EMFAC 2014 Training

California Environmental Protection Agency
AIR RESOURCES BOARD

June 4, 2015

Outline

- Introduction
- Major Model Changes
- Project-Type Guidance
- Documentation
- Demonstration
    - Installing EMFAC 2014
    - Emissions Mode: Default Activity
    - Emissions Mode: Custom Activity
    - Emission Rates Mode: Project Level Assessment
    - EMFAC 2014 Web Databases

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Part I

Introduction

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Introduction – Purpose of EMFAC

- Supports Air Quality Planning & SIPs
  - 2008 Ozone standard
  - PM2.5 plans

- Supports Rulemaking
  - Rules to set emission standards for new vehicles
  - Programs to control in-use vehicle emissions

- Supports Analyses that need to be Consistent with GHG inventory
  - New EMFAC "default" uses VMT estimates calculated such that the associated fuel use matches historical fuel sales, similar to GHG inventory

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Introduction – Previous Workshops

- June 2013
  - Model Architecture
  - Methodologies
- October 2013
  - Changes made to light duty emission rates
  - Approach to reflect ACC and Truck & Bus Rule
  - Update to data inputs and methodology
- November 2014
  - Recent updates
  - VMT comparison
  - Emissions Comparison

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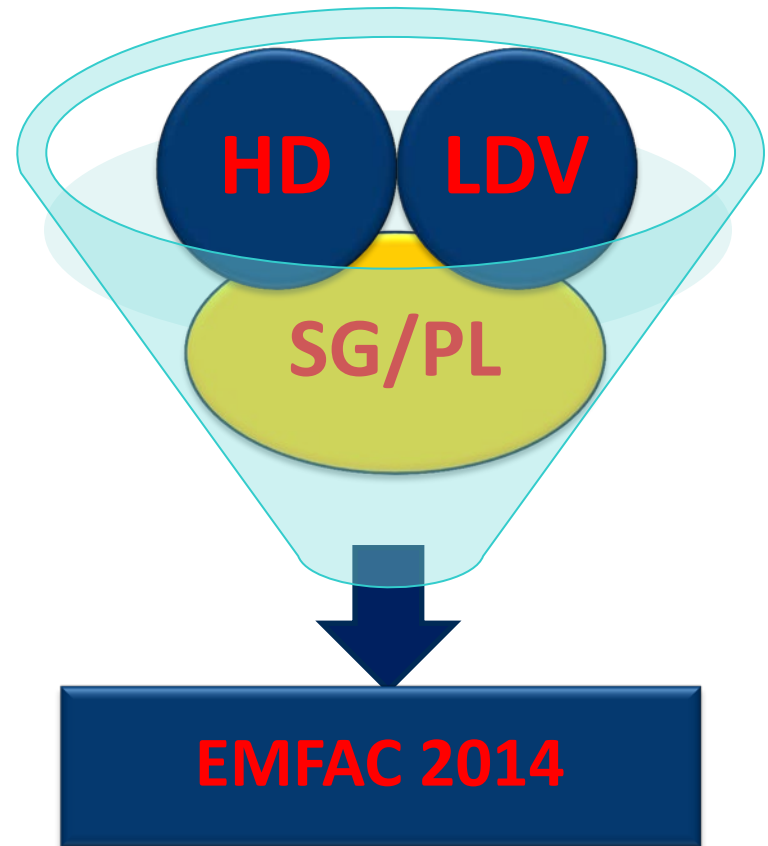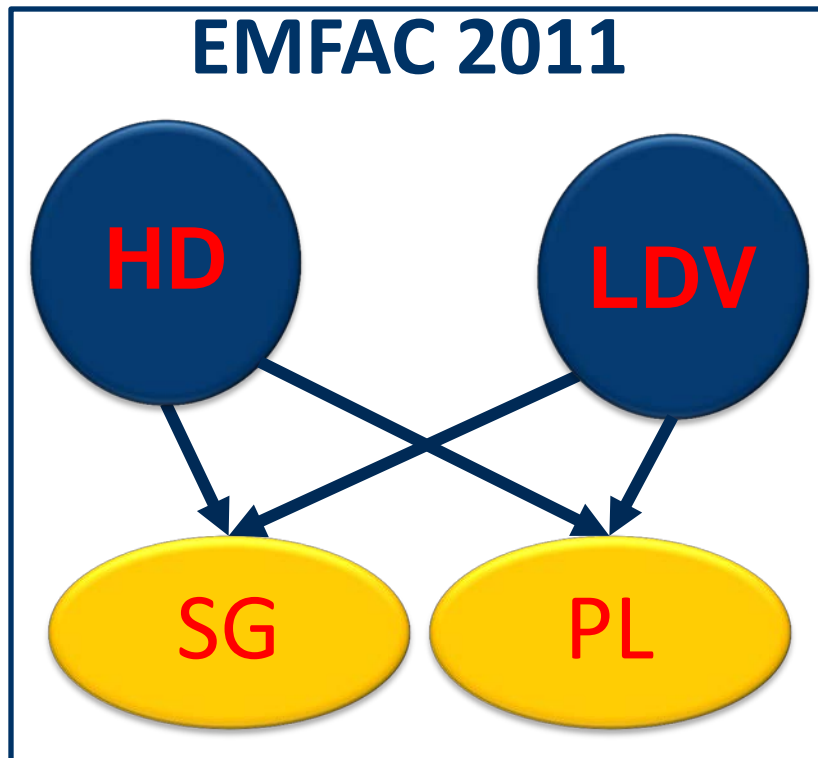Air Resources Board

Part II

Changes Reflected in EMFAC2014

- *General*
- *Model Architecture*
- *Input*
- *Regulations*
- *Formulation*

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EMFAC2014 – *General Changes*

- EMFAC2014 Publicly Released 12/31/14
- One model with new programming architecture
  - MySQL & Python
- Emission estimates through 2050
- Integrated capability to change VMT and speed profiles
- Fully integrated PL Tool that provides users capability to calculate hourly emissions for project level assessments

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EMFAC2014 – *Model Architecture*

- Designed for future programming flexibility
- Python/MySQL platform

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EMFAC2014 – *Input Data Changes*   1/4

- Updated Light Duty emission factors
  - Odometer schedule
  - Reflect baseline external adjustments for ACC
    - Zero evap penetration
  - CO2 emission factor/speed correction
    - Update to reflect relations among weight classes and fuels
  - HC Speciation

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- Updated Heavy Duty Diesel emission factors
  - Based on new ARB & SCAQMD test data on 2007 and 2010 standards Class 8 trucks
  - Higher NOx and lower PM than EMFAC2011 for 2007 standard trucks
  - NOx overall not very different but PM much lower than EMFAC2011 for 2015+ model years

- Start emission rates (g/start) for SCR-equipped trucks

- Emission rates are corrected for engine-chassis model year mismatch

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EMFAC2014 – *Input Data Changes*   3/4

- Reflects natural gas urban buses and refuse trucks
  - Based on data from SCAQMD
    - Lower PM (as compared to Diesel)
    - Lower NOx (as compared to Diesel) with Three-Way Catalyst
  - Vocation specific emission rates
    - Central Business District (CBD) Cycle for Urban Transit Buses
    - Refuse Truck Cycle (RTC) for Refuse Trucks
  - Population estimated based on
    - Bus registry data
    - DMV Registration data

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- Vehicle population from DMV2012 and earlier
  - EMFAC2011 is only using DMV2009 to fore-/back-cast vehicle population
- Regional retention rates
  - Based on 12 years of DMV registration data
- Accrual rate
  - Base mileage accrual from Smog Check reported data
- Statewide Odometer Schedule
  - Based on Smog Check reported data

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EMFAC2014 – *Formulation Changes*   1/4

- EMFAC2011 'Default' was based on MPO data
- EMFAC2014 'Default' model supports conducting analyses that need to be consistent with GHG inventory
  - Fuel based activity model that uses VMT estimates calculated such that the associated fuel use matches historical fuel sales, similar to GHG inventory
- New forecast methods involve socio-econometric modeling of new vehicle sales and VMT growth

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EMFAC2014 – *Formulation* Changes   2/4

- For **Light** Duty Vehicles:
  - New vehicle sales and VMT growth are based on socio-economic indicators:
    - Gas Price
    - Unemployment Rate
    - Disposable Income
    - Non-Farm Jobs
  - Statewide VMT growth is matched to
    - Forecasted gasoline fuel growth for 2013-2017
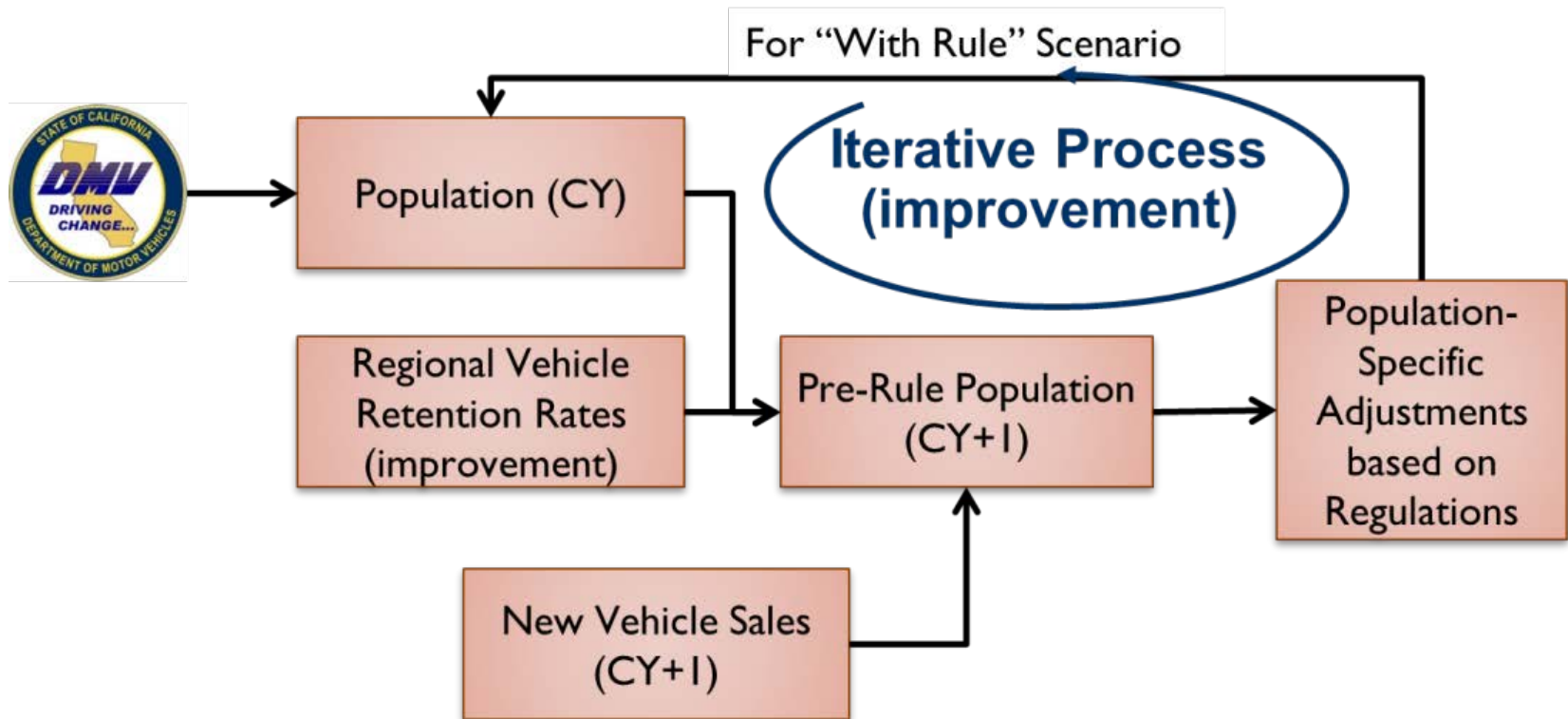   - Human-population growth for 2018-2050

New Light Duty Vehicle Sales

New Sales = f(*Gas Price*, *Unemployment Rate*, *Human Population*)

Fuel Sales = f(*Gas Price*, *Disposable Income*, *Non-Farm Jobs*)
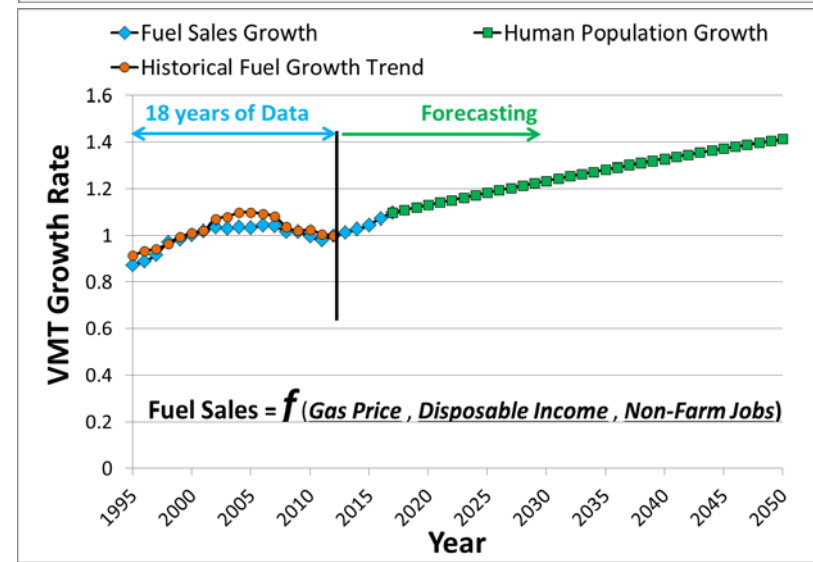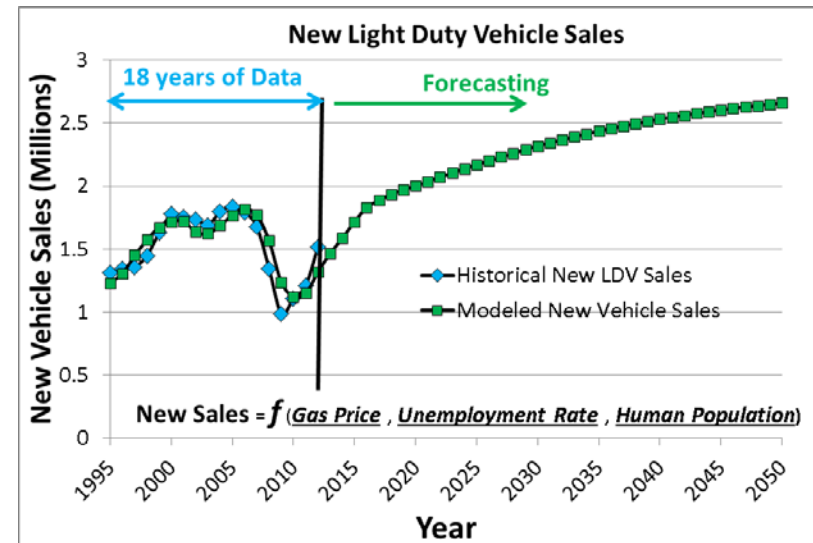
- For **Heavy** Duty Vehicles:
  - New vehicle sales follows similar growth trend as projected in Annual Energy Outlook (AEO) by U.S. Energy Information Administration
    - Distributed to vehicle categories using projected VMT growth by category
    - New vehicle sales in 2005 are used as the starting point for new sales projections

  - Statewide VMT growth is matched to
    - Forecasted diesel fuel growth for 2013-2050
    - OGV activity growth rates for Drayage trucks
   - OFFROAD activity growth rates for Construction trucks

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➢ **T&B Compliance**. Iterative approach for modeling HD population and Truck & Bus Rule compliance

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EMFAC2014 – *Regulations*

- EMFAC has been changed to reflect the current EPA and ARB regulations and standards:
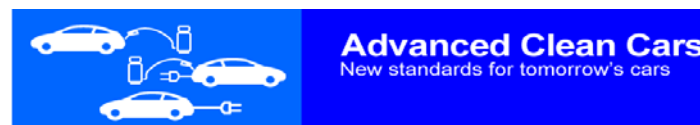
Regulation	EMFAC2011	EMFAC2014
Federal Pavley Standards	No	Yes
Advanced Clean Cars	No	Yes
In-Use heavy Duty Diesel	**2010 Amendment**	**2014 Amendment**
ARB Tractor – Trailer	No	Yes
Phase I Greenhouse Gas	No	Yes

Part III

Project Type Guidance

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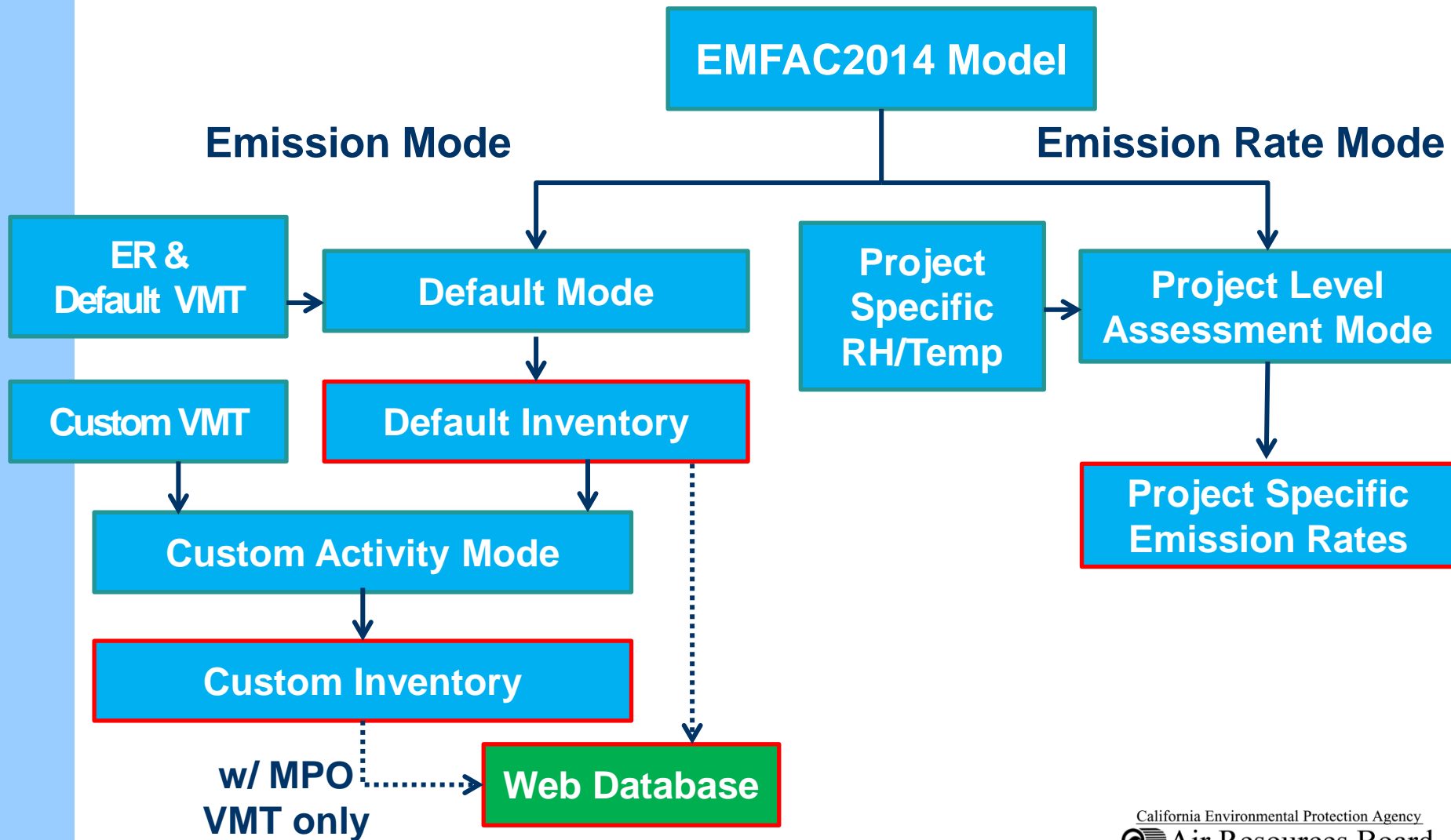
Project Type Guidance 1/3

Analysis	Recommended Tool
GHG emission inventories	GHG inventory**, http://www.arb.ca.gov/cc/ccei.htm
Criteria Pollutant Emissions	EMFAC*, EMFAC Web Database*
State Implementation Plans	EMFAC* with MPO activity
Conformity Analyses	EMFAC* with MPO activity
SB375 Analyses	EMFAC* with MPO activity with SB375
CEQA with localized data	EMFAC* emission rate mode (PL)
Strategic planning with Alternative Fuel/Technology	Vision Tool http://www.arb.ca.gov/planning/vision/vision.htm

* Unless otherwise approved by the project-specific approving agency, the USEPA approved EMFAC version should be used. EMFAC2011 is the currently approved version of EMFAC.
** For GHG emissions, the GHG inventory is the official tool for statewide analyses.

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Project Type Guidance 2/3

EMFAC2014 Model

Emission Mode

Emission Rate Mode

ER & Default VMT → **Default Mode**

Custom VMT

Project Specific RH/Temp → **Project Level Assessment Mode**

Default Inventory

Custom Activity Mode

Custom Inventory

Project Specific Emission Rates

w/ MPO VMT only ┈┈→ **Web Database**

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Project Type Guidance

	Emission Mode		Emission Rate Mode (PL)	Web Database
	Default Activity	**Custom Activity**		
Aggregated Area	N	N	N	Y
Model Year	Y	N	Y	Y
Agg. Veh Class	N	N	Y	N
Temp/RH	Default only	Default only	Users Specific	Default only
Hourly	Y	Y	Y	N
Electric Veh	Y	N	Y	Y
NG Veh	N	N	Y	N
Cat/Non-Cat	Y	In CTF format	N	N
All Pollutants	Y	Y	Y	No CH4, THC, TPM

All provide emissions/emission rates by season, speed, process, daily as well as EMFAC2007&2011 Vehicle Classes

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Supporting Tools

- http://www.arb.ca.gov/msei/categories.htm#onroad_motor_vehicles

  – EMFAC2014 installation package

  – Web Database Tool for emissions and emission rates

  – User's Guide

  – Technical Documentation

  – Project Level Assessment Handbook

  – Comprehensive Table of EMFAC Topics

  – Join MSEI listserv to receive emails

  – Contact us at EMFAC2014@arb.ca.gov

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Part IV

Installation of EMFAC2014

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Installing EMFAC 2014

- System Requirements
- Installation Steps
- Configuration

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System Requirements

- Operating System: Windows 7 or higher
- System type: 64-bit Operating System
- Hard disk space: 50 gigabytes recommended
- Installed memory (RAM): 4 GB
- Not tested with MOVES
  - Possible issues

Installation Steps

- Download/Install MySQL
- Download/Install EMFAC 2014
- Configure EMFAC 2014

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Download/Install MySQL

1. MySQL Community Server:
   http://dev.mysql.com/downloads/mysql/
2. MySQL Installer for Windows
3. Install 64 bit edition, "Server Only"
4. Remember the root password!
5. Elapsed time: ~10 minutes

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EMFAC 2014 Installation

- Download EMFAC2014 from:
  - http://www.arb.ca.gov/msei/categories.htm#emfac2014

- Extract downloaded exe to the folder of your choice
  - Elapsed Time: ~4 minutes

EMFAC2014 Configuration

- Double click "emfac.exe"
- Click "Launch MySQL Configurator"
- Provide MySQL information:
  - Server Name ('localhost' or "127.0.0.1" for PC install)
  - Username ('root' for PC install)
  - Password
- Click test, then save, restart EMFAC2014.
- Click "Import EMFAC Default Database", restart.
- Elapsed Time: ~6 minutes

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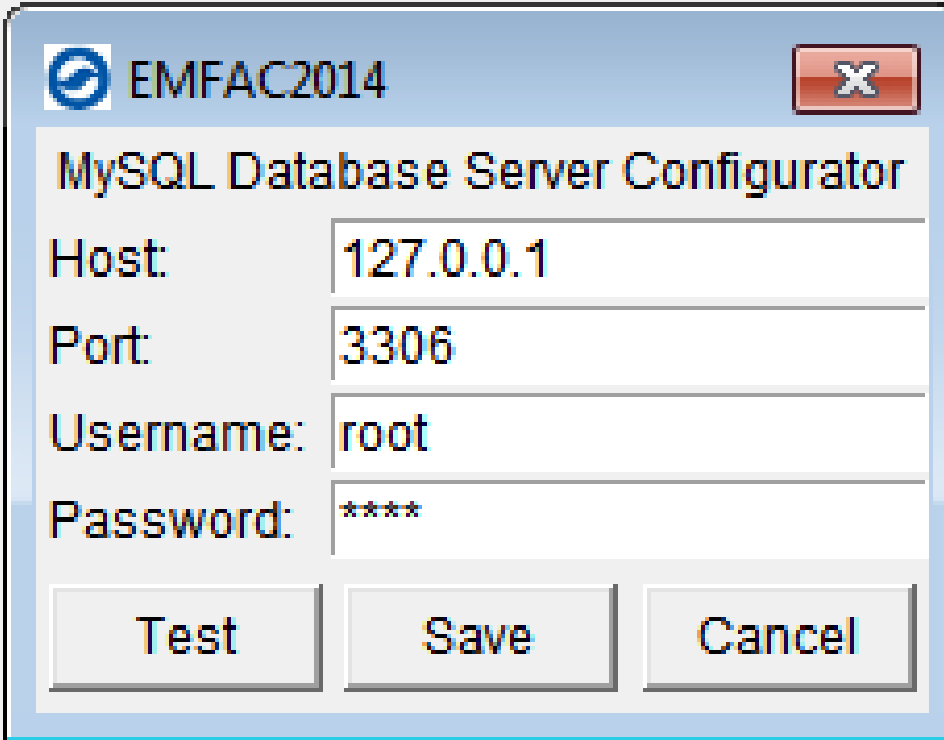Air Resources Board

File   Run   Tools   Help

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Please use the MySQL Configurator to test and configure your database settings.

Launch MySQL Configurator

Please use the MySQL Configurator to test and configure your database settings
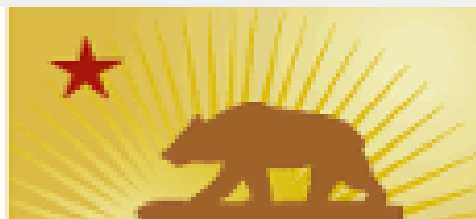
Launch MySQL Configurator

EMFAC2014

MySQL Database Server Configurator

Host:	127.0.0.1
Port:	3306
Username:	root
Password:	****

Test   **Save**   **Cancel**

The default database required to run EMFAC needs to be updated.

Please click the button below to import the default database.

Import EMFAC Default Database

Emissions Mode: Default Activity

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Default Activity Mode

EMFAC2014 Model

Emission Mode

Emission Rate Mode

ER & Default VMT → **Default Mode**

Custom VMT

Default Inventory

Custom Activity Mode

Custom Inventory

w/ MPO VMT only ·····> **Web Database**

Project Specific RH/Temp → **Project Level Assessment Mode**

Project Specific Emission Rates
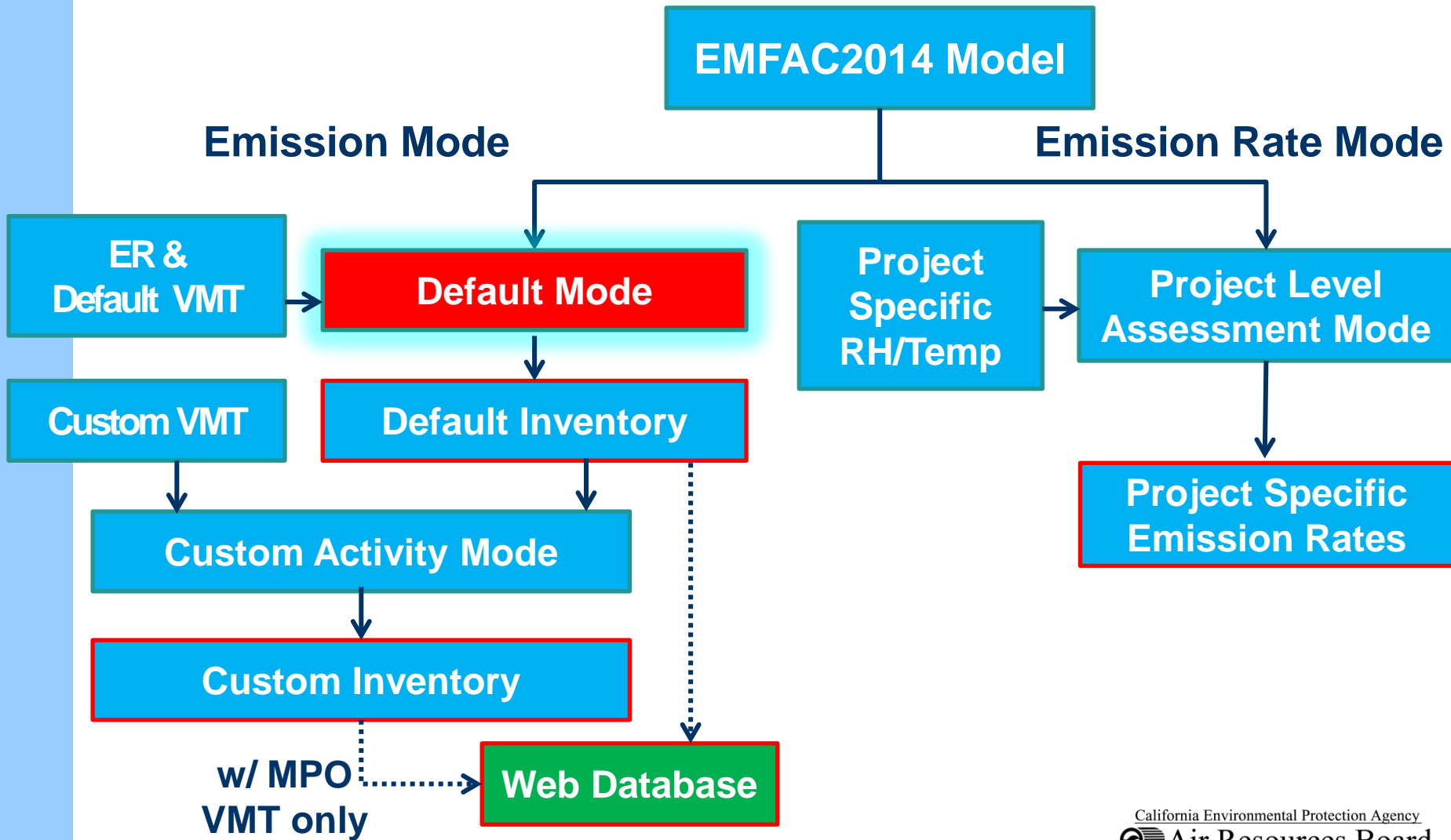
Emissions: Default Activity

- Uses
- Reports: CSV
- Demonstration

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Emissions Mode: Custom Activity

Overview

- Overview of Custom Activity Mode
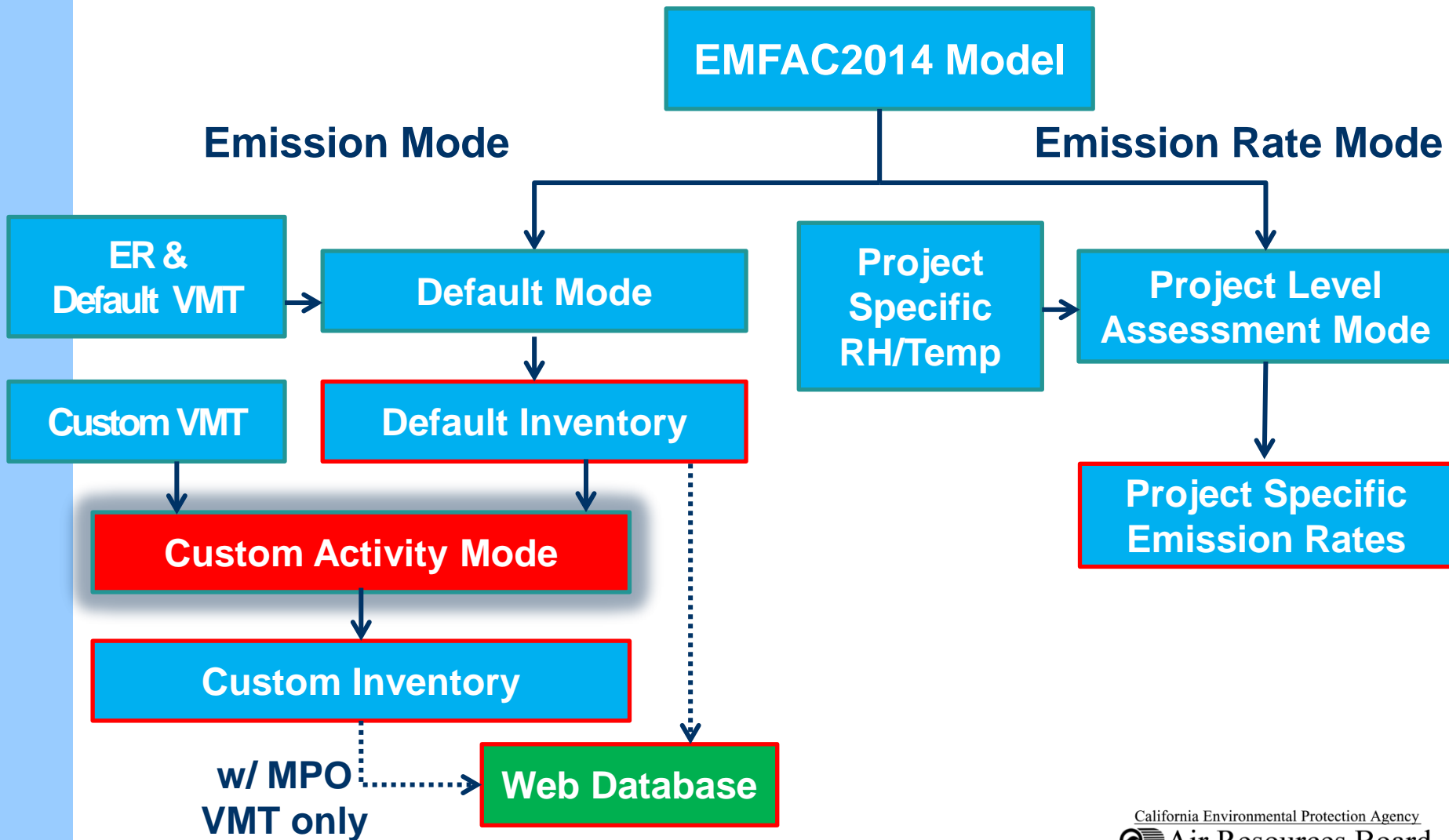- Create custom activity template
- Changing total VMT
- Changing VMT by vehicle class & fuel type
- SB 375 output

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Custom Activity Mode

EMFAC2014 Model

Emission Mode

Emission Rate Mode

ER & Default VMT → Default Mode

Custom VMT

Default Mode → Default Inventory

Project Specific RH/Temp → Project Level Assessment Mode

Custom VMT → **Custom Activity Mode**

Custom Activity Mode → Custom Inventory

Project Level Assessment Mode → Project Specific Emission Rates

Custom Inventory → w/ MPO VMT only ⋯→ **Web Database**

Default Inventory ⋯→ **Web Database**

Overview of Custom Activity

- Allows using latest MPO activity to support SIP planning, conformity & SB 375

- Similar to Scenario Generator ("SG") in EMFAC2011

- VMT Scalar $= \dfrac{\text{Custom VMT}}{\text{Default VMT}}$

- One season/area at a time

- Emissions Report
  - CSV
  - Planning Inventory/SB375
  - CTF

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Create Custom Activity Template

- Custom Activity types
  - Total daily VMT
  - VMT by vehicle class and fuel type
- Outputs default VMT in an excel format
- Default VMT can be replaced with user defined VMT
- Output includes speed fractions by hour of day by vehicle class and fuel
- Used as input to custom activity mode

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Changing Total Daily VMT

- Scenario: Increase total daily VMT by 10%
- Modify custom activity template to reflect new VMT
- Could modify speed fractions if available
- Output includes activity and emissions by area type, calendar year and vehicle class and fuel type

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Changing VMT by Vehicle & Fuel Type

- Scenario: Increase LDV VMT by 5%
- Modify custom activity template to reflect new VMT by vehicle & fuel type
- Could modify speed fractions if available
- Output includes activity and emissions by area type, calendar year and vehicle class and fuel type

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Generate SB 375 Output

- SB 375 output only includes 4 vehicle class (LDA, LDT1, LDT2 & MDV)

- Does not include Pavley I and ACC

- Estimates CO_2 & fuel consumption only

- CO_2 estimates are not ARB's official GHG inventory

- Scenario: Modify total daily VMT

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Supporting Tools

- http://www.arb.ca.gov/msei/categories.htm#onroad_motor_vehicles
  - User's Guide
  - Technical Documentation
    - Chapter 4 – Custom Activity Mode
  - Join MSEI listserv to receive emails
 - Contact us at EMFAC2014@arb.ca.gov

Part VII

Emission Rates Mode: Project Level Assessment

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Project Level Assessment Mode
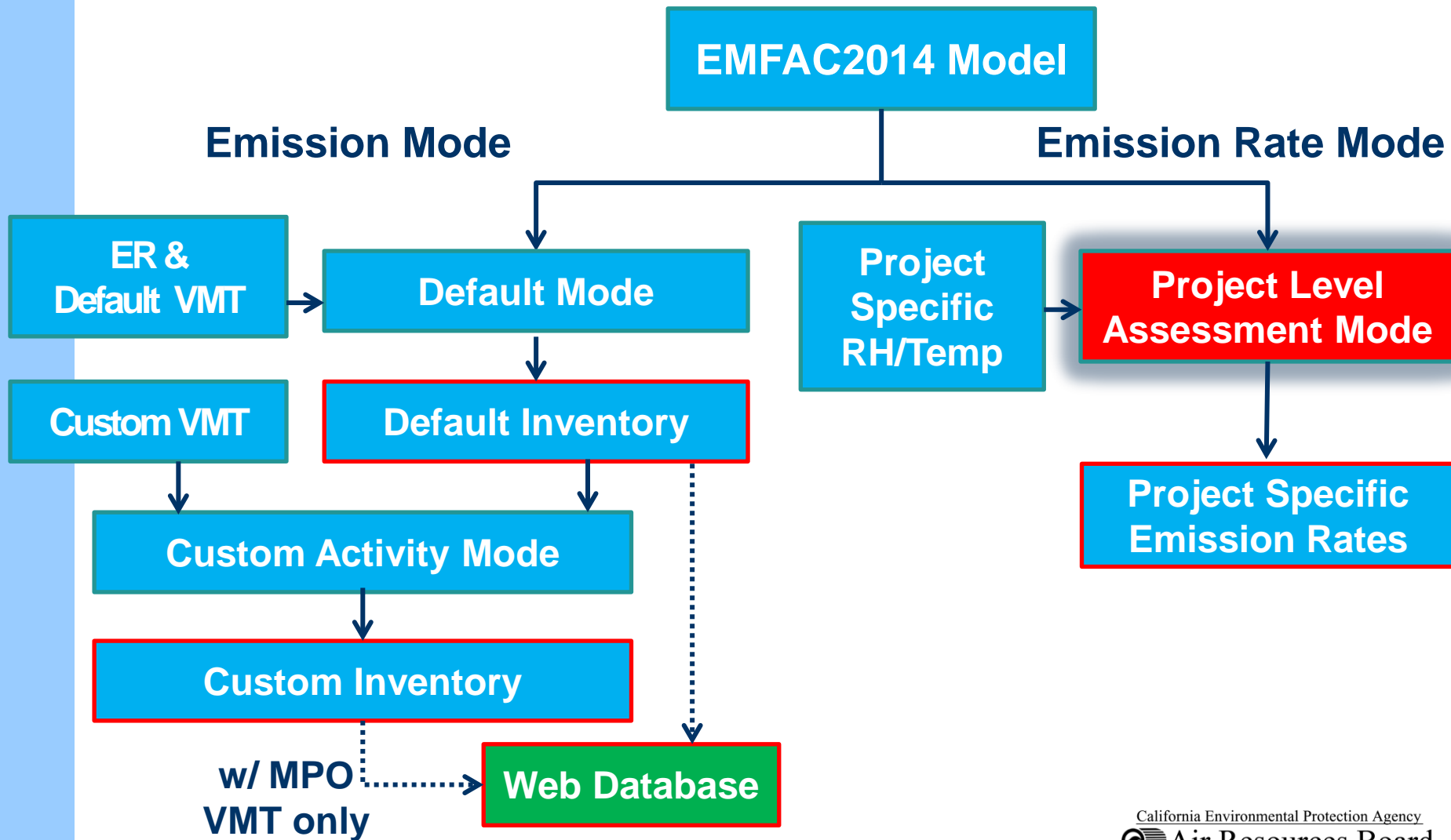
EMFAC2014-PL Design

- User specified conditions:
  - spatial scales and locations
  - season or month
  - vehicle classes, model year
  - fuel type aggregation option
  - temperature and relative humidity
  - link speeds

South Coast Air Basin

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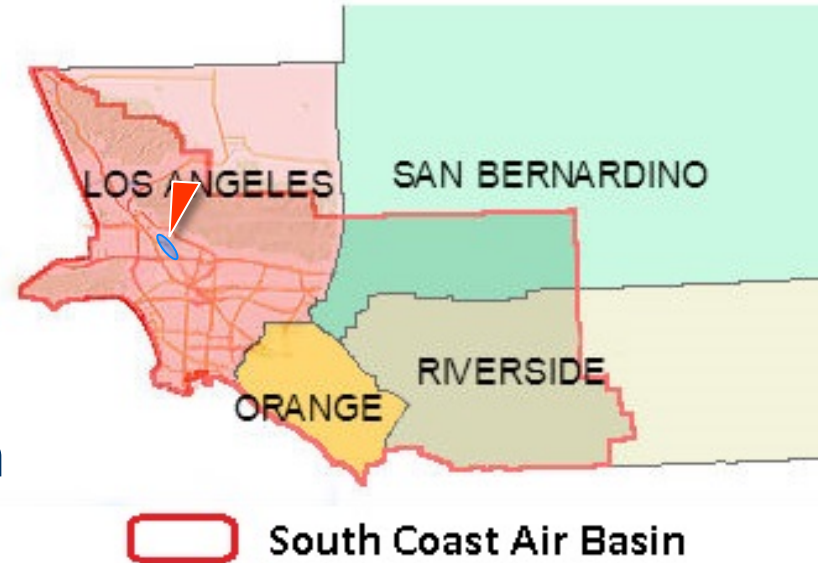
Demo Scenarios

- Scenario 1: Arterial Link with Default Fleet Mix- Running Emissions

- Scenario 2: Inter-Regional Bus Terminal - Diesel Motor Coach – Idle Emissions

- Scenario 3: Urban Bus Terminal - UBUS Idle Emissions

- Scenario 4: Park-n-Ride Parking Lot- Evaporative and Start Emissions

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Emission Process Dependency

Emission Process Code	Emission Process Name	Temperature	Humidity	Speed	Soak time
RUNEX	Running Exhaust	●	●	●	
IDLEX	Idle Exhaust				
STREX	Start Exhaust	●			●
HOTSOAK	Hot Soak Evaporative	●			
RUNLOSS	Running Loss Evaporative	●			
PRESTLOSS	Partial Day Resting Loss Evaporative	●			
MDRESTLOSS	Multi-Day Resting Loss Evaporative	●			
PDIURN	Partial Day Diurnal Evaporative	●			
MDDIURN	Multi-Day Diurnal Evaporative	●			
PMTW	Tire Wear Particulate Matter				
PMBW	Brake Wear Particulate Matter				

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Scenario 1 - Project Details

○ The project is for a lane expansion on an existing arterial

○ Location: Sacramento, CA

○ Analysis year: 2020

○ Area is in nonattainment of the annual PM2.5 NAAQS and the 2006 24-hour PM2.5 NAAQS

○ Assessment performed for four periods of a day: Morning peak, Midday, Evening peak, and Overnight

○ VMT split between Truck and Non-Truck is known

○ Average link speed: 30 mph, same for all periods of a day

○ Meteorology data for the four periods available

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Scenario 2 - Project Details

- This project is a interregional bus terminal where all buses are diesel motor coaches.
- Main process under study at the terminal: idling
- Located in Solano county in San Francisco Bay Area Air Basin
- Analysis year: 2016
- Fleet consists of model year 2008 and 2014
- Population is specified by model year
- Temperature and humidity available, but they do not affect idle emissions.

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Scenario 3 - Project Details

o This project to evaluate the idling emissions from urban buses at a bus terminal.

o Sacramento county, 2016

o Population specified by model year: 2008 and 2014

o Population specified by fuel type

o Temperature and humidity: 70F, 70%

o Use running exhaust at 5mph to approximate idle:

o $\text{Idle } Rate\left(\frac{g}{hr}\right) = RUNEXER\left(\frac{g}{mile}\right) * 2.5mph$

Speed Bin	Speed Value to compute SCF	Definition
5	2.5*	Speed <=5.0
10	7.5	5.0 < Speed <= 10.0
15	...	...

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Scenario 4 - Project Details

o   This project is for a park-n-ride parking lot

o   Located in Sacramento county

o   Analysis year: 2020

o   Vehicle activities including population, number of starts and soak time distributions are collected for fleets defined using EMFAC2007 language: LDA, LDT1, LDT2, MDV and MCY

o   Soak time intervals are 5, 360 and 720 minutes

o   Population by model year unknown

o   Population by fuel type unknown

o   Temperature and relative humidity: (70F, 70%)

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For More Information

- EMFAC2014 User Guide
- EMFAC2014 Technical Documentation
- EMFAC2014 Handbook for Project-level Analyses

  (http://www.arb.ca.gov/msei/categories.htm)
- Contact EMFAC team at EMFAC2014@arb.ca.gov

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Part VII

EMFAC Web Database

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EMFAC Web Database

- The EMFAC Software provides all the components and functionalities that the users will need for different types of emissions analyses.

- On the other hand, the EMFAC Web Database provides a quick and easy way to access commonly used emissions and emission rates data without having to install and run the EMFAC model.

- The Web Database contains **daily** emissions and emission rates data for **all areas, calendar years and seasons** generated from the EMFAC model.

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EMFAC Web Database

- Advantages of Web Database vs. running the model:
  - No need to install anything
  - Faster
  - Provides spatially aggregated data

- Limitations
  - No hourly emissions FOR NOW
  - No Cat/NonCat split
  - Does not accept user activity inputs (but there is plan to include emissions data based on MPO provided activities)
  - Does not provide emission rates by temperature and humidity (which should be obtained by running PL using the model)

EMFAC Web Database

Both EMFAC2011 and EMFAC2014 versions of the Web Database are available now. Unless otherwise approved by the project-specific approving agency, the EPA approved EMFAC version should be used for analyses.

- EMFAC2011:
  - http://www.arb.ca.gov/emfac/2011
  - Currently approved version by USEPA

- EMFAC2014:
  - http://www.arb.ca.gov/emfac/2014
  - Pending USEPA approval as of today

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For Additional Information

- Technical Documentation, User Guide, and PL Handbook at: http://www.arb.ca.gov/msei/categories.htm

- Join MSEI email list at http://www.arb.ca.gov/listserv/listserv_ind.php?listname=msei

- Contact EMFAC team at EMFAC2014@arb.ca.gov

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