

Future Year Projections

- ▶ Overview
 - Inventories and ancillary data
 - Sets of future years: strive for consistency in methods
- ▶ Projection techniques
 - Replace the full inventory or section thereof
 - Have a set of sources that we apply factors to – both activity change and controls
 - Model-based categories/sectors
- ▶ Estimate changes between base and future years
 - Activity changes
 - Rules / technology changes in intervening years
 - Closures
 - Interpolation / extrapolation often difficult

Developing Projections

- ▶ Future year emission inventories are developed in different ways, depending on the sector
 - For all sectors, federal rules that go into effect in the intervening years are considered
 - Changes in sector activity are considered when possible
 - Future EGU emissions are output from IPM
 - Onroad and nonroad mobile source inventories are updated using future year model inputs including VMT growth and fuel changes
 - Stationary sources are also adjusted to account for consent decrees, planned shutdowns, etc.
 - Base year-specific point source fires and biogenics are used for both years

Projections overview: Sectors projected based on NEI emissions

Sector(s)	High-level Description
Agricultural NH3 (ag)	USDA animal population growth estimates, livestock only.
Fugitive dust (afdust)	County-level VMT and population Annual Energy Outlook (AEO)-based projections to unpaved/paved roads.
RWC	2015 Wood heaters New Source Performance Standards (NSPS) with growth and appliance change outs/retirement assumptions.
Class 1&2 CMV + trains (c1c2rail)	OTAQ Locomotive and Marine (RIA-based) rule growth and controls; California data scaled from CARB inventories.
Class 3 CMV (c3marine, othpt*)	ECA-IMO projections. Regional-based GFs + ECA-IMO engine and fuel controls, extending from ports (state), to near-offshore (EEZ) to global; California scaled from CARB.
Oil and Gas (pt_oilgas, np_oilgas)	AEO production, consumption fuel-based growth, some at basin-level. Various NSPS impacts + local information.
Remaining non-EGUs (ptnonipm, nonpt)	AEO production, consumption fuel-based growth. Various NSPS impacts + local information. Numerous additional growth/control/closure information

Projections overview: Sectors not projected from NEI base year emissions

Sector(s)	High-level Description
EGUs (ptipm)	IPM 5.14 w/ 2011 CEMs-based temporalization
Onroad mobile (onroad, onroad_rfl)	MOVES 2014 w/ activity, fuels, I/M, controls, speciation; California magnitude from CARB but temporalized based on SMOKE-MOVES
Nonroad mobile (nonroad)	NMIM/NONROAD projected inventories, except for California data provided by CARB
Canada/Mexico (othar, othpt, othon)	Canada: held constant at 2010 levels Mexico: Future-year inventories projected from 2008 base year inventory
Biogenics & Fires	No projections, same as base year

Future-year Ancillary Data

- ▶ Most ancillary data stays the same in base and future year modeling
- ▶ Meteorology is held constant
- ▶ Spatial surrogates are constant
- ▶ Temporal profiles are constant for most sectors (except for EGUs)
- ▶ Speciation profiles are constant for many sources
 - Updated in future year for mobile sources

Future Year Projections: Summary of significant updates

- ▶ New IPM version 5.14
 - Uses Annual Energy Outlook (AEO) 2014, NEEDS database updated from comments
 - New cross reference with more matches
- ▶ Incorporated data from Federal Register comments & new growth data for many non-EGU industrial sources
- ▶ Onroad now uses MOVES2014, including refueling
 - AEO2014 used for VMT, fuels, etc.
- ▶ Projections for Mexico developed by ERG
- ▶ Nonroad projections same as v1 except for Delaware

Other Significant Non-EGU Projections Updates

- ▶ Upstream mobile source emissions
 - Stationary impacts of mobile rules (e.g. changes to refineries and pipelines due to increase of ethanol blends)
 - Simplified the approach; fewer source categories included
 - OTAQ provided some updated scalars
- ▶ Introduced additional growth for non-EGU industrial sources
 - 2018 docket comments from RPOs and states: impacts most non-EGU source categories beyond oil and gas, including aircraft, RWC, PFCs
 - RPO/regional studies/SIP planning
- ▶ Updated facility/unit closures based on comments and NEI 2012 and 2013 submissions
- ▶ Updated consent decrees/settlements

EGU Projections

- ▶ EGUs are identified in the NEI point inventory by filling in the IPM_YN column of the flat file
 - Populated from a set of alternate IDs stored in EIS
 - Sometimes there are not 1–1 matches between NEI and NEEDS database used by IPM (some manual)
- ▶ IPM reflects impacts of rules in intervening years
- ▶ IPM produces outputs for future years
 - 2016, 2018, 2020, 2025, 2030, 2040, 2050
 - Years not directly produced by IPM are typically mapped to years that are produced
- ▶ IPM 5.14 base case available here:
<http://www.epa.gov/powersectormodeling/>

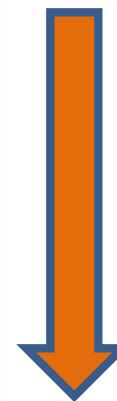
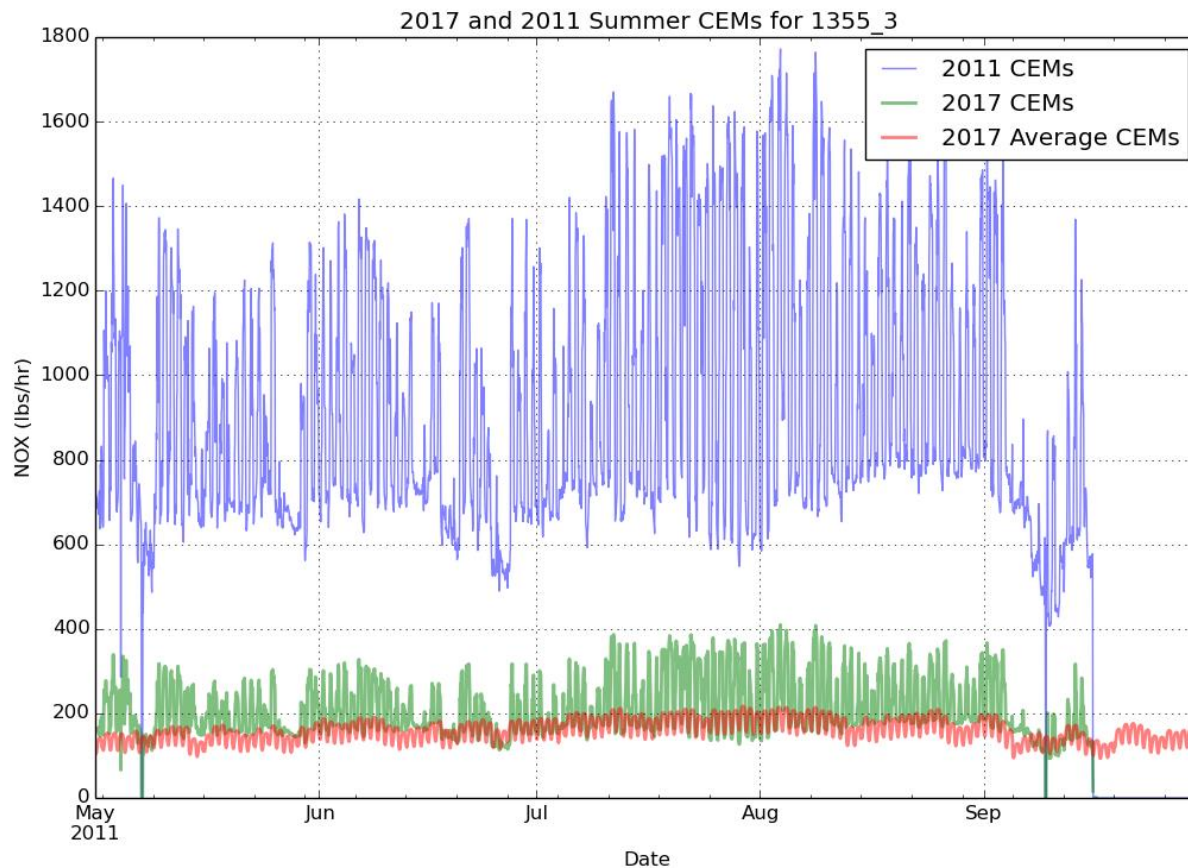
Flat Files Created from IPM Outputs

- ▶ IPM regional, seasonal outputs are converted to a Flat File that can be input to SMOKE in multiple postprocessing steps
 1. For a specific model output year, parse results to unit-level for each season (Pollutants = NO_x, SO₂, Hg, CO₂)
 2. SMOKE-ready Flat file is created from parsed file
 - Cross reference from NEEDS to NEI units is used to assign IDs, locations, stack parameters (was improved with state review)
 - PM emissions are created based on emission factors, fuel, and controls
- ▶ The base year EGU inventory is fully replaced by the flat file inventory output from IPM
 - IPM results are not used in air quality modeling for municipal waste combustors, nuclear, wind, solar

EGU Temporal Allocation for Future Years

- ▶ For sources that exist in both base and future years, allocate seasonal emissions to 2011 hourly temporal pattern by pollutant
 - Compute hourly ratio for each hour of season in base year and multiply that ratio by the seasonal total to get the future year hourly emissions
- ▶ Units not matched to base year units are temporalized using fuel- and pollutant-specific regional average profiles to allocate emissions to month, then day, then hour
 - Method is also used for new units, units with no 2011 emissions, units that change fuels from base to future, and units with large predicted increases in emissions

Example Temporal Plots: base year, unit-specific, regional



Seasonal emissions going down

Questions?

- ▶ Any questions on projections background or EGU projections?

Onroad Projections Overview

- ▶ Main components to projections:
 - Regulatory impacts
 - Fuel changes
 - I/M programs
 - Future year VMT and other activity
 - Age distributions
- ▶ Constant between base year and future year
 - Meteorology
 - Representative counties
 - If change representative counties, will create artificial spatial inconsistencies between base and future years

VMT projections v6.2

- ▶ National projections based on AEO2014
- ▶ Previous platforms used national projection factors (AEO2013) with no geographic variation
- ▶ Key Updates:
 - New SCCs have more fuels/vehicles and need to match against AEO projections
 - Geographic variation in projections

VMT projections variation (1 of 2)

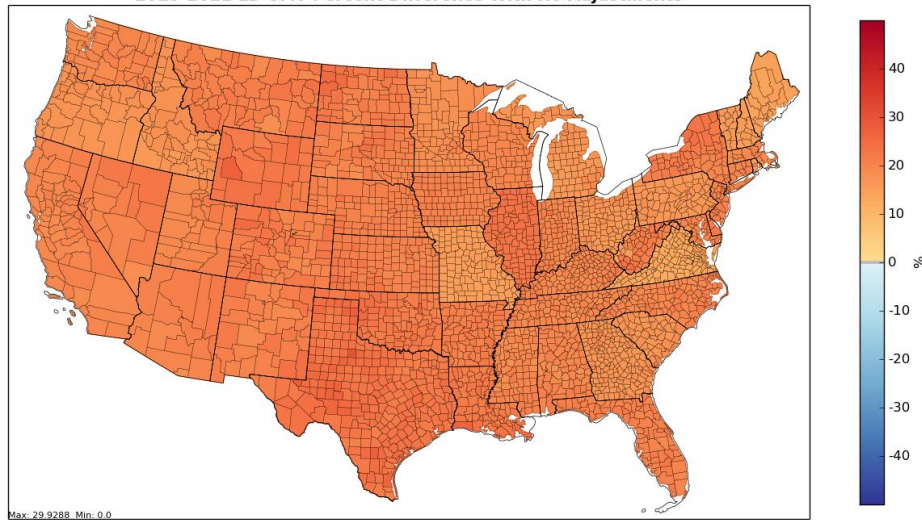
- ▶ Use AEO2014 to get magnitude
- ▶ Adjust light duty (LD) VMT projections geographically based on human population projections
- ▶ Analysis indicated strong correlation b/w population and LD VMT
- ▶ Correlation b/w population and medium and heavy duty (MD/HD) VMT is not as strong
 - Use national projection for these source types

VMT projections variation (2 of 2)

▶ LD VMT projections for 2025

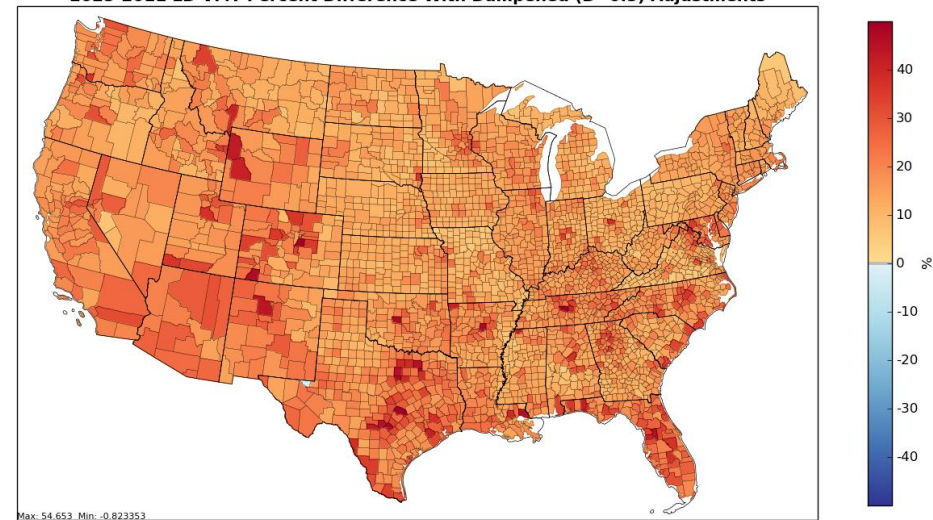
National projection

2025-2011 LD VMT Percent Difference With No Adjustments



County adjustment

2025-2011 LD VMT Percent Difference With Dampened (D=0.5) Adjustments



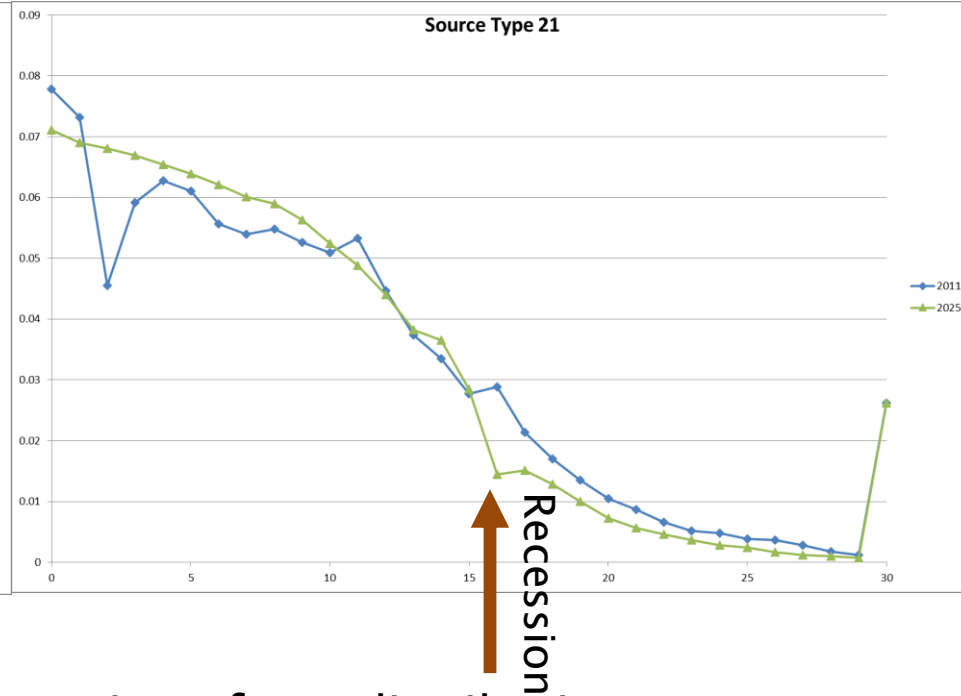
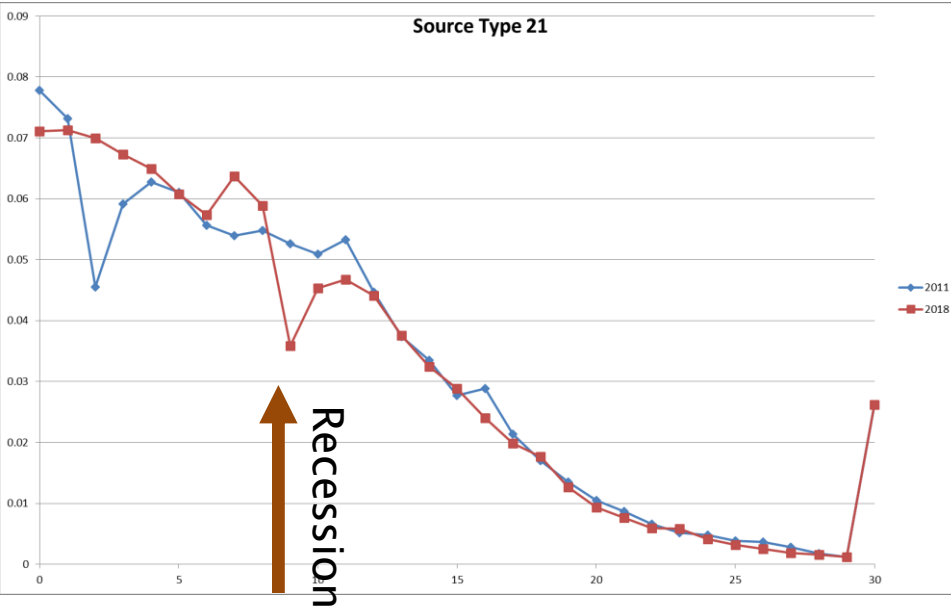
Age distribution

- ▶ Previous platforms (v6.1 and before) have used same age distribution in future years as base year
- ▶ Problem is that this will project the 2008/2009 recession into the wrong years in the future
 - 2025 projection would have a recession in 2022/2023
- ▶ In V6.2 platform, project the age distribution so that recession stays in the 2008/2009 MYs in the future

Projecting Age distribution

2018

2025



- Shift in recession to older section of age distribution to maintain model year impacts
- Dampening of spikes/troughs due to scrappage
- If project far enough into the future, will converge to the same age distribution

Onroad Projection Additions

▶ Speciation

- Changes in model year and fuels impacts not only the emissions but the speciation
- Speciation internal to MOVES2014– makes it possible to consider detailed model year, regulatory class, and fuel information

▶ Hotelling

- Calculate the total hotelling hours from future year combination long-haul restricted VMT
- Split between auxiliary power units (APUs) and extended idling (EXT) changes in future years due to greater penetration of APUs

Nonroad Projections

- ▶ Collect input databases
- ▶ Adjust to future year and appropriate MET/fuels
 - Meteorology is consistent with base year
 - Fuels should be consistent with future year and ideally with onroad
- ▶ Run National Mobile Inventory Model (NMIM)
 - Nonroad is also in MOVES2014
- ▶ Use CARB data for California
- ▶ Delaware minor edit from previous version
- ▶ Change VOC speciation
 - Account for changes in fuels (i.e. shift toward E10)

Questions?

- ▶ Any questions on mobile source projections?

Introducing: NEI non-EGU Point/Nonpoint Projections

The remainder of this section discusses how we project emissions for NEI non-EGU point and nonpoint inventories

Control Strategy Tool

- ▶ Part of the Emissions Modeling Framework (EMF)
- ▶ Used to project most NEI non-EGU point and nonpoint inventories
 - Exceptions include stand-alone future year inventories (e.g., biodiesel and cellulosic plants, new cement kilns)
- ▶ Hierarchy of how “packets” are applied
- ▶ Data sources for projections (AEO, rule information)
- ▶ How we obtain the factors we are using
- ▶ List of packets and their scope
- ▶ State comments

Control Strategy Tool: Packet Types

- ▶ **Plant CLOSURE**
 - Facility, unit, stack and/or process-level
 - Effective date needed
 - July 1 cut-off
- ▶ **PROJECTION**
 - Scalars (e.g., 0.5 = 50% reduction, 2.0=100% increase)
 - Point: facility/sub-facility/NAICS allowed
 - All: geographic, pollutant, source category (SCC)
- ▶ **CONTROL**
 - Similar facility/geographic/SCC/pollutant applicability as PROJECTION packets
 - Percent reductions (0-100), optional effectiveness/penetration
 - Compliance date optional
 - July 1 cut-off

Control Strategy Tool: Hierarchy

- ▶ CLOSURES, PROJECTION, CONTROL packet types applied separately in a run
- ▶ All packets for each type concatenated and QA'd
- ▶ Most-specific applicable (compliance date, application flag) entry supersedes more general entries
- ▶ Consequences for consent decrees, comments, broad control programs
 - Need to be careful how you build packets
 - QA very important to ensure output from strategy matches intended inputs

Control Strategy Tool: Data Sources

- ▶ Energy Information Administration/Annual Energy Outlook
 - Oil &, industrial sources, VMT
- ▶ Data comes from multiple EPA offices
 - Office of Research and Development: animal NH₃
 - Office of Air Quality Planning and Standards: cement & RICE NESHAPs, regional haze, consent decrees, oil & gas, RWC, CISWI
 - Office of Transportation and Air Quality: commercial marine vessels, trains, portable fuel containers (PFCs), upstream emissions
 - Office of Atmospheric Programs: oil & gas
- ▶ Outside agencies
 - State/local/regional contacts: consent decrees, closures, projections for many sources, comments, ICI boilers, fuel sulfur
 - Federal Aviation Administration: aircraft
 - Contractors: projections and controls for industrial sources including oil & gas, RWC
- ▶ Much collaboration to come up with “most-appropriate” data for many source categories
 - Note source categories in multiple bullets above

Control Strategy Tool: Sectors / Complexity

- ▶ Some packets shared over multiple sectors, some packets contain several sources of data/programs
- ▶ Non-EGU point, not oil & gas (ptnonipm):
 - 22 packets, 2 control strategies
- ▶ Oil & gas point (pt_oilgas):
 - 15 packets, 2 control strategies
- ▶ Oil & gas nonpoint (np_oilgas):
 - 4 packets, 2 control strategies
- ▶ Remaining nonpoint (nonpt):
 - 10 packets, 2 control strategies
- ▶ Fugitive dust (afdust), ag NH₃ (ag), RWC, CMV & trains (c1c2rail, c3marine, othpt):
 - 1 packet each sector

Non-EGU Projections: Ag NH₃

- ▶ Animal-specific livestock only (no fertilizer approach)
- ▶ Based on national population estimates from the USDA and Food and Agriculture Policy and Research Institute (FAPRI)
- ▶ Also used historical trends comparing number of animals vs production rates, net impact through 2025:
 - No change (growth) for dairy cows and turkey
 - Very slight decrease beef
 - Increases in pork, broilers, layers and poultry

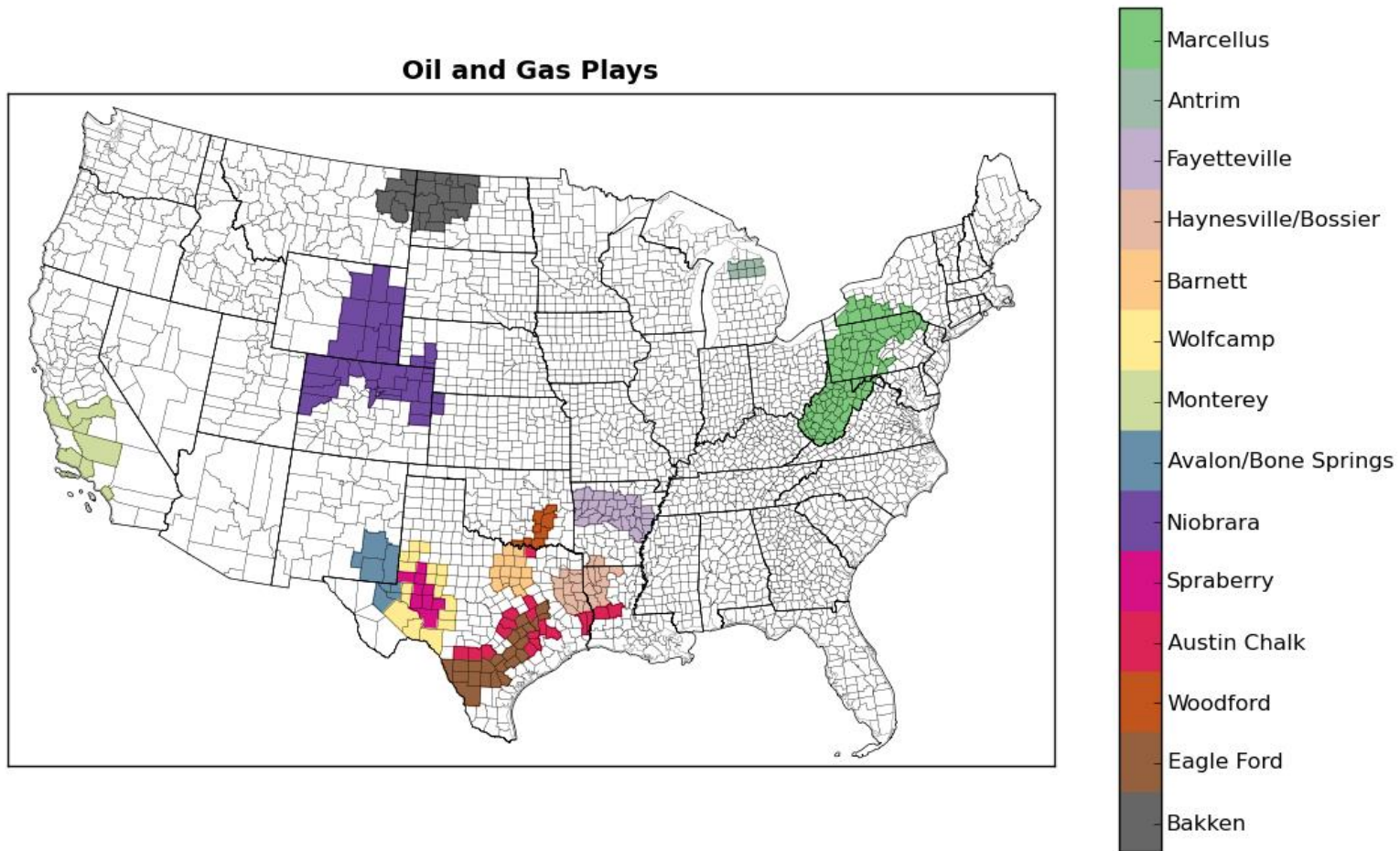
Non-EGU Projections: Fugitive Dust

- Impacts to unpaved and paved roads only
- AEO2014 VMT and population data used
- VMT national
- Population county-level
- Resulting growth factors county-level but 'dampened' based on analysis and collaboration with OTAQ

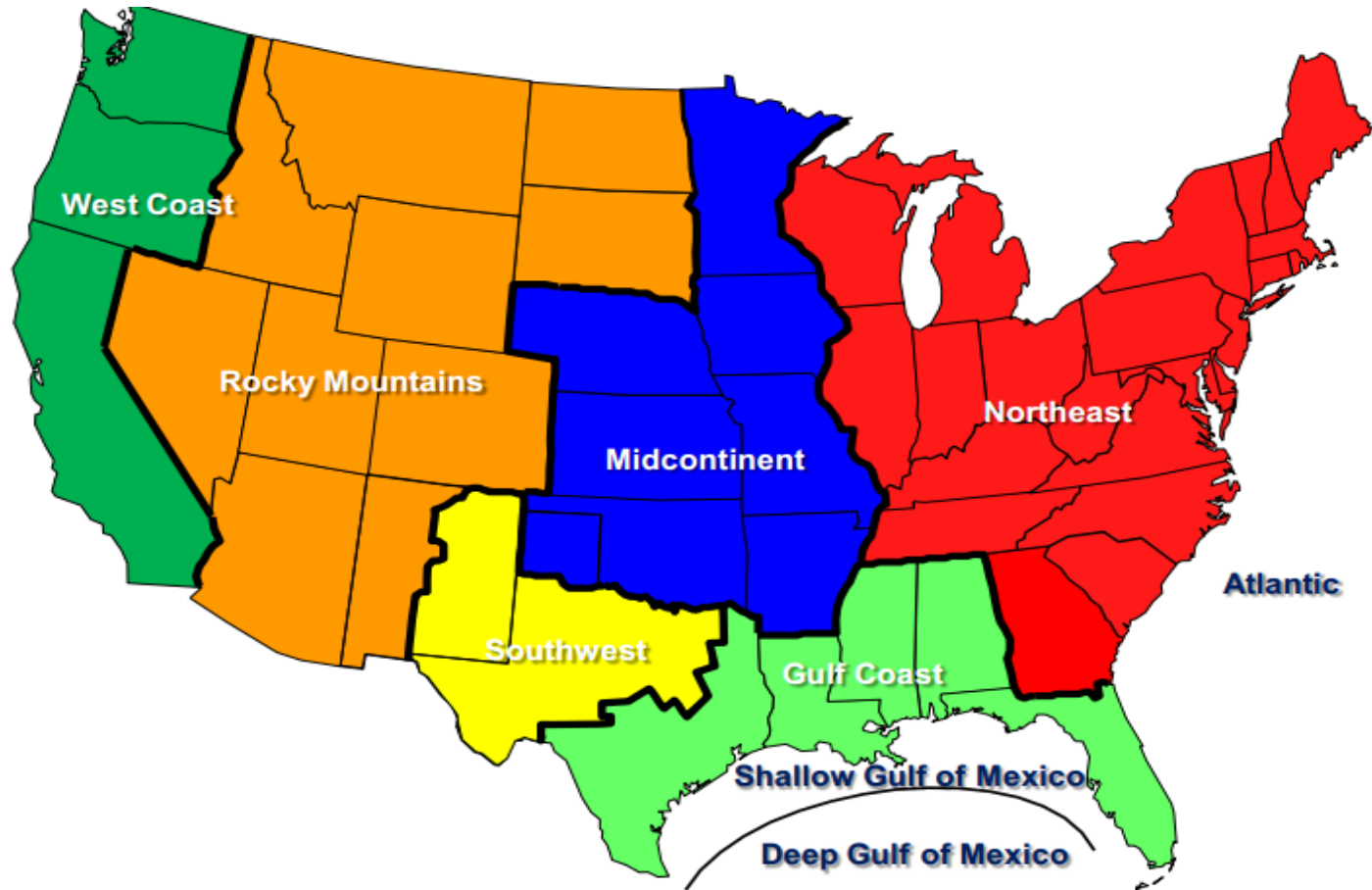
Oil and Gas Projections

- ▶ Updated to 2014 AEO production data to estimate activity in future years
- ▶ Use of more spatially-refined data (O&G plays and “rest-of” Census Division)
- ▶ Use of Natural Gas Lease/Pipelines for consumption-related activities
- ▶ O&G VOC NSPS application
- ▶ New NSPS (NOX) for Process Heaters, IC Engines and Turbines
- ▶ Sector “redesign” for point sources –many other control programs now apply
- ▶ Includes comments from States on 2018 Emissions Modeling Platform (2011v6.0) docket

Oil and Gas Projections: Plays



Oil and Gas Projections: NEMS regions



Source: U.S. Energy Information Administration, Office of Energy Analysis.

Non-EGU Projections: Residential Wood Combustion

- ▶ Updated to include recently promulgated NSPS for ‘wood heaters’: <http://www2.epa.gov/residential-wood-heaters/final-new-source-performance-standards-residential-wood-heaters>
- ▶ Net decrease rather than increase in RWC emissions vs business as usual approach in prior platform
- ▶ Overall method ‘tool’ updated to reflect year-2015 signature and minor corrections
- ▶ Appliance-specific retirement/replacement rates for most sources
- ▶ “No-change” assumption used in western states: WA, OR, CA
- ▶ No integration of burn ban data

Non-EGU Projection Packet: ICI Boiler (MACT)

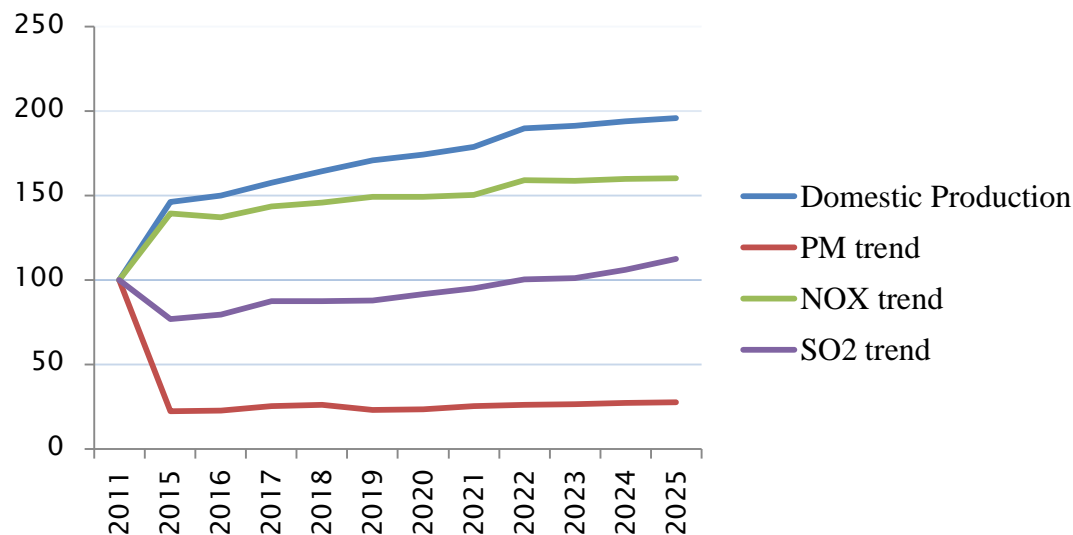
- ▶ New EPA-MARAMA/OTC “hybrid” method:
 - CIBO (Council of Industrial Boiler Owners) data collected and analyzed to craft how boiler emissions changing due to regulations and economics (replacements and conversions)
 - Impacts nonpoint sources
 - Includes NO_x cobenefits
 - Simplified set of fuel-based control assumptions (coal, distillate and residual)
- ▶ Retains list of facility categories subject to control (point sources)
- ▶ Limited state comments/rules (NY, NJ)

Non-EGU Projections: Non-CoST

- ▶ Some future-year inventories do not exist in 2011 NEI
 - New cement kilns
 - Biodiesel and cellulosic ethanol plants
- ▶ “Messy” projections
 - Portable Fuel Containers (PFCs)
 - Combination of OTAQ inventories, state comments and extrapolations/scaling factors

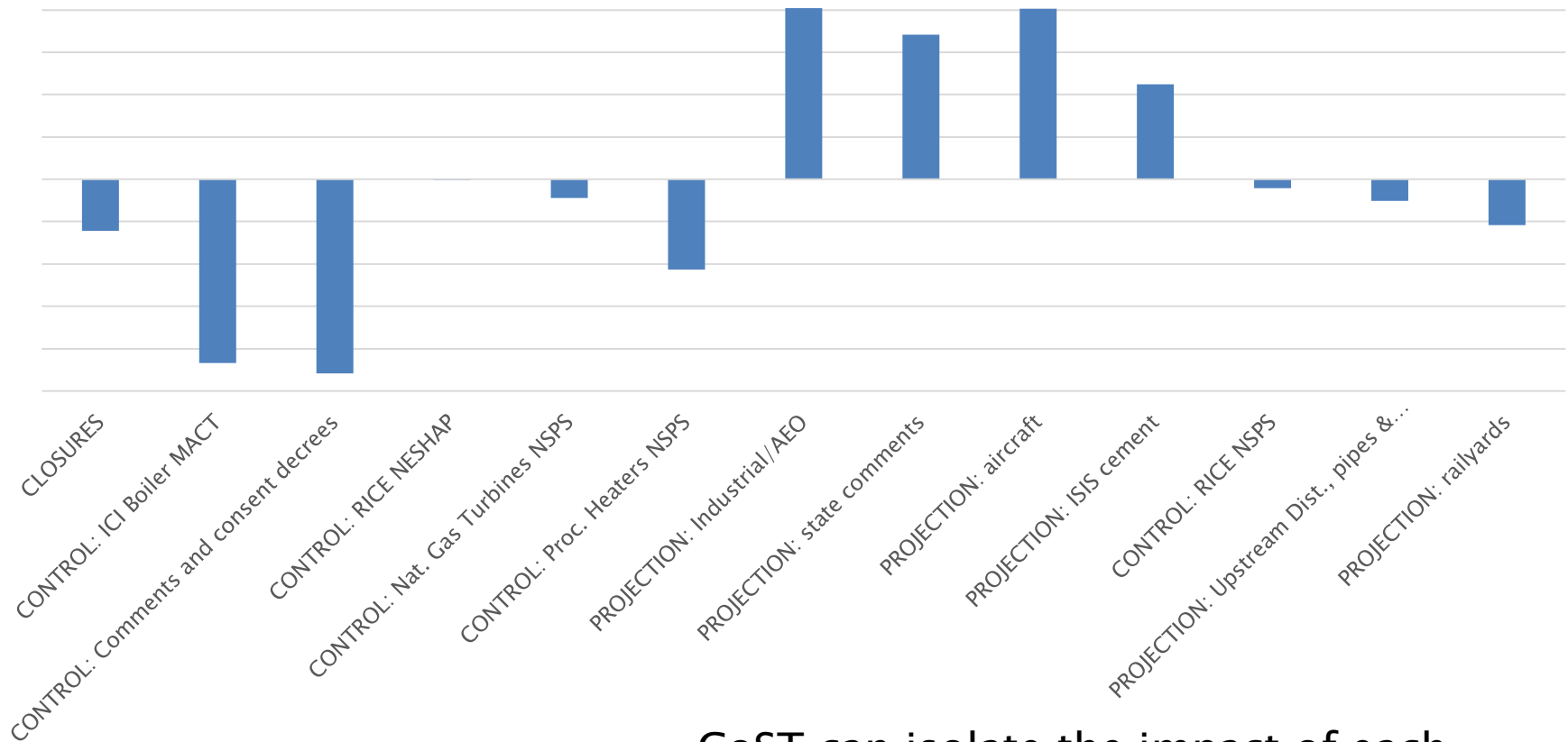
Non-EGU Projections: Cement Manufacturing

- ▶ Blend of Industrial Sector Integrated Solutions (ISIS)–based PROJECTION packet factors and new future–year inventories:
 - Point: permitted kilns
 - Nonpoint: ISIS–generated “generic” kilns
- ▶ Reflects demand growth + NESHAP



Projections High-level impacts: ptnonipm sector NO_x

2025 minus 2011



CoST can isolate the impact of each control/projection packet

Projections: Quality Assurance

- ▶ CoST detailed summaries
- ▶ Numerous template options for Structured Query Language (SQL)–based QA reports
 - By control program
 - Geography
 - Source category
 - Can limit pollutants
 - Option to show “unaffected” sources
- ▶ Can also create custom reports
- ▶ CoST filter/sorts, export to CSV
- ▶ Careful with “Emission Reductions” –based on backing out existing controls in some cases

Non-EGU Projections: Challenges / Limitations

- ▶ Response to prior platforms:
 - Limited to mostly Northeast, Mid-Atlantic and Midwest states
 - Year “2017”: Data mostly year 2018 for some sectors
 - Some data also provided for 2025, some data provided for many years
 - So many different sources of data –need to correctly layer so most-proper controls/projections apply
- ▶ Promulgated vs proposed rules vs SIP inventories
- ▶ Rapidly-changing world! How will 2015 AEO projections look vs 2014-based data?

Limitations / New Directions

- ▶ Projections of changes in land use/population
 - Surrogates
 - New sources
 - VMT
 - Biogenics
 - ag,
 - Etc.
- ▶ Fires
 - Impact on biogenics
 - Projections
- ▶ Temporalization of future year EGUs
- ▶ Big Data sources/opportunities
- ▶ Climate impacts
- ▶ Data warehousing and sharing

Emissions Modeling Platform

Data Availability

- ▶ Data and documentation is available from <http://www.epa.gov/ttn/chief/emch/index.html#2011>
 - TSD from Ozone NAAQS Proposal
 - 2011 NEIv2-based data and scripts are available
 - Speciation profiles available for CB05, CB6, SAPRC07
 - Spatial surrogates available for 4km, 12km, 36km
- ▶ Watch that site for future year emissions...
- ▶ **Any final questions??**