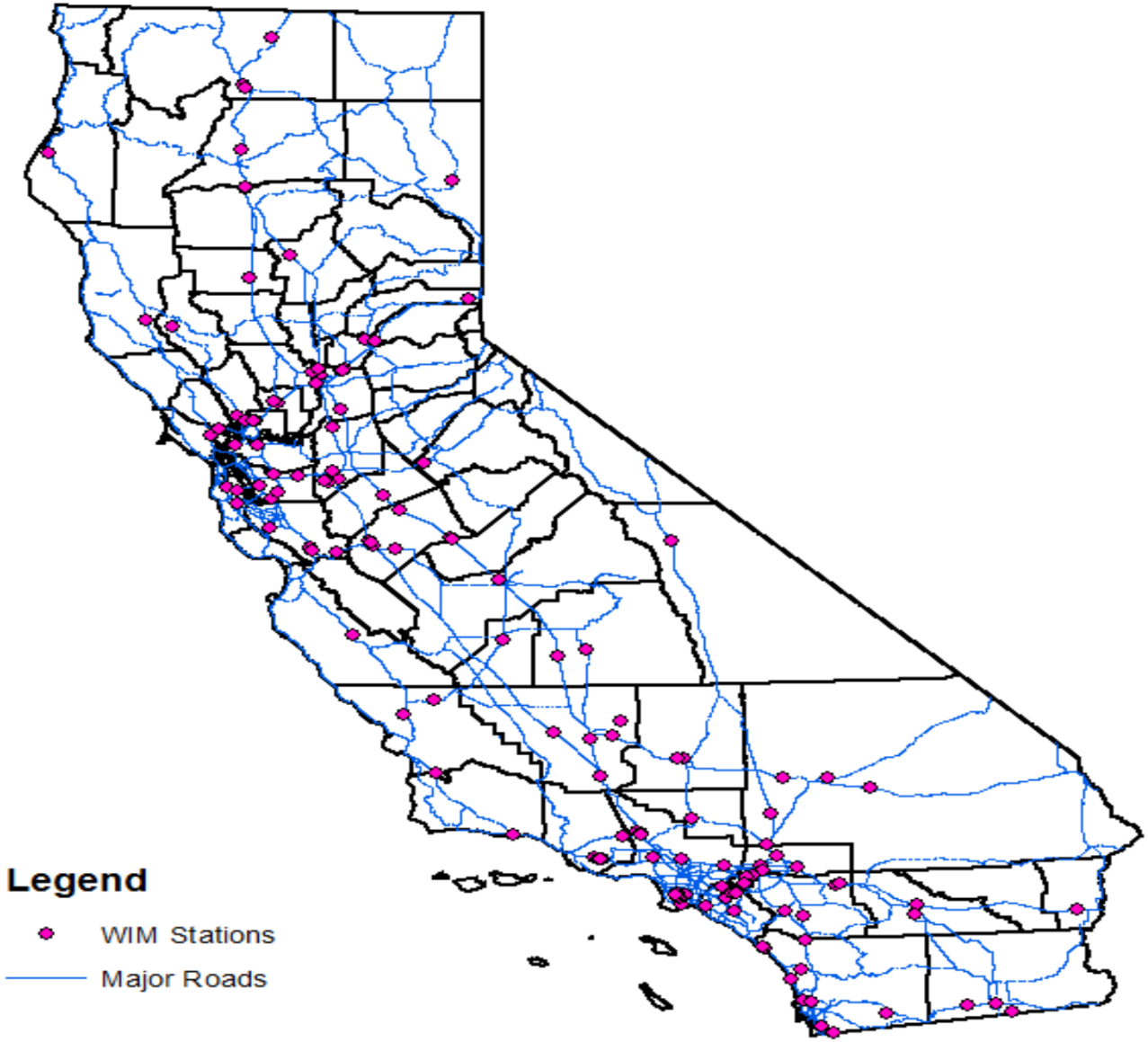
- WIM Stations
  - Weigh-in Motion
- PeMS
  - Freeway Performance Measurement System
- HPMS
  - Highway Performance Monitoring System
- Local traffic volume counts
- Open Street Map

Weigh-In-Motion (WIM)

- Provides 24-hour truck information at key locations on California highways
- Currently 125 WIM sites are in operation
- Collects speed, gross weight, axle weight & axle spacing for different vehicle classes



Weigh-In-Motion (WIM)



Loop Detector

PeMS Data

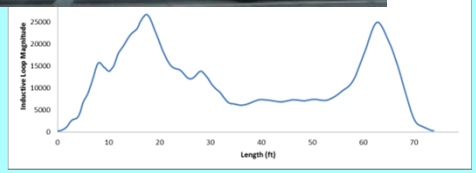
- More than 25,000 detectors
- PeMS collects, processes & analyzes traffic data to assess the performance of the freeway system
- Measures volume counts & speeds by lane
- About 2 million observations per detector per year

Beyond PeMS & WIM

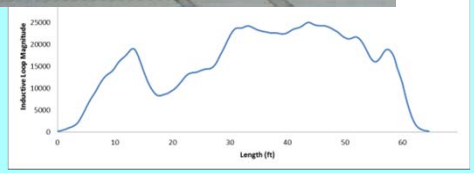
- PeMS currently counts vehicles
- Existing PeMS & WIM infrastructure can classify & count vehicles by their shape & size using ‘vehicle signatures’
- This can be implemented by replacing detector cards
- ARB is funding research to classify vehicles at PeMS & WIM sites

Comparison of Commercial Vehicle Signatures

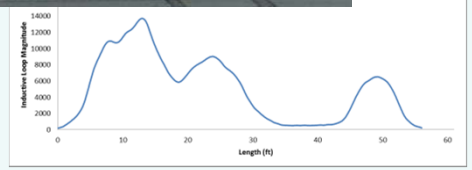
Basic Platform



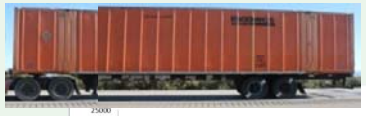
Low Boy Platform

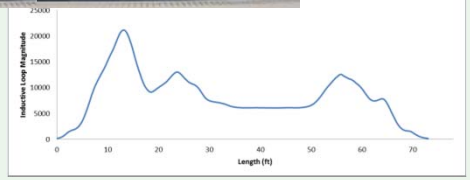


Logging

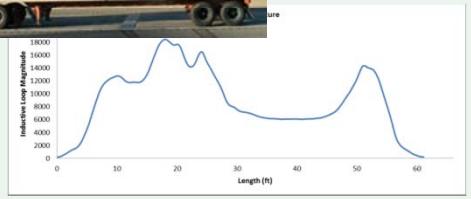


53ft Box Container

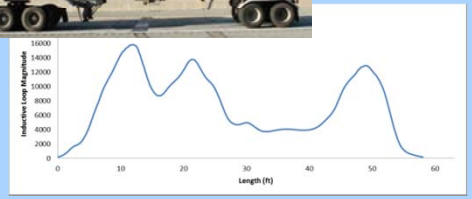




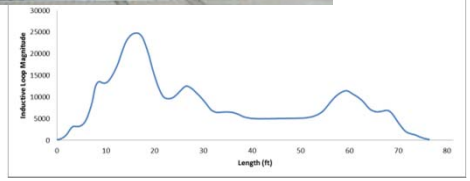
40ft Box Container



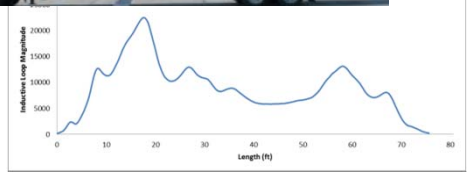
Tanks



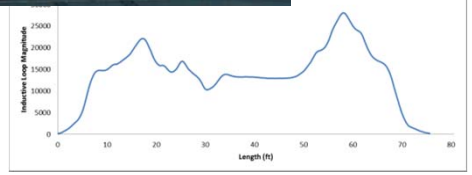
Enclosed Van



Refrigerated Van



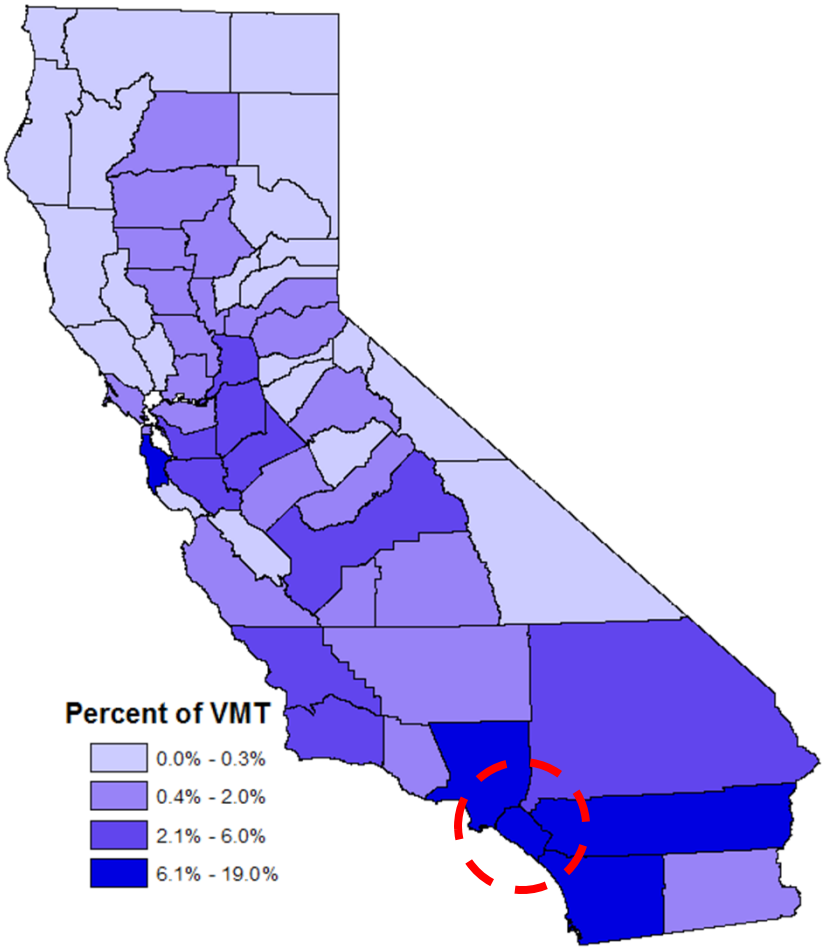
Drop Frame Van



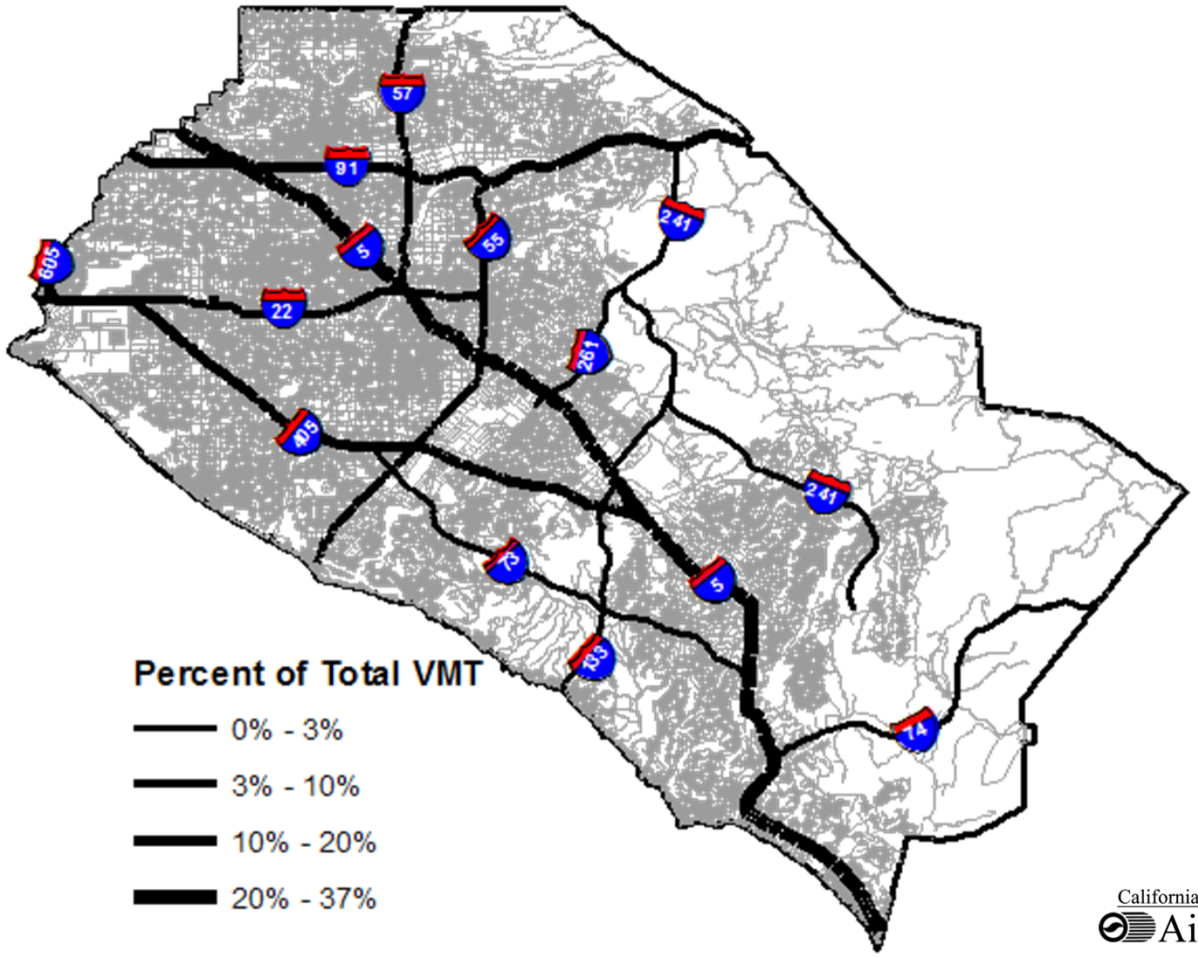
CalVAD Methodology

- Process data
  - Impute missing data at WIM/PeMS stations
  - Pair PeMS detector to the nearest WIM station
  - Supplement with HPMS and Census counts
- Estimate volume/speed at each site
- Generate VMT by multiplying volume and road length

Distribution of Statewide On-Road VMT



Distribution of VMT by Roadway in Orange County



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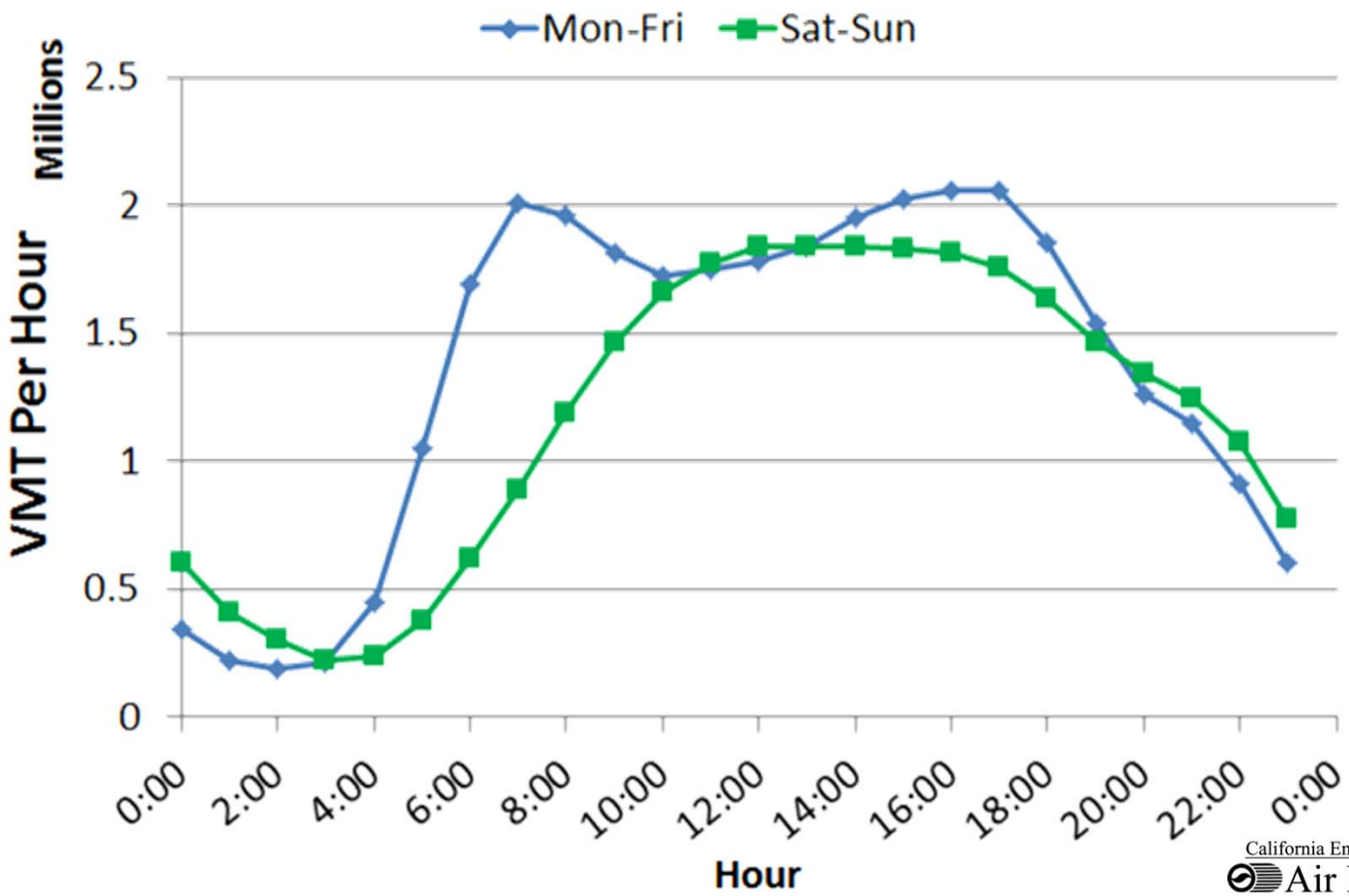
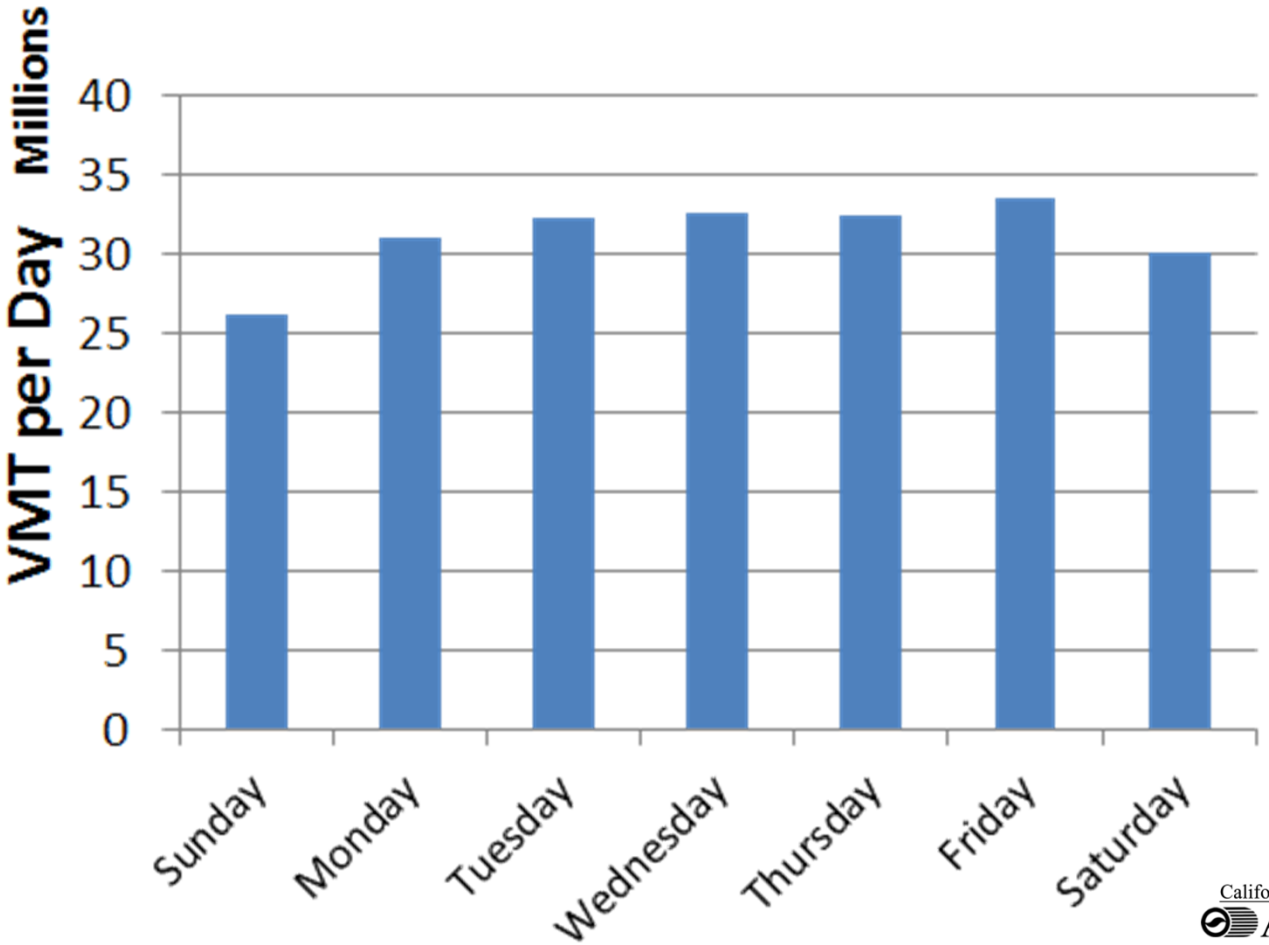
Hourly Distribution of VMT in Orange County



Orange County VMT by Day of the Week



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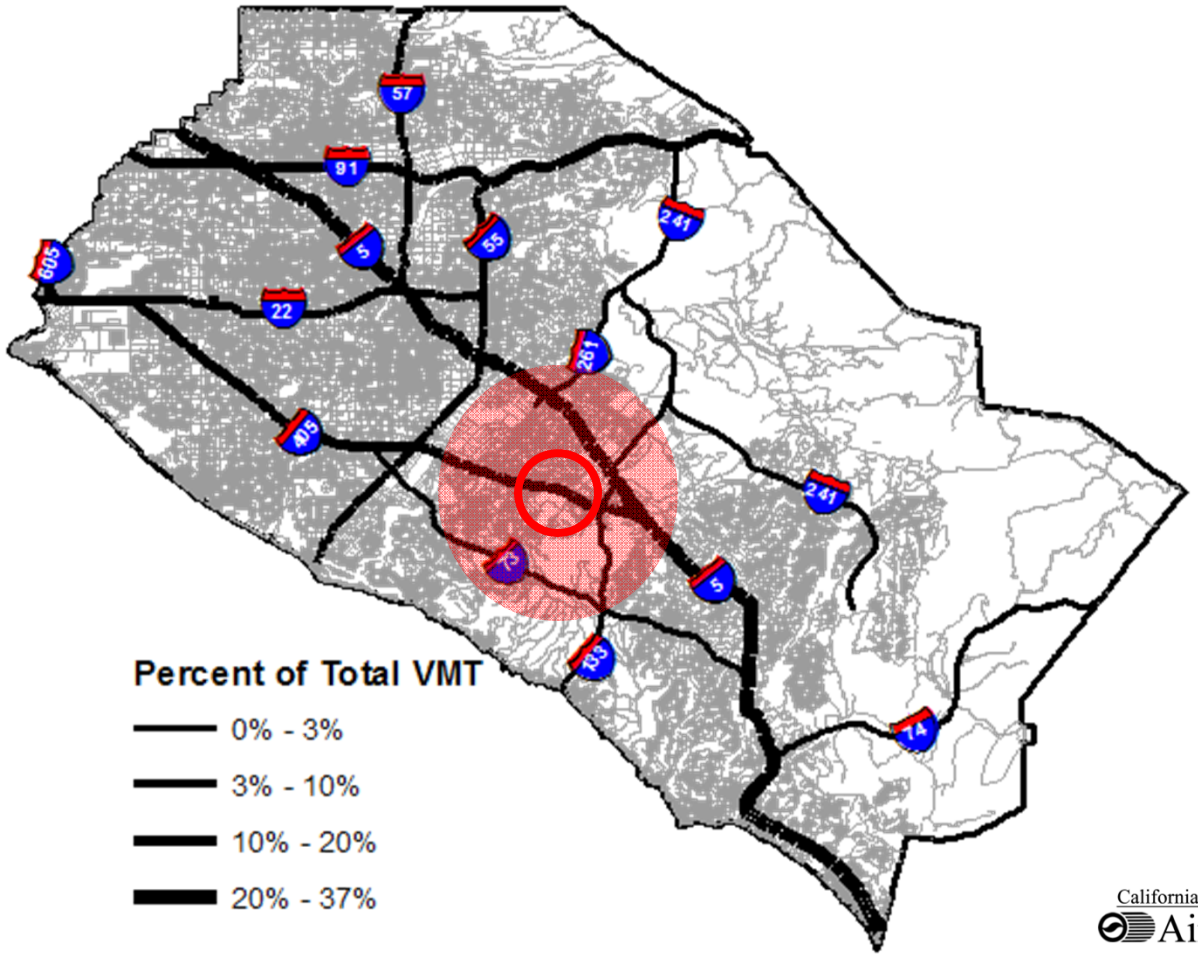

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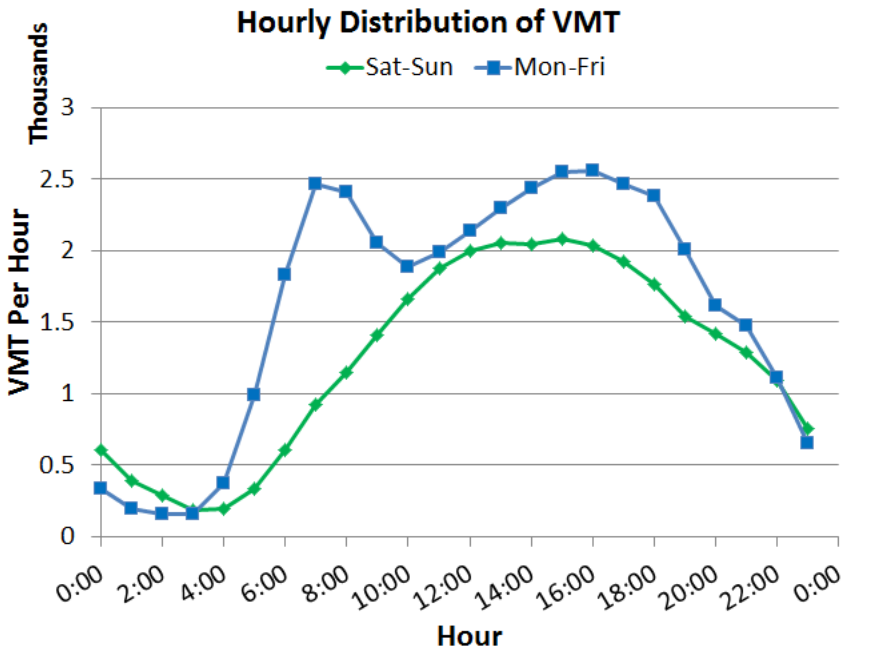
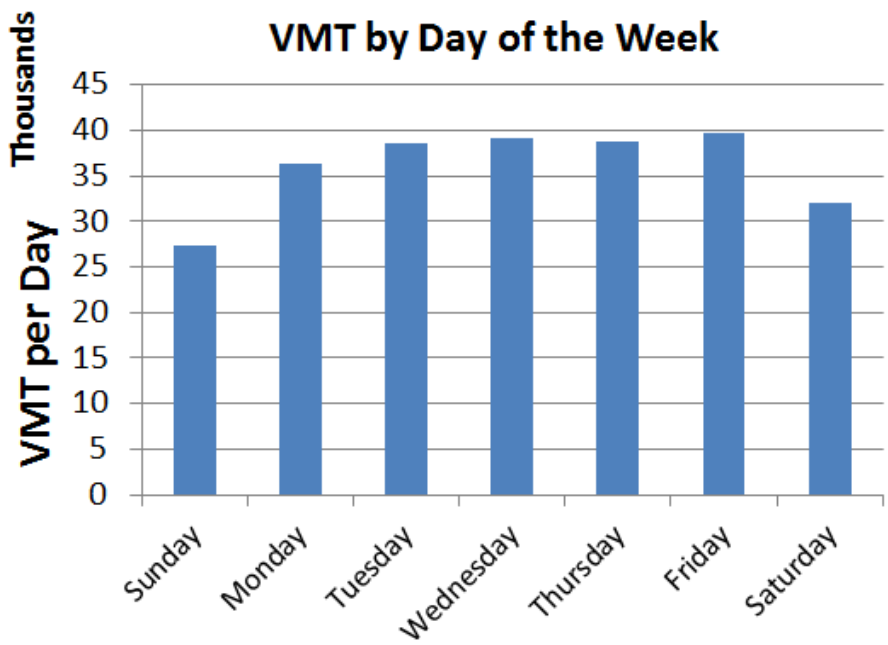
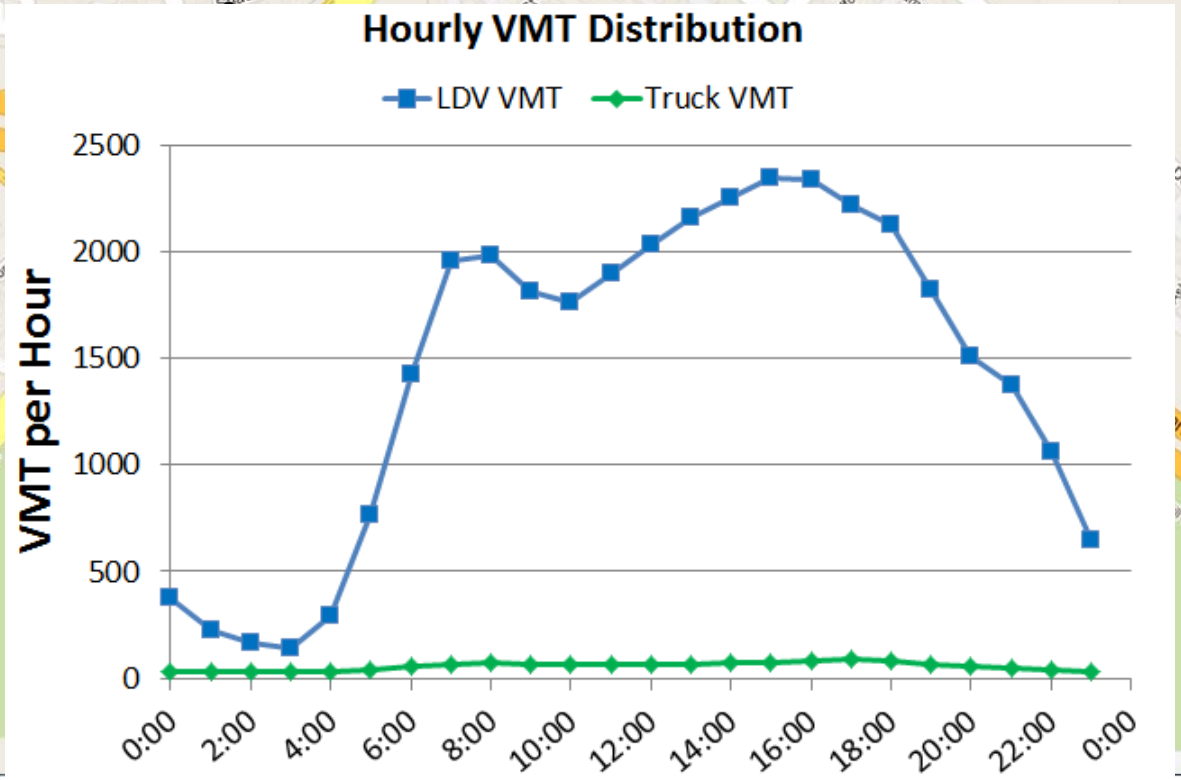
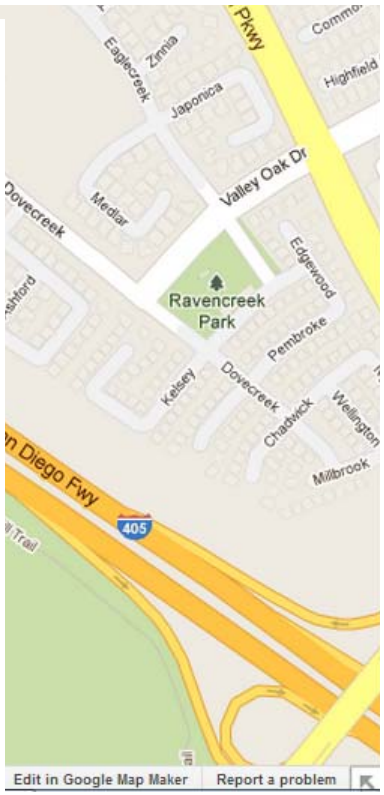

Hourly Distribution of VMT
Sat-Sun
Mon-Fri
Thousands
VMT Per Hour
3
2.5
2
1.5
1
0.5
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Hour

Jeffrey Rd


VMT by Day of the Week
Thousands
VMT per Day
45
40
35
30
25
20
15
10
5
0
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

405
4
Chestnut
Citron
Cherry N
Cherry S
Dogwood S
Jordan Ave
Carob
Camphor S
Eucalyptus
Jordan E
A Scientific Approach to Traditional Chinese Medicine
Juniper
Irvine Veterinary Services
University Dr
Sand Canyon Wash Trail
500 ft
200 m

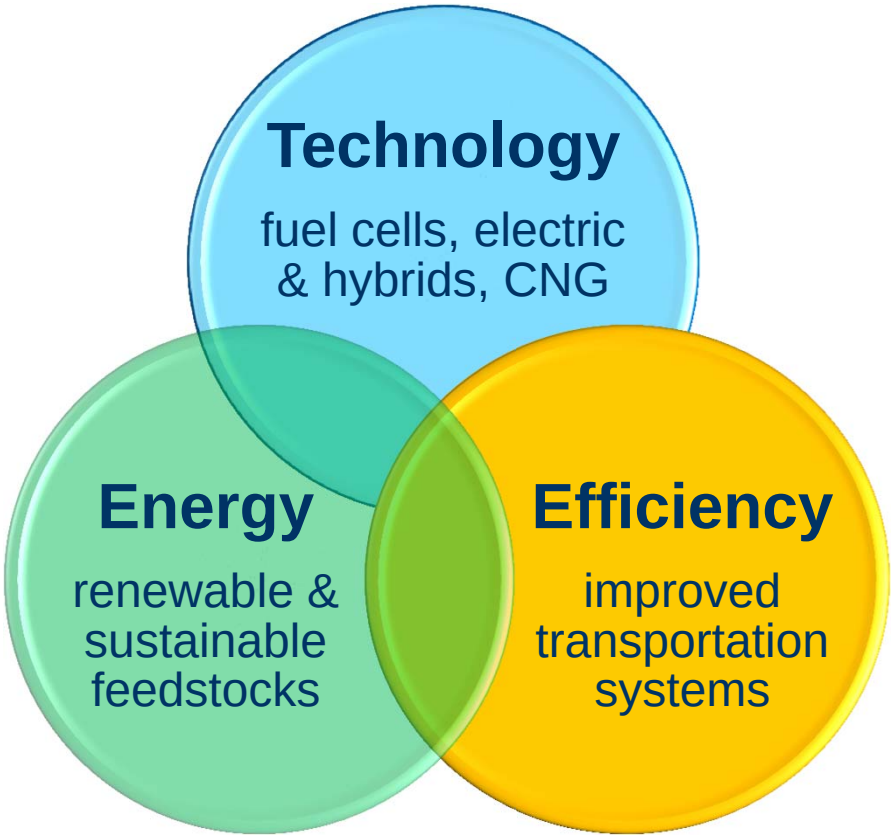

Hourly VMT Distribution
LDV VMT
Truck VMT
VMT per Hour
2500
2000
1500
1000
500
0
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00


Eaglecreek
Zinnia
Japonica
Highfield
Valley Oak Dr
Dovecreek
Medlar
Ravencreek Park
Edgewood
Pembroke
Kelsey
Chadwick
Wellington
Millbrook
405
Edit in Google Map Maker
Report a problem

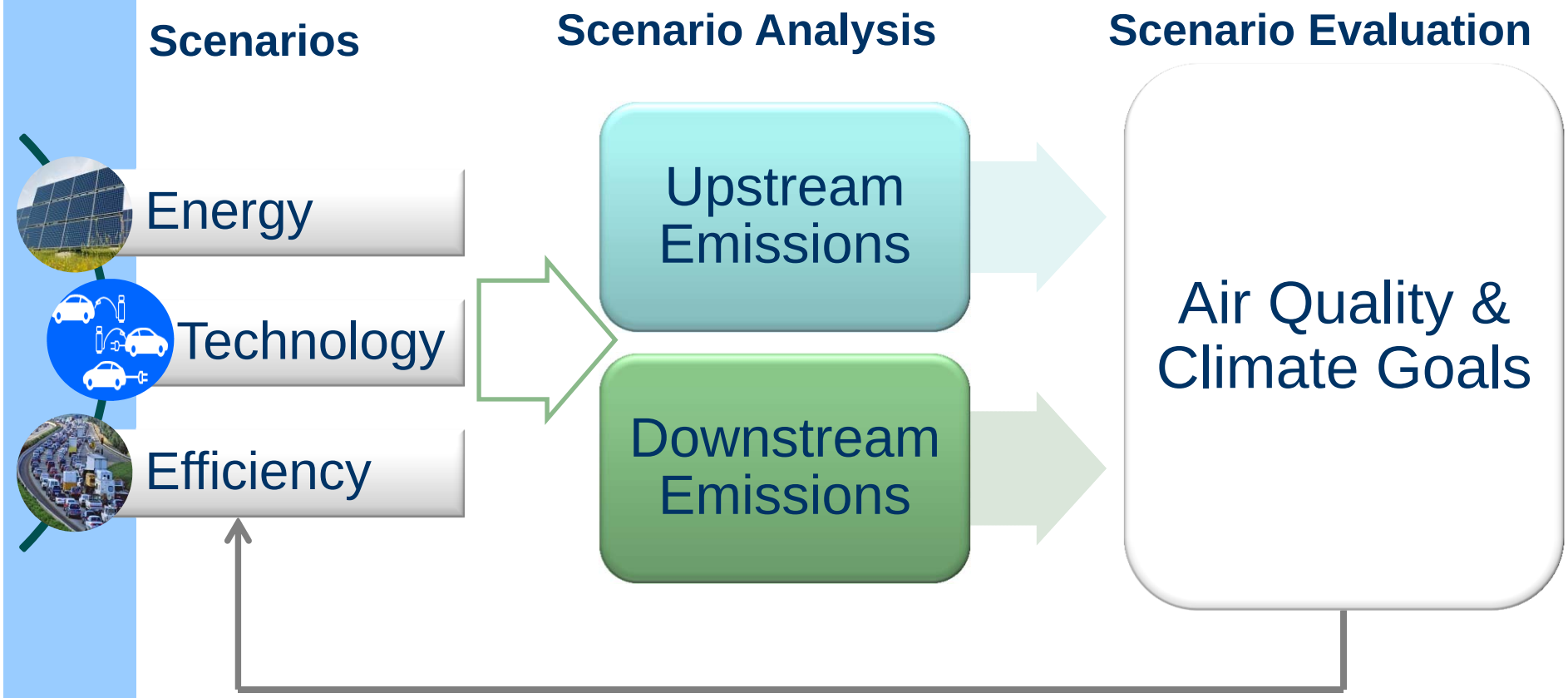
Vision Scenario Tools

Vision Scenarios

- VISION2011 (Argonne Laboratory)
- Customized to California vehicles
- Scenarios consider advanced technology, energy transformation and efficiency



Vision Scenario Analysis



Freight Modeling Can Inform . . .

Freight Models

Commodity- and mode-specific freight movements under environmental and economic policies.

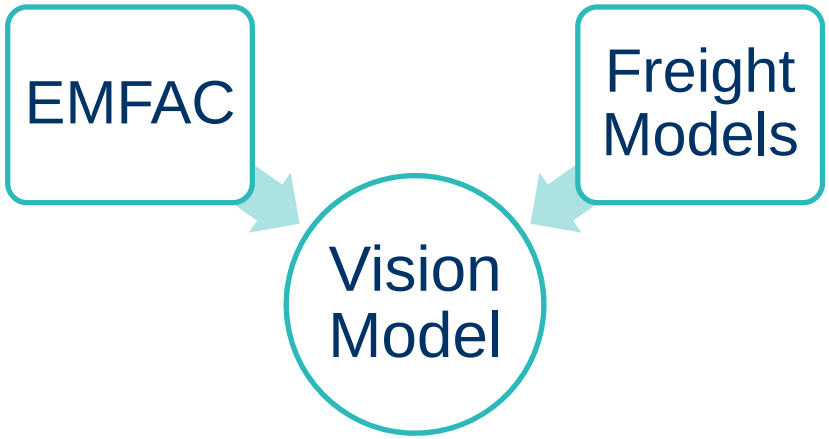
Technology choices for areas where interregional trips are concentrated.

Infrastructure to support mode shifts, efficiencies, technology, and energy sector demands.

Spatial allocation of emissions by identifying corridors where technology operates or efficiencies occur.

SIP Scenario Planning

- Continue building on Vision tools for SIP strategy development.
- Utilize updated EMFAC model output.
  - Statewide, regional and corridor assessments
- Utilize freight models to inform scenario development.



Future Work

Moving Forward

- Continue to rely on EMFAC for emissions and statewide activity assessments.
- Use CalVAD to help reconcile regional MPO and statewide activity.
- Use Vision tools to inform strategies to meet air quality and greenhouse gas goals.

What Happens Next?

- **EMFAC**
  - August 2013 – Workshop on methods and preliminary results
  - October 2013 – Workshop on model and results
  - EMFAC2013 / SG runs using MPO data will be basis for 2015 Ozone SIP development
  - Release target in Early 2014
- **CALVAD**
  - Model completion – Dec 2013
  - QA/QC – Mar 2014
  - Final Project Report – June 2014

For More Information

- Mobile Source Emission Inventory
  - Website: http://www.arb.ca.gov/msei/msei.htm
  - Email list: http://www.arb.ca.gov/listserv/listserv_ind.php?listname=msei
  - Email: msei@arb.ca.gov
- Vision for Clean Air: http://www.arb.ca.gov/planning/vision/vision.htm